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1. Introduction

Within the electrical industry context Demand Side Management (DSM) can be defined as initiatives that influence consumer patterns of electricity consumption. Key DSM initiatives include, but are not limited to, actions that reduce electricity use (electrical conservation) and/or shift electricity use from peak times to periods when less electricity is required. This document describes the existing opportunity for DSM in the territory, utility-led DSM programs, the partnership between Yukon Energy Corporation and Yukon Electrical Company Limited to implement programs, as well as the current, and planned, collaboration between the Utilities and Yukon government.

As electrical demand and the cost of building additional infrastructure to meet that demand increases, there is renewed interest in investigating DSM in Yukon. After public consultation, Yukon government released the Energy Strategy for Yukon (2009), which commits to investigating incentives for DSM as a priority action related to electricity. Both Yukon Electrical Company Ltd. (Yukon Electrical) and Yukon Energy Corporation (Yukon Energy) have recently received direction (Board Order 2009-2 and 2009-8, 2010-13 respectively) from the Yukon Utilities Board to consult with stakeholders and jointly develop (in consultation with interveners and communities) a DSM Plan.

In the interest of providing stakeholders and the public with opportunities to participate in developing a DSM framework, Yukon Energy, Yukon Electrical, and Yukon government jointly hosted a number of consultative events including public surveys and meetings. Yukon Energy and Yukon Electrical partnered to visit Yukon communities in 2011, and partnered with Yukon government to engage stakeholders in three days of workshops contributing to the results of the Conservation Potential Review Technical Summary (Appendix A.) Stakeholders were engaged early in 2011 at a roundtable hosted by Yukon Energy and still other stakeholders were engaged in one-on-one interviews during the Utility led Market Characterization study (Appendix B1,B2,B3). Yukon Energy held a public Demand Side Management workshop in early 2012 and visited a number of communities in the Fall of 2012. Both a steering committee and working group comprised of Yukon Energy, Yukon Electrical, and Yukon government partners' representatives have been active since 2010. The intention of this plan is to provide a roadmap for continued utility collaboration on DSM in the territory.

1.1. Demand Side Management

There are numerous definitions for Demand Side Management which generally describe a mechanism, or suite of options for reducing, shifting or reallocating electrical demand. These definitions and terms reflect the specific needs and priorities of a jurisdiction or utility and range from "Energy Security" to "Conservation and Demand Side Management". The most prevalent distinction is between Supply Side Management or Internal Demand Side Management and Demand Side Management. Internal DSM includes measures to reduce the costs of production and transmission of electricity. Demand Side Management focuses on the end user of electricity and is intended to affect consumer behaviour through incentives or disincentives for electricity usage.

In the *Energy Strategy for Yukon*, Yukon government uses the term "Demand Management" which is broadly defined as "initiatives that influence patterns of energy consumption, including actions to shift energy use from peak times to periods when less energy is required" (*Energy Strategy for Yukon*; www.energy.gov.yk.ca/energy_strategy.html; p. 27).

The two Utilities defined DSM as a term “to describe the options available to electric Utilities to alter the volume and pattern of electricity end-use, so as to improve or increase the efficiency of electricity production and system performance” The intent of DSM was, from the Utilities’ perspectives to implement programs or rate structures that influenced electricity consumption patterns by reducing and/or shifting loads. In the most recent YEC Resource Plan (2011), resource options are listed in order of expected performance in the stakeholder-determined categories or reliability, affordability, flexibility, and environmental responsibility (Overview of 20 Year Resource Plan: 2011-2030; www.yukonenergy.ca/about/business/resourceplans/ Table 4.1; p. 14). Conservation and Efficiency (DSM/SSE) is listed as one of the top three resource options highlighted for its relatively low cost and high degree of environmental responsibility. SSE (supply side enhancements) also known as Internal DSM increases generation efficiency and decreases line losses.

1.2. Current Electrical Demand in Yukon

In 2011, Yukon Energy, Yukon Electrical, and Yukon government collaborated to form the DSM Steering Committee and Working Group. The shared goal, reflected in the Yukon Demand Side Management Guiding Document (Appendix C), was to work together for sustainable and secure electricity in the Yukon in an economically and socially responsible manner. As an early step in their work, the DSM Working Group (DSMWG) engaged the consulting firm ICF Marbek to complete the Yukon’s first Conservation Potential Review (CPR 2011, Appendix G1, G2, G3, G4, G5). A technical summary is provided in Appendix A. The team worked with Yukoners to develop a reference case of electrical use in the territory and design a peak load profile, using 2010 as the base year. This work culminated in the creation of a forecast for electrical consumption with and without conservation measures, at five year intervals out to 2030. The CPR examined the residential, commercial and institutional sectors (these last two are discussed together in the report as the “commercial sector”), but not the large industrial consumers (mines). Being that the industrial sector includes so few customers, it was determined that each would be dealt with on a one-one basis. Please see section 5.11 for more information.

1.2.1. Residential Sector

The CPR shows that in 2010, Yukon’s residential sector consumed about 146,000MWh of electricity (Exhibit 7; p. 22 Appendix G1). Domestic hot water and space heating each accounted for about 19 percent of total residential electricity use. These were followed by spa heaters and pumps with about nine percent, indoor lighting with eight percent, and computers (with their peripherals) and clothes dryers with about seven percent each. Refrigerators accounted for six percent, followed by cooking, ventilation/circulation, and freezers with four percent each. Other end uses accounted for three percent or less of the total. Single detached dwellings accounted for the largest share (71 percent) of the residential sector electricity use (Exhibit 7; p.22; Appendix G1).

1.2.2. Commercial Sector

Also in 2010, Yukon’s commercial sector consumed about 166,000MWh of electricity (Exhibit 10; p. 21; Appendix G3). Lighting was the largest commercial sector end use, accounting for approximately 37 percent of the total. Indoor lighting, which consists of general, architectural and high-bay lighting, accounted for approximately 34 percent, while outdoor lighting accounted for the remaining three percent. Heating, ventilation and air conditioning (HVAC) end uses (space heating, space cooling and HVAC fans & pumps) account for 22 percent of electricity use. Cooking equipment, domestic water heating and a number of smaller end uses accounted for the remaining commercial sector electricity use. Non-building loads (for example traffic

lights) accounted for 13 percent of commercial sector electricity consumption. Other “general service buildings”, for example cell towers, or those buildings in the territory which do not have comparable counterparts, accounted for the largest share of electricity use within the building sub sectors (18 percent), followed by office buildings (14 percent), and education buildings, warehouse/wholesale and non-food retail at nine percent each (Exhibit 10; p. 21; Appendix G3).

1.3. Projected Electrical Demand in Yukon

1.3.1. Residential Sector

The CPR shows that in the absence of new DSM initiatives, electricity consumption in the residential sector will grow from about 146,000MWh/yr in 2010 to 232,000MWh/yr by 2030, an increase of about 59 percent (Exhibit 18; p. 36; Appendix G1). This is higher than the forecast set out in YEC’s 20-Year Resource Plan (2011), largely because projections of construction of electrically heated residential dwellings have been revised since the publication of that forecast.

Space heating is expected to rise to 24 percent of electricity consumption, while domestic hot water heating is expected to fall to 13 percent. These will be followed by computers (and their peripherals) at 10 percent, small appliances also at 10 percent, clothes dryers at six percent, home entertainment electronics and indoor lighting at five percent each, and refrigerators at four percent. Other end uses each account for three percent or less of the total. Single detached dwellings are expected to account for a somewhat smaller share in 2030 than 2010 at 65 percent while the biggest increase is expected to be in apartment buildings, because of their higher rate of construction and because so many of them are expected to be electrically heated. Over the study period, they are expected to rise from approximately nine percent to 17 percent of electricity consumption (p. 34-35; Appendix G1).

The CPR shows that DSM measures could provide between 22,000 and 37,000MWh/yr of electricity savings by 2030 (Exhibit 45; p.83; Appendix G1). The most significant opportunities described are ones that address space heating. Significant savings were also described for domestic hot water systems, clothes dryers, standby load in household electronics and 13 other end uses. These electrical savings could provide peak load savings of approximately 6.4 to 10.5MW during Yukon’s annual system peak hour by 2030 (Exhibit 59; p. 106; Appendix G1).

1.3.2. Commercial Sector

For the commercial sector, the CPR shows that in the absence of new DSM initiatives, electricity consumption will grow from about 166,000MWh/yr in 2010 to 284,000MWh/yr in 2030, which is an increase of about 71 percent.

The growth in the commercial sector’s electricity consumption is expected to be driven in large part by increases in space heating electricity consumption, which is projected to grow 179 percent between 2010 and 2030. This growth is expected to be caused by a large number of new electrically heated buildings being introduced to the building stock. The move toward electric space heating in new buildings is predicted to cause a 211 percent increase in electricity consumption for water heating because owners of electrically heated buildings rarely invest in fossil fuel infrastructure for water heating only. In terms of absolute contribution, space heating is expected to account for the largest portion of overall load growth (nearly 39,000MWh, or approximately one-third of total

commercial sector load growth). This is followed by general lighting (10 percent), HVAC fans and pumps (eight percent), refrigeration (eight percent) and computer equipment (seven percent) (p. 37; Appendix G3).

The CPR shows that DSM measures could provide between 44,000 (Exhibit 58; p. 99; Commercial Sector: CPR, 2011) and 60,000MWh/yr (Exhibit 52; p. 95; Appendix G3) of electricity savings by 2030. The most significant opportunities described are ones that address indoor lighting and space heating. Significant savings were also described for refrigeration equipment, computer equipment and HVAC fans and pumps. These savings could provide peak load reductions of approximately 8.5 to 11.9MW during Yukon's annual system peak hour by 2030 (p. 101; Appendix G3).

2. Scope

This document refers to DSM planning conducted by Yukon Energy and Yukon Electrical toward the collaborative efficiency/conservation target as described in Section 3. A high level description of the existing opportunities related to DSM will be outlined alongside an overview of the utility programs planned for the duration of the five year plan. As part of the DSM-WG, Yukon government has collaborated in the planning of utility programs to ensure the greatest breadth of impact on territory wide DSM. An example of Yukon government programs (2011/2012) are outlined in Appendix D.

The majority of this document is dedicated to an overview of proposed utility DSM programs. This includes a brief description of each of the residential and general service programs and measures of success. Yukon Energy and Yukon Electrical have worked closely to determine the best delivery option for each program based on market characterization research (Appendix B) and the distinct mandates of each utility as outlined in the roles and responsibilities section. Further information regarding program details can be found in Appendix E.

3. Commitments to DSM and Energy Efficiency

Based on full implementation of the five year DSM plan, the Utilities commit to an electricity conservation target of 8.5GWh of sustained savings by year five. This target recognizes, and acts in compliment to, the Yukon government's commitment in the Energy Strategy to increase territory wide efficiency by 20 percent by 2020.

4. Roles and Responsibilities

4.1. Yukon Energy Corporation (YEC)

Through ongoing consultation, with the Yukon public, stakeholders and interveners, it has been made clear that DSM should be among Yukon Energy's top choices in providing for the growing electricity demands of the territory. In response, Yukon Energy has included DSM as an integral component of its 20 year Resource Plan: 2011 to 2030.

In 2011, Yukon Energy opened its Energy Conservation department and dedicated staff time to testing technology, working with large industrial, commercial, and institutional customers, providing public education, conducting research, and coordinating a Yukon wide DSM plan with Yukon government and Yukon Electrical.

Moving forward, Yukon Energy will lead by example through its Internal Demand Side Management program and will work with its large industrial customers on a one-on-one basis to increase understanding and uptake of energy efficient equipment and best practices as defined in Section 5.10.

Yukon Energy will partner with Yukon Electrical Company Ltd. to deliver residential and commercial programs through the joint brand inCharge as defined in Section 6.1 provided that they meet the economic thresholds described in Appendix F and do not contradict Yukon Energy's mandate or guiding principles. Yukon Energy will act as the project manager for all inCharge programs and will lead in the areas of program technical expertise, technical education, evaluation, measurement and verification, and other areas as determined by the Joint Utility working group and steering committee.

Yukon Energy commits to the priorities of the Yukon Demand Side Management Guiding Document (Appendix F) and will continue to work collaboratively with Yukon Electrical and Yukon government to achieve the Yukon wide DSM target through programs, education, and evaluation.

4.2. Yukon Electrical Company Limited (YECL)

Yukon Electrical Company Limited will partner with Yukon Energy to deliver residential and commercial programs through the joint brand inCharge as defined in Section 6.1 provided that they meet the economic thresholds described in Appendix F and do not contradict Yukon Electrical's mandate or business principles. Yukon Electrical will lead in the area of inCharge customer outreach and engagement regardless of customer class and service area. Yukon Electrical will also work with large industrial customers on a one-on-one basis and in other areas as determined by the Joint Utility working group and steering committee.

Yukon Electrical will continue to collaborate with Yukon Energy and Yukon government and commits to the priorities of the Yukon Demand Side Management Guiding Document (Appendix C) within this context, Yukon Electrical will develop and implement projects and programs which meet the economic thresholds of the four cost-effectiveness tests (described in Appendix F), as well as Yukon Electrical's mandate.

4.3. Yukon government

In the Energy Strategy for Yukon, Yukon government committed to developing policies that will support energy efficiency and conservation. The strategy set a target to increase territory-wide efficiency by 20 percent by 2020 including a prioritization of reduced energy consumption in Yukon buildings and government operations (Energy Strategy; www.energy.gov.yk.ca/energy_strategy.html; p. 3).

In its Climate Change Action Plan (2009), Yukon government commits to a 20 percent reduction of government greenhouse gas emissions by 2015 and carbon neutral government operations by 2020. The Yukon government's Climate Change Secretariat maintains a strong focus on minimizing and tracking greenhouse gas emission in the Yukon.

The Yukon government will build on its current programming as listed in Appendix D, and continue to collaborate with the Utilities to enable a coordinated approach to DSM programming in the Yukon.

In its own operations, government will build on commitments in the Energy Strategy for Yukon and the Climate Change Action Plan to improve and expand on energy conservation initiatives.

4.4. Yukon Utilities Board (YUB)

The YUB will review and make recommendations to the Minister of Justice regarding DSM priorities. It will provide the Utilities with Board Orders regarding DSM and review the prudence of utility costs and benefits to ratepayers regarding implementation of DSM projects. The YUB will approve all prudent costs into electrical rates.

4.5. Other Governments and Organizations

Recognizing the value of partnership in Yukon, the Utilities endeavour to collaborate with communities of practice, non-profit and charitable organizations, chamber organizations, municipal and First Nation governments, and business as appropriate to each project and program.

Notably, data collected to inform the Conservation Potential Review (2011), does not differentiate between municipal, territorial, or federal government electricity use. Furthermore, information regarding First Nation government electricity use cannot be separated from the general service rate class. This limitation is relevant to evaluation, measurement, and verification activities as there would be restrictions on the ability of the Utilities to differentiate between levels of government in the instance that one was permitted to engage in Utility led programming and another was excluded

4.6. DSM Working Group

The Utilities and Yukon government have met frequently since 2010 to discuss ongoing efforts and plan future work related to electricity conservation in Yukon. Through the DSM-WG, Yukon Energy, Yukon Electrical, and Yukon government partnered to complete the Conservation Potential Review (Appendix A) as well as a number of collaborative projects such as the 2011 LED streetlight pilots. The collaborative efforts of the DSM-WG have resulted in the completion of this document and a five year DSM plan for the Utilities which is complimentary to activities currently in progress in the territory and which maximizes the benefit and reach of electricity conservation.

4.7. DSM Steering Committee

The DSM steering committee has met regularly to discuss DSM at the senior management level. In future, the steering committee will meet as necessary to discuss Yukon wide targets and DSM related policy issues such as IPP and net-metering.

4.8. Joint Utility DSM Working Group

Yukon Energy and Yukon Electrical as the Joint Utility DSM Working Group commits to the following:

Yukon Energy and Yukon Electrical will collaborate to deliver electricity conservation education and programming to the general service and residential customers regardless of service area. The working group will jointly agree to develop: a program delivery process, electricity conservation public messaging, youth education programming, stakeholder consultation, evaluation, measurement, and verification of programs.

Yukon Energy and Yukon Electrical will share all DSM related costs as defined in Section 6.2

4.9. Joint Utility DSM Management Committee

Yukon Energy and Yukon Electrical as the Joint Utility DSM Management Committee agree to appoint one member from each of Yukon Energy and Yukon Electrical's senior management teams to meet quarterly. The management committee will act as a venue for dispute resolution. During quarterly meetings, the committee will also approve budgets, review progress, and discuss regulatory concerns.

5. Yukon Utility Five Year Demand Side Management Plan

DSM is a portfolio best managed on a continuous basis with multiple opportunities for evaluation and improvement. In order to reduce administrative costs the utility DSM plan has been spread out over a five year period which includes intervals for tiered implementation, project and program evaluation, and data collection. Further information regarding the evaluation, measurement, and verification of DSM will be made available in the EM&V plan (2013).

5.1. Priority Opportunities

The first task in the planning process was to determine which of the several hundred technologies and measures analyzed in the Yukon CPR 2011 should provide the initial program focus. As a starting point the extensive listing of individual measures and technologies contained in the CPR results were screened using a seven step process, as outlined below in Exhibit 1.



Exhibit 1: Priority Opportunities Screening Process

Step 1: The Economic Potential and Achievable Potential results for the residential and commercial sectors were sorted on the basis of the following criteria:

Measures providing the largest electricity savings potential by 2015 and by 2020

Measures providing electricity savings at the lowest levelized cost

Measures providing electricity savings with the shortest customer payback

Step 2: Based on the results of Step 1, individual measures were assigned priority, with highest priority assigned to those measures that provided the largest savings potential in the period at the lowest levelized cost of electricity under the total resource cost test (see Appendix F).

Step 3: Priority measures from Step 2 were grouped into “opportunity areas” e.g., multiple individual commercial lighting measures were combined into a single aggregate “commercial lighting” opportunity. As applicable, complementary measures with smaller savings potential and/or higher levelized costs of electricity were added to the applicable opportunity area. The composition of the package of measures contained in the selected opportunity areas also considered factors such as: commonality of market delivery channels, information flows, typical purchase decision making processes etc.

Step 4: The qualitative notes from the CPR achievable potential workshops were reviewed to determine if participants had noted any compelling technology or market considerations, either positive or negative, that would potentially affect the priorities established in Step 3. Customer payback periods, as generated in Step 1, were also considered at this time. The assigned priority for each “opportunity area” was adjusted, as applicable.

Step 5: A brief scan of DSM program experience in other jurisdictions was conducted with the objective of identifying potential program delivery experience that would affect the priorities established in Step 3. The assigned priority for each “opportunity area” was adjusted, as applicable.

Step 6: The estimated upper and lower achievable potential electricity savings for the resulting combined residential and commercial sector opportunity areas was calculated, together with an approximate weighted average CCE for each opportunity area. The results were compared with the notional 8.5GWh/year savings target.

Step 7: A select number of opportunity areas were recommended for this initial set of DSM programs.

Exhibit 2: Priority Opportunities

Residential

- Appliances and lighting, including CFL and LEDs
- Relatively low-cost, easy-to-install measures including: low flow showerheads and pipe insulation, programmable thermostats
- Technologies providing significant potential savings but requiring further performance proofing in Yukon conditions including: block heater timers, cold climate heat pumps
- New home construction

General Service (Commercial)

- Lighting including: LED, high performance T8, pulse start MH, high output T5, etc
- Building optimization – operations and HVAC
- Refrigeration and computer equipment

5.2. Market Characterization

The priority opportunities identified in Exhibit 2 were bundled into potential program elements and each was subjected to further detailed market research. The detailed market research provided the program design team with a comprehensive understanding of the key factors influencing market penetration of the electricity efficiency technologies and measures which, as outlined in further detail in later sections of this report, informed the design of the specific programs and activities.

The detailed market research employed a variety of data collection methods and involved a broad range of Yukon personnel involved in the supply, service, purchase and use of electricity efficiency technologies and measures. The research focused on developing clarity around four key areas, namely:

Market Barriers:	· Are there financial, informational, technical, etc., constraints that prohibit or restrict customer use of the electricity efficiency technologies and measures?
Market Structure:	· How do the electricity efficiency products and services get to the customer? · What is the policy & regulatory context? · Are there market drivers such building codes or certifications?
Actors:	· Who are the providers of the products, installation and services? · Where are decisions made and who are the key decision makers? · What are the key decision criteria?
Baseline Conditions:	· What is the current practice regarding sales of electricity efficiency models? · What are the trends?

The market research results are summarized in Sections 3 & 4 of Appendix E.

5.3. Program Design

The knowledge gained from the above market research provided key design inputs into the programs presented in the following sections of this report. For example, the understanding of market barriers is critical to selection of appropriate activities or program offerings; similarly, a thorough knowledge of the market structure and major actors within the supply chain provides insight into potential partners and marketing strategies that will be most effective. Finally, the collection of data on baseline conditions provides important inputs to the cost effectiveness testing that is critical to the program design process, and to the eventual program evaluation requirements.

Program design is developed with the constraint of ensuring that the electricity savings are achieved in a cost-effective manner and with minimum impact on ratepayers and electricity rates. Program design and the determination of program cost effectiveness is an iterative process. Differing levels of program expenditures on incentives as well as program promotion and administration costs affect program participation rates and electricity savings. Increased program expenditures increase participation rates but typically at diminishing rates of cost effectiveness.

The cost effectiveness results presented are consistent with industry best practice and are based on the methods outlined in the California Standard Practice Manual. The four standard tests, described in Appendix F, were originally developed by the California Public Utilities Commission (CPUC) and defined by the California Standard Practice Manual. Together, these tests were used to screen opportunities, adjust incentive levels and to set program administration costs as well as related education, training and promotional activities.

5.4. Program Portfolio

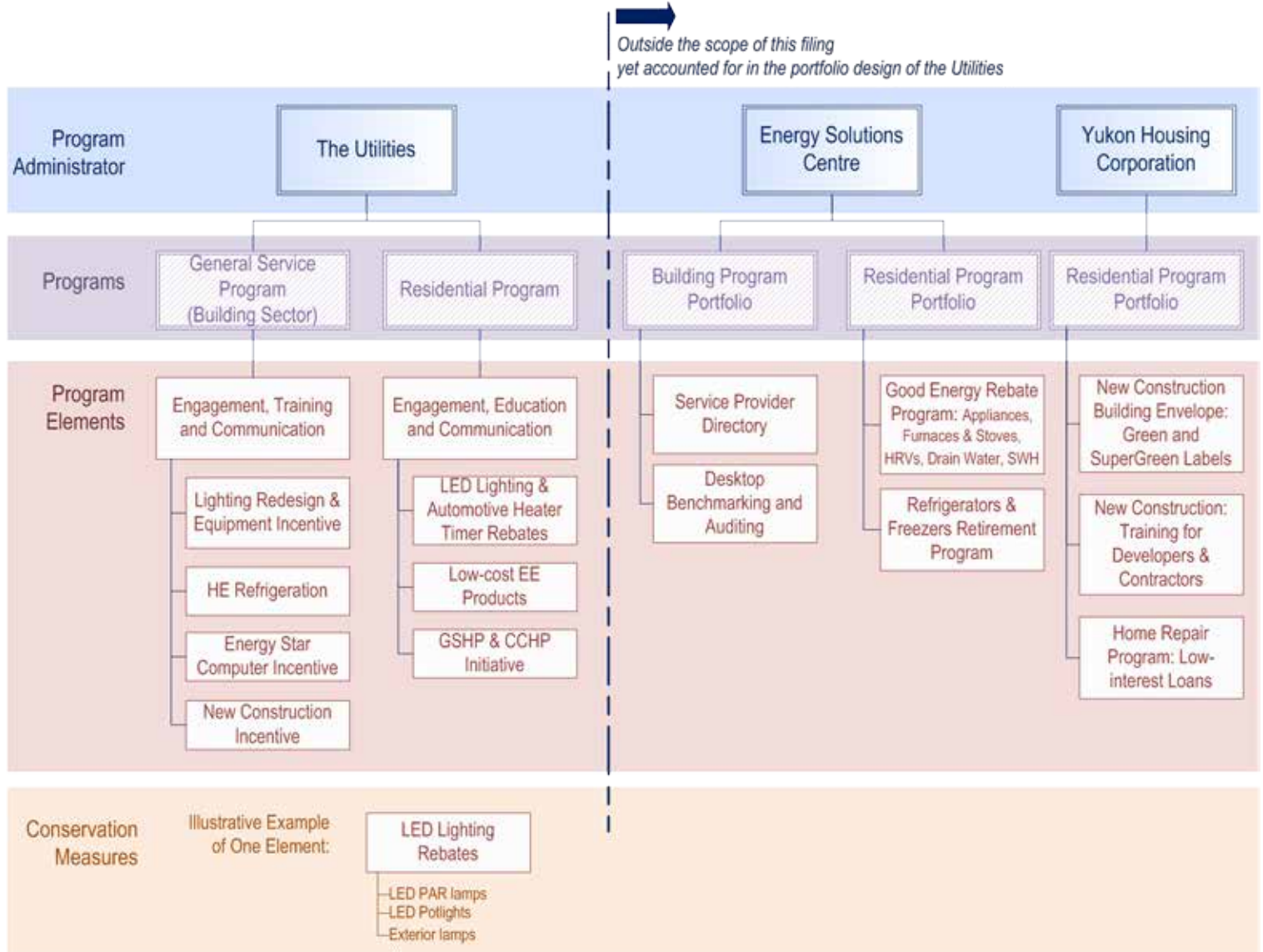
Consistent with best practice program design principles, two broad solutions-based programs are presented: General Service Program and Residential Program. Each includes multiple program elements. The objective is to offer customers a broad suite of options to meet their electricity management needs, rather than forcing customers to sort through a variety of individual programs. Grouping program elements under these solutions-based umbrellas also enables the Utilities to design sector-based branding, marketing and awareness building initiatives (inCharge) that encourage customers to take action to manage their energy service needs rather than trying to promote participation in a variety of individual programs.

Several specific design guidelines were applied to the programs presented. They are:

- Minimize the number of program offerings to reduce the costs of program administration and the market confusion that can arise from too many program requirements.
- Minimize program design complexity in the interest of speeding up time-to-market, reducing administrative costs, and encouraging participation.
- Retain design flexibility to enable program implementers to adjust specific designs as dictated by customer response and evaluation results.
- Balance the need to quickly acquire significant electricity savings with the need to lay a foundation for continued program scale-up and foster a transformation in customer electricity management.
- Ensure that the program offerings complement existing Yukon energy initiatives and minimize duplication or potential customer confusion. To this end, there has been extensive collaboration with local entities such as the Energy Solutions Centre, Yukon Housing, City of Whitehorse and others.

Exhibit 3: Portfolio Structure

(Please note that an updated list of Energy Solutions Centre programs is available in Appendix D.)



The portfolio shown in Exhibit 3 is built around two broad Solutions programs – General Service and Residential; each Solution program contains several program elements designed to provide a range of electricity efficiency options for commercial and residential customers. As noted previously, the selection of specific program elements carefully considered existing Yukon initiatives, which are energy-focused as opposed to electricity-focused (Demand Side Management Program Portfolio for the Yukon, 2012).

5.5. Overview of Portfolio Benefit-Cost Results

The exhibits below present an overview of the portfolio benefit-cost (B/C) results. The results are presented by program element as well as for the portfolio as a whole. The results are also organized within two scenarios:

- Without Government Buildings: This assumes that government owned buildings are not eligible to participate in the programs.
- With Government Buildings: This assumes that all Yukon buildings are eligible to participate in the programs.

Government buildings include buildings from all levels of government: federal, territorial, first nation, and municipal. Given the limitations of available data, it's not possible to separate the various levels of government from each other.

In each case where the B/C is presented, the results include:

- Net Savings – Lifetime MWh: These are the lifetime electricity savings attributed to (only) the measures implemented in the year shown and are inclusive of T&D losses.
- Net Savings – Annual MWh: These are the electricity savings that would occur in the milestone year shown due to the impacts of the measures implemented to date under the program. They are inclusive of T&D losses.
- Utility Expenditure: These show the associated incentive and non-incentive program costs that would be incurred in each milestone year.
- Benefit/Cost Ratios: These are the results of the benefit-cost tests described previously in Exhibit 4. Values greater than 1 indicate net positive benefits.

As illustrated in Exhibits 4 and 5:

- All of the proposed programs provide positive net benefits to the Yukon, to the electric Utilities and to program participants.
- Benefit/Cost results are not calculated for program elements that are promotional or educational in nature; however, their associated costs are captured and distributed among those program elements that do create electricity savings.
- The selected occurrences where the RIM results are less than 1 indicates that rates may be affected negatively (i.e., they may increase in the short term as a result of the program expenses).

Results are moderately more positive under the scenario that includes government participation. More detailed descriptions of the programs and program elements shown in Exhibits 4 and 5 are presented in Section 3 (General Service) and Section 4 (Residential) of Appendix E. Program-level evaluation, measurement and verification costs are included in the utility expenditure presented in Exhibits 4 and 5.

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Yukon Electrical Company Limited, Yukon Energy Corporation

Exhibit 4: Portfolio Results excluding Government Buildings

Program Elements	Net Savings with T&D Losses							Utility Expenditure (\$1,000s)							Benefit/Cost Ratios for the 5-Year Period			
		Year 1	Year 2	Year 3	Year 4	Year 5	Total		Year 1	Year 2	Year 3	Year 4	Year 5	Total	TRC	PAC	PC	RIM
Lighting Redesign and Equipm't Incentive - excluding gov. buildings	Lifetime MWh:	0	2,476	6,240	7,132	7,132	22,981	Incentive:	\$4	\$96	\$213	\$239	\$222	\$773	1.1	2.8	2.5	0.9
	Annual MWh:	0	333	1,140	2,062	2,985	N/A	Non-Incen.:	\$77	\$78	\$81	\$85	\$111	\$432				
	Coincident kW:	0	79	269	486	703	N/A	Total:	\$81	\$175	\$294	\$323	\$333	\$1,205				
New Construction Incentive - excluding gov. buildings	Lifetime MWh:	0	306	1,377	2,142	2,448	6,273	Incentive:	\$0	\$4	\$19	\$30	\$34	\$87	4.2	4.9	6.3	1.0
	Annual MWh:	0	15	84	191	314	N/A	Non-Incen.:	\$4	\$31	\$5	\$31	\$12	\$82				
	Coincident kW:	0	3	19	44	72	N/A	Total:	\$4	\$35	\$24	\$60	\$46	\$169				
High-Efficiency Refrigeration Incentive - excluding gov. buildings	Lifetime MWh:	0	0	6,301	0	6,301	12,602	Incentive:	\$0	\$0	\$122	\$0	\$122	\$243	3.2	4.5	4.2	1.0
	Annual MWh:	0	0	630	630	1,260	N/A	Non-Incen.:	\$10	\$91	\$17	\$54	\$42	\$214				
	Coincident kW:	0	0	72	72	143	N/A	Total:	\$10	\$91	\$138	\$54	\$163	\$458				
Energy Star Computer - excluding gov. buildings	Lifetime MWh:	32	205	335	0	0	573	Incentive:	\$2	\$10	\$17	\$0	\$0	\$29	1.8	1.2	*	0.6
	Annual MWh:	8	59	143	143	135	N/A	Non-Incen.:	\$26	\$12	\$15	\$2	\$5	\$60				
	Coincident kW:	1	11	26	26	24	N/A	Total:	\$28	\$22	\$32	\$2	\$5	\$89				
Engagement, Education and Communication - excluding gov. buildings	Lifetime MWh:	N/A	N/A	N/A	N/A	N/A	N/A	Incentive:	\$0	\$0	\$0	\$0	\$0	\$0	N/A	N/A	N/A	N/A
	Annual MWh:	N/A	N/A	N/A	N/A	N/A	N/A	Non-Incen.:	\$167	\$251	\$224	\$175	\$217	\$1,034				
	Coincident kW:	N/A	N/A	N/A	N/A	N/A	N/A	Total:	\$167	\$251	\$224	\$175	\$217	\$1,034				
Total General Service Program excl. gov. buildings	Lifetime MWh:	32	2,988	14,253	9,274	15,881	42,428	Incentive:	\$5	\$111	\$371	\$268	\$377	\$1,132	1.3	2.1	3.2	0.8
	Annual MWh:	8	408	1,997	3,027	4,693	N/A	Non-Incen.:	\$284	\$463	\$341	\$346	\$387	\$1,822				
	Coincident kW:	1	93	385	627	942	N/A	Total:	\$290	\$574	\$712	\$615	\$764	\$2,954				
LED Lighting and Automotive Heater Timer Rebates	Lifetime MWh:	718	3,149	3,207	3,207	3,207	13,487	Incentive:	\$12	\$51	\$52	\$52	\$52	\$217	1.9	3.0	2.5	1.0
	Annual MWh:	36	199	368	537	705	N/A	Non-Incen.:	\$82	\$84	\$55	\$59	\$107	\$387				
	Coincident kW:	13	71	131	191	252	N/A	Total:	\$94	\$135	\$106	\$111	\$159	\$604				
Low-cost Energy Efficient Products	Lifetime MWh:	1,849	3,969	3,672	3,540	3,342	16,371	Incentive:	\$34	\$48	\$43	\$36	\$30	\$192	1.8	2.7	2.8	1.0
	Annual MWh:	169	543	896	1,236	1,558	N/A	Non-Incen.:	\$165	\$179	\$145	\$153	\$169	\$811				
	Coincident kW:	60	194	319	441	556	N/A	Total:	\$199	\$227	\$188	\$189	\$199	\$1,003				
New-construction CCHP and GSHP Initiative	Lifetime MWh:	148	188	188	1,223	1,075	2,821	Incentive:	\$5	\$9	\$9	\$24	\$19	\$65	0.9	1.7	1.2	0.8
	Annual MWh:	7	17	26	87	141	N/A	Non-Incen.:	\$18	\$34	\$28	\$39	\$24	\$144				
	Coincident kW:	3	6	9	31	50	N/A	Total:	\$23	\$43	\$37	\$63	\$43	\$209				
Engagement, Education and Communication	Lifetime MWh:	N/A	N/A	N/A	N/A	N/A	N/A	Incentive:	\$0	\$0	\$0	\$0	\$0	\$0	N/A	N/A	N/A	N/A
	Annual MWh:	N/A	N/A	N/A	N/A	N/A	N/A	Non-Incen.:	\$113	\$130	\$134	\$138	\$142	\$657				
	Coincident kW:	N/A	N/A	N/A	N/A	N/A	N/A	Total:	\$113	\$130	\$134	\$138	\$142	\$657				
Total for the Residential Program	Lifetime MWh:	2,715	7,306	7,066	7,969	7,623	32,679	Incentive:	\$51	\$108	\$104	\$112	\$100	\$474	1.4	2.0	2.4	0.9
	Annual MWh:	213	759	1,289	1,860	2,405	N/A	Non-Incen.:	\$379	\$427	\$361	\$389	\$443	\$1,999				
	Coincident kW:	76	271	460	664	858	N/A	Total:	\$429	\$535	\$465	\$501	\$543	\$2,473				
Grand Total All Programs Portfolio	Lifetime MWh:	2,747	10,294	21,319	17,243	23,504	75,108	Incentive:	\$56	\$219	\$474	\$380	\$477	\$1,606	1.3	2.1	2.9	0.8
	Annual MWh:	221	1,167	3,287	4,887	7,098	N/A	Non-Incen.:	\$706	\$824	\$670	\$703	\$815	\$3,718				
	Coincident kW:	77	363	845	1,290	1,800	N/A	Total:	\$762	\$1,043	\$1,145	\$1,083	\$1,292	\$5,325				

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Yukon Electrical Company Limited, Yukon Energy Corporation

Exhibit 5: Portfolio Results Including Government Buildings

Program Elements	Net Savings with T&D Losses							Utility Expenditure (\$1,000s)							Benefit/Cost Ratios for the 5-Year Period			
		Year 1	Year 2	Year 3	Year 4	Year 5	Total		Year 1	Year 2	Year 3	Year 4	Year 5	Total	TRC	PAC	PC	RIM
Lighting Redesign and Equipm't Incentive - including gov. buildings	Lifetime MWh:	0	4,314	10,711	12,241	12,241	39,506	Incentive:	\$6	\$135	\$294	\$327	\$299	\$1,062	1.2	3.8	2.4	0.9
	Annual MWh:	0	507	1,731	3,128	4,526	N/A	Non-Incen.:	\$81	\$77	\$66	\$72	\$127	\$425				
	Coincident kW:	0	127	432	781	1,129	N/A	Total:	\$88	\$213	\$360	\$400	\$427	\$1,487				
New Construction Incentive - including gov. buildings	Lifetime MWh:	0	471	2,118	3,295	3,766	9,651	Incentive:	\$0	\$6	\$25	\$39	\$45	\$115	4.7	6.1	6.7	1.0
	Annual MWh:	0	24	129	294	483	N/A	Non-Incen.:	\$28	\$9	\$6	\$33	\$16	\$93				
	Coincident kW:	0	5	30	67	110	N/A	Total:	\$28	\$15	\$32	\$72	\$61	\$208				
High-Efficiency Refrigeration Incentive - including gov. buildings	Lifetime MWh:	0	0	7,580	0	7,580	15,161	Incentive:	\$0	\$0	\$132	\$0	\$132	\$263	3.2	4.3	4.6	1.0
	Annual MWh:	0	0	694	694	1,388	N/A	Non-Incen.:	\$36	\$100	\$19	\$86	\$49	\$290				
	Coincident kW:	0	0	80	80	161	N/A	Total:	\$36	\$100	\$151	\$86	\$180	\$553				
Energy Star Computer - including gov. buildings	Lifetime MWh:	107	681	1,111	0	0	1,899	Incentive:	\$6	\$35	\$57	\$0	\$0	\$98	2.0	1.3	*	0.6
	Annual MWh:	27	197	475	475	448	N/A	Non-Incen.:	\$36	\$52	\$74	\$6	\$17	\$185				
	Coincident kW:	5	35	85	85	80	N/A	Total:	\$41	\$88	\$131	\$6	\$17	\$284				
Engagement, Education and Communication - including gov. buildings	Lifetime MWh:	N/A	N/A	N/A	N/A	N/A	N/A	Incentive:	\$0	\$0	\$0	\$0	\$0	\$0	N/A	N/A	N/A	N/A
	Annual MWh:	N/A	N/A	N/A	N/A	N/A	N/A	Non-Incen.:	\$202	\$290	\$255	\$200	\$252	\$1,199				
	Coincident kW:	N/A	N/A	N/A	N/A	N/A	N/A	Total:	\$202	\$290	\$255	\$200	\$252	\$1,199				
Total General Service Program incl. gov. buildings	Lifetime MWh:	107	5,466	21,520	15,536	23,587	66,217	Incentive:	\$12	\$176	\$508	\$367	\$476	\$1,538	1.3	2.5	3.2	0.8
	Annual MWh:	27	728	3,029	4,591	6,845	N/A	Non-Incen.:	\$383	\$529	\$420	\$398	\$461	\$2,192				
	Coincident kW:	5	167	627	1,013	1,480	N/A	Total:	\$395	\$705	\$928	\$765	\$937	\$3,730				
LED Lighting and Automotive Heater Timer Rebates	Lifetime MWh:	718	3,149	3,207	3,207	3,207	13,487	Incentive:	\$12	\$51	\$52	\$52	\$52	\$217	1.9	3.0	2.5	1.0
	Annual MWh:	36	199	368	537	705	N/A	Non-Incen:	\$82	\$84	\$55	\$59	\$107	\$387				
	Coincident kW:	13	71	131	191	252	N/A	Total:	\$94	\$135	\$106	\$111	\$159	\$604				
Low-cost Energy Efficient Products	Lifetime MWh:	1,849	3,969	3,672	3,540	3,342	16,371	Incentive:	\$34	\$48	\$43	\$36	\$30	\$192	1.8	2.7	2.8	1.0
	Annual MWh:	169	543	896	1,236	1,558	N/A	Non-Incen:	\$165	\$179	\$145	\$153	\$169	\$811				
	Coincident kW:	60	194	319	441	556	N/A	Total:	\$199	\$227	\$188	\$189	\$199	\$1,003				
New-construction CCHP and GSHP Initiative	Lifetime MWh:	148	188	188	1,223	1,075	2,821	Incentive:	\$5	\$9	\$9	\$24	\$19	\$65	0.9	1.7	1.2	0.8
	Annual MWh:	7	17	26	87	141	N/A	Non-Incen:	\$18	\$34	\$28	\$39	\$24	\$144				
	Coincident kW:	3	6	9	31	50	N/A	Total:	\$23	\$43	\$37	\$63	\$43	\$209				
Engagement, Education and Communication	Lifetime MWh:	N/A	N/A	N/A	N/A	N/A	N/A	Incentive:	\$0	\$0	\$0	\$0	\$0	\$0	N/A	N/A	N/A	N/A
	Annual MWh:	N/A	N/A	N/A	N/A	N/A	N/A	Non-Incen:	\$113	\$130	\$134	\$138	\$142	\$657				
	Coincident kW:	N/A	N/A	N/A	N/A	N/A	N/A	Total:	\$113	\$130	\$134	\$138	\$142	\$657				
Total for the Residential Program	Lifetime MWh:	2,715	7,306	7,066	7,969	7,623	32,679	Incentive:	\$51	\$108	\$104	\$112	\$100	\$474	1.4	2.0	2.4	0.9
	Annual MWh:	213	759	1,289	1,860	2,405	N/A	Non-Incen:	\$379	\$427	\$361	\$389	\$443	\$1,999				
	Coincident kW:	76	271	460	664	858	N/A	Total:	\$429	\$535	\$465	\$501	\$543	\$2,473				
Grand Total All Programs Portfolio	Lifetime MWh:	2,822	12,772	28,586	23,505	31,210	98,896	Incentive:	\$63	\$284	\$612	\$478	\$576	\$2,012	1.4	2.3	2.9	0.8
	Annual MWh:	240	1,487	4,318	6,451	9,250	N/A	Non-Incen.:	\$762	\$957	\$782	\$787	\$904	\$4,191				
	Coincident kW:	81	438	1,087	1,677	2,338	N/A	Total:	\$824	\$1,240	\$1,393	\$1,266	\$1,480	\$6,203				

5.6. Savings Highlights

As illustrated in Exhibit 4 and in Exhibit 5:

Over the course of the five year program period and under the scenario that includes government buildings, the General Service Program and the Residential Program will generate 98.9GWh of measure-lifetime net savings, 9.3GWh of annual net savings, and 2.3MW of coincident peak savings.

Under the with-government scenario, the General Service Program will generate 67 percent of the measure-lifetime net savings and the Residential Program will generate 33 percent of the net savings.

Under the scenario that excludes government buildings, the programs will generate 75.1GWh of measure-lifetime net savings, 7.1GWh of annual net savings, and 1.8MW of coincident peak savings.

Under the without-government scenario, the General Service Program will generate 56 percent of the measure-lifetime net savings and the Residential Program will generate 44 percent of the net savings.

5.7. Residential Programs

This section presents a description of the proposed Residential Program as well as a detailed description of each of the proposed program elements. The proposed program offerings set out in this section have been developed based on the results of market information collected during the research phase of this program design study.

The market characterization was primarily focused on retailers and shoppers for lighting equipment and domestic appliances; and on housing developers. Lighting products and domestic appliances were selected because of the predominance of rebates as the preferred tool to increase the penetration of electricity efficiency among these items. Rebates were perceived as being an essential component of a program implemented with retail channel partners.

The detailed reports of the characterization studies including the main conclusions which form the basis for the proposed program design can be found in Appendix B.

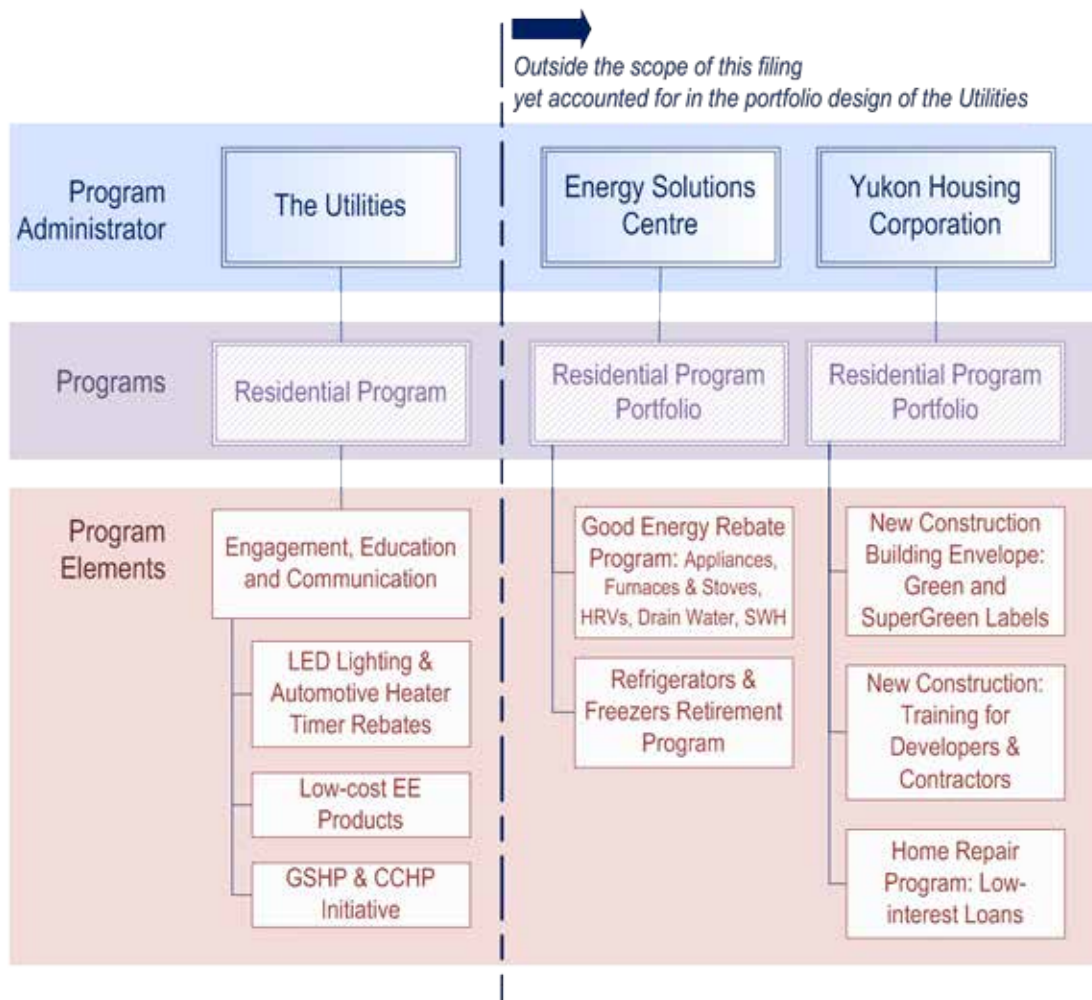
Barriers which emerged as themes during the market research activities include, in order of priority:

- The high cost of some lighting equipment, LED in particular
- The lack of information, or confused information and beliefs of end-users with regard to electricity efficiency equipment in stores
- The missing lighting products on the shelves of retailers in the Yukon, LED in particular
- Few CCHP and GSHP projects in the Yukon, a few poor installations and the resulting lack of information resulting from the situation
- The high cost of central heating, CCHP or GSHP systems in new housing construction

5.8. Residential Programs: An Overview

The Residential Program and its elements are presented on the left side of Exhibit 6. Other residential electricity conservation programs offered in the Yukon are presented on the right side of Exhibit 6. As shown in this exhibit, the Residential Program avoids overlaps and exploits potential for synergy. Eligibility for participation in utility led Residential programs will be restricted to Residential rate class customers of Yukon Energy or YECL.

Exhibit 6: Portfolio View of the Utilities', Energy Solutions Centre, and Yukon Housing Residential Programs (2012)



(Where: EE is “electricity efficiency” or “electricity efficient,” HRV is heat recovery ventilation, SWH is solar water heating, LED is light-emitting diode, GSHP is ground-source heat pump, and CCHP is cold climate heat pump. Please note that an updated list of Energy Solutions Centre programs is available in Appendix D.)

The Residential Program will integrate resource acquisition and market transformation tactics, offerings and activities which mean that it will aim at both the end-users and the supply-chain actors. The Utilities will increase the demand and the supply of electricity efficiency products and equipment.

The Residential Program consists of three program elements, as presented below:

LED Lighting & Automotive Heater Timer Rebates:

The Utilities will pay a flat amount of money per unit to shoppers after they purchase LED lighting lamps or fixtures selected from a prescriptive list of eligible products. The Utilities will also provide a flat rebate per unit to shoppers and housing developers after they purchase a timer for a block heater, car warmer and/or battery blanket selected from a prescriptive list of eligible products.

Low-cost Energy Efficient Products:

The Utilities will prepare and disseminate information on products that generate electricity savings but do not have a perceptible price increment as compared with the baseline equipment. The Utilities will disseminate information through point of purchase displays and brochures in retail stores, and through community engagement. Certain low-cost items will be provided by the Utilities to community volunteers to test and showcase: for example certain LED lamps, low-flow showerheads, faucet aerators, etc. The Utilities will give out a limited number of these items free of charge; volunteers will try them out, fill out a scorecard and send it back. The results will be fed back first to the store managers, and then to the consumers through point of purchase displays and brochures and through community engagement.

CCHP and GSHP Initiative:

The Utilities will pilot three-element hot water heaters (mostly a demand-response technology), cold climate heat pumps (CCHPs) and ground-source heat pumps (GSHPs). The pilot systems will be subsidized, not provided free of charge, and the results will be disseminated through different channels, such as HVAC contractors, electrical contractors, housing developers and municipalities.

After the completion of these pilot projects, the Utilities will provide a flat amount of money to buyers of new houses or condominium units if they buy a home with a cold climate heat pump (CCHP) or a ground-source heat pump (GSHP) system, or to owners of homes with electric central air heating systems to retrofit their home with a CCHP or a GSHP.

Public Engagement, Education and Communication:

The Utilities will disseminate information and receive feedback from residents of Whitehorse and the communities through multiple means:

- Partnership and direct engagement with retail store managers.
- Point-of-purchase displays and brochures.
- Partnership with applicable non-profit and community organizations.
- Outreach and participation in community events.
- Identification and enrolment of community electricity efficiency (EE) “ambassadors”.
- EE workshops taking place in EE ambassadors’ homes.
- Direct engagement with HVAC contractors, electrical contractors and house developers.
- Dissemination of information, in particular about the seasonal LED rebates, in local newspapers, radio stations, cooperative advertisements, and bill inserts.
- Information on rebates and electricity efficiency products on the Utilities’ website.

Many of the engagement initiatives carried out by the Utilities will also be used to disseminate information about the Yukon Housing conservation programs and the ESC energy conservation programs to increase value for the audience and create synergy between stakeholders.

5.9. General Service Programs

This section presents a description of the proposed General Service Programs as well as a detailed description of each of the proposed program elements. The proposed program offerings set out in this section have been developed based on the results of market information collected during the research phase of this programs design study.

The market characterization was primarily focused on lighting systems and HVAC systems: lighting systems are by far the most electricity-intensive end use in existing buildings in the Yukon. HVAC systems are the second most electricity-intensive end use in existing building and first in new construction.

Further detail on the research methodology employed is presented in Appendix B.

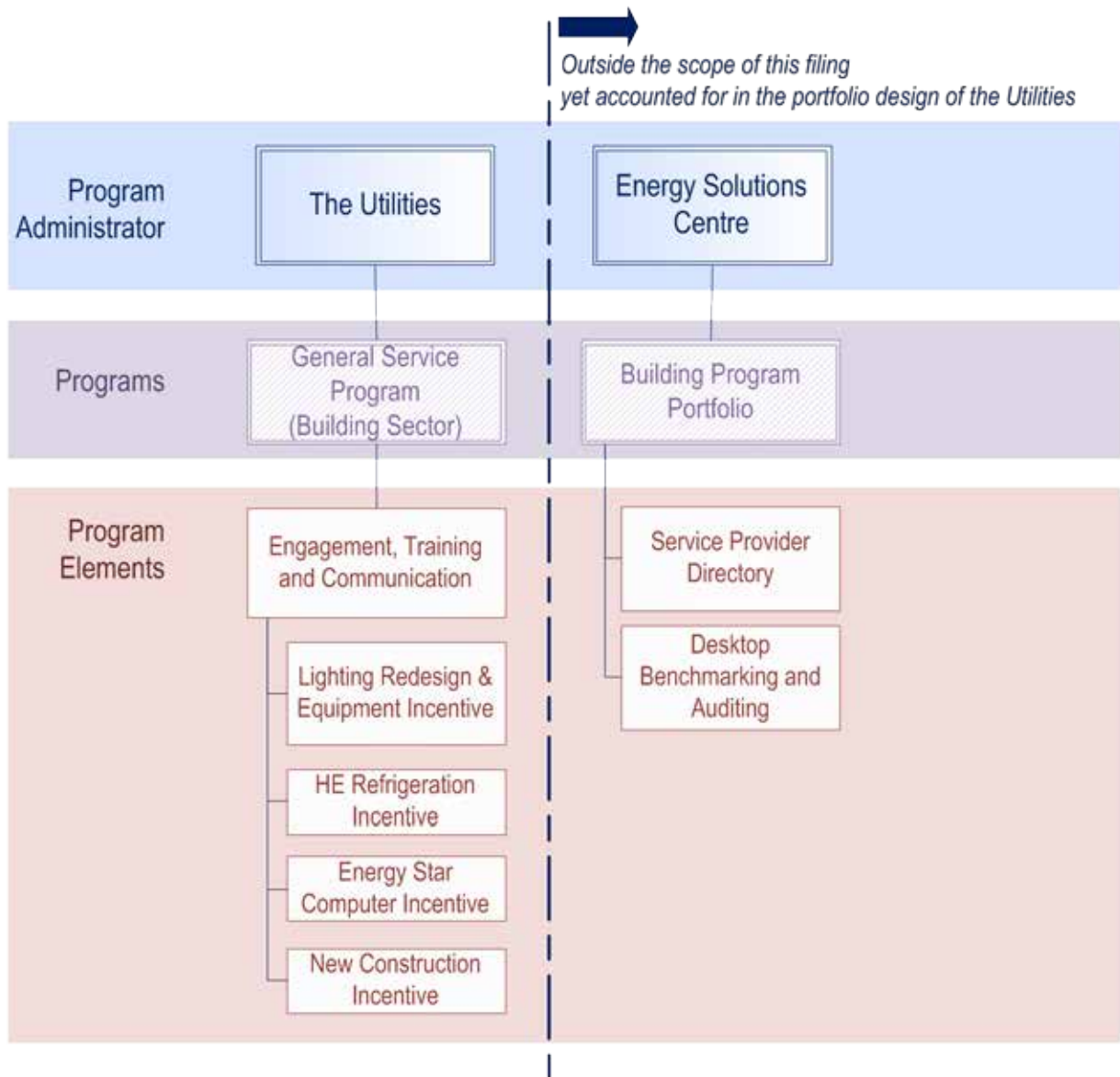
Barriers which emerged as themes during the market research activities include, in priority order:

- Prohibitive cost of electricity efficiency equipment both in retrofit and new construction
- Split-incentive barriers inside governmental or municipal organizations
- Clogged information channel between manufacturers in and end-users in the Yukon
- Limited offerings in energy engineering
- Reactive building maintenance rather than preventive building maintenance

5.10. General Service Programs: An Overview

The General Service Program and its components are presented on the left hand side of Exhibit 7. Other energy conservation building programs offered in the Yukon are presented on the right hand side of the exhibit. As shown in this exhibit, the General Service Program avoids overlaps and exploits potential for synergy. Eligibility for participation in utility led General Service programs will be restricted to General Service rate class customers of Yukon Energy or YECL.

Exhibit 7: Portfolio View of the Utilities', and Energy Solutions Centre Building Programs



(Please note that an updated list of Energy Solutions Centre programs is available in Appendix D)

The General Service Program will integrate resource acquisition and market transformation offerings and activities aimed at building owner/managers, and at building industry actors. Through this program, the Utilities will increase the demand and the supply of electricity efficiency systems, with a focus on lighting systems in existing buildings, and both lighting and HVAC systems in new construction.

The General Service Program consists of four distinct program elements, as presented below:

Lighting Redesign and Equipment Incentive:

The Utilities will pay an incentive to building owners/managers to have their lighting systems retrofitted. The total incentive will be the sum of three layers:

- Lighting redesign incentive
- Prescriptive LED lighting incentive
- Custom lighting incentive

The custom lighting incentive includes a base incentive for the equipment and installation determined using a dollar per kilowatt-hour of annual savings rate. This approach provides flexibility in choice of lighting technologies and also allows contractors and designers to be innovative.

For the prescriptive LED incentive layer, the Utilities will add a flat amount of money per unit for LED products selected from a prescriptive list of eligible products.

The Utilities will pay an incentive to building owners/managers to have a lighting redesign study conducted in their building. The purpose of the lighting redesign study will be to design the optimal lighting system in term of visual comfort, ease of maintenance, and electricity savings considering the existing spaces, windows and fixtures. The incentive for the study will be determined using a dollar-per-square foot rate. The lighting designers will be required to develop designs that meet minimum power density thresholds.

Building owners/managers will be able to combine the custom incentive layer, the LED prescriptive incentive layer, and the lighting redesign study layer to best suit their needs and to generate a larger incentive for LED technologies: the initial-cost hurdle is higher for the LED technologies and the Utilities have a goal of accelerating market penetration of these products. The prescriptive list of eligible LED products will be consistent with that used in the Residential Program.

High Efficiency Refrigeration Incentive:

The Utilities will pay an incentive to building owners/managers who retrofit their refrigeration systems. This will be a custom incentive for equipment and installation, i.e. it will be determined using a dollar per kilowatt-hour rate for each kilowatt-hour of savings realized annually as compared with the pre-retrofit consumption and demand level. In addition to the incentive, the Utilities will provide extensive refrigeration-specific technical assistance to identify the opportunities, to develop the projects, to manage the construction works, and to measure and monitor the performance of the projects. It is expected that this program element will aim at hockey and curling arenas and grocery stores in particular.

ENERGY STAR Computers Incentive:

The Utilities will pay an incentive to participating Yukon-based companies or organizations that purchase computers and computer equipment that meet ENERGY STAR requirements. The incentive will be prescriptive i.e., it will be determined using a fixed amount per piece of equipment installed. The rebate will be offered year-round. However, it will be advertised and offered for a limited period of time i.e., until the end of Y3, to create a sense of urgency and cause early replacement of non-ENERGY STAR computers.

New-Construction Incentive:

The Utilities will pay an incentive to building owners/managers for high performance new buildings. The incentive will have two paths: a prescriptive path for small buildings and a custom path for large buildings. The prescriptive incentive will be determined using a dollar-per-square foot rate if the building complies with a certain standard. The custom incentive will be determined using a dollar per kilowatt-hour of annual savings rate for each kilowatt-hour of savings realized above a minimum level. Savings will be determined through building modeling.

Engagement, Training and Communication

The Utilities will disseminate information, train and receive feedback from building owner/managers and other building industry actors through the following methods:

- Direct engagement with building industry actors: emails, phone calls and in-person meetings with electrical distributors, lighting designers, electrical contractors, as well as HVAC contractors, architects, building controls contractors, and HVAC designers
- Hands-on, in-person courses for local building industry actors, including course on advanced electricity efficiency lighting design, electricity efficiency project business cases, and energy performance contract (EPC) project implementation approach
- Project-specific, in-person or distance advanced lighting design or advanced HVAC design technical support to building industry actors
- Trade events supported by the Utilities and gathering local building owners/managers and building industry actors, with a focus on building electricity conservation, advanced lighting design and/or advanced HVAC design
- Direct engagement and key-account management for building owners/managers. In particular, the Utilities will leverage their partnerships with retail store managers
- Support for building owners/managers to do asset management planning and to identify in which buildings to develop projects
- Support to building owners/managers on optimizing decisions about implementation and procurement
- Support to building owners/managers before and during the tendering of project design services, particularly if the procurement approach is EPC
- Public relation activities including press releases to the local newspapers and radio, web content, joint events with interested applicable trade, commerce, non-profit and community organizations, engagement with electrical contractors during the health and safety training of the Utilities.

The Utilities hope to work with the Energy Solutions Center (ESC) to advertise and maintain the Service Provider Directory.

For further detail regarding the objective, target market, description, participation process, duration, milestones and eligible measures, related to each of the programs listed above please refer to Appendix E.

5.11. Industrial Programs

The Utilities will work with new industrial customers to facilitate efficiency planning during initial negotiations. Each utility will work on a one-on-one basis with its industrial customers to develop baseline energy use

information, to increase conservation behaviour, to increase process efficiency and to increase the uptake of efficient equipment. All projects conducted in the Industrial sector will be subject to the standard four cost-effectiveness tests listed in Appendix F as well as the same rigorous EM&V established in Section 7 of the Yukon Five Year Demand Side Management Plan. EM&V will be conducted separately from the inCharge programs but will be considered toward the joint utility goal of 8.5GWh. Eligibility for participation in Industrial programs will be restricted to Industrial rate class customers of YEC or YECL.

6. Implementation

6.1. inCharge

Yukon Energy and Yukon Electrical agree to work collaboratively to achieve the 8.5GWh electricity savings target. The work to achieve this target will be conducted through the administration of the Joint Utility DSM Working Group and will be publicly delivered through the Utilities joint brand, inCharge.

inCharge is the public vehicle that will represent the Joint Utility DSM Working Group and will deliver all Residential and General Service conservation messages and programs. inCharge will be staffed directly by Joint Utility DSM Working Group assigned staff. Although each utility will lead in various tasks associated with inCharge programming (as described in Section 4), the Utilities will share equal rights and responsibility to the success of inCharge. The Utilities will enter into a formal partnership agreement following YUB approval of the proposed DSM programs.

inCharge:

- inCharge will deliver clear, electricity conservation messages to all general service and residential electricity customers, regardless of service location or grid type.
- inCharge will implement, deliver and evaluate all utility led demand-side management programming in the Yukon.
- inCharge will engage and consult local stakeholders for appropriate feedback to ensure that DSM programming is reaching the desired target customers.
- inCharge will utilize the extensively researched programs specifically designed for the Yukon to achieve the agreed electricity goals.
- inCharge will adhere to a stringent evaluation, measurement and verification process to ensure targets are being met.
- inCharge will work in collaboration with Yukon government, specifically the Energy Solutions Centre, to ensure electricity conservation programming is not duplicated.

6.2. Utility Expenditures

The working group will administer the program funds as follows:

- The Utilities will equally share any program delivery implementation costs.
- The Utilities will share human resource costs related to inCharge program implementation as determined by the demands of the programs.

Yukon Electrical Company Limited, Yukon Energy Corporation

- The Utilities will equally share the program delivery costs as outlined in the Demand Side Management Program Portfolio for the Yukon Program Design document.
- The Utilities will equally share marketing and communications costs that occur outside of the Demand Side Management Program Portfolio for the Yukon including, but not limited to, inCharge brand development costs, website development and maintenance, youth education development programs and materials, and other equally agreed upon costs.
- The Utilities will equally share costs of agreed upon pilot projects (LED street lights) which fall outside of the Demand Side Management Program Portfolio for the Yukon.

Each utility will have costs and responsibilities beyond those defined by the inCharge programs. Yukon Energy and Yukon Electrical will be independently responsible for these costs and any required application to the YUB for these costs. These responsibilities are defined as:

Yukon Energy Roles and Responsibility – beyond inCharge Commitments

- Internal DSM projects
- Administrative costs
- Staff training and development
- Maintaining the YEC energy conservation office
- YEC industrial customer DSM programs
- Additional staff costs

Yukon Electrical Roles and Responsibility – beyond inCharge Commitments

- Internal DSM projects
- Administrative costs
- Staff training and development
- YECL industrial customer DSM programs
- YECL office costs
- Additional staff costs

7. Accountability

Program-level evaluation, measurement & verification (EM&V) planning is an important component of the overall DSM program design process. Below we propose a set of EM&V objectives and outline preliminary principles and recommendations related to both objectives and approach. Further information regarding the EM&V of programs listed in the five year DSM plan is available in the Joint Utility EM&V Plan (2013).



Yukon Electricity Conservation and Demand Management Potential Review (CPR 2011)

Summary Report

9 January 2012

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Yukon Energy, Yukon Electrical Company,
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1 Introduction

1.1 Background and Objectives

Yukon residents rely on electricity not only to live meaningful, healthy lives but also to support and strengthen the economy. Given the concerns over the environmental implications, including climate change, and the limited generating capacity in the Yukon, there is growing interest not only in how electricity is generated, transmitted and distributed, but also in how efficiently it is used on the customer's end. In Yukon, as well as in a growing number of North American jurisdictions, how electricity is generated and used is being closely analyzed to find innovative ways of meeting individual and corporate energy service needs while minimizing pollution and the creation of greenhouse gases.

Experience throughout many North American jurisdictions has demonstrated that energy efficiency, conservation and customer-supplied alternative energy technologies all have a significant potential to reduce energy consumption, energy costs and emissions. The 2009 *Energy Strategy for the Yukon* also recognizes this potential and notes the following efficiency and conservation priorities:

- Avoid the cost and environmental impact of building new generation
- Increase energy efficiency in Yukon by 20% by 2020
- Reduce energy consumption in Yukon buildings
- Reduce energy consumption for transportation in Yukon
- Promote the use of energy-efficient products by providing incentives for products that meet energy performance standards
- Improve energy efficiency for Yukon government operations.

Efficient use of electricity through conservation, peak demand control and alternative energy sources can assist greatly in the path forward for the electrical supply industry. This study will provide a resource for Yukon Energy Corporation (YEC), Yukon Electrical Company Limited (YECL), and the Government of Yukon to develop a comprehensive vision of the territory's future electricity service needs.

More specifically, the objective for this study is to provide:

"...a necessary reference point to determine the potential for (electricity) demand-side management (DSM) in the Yukon."¹

1.2 Scope of Study

The scope of this study is summarized below:

- **Sector Coverage:** This study addresses two sectors: residential households (Residential sector), and commercial and institutional buildings (Commercial sector). Yukon's on-grid Industrial sector consists primarily of a small number of operating mines, which are not

¹ Yukon Energy Corporation Request For Proposals #2010-045, "Consulting Services for Electricity Conservation and Demand Management Potential Study," 2011.

appropriate to be included in this type of study. Efficiency opportunities within these sites will be addressed outside of this study.

- **Geographical Coverage:** The study addresses all regions of Yukon that are served by either YEC or YECL. Customers served by both the hydroelectric grid and the stand-alone diesel grids are included. Note that the hydroelectric grid is remote, not connected to other grids, and dependent on trucked fuel to meet demand above the existing hydro / wind capacity, while the stand-alone diesel grids rely at all times on fuel that is trucked or flown in.
- **Study Period:** This study covers a 20-year period. The Base Year is the calendar year 2010, with milestone periods at five-year increments: 2015, 2020, 2025 and 2030. The Base Year of 2010 was selected to enable this study's results to be aligned with the most recent Yukon load forecast.²
- **Technologies:** This study addresses a comprehensive range of demand-side management (DSM) measures. This includes all electrical efficiency technologies or measures that are expected to be commercially viable by the year 2015, as well as peak load reduction technologies and customer-side renewable and alternative energies.

1.2.1 Data Caveat

As in any study of this type, the results presented in this report are based on a large number of important assumptions. Assumptions such as those related to the current penetration of energy-efficient technologies, the rate of future growth in the building stock and customer willingness to implement new energy-efficiency measures are particularly influential. Wherever possible, the assumptions used in this study are consistent with those used by YEC, YECL and the Government of Yukon and are based on best available information, which in many cases includes the professional judgment of the consultant team, client personnel and local experts. The reader should, therefore, use the results presented in this report as best available estimates; major assumptions, information sources and caveats are noted throughout the report.

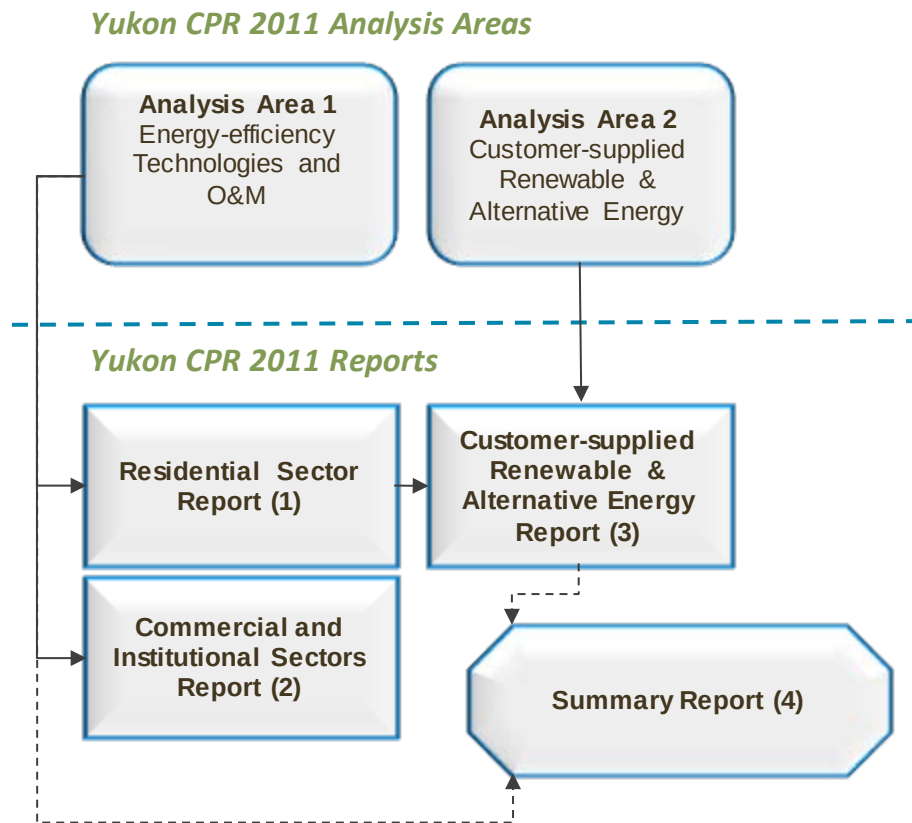
1.3 Study Organization

Exhibit 1 presents an overview of the study's organization; as illustrated, the study has been organized into two analysis areas and four individual reports.

A brief description of each analysis area and the report contents is provided below in Exhibit 1.

² Yukon Energy Corporation, *20-Year Resource Plan – 2011, First Draft*, April 2011.

Exhibit 1 Overview of CPR 2011 Organization – Analysis Areas and Reports



1.3.1 Analysis Area 1 – Energy-efficiency and Peak Load Technologies and O&M

This area of the CPR 2011 assesses electric energy and peak load reduction opportunities that could be provided by electrical efficiency and peak load reduction technologies that are expected to be commercially viable by the year 2015; operation and maintenance (O&M) practices are also addressed. The results of Analysis Area 1 are presented in two individual sector reports and summarized in the Summary Report.

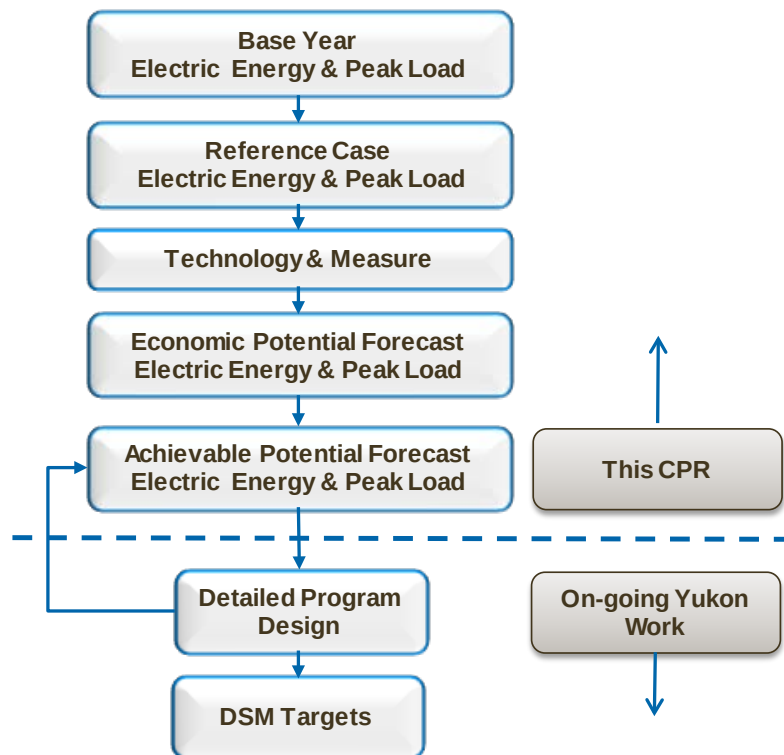
1.3.2 Analysis Area 2 – Customer-Supplied Renewable and Alternative Energies

This area of the CPR 2011 assesses electric energy reduction opportunities that could be provided by customer-supplied renewable and alternative energies. The results of Analysis Area 2 are presented in a single report and are also summarized in the Summary Report.

1.4 Major Analytic Steps

The study was conducted within an iterative process that involved a number of well-defined steps. A summary of the steps for Analysis Area 1 is presented below in Exhibit 2. (Major analytical steps for Analysis Area 2 are presented below in Section 5 of this report.)

Exhibit 2 Major Analytic Steps



A summary of the steps is presented below.

Step 1: Develop Base Year Electric Energy and Peak Load Calibration Using Actual Utility Billing Data

Build a model of electric energy and demand for the sector, disaggregated to all the building types and end uses, and calibrated to sales of electricity in Yukon. This includes the following sub-steps:

- Compile and analyze available data on Yukon's existing building stock.
- Develop detailed technical descriptions of the existing building stock.
- Undertake computer simulations of electricity use in each building type and compare these with actual building billing and audit data.
- Compile actual utility billing data.
- Create sector model inputs and generate results.
- Calibrate sector model results using actual utility billing data.
- Use end-use load shape data to convert electric energy use to electric demand in each selected peak period.

Step 2: Develop Reference Case Electric Energy Use and Peak Load Profile

Extend the base year model to the end of the study period, based on forecast building stock growth and expected natural changes in construction practices, equipment efficiency levels and/or practices. This includes the following sub-steps:

- Compile and analyze building design, equipment and operations data and develop detailed technical descriptions of the new building stock.
- Develop computer simulations of electricity use in each new building type.
- Compile data on forecast levels of building stock growth and “natural” changes in equipment efficiency levels and/or practices.
- Define sector model inputs and create forecasts of electricity use for each of the milestone years.
- Compare sector model results with the load forecasting data provided by YEC for the study period.
- Use end-use load shape data to convert electric energy use to electric demand in each selected peak period over the study period.

Step 3: Identify and Assess Energy-efficiency and Peak Load Reduction Measures

Compile information on upgrade measures that can save electric energy and/or reduce peak demand, and assess them for technical applicability and economic feasibility. This includes the following sub-steps:

- Develop list of energy-efficiency upgrade and peak load reduction measures.
- Compile detailed cost and performance data for each measure.
- For energy-efficiency measures, identify the baseline technologies employed in the Reference Case, develop energy-efficiency upgrade options and associated electricity savings for each option, and determine the cost of conserved energy (CCE) for each upgrade option.
- For each peak load reduction measure, identify the affected end use, the potential load reduction or off-peak shifting and determine the cost of electric peak reduction (CEPR).
- Based on the above results, prepare summary tables that show the amount of potential peak load reduction provided by each measure and at what cost (\$/kW/yr.).
- Apply each peak load reduction measure to the affected end use, regardless of cost, and determine total peak reduction.
- Summarize the peak load reduction impacts in a supply curve.

Step 4: Estimate Economic Electric Energy Savings Potential

Develop an estimate of the electric energy savings potential that would result from implementing all of the economically feasible measures in all the buildings where they are applicable. This includes the following sub-steps:

- Compile utility economic data on the forecast cost of new electricity generation and set an economic threshold value; different economic threshold values were selected for each supply system (hydroelectric and diesel grids).
- Identify the combinations of energy-efficiency upgrade options and building types where the cost of saving one kilowatt of electricity is equal to, or less than, the cost of new electricity generation.
- Apply the economically attractive electrical efficiency measures from Step 3 within the energy-use simulation model developed previously for the Reference Case.
- Determine annual electricity consumption in each building type and end use when the economic efficiency measures are employed.
- Compare the electricity consumption levels when all economic efficiency measures are used with the Reference Case consumption levels and calculate the electricity savings.

Step 5: Estimate Achievable Potential Electricity Savings

Develop an estimated range for the portion of economic potential savings that would likely be achievable within realistic DSM programs. This includes the following sub-steps:

- Bundle the electric energy and peak load reduction opportunities identified in the Economic Potential Forecasts into a set of opportunities.
- For each of the identified opportunities, create an Opportunity Profile that provides a high-level implementation framework, including measure description, cost and savings profile, target sub sectors, potential delivery allies, barriers and possible synergies.
- Review historical achievable program results and prepare preliminary Assessment Worksheets.
- Conduct a full day workshop involving the client, the consultant team, trade allies and technical experts to reach general agreement on the upper and lower range of Achievable Potential.

Step 6: Estimate Peak Load Impacts of Electricity Savings

Develop an estimate for the peak load impacts associated with the measures that save electric energy. This includes the following sub-steps:

- The electricity (electric energy) savings (MWh) calculated in the preceding steps were converted to peak load (electric demand) savings (kW).³
- The conversion of electricity savings to hourly demand drew on a library of specific sub sector and end-use electricity load shapes. Using the load shape data, the following steps were applied:
 - Annual electricity savings for each combination of sub sector and end use were disaggregated by month
 - Monthly electricity savings were then further disaggregated by day type (weekday, weekend day and peak day)
 - Finally, each day type was disaggregated by hour.

1.5 Definition of Terms

This study uses numerous terms that are unique to analyses such as this one and consequently it is important to ensure that readers have a clear understanding of what each term means when applied to this study.

A brief description of some of the most important terms and their application within this study is included below.

Base Year Electricity Use The Base Year is the starting point for the analysis. It provides a detailed description of where and how electrical energy is currently used in the existing building stock. Building electricity use simulations were undertaken for the major sub sector types and calibrated to actual utility customer billing data for the Base Year. As noted previously, the Base Year for this study is the calendar year 2010.

Base Year Electric Peak Load Profile Electric peak load profiles refer to specific time periods throughout the year when Yukon's generation, transmission and distribution system experiences particularly high levels of electricity demand. These periods are of particular interest to system planners; improved management of electricity demand during these peak periods may enable deferral of costly system expansion. This study addresses three specific peak periods, as outlined in the main text.

³ Peak load savings were modelled using the Cross-Sector Load Shape Library Model (LOADLIB).

*Reference Case
Electricity Use (includes
“natural” conservation)*

The Reference Case electricity use estimates the expected level of electrical energy consumption that would occur over the study period in the absence of new (post-2010) utility-based DSM initiatives. It provides the point of comparison for the subsequent calculation of Economic and Achievable electricity savings potentials. Creation of the Reference Case required the development of profiles for new buildings in each of the sub sectors, estimation of the expected growth in building stock, and finally an estimation of “natural” changes affecting electricity consumption over the study period. The Reference Case is calibrated to YEC’s most recent load forecast, minus the impacts of new, future DSM initiatives.

*Reference Case Electric
Peak Load Profile*

The Reference Case peak load profile estimates the expected electric peak loads in each of the three defined peak periods over the study period in the absence of new utility DSM program initiatives. It provides the point of comparison for the subsequent calculation of Economic and Achievable Potentials for peak load reduction.

*Demand-Side
Management (DSM)
Measures*

DSM measures can include energy efficiency (use more efficiently), energy conservation (use less), demand management (use less during peak periods), fuel switching (use a different fuel to provide the energy service) and customer-side generation (displace load off of grid). Fuel switching is not included in this study.

*The Cost of Conserved
Energy (CCE)*

The CCE is calculated for each energy-efficiency technology measure. The CCE is the annualized incremental capital and O&M cost of the upgrade measure divided by the annual energy savings achieved, excluding any administrative or program costs. The CCE represents the cost of conserving one kWh of electricity; it can be compared directly to the cost of supplying one new kWh of electricity.

*The Cost of Electric Peak
Reduction (CEPR)*

The CEPR for a peak load reduction measure is defined as the annualized incremental capital and O&M cost of the measure divided by the annual peak reduction achieved, excluding any administrative or program costs. The CEPR represents the cost of reducing one kW of electricity during a peak period; it can be compared to the cost of supplying one new kW of electric capacity during the same period.

*Levelized Cost of
Generation/Conservation
(LCG/LCC)*

The LCG or LCC is calculated for each customer-side renewable and alternative technology measure. The LCG/LCC is the annualized incremental capital and O&M cost of the measure divided by the annual energy generated or conserved, excluding any administrative or program costs. The LCG/LCC represents the cost of generating one kWh of energy; it can be compared directly to the cost of supplying one new kWh of electricity. (The choice of LCG/LCC depends on the technology: solar PV systems generate electricity, and would therefore have an LCG; wood-pellet burning furnaces conserve electricity in an electrically-heated home and would therefore have an LCC.)

*Electric Capacity-Only
Peak Load Reduction
Measures*

Capacity-only measures are technologies or activities that result in the shifting of certain electrical loads from periods of peak system demand to periods of lower system demand.

*Economic Potential
Electricity Forecast*

The Economic Potential Electricity Forecast is the level of electricity consumption that would occur if all equipment and building envelopes were upgraded to the level that is cost effective against the economic threshold value,⁴ which has been set at different prices per kWh for the different supply system types. (One kWh from the hydroelectric grid is much less expensive than one kWh from the diesel grid in Old Crow.) All the energy-efficiency, renewable or alternative energy upgrades included in the technology assessment that had a CCE or LCG/LCC equal to, or less than, the economic threshold value for a given supply system were incorporated into the Economic Potential Forecast.

*Economic Potential
Electric Peak Load
Forecast*

The Economic Potential Electric Peak Load Forecast is the expected electric peak loads that would occur in each of the three defined peak periods if all peak load reduction measures that are cost effective against the future avoided cost of new capacity in Yukon were fully implemented.

Achievable Potential

The Achievable Potential is the proportion of the savings identified in the Economic Potential Forecasts that could realistically be achieved within the study period. The Achievable Potential recognizes that it is difficult to induce customers to purchase and install all the electrical efficiency technologies that meet the criteria defined by the Economic Potential Forecast. The results are presented as a range, defined as lower and upper.

1.6 Peak Period Definitions

Based on discussions with utilities personnel, the following three peak period definitions were selected for inclusion in this study:

⁴ The economic threshold value is related to the cost of new avoided electrical supply. The values for each supply system were selected to provide the CPR study with a reasonably useful time horizon (life) to allow planners to examine options that may become more cost effective over time.

- **Annual Peak Hour** – This has traditionally been the hour ending at 6 pm on a day in December; it is highly correlated with the coldest day of the year when occurring in December, although it has sometimes occurred in January.
- **Evening Peak** – The 4-8 pm period on the coldest four days of the year when occurring in December or January (total 16 hours).
- **Morning Peak** – The 7-9 am period on the 10 coldest days of the year when occurring in December or January (total 20 hours).

1.7 Report Organization

This report is Report 4 in Exhibit 1, above, and is organized as follows:

- Section 2 presents the combined electric energy and peak load savings for the two sectors from technology adoption and O&M measures.
- Sections 3 and 4 present a summary of the electric energy and peak load savings from technology adoption for the Residential and Commercial sectors, respectively.
- Section 5 presents a summary of the electric energy savings from small-scale customer-supplied renewable and alternative energies in the Residential and Commercial sectors.

2 Summary of Findings

CPR 2011 confirms that significant cost-effective electric energy and peak load savings opportunities exist in both the Residential and Commercial sectors.

To determine the total electric energy and peak load savings potential, this study combined the results contained in each of the stand-alone sector reports included in Analysis Area 1, as depicted in Exhibit 1.

The combined results presented in this section are net of overlapping measures that, if simply summed, would result in double counting of results. In addition, all savings are reported at the customer meter and do not include line losses. Results from Analysis Areas 2 (Customer-side Renewable and Alternative Energy) are not included in the calculation of combined savings as these measures also fundamentally alter the load forecast.

Additional Achievable Potential electricity savings are likely available from electrical efficiency technologies and measures that become commercially viable beyond 2015, or step changes in energy-efficient technologies that are not reflected in the following results. Finally, supply-side efficiency improvements in Yukon utility supply systems could provide additional electricity savings, which are not included here.

2.1 Electric Energy Savings

Exhibit 3 and Exhibit 4 summarize the total combined Achievable Potential electric energy savings that have been identified in each of the stand-alone Commercial and Residential sector reports (Analysis Area 1). As illustrated:

- In the upper Achievable Potential scenario, electricity savings are about 16,000 MWh/yr. in 2015 and increase to about 97,000 MWh/yr. by 2030.
- In the lower Achievable Potential scenario, electricity savings are about 11,000 MWh/yr. in 2015 and increase to about 66,000 MWh/yr. by 2030.
- In the Reference Case, total electricity consumption increases from approximately 312,000 MWh/yr. in 2010 to about 515,000 MWh/yr. by 2030, an increase of about 65%.
- In the combined upper Achievable Potential scenario, the electricity savings of 97,000 MWh/yr. in 2030 means that the total electricity consumption would increase to about 418,000 MWh/yr., a decrease of about 18% relative to the Reference Case.
- In the combined lower Achievable Potential scenario, the electricity savings of 11,000 MWh/yr. in 2030 means that the total electricity consumption would increase to about 450,000 MWh/yr., a decrease of about 13% relative to the Reference Case.

Exhibit 3 Combined Annual Electricity Consumption—Energy-efficiency Economic and Achievable Potential Relative to Reference Case Forecast, (MWh/yr.)

Milestone Year	Annual Consumption, Combined				Potential Annual Savings, Combined					
			Achievable Potential				Achievable Potential			
	Reference Case	Economic Potential	Upper	Lower	Economic Potential		Upper		Lower	
	MWh/yr.	MWh/yr.	MWh/yr.	MWh/yr.	MWh/yr.	%	MWh/yr.	%	MWh/yr.	%
	(A)	(B)	(C)	(D)	(A-B)		(A-C)		(A-D)	
2010	312,117									
2015	345,540	243,694	329,304	334,560	101,846	29%	16,236	5%	10,980	3%
2020	387,814	266,823	350,883	362,814	120,991	31%	36,931	10%	25,000	6%
2025	443,564	300,607	381,949	401,819	142,957	32%	61,615	14%	41,745	9%
2030	515,412	347,760	418,496	449,556	167,652	33%	96,916	19%	65,856	13%

Exhibit 4 Annual Electricity Consumption—Energy-efficiency Achievable Potential Relative to Reference Case and Economic Potential Forecast, (MWh/yr.)

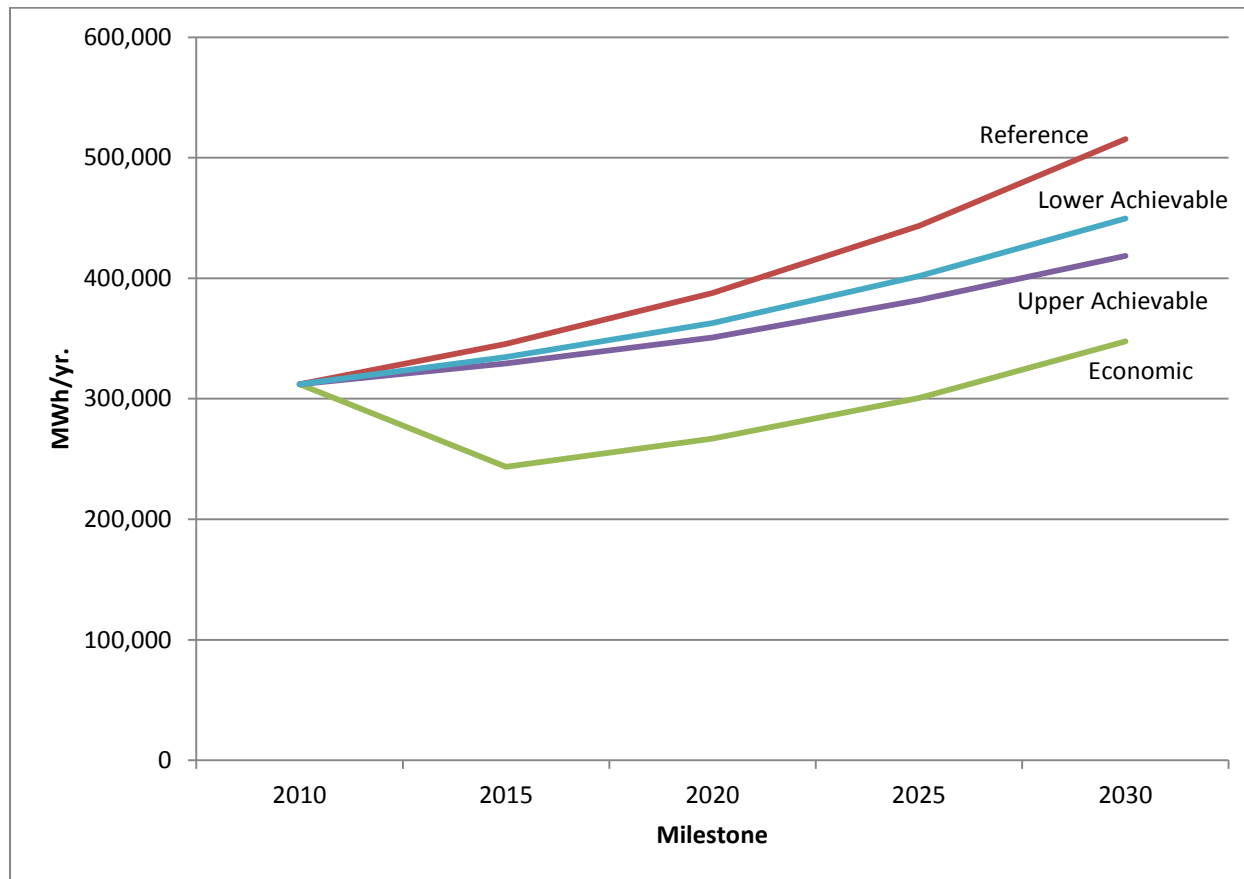
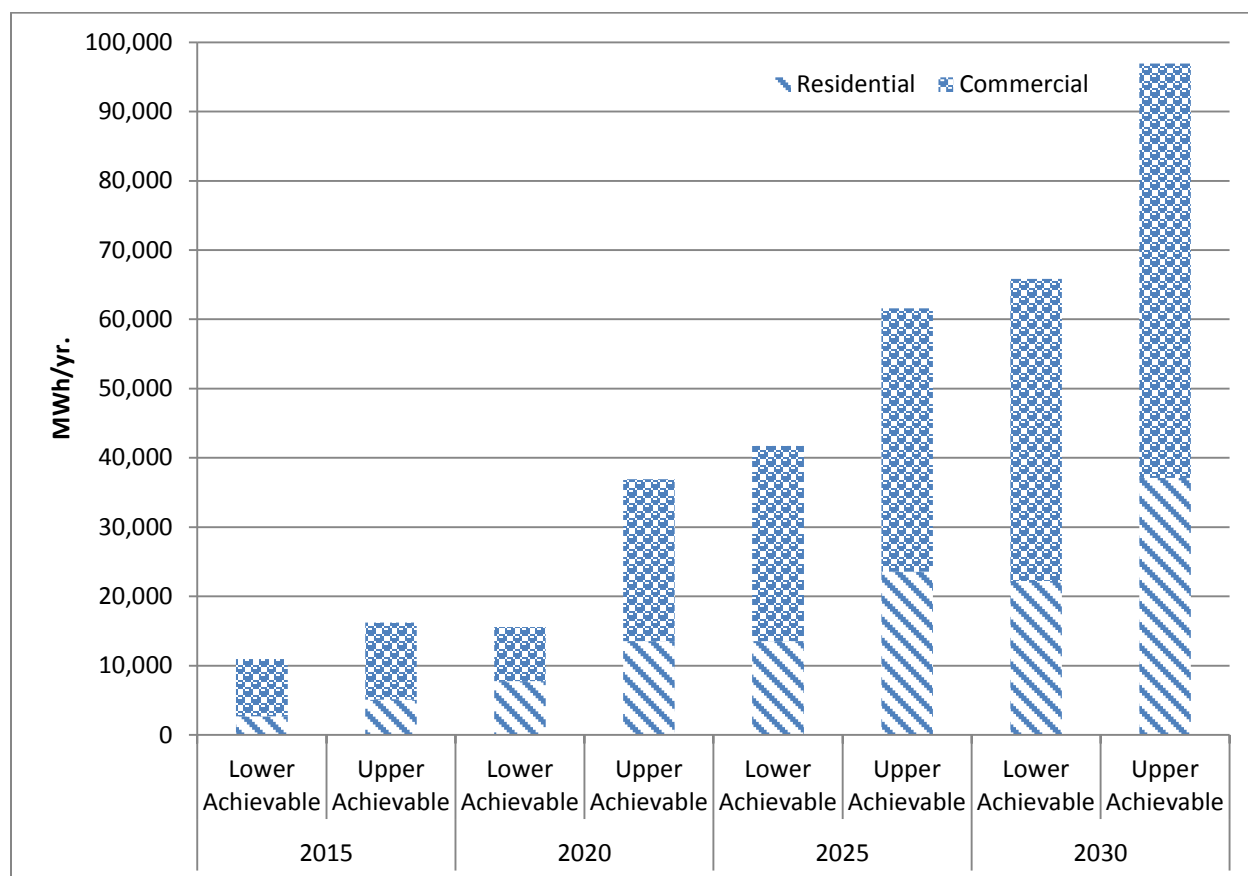


Exhibit 5 indicates how the upper and lower Achievable savings are distributed by sector. The potential savings in the Commercial sector are slightly larger than those in the Residential sector.

Exhibit 5 Upper and Lower Achievable Electricity Consumption Savings by Sector (MWh/yr.)



2.2 Electric Peak Load Savings

This study also confirmed that significant cost-effective opportunities exist for peak load savings during each of the three peak periods. The peak load savings considered in this study are those that result from electric energy savings measures.

For the purposes of this report, the results for the Annual Peak Hour are presented in Exhibit 6; details for the other two peak periods are provided in each of the stand-alone reports listed at the end of this section

As illustrated in Exhibit 6:

- In the Base Year 2010, the peak load was approximately 64 MW for the Annual Peak Hour.
- In the absence of new DSM initiatives, the study estimates that the total peak load in the Annual Peak Hour will grow to about 107 MW by 2030, an increase of about 67%.

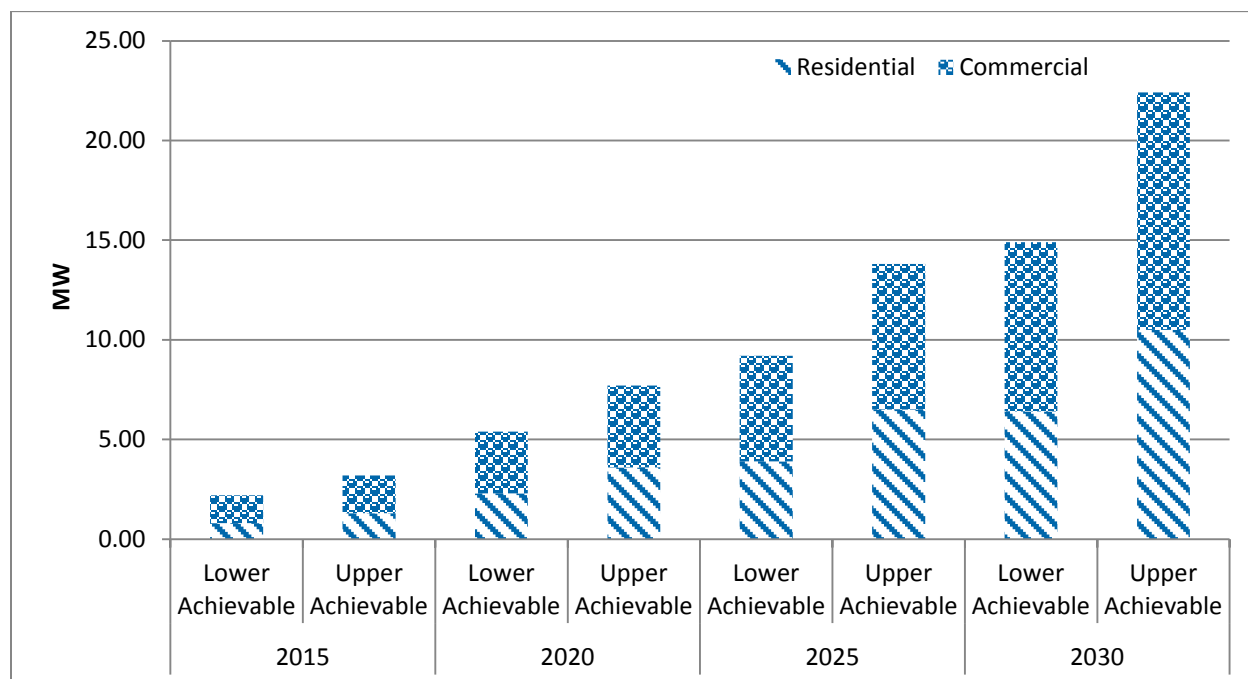
- Electric energy savings would provide peak load savings of approximately 22 MW (21%) and 15 MW (14%) during the Annual Peak Hour by 2030 in, respectively, the upper and lower Achievable Potential scenarios.

Exhibit 6 Combined Peak Load Reductions for the Annual Peak Hour, from Electric Energy Savings Measures, Reference Case, Economic and Achievable Scenarios (MW)

Milestone Year	Average Peak Load (MW)	Peak Load Savings (MW, %)					
	Reference Case	Economic Case		Upper Achievable		Lower Achievable	
2010	64.4						
2015	71.9	22.8	32%	3.2	4%	2.2	3%
2020	81.1	26.9	33%	7.7	9%	5.4	7%
2025	92.7	31.7	34%	13.8	15%	9.2	10%
2030	107.4	37.1	35%	22.4	21%	14.9	14%

Exhibit 7 shows how the Annual Peak Hour potential savings are distributed between the Residential and Commercial sectors. Consistent with the energy savings, the Commercial sector peak savings are slightly larger than those for the Residential Sector

Exhibit 7 Upper and Lower Achievable Annual Peak Hour Reductions by Sector (MW)



2.3 Additional Information

The combined potential electricity savings results presented in this section are based on the detailed data and analysis contained in the reports listed below. The reader is referred to these reports for additional information:

- *Yukon Electricity Conservation and Demand Management Potential Review (CPR 2011): Residential Sector*
- *Yukon Electricity Conservation and Demand Management Potential Review (CPR 2011): Commercial Sector*
- *Yukon Electricity Conservation and Demand Management Potential Review (CPR 2011): Customer-side Renewable and Alternative Energy*

2.4 Caveats

The CPR 2011's scope was limited to the two analysis areas outlined in Section 1.3. Within each analysis area, analysis was limited to known or expected technologies and measures for which sufficient information was available. Estimates of combined Achievable Potential savings were limited to Analysis Area 1. As a result, additional electricity savings beyond those identified in the combined Achievable Potential are likely feasible. These additional savings could come from electrical efficiency technologies and measures not reflected in the CPR, including those that become commercially viable beyond 2015 or through step changes in energy-efficient technologies. They could also come from behaviour changes, customer-supplied renewable or alternative energy use, or fuel switching. Finally, they could come from supply-side efficiency improvements within Yukon's electrical systems.

As in any study of this type, the results presented in this report are based on a number of important assumptions. Assumptions such as those related to the current penetration of efficient technologies and the rate of future growth in the economy and the stock of buildings are particularly influential. Wherever possible, the assumptions used in this study are consistent with the Yukon load forecast, discount rates and economic threshold price.

This summary describes the key assumptions underlying the report. However, the full text of the individual sector reports contain a number of specific definitions and cautions that could influence the interpretation of the results. Readers should review the full texts before drawing any conclusions based on this summary.

3 Residential Sector

The Residential sector includes single-family detached homes, attached and row homes, apartment and condo buildings and mobile homes. Seasonal homes and separately-metered garages are also included as distinct sub sectors.

3.1 Approach

The detailed end-use analysis of electric energy in the Residential sector employed two linked modelling platforms: HOT2000, a Natural Resources Canada supported residential building energy-use simulation software, and RSEEM (Residential Sector Energy End-use Model), an ICF Marbek in-house spreadsheet-based macro model. Peak load savings were modelled using Lopes Consulting Services' Cross-Sector Load Shape Library Model (LOADLIB).

The major steps in the general approach to the study are outlined in Section 1.4. Specific procedures for the Residential sector were as follows:

Modelling of Base Year

Utility customer billing data, and, to a lesser extent, housing data from the Yukon Housing Corporation and the results of Yukon's Residential Electrical End-Use Survey (REEUS), were used to break down the Residential sector by three factors:

- Type of dwelling (single detached, attached or row house, apartment, etc.)
- Heating category (electric or non-electric heat)
- Vintage (age of the building).

To estimate the electric energy used for space heating, the consultants factored in building characteristics such as insulation and air-tightness using the EnerGuide for Houses database as well as climate data. They also used Yukon survey data on hot water heaters, appliances, lights, etc. to estimate electricity consumption for these end uses. The resulting average total electricity use per dwelling was then calibrated to actual Yukon utility data by adjusting assumptions about the individual electric end uses to produce the correct totals. HOT2000 models were developed to match the calibrated average consumption per dwelling; these later served as baselines to estimate the savings from building shell improvement measures.

To estimate the peak loads in each of the three peak periods, the consultants developed a series of factors, based on measured load data for the major dwelling types and end uses, which provide the basis for converting annual energy to any hourly demand specified, including the grouping of hours used in the three peak periods defined in this study.

Reference Case Calculations

For the Residential sector, the consultants developed detailed profiles of new buildings for each type of dwelling. They estimated the growth in building stock and estimated the amount of electricity used by both the existing building stock and the projected new buildings and appliances. In doing so, they incorporated the energy savings that would be expected to occur naturally due to improvements to thermal characteristics of existing homes and appliances over the study period. As with the Base Year calibration, the consultants' projection closely matches Yukon utility forecasts of future electricity requirements.

Assessment of Electric Energy Savings Options Technologies

To estimate the Economic and Achievable electric energy and peak savings potentials, the consultants assessed technologies such as:

- Improved lighting systems
- Reduced standby losses in computers and electronic equipment
- Improved designs for new buildings
- Upgrades to the basement walls, windows and air leakage sealing of existing buildings
- Improved space heating and cooling equipment
- Improved ventilation fans and furnace blowers
- Improved water heaters and devices to reduce hot water use
- More efficient household appliances and other plug-in equipment.

Assessment of Capacity-Only Peak Load Reduction Options

To evaluate the additional peak load reduction potentials resulting from capacity-only measures, the options assessed included utility control of water heating equipment, engine block heating, non-essential lighting, overridable utility control of non-essential plug loads, and electric thermal storage.

3.2 Summary of Electric Energy Savings

A summary of the levels of annual electricity consumption contained in each of the Residential sector forecasts addressed by this study is presented in Exhibit 8 and Exhibit 9 by milestone year. These results, net of any double counting, are included in the combined savings levels presented previously in Section 2. Highlights of this analysis include:

- Electric energy savings from electrical efficiency improvements would provide between 22,000 and 37,000 MWh/yr. of electricity savings by 2030 in, respectively, the lower and upper Achievable scenarios. The most significant Achievable savings opportunities were in the actions that addressed space heating. Significant savings were also found in domestic hot water (DHW) systems, clothes dryers,⁵ standby load in household electronics (e.g., computers and their peripherals, televisions, and other home entertainment electronics), and 13 other end uses.
- The electric energy savings noted above would provide peak load savings of approximately 6.4 to 10.5 MW during Yukon's annual system peak hour by 2030 in, respectively, the lower and upper Achievable scenarios.⁶

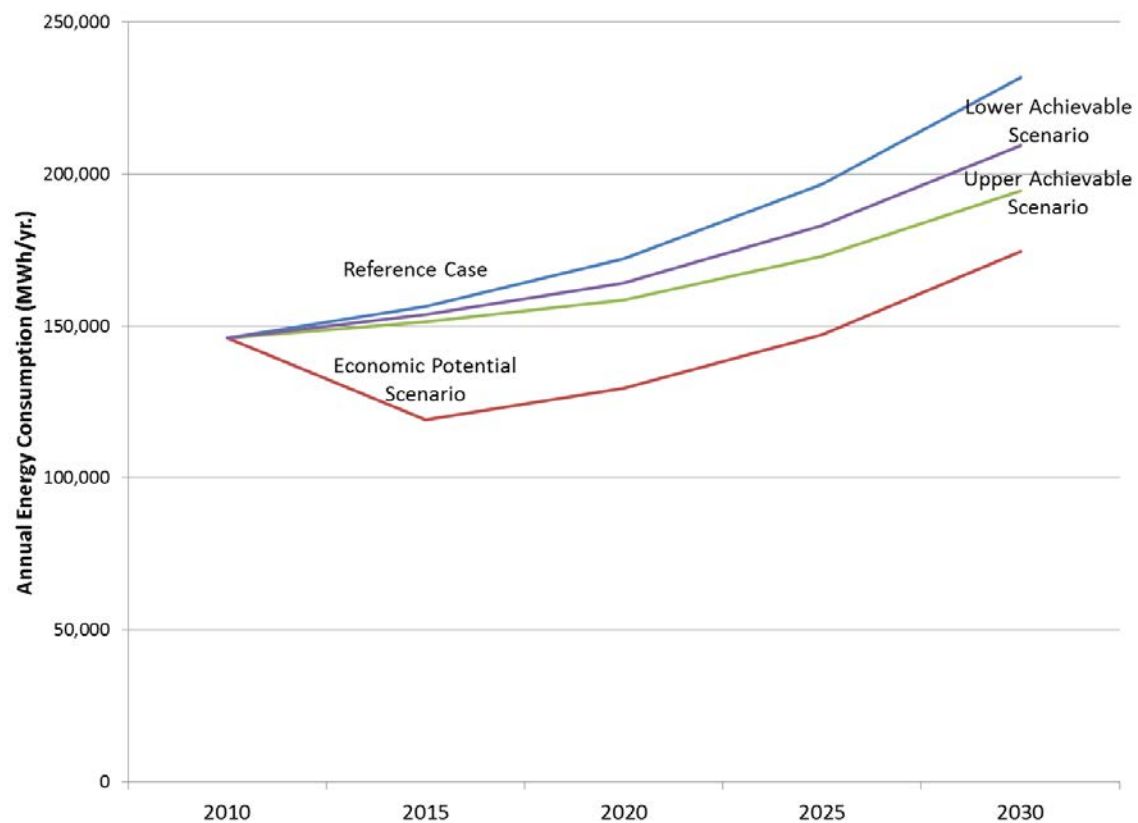
⁵ Savings in the clothes dryers result from the faster spin cycle in energy-efficient clothes washers. Spinning the clothes more thoroughly in the washer reduces the runtime of the clothes dryer.

⁶ These reduction estimates do not include the change in load shape that results when timers are used on block heaters. In fact, if timers are used, close to 90% of the peak load caused by block heaters would be eliminated because the block heater load at most homes with timers would not begin until the early hours of the morning. At the same time, the figures include an overestimate of peak impact from space heating measures because the heat pump measures do not offer demand reductions. These effects almost cancel out: the range of peak savings is between 6.6 MW and 9.9 MW if they are included.

Exhibit 8 Annual Electricity Consumption—Energy-efficiency Economic and Achievable Potential Relative to Reference Case Forecast for the Residential Sector, (MWh/yr.)

Milestone Year	Annual Consumption, Residential				Potential Annual Savings, Residential					
			Achievable Potential				Achievable Potential			
	Reference Case	Economic Potential	Upper	Lower	Economic Potential		Upper		Lower	
	MWh/yr.	MWh/yr.	MWh/yr.	MWh/yr.	MWh/yr.	%	MWh/yr.	%	MWh/yr.	%
	(A)	(B)	(C)	(D)	(A-B)		(A-C)		(A-D)	
2010	145,984									
2015	156,505	119,271	151,391	153,794	37,234	24%	5,114	3%	2,711	2%
2020	172,039	129,467	158,485	164,247	42,572	25%	13,554	8%	7,792	5%
2025	196,519	147,104	172,921	182,980	49,415	25%	23,598	12%	13,539	7%
2030	231,739	174,493	194,642	209,500	57,246	25%	37,097	16%	22,239	10%

Exhibit 9 Annual Electricity Consumption—Energy-efficiency Achievable Potential Relative to Reference Case and Economic Potential Forecast for the Residential Sector, (MWh/yr.)



Base Year Electricity Use

In the Base Year of 2010, Yukon's Residential sector consumed about 146,000 MWh. Exhibit 10, below, shows that DHW and space heating each account for about 19% of total residential electricity use. These are followed by spa heaters and pumps with about 9%, indoor lighting with 8%, and computers (with their peripherals) and clothes dryers with about 7% each. Refrigerators account for 6%, followed by cooking, ventilation/circulation, and freezers with 4% each. Other end uses account for 3% or less of the total.

Exhibit 11, also below, shows the distribution of Base Year electricity consumption by dwelling type. As illustrated, single detached housing dwellings account for the largest share (72%) of Residential sector Base Year electricity use.

Reference Case

In the absence of new DSM initiatives, CPR 2011 estimates that electricity consumption in the Residential sector will grow from 146,000 MWh/yr. in 2010 to about 232,000 MWh/yr. by 2030. Exhibit 10 and Exhibit 11 below show the year 2030 Reference Case consumption breakdown by end use and dwelling type. The overall growth is about 59% in the period and is higher than the forecast set out in YEC's 20-Year Resource Plan – 2011. This is largely because projections of construction of electrically heated residential dwellings have been revised since the publication of that forecast.

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Exhibit 10 Base Year and 2030 Reference Case Year Electricity Use by End Use, Residential Sector

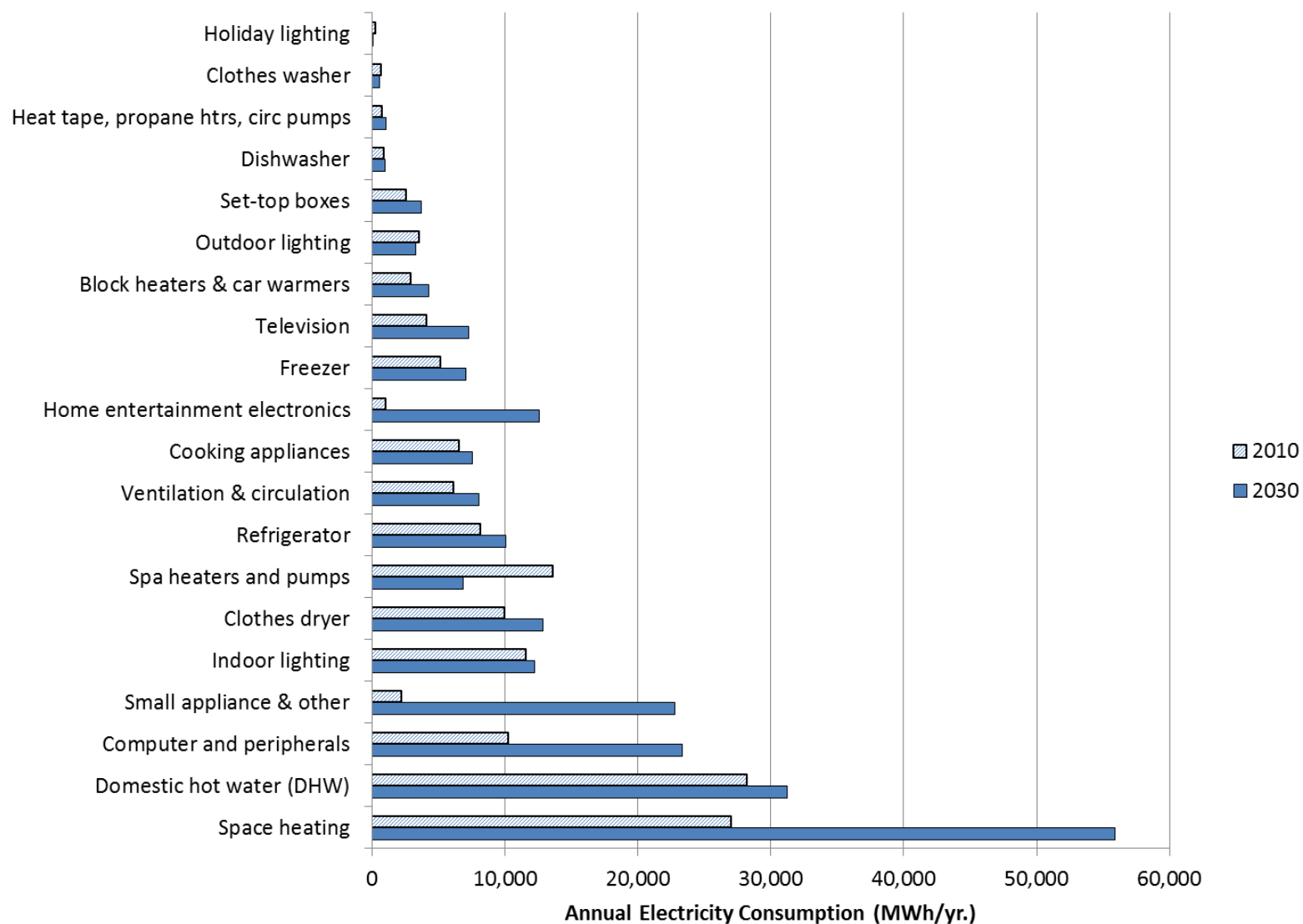
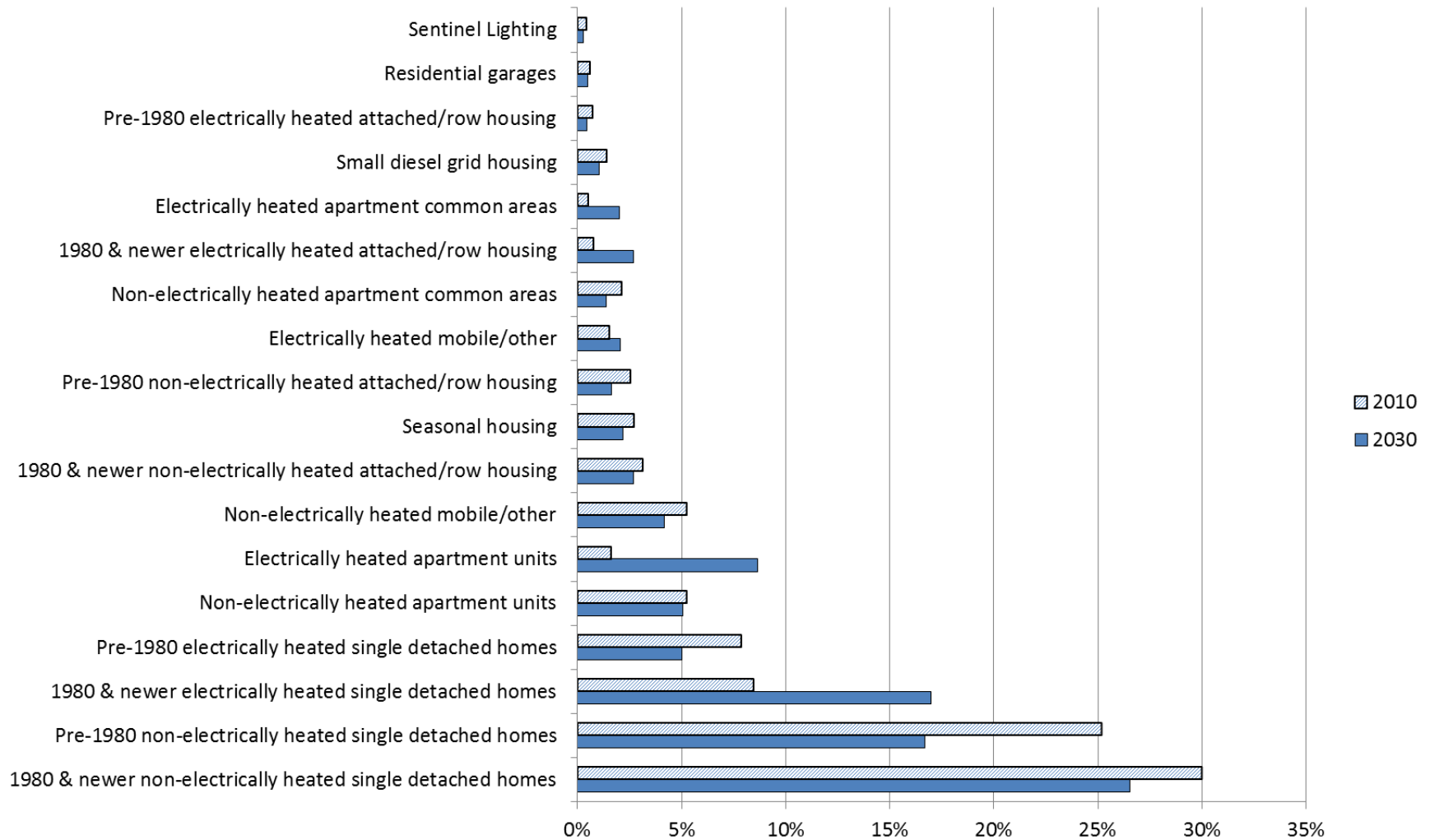


Exhibit 11 Base Year and 2030 Reference Case Year Electricity Use by Dwelling Type, Residential Sector



Economic Potential Forecast

Under the conditions of the Economic Potential Forecast, the study estimated that electricity consumption in the Residential sector would grow to about 174,000 MWh/yr. by 2030. Annual savings relative to the Reference Case are 57,000 MWh/yr. or about 25%. The Economic Potential annual savings in the intermediate milestone years are 37,000 MWh/yr. in 2015, 43,000 MWh/yr. in 2020, and 49,000 MWh/yr. in 2025.

Achievable Potential

In the Residential sector, the Achievable Potential for electric energy savings through technology adoption was estimated to be 22,000 MWh/yr. and 37,000 MWh/yr. by 2030 in, respectively, the lower and upper scenarios.

Consistent with the results in the Economic Potential Forecast, the most significant Achievable savings opportunities were in the actions that addressed space heating. Significant savings can also be found in DHW, clothes dryers, standby load in household electronics (e.g., computers and their peripherals, televisions and other home entertainment electronics), and 13 other end uses.

3.3 Summary of Peak Load Savings

This study assessed the electric peak load reduction for each of the three peak periods resulting from electric energy savings measures.

Exhibit 12 provides a summary of the peak load savings from the electric energy savings, for the Annual Peak Hour. Details for the other two peak periods are provided in the main body of the Residential sector report. In each case, the reductions are an average value over the peak period and are defined relative to the Reference Case.

Exhibit 12 Residential Peak Load Reductions for the Annual Peak Hour, from Electric Energy-savings Measures, Reference Case, Economic and Achievable Scenarios (MW)

Milestone Year	Average Peak Load (MW)	Peak Load Savings (MW, %)					
		Economic Case		Upper Achievable		Lower Achievable	
2010	34.5						
2015	37.3	10.0	27%	1.3	3%	0.8	2%
2020	41.2	11.3	27%	3.6	9%	2.3	6%
2025	46.6	13.0	28%	6.5	14%	3.9	8%
2030	54	14.9	28%	10.5	19%	6.4	12%

Highlights of the peak load savings are:

- In the Base Year 2010, the peak load for Yukon's total Residential sector was approximately 34.5 MW for the Annual Peak Hour.

- The study estimates that the Residential sector peak load in the Annual Peak Hour will grow to 54 MW by 2030, an increase of about 57%
- Electric energy savings would provide peak load savings of approximately 6.4 to 10.5 MW during Yukon's annual system peak hour by 2030 in, respectively, the lower and upper Achievable scenarios.

3.4 Additional Information

Additional information on the summary results presented above is available in the main Residential sector report and accompanying appendices entitled:

- *Yukon Electricity Conservation and Demand Management Potential Review (CPR 2011): Residential Sector*

4 Commercial Sector

The Commercial sector includes office and retail buildings, hotels and motels, restaurants, warehouses and a wide variety of small buildings. In this study, it also includes buildings that are often classified as “institutional,” such as health and educational buildings. Throughout this report, use of the word “commercial” includes both commercial and institutional buildings unless otherwise noted. The Commercial sector also includes some non-building electricity uses such as microwave repeater stations and telephone exchange buildings. Buildings or plants where energy use is primarily process driven (e.g., mines) are outside the scope of this study.

4.1 Approach

The detailed end-use analysis of electric energy use in the Commercial sector employed two linked modelling platforms: CEEAM (Commercial Electricity and Emissions Analysis Model), an in-house simulation model developed in conjunction with Natural Resources Canada for modelling electricity use in commercial and industrial buildings, and CSEEM (Commercial Sector Electricity End-use Model), an in-house spreadsheet-based macro model. Peak load savings were modelled using Lopes Consulting Services’ Cross-Sector Load Shape Library Model (LOADLIB).

The major steps in the general approach to the study are outlined in Section 1.4. Specific procedures for the Commercial sector were as follows:

Modelling of Base Year

The consultants created building energy-use simulations for nine of the building types. These models were then calibrated to reflect actual Yukon customer sales data. Estimated savings for the Other General Service Buildings⁷ and non-buildings categories were derived from the results of the modelled segments. These building categories were not modelled because they are extremely diverse and the electricity use of individual categories is relatively small.

Reference Case Calculations

Detailed profiles of new buildings in each of the building segments were then created, and building stock changes and “natural” changes affecting electricity consumption over the study period were estimated. These estimates were then adjusted to generate electricity totals that match the Yukon future electricity requirement forecast.

Assessment of Electric Energy-savings Options

To estimate the Economic and Achievable electric energy and peak savings potentials, the consultants assessed technologies such as:

- More efficient lighting and office equipment
- Improved construction in new buildings and building shell upgrades to existing buildings
- Upgraded domestic hot water, refrigeration, and heating, ventilating and cooling systems

⁷ Other General Service Buildings sub sector represents buildings that do not fit into specific sub sectors, such as churches, theatres, service stations and transportation buildings, as well as buildings with a significant “process” load such as placer mines, manufacturing facilities and light industrial facilities.

- Whole building recommissioning
- Measures specific to recreation centres such as low-emissivity ceilings and refrigeration plant controls.

Assessment of Capacity-only Peak Load Reduction Options

To evaluate the additional peak load reduction potentials resulting from capacity-only measures, the consultants assessed options including utility control of water heating equipment, engine block heating, non-essential lighting, overridable utility control of non-essential plug loads, electric thermal storage, and occupancy-controlled heating system circuits.

4.2 Summary of Electric Energy Savings

A summary of the levels of annual electricity consumption contained in each of the forecasts addressed by this study is presented in Exhibit 13 and Exhibit 14. These results, net of any double counting, are included in the combined savings levels presented previously in Section 2. Further discussion is provided in the paragraphs below.

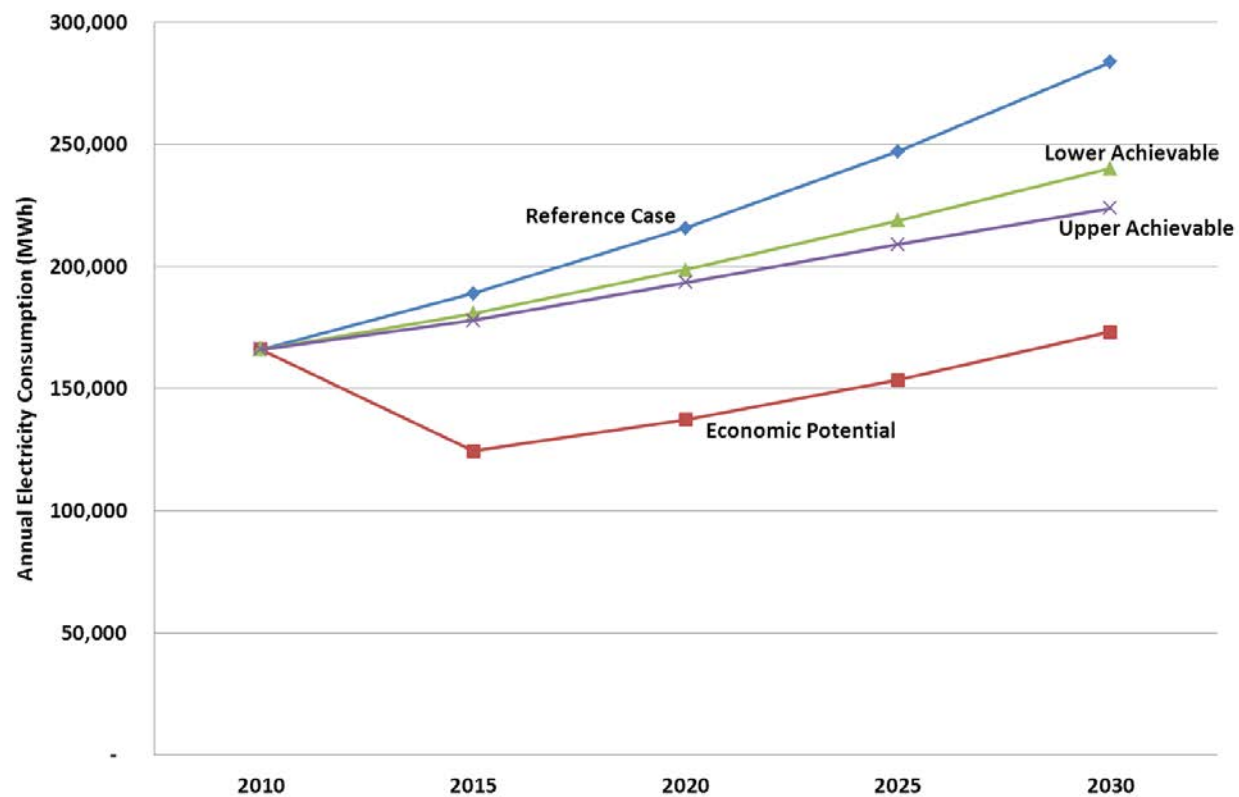
Electric energy savings from electrical efficiency improvements would provide between 44,000 and 60,000 MWh/yr. of electricity savings by 2030 in, respectively, the lower and upper Achievable scenarios. The most significant Achievable savings opportunities addressed indoor lighting and space heating. Significant savings were also found in refrigeration equipment, computer equipment and HVAC fan & pumps.

The electric energy savings noted above would provide peak load savings of approximately 8.5 to 11.9 MW during Yukon's annual system peak hour by 2030 in, respectively, the lower and upper Achievable scenarios.

Exhibit 13 Annual Electricity Consumption—Energy-efficiency Achievable Potential Relative to Reference Case and Economic Potential Forecast for the Commercial Sector (MWh/yr.)

Milestone Year	Annual Consumption, Commercial				Potential Annual Savings, Commercial					
			Achievable Potential				Achievable Potential			
	Reference Case	Economic Potential	Upper	Lower	Economic Potential		Upper		Lower	
	MWh/yr.	MWh/yr.	MWh/yr.	MWh/yr.	MWh/yr.	%	MWh/yr.	%	MWh/yr.	%
	(A)	(B)	(C)	(D)	(A-B)		(A-C)		(A-D)	
2010	166,133									
2015	189,035	124,423	177,913	180,766	64,612	34%	11,122	6%	8,269	4%
2020	215,775	137,356	192,398	198,567	78,419	36%	23,377	11%	17,208	8%
2025	247,045	153,503	209,028	218,839	93,542	38%	38,017	15%	28,206	11%
2030	283,673	173,267	223,854	240,056	110,406	39%	59,819	21%	43,617	15%

Exhibit 14 Annual Electricity Consumption—Energy-efficiency Achievable Potential Relative to Reference Case and Economic Potential Forecast for the Commercial Sector (MWh/yr.)



Base Year Electricity Use

In the Base Year of 2010, Yukon's Commercial sector consumed about 166,000 MWh. Exhibit 15, below, shows that lighting is the largest Commercial sector end use, accounting for approximately 37% of total Commercial sector electricity use. Indoor lighting, which consists of general, architectural and high-bay lighting, accounts for approximately 34%, while outdoor lighting accounts for the remaining 3% of lighting use. HVAC end uses (space heating, space cooling and HVAC fans & pumps) account for 22% of Base Year electricity use. Cooking equipment, domestic water heating and a number of smaller end uses account for the remaining Commercial sector electricity use. Non-building loads are treated as both an end use and sub sector in this analysis. These loads account for 13% of Commercial sector end-use electricity consumption.

Exhibit 16, also below, shows the distribution of Base Year electricity consumption by sub sector. As illustrated, Other General Service Buildings account for the largest share of electricity use within the building sub sectors (18%), followed by Office (14%), and Education, Warehouse/Wholesale and Non-food Retail at 9% each. Non-buildings account for 13% of Base Year Commercial sector electricity use.

Reference Case

In the absence of new DSM initiatives, CPR 2011 estimates that electricity consumption in the Commercial sector will grow from 166,000 MWh/yr. in 2010 to about 284,000 MWh/yr. by 2030. Electricity use breakdown by end use and sub sector are shown in Exhibit 15 and Exhibit 16. This represents an overall growth of about 71% in the period and is higher than the forecast set out in YEC's 20-Year Resource Plan – 2011. This is largely because projections of construction of electrically heated commercial buildings have been revised since the publication of that forecast.

Exhibit 15 Base Year and 2030 Reference Year Electricity Use by End Use, Commercial Sector

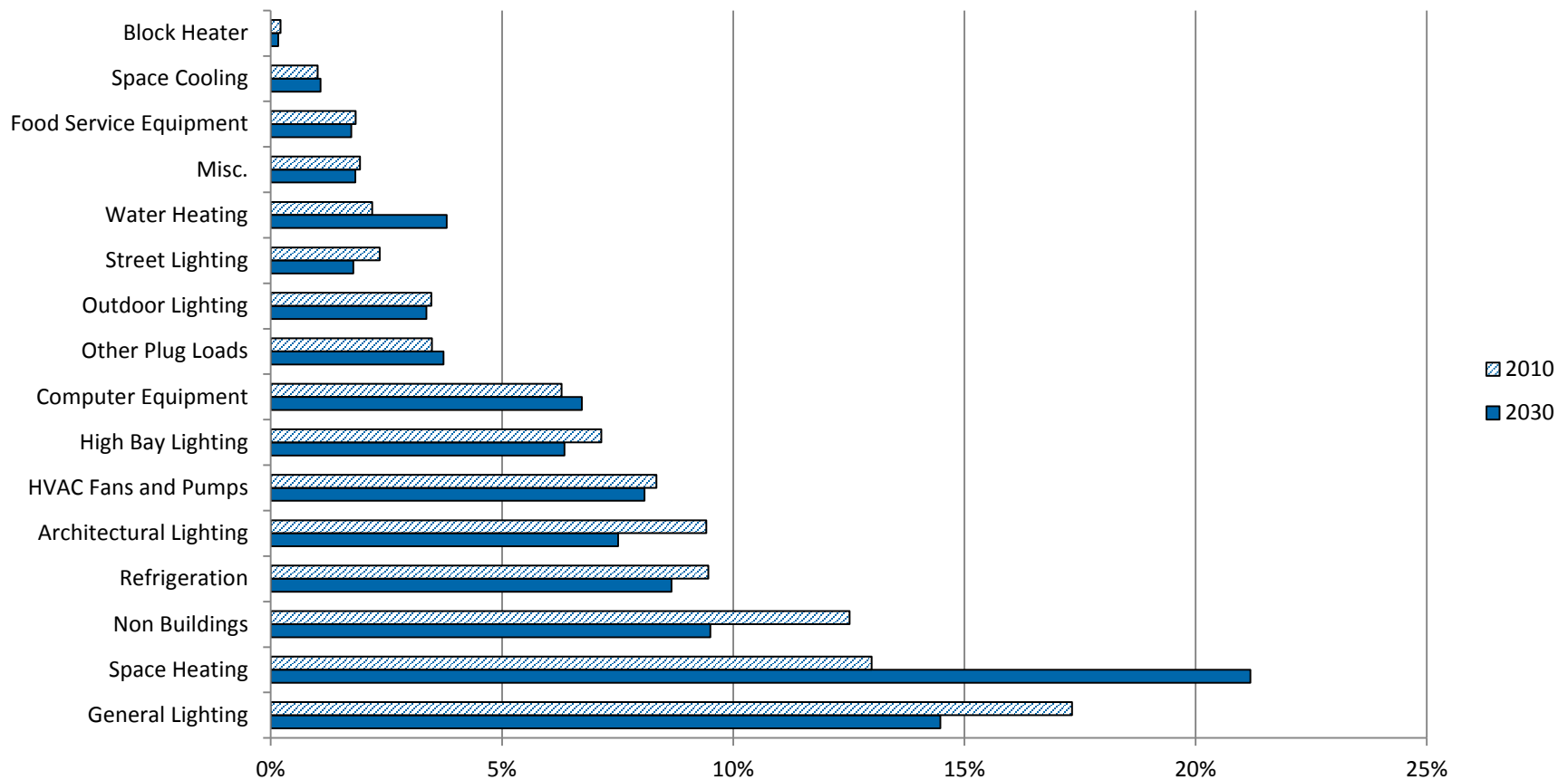
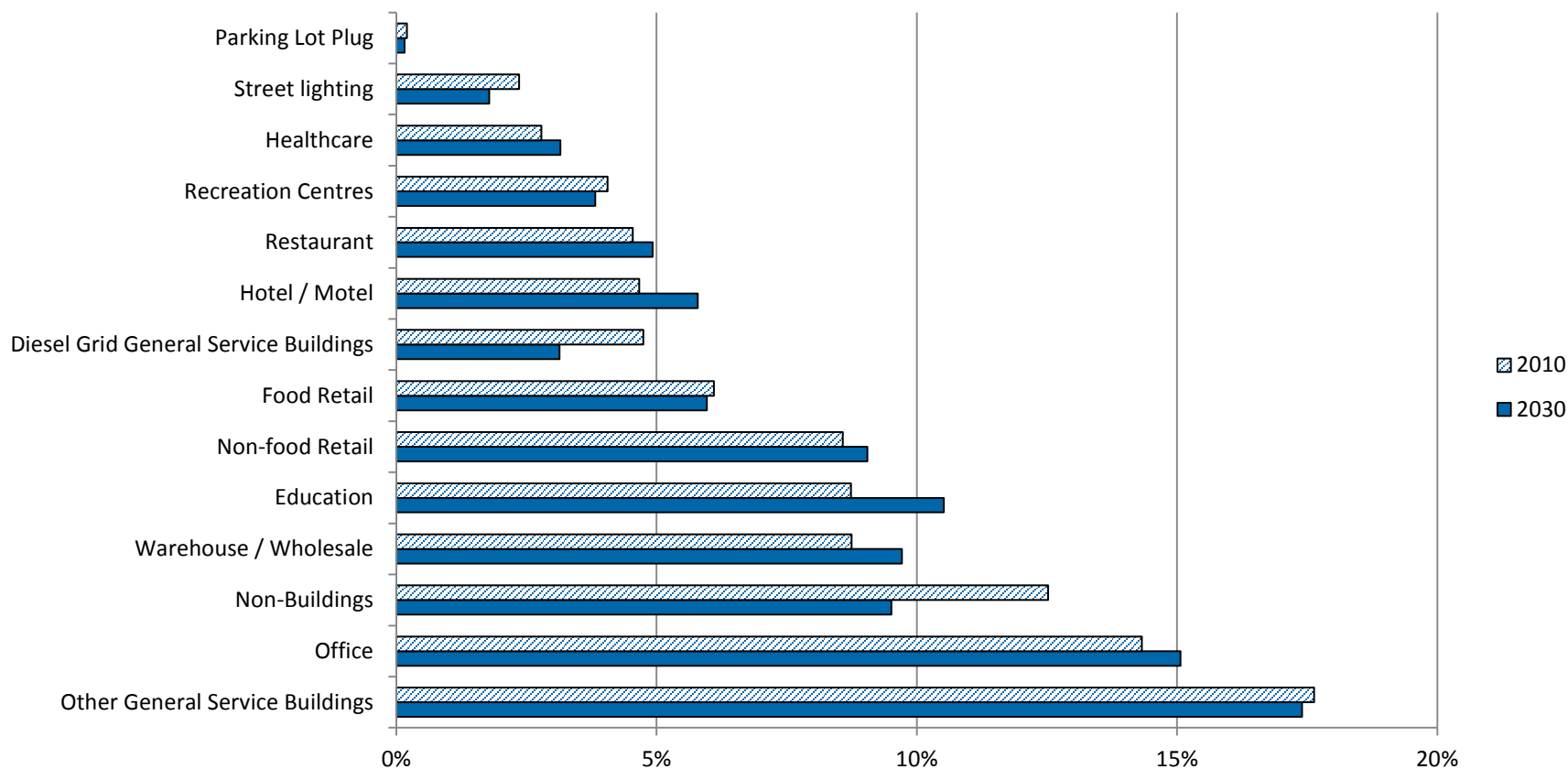


Exhibit 16 Base Year and 2030 Reference Year Electricity Use by Sub Sector, Commercial Sector



Economic Potential Forecast

Under the conditions of the Economic Potential Forecast, the study estimated that electricity consumption in the Commercial sector would grow to about 173,000 MWh/yr. by 2030. Annual savings relative to the Reference Case are 110,000 MWh/yr., or about 39%. The Economic Potential annual savings in the intermediate milestone years are 65,000 MWh/yr. in 2015, 78,000 MWh/yr. in 2020, and 94,000 MWh/yr. in 2025.

Achievable Potential

In the Commercial sector, the Achievable Potential for electric energy savings through technology adoption was estimated to be 44,000 MWh/yr. and 60,000 MWh/yr. by 2030 in, respectively, the lower and upper scenarios.

Consistent with the results in the Economic Potential Forecast, the most significant Achievable savings opportunities were in the actions that addressed indoor lighting and space heating.

4.3 Summary of Peak Load Savings

This study assessed the electric peak load reduction on each of the three peak periods resulting from electric energy savings measures. Exhibit 17 provides a summary of the peak load savings from the electric energy savings for the Annual Peak Hour. Details for the other two peak periods are provided in the main body of the Commercial sector report. In each case, the reductions are an average value over the peak period and are defined relative to the Reference Case.

Exhibit 17 Commercial Peak Load Reductions for the Annual Peak Hour, from Electric Energy-savings Measures, Reference Case, Economic and Achievable Scenarios (MW)

Milestone Year	Average Peak Load (MW)	Peak Load Savings (MW,%)					
	Reference Case	Economic Case		Upper Achievable		Lower Achievable	
2010	29.9						
2015	34.6	12.8	37%	1.9	5%	1.4	4%
2020	39.9	15.6	39%	4.1	10%	3.1	8%
2025	46.1	18.7	41%	7.3	16%	5.3	11%
2030	53.4	22.2	42%	11.9	22%	8.5	16%

Highlights of the peak load savings shown are presented below:

- In the Base Year 2010, the peak load for Yukon's total Residential sector was approximately 29.9 MW for the Annual Peak Hour
- The study estimates that the Commercial sector peak load in the Annual Peak Hour will grow to 53 MW by 2030, an increase of about 78%

- Electric energy savings would provide peak load savings of approximately 8.5 to 11.9 MW during Yukon's annual system peak hour by 2030 in, respectively, the lower and upper Achievable scenarios.

4.4 Additional Information

Additional information on the summary results presented above is available in the main report and accompanying appendices entitled:

- *Yukon Electricity Conservation and Demand Management Potential Review (CPR 2011): Commercial Sector*

5 Customer-side Renewable and Alternative Energy Technologies

This component of the study addressed a selected number of small-scale customer-side renewable or alternative energy (CSRAE) technologies that were identified in consultation with YEC, YECL and the Government of Yukon. They include solar photovoltaic (PV), solar domestic hot water heating, wood-pellet burning furnaces in the Residential sector and wood-pellet burning boilers in the Commercial sector.

For the purposes of this study, small-scale was defined as suitable for application at the level of an individual residential dwelling or commercial facility that is connected to the power grid. Specific system size assumptions are defined in the main CSRAE report, which is identified at the end of this section.

5.1 Approach

The CSRAE measures were modeled using the RETScreen model at the level of individual application. RETScreen is a modelling tool developed and maintained by Natural Resources Canada specifically for analyzing renewable energy systems such as those addressed by this study.

The potential contribution of CSRAE measures to electricity savings in the Residential and Commercial sectors used the same definitions of building types and end uses as used in the other study analysis areas and aggregated in the RSEEM (Residential Sector Energy End-use Model) and CSEEM (Commercial Sector Electricity End-use Model) models.

The major steps in the general approach to the study are outlined in Section 1.4. Specific procedures for the CSRAE options were as follows:

- Step 1: Select candidate CSRAE technologies
- Step 2: Define “typical” small-scale applications
- Step 3: Estimate Yukon resource potential for each CSRAE technology
- Step 4: Model the potential energy production for each CSRAE technology
- Step 5: Establish the current cost and performance data for each CSRAE technology
- Step 6: Calculate the levelized cost of energy production or conservation for each CSRAE technology
- Step 7: Estimate the “unbundled” Technical, Economic and Achievable Potentials for each CSRAE technology.

5.2 Summary of Electric Energy Savings

A summary of the potential levels of savings in purchased electric energy provided by the CSRAE technologies is presented in Exhibit 18. By 2030, the potential reduction in purchased electricity from the use of CSRAE technologies was estimated to be approximately 18,030 MWh/yr. for the upper Achievable Potential scenario and about 5,860 MWh/yr. for the lower Achievable Potential scenario.

Exhibit 18 CSRAE Achievable Potential (MWh/yr.)

Technology	Milestone Year							
	2015		2020		2025		2030	
	Upper Achievable	Lower Achievable	Upper Achievable	Lower Achievable	Upper Achievable	Lower Achievable	Upper Achievable	Lower Achievable
Solar PV	-	-	-	-	1,125	729	5,177	3,351
Solar Thermal	74	40	350	186	923	489	1,911	1,012
Pellet-Burning Appliance	220	32	1,284	166	1,284	467	10,945	1,498
Sub Total	295	72	1,634	352	3,332	1,685	18,033	5,861

As shown in Exhibit 19, in the Residential sector, small-scale CSRAE technologies would provide between 6,500 MWh/yr. and 2,830 MWh/yr. of electricity by 2030 in, respectively, the upper and lower Achievable Potential scenarios. In the Commercial sector, small-scale CSRAE technologies would provide between 11,540 MWh/yr. and 3,030 MWh/yr. of electricity by 2030 in, respectively, the upper and lower Achievable Potential scenarios.

Exhibit 19 CSRAE Achievable Potential by Sector (MWh/yr.)

	Technology	Scenario	Achievable Potential (MWh/yr.)			
			2015	2020	2025	2030
Residential	Solar PV	Upper	0	0	423	1873
		Lower	0	0	282	1249
	Solar Thermal	Upper	62	283	724	1462
		Lower	33	152	390	787
	Pellet-Burning Appliance	Upper	78	312	700	3162
		Lower	20	78	175	791
	Sub Total	Upper	140	595	1,846	6,497
		Lower	53	230	846	2,827
Commercial	Solar PV	Upper	0	0	702	3304
		Lower	0	0	447	2102
	Solar Thermal	Upper	12	68	199	449
		Lower	6	34	100	224
	Pellet-Burning Appliance	Upper	142	972	3214	7783
		Lower	13	88	292	708
	Sub Total	Upper	155	1,040	4,116	11,535
		Lower	19	122	839	3,034

Selected highlights are presented below:

- The range of potential results varies very widely between the upper and lower Achievable scenarios. This reflects the large number of unknown factors
- Under the upper scenario, the Commercial sector has a significantly higher potential than the Residential sector. However, under the lower scenario, the potentials in the Commercial and Residential sectors are comparable
- The largest potential may be with pellet-burning appliances, assuming an aggressive approach
- Even under the upper scenario, the absolute amount of savings possible from solar hot water is the smallest for the technologies examined
- Solar PV could provide considerable generation under the upper scenario, even though the penetration of this technology is expected to start later than for the others.

5.3 Summary of Peak Load Savings

The CSRAE report does not estimate peak load savings. This is because the electricity contributions of these systems are intermittent and cannot be reliably assigned to any of the selected peak periods. Therefore, no electric peak load savings for customer-supplied renewable or alternative energy technologies are included.

5.4 Additional Information

Additional information on the summary results presented above is available in the main report and accompanying appendices entitled:

- *Yukon Electricity Conservation and Demand Management Potential Review (CPR 2011): Customer-side Renewable and Alternative Energy*

6 Conclusions and Recommendations

The study findings confirm the existence of significant potential for cost-effective electrical efficiency improvements in the Yukon.

In the Lower and Upper Achievable potential scenarios⁸, electrical efficiency improvements would provide between 44,000 and 60,000 MWh/yr. of savings in commercial buildings in 2030 and between 22,000 and 37,000 MWh/yr. of savings in residential dwellings in 2030. Combined, these potential savings represent approximately 32% to 48% of the forecast growth in electricity demand by 2030.

Substantial electric peak demand reductions would also occur as a result of the above efficiency improvements. The study estimates that in 2030 the associated electric peak demand reductions would be approximately 8.5 to 11.9 MW in commercial buildings and 6.4 to 10.5 MW in residential dwellings.

The most significant electrical efficiency opportunities in the residential sector are associated with electric space heating measures. The biggest single measure would encourage new homes to be constructed with an energy performance rating of EGH 85. This would reduce space heating consumption in new electrically-heated houses by approximately half, relative to the current building code in Whitehorse. Heat pumps, including both central units and ductless mini-split systems, offer the next largest space heating potential. Other space heating measures, such as deep insulation retrofits and improved control systems, also offer considerable potential. There is also considerable potential for saving electricity used for DHW, clothes dryers, computers and their peripherals, and 13 other end uses in the home.

The most significant electrical efficiency opportunities in the commercial sector are in space heating and indoor lighting. At the beginning of the study period, indoor lighting accounts for the largest fraction of savings potential. By 2030, however, many of the lighting measures are expected to be adopted naturally as a result of continued improvements to national lighting equipment performance standards, gradually eroding the lighting potential. In contrast, the potential for space heating savings is expected to increase substantially over the study period, eventually overtaking and surpassing the lighting savings. This is because of the expected large share of electric heating in new commercial construction.

The potential savings found in this CPR are generally larger than typically found in other jurisdictions, for a number of reasons:

- The Yukon climate is more severe, making space heating measures of all kinds more economically attractive.
- The cost of new marginal electricity generation options in Yukon is relatively high. Even on the hydro grid, new demand at the margins is assumed to be supplied by diesel generators.
- The past success of conservation programs suggests that the receptiveness of Yukon customers to efficiency measures is greater than is typical of other jurisdictions.

⁸ It should be noted that these potential savings estimates are not yet constrained by the availability of program funding. These considerations will be addressed during the program design phase, which will build on the results of this CPR.

Other highlights of the study are as follows:

- Electricity consumption and peak demand over the study period are expected to grow by approximately 65%, because of both the rate of new construction and the proportion of new buildings that are expected to be electrically heated. It is currently less expensive to heat with electricity than with oil in Yukon, due to the relative prices of electricity and fuel oil.
- Because of the cost of new electricity supply from diesel generation, energy efficiency measures are comparatively attractive. Retail rates reflect more of an average cost of supply because they include the legacy hydro supply. Rates tied more closely to marginal supply costs would substantially change the economics of heating with electricity.
- There are large uncertainties in the rate of growth of electrical demand. The overall rate of new construction is heavily dependent on growth in the mining sector, which is difficult to forecast. The penetration of electric heat is also uncertain: rates that reflect the cost of diesel generation would reduce electric heating.
- There are also uncertainties about specific technologies that offer savings potential. Some technologies have not been subjected to rigorous testing and demonstration in the Yukon climate. They may require adaptation or may prove unsuitable.
- The Yukon utilities have good client data and their staff have a great deal of detailed customer knowledge. The availability of information at this level of detail was key to the success of the project. Nonetheless, there is scope for improvement. Specifically, the scope and timing of the future electrical end use surveys should take into account the needs of subsequent CPR studies.

The study also concluded that customer-side renewable and alternative energy (CSRAE) technologies could provide between 5,000 and 15,000 MWh/yr. of savings in residential and commercial buildings in 2030. A substantial portion of these savings overlap with the efficiency measures noted above and, therefore, are not directly additive.

The most significant opportunities in CSRAE are from wood pellet-burning appliances. These may include either pellet furnaces or pellet boilers, both of which can have hopper feeding systems for unattended operation. Pellet-burning stoves were not considered in this study because it is harder to quantify the fraction of the space heated by a stove, however stoves have the potential to provide additional savings. The success of wood pellet initiatives will be dependent on measures to ensure that customers consistently use the pellet appliances and avoid using electric heat backup systems. Solar hot water systems also meet the economic threshold in many but not all potential applications in Yukon. Photovoltaic generation is not cost-effective at the beginning of the study period, but costs are expected to drop so that it becomes cost-effective before 2030.

6.1 Recommendations

Throughout the conduct of CPR 2011, a number of suggestions emerged from those involved with the study that could improve the next CPR. A summary is listed below:

- The Yukon should proceed to develop electricity DSM programs addressing both the commercial and residential sectors.
- The technologies selected for program development should be subjected to more rigorous study than was possible with the large number of technologies examined in this CPR. This may include testing and demonstration in the Yukon climate in addition to an examination of the market barriers in the Yukon context.

- DSM program efforts should be leveraged as much as possible through collaboration with existing and planned programs by other entities.
- As mentioned above, the scope and timing of electrical end use surveys undertaken in the future should be informed by the needs of subsequent CPR studies. Ideally, the final results of a recent REEUS should be in hand before the next CPR begins. Questions should be included in the survey to provide the level of detail needed so that the CPR can cover the building types, end uses, and technologies the clients will require. Undertaking a commercial end use survey would improve the commercial component of the next CPR in the same way.

Market Characterization Report – Residential Retail

Client: Yukon Energy Corporation (YEC)
Yukon Electrical Company Limited (YECL)
Re: Electricity Conservation Market Characterization Report – Residential Retail
Project: Residential and Commercial DSM Program Design
Version: September 28, 2012

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1. Introduction

Yukon Energy Corporation (YEC), Yukon Electrical Company Limited (YECL) and the Yukon Government completed a Conservation and Demand Management Potential Review (the CPR) for the Yukon in 2011. The results of the CPR revealed a significant cost-effective potential for demand-side management (DSM) in the Yukon.

In order to further pursue this goal, the YEC and YECL (i.e. the collaboration is hereinafter referred to as YEC/YECL), will design a portfolio of new Demand Side Management (DSM) programs for presentation to the Yukon Utilities Board.

YEC/YECL has contracted ICF Marbek with developing this new portfolio of DSM programs.

If the proposed Electricity DSM program portfolio is approved by the Yukon Utilities Board (YUB), the next steps in this process would be the development of a program implementation plan followed by program launch.

Based on the result of the CPR, ICF Marbek identified four sectors of interest: 1) Residential Retail (Lighting equipment and domestic appliances), 2) Residential New Construction, 3) Commercial Lighting, and 4) Commercial HVAC Retrofit. The justification of this market segmentation and prioritization is presented in a separate document: *Program Focuses – Preliminary Team Discussion Paper*.

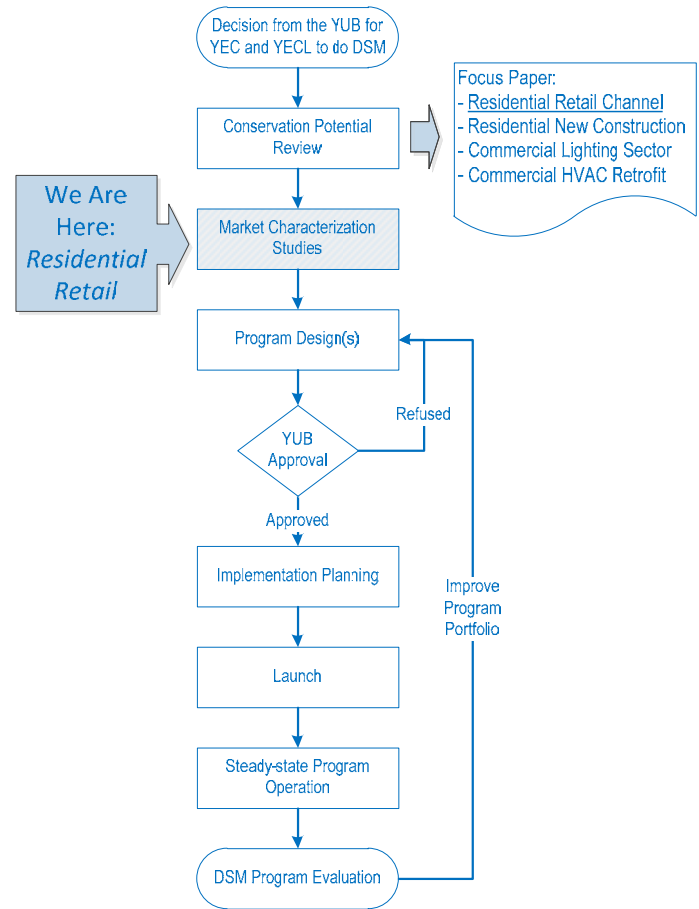
This report presents the results and conclusions of the market characterization study of the Residential Retail Channel. These results will be used to design DSM programs and initiatives in this sector; and provide justification for the design decisions to the YUB.

The research and questions focused on two types of products in order to increase the quality of the data that we would collect by being specific and tangible:

- Lighting equipment: screw-in CFLs, Energy-Star CFLs, PAR or floodlight CFLs, Energy-Star fixtures, and LED lamps and fixtures.
- Domestic appliances: dishwashers, clothes washers, refrigerators, and freezers.

We selected these two sets of equipment based on the following criteria: (1) potential savings, (2) likeliness of the preferred program tactic to be an incentive, and (3) existence of labeling and

Exhibit 1 DSM Program Cycle



standard framework in Canada¹. The second criterion (likeliness of the preferred program tactic to be an incentive) was deemed important because we intend to create a program that would include engagement tactics with the retailers; and likely a sort of partnership.

Ultimately, if the program initiates a partnership with retailers this could lead to all sorts of program tactics such as education, in-store displays, in-store promo events, information dissemination, and pilot projects, etc. These tactics could target all kinds of energy-intensive equipment beyond the technologies that require a rebate to get program uptake, such as hot water tanks, faucet aerators, block heater timers, low-flow showerheads, etc. However, to achieve this there should be at least a few mail-in rebates to show seriousness and convince retailers to partner with YEC and YECL.

¹ The quality standard labeling for LEDs that is recommended by Natural Resource Canada (NRCAN) is follows the United States. NRCAN's ENERGY STAR program webpages forward readers to EPA webpages for technical details and A list of Energy Star-rated equipment.

2. Sector Segmentation

This section presents the market segmentation that has been used in the Residential Retail market characterization study. Each segment presented in Exhibit 2 was engaged with during the characterization.

Exhibit 2 Residential Retail Channel Segmentation



Each of the sector segments is presented by populating a table, as illustrated in Exhibit 2 – except for the Other Associations or Stakeholders that are presented in Section 10.

As shown in Exhibit 2 the sample sizes (n) that we achieved are representative of the overall populations (p).

Exhibit 3 Market Actor: Appliance and Lighting Retail Store

Market Role	These are big-box retail stores located in Whitehorse. They have a large retail space with a lighting department and a domestic appliance department. They national corporations. They buy directly from manufacturer. We had interviews with the branch managers and carried out mystery shopper activities to consult with the sales force on the store floor.
Strengths and Resources	- Training and educational materials from headquarters - Energy conservation initiatives from headquarters - Marketing capacity - Knowledge of the local market - Interest in joint activity with YEC/YECL like displaying brochures, flyers, etc.
Weaknesses	- Some decisions might be made from headquarters, some made locally - Vetted interest. - Busy/ little time to plan joint tactics. - High staff turnover

Exhibit 4 Market Actor: Appliance-Only Store

Market Role	Furniture stores in Whitehorse or elsewhere in the Yukon. They have an appliance department. They sell large energy-intensive appliances such as refrigerators, freezers, clothes washers, dryers, hot water tanks, and dishwashers.
Strengths and Resources	- Lower staff turnaround - Knowledge of the local market - They have been participating in ESC Good Energy programs - Relationship with some developers
Weaknesses	Lower marketing capacity and lower administrative capacity than the big box retailers

Exhibit 5 Market Actor: Housing Developers

Market Role	Developers are general contractors who design, procure the materials and equipment, construct and sell new houses in the Yukon. They sell new houses with lighting equipment installed and, in most cases, including large domestic appliances such as refrigerators, freezers, clothes washers, dryers, hot water tanks, and dishwashers. They do business with many contractors and suppliers to complete each project. They do business with electrical contractors for the installation of lighting equipment. They either buy the equipment directly from distributors, or else from the electrical contractors. They do business with local appliance suppliers.
Strengths and Resources	- Knowledgeable about insulation and building envelope - Network of vendors and contractors.
Weaknesses	- Slit-incentive barrier: they will not pay the energy bills - Very busy

Exhibit 6 Market Actor: Landlords

Market Role	Landlords own apartment buildings or detached homes in the Yukon. They rent to many types of tenants: professionals, middle class family, low-income family, etc. They provide the lighting equipment and domestic appliances. They purchase the lighting equipment from the big-box retailers and install them by themselves; or else they buy equipment and installation services from electrical contractors. Some landlords manage the buildings themselves and many have property managers to take care of the building.
Strengths and Resources	- Channel of communication with tenants – some that are hard to reach. - They make decisions on behalf of end-users (tenants) - They have access to more financing than many of their tenants
Weaknesses	- Split-incentive barrier: they don't pay the energy bill. Even if they do, they are reluctant to provide the unit with expensive appliances and lighting equipment. - Some owners are not located in the Yukon and would be difficult to engage. It would be necessary to engage with property managers.

Exhibit 7 shows the consolidated results of the questions that were ask to identify the weakest link in the distribution chain toward the residential sector in the Yukon.

Exhibit 7 Market Actors Promoting Energy Efficiency

Are the following market actors doing a good job at promoting better and more energy efficient products in the Yukon? Where: 1 = Poor Job, and 10 = Excellent Job.

Suppliers (Manufacturers or Distributors) as seen by:

Retailers Managers: 8/10, n=3	End-users (Shoppers): N/A
Retailer Sales force: N/A	House Developers: 5.8/10, n=2
Landlords: 7.5/10, n=2	Independent Lighting Supplier: 8/10, n=1
<u>Grand Average: 7.3/10, n=8</u>	

Retailer Branch Management as seen by:

Retailers Managers: 8/10, n=2 (How managers see corporate management.)	End-users (Shoppers): N/A
Retailer Sales force: Positive view in general	House Developers: N/A
Landlords: 5.3/10, n=4	Independent Lighting Supplier: 2/10, n=1
<u>Grand Average: 4.6/10, n=5</u>	

Retailer Sales force as seen by:

Retailers Managers: N/A	End-users (Shoppers): N/A
Retailer Sales force: N/A	House Developers: N/A
Landlords: 8.0/10, n=1	Independent Lighting Supplier: N/A
<u>Grand Average: N/A</u>	

House Developers as seen by:

Retailers Managers: 5.5/10, n=4	End-users (Shoppers): N/A
Retailer Sales force: N/A	House Developers: 9/10, n=1 (How managers see corporate management.)
Landlords: N/A	Independent Lighting Supplier: DK
<u>Grand Average: 5.5/10, n=4</u>	

Landlords as seen by:

Retailers Managers: 4/10, n=4	End-users (Shoppers): N/A
Retailer Sales force: N/A	House Developers: N/A
Landlords: N/A	Independent Lighting Supplier: 3/10, n=1
<u>Grand Average: 3.8/10, n=5</u>	

Electrical Contractors Doing Business in the Residential Sector as seen by:

Retailers Managers: 8.5/10, n=2	End-users (Shoppers): N/A
Retailer Sales force: N/A	House Developers: 5.3/10, n=3
Landlords: 7.0/10, n=3	Independent supplier: 4/10, n=1
<u>Grand Average: 6.4/10, n=9</u>	

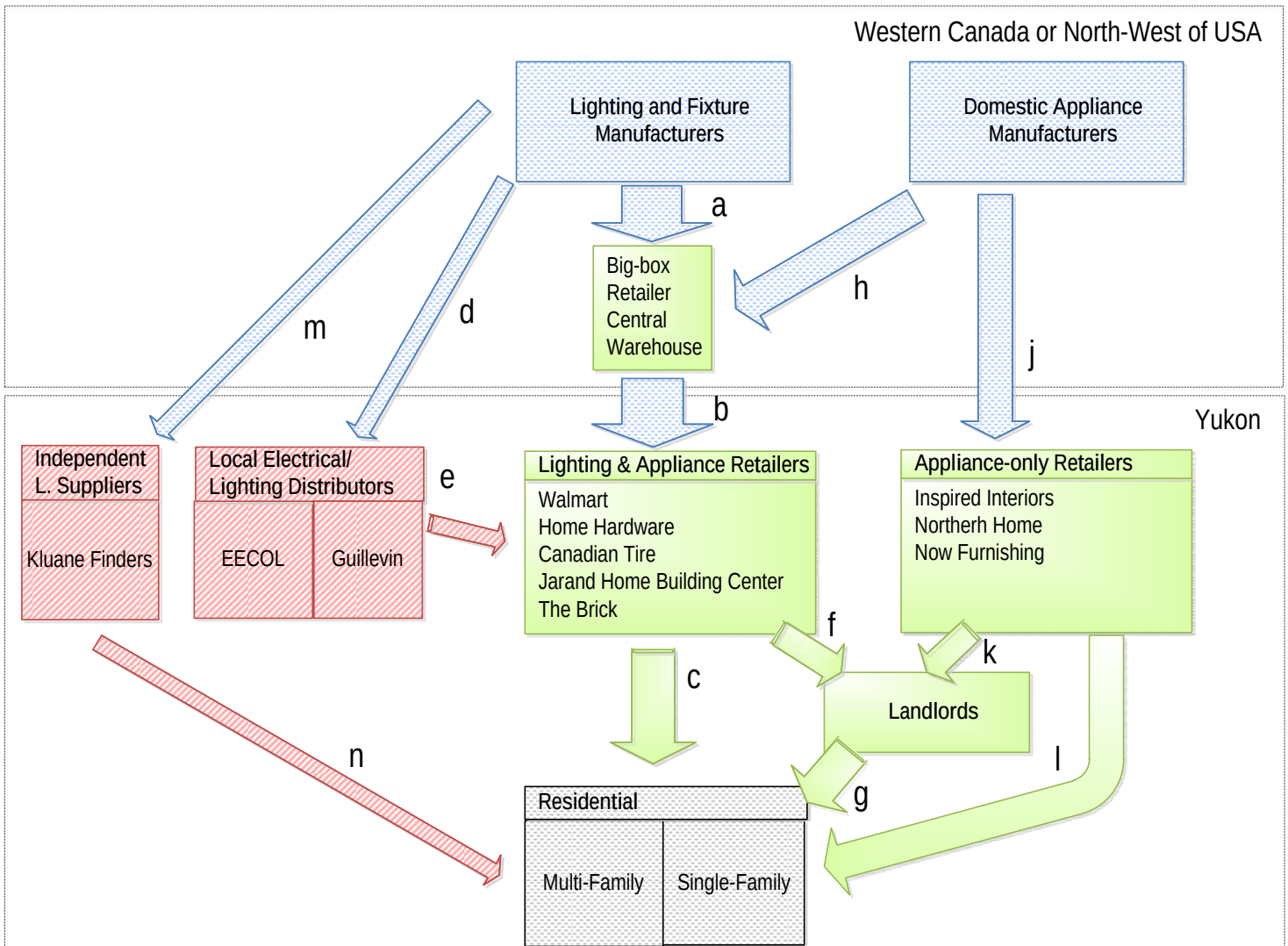
Comments on Exhibit 1:

- As reported by a retail manager: *The property managers are looking for the cheapest option, so they don't care about energy efficiency. They are looking for something quick and cheap. Doesn't hear much of a demand from Property Managers.*
- As reported by a developer: *Electrical contractors just put in what you ask for – they are not into selling etc.*

3. Distribution Chain

A flow diagram of product purchases and sales is presented in Exhibit 8. This depiction of the market is an effective means to understand the interaction of the actors introduced in Section 1. The data underlying the diagram were obtained from interviews with market actors.

Exhibit 8 Residential Retail Supply Chain for Lighting Equipment and Domestic Appliances



Additional comments and explanation of Exhibit 8 are presented below.

Exhibit 9 Residential Retail Supply Chain for Lighting Equipment and Domestic Appliances

a&b	Lamp and Fixture Manufacturers Sell to Local Big-box Retailers Through Their Central Warehouse
	- For more information about the Lamp and Fixture Manufacturers and about the supply chain upstream of the lighting and appliance retailers, see the commercial lighting characterization report. - Both big-box retailers that we interviewed told us that they have to order from the warehouse. They have a large list of options. They decide what to order and how much shelf space. - The warehouses are located in Alberta, BC or even as far as Ontario.

c	Tenants and Homeowners Shop and Purchase Lighting Equipment and/or Domestic Appliances from Lighting & Appliance Retailers. They Install by it Themselves, or They Have it Installed by Electrical Contractors. - Approximately 50% of the lighting equipment sold by Lighting and Appliance Retailers is sold to the residential sector (for residential use). 50% is sold for use in businesses. - Approximately 50% of the lighting equipment sold for residential use is sold to homeowners, 30% to electrical contractors doing business in the residential sector, and the remaining is broken down between landlords (approx. 10 to 15%) and renters (approx. 5 to 10%) - Approximately 70% of the appliances sold by big-box retailers are sold for residential use and the remaining for business use. - Approximately 70% of the appliances sold by big box retailers for residential use are sold to homeowners. 10 to 15% is sold to renters, 10 to 15% to landlords and approximately 5% to contractors.
d&e	Lighting Equipment is Sold to Electrical or Lighting Distributors and then Sold to the Retailers This channel is minor: approximately 1%.
f&g	Landlords Shop and Buy Lighting Equipment and/or Domestic Appliances from Lighting and Appliance Retailers. They Install by it Themselves, or They Have it Installed by Electrical Contractors. - Landlords provide lamps and fixtures. Three landlords reported providing incandescent bulbs, three reported providing fluorescent tubes, one provides CFLs, and one provides LED lamps. n=4. - Three out of four landlords provide appliances. These landlords provide refrigerators and ranges. Two provide in-suite clothes washer and dryer, and one provided a clothes washer and dryer in the common area. - Out of all of the appliances that were described by the four landlords we had interview with, only one was energy star: a refrigerator. Landlords reported having installed one energy efficient microwave and one range – which is surprising because these appliances do not have much savings potential. - Landlords reported that they buy close to 100% of their lighting equipment from suppliers in the Yukon. - Landlords reported that they buy approximately 60% of the lighting equipment directly from the retailers; and 40% from electrical contractors.
h	Domestic Appliance Manufacturers Sell Appliances to Big-Box Retailer Central Warehouse These transactions are far removed from the Yukon.
j	Appliance-only Retailers Order Appliances Directly from Domestic Appliance Manufacturers Online - The domestic appliances of interest are refrigerators, freezers, clothes washer, and dishwashers because these are energy-intensive appliances with high savings potential. - Appliance-only retailers purchase directly from manufacturer through an online portal. They generally do not talk to anyone. - Manufacturers are located in Western Canada or the Northwest of the United States.
k&g	Landlords Shop at Appliance-Only Retailers, Then Install Them in the Living Spaces That They Rent

Homeowners Shop in Appliance-only Retailers and Purchase Appliances

- Approximately 85% of the appliances sold by big-box retailers are sold for residential use and the remaining for business use.
- Approximately 40% of the appliances sold by big box retailers for residential use are sold to homeowners. 0 to 5% is sold to renters, 5 to 10% to landlords and approximately 50% to contractors.
- Based on the finding presented in the bullet above, we assume that 50% of their sales are for “new construction”.

m&n

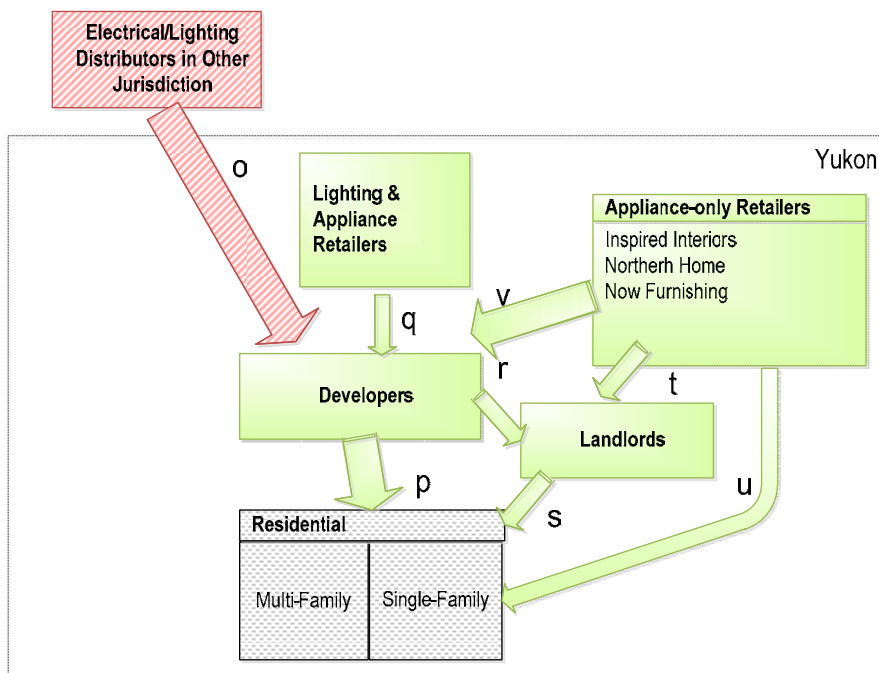
Some Equipment is Channeled to the Residential Sector Through Independent Lighting Suppliers

- This is a relatively new phenomenon that is growing with the increasing popularity of the LED lamps. LED lamps are expensive and some new channels have been created to reduce the cost.
- The independent lighting supplier we spoke with told us that they sell 50% of their LED equipment for residential use.

4. Lighting Equipment and Domestic Appliances in New Construction

A flow diagram of product purchases and sales is presented in Exhibit 10. This depiction of the market is an effective means to understand the interaction of the actors introduced in Section 2. The data underlying the diagram were obtained from interviews with market actors.

Exhibit 10 Residential New Construction Supply Chain for Lighting Equipment and Domestic Appliances



Highlights, comments and explanation of Exhibit 10 are presented below in Exhibit 11.

Exhibit 11 Residential New Construction Supply Chain for Lighting Equipment and Domestic Appliances

o	Developers Buy Fixtures and Lamps from Electrical Distributors Outside of the Yukon and Install the Lamps and Fixtures in the New Home Developers said that they buy 100% of their lighting from a lighting distributor in Alberta.
p	The Developers Sell House or Condo to New Home Owner with Fixtures and Lamps The main motivation of the developers according to those we spoke with are: Provide best value to home buyers and be a good corporate citizen.
q	The Developers Purchase Some Lighting Equipment from the Local Big-box Retailers This channel will be small. We believe it does exist because the big-box retailers said they do sell 30% of their lighting equipment to electrical contractors. Some must be used in new construction.
r,s&t	The Developers Sell Some Apartment Building With the Lighting Equipment to the Landlords. The Landlords Will Buy Appliances from Local Appliance-only Retailers This channel is limited in size because it is very challenging to build an apartment building in the Yukon that is competitive rent-wise with the old apartments building from the 70s that have been paid for a long time ago; hence few to no new apartment buildings are being built.
u	The New Home Buyer Buy Appliances from Local Appliance-only Retailers One of the developers said that they did not supply appliances with the house. The new home owners will probably buy them locally with an allowance provided by the developer.
v	Developers Purchase Appliances from local Appliance-only Retailers and Provide the House with the Appliances - Two out of three developers provide the appliances with the new units. They provide: refrigerators, freezer, clothes washer, dryer, dishwasher, ranges, and hot water tank. - All of the appliances that they sell are Energy Star. - Developers said that they buy appliances from local retailers.

5. Existing and Prospective Information Dissemination Mechanisms

This section presents an overview of how information about energy efficient design and equipment flows from the main source, manufacturers, to energy end-users.

Exhibit 12 presents the preferred sources of information of end-users and supply-chain actors.

Exhibit 12 Main Sources of Information

According to:	What is the Main <u>Sources</u> of Information that you Use?	Sample Size (n)
Retail Managers <i>through interviews</i>	1 st : Manufacturers rep. or agents 2 nd : Energy efficiency programs (BC Hydro, etc) 3 rd : Governments	4
Lighting Retail Sales forces <i>through Mystery shopper</i>	<i>A brochure to hand out to customer</i> was mentioned once. Mild interest in email to educate staff (one interviewee was for it, and another was against). No interest in online information by YEC/YECL.	3
Appliance Retail Sales forces <i>through Mystery shopper</i>	Two interviewees had no interest in more training because they felt they were already well versed in E-Star products. Mild interest in email and website info (one interviewee was for it).	3
End-users: <i>All shoppers through Retail intercepts</i>	1 st : Store website, staff or POP: suppliers (10 hits) 2 nd & 3 rd : Wikipedia and the like <i>tied with</i> Friends and relatives (8 hits) 4 th , 5 th & 6 th : YEC/YECL, <i>tied with</i> Energy Solutions Centre, <i>tied with</i> Customer ratings & forums (4 hits)	21
<i>Lighting shoppers versus Appliance shoppers</i>	<i>No clear nuance to report between lighting and appliances</i>	17 v. 4
Landlords <i>through interviews</i>	1 st : Governments & Energy Solutions Center – <i>with a narrow lead</i> 2 nd : Suppliers (Manufacturers or distributors) 3 rd & 4 th : Other Energy efficiency programs <i>tied with</i> Retailers.	4
Housing Developers <i>through interviews</i>	1 st & 2 nd : Equipment suppliers (Distributor or Manufacturer) <i>tied with</i> Other third-party organizations	2
Independent Supplier <i>through interviews</i>	1 st : Manufacturers rep. or agents (No other)	1

Notes on Exhibit 12:

- One landlord mentioned “Retailers” even though it was not a choice. Thus, “Retailers” might be more important than was envisioned at first.
- One landlord said that they have used the ESC a lot, even for his own home.

This information is applicable and they agreed that no research or “adaptation” of the information to the Yukon context is required. (Market actors said applicability is 8.3/10 where 10 is perfectly applicable with n=8, and shoppers said 3.8/4 or 9.5/10 with n=22)

With regard to applicability, we have the following comments.

- Retail Managers made the following comments: *Energy efficiency lighting should be promoted in the fall when it is getting darker. Packaging shows savings but not the savings in the Yukon – the savings in the Yukon are actually more.*
- One developer said that applicability is actually bad (5/10). This explains why the applicability ranking is actually lower than was presented in other sectors. They did not provide any further explanation.
- There was no nuance between lighting shopper (3.7/4, n=18) and appliance shoppers (3.8/4, n=4).
- EE lighting shoppers seemed to believe in the applicability of the information (4.0/4, n=9) more than standard lighting shoppers (3.4/4, n=9).

When asked about the best means to convey information to the end-users, interviewees answered with the following, as presented in Exhibit 13:

Exhibit 13 Main Media Used to Convey Information to End-users

According to:	What are the Main <u>Media</u> that Could Effectively Convey Information to End-users?	Sample Size (n)
Retail Managers through interviews	<i>There is a significant difference between lighting and appliances. See below.</i>	4
Lighting Store Managers:	1 st : Point of purchase materials (posters, display) 2 nd & 3 rd : Flyers <i>tied with</i> the internet	2
Appliance Store Managers:	1 st : Point of purchase materials (posters, display) 2 nd : Newspapers, magazines or consumer reports – <i>close call w/ 1st</i> 3 rd : Radio	4
End-users: All shoppers through retail intercepts	1 st : With electricity bill (20 hits) 2 nd : POP materials at the store (13 hits) 3 rd : Local newspapers (6 hits) 4 th : In-store promo event (5 hits)	22
Lighting shoppers versus Appliance shoppers	<i>No clear nuance to report between lighting and appliances</i>	18 v. 4
Landlords through interviews	<i>There is a significant difference between lighting and appliances. See below</i>	3
Lighting:	1 st : Television 2 nd & 3 rd : Flyers <i>tied with</i> the internet	3
Appliances:	1 st : Flyers 2 nd : Television – <i>close call w/ 1st</i> 3 rd & 4 th : Radio <i>tied with</i> Newspapers, magazines or consumer reviews	3
Housing Developers through interviews	1 st : Newspapers, magazines or consumer reports 2 nd : Flyers 3 rd : Point of purchase materials (posters, display)	2
Independent Supplier (lighting) through interviews	1 st : The internet 2 nd : Flyers 3 rd : POP materials	1

Notes on Exhibit 13:

- Create POP materials and sending flyers with the bills seem to be the most obvious and effective means.
- During the mystery shopper, floor staff at a certain store mentioned: *They would welcome displays, and brochures they can hand out to customers to help illustrate cost savings.*

- The internet shows often in the rankings. As shown in Exhibit 12, *Wikipedia as well as Friends and relatives* were mentioned very often as sources.
- Local newspapers would come fourth.
- Relevant comments made by developers: *They use Facebook to advertise. A lot of people are educated about energy efficiency but don't buy into the savings.*

When asked about the best means to convey information to them, interviewees answered with the following, as presented in Exhibit 14:

Exhibit 14 Main Media Used to Convey Information to Supply-side Actors

According to:	What are the Main Media that Could Effectively Convey Information to You?	Sample Size (n)
Retail Managers through interviews	1 st : Direct engagement 2 nd : Printed brochure of flyer 3 rd & 4 th : Newsletter (email) tied with Trade shows or events	4
Lighting Retail Sales forces through Mystery shopper	Would welcome POP materials (In particular: end cap displays and education brochures about cost savings in YT and benefits). Not all people consulted with were convinced about training programs (one out of three was convinced, and one out of three opposed to it.)	3
Appliance Retail Sales forces through Mystery shopper	Would welcome brochures and signage. Two interviewees felt training programs at their stores were excellent.	3
Main mean(s) to train retail sales force according to managers	1 st : Online / Computer-assisted training 2 nd , 3 rd , 4 th & 5 th : Classroom / Hands-on training, tied up with Direct engagement from suppliers tied up with On-site staff meetings tied up with Product box and packaging	
Landlords through interviews	1 st : Printed brochure or flyer 2 nd : Direct engagement 3 rd & 4 th : Newsletter (email) tied with Trade shows or events	4
Housing Developers through interviews	1 st : Direct engagement 2 nd : Newsletter (email) 3 rd : Printed brochure or flyer	3
Main mean(s) to train retail salesforce according to developers	1 st : On-site staff meeting. 2 nd : Direct engagement from suppliers 3 rd : Classroom / Hands-on training	3
Independent Supplier through interviews	1 st : Direct engagement 2 nd : Trade shows or events 3 rd : Newsletter (email)	1

Notes on Exhibit 14:

- The “normal” result of this question is “Direct engagement”. Our group of interviewees did not seem to be an exception.
- POP materials and flyers would probably hit the “salesforce” and “retail managers” target as well as customer.
- It is probably not worth developing a trade show for residential retail. It was not rated highly often enough.
- Retail store managers thought that short on-the-job or after-hour meetings would work very well. Evening seemed to be the favorite time slot for this sort of meeting.

- A developer reported: *There seems to be lots of invitations to engagement things – developers are already super busy. Try to coordinate with other direct engagement pushes, for example Yukon Housing. Direct & personalized email works better than blanket email.*
- The independent supplier reported: *They would come from a remote community if there was a trade event on lighting in Whitehorse.*

6. Purchase Decisions

This section presents how purchase decisions in the residential retail sector are made and how energy conservation is part of this process. We address topics such as purchase drivers, purchase barriers, and the split-incentive barrier.

Exhibit 15 shows the reported end-user purchase motivations.

Exhibit 15 Main Drivers/Motivations of End-Users

According to:	What are the most important motivations of the end-users when buying products?	n
Retail Managers	<i>There is a significant difference between lighting and appliances. See below</i>	3
Lighting Store Managers:	1 st : Lower/lowest price 2 nd : Aesthetic considerations 3 rd & 4 th : Shipping costs or constraints <i>tied with</i> Monetary savings because of the electricity savings:	2
Appliance Store Managers:	1 st : Lower/lowest price 2 nd : Life expectancy and reliability of product 3 rd : Immediate/short-term availability of product and parts	3
Lighting Retail Sales forces through Mystery shopper	Price, reliability and availability are the most important drivers. According to one salesperson: approximately 70% of buyers were looking for EE bulbs. According to another salesperson: Many customers were not aware of benefits of EE bulbs until they spoke with sales people in store	2
Appliance Retail Sales forces through Mystery shopper	Cost and energy savings are the main drivers/motivations of most customers.	3
End-users: All shoppers through retail intercepts	1 st : Environmental considerations (10 hits) 2 nd : \$\$ savings on energy bills (9 hits) 3 rd : Aesthetic considerations (5 hits) 4 th : Lower/lowest price (4 hits)	22
Lighting shoppers versus Appliance shoppers	<i>No clear nuance to report between lighting and appliance shoppers however there a distinction between EE lighting shoppers and standard lighting shoppers as shown below</i>	18 vs. 4
EE lighting shoppers versus Standard lighting shoppers	1 st : Environmental considerations (7 hits) 2 nd : \$\$ savings on energy bills (6 hits) 3 rd : Lower/lowest price (2 hits)	9 v. 9
Landlords through interviews	No significant nuance between lighting and appliances. 1 st : Low initial cost of retrofit / i.e. minimal impact on rent – <i>with a solid lead</i> . 2 nd : Higher reliability of systems (Not having to fix it so often) 3 rd : Expectation of monetary savings because of the electricity savings	4
Housing Developers through interviews	No significant nuance between lighting and appliances. 1 st : Aesthetic considerations – <i>with a solid lead</i> 2 nd & 3 rd : Environmental considerations (incl. GHG emissions) tied with monetary savings because of the energy savings	3
Independent Supplier through interviews	1 st : Monetary savings because of the energy savings 2 nd : Environmental considerations (incl. GHG emissions) 3 rd : Life expectancy and reliability of product	1

Notes on Exhibit 15:

- Supply-chain actors seem to agree that price point is the main driver. Shoppers do not. There might be room to move supply-side actors to compete on other aspects than price.
- Among lighting shoppers: People who already buy energy efficient products are already driven by the following benefits: environmental considerations and monetary savings. People who did not purchase energy efficient lighting equipment either do not know about these benefits or deem that aesthetic is more important. There is an opportunity to convince them that aesthetic can be equivalent or better with energy efficient products. Some had concerns regarding the mercury levels and disposal options of CFLs.
- Among domestic appliance shoppers: *They all had purchased E-star or energy efficient appliances. | Three of them reported having purchased energy efficient stove – the real gain in efficiency of which is debatable. | None of them reported that the Good Energy Rebate was one of their motivations (0 hits, n=4).*
- Retail store managers said: *Most of his/her appliance stock is Energy Star anyway thus energy efficiency is not a driver anymore. But offering the Good Energy Rebate can help him/her closing some more sales.*
- Housing developers said: *Lighting doesn't seem to be a concern, he/she just wants to make sure all the bulbs match and it's not difficult to replace them. | Lighting is just selling style. Perception that it's not a big energy user.*
- Appliances sales staff consulted during the mystery shopping outing reported that most customers are driven to purchase ENERGY STAR products to save money and energy.

All the market actors were asked about the purchase barriers to energy efficient equipment. Their answers are reported in Exhibit 16.

Exhibit 16 Main Purchase Barriers of End-Users

According to:	What are the most important purchase barriers to the end-users buying EE products?	n
Retail Managers	<i>There is a significant difference between lighting and appliances. See below</i>	3
Lighting Store Managers:	1 st : High price 2 nd : Availability of product 3 rd : Lack of awareness or knowledge about energy consumption of product	2
Appliance Store Managers:	1 st : Lack of awareness or knowledge about energy consumption of product – <i>with a solid lead</i> . 2 nd & 3 rd : High price <i>tied with</i> Aesthetic considerations	3
Lighting Retail Sales forces through Mystery shopper	The most important barrier is the price point – especially for LED bulbs. People are waiting to see the price go down. Then the sales people mentioned the following potential barriers: not aware of the cost savings; uncertainty on the cost savings; and lack of choice of LED lamps.	3
Appliance Retail Sales forces through Mystery shopper	There is no barrier for most customers; three interviewees noted that only landlords seem to purchase standard appliances. Price is a barrier for customers with a limited budget.	3
End-users through retail intercepts	All of the appliance shoppers that we managed to speak with had purchased the energy efficient equivalent of the appliances hence we were not able to ask about the barrier.	
Standard Lighting shoppers	1 st : Special application needed (6 hits) 2 nd : Don't like the aesthetic (4 hits) 3 rd & 4 th : Health, safety and environment <i>tied with</i> No proper waste handling (3 hits)	9
Landlords through interviews	1 st : Higher initial cost of the services and equipment / maybe resulting in higher impact on rent: 2 nd : Electricity bills are rolled into the rent, thus tenants don't pay them directly. (one landlord said that) One landlord answered because: He/she couldn't see why people would not buy EE lighting or appliances.	2
Housing Developers through interviews	No difference between lighting and appliances: 1 st : They don't want to pay – i.e. when confronted with the higher initial cost of energy efficient equipment, home buyers go for the cheapest alternative – <i>with a solid lead</i>	3
Independent Supplier through interviews	1 st : High price 2 nd : Lack of awareness or knowledge about energy consumption of product 3 rd : Special application needed and unavailable among energy efficient products (feature, or need to fit in some fixture):	1

Where EE means Energy Efficiency or Energy Efficient.

Where * mark indicators of the split-incentive barrier.

Notes on Exhibit 16:

- All supply-chain actors, except for appliance store managers, unanimously reported the higher initial cost of energy efficient equipment as being the most important barrier to energy efficiency.
- End-users reported that the main barriers are *Special application*. There is not much that can be done regarding this except to engage with retail stores to convince them to add stock-keeping units or to help shoppers locate the EE alternative if it is already in stock, but not placed with the conventional lighting. The second barrier is of interest and there is an opportunity to change people's perspective: *Don't like the aesthetics*. The third barrier would

need to be addressed if a program to promote CFLs was introduced: *Health, safety and environment.*

- Retail store managers reported: People don't know how much they can save w/ EE. Most important is they want all their appliances to match. | People are looking for the Energy Star logo. *The front loaders clothes washer requires a little bit more maintenance. Some people want the dirt-cheap and go top-loader. Others buy this out of habit. You can now get low-water top loader. They still don't perform as well as the front loader, but it's a little better.*
- Housing developers reported: *Due to the housing prices being so high, additional cost is a big factor. They were able to put in better insulation in walls and attic for little additional cost.*
- The independent lighting supplier reported: *They have a 4-week delivery delay.*
- The appliances sales staff consulted during the mystery shopper outing reported that cost is not a barrier to purchasing ENERGY STAR appliances for most customers. Cost only represents a barrier for customers on a limited budget. Three out of four sales people reported that *only landlords shopping for tenants purchase standard models.*
- We cannot draw conclusions on the extent of the split-incentive barrier based on the shoppers' answers because most of the shoppers that we consulted were home owners and thus they were not in the position to answer.

We asked standard lighting shoppers why they had not considered the energy savings in their purchase decision. Out of nine standard lighting shoppers, six people answered (i.e. n=6). Their answers were:

- Don't believe in this (2 hits)
- I did not know (1 hit)
- I don't know how much (1 hit)
- No savings would be generated because of the heating interactive effect (1 hit)

Among standard lighting shoppers, we asked how likely a rebate worth 15% of the cost of the product would have changed their decision in favor of the energy efficient product. Five people chose to answer out of nine standard lighting shoppers. They answered unanimously "Very unlikely" (Average 1.0/4, Where 1=Very unlikely & 4=Very likely, n=5, complete data set: 1-1-1-1-1).

Discussion on the Split-Incentive Barriers

The split-incentive barrier ranked 2nd twice (end-users and designers) and 3rd once (distributors). The split-incentive barrier is particularly difficult to address, and it can be a show stopper in some sub-sectors of the commercial sector. So, it was worth more investigation and –in some cases- it was a direct question. This barrier is found in all jurisdictions. What varies between jurisdictions is the extent of the split incentive barrier or what percentage of the commercial sector it affects.

In few words, the split-incentive barriers (or principal-agent barriers) treat the difficulties that arise under conditions of divergent interest when a party/individual is in charge of paying the energy bills and another party/individual makes the purchase/investment decision. For the sake of our analysis, we will divide it in three cases – as shown in Exhibit 17.

Exhibit 17 Discussion on the Extend of Split-Incentive Barriers in the Yukon

Cases	Findings and Discussion
S.-I. Barrier B: Tenants pay directly the energy bills but will not invest: Tenants pay the energy bills directly for the commercial space that they rent. Neither the landlords nor the tenants will invest in energy efficiency.	Three landlords out of the four we spoke with told us that their tenants can make changes to the lighting systems or to the appliances in the space they rent if they want to. However, they don't tend to make changes by themselves, even those who pay for their electricity bills directly (n=4). Very rarely do tenants ask for lighting or appliance upgrades (Lighting: 2 times never and 2 times sometimes. n=4, Appliances: 3 times never, and 1 time sometimes. n=4. The scale was: Never-Sometimes-Often-Always) Convincing tenants to invest might be challenging, but not impossible for products with very short payback periods because tenants will actually benefit from their investment in terms of lighting quality/comfort as well as avoided cost of electricity. Instead, landlords could be convinced to invest the incremental money to obtain energy efficient lighting equipment or appliances, to increase the rent accordingly, and to pitch the increase by showing tenants that they are going to save the equivalent or more on their electricity bill. All the shoppers we intercepted pay their own energy bills and most of them owned their home. Thus, we were not able to test the extent of the split-incentive barrier with them (n=22, 16 Detached homes, 3 Apartments/condos, and 3 Town/Row houses).
S.-I. Barrier C: Landlords pay the energy bills but will not invest: Renters own the buildings and pay the electrical bills. Neither the renters nor the tenants will invest in energy efficiency.	This issue should be less significant in nature than S.-I. A and B because it would make sense for the owners/renters to invest in their building(s) and then benefit directly from the savings, and at the same time increase tenant satisfaction and retention. The issue is that some landlords perceive that they are being repaid the electricity cost through the rent. It may be possible to change this perception. By reducing their operating costs, they can either increase their bottom line, or their competitiveness.
S.-I. Barrier D: Developers will not pay the energy bills: Housing developers make design decision or design changes that might increase the electrical consumption of the house	This barrier is significant in the residential new construction sector because the future owner is often not known well in advance and thus very few future owners partake in developing the specifications for their homes.

Notes on Exhibit 17:

- Two landlords out of three to we spoke to told us that the “split-incentive barrier” did not apply to their properties (0%); and one told us it applies fully (100%).

- One developer told us that... *In the Yukon some landlords own apartment blocks built in the 1970s. The mortgages on these blocks have been paid off for a long time. The rent is already very low and impossible to compete with if developers were to construct new apartment blocks. Landlords do not have to worry about competitiveness and price point. These landlords have little incentive to invest.*
- One developer reported that... *Developers are not seeing any benefits to their bottom line with EE lighting. We are passing on the benefits to the customers. YEC/YECL could help them understand why this is a good thing. YEC/YECL could help everyone understand where the biggest benefits are.*

As a result of the discussion in Exhibit 17, we conclude that the split-incentive barriers should be accounted for in the design, but should not prevent program uptake and the realization of savings.

7. Motivations of the Market Actors

In this section, we map out the motivations and interests that exist within the chain of distribution, how these interests influence the market penetration of energy efficient technologies and practices. This will give us some hints on how these natural drivers can be used to influence the market to become more energy efficient.

Reasons for making special efforts with regard to energy efficiency

The majority of interviewees, as shown in Exhibit 18, make special efforts to promote energy efficiency in their businesses.

Exhibit 18 Occurrence of Special Efforts for Energy Efficiency Among All Market Actors

Does your organization make special efforts for energy efficiency?				
	Never:	Sometimes:	Often:	Always:
Number of responses from all interviewees including landlords (n=11)	2	2	3	4
Number of responses from landlords only (n=4)	2	1	1	0

Where the sample size for all interviewees is n=11 among which 4 are retail store managers, 2 are developers, 4 are landlords, and 1 is an independent lighting supplier.

Notes on Exhibit 18:

- The two “Never” responses from landlords were unexpected. The comments made by landlords imply that this is due to the split-incentive barrier. Given the answers of the same landlords presented in Exhibit 21, we believe that the barrier is “Split-incentive Barrier B: Tenants directly pay the energy bills but will not invest.”
- One retail store manager made the following comment: *They seek to show the ENERGY STAR logo.*
- One developer reported: *Always for appliances but only sometimes for lighting. The EE lighting is too expensive. Something they would consider if it fit in the price point they are targeting.*
- Landlords reported: *They only replace things when no longer working | The cost has to be the same as a regular appliances | May look into EE in the future; but will likely charge more rent if more expensive to purchase.*
- The independent lighting supplier reported: *They only sell LED lamps so he/she makes special effort to promote EE as their core business.*

Exhibit 19 presents the motivations of the market actors for making a special effort regarding energy efficiency.

Exhibit 19 Reasons for Making Special Efforts Regarding Energy Efficiency

Motivations of:	What are the greatest motivations of your organization regarding energy efficiency?	Sample Size (n)
Retail Managers <i>through interviews</i>	1 st : Reactiveness to customer demand – <i>close call with</i> 2 nd : Maintenance or gain of competitive advantage 3 rd : Good corporate citizenship 3 rd & 4 th : Higher profit margin of energy efficient products <i>tied with</i> Green public image	4
Lighting Retail Sales forces <i>through Mystery shopper</i>	Floor staff seemed motivated by their own curiosity. All floor staff that we talked to was offered training by the management. Retailers want to be seen as “green companies.”	2
Appliance Retail Sales forces <i>through Mystery shopper</i>	Floor staff seemed to be motivated by training and experience. Staff at one store was motivated by commitment to E-Star because it only sells one brand of appliances.	3
Retail Sales forces according to managers	1 st : Customer satisfaction – <i>with a solid lead</i> 2 nd : Curiosity / Gaining knowledge 3 rd : Non-monetary recognition (e.g. employee of the month, etc) – in this specific case the interviewee said “closing the deal”.	4
Landlords <i>through interviews</i>	No significant difference between lighting and appliances 1 st : Maintenance or gain of property value 2 nd & 3 rd : Operation cost reduction <i>tied with</i> Increase buildings' ability to retain or attract tenants	4
Housing Developers <i>through interviews</i>	1 st : Green public image 2 nd & 3 rd : Maintenance or gain of competitive advantage <i>tied with</i> Reactiveness to customer demand 4 th : Good corporate citizenship	3
Independent Supplier <i>through interviews</i>	1 st : Strong personal interest 2 nd : Reactiveness to customer demand 3 rd : Good corporate citizenship	1

Notes on Exhibit 19:

- Retail store managers selected *Reactiveness to customer demand* and *Maintenance or gain of competitive advantage* as their first and second motivations. *Higher profit margin of energy efficient products* ranked 4th or 5th. This is not as much a driver as we suspected.
- All supply-chain actors seem to care for their competitiveness and have an appreciation that energy efficiency could be a component of it.

- Salespeople from a retail store mentioned that *they want to be perceived as a “green company” and already have many recycling initiatives in place.*

Exhibit 20 presents the motivation of the retailers’ sales force:

Exhibit 20 Reasons for Making Special Efforts Regarding Energy Efficiency

According to:	What are the greatest motivations of your organization regarding energy efficiency?	Sample Size (n)
Mystery shopper Lighting Sales force	Floor staffs seemed motivated by their own curiosity. All floor staff that we talked to were offered training by the management. Retailers want to be seen as “green companies”.	2
Mystery shopper Appliance Sales force	Floor staff seemed to be motivated by training and experience. Staff at one store was motivated by commitment to E-Star because it only sells one brand of appliances.	2
Retail Store Managers	1 st : Customer satisfaction – <i>with a solid lead</i> 2 nd : Curiosity / Gaining knowledge 3 rd : Non-monetary recognition (e.g. employee of the month, etc) – in this specific case the interviewee said “closing the deal”.	4
Shoppers Appliance Sales force	1 st : Service and value to you (2 hits) 2 nd : Sell pricier product(s) (1 hit)	3

Only one retail manager reported that his/her sales force received a commission. Hence, the motivation of the sales force in the Yukon seems to be mostly customer satisfaction and curiosity.

Exhibit 21 shows the answers of the interviewees when they were asked about reasons to not do more regarding energy efficiency.

Exhibit 21 Reasons for NOT Making More Efforts Regarding Energy Efficiency

Motivations of:	What are the reasons why your organization would not make more effort to promote energy efficiency?	Sample Size (n)
Retail Managers <i>through interviews</i>	1 st & 2 nd : Don't know what products to concentrate on <i>tied with</i> Difficult sale, i.e. energy efficient products are more difficult to sell (Lack of consumer demand) 3 rd : Lower profit margin of certain energy efficient products	2
Landlords <i>through interviews</i>	No difference between lighting and appliances. 1 st : Energy efficient systems do not improve the financial results or situation of your organization because electricity costs are paid for by another party (2 hits) 2 nd & 3 rd : Energy efficient systems do not increase the value of your properties as much as other asset management expenditures or investments. <i>tied with</i> High cost of EE products.	3
Housing Developers <i>through interviews</i>	1 st & 2 nd : Against the market trend i.e. it is not what consumers demand <i>tied with</i> High cost of EE products. 2 nd : Issues with availability of energy efficient equipment (it is not being stocked locally)	2

Where EE means Energy Efficiency or Energy Efficient.
Where * mark indicators of the split-incentive barrier.

Notes on Exhibit 21:

- During the mystery shopper activity, the following was mentioned by a store manager: *It would be detrimental to RETAILER X if YEC was to start promoting LED bulbs within the next eight months. At this time, there is a limited selection of LED bulbs and fixtures available at RETAILER X. They are concerned that customers would respond negatively if RETAILER X did not have an appropriate supply of LED lighting. Also, he/she feel it would be best to wait until pricing on LED drops significantly before making the push to sell more LED products.*
- "High cost of energy efficient products" was not among the choices provided to the landlords, yet one of the three interviewees added it and ranked it his/her 1st reason for not making more efforts with regard to energy efficiency.
- Similarly "High cost of energy efficient product" was not among the choices provided to the developers yet one of the three interviewees added it and ranked it his/her 1st reason for not making more efforts with regard to energy efficiency.
- One developer reported: *People are mainly looking for functionality in their living space (i.e., does it have the right layout and square feet to meet the needs of their families). If all criteria are met, then they will look at the energy efficiency. People know the new building codes will give them efficient houses with low maintenance. Everything is base-cost driven. They would rather put in EE if possible.*
- Developers said the following about the challenges of doing business in the Yukon: *Shipping costs are a challenge. People are not willing to pay for EE. Soundproofing is the big thing nowadays. | Getting affordable materials is a challenge and so is the logistics of getting materials in Whitehorse ordering kitchens. It is also challenging to reduce waste. It is*

challenging to maintain a low price of housing. It's hard to build starter homes that are not too expensive.

8. Policy, Program and Regulatory Framework

This section lists and explains policy, program and characteristics of the regulatory framework that have a significant influence on energy conservation in the lighting sector.

The national building code applies to houses in the Yukon. The City of Whitehorse Building and Plumbing Bylaw specifies stricter energy performance requirements for buildings, but only applies within the City of Whitehorse.

The Yukon Housing Corporation (YH) offers a variety of programs for home owners looking for information and resources to increase the energy efficiency of their homes. There are self-help courses to educate people wanting to build or renovate their homes. There are also courses for professionals in the residential building field to help them understand the various aspects of the R2000 standard. Heating and ventilation certification courses are also offered from the Heating Refrigeration and Air Conditioning Institute of Canada and the EnerGuide Evaluator (or Energy Advisor) certification through Natural Resources Canada.

The YH also offers home energy audits, linking interested homeowners with certified energy auditors. They also maintain a network of certified auditors to provide this service. Homeowners are able to take advantage of Yukon Housings low interest home repair loan after having an energy audit completed. This can help to cover the cost of energy efficiency upgrades identified during the energy audit as well as other eligible upgrades. During the retail intercepts, shoppers were asked if they had participated in the EcoEnergy program. Five responded that they had participated and ranked the program three out of a possible four points. The only comments given were that *the report was quite dense and hard to access for a layperson and that it was a little too generic and contained some strange information*. Of the landlords interviewed, only one had taken advantage of the EcoEnergy program and rated it eight out of a possible ten points.

The Energy Solutions Centre (ESC) also delivers technical information and financial rebates to support energy efficiency household appliances and heating systems as well as a financial rebate for homeowners that have completed a home energy audit through YH. ESC conducts research to help identify appropriate and applicable energy efficiency measures and provides training courses to help build the local technical capacity to deliver these products and services to Yukoners. The public is able to visit the ESC office and website to access a wide variety of information on energy efficiency and renewable energy.

During the retail intercepts, shoppers were asked if they had participated in the Good Energy Rebate program. The twelve shoppers who participated rated the program a 3.7 out of possible 4 points. The only negative comment was from a shopper who had not been able to get the rebate because the program had ended for the year and he had missed the deadline. Two of the landlords interviewed had participated in the Good Energy rebate program and rated it 9.5 out of a possible 10 points.

9. YEC & YECL Credibility and Visibility

This section reports on the interviewees' perception of YEC & YECL with regard to energy conservation. Exhibit 22 shows the results of the set of credibility questions.

Exhibit 22 Level of Credibility of Selected Stakeholders

What is the level of credibility of the following organizations with regard to electricity conservation? Where: 1 = No Credibility, and 10 = High Level of Credibility.

Yukon Energy Corporation (YEC) as seen by:

Retailers Managers: 7.5/10, n=4	End-users (Shoppers): 3.3/4, n=22 Equivalent to 8.2/10, n=22
Landlords: 8.3/10, n=3	Independent Lighting Supplier: 7/10, n=1
House Developers: 8.0/10, n=3	<u>Grand Weighted Average*: 8.0/10</u>

Yukon Electrical Company Limited (YECL) as seen by:

Retailers Managers: 7.5/10, n=4	End-users (Shoppers): 3.2/4, n=21 Equivalent to 8/10, n=21
Landlords: 8.3/10, n=3	Independent Lighting Supplier: 7/10, n=1
House Developers: 7.7/10, n=3	<u>Grand Weighted Average*: 7.9</u>

Yukon Government Organization such as Energy Solutions Centre as seen by:

Retailers Managers: 8/10, n=4	End-users (Shoppers): 3.4/4, n=22 Equivalent to 8.5/10, n=22
Landlords: 8.3/10, n=3	Independent Lighting Supplier: 8/10, n=1
House Developers: 8.3/10, n=3	<u>Grand Weighted Average*: 8.3/10</u>

Other Energy Efficiency Program Administrators (BC Hydro, MB Hydro, etc.) as seen by:

Retailers Managers: 8.3/10, n=3	End-users (Shoppers): N/A
Landlords: 9.0/10, n=2	Independent Lighting Supplier: 9/10, n=1
House Developers: 8.5/10, n=2	<u>Grand Weighted Average*: 7.6/10</u>

Equipment Suppliers of Any Sort as seen by:

Retailers Managers: 8.0/10, n=4	End-users (Shoppers): 2.8/4, n=22 Equivalent to 7/10, n=22
Landlords: 9.0/10, n=2	Independent Lighting Supplier: 9/10, n=1
House Developers: 7.3/10, n=3	<u>Grand Weighted Average*: 7.5</u>

Hypothetical Third-party Energy Efficiency Program Delivery Contractor as seen by:

Retailers Managers: 9.0/10, n=3	End-users (Shoppers): N/A
Landlords: 7.5/10, n=2	Indep. Lighting Supplier: No answer
House Developers: No answer	<u>Grand Weighted Average*: 8.4</u>

Where Grand Weighted Average = 50% of the Grand Average of all Supply-side Actors + 50% of the Average for End-users (Shoppers)

Based on the results shown in Exhibit 22:

- No significant differences were noted regarding the credibility perception of YEC and YECL among shoppers who bought EE lighting, shoppers who bought standard lighting, and shoppers who bought EE appliances.
- The credibility perception of ESC ranked higher among shoppers who bought EE appliances (3.8/4, n=4) than among shoppers who bought lighting (3.4/4, n=22). The credibility perception of ESC ranked higher among shoppers who bought standard lighting (3.6/4, n=9) than among shoppers who bought EE lighting (3.0/4, n=9).
- The credibility perception of manufacturers ranked higher among shoppers who bought lighting equipment (2.9/4, n=18) than among shoppers who bought appliances (2.3/4, n=4). The credibility perception of manufacturers ranked higher among shoppers who bought EE lighting (3.1/4, n=9) than among shoppers who standard lighting (2.7/4, n=9).
- Said by managers: *there are a lot of complaints about YECL's electricity and increasing bills. People don't find them reliable enough that they would find them a credible source of information. | Suppliers are promoting just to make \$\$.* | *Ensure that people know Utilities are funding any third party.* | *Do programs yourselves. Will help raise your image in community rather than paying consultants and upping people's bills.*
- Said during mystery shopper outing: *A retail manager feels YEC info would go over better with the public if there was corporate support (i.e. the retailer and Yukon Energy partner in a marketing campaign). This way they can illustrate how they are committed in promoting green lighting alternatives. They feel energy message will go over with the public much better if in tandem with corporate support.*
- As reported by house developers: *Just do the programs yourselves | ESC seems to be doing really experimental stuff, which is not always relevant. They have also been given the mandate to be all things to all people, and energy isn't a mass market kind of thing. Needs to be tailored to each situation | Sometimes hard to find info you are looking for from suppliers | Depends on the contractor you choose, would need to be very credible. | There were a lot of 'energy specialists' doing this kind of work in the 1980s when it was fashionable and lots of them were very inexperienced.*
- As reported by house developers: *Depends on what contractor you use as third party.* The fourth developer said: *I can't really comment – would just be one opinion, otherwise all 7s*
- As reported by independent supplier: *ECS needs to get back into the public eye | If had asked, Yukon Housing would be a 7/10.*

It appears to us that Yukoners in the Residential Retail Channel are open to the idea that YEC, YECL or both, could do energy conservation. There is no clear preference between YEC and YECL.

YEC and YECL credibility is slightly lower than that of Energy Solutions Center.

There would be a significant level of trust in YEC and YECL and this trust would be significantly above that for equipment suppliers.

It appears that a third party delivery agent would have a higher level of credibility. However, there is contradiction between the numbers and what people actually said during the interviews. At least two interviewees mentioned that they were firmly convinced that this was not a proper delivery mechanism because it would be too costly.

10. Market Stakeholders

The following section describes the primary groups or organizations active in the Yukon and relevant to the market segment being researched. The following exhibits describe these groups, along with their strengths and weaknesses.

Exhibit 23 Market Actor: Yukon Housing Corporation

Market Role	Yukon Housing is a crown corporation of the Yukon government working to support the housing needs of Yukoners through programs and services such as social housing, home repair programs, staff housing, education, seniors housing programs and provide information on housing related topics. Yukon Housing is the delivery agent for the EcoEnergy Program through the federal Office of Energy Efficiency. This program provides energy audits for homes. Yukon Housing trains and maintains a list of local certified energy advisors. Their very generous low-interest home repair loan could be used in energy efficiency upgrades. This can be applied for after a home assessment is completed. Yukon Housing has a long history of building, maintaining and training people on housing in the north. There is a strong interest in energy efficiency and many of the recent Yukon Housing units are very many efficient design elements, such as the double wall system, incorporated.
Strengths and Resources	▪ A long history of working with housing in the Yukon, including building and maintaining social and staff housing ▪ Delivers training courses on a variety of home building and ownership topics, including some aspects of energy efficiency. Also deliver the certified energy advisor course and HRV training by HRAI. Has the experience and capacity to deliver courses ▪ Maintains a list of certified energy auditors ▪ Has hosted a series of contractors' breakfasts to engage contractors on aspects of R-2000 homes with the goal on providing information on high quality, energy efficient and healthy homes ▪ Strong internal interest in energy efficiency
Weaknesses	▪ Vulnerable to change in political mandates and funding ▪ The funding agreement for the EcoEnergy Program is renewed on an annual basis making continuity of the program a challenge.

Exhibit 24 Market Actor: City of Whitehorse

Market Role

The City of Whitehorse is the largest Canadian municipality's north of the 60th parallel, with nearly 25,000 citizens. The city has approximately 200 staff and its departments include a Fire Department, Parks and Recreation, Transit, Planning and Development Services, Public Works, Engineering and Environment, Sustainability, Services, Information Systems, Bylaw Services, Maintenance and Safety Services, Council Services, and Tourism and Economic Development. They run a number of their own faculties as well as the Canada Games Centre, the Landfill and provide water, sewer, garbage and compost collection as well as transit services.

The City of Whitehorse is very sustainability minded and has adopted a sustainability plan which includes energy efficiency and has won awards for sustainability. The City has just initiated a large scale energy audit of 25 of their facilities that is meant to inform a new Energy Strategy. The city has also started an initiative to track all of its energy use on a per-building basis. The information is generally from the monthly electricity bills and fuel delivery records.

In 2009 the City enacted a Bylaw to make all new houses in the city R80 or a similar efficiency with a prescriptive list of minimum standards. HRVs were also made mandatory for new homes as well as other efficiency measures.

Strengths and Resources

- Very sustainability and conservation minded organization, including energy
- A full-time sustainability project manager and potentially an environmental manager position starting soon
- Staff has been involved in CPR workshops and YECs energy planning charrettes.
- Strong leadership shown with the Building Bylaw, which has significantly raised the standard of energy efficiency in the city. Furthermore, even if it is already higher than in most of Canadian municipalities, this bylaw is being reviewed to increase the minimum performance requirement.

Weaknesses

- As with many municipalities, they are tight on money and energy projects compete with the money needed to provide core services.
- Vulnerable to changes in municipal government and changes to government funding streams from all level of government

Exhibit 25 Market Actor: Energy Solutions Centre

Market Role

The Energy Solutions Centre is a branch of the Yukon Government's Department of Energy, Mines and Resources. The mandate of the branch is to encourage improvements in energy efficiency and the adoption of more forms of renewable energy. To accomplish this mandate, the branch participates in the design of energy policies, and delivers energy programs and projects that enhance the environmental, economic and social sustainability of the territory. Their clients consist of Yukon citizens, other government departments, First Nations, municipalities and businesses.

Their services include:

- Delivering market transformation programs, such as those that provide technical information and financial rebates to encourage Yukoners to use the most energy efficient household appliances and heating systems
- Conducting research projects to determine the best opportunities for improvements in energy efficiency and the adoption of more forms of renewable energy
- Providing training courses to build local technical capacity to provide market-based sales, installation and service support for more efficient technologies and processes
- Participating in outreach and public education initiatives that provide opportunities for Yukoners to learn about the health, safety, economic and environmental benefits of energy efficiency and renewable energy
- Working cooperatively with agencies such as Natural Resources Canada and other Federal, Territorial, First Nation, Provincial and Municipal government organizations to deliver energy programs to Yukoners.

Taken from <http://www.energy.gov.yk.ca/aboutesc.html> on June 2012

Strengths and Resources

- Currently offer:
 - A fridge and freezer retirement program
 - Good Energy Rebate program: rebates on energy efficiency refrigerators, freezers, clothes washers, dish washers, wood stoves & furnaces, wood pellet stoves/ furnaces/ boilers, oil furnaces/ boilers/ heaters, propane furnaces/ boilers, solar hot water heaters, drain water heat recovery systems, water efficient toilets and home energy audits
 - Wind prospecting services
 - Directory of renewable and/or efficient energy products and services
- Long history of offering energy efficiency programs in the territory
- Staff with strong technical knowledge of established and emerging energy efficiency technologies
- Large library of public information sheets on energy efficiency, reports on various technologies and their application in the Yukon
- Ability to create programs around all aspects of energy, not simply electricity

Weaknesses

- Vulnerable to change in political mandates and funding

Exhibit 26 Market Actor: Yukon Contractor Association

Market Role	A contractor association's primary objective is the overall improvement of the industry and the provision of services to its members. The YCA works to increase contractors' knowledge and efficiency through promoting the interchange of thoughts and ideas between all industry sections relating to electrical contracting. In addition, the YCA acts as the government liaison for apprenticeship training, qualifications and regulations. NOTE: The YCA was not interviewed. It is nevertheless a relevant actor to consider in our analysis.
Strengths and Resources	▪ Authority, credibility and visibility among contractors ▪ Several communication channels with members, which are the hard-to-reach contractors
Weaknesses	▪ No website. ▪ Hard to engage

11. Qualitative Baseline of the Retail Stocking and Merchandizing Practices

In this section, we make a qualitative assessment of the retail stocking and merchandizing practices in the absence of DSM programming in the Yukon.

Retailers' Stocking, Purchase and Merchandizing Practices

The retailers that we interviewed use purchase and stocking to influence the demand for the products that they sell. The big-box retailers answered: "Always", and "Often". The smaller retailers answered "Sometimes". n=4. The choices were: Never-Sometimes-Often-Always.

For lighting equipment, the most important purchase/stocking motivations of retailers in the Yukon are (n=2):

- 1st and 2nd: Strictly dictated by headquarters (i.e. outside of the branch) *tied with* Customer feedback
- 3rd and 4th: Preference of the sales people *tied with* If it benefits the Yukon.

If it benefits the Yukon was not a choice offered to the interviewee. It was added by interviewee as "Other".

For appliances, the most important purchase/stocking motivations of retailers in the Yukon are (n=4):

- 1st and 2nd: Customer feedback (e.g. complaints) *tied with* Sales or demand forecast
- 3rd and 4th: Strictly dictated by headquarters (i.e. outside of the branch) *tied with* Profit margin on each product.

One big box retailer answered *strictly dictated by headquarters (i.e. outside of the branch)*. This might limit the opportunities to work with this specific retailer.

During the in-person interviews, three of four retail store managers reported that they currently promote energy efficient equipment through a specific merchandising strategy or allocation of shelving space.

Retail store managers reported: *they have a sticker on the door about green products, including the Energy Star label. | Sometimes put tags with a green slogan on things that are EE or organic. | Energy efficiency is part of their sales pitch. | They have a full display of EE lighting you can test and light up etc. It is being used. | They recommend doing coupons. People just have to try and then they like it. | Their store promotes ENERGY STAR.*

Exhibit 27 shows the result of our field observations on the merchandizing practices in retail stores in the lighting equipment section.

Exhibit 27 Lighting In-Store Field Observations (n=3)

Product	Approx. % of Linear Shelf	Promo or Discount Available?	Other Observations
Incandescent	60%-30%-30%	No	None
CFL incandescent replacement	40%-70%-70%	Yes in 3 retailers out of 3 retailers.	None
Energy-star CFLs	60%-10%-10%	Yes in 1 retailers out of 3 retailers.	None
All other CFLs	40%-90%-90%	No	None
Incand./Halogen PAR Lamps	90%-80%-50%	No	None
CFL PAR lamp replacement	10%-20%-50%	No	None
Energy-star fixtures	n/a-50%-40%	No	None
Other fixtures	n/a-50%-60%	No	None
LED lamp	10%-10%-10%	No	None
All other lamps	90%-90%-90%	No	None

Notes on Exhibit 27:

- The discounts that we saw were brand-related. The rebate comes from the manufacturers. The displays (if any) promoted the discount but did not inform the shoppers about energy savings.
- No “out-of-stock” statuses were observed in any of the retailers. Retailers were well-stocked and had good selection of products and brands.
- Retailers mostly displayed standard labeling of product and price.
- Only one store had a “green” slogan sign with the retailer’s branding.
- One store did have a light bulb info book on display which explained many key benefits of the various lighting options. They also had an excellent light bulb display case showing the differences between LED and CFL light bulbs, illustrating cost savings, brightness, color, etc
- The lighting mystery shopper outing took place in the spring at a time when the daylight lasts from 5 am to 10 pm. The push for lighting from retailers happens in the fall.

Exhibit 28 shows the result of our field observations on the merchandizing practices in retail stores in the appliance equipment section or in appliance-only stores.

Exhibit 28 Domestic Appliance In-Store Field Observations (n=4)

Product	Approx. % of Floor Space	Promo or Discount Available?	Merchandizing Activity Going On
Energy Star Cloth Washers	50%-50%-0%-30%	Yes, 3 times	Yes, 2 times
Normal Cloth Washers	50%-50%-100%-70%	Yes, 1 time	No
Energy Star Refrigerator	90%-80%-60%-70%	Yes, three times	Yes, 3 times
Normal Refrigerator	10%-20%-40%-30%	No	No
Energy Star Freezer	80%-70%-100%-0%	Yes, 2 times	Yes, 1 time
Normal Freezer	20%-30%-0%-100%	No	No
Energy Star Dishwasher	100%-100%-0%-60%	Yes, 3 times	Yes, 2 times
Normal Dishwasher	0%-0%-100%-40%	No	No

Notes on Exhibit 28:

- Only one of the stores had a sign promoting the “Good Energy Rebate”.
- Except for clothes washers, a lot of floor space was allocated to Energy Star appliances.
- None of the shops had “Out of Stock” status on the Energy Star Appliances.
- The sales people told the shopper that: *Generally speaking, home owners are keen on purchasing ENERGY STAR appliances and usually do. Landlords are far less interested because they do not pay for the electricity bill; their tenants do. So they are more interested in buying the cheapest appliances regardless of the energy consumption.*

Ease of Getting Information on Energy Efficiency of Products in Stores

The main outcomes of the retail intercept with regard to the ease of getting information on EE of products in the store are presented in the paragraph below.

Reported satisfaction with regard to the ease of getting information on EE of products is 3.1/4 (n=20) for both lighting equipment and appliances (where 1=Very easy and 4=Very difficult). This is equivalent to 7.7/10. This is deemed acceptable. We often use 8/10 as a threshold of acceptability.

- Satisfaction seems higher for appliance shoppers (A=3.3/4, n=4) but sample size is so small; so it is difficult to say.
- Satisfaction of EE lighting shopper (3.4/4, n=9) is much higher than the satisfaction of standard lighting shoppers (2.5/4, n=7). Either they could genuinely need a little more support, or they are blaming the retailers for their decision that they think might be judged by the interviewer.

None of the 18 lighting shoppers that we intercepted had talked to a salesperson to carry out their purchase.

Three appliance shoppers out of four did speak with a salesperson. Two out of three actually talked about the energy efficient products that they would purchase.

- These two people scored the performance of the sales people relatively low: 2.5/4 where n=2.
- One of the salespeople told the customer about the monetary savings on energy bills and the Good Energy rebate.
- According to the [other] interviewee: *The [other] salesperson did not really talk about the energy efficiency aspect.*

With regard to the visibility of the energy efficient product(s) as compared with the non-energy efficient product(s), for lighting and appliances, the shoppers answered 3.1/4 on average (n=22) where 1= Low level of visibility and 4=Very visible.

- The lighting shoppers (3.3/4, n=18) seemed more satisfied than the appliance shoppers with regard to the visibility of the EE products (2.5/4, n=4).

The lighting mystery shopper reported that getting a salesperson to answer was easy in two stores and very difficult in a third store. In the third store, they refused to help them at first and he had to persist. The mystery shopper had to wait more than three minutes. The appliances mystery shopper stated that three out of four salespeople were readily available and able to answer his questions. At the fourth store, the salesperson was unable to answer his questions about Energy Star appliances.

12. Preferred Approaches of the Market Actors

Interviewees were asked about their preferred DSM program approach, tactics and activities to gain a general idea of what the program uptake might be depending on the set of tactics that future DSM programs might include. We would like to highlight that the end goal of a program is not to have participation, but to tackle barriers. Program tactics would not be chosen solely based on the preferences of the interviewees.

Exhibit 29 presents the answers with regard to the preferred program approach.

Exhibit 29 Preferred Program Tactics and Activities

Preferred tactics of:	What are the energy conservation program activities you are the most likely to participate in?	Sample Size (n)
Retail Managers <i>through interviews</i>	1 st & 2 nd : Direct incentive to you in exchange for selling EE products <i>tied with</i> Mail-in Rebate for your customer to buy EE products 2 nd : Low-cost training and certification for your staff 3 rd & 4 th : Instant Rebate for your customer to buy EE products <i>tied with</i> Partnership, branding and/or support for marketing	4
End-users: <i>All shoppers through retail intercepts</i>	1 st : Fill in a form, and send it to receive a mail-in rebate (3.4/4, n=21) 2 nd : Visit a website and spend time online reading on EE (3.2/4, n=22) 3 rd : Have an EE expert come to your home to advise you (3.0/4, n=20) 4 th : Attend an after-hours meeting or demo on EE (1.8/4, n=22)	22
Landlords <i>through interviews</i>	1 st : Instant rebate for buying EE products 2 nd : Direct incentive to you in exchange for installing EE products: 3 rd : Mail-in rebate for buying EE products	4
Housing Developers <i>through interviews</i>	1 st : Direct incentive to you in exchange for installing EE products 2 nd : Instant Rebate for buying EE products 3 rd : Low-cost training and certification for your staff 4 th : Free simple information brochure for your customers 5 th : Partnership, branding and/or support for marketing	3
Independent Supplier <i>through interviews</i>	1 st : Free simple information brochure for your customers 2 nd : Free simple information brochure for you or your staff 3 rd : Instant rebate for residential customers to buy EE products	1

Where EE means Energy Efficiency or Energy Efficient.

Notes on Exhibit 29:

- Rebate and incentive consistently come first among retail managers, end-users, landlords and developers.
 - They do like the “direct incentive” concept – sometimes referred to as “Market transformation” incentive.
 - Retail managers preferred the mail-in rebate more than the instant rebate, as it creates less administrative work for them. It is good to know because some retailers in other jurisdiction prefer the “Instant rebate” because it is more effective – regardless of the extra work for them.
 - Developers and landlords preferred the “instant rebate”. It is not a surprise. It requires less administrative work for them.
- Training offerings would come in second place overall.
- Education to the customer would come in second place overall.
- Comments made by retail store managers: *LEDs are great, but took a long time to come on. Now they sell about 15% LEDs | they would like help to show local savings that have been measured here. Show performance in local climate. | People are very aware of the fact they are on diesel generators in the does; communities. They are aware of peak demand.*
- Landlords reported: *YEC/YECL should help his/her tenants understand that opening their windows during the winter wastes heat. Their tenants pay for electric baseboard heat. | There should be programs to retrofit old apartment buildings. Many apartments were built in 1970's. Owners have long paid them off and are just making money on them now. There is very little incentive to invest further.*
- Even though this particular tactic ranked 4th, three four of store managers said that they are open to the idea of working with YEC & YECL in in the future to use merchandising tactics to promote energy efficient products.

13. Barrier Analysis

Barriers that will emerge as themes during the market research activities were identified and categorized through a barrier analysis. This analysis will be used to support program design in terms of informing the type(s) of program that should be created as well as pertinent activities that should be included. For our purposes, we divide barriers and hurdles into five types: informational, financial, technical, institutional/cultural, and market.

We believe that there are four main barriers to energy efficiency in the Residential Retail Channel in the Yukon. Exhibit 30 presents these four barriers.

Exhibit 30 Key Market Defects

Identification	Hurdle or Barrier ²	Type	Substantiation
High cost of some lighting equipment: LED in particular.	Hurdle	Financial	Supply-side actors agreed that the high price of lighting equipment is the most important barrier. However, the lighting shoppers we intercepted disagreed and we identified other motivations and drivers. LED is still cost-prohibitive as compared with, for example, the CFLs. However, the price point is expected to come down soon. YEC/YECL could drastically accelerate the market penetration of LEDs before and while the price point is going down. CFL waste cannot be handled in the Yukon. It would be more environmentally and health conscious not to promote them. They have issues with power quality. They do not work well in the cold. LED does not have these problems.
Lack of information or confused information and beliefs of end-users with regard to energy efficient equipment	Hurdle	Informational	Reasons provided by end-users for not purchasing EE lighting products included: aesthetic, environmental consideration, did not know about the savings, don't know how much is the savings and don't believe in the savings. Many other energy efficient products that are in the store could benefit from point-of-sale information by YEC/YECL; including appliances but also low-flow showerheads, block heater timers, faucet aerators, three-element hot water tanks, etc.
S.-I. Barrier B: Tenants pay directly the energy bills but will not invest	Hurdle	Financial	Tenants pay directly the energy bills but will not invest because they consider that the landlord should. Landlords will not change the appliances or lighting equipment because they do not pay the electricity bill. Landlords who provide appliances to low-income tenants will not change the appliances, fixtures or lamps unless they break or burn; and if they do then they will go for the cheapest.
Missing lighting products on the shelves of retailers in the Yukon: LED in particular	Barrier	Market	The variety of LED lamps is less and products will be available for less applications in the Yukon than in the rest of Canada because of the size of the market. We believe that there is room for fast-tracking the extent of the LED products offering by working with the retailers to have them add stock-keeping units. They will be interested in doing so because we will provide an incentive for certain LED products; and by doing some testing and information dissemination in their store.

² Hurdles and barriers are words to distinguish market defects. Hurdles are considered easier to address and – eventually– to overcome. Barriers are more difficult to mitigate; and change is slower. Some barriers are externalities that cannot be changed and have to be lived with. Programs generally focus on implementing activities to tackle hurdles.

There are other barriers to energy efficiency in the Residential Retail Channel than those presented in Exhibit 30. Nevertheless, these barriers appear to be the most significant. A justification has been provided in the same exhibit. We believe that these barriers should be addressed first.

Market Characterization Report – Commercial Lighting

Client: Yukon Energy Corporation (YEC)
Yukon Electrical Company Limited (YECL)
Re: Electricity Conservation Market Characterization Report – Commercial Lighting
Project: Residential and Commercial DSM Program Design
Version: September 28, 2012

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1. Introduction

Yukon Energy Corporation (YEC), Yukon Electrical Company Limited (YECL) and the Yukon Government conducted a Conservation and Demand Management Potential Review (the CPR) for the Yukon in 2011. The results of the CPR revealed a significant cost-effective potential for demand-side management (DSM) in the Yukon.

In order to further pursue this goal, the YEC and YECL (i.e. the collaboration is hereinafter referred to as YEC/YECL), will design a portfolio of new Demand Side Management (DSM) programs for presentation to the Yukon Utilities Board.

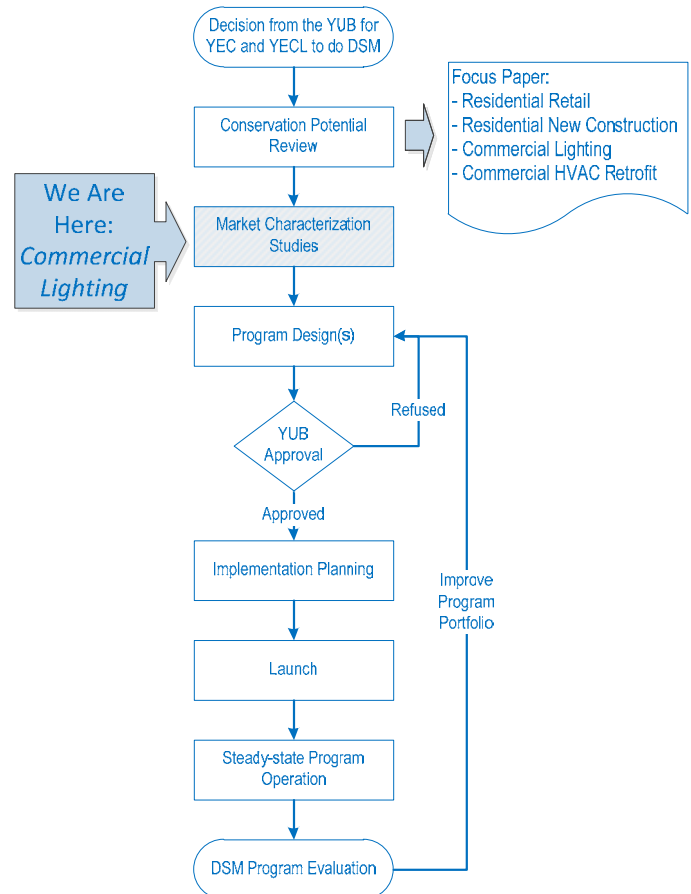
YEC/YECL has contracted ICF Marbek with developing this new portfolio of DSM programs.

If the proposed Electricity DSM program portfolio is approved by the Yukon Utilities Board (YUB), the next steps in this process would be the development of a program implementation plan followed by program launch.

Based on the result of the CPR, ICF Marbek identified four sectors of interest: 1) Residential Retail (Lighting equipment and domestic appliances), 2) Residential New Construction, 3) Commercial Lighting, and 4) Commercial HVAC Retrofit. The justification of this market segmentation and prioritization is presented in a separate document: *Program Focuses – Preliminary Team Discussion Paper*.

This report presents the results and conclusions of the market characterization study of the commercial lighting sector. These results will be used to design DSM programs and initiatives in this sector in the Yukon; and to provide justification for the design decisions to the YUB.

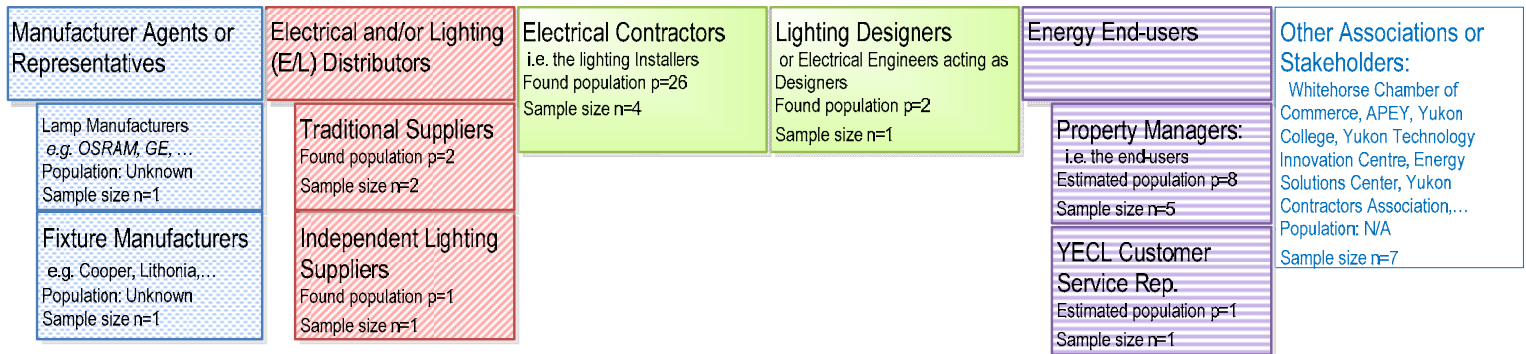
Exhibit 1 DSM Program Cycle



2. Sector Segmentation

This section presents the market segmentation that has been used in the commercial lighting market characterization study. Each segment presented in Exhibit 2 was consulted during the characterization.

Exhibit 2 Commercial Lighting Sector Segmentation



We present each of the sector segments by populating a table as illustrated in Exhibit 6, except for the Other Associations or Stakeholders because they are presented in Section 10.

As shown in Exhibit 2, the sample sizes (n) that we achieved are overall representative of the populations (p).

Exhibit 3 Market Actor: Lighting Manufacturers

Market Role

Manufacturers are multinational corporations headquartered outside of the Yukon – and outside Canada for the most part. There are two types of manufacturers of interest: the lamp manufacturers and the fixture manufacturers. There are only a few large manufacturers in the lighting sector, as presented in Exhibit 9.

The word “Manufacturer” in this report when used alone is a simplification for manufacturer representative (rep) or manufacturer agent. A manufacturer “rep” is one or a group of employees that are directly on a manufacturer’s payroll – they represent the manufacturer exclusively. In contrast, a manufacturer agent has an agreement can represent multiple lamp manufacturers, fixture manufacturers and many other electrical equipment manufacturers. Reps tend to be able to specialize and focus on their products more than agents.

Manufacturer agents and reps serving the Yukon are located outside the Yukon: they are located in Alberta, British Columbia and Washington State.

In other jurisdictions, agents & reps offer “value added” services, including lighting design and layout and sample specifications. These kind of value added services are much more limited in the Yukon.

Strengths and Resources

- Major lighting manufacturers such as Osram/Sylvania and Philips are well known, recognizable global brands.
- Reps/Agents are viewed within the supply chain as the “go to” market actors for technical advice. Agents typically have a high level of “in-house” knowledge, and have direct access to the latest product information and training from the manufacturers they represent.
- According to interviewees, manufacturers were rated as doing a good job at promoting energy efficiency. (See Exhibit 10: 6.6/10, n=5) They score lower than E/L distributors (See Exhibit 10: 7.0/10, n=5), which is unusual and reinforces the assumption that E/L distributors are more trusted because of local presence even though lighting is not their primary business.

Weaknesses

- Vested interests: The goal of manufacturer and their agents/representatives is to promote their products to the exclusion of others, which is not necessarily compatible with the provision of the most efficient products.
- No manufacturers were found to have dedicated representatives –either agents or rep– based in Yukon.
- Sufficient resources are not always available to play the role of “client educator”.
- In other markets, manufacturer’s agents maintain close relationships with both distributors and contractors, and have a strong knowledge of the overall lighting market in their jurisdiction. Based on the challenges encountered by the study team in attempting to contact manufacturer agents and reps representing the Yukon, it appears that the Yukon is not currently a high priority for manufacturer reps and agents. The one manufacturer rep that we managed to speak with did not have specific knowledge about the Yukon market and was not able to make distinction between the Yukon market and that of other jurisdictions.

Exhibit 4 Market Actor: Electrical and/or Lighting Distributors

Market Role

Electrical distributors sell all sorts of electrical equipment; however, lighting equipment typically represents a large portion. Their clientele is composed mostly of contractors. When they sell to end-users, it is because the end-users have in-house electricians. There are two electrical distributors located in the Yukon, as shown in Exhibit 9.

Lighting distributors act as wholesalers, typically selling lighting products from one or many lighting manufacturers. There are no lighting distributors located in the Yukon.

In this report we refer to all distributors selling lighting equipment as Electrical and/or Lighting Distributors – E/L distributors. Electrical contractors do business with E/L distributors that are not located in the Yukon.

The core market role of distributors is 1- to stock the equipment, and 2- to finance the equipment. Distributors also offer advice to their clients. For example, in the South some E/L distributors offer added-value services such as doing the lighting layout and equipment specifications. Yukon-based E/L distributors offer little of these “value added” services.

Strengths and Resources

- E/L distributors often maintain relationships with a variety of market actors situated both upstream and downstream in the supply chain, including lighting designers, building owners, electrical contractors and manufacturer agents and reps.
- E/L distributors have specific knowledge of the lighting market.
- According to the interviewees, distributors were rated as doing a good job at promoting energy efficiency. (See Exhibit 8: 7.2/10, n=6) They have the highest score – above lighting manufacturers and lighting designers. It seems to indicate that they are the more trusted source.

Weaknesses

- Business model provides little inherent incentive to promote efficient lighting.
- Key decision-makers for most distributors are located outside the territory.
- Typical transactions involve provision of equipment only, not specification, design, layout or other advice. This limits the potential influence of distributors in the uptake of efficient equipment.
- Distributors often receive very detailed specifications. In these cases, there is little room to influence equipment decisions.

Exhibit 5 Market Actor: Electrical Contractors

Market Role	Electrical contractors are typically the last link in the commercial lighting supply chain before the end user. Their role is to be “<i>the installers</i>”. They purchase equipment from the E/L distributors and install it. Then they bill their clients for equipment and services. Depending on the type of project, electrical contractors may have a contractual relationship with a general contractor, or directly with a building owner. Electrical contractors active in the territory are smaller regional firms with a handful of employees. In general, smaller companies tend to take on more design/build type projects (including small renovations and retrofits). These projects tend to involve simple design & specification, while larger companies tend to work on the plan/specify jobs, which do not involve specification or design components.
Strengths and Resources	Contractors have significant direct interactions with owners. Some contractors also do design-build projects, which provides them with an opportunity to influence design choices.
Weaknesses	- Except when contracted for a design/build project, contractors tend to receive specifications from others, leaving them very little latitude to influence design. Contractors often feel that it is too late to incorporate significant design changes by the time they are involved in a project. - Electrical contractors typically have a business model that promotes quick project turnaround with an emphasis on short lead times and few callbacks. In some instances this creates a barrier to the uptake of energy efficient lighting and tends to discourage design changes. - Contractors focus on cost because they make money on margin. They buy equipment and services which they sell for more to the client, typically a pre-agreed amount. If they can buy equipment for cheaper and are able to convince the client that the quality is equivalent, then they improve their bottom line. - The contractors seemed to indicate that most of the commercial lighting equipment needed to be ordered for all but the smallest jobs. - Contractors seem to be the least trusted party in this channel. They scored the lowest on the question “How good of a job are they doing at promoting energy efficiency?” 4.3/10, with n=10. (See Exhibit 8)

Exhibit 6 Market Actor: Lighting Designers

Market Role	Lighting designers design lighting systems in new construction projects and major retrofits. Services typically include both layout/design and equipment specification. Only two firms with professional electrical engineers doing lighting design were identified. There is no certification mechanism available in the Yukon for lighting designers like there are in many jurisdictions in North America, and the training offerings are very limited.
Strengths and Resources	▪ Designers are typically involved in the early phases of a project, where efficient equipment can be integrated most easily and effectively. ▪ Designers are the market actors most likely to be in a position to educate end users re: first cost vs. lifecycle cost. ▪ Designers are professionals; maintaining an up-to-date knowledge of the technologies is part of their work ethic. They can learn and work on their skills and capabilities in an autonomous fashion more easily than other trades.
Weaknesses	▪ Lighting designers attached to professional services firms may have primary goals that are not necessarily compatible with efficient design. These may include minimizing equipment cost and aesthetic design considerations. ▪ Lighting design professionals in the Yukon would be primarily trained “on the job” because there is no lighting design training offerings. This can present resourcing issues for companies wishing to expand their design offering. ▪ The level of trust in the lighting designers is relatively low among all parties (See Exhibit 8, 6.3/10, n=11), which is likely to mean that there is a lack of lighting designers in the territory.

Exhibit 7 Market Actor: Retailers

Market Role	These are big-box retail stores located in Whitehorse. They have a large retail space with a lighting department. They are national or international corporations that buy directly from manufacturers. We had interviews with the branch managers and carried out mystery shopper activities to consult with the sales force on the store floor. They play a role in the commercial lighting segment because some contractors buy lighting equipment from the retailers rather than the distributors, perhaps for the smaller jobs, and perhaps because the retailers have more units in stock.
Strengths and Resources	▪ Training and educational materials from headquarters ▪ Energy conservation initiatives from headquarters ▪ Marketing capacity ▪ Knowledge of the local market ▪ Interest in joint activity with YEC/YECL like displaying brochures, flyers, etc.
Weaknesses	▪ Sales staff are not as knowledgeable about lighting as the electrical and lighting distributors ▪ Contractors may rely on retailers for inexpensive, readily available but lesser energy efficient equipment; this is¹ appealing to the contractors, because they want to “get the job done quickly”. ▪ Some decisions may be made by headquarters. ▪ Vested interest. ▪ Busy/ little time to plan joint tactics. ▪ High staff turnover

¹ This is a working assumption, and the research team was not able to fully confirm it. There is a general nation-wide trend of retailers pursuing “contractor business”.

Exhibit 8 shows the consolidated results of the questions related to identifying the weakest link in the Yukon lighting distribution chain.

Exhibit 8 Actors promoting energy efficiency

Are the following market actors doing a good job at promoting better and more energy efficient products in the Yukon? Where: 1 = Poor Job, and 10 = Excellent Job.

Lighting Manufacturers as Seen By:

Manufacturers: N/A	Distributors incl. independents: 5.6/10, n=3
Electrical Contractors: 8.0/10, n=2	Lighting Designers: 8.0/10, n=1
Property Managers: N/A	<u>Grand Average: 6.6/10, n=6</u>

E/L Distributors as Seen By:

Manufacturers: 6/10, n=1	Distributors incl. independents: N/A
Electrical Contractors: 7.5/10, n=4	Lighting Designers: 7.0/10, n=1
Property Managers: 6.4/10, n=5	<u>Grand Average: 6.7/10, n=11</u>

Electrical Contractors as Seen By:

Manufacturers: 4/10, n=1	Distributors incl. independents: 3.6/10, n=3
Electrical Contractors: N/A	Lighting Designers: 4.0/10, n=1
Property Managers: 4.8/10, n=5	<u>Grand Average: 4.3/10, n=10</u>

Lighting Designers as Seen By:

Manufacturers: 8/10, n=1	Distributors incl. independents: 6.0/10, n=3
Electrical Contractors: 6.75/10, n=4	Lighting Designers: N/A
Property Managers: 5.0/10, n=3	<u>Grand Average: 6.3/10, n=11</u>

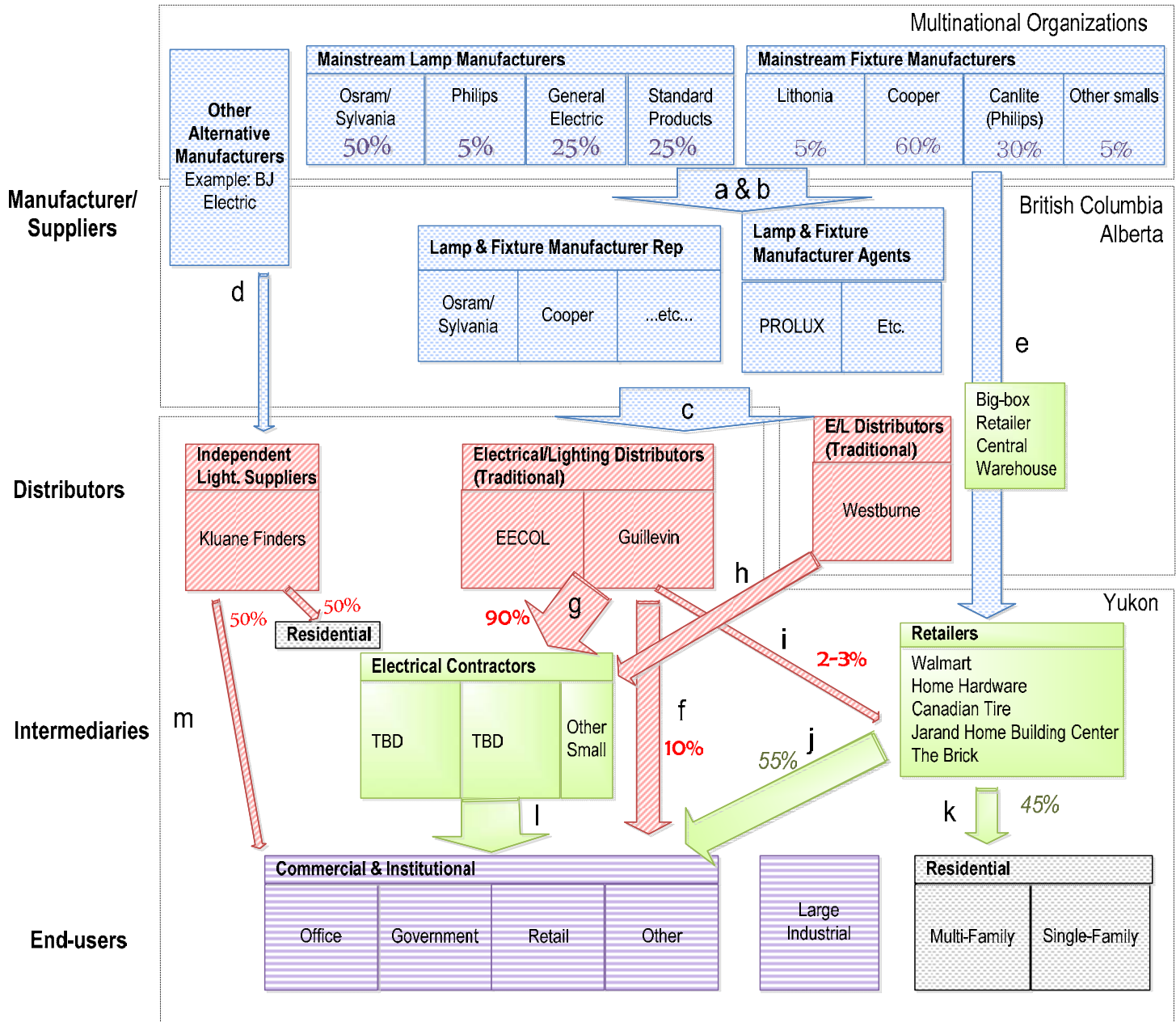
Property Managers as Seen By:

Manufacturers: N/A	Distributors incl. independents: 3.0/10, n=1
Electrical Contractors: N/A	Lighting Designers: N/A
Property Managers: N/A	<u>Grand Average: 3.0/10, n=1</u>

3. Chain of Distribution

A flow diagram of product purchases and sales is presented in Exhibit 9. This depiction of the market is an effective means to understand the interaction of the actors introduced in Section 2. The data underlying the diagram were obtained from interviews with distributors and contractors. They are estimates.

Exhibit 9 Lighting Equipment Supply Chain



Highlights from Exhibit 9 are presented below.

Exhibit 10 Comments on the Chain of Distribution of Lamps and Fixtures

-
- a Lamp and Fixture Manufacturers Sell Through Manufacturer Representatives**
- There is no actual manufacturer rep or agent in the Yukon. Distributors do business with reps or agents in BC and Alberta – or even in the US in the case of OSRAM/Sylvania. Distributors do business with rep and agents approximately 45% and 55% of the time respectively.
 - Based on our sample data, sales of lamps would breakdown between the four main manufacturers in the following way: Osram/Sylvania 50%, Philips 5%, General Electric 5% and Standard Products 25%.
-
- b Lamp Manufacturers Sell Through Manufacturer Agents**
- Based on our sample data, sales of lamps would breakdown between the four main manufacturers in the following way: Lithonia 5%, Cooper Lighting 60%, and Canlite 30%.
-
- c Lamps and Fixtures Are Sold to E/L Distributors Through Lamp Manufacturer Representatives and Agents**
- All manufacturer reps and agents are located outside of the territory: Alberta, British Columbia and Washington State.
 - There seems to be no problems and limitations regarding the types of items that can be ordered and shipped to the Yukon.
-
- d Alternative Manufacturers Sell to Independent Lighting Suppliers**
- It turns out that only two independent distributors were found – and only one at the time the study was conducted. The second one was found after.
 - This local independent supplier specializes in LED lamps and fixtures.
-
- e Lamps and Fixtures Are Sold to Retailers From the Manufacturer Through Central Warehouse**
- The retailers we spoke with told us that they can select what products they want carry from a centralized warehouse (maybe regional). The equipment is likely to be purchased directly from the manufacturers.
-
- f E/L Distributors Sell Some Equipment Directly to Commercial & Governmental Clients**
- Distributors sell some equipment to end-users but it is fairly minor: approx. 10%.
 - As a general rule, distributors sell only to electricians. Therefore, they can sell to end-users as long as they have an electrician on staff.
-
- g E/L Distributors Sell Directly to Electrical Contractors**
- 50% of the equipment is sold for new construction projects, and 50% is sold for retrofit projects.
 - Approximately 60% of the equipment is sold to the commercial sector, and 40% is sold to the government sector. Note: some commercial property owners could have government tenants.
 - Of the 60% that is sold to the commercial sectors, 40% is sold to offices, 40% to warehouse and wholesales, and 20% to non-food retails.
 - Distributors make stocking decisions locally based on sales, and on new products sales forecasting.
 - Stocking practices do not seem to be a barrier in the Yukon – no more than in any other jurisdictions in southern Canada – as it is a common practice to stock a limited number of items and to frequently make special orders. Clients expect this. There are an extra few days in the Yukon for shipping, but this does not seem to be problematic.
-

h Some Distributors from Outside the Territory Sell To Contractors in the Yukon

- It is likely that some distributors do business in the Yukon without actually having a branch in Whitehorse or in the rest of the Yukon. It was not possible to identify a specific transaction or individual who has done this, but at least one distributor name –based in Alberta– was mentioned as a potential equipment supplier in the Yukon.
- However, if some distributors sell to the Yukon without being in the Yukon, the phenomenon is relatively small. Most large property managers told us that they purchase mostly from suppliers with a local presence (approx. 90%).
- Three of the four contractors told us that they mostly buy from suppliers with a local branch in the Yukon.

i Electrical/Lighting Distributors Sell to Retailers

- Retailers purchasing from local distributors represents approximately 2 to 3% of the lighting equipment sales of the distributors.
- Sales of lighting equipment by E/L distributors to the residential sector are below 10%.

j Retailers Sell to Commercial & Governmental Clients

- An important share of the retailer lighting equipment sales is to commercial end-users (approximately 55%). This is an important finding. It could indicate that retailers are an important channel serving the commercial and governmental buildings sectors – more than in other jurisdictions.
- Large property managers admitted purchasing some equipment from retailers: approx. 5%. However, the share they admitted is minor. That might indicate small shops and office buildings use retailers to procure lighting equipment – not large property managers. Given the number of small commercial buildings, the share of sales for business use is still significant.

k Retailers Sell Residential Clients

- The equipment channel to the residential sector was out of the scope of this characterization study.

l Electrical Contractors Sell and Install Equipment in Residential, Commercial & Governmental Buildings

- Electrical contractors were difficult to engage with – most likely because there are a large number of construction projects happening in the territory and electrical contractors are in high demand and very busy.
- Electrical contractors re-sell equipment to the end-users along with the installation services with a mark-up.
- The electrical contractors we spoke with seem to work evenly among the government, commercial and residential sectors. Most have a niche sector they do the majority of their work in.
- Contractors told us that approximately 60% of their lighting system installs are new construction projects and 40% are retrofits – this is heavy on new construction as it tends to be lower in other jurisdictions.
- Designers sell services mostly to the government (60%) and to the commercial sector (40%). In the commercial sector, they mostly sell services for offices lighting designs.
- Most of the lighting designer business (80%) is for new construction projects. Much less business is for retrofit project (20%).
- Both contractors and distributors told us that 50% of equipment is sold for retrofit projects. This might mean that a significant share of the retrofit projects occur without a formal designer.

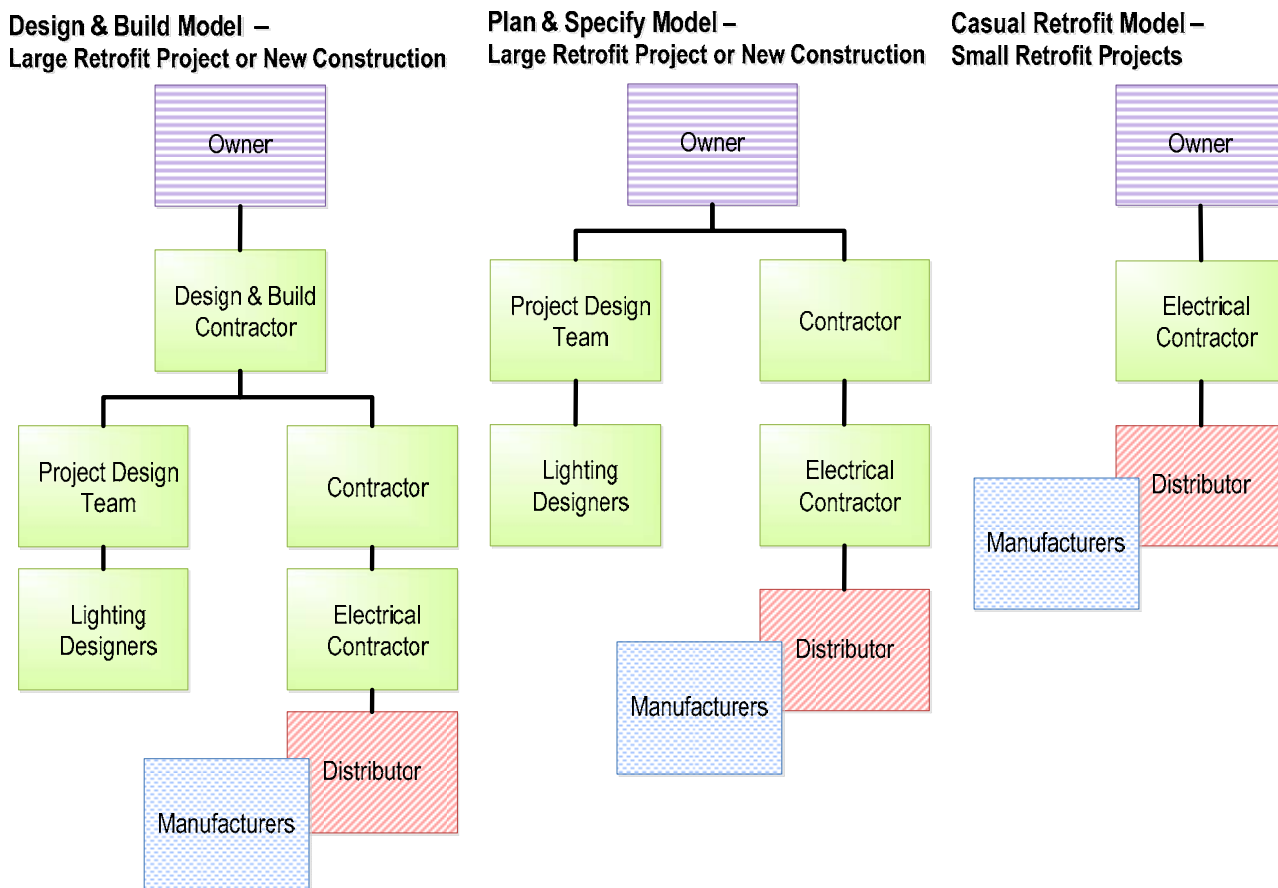
m**Independent Lighting Suppliers Sell Mostly to End-users Directly**

- The independent lighting supplier that we met with was selling to the residential and commercial sectors. Approximately 50% of sales go to the residential sector and 50% to the commercial. Nothing was sold to the government.
 - The independent suppliers primarily sell directly to homeowners or end-users.
 - The LEDs that they sell are mostly used in retrofit projects.
-

4. Typical Contractual Relationships

A summary of the common contractual relationships employed during the design and construction process is provided in Exhibit 11.

Exhibit 11 Common Contractual Models



Design & Build Model – Large Retrofit Project or New Construction: The owner contracts with a Design & Build contractor for both design and construction. The contractor is then responsible for selecting, sub-contracting and managing architects, mechanical and electrical engineers, contractors, etc. as needed. This approach has the benefit of being quicker. However, the D&B contractor has no incentive to take schedule or budget risks with innovative lighting designs or equipment. All of the focus will be on cost and compliance with the schedule.

Plan & Specify Model – Large Retrofit Project or New Construction: The owner contracts with an architectural or architectural/engineering firm for all the design. The architect is responsible for selecting and managing electrical and mechanical engineers as needed. A second contract is made between the prime contractor and the owner for the all materials, equipment, installation and other services related to construction. Some advantages are obtained regarding construction oversight by separating the construction and design roles.

Casual Retrofit Model – Small Retrofit Projects: The owner contracts with an electrical contractor. Design is minimal and carried out by the contractors; no blueprint or specification sheet is actually drafted. These designs are generally very simple: one-to-one replacement of lamps, ballasts and/or fixtures. Professional designers have no direct influence on the owners, the electrical contractors and

the design. This approach is *not* fully compliant with the laws, codes and rules of the land; and thus program administrators in other jurisdictions have generally avoided sponsoring or recommending it “publically”. However, we believe that the existence of the approach needs to be acknowledged.

We did not ask specific questions on the occurrence of design-build, plan & specify and casual design to the interviewees. However, from the conversation we had with them, we know that:

- Design-build does occur in the Yukon. However it does not occur as often as Plan & Specify for new construction – probably less than in other jurisdictions. (Approx. 10% to 30%)
- It appears that casual retrofits do occur in the Yukon – probably more than in other jurisdictions.

The last statement is based on three findings: 1) distributors and contractors reported that retrofits represent 50% of their business in the Yukon, but 2) the designer told us that retrofits represent 20% of their business; and 3) interviewees reported that contractors often do the design or exert heavy influence on the design during retrofit projects (see Exhibit 22).

5. Existing and Prospective Information Dissemination Mechanisms

This section presents an overview of how information about energy efficient design and equipment flows from the main source, manufacturers, to the energy end-users.

The main actors in the supply chain tend to draw their information from manufacturer reps, agents, websites or publications. (See responses from actors in Exhibit 12). These are their preferred sources of information.

Exhibit 12 Main Source of Information

According to:	What is the Main <u>Source</u> of Information that you Use?	Sample Size (n)
Independent Supplier	1 st : Manufacturers/agents/lighting reps Did not name a third medium.	1
E/L Distributors	1 st : Manufacturers/agents/lighting reps 2 nd : Trade magazines/publications Did not name a third medium.	1
Lighting Designer	1 st : Manufacturers/agents/lighting reps 2 nd : Trade magazines/publications In particular: The Illumination Engineering Society 3 rd : Energy conservation / efficiency programs	1
Electrical Contractors	1 st : E/L distributors 2 nd : Manufacturers/agents/lighting reps 3 rd : Other source: not government, not Energy conservation / efficiency programs	4
Lighting Manufacturer	1 st : Energy efficiency programs (BC Hydro, MB Hydro, etc.) 2 nd : Own manufacturer headquarters and R&D teams	1

When asked, all market actors agreed that they have all the information that they need either through the manufacturers or through the widely available engineering handbooks. This information is applicable and they agreed that no research or “adaptation” of the information to the Yukon context is required. (Applicability 8.6/10 where 10 is perfectly applicable. n=8) However, most of market actors agreed that they need to know what works and what does not work with the current power quality.

When asked about the best means to convey information to the end-users, interviewees answered the following, as presented in Exhibit 13:

Exhibit 13 Main Media Used to Convey Information to End-users

According to:	What are the Main <u>Media</u> that Could Effectively Convey Information to End-users?	Sample Size (n)
E/L Distributors	1 st : Trade association publications 2 nd : Any form of broadcast (radio, television) 3 rd and 4 th : Ads in newspapers and magazines <i>tied with</i> In store display	2
Property Managers (<i>about themselves</i>)	1 st and 2 nd : Direct engagement <i>tied with</i> Newsletter (email) 3 rd : Trade shows or events:	5
Designers	1 st : Direct Engagement 2 nd : Trade Show 3 rd : Newsletter (email)	1
Independent Supplier	1 st : Trade Association Publication 2 nd : Printed brochure or flyer 3 rd : Trade shows or events OR direct engagement	1
Lighting Manufacturer	1 st : Trade shows or events 2 nd : Direct engagement 3 rd : Email blast/newsletter	1

Based on the answers that we obtained, it is not clear what the best means is. There seems to be a contradiction. On one hand, some end-users (property managers) are telling us that they prefer direct engagement and trade events. The designer and manufacturer seemed to agree. On the other hand, distributors are telling us that they've mostly been using trade association publications, broadcast and print media to reach out to the end-users. One explanation could be that distributors are not directly in touch with the end-users the majority of the time. Electrical contractors are directly in touch with end-users, but they try not to be. In other jurisdictions distributors would be a little more proactive.

With regard to direct engagement, we were told that:

- A full day of in-person training could actually be successful because there are very few continuous training opportunities in Yukon. "We could make it an event and make it a big deal" was one of the respondent's answers. However, respondents told us that the frequency should be relatively low: maybe an annual event.
- Webinars are used extensively to reach out and extend the training offerings to the communities. There is an opportunity to make use of the Yukon College classrooms and technology in some of the communities.
- If the information to be disseminated is not training in nature, then the direct engagement should be kept short: maximum 2 hours.
- One of the respondents reported that his company tries to attend 'unconventional trade shows,' such as one for hospital facility managers or school building managers. These types of trade shows target end-users instead of contractors and distributors.

- With regard to the format for a short in-person meeting, respondents did not show any preference between lunches, breakfast or dinner.

When asked about the best means to convey information to the electrical contractors, interviewees answered the following, as presented in Exhibit 14.

Exhibit 14 Main Media Used to Convey Information to Electrical Contractors

According to:	What are the Main Media that Could Effectively Convey Information to Electrical Contractors?	Sample Size (n)
E/L Distributors	1 st and 2 nd : “Other: In-store displays” <i>tied with</i> “Other: Suppliers” 3 rd and 4 th : Trade association publications <i>tied with</i> Trade shows or events	2
Electrical Contractors (<i>about themselves</i>)	1 st Printer brochures and flyers 2 nd Direct engagement – quarterly breakfast meetings preferred 3 rd E-mail newsletter	4
Independent Suppliers	1 st : Trade association publication 2 nd : Trade shows or events 3 rd : Printed brochure or flyer	1

The results presented Exhibit 14 appear to be contradictory and are based on a relatively small sample size. Our interpretation is that contractors learn from distributors, likely through printed material in the show room, on a flyer, or on the actual packaging. Both contractors indicated that they would go to a contractors’ “breakfast” as their preferred means of direct engagement. Electrical contractors were a hard sector to engage with. Direct engagement programs should be approached with caution.

When asked about the best means to convey information to them, interviewees answered the following, as presented in Exhibit 15:

Exhibit 15 Main Media Used to Convey Information to Other Market Actors

According to:	What are the Main <u>Media</u> that Could Effectively Convey Information to You?	Sample Size (n)
E/L Distributors (<i>about themselves</i>)	1 st : Newsletter (email) 2 nd : Direct engagement	2
Training for E/L distributor salesforce	1 st and 2 nd : Direct engagement from manufacturers <i>tied with</i> On-site staff meetings – <i>Solid lead of both</i> 3 rd : Online / Computer-assisted training	2
Designers (<i>about themselves</i>)	1 st : Direct Engagement 2 nd : Newsletter (email) 3 rd : Trade shows or events	1
Independent Supplier (<i>about themselves</i>)	1 st : Direct engagement 2 nd : Trade show or event 3 rd : Newsletter (email)	1
Manufacturer (<i>about himself</i>)	1 st : Newsletter (email) 2 nd : Trade show or event	1

Given the answers presented in Exhibit 15, and the small number of distributors, designers and independent suppliers in the Yukon, it is clear that direct engagement through email, phone calls, and in-person meetings could be very effective. They would also probably be interested in participating in a short event (a breakfast for example) organized for contractors or an all-day training event. The manufacturer indicated that a representative from his company would attend if a trade show or event was held.

6. Purchase Decisions

In this section we present how lighting equipment purchase decisions are made and how energy conservation is part of this process. We address topics such as purchase drivers, purchase barriers, and the split incentive barrier.

Exhibit 16 shows the reported end-user purchase motivations.

Exhibit 16 Main Drivers/Motivations of End-Users

According to:	What are the most important motivations of the end-users when buying lighting equipment?	Sample Size (n)
End-users (<i>About Themselves</i>)	1 st : More comfort (color rendering or light level) 2 nd : Quick installation/Compliance with deadline 3 rd : Expectation of monetary savings because of the electricity savings 4 th : Low initial cost of retrofit 5 th : Environmental considerations 6 th : Better aesthetics	5
E/L Distributors	1 st : Initial cost 2 nd : Monetary savings because of the energy savings 3 rd : Total cost of ownership	1
Lighting Designer	1 st : Initial cost 2 nd : Total cost of ownership 3 rd : Quick installation/Compliance with deadline	1
Electrical Contractors	1 st : Initial cost 2 nd : Monetary savings because of the energy savings 3 rd and 4 th : Aesthetic considerations <i>tied with</i> Life expectancy and reliability of product	2
Independent Supplier	1 st : Initial cost 2 nd : Monetary savings because of the energy savings 3 rd : Life expectancy and reliability of product	1
Lighting Manufacturer	1 st : Initial cost 2 nd : Rebate, discount or other incentive Did not specify a third motivation.	1

All supply-chain actors identified initial cost as the main purchase motivation for end-users. The end-users reported “more comfort” as being their main motivation. This is contradictory in appearance only. As reported in Exhibit 17, end-users also reported that the higher initial cost of services and equipment is the most important barrier when purchasing EE energy efficient lighting equipment.

Our interpretation is: end-users will not do a lighting retrofit project to gain energy savings. They will do a project to gain more comfort. If the technology can be obtained in the Yukon within a reasonable timeframe, then they will be interested in buying equipment that can also generate monetary savings.

The higher cost of energy efficient equipment will still be an issue, but they can be convinced. Environmental considerations seem to be a relatively minor driver as is the appearance of the fixture and light.

All the market actors were asked about the purchase barriers to energy efficient equipment. Their answers are reported in Exhibit 17.

Exhibit 17 Main Purchase Barriers of End-Users

According to:	What are the most important purchase barriers to the end-users buying EE lighting equipment?	Sample Size (n)
End-users (About Themselves)	1 st : Higher initial cost of the services and equipment / Higher impact on rent 2 nd : Electricity bills are rolled in the rent, thus occupants/tenants don't pay them directly.* 3 rd : Don't know / Not aware of the existence of this type of service	5
E/L Distributors	1 st : High price 2 nd : Lack of awareness or knowledge about electricity consumption of product 3 rd : Direct customer (e.g., building owner) does not pay electricity bills*	1
Lighting Designer	1 st : High price 2 nd : Direct client will not pay the energy bills* 3 rd : Unwillingness to pay for more professional fees spent designing a better system	1
Electrical Contractors	1 st : High price 2 nd : Lack of awareness about the electricity consumption of the product 3 rd : Availability of product <i>tied with</i> Aesthetic considerations <i>tied with</i> previous negative experience with energy efficient products	4
Independent Supplier	1 st : High price 2 nd : Time and hassle of comparing products 3 rd : Previous negative experience with EE product	1
Lighting Manufacturer	1 st : High price 2 nd : Lack of awareness about the electricity consumption and the product	1

Where EE means Energy Efficiency or Energy Efficient.
Where * mark indicators of the split-incentive barrier.

Supply-chain actors as well as end-users unanimously reported that the higher initial cost of energy efficient equipment is the most important barrier to energy efficiency; based on our experience this is not the case in all jurisdictions.

Discussion on the Split-Incentive Barriers

The split-incentive barrier has ranked 2nd twice (end-users and designers), and 3rd with distributors. The split-incentive barrier is particularly difficult to address, and can represent a major barrier to EE investment.

The split-incentive barriers (or principal-agent barriers) treat the difficulties that arise under conditions of divergent interest when a party/individual is in charge of paying the energy bills and another party/individual makes the purchase/investment decision. For the purposes of our analysis, we divide this barrier into four cases, as shown in Exhibit 18.

Exhibit 18 Discussion on the Extend of Split-Incentive Barriers in the Yukon

Cases	Findings and Discussion
S.-I. Barrier A: Internal to an organization: one person or department is in charge of the management, operation and maintenance of a building; and another person/department makes decisions regarding investment.	The extent of this barrier is significant in the Yukon because a large share of the buildings are government owned and operated (approx. 40%) and no “Leading by example” program has been rolled out so far. Most of interviewees referred to Barrier A when inquired about the split-incentive barrier. Designers told us that the extent of the double-agent barrier was 25% of their clients – and specified that these clients were mostly government. Government property managers confirmed that this barrier fully applies in the Yukon – and that it does apply to Crown corporations as well. A respondent mentioned that the requirement for all new government buildings to be LEED certified is being by-passed in some cases to reduce the initial cost. There is a disconnection between the people who issued the LEED certification requirement, and the people who are authorizing capital budgets. Program tactics exist to tackle Split-Incentive (S.-I.) Barrier A.
S.-I. Barrier B: Tenants pay directly the energy bills but will not invest: Tenants pay the energy bills directly for the commercial space that they rent. Neither the renters nor the tenants will invest in energy efficiency.	The extent of this barrier is much less significant than the S.-I. Barrier A. All property managers we spoke with told us that their tenants can make changes to the lighting systems (3 times Yes, 2 times <i>It depends</i>, n=5) in their commercial space if they want. However, they tend not to – even those who do pay for their electricity bills directly (2 times <i>Never</i>, 2 times <i>Sometimes</i>; Average: 3.0/4 where 1 is <i>Never</i> and 4 is <i>Always</i>, n=4). Convincing tenants to invest might be challenging – yet not impossible because these tenants will actually benefit from their investment in term of lighting quality/comfort as well as avoided cost of electricity.
S.-I. Barrier C: Owners/ Landlords pay the energy bills but will not invest: Landlords own the buildings and pay the electrical bills. Neither the landlords nor the tenants will invest in energy efficiency.	This issue should be less stringent in nature than S.-I. A and B. because it would make sense for the owners/ landlords to invest in their building(s) and then benefit directly from the savings – and at the same time increase tenant satisfaction and retention. The issue is that some owners perceive that they are being repaid the electricity cost through the rent. We might be able to change this perception. By reducing their operation cost they can either increase their bottom line, or their competitiveness.
S.-I. Barrier D: Builders/Contractors will not pay the energy bills: Builders/Contractors make design decision or design changes that might increase the electrical consumption of the building	This barrier is less critical in the commercial sector because the owner is known well in advance – before the design and the construction– and provides his/her preferences to the design team. Design-build projects can be more problematic because the owners do not interact directly with the design team.

As a result of the discussion in Exhibit 18, we conclude that the split-incentive barriers should be accounted for in the design, but should not prevent program uptake and the realization of savings.

7. Practices and Motivations of the Market Actors

In this section we map the motivation and interests that exist within the distribution chain, how these interests influence the market penetration of energy efficient technologies and practices. We also identify how these natural drivers can be used to influence the market to become more energy efficient.

Reasons for making special efforts with regard to energy efficiency

As illustrated in Exhibit 19A, a large majority of interviewees make special efforts to offer, sell, install or purchase energy efficient lighting products and system. This does not come as a surprise because: potential respondents with a relatively low level of interest in energy efficiency probably self-screened themselves out of our samples.

Exhibit 19 Occurrence of Special Efforts for Energy Efficiency Among All Market Actors

Does your organization make special efforts for energy efficiency?

	Never:	Sometimes:	Often:	Always:
Number of Responses:	0	1	7	3

Where the sample size is n=11 among which 3 are end-users, 1 is a designer, 4 are contractors, 2 are distributors and 1 is an independent supplier.

More importantly from a program design standpoint are the reasons why market actors make a special effort regarding energy efficiency. Exhibit 20 presents their motivations.

Exhibit 20 Reasons for Making Special Efforts Regarding Energy Efficiency

Motivations of:	What are the greatest motivations of your organization regarding energy efficiency?	Sample Size (n)
End-users <i>About themselves.</i>	1 st : Operation cost reduction – <i>with a solid lead</i> 2 nd : Good corporate citizenship 3 rd : Increase buildings' ability to retain or attract tenants	5
E/L Distributors <i>About themselves.</i>	1 st , 2 nd & 3 rd : Higher profit margin of energy efficient products <i>tied with</i> Maintenance or gain of competitive advantage <i>and with</i> Reactiveness to customer demand 4 th : Green public image	2
Lighting Designer <i>About themselves.</i>	1 st : Good corporate citizenship 2 nd : Motivation of staff 3 rd : Maintenance or gain of competitive advantage	1
Electrical Contractors <i>About themselves.</i>	1 st : Good customer service 2 nd : Reactiveness to customer demand 3 rd : Good corporate citizenship	4
<i>Purchase Drivers of Contractors According to E/L Distributors</i>	1 st : Value to the end-users in terms of monetary savings 2 nd : Initial cost 3 rd : Conservativeness – advantages of buying the same equipment: less risk, simpler, easier to install, etc.	2
Independent Supplier <i>About themselves.</i>	1 st : Motivation of staff 2 nd : Reactiveness to customer demand 3 rd : Good corporate citizenship	1
Lighting Manufacturer <i>About themselves.</i>	1 st : Green public image 2 nd : Maintenance or gain of competitive advantage 3 rd : Utility incentives or rebates	1

Money is the main focus of end-users: both the operational cost reduction and the initial cost of energy efficient systems as seen in Exhibit 21. This appears to be more of a focus than is common in other jurisdictions.

Supply-side actors do not have a main common driver. Each pursues a different goal:

- E/L Distributors' drivers seek higher profit margin. Energy efficiency is a tool to gain market share. Energy efficiency is consistent with their business model.
- Lighting designers seek a feeling of achievement or the feeling of a job well done.
- Electrical Contractors are reactive to what the clients ask for. Best customer service is their main driver. They do not seem to believe that providing information and explanation to their customer on newer products is part of their job description.

- Lighting manufacturers want a green public image and to gain or maintain a competitive advantage.

Exhibit 21 shows the answers of the interviewees when they were asked about reasons not to do more.

Exhibit 21 Reasons for Not Making More Efforts Regarding Energy Efficiency

Motivations of:	What are the reasons why your organization would not make more effort to promote energy efficiency?	Sample Size (n)
End-users <i>About themselves.</i>	1 st : Energy efficiency is cost-prohibitive – <i>with a solid lead</i> 2 nd : Don't know what to do / Don't know what products 3 rd and 4 th : Return on investment is too low <i>tied with</i> Maintenance is reactive rather than being preventive Came after (in no specific order): lack of capacity to build the business case, EE does not improve tenant retention, EE does not increase the property value, split-incentive barrier, reliability concerns, shipping cost	5
E/L Distributors <i>About themselves.</i>	1 st : Higher risk of newer products being returned by dissatisfied customers 2 nd : Against the market trend i.e. it is not what customers demand	2
Lighting Designer <i>About themselves.</i>	1 st : Higher risk of using newer products or methods in your designs 2 nd : Higher risk of scope creep leading to budget overruns and, in turn, lower profitability of firm 3 rd : Energy efficiency is a difficult sale	1
Electrical Contractors <i>About themselves.</i>	1 st and 2 nd : Don't know what products to concentrate on <i>tied with</i> Not what customers demand 3 rd : Not our role in the market	4
<i>Purchase Barriers of Contractors According to E/L Distributors</i>	1 st : Energy efficiency is a difficult sale 2 nd : High price 3 rd : Lack of awareness or knowledge about electricity consumption of product	2
Independent Supplier <i>About themselves.</i>	1 st : Motivation of staff 2 nd : Reactiveness to customer demand 3 rd : Good corporate citizenship	1
Lighting Manufacturer <i>About themselves.</i>	1 st : Shipping cost and constraints 2 nd : No or little support from governments or utilities in the Yukon.	1

Where EE means Energy Efficiency or Energy Efficient.
Where * mark indicators of the split-incentive barrier.

Almost none of the end-users picked from the choices that were presented to them. *Energy efficiency is cost-prohibitive* was not even among the choices; neither was *Return on investment is too low* nor

Maintenance is reactive rather than being preventive. This reinforces the idea that end-users do focus a lot on the initial cost of energy efficient systems rather than having a more holistic vision.

The actual choices presented to end-users during the interview were designed to test what investment they value more than energy efficiency – i.e. what are they currently purchasing rather than spending on energy conservation. For example, we suggested that they could invest in increasing the value of their property, or increase tenant retention and satisfaction. Because they insisted on creating their own choice – in this specific case they created *Energy efficiency is cost-prohibitive* –, thus we believe that energy efficiency is not perceived as an investment or a sound use of taxpayer money and is treated accordingly.

It appears that end-users are not thinking in terms of asset management and preventive maintenance.

Practices That Are Specific to Electrical Contractors

Electrical contractors have been identified as the weakest link in the energy efficient lighting equipment distribution chain in many jurisdictions. Consequently, we asked a few additional questions about electrical contractors to distributors, designers and end-users. The corresponding answers are presented in Exhibit 22.

As noted previously in Exhibit 20 and Exhibit 21, the E/L distributors who deal with electrical contractor on a daily basis indicated that:

- Contractors focus on customer satisfaction and value to the customer; and
- To contractors, customer satisfaction and value means installing exactly what the customer has asked for at the lowest cost.

One contractor told us that: *In many cases the lighting equipment has already been specified, designed and chosen. Any suggested changes by the contractor could potentially cause delays in the process. Consequently, they rarely dare to suggest changes.*

It should be noted that the same questions were also asked to independent suppliers; however, they indicated that they do little business with contractors.

Exhibit 22 presents the result of selected questions regarding some practices of electrical contractors that have been observed in other jurisdictions.

Exhibit 22 Influence of the Electrical Contractors on the Lighting Design

Occurrence of the electrical contractors to decide (or exert heavy influence) on what equipment to install during retrofit projects? n=10

	Rarely:	Not much:	Sometimes:	Often:
	0	2	2	6
Number of Responses:				

Occurrence of the electrical contractors to decide (or exert heavy influence) on what equipment to install during new construction projects? n=7 because of 3 N/A or Don't Know among end-users.

	Rarely:	Not much:	Sometimes:	Often:
	1	3	1	2
Number of Responses:				

Occurrence of the electrical contractors to substitute equipment after the design phase of a project. n=10

	Rarely:	Not much:	Sometimes:	Often:
	3	2	2	3
Number of Responses:				

Where the sample size is n=8 among which 5 are end-users, 1 is a designer, and 2 are contractors.

Based on Exhibit 22:

- Electrical contractors in the Yukon do carry out simple design for customers during retrofit projects relatively often.
- Electrical contractors are not as involved in the design of new buildings, unless it is a design-build approach.
- Electrical contractors do suggest some minor changes after the design phase of a project, especially if they see something in the design they are concerned about, but this does not seem to be a problem.

Practices That Are Specific to E/L Distributors

E/L Distributors generally have a small show room and often use stocking and merchandizing practices to influence demand. The two distributors we interviewed in the Yukon reported.

The most important purchase/stocking motivations of E/L Distributors in the Yukon are (n=2):

- 1st and 2nd: Strictly dictated by headquarters *tied with* Customer feedback
- 3rd and 4th: Profit margin on each product *tied with* Marketing strategy or positioning
- 5th: Sales or demand forecast.

The most important motivations of E/L Distributors salesforce are (n=2):

- 1st: Monetary recognition like commission or bonus – *with a solid lead*
- 2nd: Customer satisfaction
- 3rd: Curiosity / Gaining knowledge

8. Policy, Program and Regulatory Framework

In this section we would list and explain policy, program and characteristic of the regulatory framework that have a significant influence on energy conservation in the lighting sector.

Based on our research, we found no organization, program or piece of regulation – except for the building electrical code – that would have or had any form of influence positively or negatively on the commercial lighting sector in particular in the past five years.

The federal government used to have the EcoEnergy program for commercial building, however this program did not target lighting in particular and the program has been discontinued.

Currently the Energy Solutions Center does not have a program that specifically targets the commercial lighting sector; however, they can provide assistance, if requested.

9. YEC & YECL Credibility and Visibility

This section reports on interviewee perceptions of YEC & YECL with regard to energy conservation. The results are summarized in Exhibit 23.

Exhibit 23 Level of Credibility of Selected Stakeholders

What is the level of credibility of the following organizations with regard to electricity conservation? Where: 1 = No Credibility, and 10 = High Level of Credibility.

Yukon Energy Corporation (YEC) as Seen By:

Manufacturers: Was not able to answer.	Distributors incl. independents: 6.5/10, n=2
Electrical Contractors: 6.2/10, n=4	Lighting Designers: 9.0/10, n=1
Property Managers: 8.2/10, n=5	<u>Grand Average: 7.6/10, n=10</u>

Yukon Electrical Company Limited (YECL) as Seen By:

Manufacturers: Was not able to answer.	Distributors incl. independents: 6.5/10, n=2
Electrical Contractors: 6.0/10, n=4	Lighting Designers: 9.0/10, n=1
Property Managers: 7.6/10, n=5	<u>Grand Average: 7.2/10, n=10</u>

Yukon Government Organization such as Energy Solutions Centre as Seen By:

Manufacturers: Was not able to answer.	Distributors incl. independents: 6.0/10, n=3
Electrical Contractors: 6.5/10, n=4	Lighting Designers: 8.0/10, n=1
Property Managers: 7.6/10, n=5	<u>Grand Average: 7.2/10, n=11</u>

Other Energy Efficiency Program Administrators (BC Hydro, MB Hydro, etc.) as Seen By:

Manufacturers: Was not able to answer.	Distributors incl. independents: 5.5/10, n=2
Electrical Contractors: 6.3/10, n=3	Lighting Designers: 9.0/10, n=1
Property Managers: 8.3/10, n=3	<u>Grand Average: 7.4/10, n=7</u>

Equipment Suppliers of Any Sort as Seen By:

Manufacturers: Was not able to answer.	Distributors incl. independents: 8.7/10, n=3
Electrical Contractors: 7.0/10, n=4	Lighting Designers: 7.0/10, n=1
Property Managers: 5.6/10, n=5	<u>Grand Average: 6.8/10, n=11</u>

Hypothetical Third-party Energy Efficiency Program Delivery Contractor as Seen By:

Manufacturers: Was not able to answer.	Distributors incl. indep.: Refusal to Answer
Electrical Contractors: 6.0/10, n=1	Lighting Designers: 9.0/10, n=1
Property Managers: 6.6/10, n=5	<u>Grand Average: 6.9/10, n=7</u>

Based on the results shown in Exhibit 23:

- The credibility of YEC and YECL is relatively good compared with other jurisdictions and compared with other stakeholders.
- The credibility of YEC is higher than that of YECL; however, it is a relatively minor difference.
- The credibility of the Energy Solutions Centre seems to be approximately equivalent to that of YECL.

- One interviewee provided the following relevant explanation: YEC – as for YEC – has never operated programs, while the Energy Solutions Centre has. Thus YECL would have to prove itself.
- The least trusted group is the suppliers, particularly among the property managers (end-users). Respondents were suspicious of vested interests.
- The level of credibility for suppliers among distributors is relatively high. This could be because this is where distributors obtain much of their information.
- Contractors and designers have a relatively low level of trust in suppliers. This could be attributed to the fact that they assume their main motive is to sell product.
- The level of credibility of other energy efficiency program administrators (BC Hydro, MB Hydro, Office of Energy Efficiency, etc) appear to be equivalent to that of YEC and of YECL.
- The credibility of a hypothetical third-party energy efficiency program delivery contractor is relatively low. As with “other program administrators” fewer people chose to answer this question. The concept of delivery agents is relatively new in the Yukon. We believe this explains why people would not have an opinion and thus did not answer. A common explanation provided by two people who answered was that a third party delivery contractor would not be cost effective in a small jurisdiction like the Yukon.

It appears that Yukoners in the commercial lighting sector are open to the idea that YEC, YECL or both, could do energy conservation. There is no clear preference between YEC and YECL. YEC and YECL credibility is on par with that of Energy Solutions Center. There would be a certain level of trust in YEC and YECL and this trust would be above that in equipment suppliers.

Finally, YEC and YECL would probably be better using their own branding rather than that of a third-party delivery agent.

10. Market Stakeholders

The following section describes the primary groups or organizations active in the Yukon and relevant to the market segment being researched. The following exhibits describe these groups, along with their strengths and weaknesses.

Exhibit 24 Market Actor: Association of Professional Engineers of Yukon (APEY)

Market Role	The Association of Professional Engineers of the Yukon (APEY) is a non-profit trade association representing professional engineers. Like all other professional engineering associations, the role of APEY is to certify and control the quality of professional engineers in the Yukon and to protect the public. Engineering is a restricted practice reserved to Professional Engineers by federal law; backed by a territorial law. APEY can use a certain degree of discretion in deciding who can or cannot bare the title of “Professional Engineer”, and by removing the title from those who fail to comply with the Professional Engineer code of ethics. They can prosecute incompetence as well. APEY also has the mission to enhance quality through capacity building, dissemination of information, a system of mentorship for engineers-in-training, organization of meetings and congresses, etc.
Strengths and Resources	▪ Authority and legitimacy backed by a federal law ▪ Small office in Whitehorse ▪ APEY has one part-time staff and one full-time staff ▪ APEY has a stable source of revenue: membership payments ▪ APEY has 150 members in the Yukon, and 600 members across Canada. ▪ Established communication activities: a website, two newsletters per year, one annual meeting. ▪ APEY would agree to publish messages regarding training from YEC/YECL in its newsletters. ▪ APEY has an education committee. ▪ APEY has an annual member survey
Weaknesses	▪ APEY serves a membership that has interests beyond energy-using equipment and energy efficiency. They have no particular interest in energy efficiency. For example, APEY does not have an energy committee. ▪ APEY did not show a high degree of interest in being an active stakeholder in YEC/YECL programs. ▪ APEY finds it challenging to find volunteers to sit on its boards. ▪ APEY has limited resources. To date, APEY has only channeled “messages” about training offerings in the Yukon. ▪ APEY has a dated website – but is in the process of building a new one. ▪ APEY does not have any trade events.

Exhibit 25 Market Actor: Yukon Contractor Association

Market Role	A contractor association's primary objective is the overall improvement of the industry and the provision of services to their members. The YCA works on increasing contractors' knowledge and efficiency through promoting the interchange of thoughts and ideas among all industry sections relating to electrical contracting. In addition, YCA acts as the government liaison for apprenticeship training, qualifications and regulations. NOTE: YCA has not been interviewed. It is a relevant actor to consider in our analysis nevertheless.
Strengths and Resources	- Authority, credibility and visibility among contractors - Several communication channels with members, who are hard-to-reach contractors
Weaknesses	- No website - Hard to reach

Exhibit 26 Market Actor: Yukon College

Market Role	Yukon College is the only post-secondary provider in the Yukon. Yukon College has 13 campuses in the Yukon. YC works with communities, Yukon First Nations, local governments, business and industry to enhance the Yukon's capacity through education and training.
Strengths and Resources	- Facilities and resources: classroom, labs, etc. - Webinar tools - One large campus in Whitehorse and 12 other community campuses. - Visibility
Weaknesses	Limited resources because it is a small college.

Exhibit 27 Market Actor: Yukon Technology Innovation Center

Market Role

Technology Innovation (TI) encourages the development of innovative technologies and technology-based capacity in the Yukon. Its goals are to assist innovators in the development of commercial products and services that will contribute to the social and economic prosperity of the Yukon. TI provides financial assistance to a wide range of innovative Yukon projects, ranging from software development to mechanical engineering.

TI currently works on the following R&D projects: Insulation Testing on Huts, Northern Greenhouse Research Project, Petrolink Cardlock System, Plastovac: Removing Plastics From Compost, Research Into the Use of Biochar in Yukon Mine Reclamation, and Three-Purpose Biochar Machine.

TI supports business development for the projects stated above. TI involves providing business development assistance to start-up enterprises, and to existing enterprises which have growth and export potential that remains unrealized because of inhibiting factors. No money is provided to the companies, but the advice of custom-tailored business advisory boards, plus the assistance of the program's expert business advisor, are provided to qualifying companies free of charge. TI serves on the selection and steering committee for this project.

The manager of TI also manages the Cold Climate Innovation (CCI). The CCI is focused on the development, commercialization and export of sustainable cold climate technologies and related solutions for subarctic regions around the world.

The CCI works on the following projects: Drilling Hot Water Supply Heater and Pump, Dual Frequency Ice Penetrating Radar, Effectiveness of Biochar on Northern Soils, Infinia Stirling Engine Project, Insulated Communication Shed, and the Vacuum Insulated Panels Testing.

Strengths and Resources

- Research and development
- Metrology technicians, and stock of measurement instrument
- Access to R&D federal funding, and internship grants
- Students and interns
- Interest in research, statistics, mathematics and –maybe– program evaluations
- Capacity to work with private firms either as lead contractor or sub

Weaknesses

- They focus on R&D: not on consulting, not on market adoption of mature technology, and not on business.

Exhibit 28 Market Actor: Whitehorse Chamber of Commerce

Market Role

The Whitehorse Chamber of Commerce is a local organization of businesses whose goal is to further the interests of businesses. The Chamber advocates on behalf of the business community. Local businesses are members, and they elect a board of directors to set policy for the chamber. The Chamber lobbies both the municipal and Territorial governments on behalf of the business community. The Chamber represents small business interests on various committees and stakeholders groups including: City of Whitehorse Downtown Planning Committee, Land Development Committee Yukon Government, Stakeholders Advisory Committee of the Yukon Workers' Compensation Board, and economic development.

The board has 14 members who do not change very often. The Chamber is financed through membership fees and projects. One fund raising project is the advertisement highway signs that the Chamber manages on the behalf of the City.

The Chamber works on several projects and manages several programs on the behalf of others (federal or territorial government, for example): support to business venture, courses, program to improve customer service, business training, the “partnering for success” – a program aiming at fostering the private sector.

Strengths and Resources

- The chamber has 2 full-time equivalent staff + program or project managers based on the level of funding. They currently have 3 of them.
- The board has a monthly meeting. The next one is on May 8th.
- The Chamber organizes or promotes “business after-hours”. Approximately 150 people show up. For example, YEC could organize an after-hour event to promote its DSM programs. But YEC would have to find something to attract people. For example, people might be interested to visit the dam, or the diesel plant.
- The Chamber also organizes discussion breakfasts. They can gather 60 to 80 people.
- The Chamber has 500 members
- The Chambers has a newsletter (bimonthly)
- The Chamber has a website with an extensive news feed, an activity calendar, member-only access (through sign-up), specific program-related features like –for example– an online survey, an online library, etc.
- The Chamber organizes many events. One that is of particular interest would be the “small business week”; either to advertise on commercial program offering, or else to engage with business owners (contractors, E&A firms, etc.) who could benefit from program training offering.
- They have an energy committee that has discussions, mainly on the supply-side. Four board members are on the energy committee. The committee is relatively stable.

Weaknesses

- The Chamber serves a membership that has interests beyond energy-using equipment and energy efficiency. They have no particular interest in energy efficiency.

Exhibit 29 Market Actor: Illumination Engineering Society (IES)

Market Role	IES is a non-profit international trade association representing illumination engineers and tradespeople. The IES seeks to improve the lighted environment by bringing together those with lighting knowledge and by translating that knowledge into actions that benefit the public. The IES is composed of a diverse membership, all with an interest in and a dedication to good lighting. 25% of the membership is involved in manufacturing (lamps, sources, luminaires, and accessories); another 25% is composed of lighting designers and architects. The remaining 50% is composed of consultants, electrical and building contractors, distributors, and wholesalers, individuals working in affiliated lighting fields, those working for utilities and energy services, and people in government and education. Over one thousand of these members serve on committees, most serving on the Society's document development committees; these committees develop standards, design guides, technical memoranda, lighting energy management materials, guidelines and lighting measurement, testing and calculation guides. (Source: IES Website) The IES does not have a Chapter in the Yukon, but has several Chapters in the West: in British Columbia, Alberta and Saskatchewan.
Strengths and Resources	▪ The IES creates updates and disseminates training courses and certification. A well-known training is the Lighting Certified (LC) designation which involves a written exam. ▪ The IES has a trade magazine. ▪ The IES mission is in-line with the YEC/YECL objectives. ▪ The IES provides a "third-party" perspective on the technical information published by manufacturers.
Weaknesses	▪ No IES Chapter in the Yukon ▪ The Yukon population is too small to sustain a Chapter.

Exhibit 30 Market Actor: Building Owners and Managers Association (BOMA)

Market Role	BOMA Canada's Mission is to represent the Canadian commercial real estate industry on matters of national concern, to develop a strong communications network between its local associations, BOMA International and other real estate associations and promote professionalism of its members through education programs and effective public relations activity. (Source: BOMA Canada's website) This is typically achieved through seminars, and an email newsletter. BOMA does not have a Chapter in the Yukon, but has several Chapters in the West: in British Columbia, Alberta and Saskatchewan.
Strengths and Resources	▪ BOMA publishes a magazine in print, advertises in newspaper, and organize events on a regular basis (seminars, career fairs, etc) ▪ BOMA runs the popular building excellence certification program "BOMABest"
Weaknesses	▪ No BOMA Chapter in the Yukon. ▪ The Yukon population is too small to sustain a Chapter. ▪ BOMA serves a membership that has interests beyond energy-using equipment and energy efficiency.

11. Qualitative Assessment of the Baseline

This section presents a qualitative assessment of the market adoption of technologies and services in the absence of DSM programming in the Yukon.

The approach used in this section had the following four objectives: 1st be a warm up at the beginning of the interviews, 2nd get to know the interviewee and his/her level of familiarity with the technologies, 3rd become a baseline for future program evaluation, and 4th retrieve information on market adoption. We believe that the three first objectives were achieved, but not the fourth.

Exhibit 31 shows the level of familiarity of market actors with lighting technologies that were considered ready for widespread market adoption at the beginning of the market characterization study.

Exhibit 31 Familiarity of Supply-chain Actors with Mature Lighting Technologies

Typical Technologies	A few times (# of Hits)	Often (# of Hits)	Score (See below)	Some Upward trend? (# of Hits)
High-performance T8 Fluorescent Tubes (High-lumen output)	1	4	9	2
Low-wattage T8 Fluorescent Tubes	4	3	10	2
High-performance Electronic Ballast	2	5	12	3
Medium- or High-bay High-output T5 Fluorescent Fixtures	3	4	11	7
Medium- or High-bay T8 Fixtures	1	0	1	1
Pin-socket CFL Fixtures	1	3	7	0
Floodlight CFLs (PAR16 or MR16)	4	2	8	0
Dimmable CFLs	2	2	6	2
Floodlight LED (PAR16 or MR16)	6	1	8	6
Medium- or High-bay LED Fixtures	2	0	2	1
Pulse-start Metal Halide	2	3	8	1
Reduced-wattage Metal Halide	2	2	6	0
Astronomical Time Clock (Timer)	3	2	7	0
Switch-plate Occupancy Sensors	2	4	10	7
Ceiling or Wall-Mounted Occupancy Sensors	3	4	11	7
Other: Pot-light LEDs, screw-in LEDs, outdoor sensors, standard T8, interior photocells				
Sample Size: n=5 --> 2 distributors, 1 designer and 4 contractors				
Scoring system: A few times = 1, Often = 2				

Most of our conclusions actually come from the discussions that surrounded the questions on the set of technologies presented in Exhibit 31.

- High-Performance (HP) T8 tubes, Reduced-Wattage (RW) T8 tubes, and HP or RW electronic ballasts required some explanation, even for interviewees who ticked *a few times* or *often*.
- No one seemed to know about the Consortium for Energy Efficiency qualified equipment list and criteria. In Canada, such items generally need to be specially ordered as most of distributors don't stock them.
- Based on the responses, it is assumed that market penetration of HP and RW fluorescent tubes and ballasts is fairly minimal. One interviewee felt that a rebate program would increase the market penetration of HP and RW T8s and noted that an upward trend is present in jurisdictions where rebate programs exist for these items.
- Medium- or High-bay High-output T5 Fluorescent Fixtures are becoming common and on the upward trend. They are becoming the standard practice in Southern jurisdictions and this trend is also starting in the Yukon. However, there is likely capacity to replace metal halide and high pressure sodium fixtures.
- HP T8 fixtures are used very minimally for high- and medium-bay applications even though savings can be the same, and operation and maintenance is much easier and cheaper.
- CFL is generally a mature technology with a good market penetration. We did not ask about the normal self-ballasted screw-in CFL lamp as we believe the market is close to saturation; and a related program would not benefit DSM. We inquired about the pin-socket CFL fixtures (you cannot replace this type of lamp with an incandescent bulb), dimmable CFL and floodlight CFL. Based on the results, market adoption appears fairly low and the trend has actually been reported to be downward. CFL has major drawbacks in the Yukon. This might explain why market penetration is not higher and adoption is not trending upward. There are issues with power quality, outside temperature, and disposal. There are no facilities to dispose of CFL in the Yukon.
- LED lamp adoption is currently minimal but there is a strong upward trend, especially in outdoor lighting. Costs are still prohibitive.
- Adoption of astronomical time clock (timer) is minimal because there are few products that can be programmed for the Yukon or have technical difficulties during the very short summer nights. There are products that do work in the Yukon, so it might be something that could be promoted.
- Adoption of occupancy sensors seems to be relatively high and trending further upward.

Exhibit 32 shows the level of familiarity of market actors with selected energy conservation services and practices.

Exhibit 32 Current Market Penetration of Energy Conservation Services or practices

Typical Technologies	A few times (# of Hits)	Often (# of Hits)	Score (See below)	Some upward trend? (# of Hits)
Lighting energy efficiency audit and/or Lighting inventory	3	2	7	3
Energy efficiency audits	3	2	7	2
Advertisement from electrical contractors using energy efficiency / conservation as a selling point	2	1	4	0
Advertisement from suppliers using energy efficiency / conservation as a selling point	2	4	10	3
Advertisement of lighting designers or electrical engineer services using energy efficiency / energy conservation as a selling point	0	3	6	3
Comprehensive re-design of lighting in existing commercial space to achieve energy conservation	4	2	8	2
Other: none were mentioned				

Sample Size: n=4 --> 1 distributors, 1 designer and 4 contractors
Scoring system: A few time = 1, Often = 2

Additional highlights are noted below:

- Some commercial energy efficiency audits are being completed in the Yukon. As mentioned above, there was a previous commercial energy audit program that was discontinued, but more commercial audits have been performed in the last few years. There is potential for growth in this sector.
- Suppliers (distributors or manufacturers) are pushing energy efficiency through advertisement more than contractors are.

12. Preferred Approaches of the Market Actors

We asked interviewees about their preferred DSM program approach, tactics and activities. The objective was to gain a general idea of what the program uptake might be depending on the set of tactics that future DSM programs might include.

Exhibit 33 presents the answers with regard to the preferred program approach.

Exhibit 33 Preferred Program Tactics and Activities

Preferred tactics of:	What are the energy conservation program activities you are the most likely to participate in?	Sample Size (n)
Property Managers (end-users)	1 st : Direct incentive to you in exchange for choosing better-than-code products for your buildings – <i>with a solid lead</i> 2 nd and 3 rd : Hands-on support for superior lighting products <i>tied with</i> Free simple information brochure for your staff 4 th : Incentive for your clients for a prescriptive list of measures that will boost higher-end equipment sales	5
E/L Distributors	1 st : Free simple information brochure for your staff 2 nd : Low-cost training and certification for your staff 3 rd : Hands-on support for superior lighting products	1
Lighting Designers	1 st : Incentive for your clients for a prescriptive list of measures that will boost higher-end equipment sales 2 nd : Low-cost training and certification for your staff 3 rd : Hands-on support for superior lighting products	1
Electrical Contractors (about themselves)	1 st : Free simple information brochure for your customers 2 nd Direct incentive to you in exchange for selling better-than-code products 3 rd Incentive for your clients for a prescriptive list of measures that will boost higher-end equipment sales 4 th : Free simple information brochure for your staff	4
Independent Suppliers	1 st : Free simple information brochure for your customers 2 nd : Free simple information brochure for you or your staff 3 rd : Instant rebate for residential customers to buy EE products 4 th : Hands-on support for superior lighting products	1

Lighting Manufacturers (<i>about themselves</i>)	1 st : Incentive to end users for a prescriptive list of measures that will boost higher-end equipment sales
	2 nd : Free simple information brochure for your customers or the end users
	3 rd : Hands-on support for superior lighting products

Where EE means Energy Efficiency or Energy Efficient.

Notes on Exhibit 33:

- Incentives are the preferred approach for property managers. This is consistent with the rest of their answers.
- *Free simple information brochure* for your customers is the contractors' preferred tactic. However, tactics that are based on incentives rank 2nd and 3rd. If bundled, they would be the first choice of electrical contractors.
- Direct incentives are not the preferred approach of E/L distributors and independent suppliers; they believe that education and training may be more effective. This does not appear consistent with the responses they provided when asked about drivers and barriers. This is difficult to explain. It may be that they don't see themselves as direct participants to an incentive scheme.
- The manufacturer's preferred program approach is to offer end users prescriptive incentives to purchase higher efficiency equipment.

13. Barrier Analysis

Barriers that emerged as themes during the market research activities were identified and categorized through a barrier analysis. This analysis will be used to support program design in terms of informing the type(s) of program that should be created as well as pertinent activities that should be included. For our purposes, we divide barriers and hurdles into five types: informational, financial, technical, institutional/cultural, and market.

We believe that there are four main barriers to energy efficiency in the commercial lighting sector in the Yukon. Exhibit 34 presents these four barriers.

Exhibit 34 Key Market Defects

Identification	Hurdle or Barrier ²	Type	Substantiation
Prohibitive cost of energy efficient equipment both in retrofit and new construction	Hurdle	Financial	As previously shown in Exhibit 16, all supply-chain actors identified initial cost as the main purchase motivation of end-users. As previously shown in Exhibit 16 and Exhibit 17, end-users (property managers) do a project to gain more comfort. If the technology can be obtained in the Yukon within a reasonable timeframe, then they will be interested in buying equipment that can also generate monetary savings. The higher cost of energy efficient equipment will still be an issue, but they could be convinced. Environmental considerations seem to be a relatively minor driver; and so is the appearance of the fixture and light. As previously shown in Exhibit 17, supply-chain actors as well as end-users unanimously reported the higher initial cost of energy efficient equipment as being the most important barrier to energy efficiency – and based on our experience it is not the case in all jurisdictions. As previously shown in Exhibit 21, energy end-users told us that energy efficiency is cost-prohibitive is the main reason not to make more effort promoting energy efficiency. What is particularly interesting about the answer of the end-users is that they did not choose any of the other choices that were presented to them in a multiple choice question. Energy efficiency is cost-prohibitive was not even among the choices that were presented. As previously shown in Exhibit 33, incentive is definitely the preferred approach of property managers. This is consistent with the rest of their answers.
Split-incentive barriers inside governmental or municipal organizations (See S.-I. Barrier A in Exhibit 18)	Barrier	Cultural/ Institutional	The extent of this barrier is significant in the Yukon because a large share of the buildings are government owned and operated (approx. 40%) and no “Leading by example” program has been rolled out so far. Most interviewees referred to Barrier A when asked about the split-incentive barrier. Designers told us that the extent of the double-agent barrier was 25% of their clients – and specified that these clients were mostly government. Government property managers confirmed that this barrier fully applies in the Yukon – and that it does apply to Crown corporations as well. A respondent noted that the requirement for all new government buildings to be LEED certified is being by-passed on occasion to reduce the initial cost. There is a disconnection between the people who issued the LEED certification requirement, and the people who are authorizing capital budgets.

² Hurdles and barriers are words to distinguish market defects. Hurdles are considered easier to address and –eventually– to overcome. Barriers are more difficult to mitigate; and change is slower. Some barriers are externalities that cannot be changed and have to be lived with. Programs generally focus on implementing activities to tackle hurdles.

Identification	Hurdle or Barrier ²	Type	Substantiation
Clogged information channel between manufacturers in and end-users in the Yukon	Hurdle	Informational	Manufacturer agents and reps serving the Yukon are located outside the Yukon: they are located in Alberta, British Columbia and Washington State. Thus, the Yukon relies heavily on local actors to get advice and support on lighting equipment. Distributors that we interviewed told us that they have very little interaction with end-users. Their direct clients are contractors. The contractors – or the designers – are those who have direct interactions with the end-users. Distributors use broadcast and print media to communicate with end-users. They do not directly engage with them. Electrical contractors have been identified as the weakest link in the lighting equipment distribution chain in many jurisdictions. As seen in Exhibit 8, it is also the case in the Yukon. In Exhibit 19 and Exhibit 20, The market does not see the contractors as the ones who would provide the technical advice on lighting equipment choices and some contractors are not interested in being sales people. They give end-users what they ask for, focusing on good customer service but at times pointing out specifications they see as not being in the clients' best interests. Electrical contractors generally come later in the process and to start changing specified equipment can cause a delay, which is not desirable. Because they are very busy with the recent building boom, they don't need to use energy efficiency as a competitive edge. There are only two lighting designers in the Yukon – yet there is so much lighting design work that could be done. An interview was completed with one of these designers. The designer told us that only 20% of their business is retrofit while the distributors and the contractors told us that 50% of their business is retrofit projects. As previously shown in Exhibit 22, Electrical contractors in the Yukon do carry out simple design for customers during retrofit projects relatively often without any other trade person or professional being involved. There are limited training opportunities in the Yukon. There is no professional association dedicated partially or entirely to lighting. There are no local trade events, shows, local publication or newsletter on lighting.
Reactive building maintenance rather than preventive building maintenance	Barrier	Cultural/Institutional	Many property managers in the Yukon seem to have a short term approach to the management of their assets, preferring to complete reactive as opposed to proactive maintenance. End-users focus on the additional cost. They do not think in terms of asset management and preventive maintenance.

There are other barriers to energy efficiency in the commercial lighting sector than those presented in Exhibit 34. However, the barriers noted above appear to be the most significant. A justification has been provided; we believe that these barriers should be addressed first.

Market Characterization Report – Commercial HVAC & Control Retrofit in the Yukon

Client: Yukon Energy Corporation (YEC)
Yukon Electrical Company Limited (YECL)

Re: Electricity Conservation Market Characterization Report –
Commercial HVAC & Control Retrofit in the Yukon

Project: Residential and Commercial DSM Program Design

Version: September 28, 2012

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1. Introduction

Yukon Energy Corporation (YEC), Yukon Electrical Company Limited (YECL) and the Yukon Government had a Conservation and Demand Management Potential Review (the CPR) conducted for the Yukon in 2011. The results of the CPR revealed a significant cost-effective potential for demand-side management (DSM) in the Yukon.

In order to further pursue this goal, the YEC and YECL (i.e. the collaboration is hereinafter referred to as YEC/YECL), will design a portfolio of new Demand Side Management (DSM) programs for presentation to the Yukon Utilities Board.

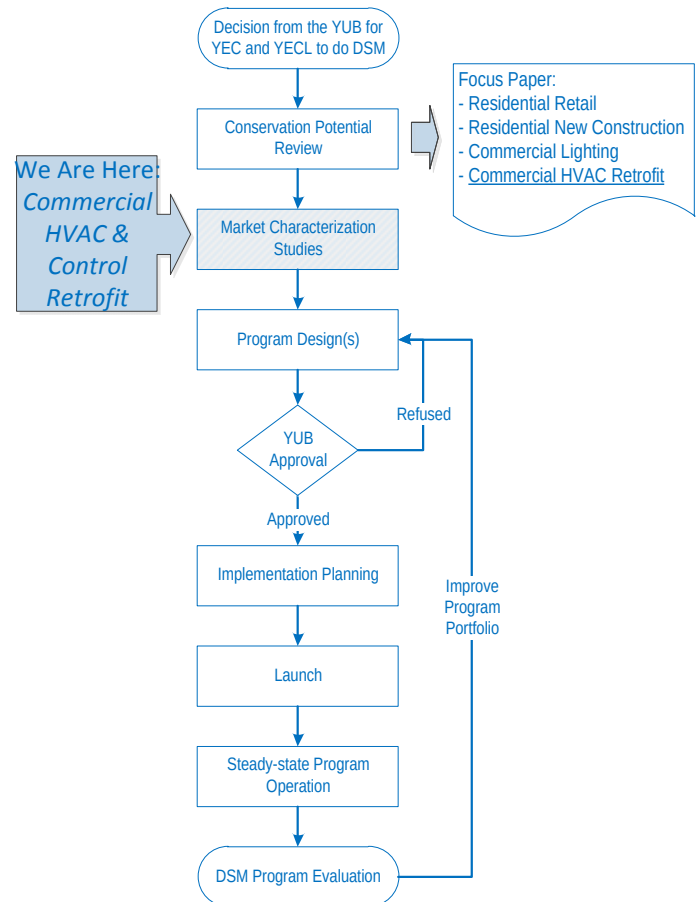
YEC/YECL has contracted ICF Marbek with developing this new portfolio of DSM programs.

If the proposed Electricity DSM program portfolio is approved by the Yukon Utilities Board (YUB), the next steps in this process would be the development of a program implementation plan followed by program launch.

Based on the result of the CPR, ICF Marbek identified four sectors of interest: 1) Residential Retail (Lighting equipment and domestic appliances), 2) Residential New Construction, 3) Commercial Lighting, and 4) Commercial HVAC Retrofit. The justification of this market segmentation and prioritization is presented in a separate document: *Program Focuses – Preliminary Team Discussion Paper*.

This report presents the results and conclusions of the market characterization study of the Commercial HVAC and Control Retrofit Sector. These results will be used to design DSM programs and initiatives in this sector in the Yukon; and provide justification for the design decisions to the YUB.

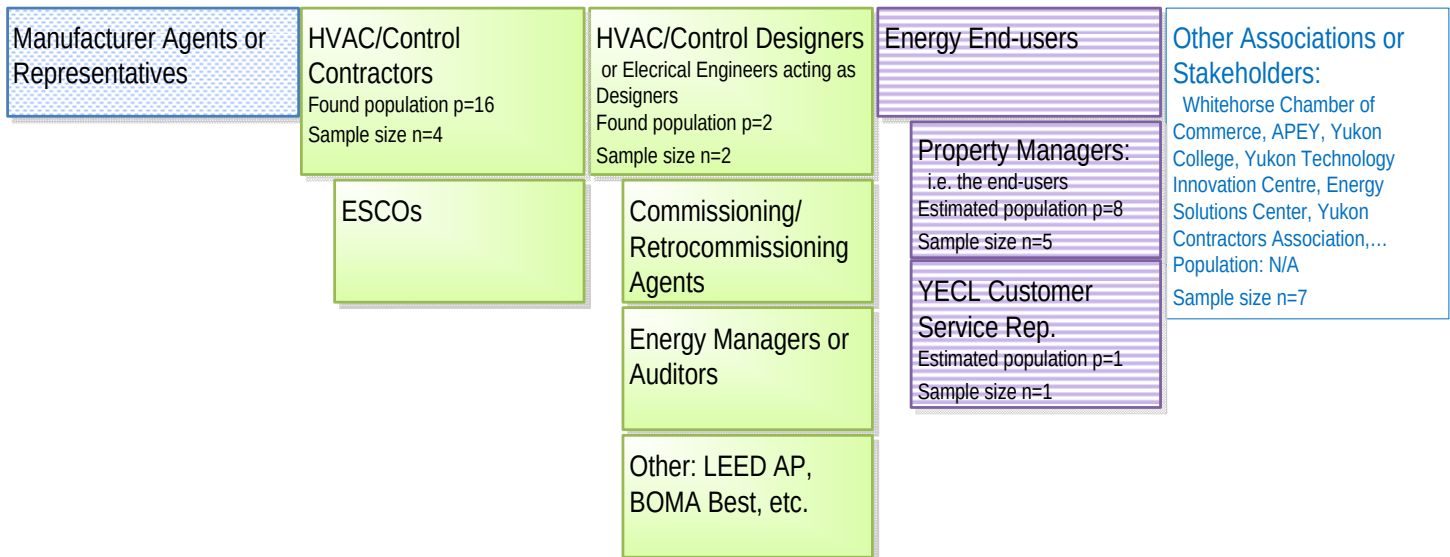
Exhibit 1 DSM Program Cycle



2. Sector Segmentation

This section presents the market segmentation that has been used in the Commercial HVAC and Control Retrofit market characterization study. All segments presented in Exhibit 2 except for the manufacturers were engaged during the characterization.

Exhibit 2 Commercial HVAC and Control Retrofit Sector Segmentation



We present each of the sector segments by populating a table such as the one presented in Exhibit 6 – except for the Other Associations or Stakeholders because they are presented in Section 10.

As shown in Exhibit 2 the sample sizes (n) that we achieved are overall representative of the populations (p).

Exhibit 3 Market Actor: HVAC and Control Manufacturers

Market Role

Manufacturers are multinational corporations headquartered outside of the Yukon – and outside Canada most of the time. For the purpose of this study, we divided these into three categories: control hardware, control software and equipment.

There are only a few large manufacturers of control hardware and software. These are often horizontally and vertically integrated: they offer equipment, installation services and design directly to the end-users. They often sell HVAC equipment as well. Example of large manufacturers of this sort are: Siemens, and Honeywell. These are the most important in the Yukon. Another large yet much less active player is Johnson Controls. Other examples of major providers in North America with little to no presence in the Yukon are: Trane, and Delta Controls.

These large companies are built around a certain proprietary direct digital control software which is often difficult to connect with competing pieces of software.

Regarding the equipment manufacturers. There are many types of equipment, and for each of these types there are a large number of manufacturers: heat pumps, air handling units, pumps, fans, heat recovery ventilation system, etc.

Equipment manufacturers tend to be horizontally integrated. For example, they will offer both boilers, air handling units, and chiller, etc. That way, they can benefit from the same network of dealers.

All of the manufacturers serving the Yukon are located outside the Yukon: they are located in Alberta, British Columbia and Washington State.

Strengths and Resources

- Major HVAC manufacturers such as Honeywell, Trane, or Siemens are well known, recognizable global brands.
- Manufacturer's agents maintain close relationships with both distributors and contractors, and have a strong knowledge of the overall HVAC market.
- Reps/Agents are viewed within the supply chain as the “go to” market actors for technical advice. Agents typically have a high level of “in-house” knowledge, and have direct access to the latest product information and training from the manufacturers they represent.

Weaknesses

- Both the climate and the size of the market keep many manufacturers out. Many won't be offering their product in the market. 1- some had unsuccessful installations in the Yukon climate or 2- some offer poor after-sale services because too few of their equipment were installed in the Yukon (they haven't reach a critical mass).
- Vetted interests: The goal of manufacturer and their agents/representatives is to promote their products to the exclusion of others, which is not necessarily compatible with the provision of the most efficient products.
- No manufacturers were found to have dedicated representatives based in Yukon and therefore resources are not always available to play the role of “client educator”.

Exhibit 4 Market Actor: Controls Contractors

Market Role

Local controls contractors are typically the last step in the Commercial HVAC and Control Retrofit supply chain before the end user. They purchase hardware and software from distributors and manufacturers, and they install them. – Note that in many cases there is no distributor in this distribution chain. – Then they bill their client for equipment and services. Depending on the type of project, electrical contractors may have a contractual relationship with a general contractor, or directly with a building owner. They often are electrician and/or have a electrical engineering background.

Controls contractors in the territory are smaller local firms with a handful of employees. There are two of them: one is a Honeywell dealer and the other is a Siemens dealer.

This is a challenging trade and it takes years to train as a controls technician or engineer.

Strengths and Resources

- Controls contractors will have long-term maintenance contracts therefore they have significant direct interactions with owners. This provides an opportunity to influence the energy end-users.
- In new construction, controls contractors are in charge of starting the operation of the new building; in addition to some level of quality control. It can be done well; or not.
- For larger, more complex projects, the profit margins are higher. Ultimately, the “ware” that they sell is much cheaper than – for example – HVAC contractors or even electrical contractors. They sell their knowledge and time. Their business model can sustain more staff. They have more time dedicated to to doing proper project management, engineering, analysis and continuous education – and partake in industry consultation.
- Controls contractors are looking for long-term maintenance contracts. They want to have a high level of customer satisfaction and to have their contracts renewed.

Weaknesses

- Contractors focus on cost because it affects their profit margin. They buy equipment and services which they sell at a mark-up to the client –typically a pre-determined and agreed-to amount of money. If they can do the job more quickly, then they improve their bottom line.
- There are only two controls contractors in the Yukon – with two “competing” and hardly incompatible systems. There are only a few controls contractors and each of these companies are relatively small. Young people interested in the trade need to study outside of the Yukon. Even after graduating, it takes years of on-the-job training and mentoring before being up to speed.

Exhibit 5 Market Actor: HVAC/Mechanical Contractors

Market Role

HVAC/Mechanical contractors are typically the last step in the Commercial HVAC and Control Retrofit supply chain before the end user. They purchase equipment from the manufacturers, and install it for the client. There is usually no distributor in the supply chain for the biggest pieces of equipment (chillers, boilers, air-handling units, etc). The client is billed for equipment and services. Depending on the type of project, mechanical contractors may have a contractual relationship with a general contractor, or directly with a building owner.

HVAC/Mechanical contractors generally work on boilers, hot water plumbing systems, as well as heat pumps, chillers, rooftop units, air handling units, ventilation ducts and heat recovery ventilation units. They represent two or three manufacturers for each of these items; typically a high-end and a low-end manufacturer.

HVAC/Mechanical contractors generally do not keep an inventory of equipment. They will order the large pieces of equipment from the manufacturers on a per project basis and will buy “small” hardware from distributors.

HVAC/Mechanical contractors active in the territory are smaller regional firms with a handful of employees.

Strengths and Resources

- Contractors have significant direct interactions with owners. Also, some contractors will do design-built projects. This provides an opportunity to influence design choices.
- The larger or more complex the project they sell to a client, the bigger the profit margins. They have more time to do proper project management, engineering, analysis and continuous education – and partake in industry consultation.
- HVAC/Mechanical Contractors are accustomed to financing large sums until they get paid and as such have to keep solid financial capacity.

Weaknesses

- Except when contracted for a design/build project, contractors tend to receive specifications from others, leaving them very little latitude to influence design. Contractors often feel that it is too late to incorporate significant design changes by the time they are involved in a project.
- Contractors focus on cost because they make money on margin. They buy equipment and services which they sell for more to the client – typically a pre-determined and agreed-to amount of money. If they can buy equipment for cheaper and are able to convince the client that the quality is equivalent, then they improve their bottom line.

Exhibit 6 Market Actor: HVAC/Control Designers

Market Role

HVAC/Control Designers are the mechanical engineers who supervise the development and sign off on the building HVAC specifications, HVAC plans, plumbing and piping plans, reflected ceiling plans (ventilation ducts), and HVAC control logic plans.

They make major design decisions on the behalf of their client for: type of heating, cooling and ventilation systems; type of heating/cooling distribution systems; number and size of the fans, ducts, pipes, heating and cooling generation equipment; and certain performance or prescriptive specifications on the equipment. They will prepare the bidding documents and support their client to select the winning contractors. They will often leave the details of the design to the contractors.

Two firms doing HVAC/control design were identified in the Yukon, with design teams lead by senior mechanical engineers.

HVAC/Control designers make money through billing professional fees to their customers. Their costs are mostly salaries.

Strengths and Resources

- Designers are typically involved in the early phases of a project, where efficient equipment can be integrated most easily and effectively.
- Designers are the market actors most likely to be in a position to educate end users re: first cost vs. lifecycle cost.
- Designers are professionals – keeping themselves up-to-date regarding the technology is part of their professional ethics. They can, more easily than other trades, learn and work on their skills and capabilities in an autonomous fashion.
- HVAC or control retrofit projects are usually small projects from the perspective of the contractors. However, from the perspective of the HVAC/Control Designers they are larger projects. It takes much more engineering time, resulting in a higher amount of professional fees, to do a retrofit project than a new construction project. With this understanding, HVAC/Control Designers some are much keener on developing this sort of project than – for example – contractors.

Weaknesses

- Engineering companies in general have relatively little financing capacity. They do not and they cannot finance large capital projects. They need to bill and be paid for their services relatively quickly after the services are provided.
- There are a small number of HVAC/control designers in the Yukon and with the large amount of new construction they are busy. Designers mentioned that it is difficult to recruit engineers to join their staff. With the high demand for their services, designers do not have to aggressively seek work, and would not need to take risks or be innovative to be steadily busy.
- HVAC/Control Designers like to focus on their core business: design and engineering. They will generally not use proactive business development approaches unless their competition drives them to.
- From the perspective of the client, engineering costs are early project costs. The perception of risk by customers is high because many retrofit projects might not go ahead.
- In addition, the engineering costs are somehow “intangible”; you don’t see what you get. It is easy for the clients not to value them.

Exhibit 7 shows the consolidated results of the questions that were asked to identify the weakest link in the HVAC and control distribution chain in the Yukon. The main results presented in Exhibit 7 were commented on in Exhibit 3 to Exhibit 6.

Exhibit 7 Actors Promoting Energy Efficiency

Are the following market actors doing a good job at promoting better and more energy efficient products in the Yukon? Where: 1 = Poor Job, and 10 = Excellent Job.

HVAC Equipment Manufacturers (Referred to as “Suppliers”) as seen by:

Manufacturers: N/A	Property Managers: 6.4/10, n=5
HVAC/Control Contractors: 6.5/10, n=4	HVAC Designers: 9.0/10, n=2
<u>Grand Average: 6.9/10, n=11</u>	

HVAC Contractors as seen by:

Manufacturers: N/A	Property Managers: 5.8/10, n=5
HVAC/Control Contractors: N/A	HVAC Designers: 8.0/10, n=2
<u>Grand Average: 6.7/10, n=7</u>	

HVAC Designers as seen by:

Manufacturers: N/A	Property Managers: 5.5/10, n=5
HVAC/Control Contractors: 9.0/10, n=4	HVAC Designers (re head office): 8.0/10, n=2 (excluded from grand avrg)
<u>Grand Average: 7.0/10, n=9</u>	

It is difficult to see the nuances in Exhibit 7. Exhibit 8 is a copy of the equivalent table from the commercial lighting characterization. We are able to see more nuance by comparing tables.

Exhibit 8 Commercial Lighting Actors Promoting Energy Efficiency

Are the following market actors doing a good job at promoting better and more energy efficient products in the Yukon? Where: 1 = Poor Job, and 10 = Excellent Job.

Lighting Manufacturers as seen by:

Manufacturers: N/A	Manufacturers: N/A
Electrical Contractors: 8.0/10, n=2	Electrical Contractors: 8.0/10, n=2
Property Managers: N/A	Property Managers: N/A

E/L Distributors as seen by:

Manufacturers: N/A	Manufacturers: N/A
Electrical Contractors: 7.5/10, n=4	Electrical Contractors: 7.5/10, n=4
Property Managers: 6.4/10, n=5	Property Managers: 6.4/10, n=5

Electrical Contractors as seen by:

Manufacturers: N/A	Manufacturers: N/A
Electrical Contractors: N/A	Electrical Contractors: N/A
Property Managers: 4.8/10, n=5	Property Managers: 4.8/10, n=5

Lighting Designers as seen by:

Manufacturers: N/A	Manufacturers: N/A
Electrical Contractors: 6.75/10, n=4	Electrical Contractors: 6.75/10, n=4
Property Managers: 5.0/10, n=3	Property Managers: 5.0/10, n=3

Property Managers as seen by:

Manufacturers: N/A	Manufacturers: N/A
Electrical Contractors: N/A	Electrical Contractors: N/A
Property Managers: N/A	Property Managers: N/A

With regard to Exhibit 7 and comparing with Exhibit 8 we can make the following assumptions:

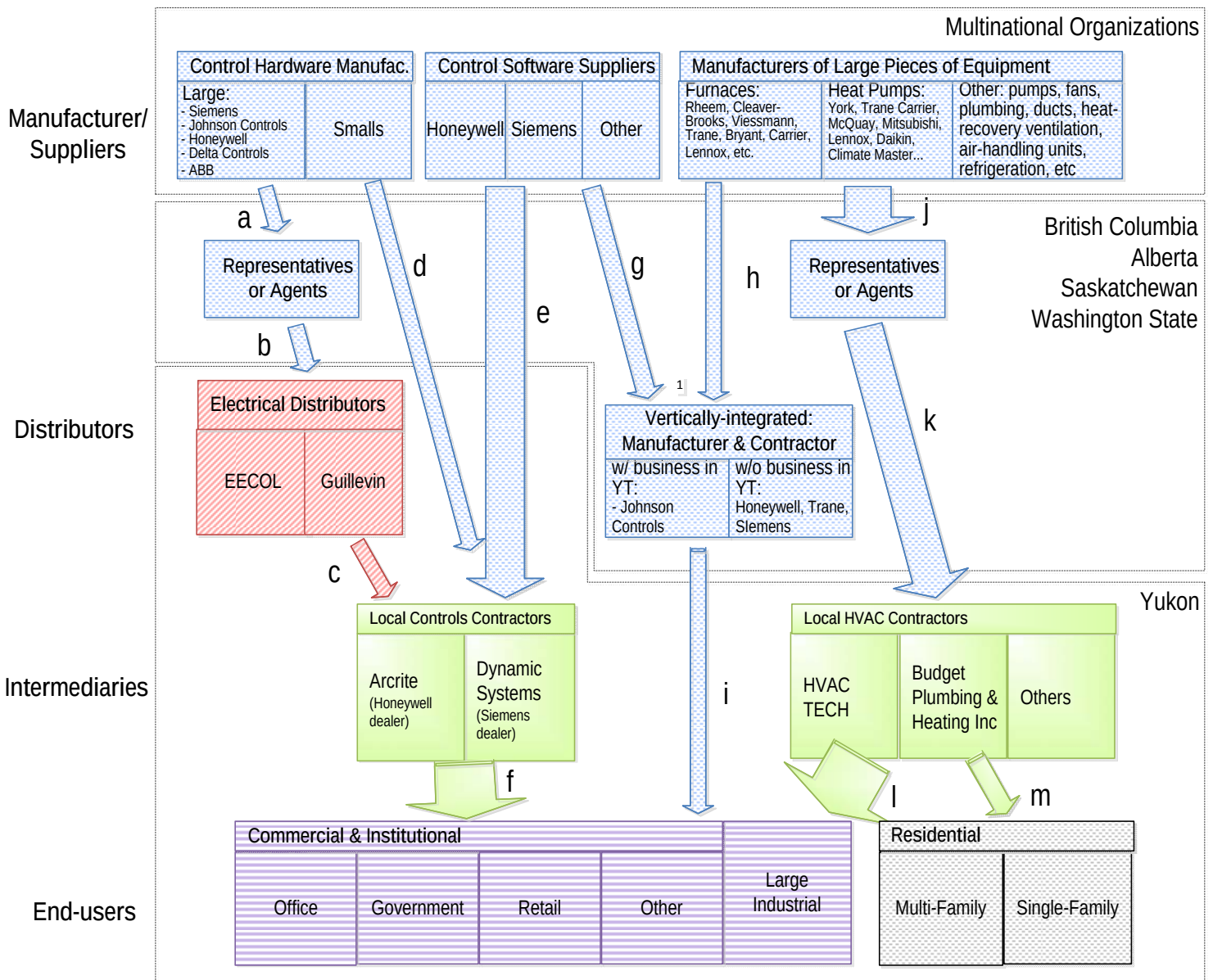
- No market actors among the HVAC/control contractors, the HVAC/controls designers and HVAC/Control manufacturers seem significantly stronger or weaker than the others – as was the case in the commercial lighting sector.
- Contractors mentioned that they have a higher level of trust in controls suppliers than in equipment manufacturers. This observation makes sense. A controls system will work regardless of the climate. The controls sequence is relatively easy to modify because it is software-based. The Yukon's harsh climate is much more of a challenge for the actual equipment – air handling systems, heat pumps, and heat-recovery ventilation.
- Contractors showed a high level of distrust in the equipment manufacturers. Designers confirmed that they know which suppliers have had successful installs in the territory – and they know which suppliers have had unsuccessful installs. There is a tendency to go with the suppliers they know and they trust. This has the effect of reducing the competition, and they might be specified at the design stage rather than being determined through a competitive process.
- It is interesting to see that property managers have a poor opinion of all the supply-side actors. The actors they seem to be trusting the most are the HVAC equipment suppliers – which are located outside of the Yukon.

- HVAC/control contractors and HVAC/control designers seem to have a fairly good working relationship. The score they gave each other is relatively high.

3. Chain of Distribution

A flow diagram of product purchases and sales is presented in Exhibit 9. This depiction of the market is an effective means to understand the interaction of the actors introduced in Section 2. The data underlying the diagram were obtained from interviews with contractors. They are estimates.

Exhibit 9 HVAC & Control Equipment Supply Chain



Highlights, comments and explanation of Exhibit 9 are presented below.

Exhibit 10 Comments on the Chain of Distribution of HVAC and Control Equipment

a,b&c	Control Hardware Manufacturers to End-user Sell Through a Conventional Distribution Chain: Distributors, then Control Contractors ■ Distributors store and finance some common pieces of equipment. ■ Hardware includes controls wiring, radio-frequency gear, thermostat, temperature sensors, CO2 sensors, and programmable logic controller. ■ Major brands are the usual Original Equipment Manufacturers (OEM): Siemens, Johnson Controls, Honeywell, etc. ■ The higher price controls equipment sold through this channel are the variable frequency drive – but they can also come with the fan, the pump or packaged inside a heat pump (e.g. in cold-climate and Variable Refrigerant Volume systems). Manufacturers are ABB, Siemens, Rockwell Automation, etc ■ There is a large number of small manufacturers as this is relatively simple equipment. ■ This part of the distribution chain will not have major influence on market, and on the end-users.
d	Some Equipment will Be Ordered by Contractors and Shipped ■ Based on our interviews this is a limited phenomenon.
e	Controls System Software are Sold to Local Control Contractors (Dealers) ■ There are two large manufacturers that have dealers in Yukon: Honeywell and Siemens. Their dealers are respectively: Acrite and Dynamic Systems. ■ The system as a whole is a big ticket item. Once a certain system is selected, it is difficult to change to another system or to maintain more than one system in the same building or even in many buildings. In theory, systems should be capable of working together, but in practice, this is often challenging. For this reason, customer loyalty is high.
f	The Two Control Contractors in the Yukon, Acrite and Dynamic Systems, Sell Equipment, Installation Services, and Support to Customers the Commercial and Institutional Sector. ■ Both controls contractors confirmed that they do very little in the residential sector. ■ Approximately 50 to 60% of the controls contractor business is with in government buildings and 40% to 50% is in commercial buildings. Results are similar for HVAC and control <i>designers</i>: 50% to 60% in the government sector, and 40% to 50% in the commercial sector. ■ Among commercial buildings, approximately 60% of the business of the controls contractors is in office space, and the remaining in warehouses and wholesales. Results are similar for HVAC and controls <i>designers</i>: 50% to 60% in office space, and 10% to 15% in non-food retail. ■ 60% of the business of the control contractors is new construction projects and 40% is retrofit projects. Results are similar for HVAC and control designers: approx. 55% of new construction office space, and 45% of retrofit projects.
g,h&i	Large Control System Supplier Provide Equipment, Software, Installation Services and Support Directly to the End-users. ■ The building manager we spoke with told us that they buy close to 100% of their equipment from local contractors. The small share that is not from the Yukon is from Northern Alberta (only one interviewee told us purchasing some equipment [30%] from Alberta). ■ End-users never buy equipment directly to retailers, distributors or up-stream suppliers.
j,k&l	Equipment Manufacturers Sell Their Equipment Through Local HVAC Contractors ■ Distributors sell some equipment to end-users but it is fairly minor: approx. 10%. ■ As a general rule, distributors can sell only to electricians. Therefore, they can sell to end-users, as long as they have an electrician on staff. ■ Manufacturers that were mentioned having many successful install in the Yukon are Engineered Air, Lennox, and Mitsubishi.

m

Equipment Contractors Sell Equipment and Installation Services to the Residential Sector

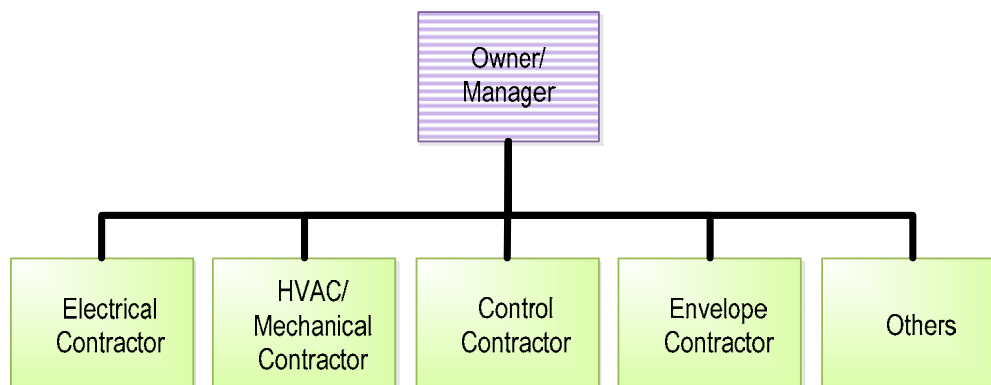
- The contractors we spoke with have some business (5% to 20%) in the residential sector.

4. Typical Contractual Relationships

The purpose of this section is to introduce some concepts and vocabulary to the readers; and some typical contractual energy conservation retrofit arrangements. We acknowledge that there are many variations, but we believe these are the main ones.

Exhibit 11 shows the service contract and casual relationship that owners and managers of an existing building need to maintain with suppliers in order to do the maintenance and repairs of their building(s). All of these suppliers could provide them with energy conservation equipment and services.

Exhibit 11 Service Contracts and Casual Relationships



You can see by looking at Exhibit 11 that a building owner/ manager looking to better understand how to manage their energy bills could find it fairly puzzling, given that they speak with various suppliers, each of whom make many suggestions and have a vested interest. This is one of the various hurdles faced in the commercial sector.

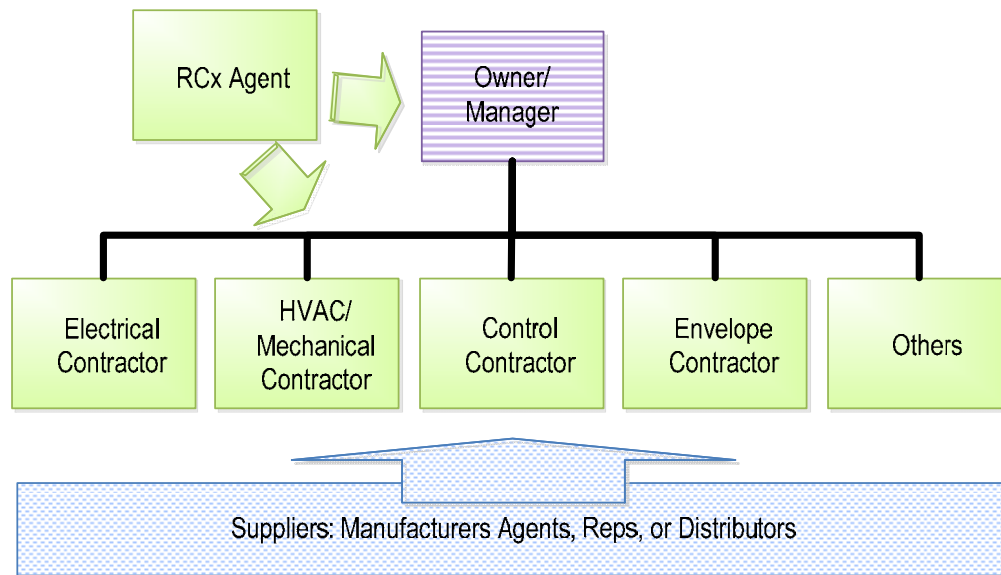
To address this hurdle (and many others) North American markets have created multiple mechanisms; often under the influence of DSM programs or other market interventions. For the purpose of this report, we will present three of them we believe are particularly important for retrofit projects:

- Retrocommissioning (RCx);
- Energy efficiency auditing; and
- Performance contracting.

We will define these three concepts in the next paragraphs.

Exhibit 12 shows the modus operandi of a retrocommissioning agent (RCx agent).

Exhibit 12 Retrocommissioning Contractual Model



Retrocommissioning (RCx): is an intensive quality assurance process that applies to existing buildings. It ensures building equipment and systems are operating optimally to meet current occupant needs. It provides a rigorous investigation approach to identify problems and integration issues. *Adapted from: Recommissioning Guide for Building Owners and Managers, NRCan 2008¹*

There are a few interesting characteristics of RCx:

- RCx's primary focus is identifying "low cost/no cost" operational improvements to obtain comfort and energy savings. These conservation measures can have payback as low as 1 to 2 years. The cost is so low that buildings owners/managers are usually very keen to implement them because the risk is very low.
- RCx is an excellent means to achieve savings in buildings that are in-between major retrofits – but that are underperforming. The energy intensive equipment of the building (furnace, heat pumps, air-handling unit, etc) has not yet reached its end of life. It may be done in concert with a major retrofit project –it's even recommended – but then it becomes a minor component of the project cost.
- A RCx agent helps the owner/manager to identify conservation measures and then to deal with its providers to implement them. Since the measures that were identified are low-cost/no-cost, the building managers can often use their maintenance budget and make casual arrangements with contractors and suppliers to do the small amount of work that is required.
- During a RCx study, the RCx agent spends a lot of time doing tests, measurement and field observations in the building. A RCx study lasts for up to 9 months (one summer, one winter and one shoulder season). In addition, the RCx agent spends a significant amount of time training the operators and maintenance staff.
- Low-cost/no-cost measures have a bad reputation in the DSM field. They are often based on changes in human behaviors and operational procedures. Savings are conditional on people changing their habits; and maintaining new habits. Based on experience, these measures have a very short lifetime. RCx agents spend a lot of time training operators and maintenance

¹ CanmetENERGY (NRCan), Recommissioning Guide for Building Owners and Managers, March 2008, Canada, [ONLINE], As seen on October 7, 2011,
URL: http://publications.gc.ca/collections/collection_2011/rncan-nrcan/M39-123-2008-eng.pdf

staff in order to achieve greater persistence. Still, it is recommended that RCx be done every three to five years to maintain the savings and benefits.

- *Commissioning* is the same quality assurance process than RCx but for new buildings.
- *Retrocommissioning* is often differentiated from *Recommissioning*. Retrocommissioning applies to buildings that were never commissioned in the first place. Recommissioning applies to subsequent commissioning studies on existing building.
- *Continuous commissioning* is the act of continuously monitoring and analyzing the energy consumption of a building and taking measurements to reduce its energy consumption. It is often linked to the installation and operation of an energy management information system.

Energy efficiency auditing: is the study of the energy use in an existing building to identify energy conservation opportunities (measures), prepare a preliminary costing of the measures, make estimates of the potential savings and prepare the business case for each of the conservation measures.

Compared to RCx, energy auditing has the following characteristics:

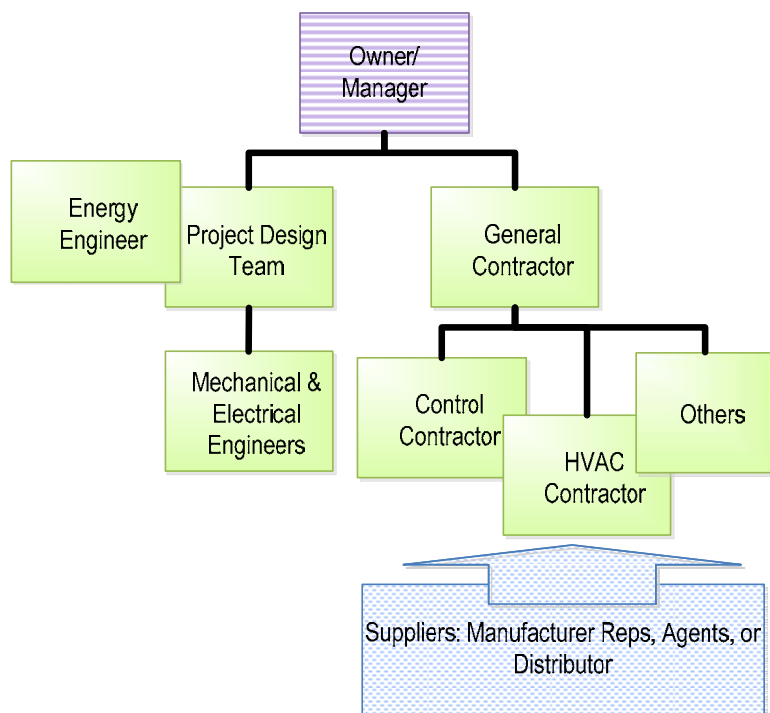
- Energy auditing's primary focus is on identifying "capital-intensive" improvements. These conservation measures have a payback that is higher: 3 to 10 years. Capital-intensive measures have a much higher persistence compared to low-cost/no-cost measures.
- Energy auditing is an excellent means to achieve savings in buildings that need to be overhauled because the energy intensive equipment in the building has reached the end of its life.
- During an energy efficiency audit, the energy engineer will spend most of his/her time working on the costing of the measures and the savings estimate (which need to be more accurate because of the amount that could be invested) and much less time inside the building doing measurements, tests and field observation.

In summary, if you are seeking to fine tune a fairly new building stock, then retrocommissioning is probably going to be the tool of choice. If you are seeking to do major retrofits of an aging building population, then energy audits are probably the way to go.

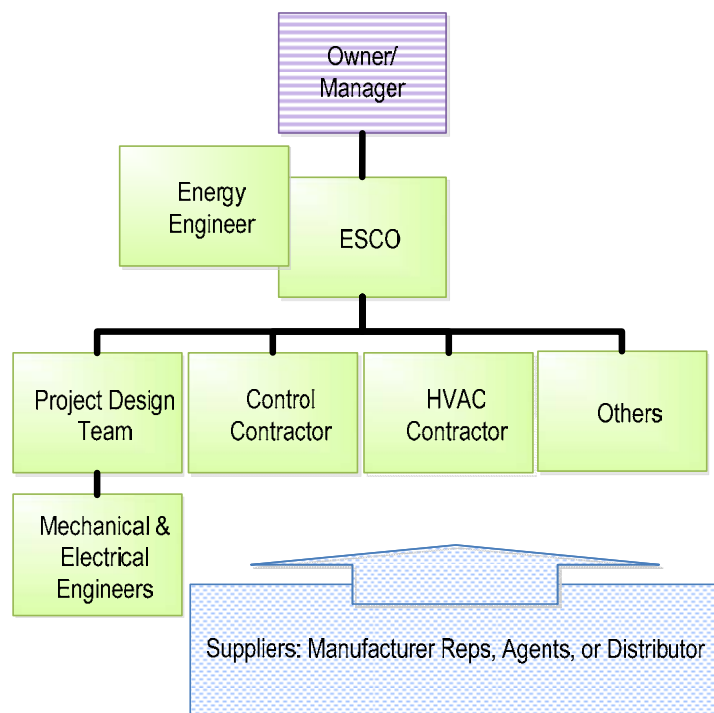
For this reason, as illustrated in Exhibit 13, we believe that two common contractual models used in major energy efficiency retrofit projects are relevant.

Exhibit 13 Common Contractual Models used in Major Energy Efficiency Retrofit

Traditional Approach



Energy Performance Contracting



Traditional Approach: The owner contracts with an Architectural/Engineering firm (A/E firm) to complete the design of the retrofit. The project design team is responsible for selecting and managing electrical and mechanical engineers as needed. The A/E firm often has energy engineers on board. These energy engineers can conduct the energy efficiency audit, do retrocommissioning, do project management, and/or carry out project performance measurement and verification. Other contract(s) are made between the other contractors – perhaps with one prime contractors – and the owner for the materials, equipment, installation and other services related to construction. Some advantages are obtained regarding construction oversight by separating the construction and design roles. Another advantage is a fair and open competition between local contractors.

Energy Performance Contracting (EPC): The owner contracts with an Energy Service Company (or ESCO) for comprehensive energy efficiency project implementation services that might include energy efficiency auditing, project management, engineering, procurement, construction, staff training, operation and maintenance, and project performance measurement and verification (M&V). Multiple conservation measures can be implemented as part of the same project including HVAC and controls measures, as well as envelope measures, lighting measures, domestic hot water measures, refrigeration measures, and retrocommissioning. The ESCO contractor is then responsible for selecting, sub-contracting and managing architects, mechanical and electrical engineers, contractors, etc. as needed.

The EPC approach has the benefit of being quicker and simpler in terms of procurement work: it's a one-stop shop. If an EPC is well written, some project risks can be passed on to the ESCO contractor.

EPC has the disadvantage of being more costly because the ESCO contractors will add overhead and profit on top of the cost of the work done by sub-contractors and the cost of the equipment; and ESCO contractors have the natural tendency to push their own equipment and services regardless of the value to the customer. One last disadvantage is the tendency for some ESCOs to cover up underperforming projects; either by avoiding the M&V all together or by using improper M&V methods (e.g. faulty baseline modeling, unjustified or blown-up baseline adjustments, etc.)

There are two elements of the EPC approach that are often mentioned in the literature. Depending on which expert you speak with, these can be important components of the definition of what an EPC is.

- Performance guarantee: The ESCO guarantees to give some money back to the client if the project is underperforming and the expected energy savings are not realized – up to 100% of the project cost in the most extreme case. This guarantee, though, generally comes with a significant risk premium.
- Support to obtain financing: Some ESCOs offer direct financing. Some ESCOs support their customers in obtaining financing from a third party financial institution.

Over the years, many types of companies have turned themselves into ESCOs or started to do EPC. A few relevant ones are:

- Large vertically-integrated control firms (like Honeywell, Siemens and Johnson Controls) have started to offer EPC. These are the most active ESCOs in North America.
- Utilities have either invested in new ESCO ventures, or created ESCOs within (Utility-based ESCO or USCO)
- A/E firms have occasionally invested in or grown ESCO businesses internally.

EPC has proven to be particularly effective in the government and institutional sectors because building managers in these sectors do not have the expertise and human resources to implement energy conservation projects. Also, the simplified and reduced procurement work is particularly attractive to them.

The EPC contract has several variation; similarly, the approach can be separated and its tactics can be used in isolation.

Only one recent EPC contract was reported in the Yukon. Johnson Controls implemented this contract.

Over the years for both the A/E firms and the contractors, energy auditing, retrocommissioning and EPC have become business development tools. Energy engineers are at the forefront of this business development. E/A firms and/or contractors are very rarely interested in the energy audit work. They are interested in the design and/or construction work that might come after. Energy engineers allow them to capture new clients. Adding an energy engineering practice in a firm is a sign that the firm wants to proactively develop its business rather than being reactive. Retrocommissioning could be used in the same fashion.

5. Existing and Prospective Information Dissemination Mechanisms

This section presents an overview of how information about energy efficient design and equipment flows from the main source, manufacturers, to the energy end-users.

The main actors in the supply chain tend to draw their information from manufacturer reps, agents, websites or publications. (See responses from actors in Exhibit 14).

Exhibit 14 Main Source of Information

According to:	What is the main <u>source</u> of information that you use?	Sample Size (n)
HVAC Designer	1 st and 2 nd : Manufacturers agents/reps <i>tied with</i> Other third party organizations (in particular, ASHRAE) 3 rd and 4 th : External consulting engineering firms <i>tied with</i> Energy conservation / efficiency programs	2
HVAC Contractors	1 st : Manufacturers rep or agents <i>with a solid lead</i> 2 nd : External consulting engineering firms 3 rd : Other third-party organizations -- <i>specifically: ASHRAE, Thermodynamic and Heliodynamic websites and trade magazines</i>	4

Similar to the lighting sector, the information that is used by the local HVAC and controls actors does originate from the manufacturers agents and reps. The information has a similar manufacturers-to-contractors-to-end-users flow.

When asked, all market actors agreed that they have all the information that they need either through the manufacturers or through the widely available engineering handbooks. This information is applicable and they agreed that no research or “adaptation” of the information to the Yukon context is required. (Applicability 7.9/10 where 10 is perfectly applicable. n=6)

When asked about the best means to convey information to the end-users, interviewees answered the following – as presented in Exhibit 15:

Exhibit 15 Main Media Used to Convey Information to End-users

According to:	What are the main <u>media</u> that could effectively convey information to end-users?	Sample Size (n)
Property Managers (<i>about themselves</i>)	1 st and 2 nd : Direct engagement <i>tied with</i> Newsletter (email) 3 rd : Trade shows or events:	5
HVAC Designers	1 st , 2 nd : Printed brochures or flyers <i>tied with</i> Trade shows or events <i>No clear third.</i>	2

When asked about the best means to convey information to them, interviewees answered the following – as presented in Exhibit 16:

Exhibit 16 Main Media Used to Convey Information to Other Market Actors

According to:	What are the main <u>media</u> that could effectively convey information to you?	Sample Size (n)
HVAC Designers (<i>about themselves</i>)	1 st and 2 nd : Trade shows or events <i>tied with</i> Direct Engagement 3 rd : Newsletter (email)	2
HVAC Contractors (<i>about themselves</i>)	1 st and 2 nd : Direct engagement <i>tied with</i> Trade show or event 3 rd and 4 th : Newsletter (email) <i>tied with</i> Direct engagement	4

There seems to be a consensus around the “trade event” idea. Also, they would come to shorter direct engagement events if they saw value in terms of learning and networking opportunities. They didn’t show a preference between morning or lunch.

6. Investment Decisions

In this section we present how HVAC and controls investment decisions are made and how energy conservation is part of this process. We address topics such as purchase drivers, purchase barriers, and the split incentive barrier.

Exhibit 17 shows the reported main end-user purchase motivations.

Exhibit 17 Main Drivers/Motivations of End-Users

According to:	What are the most important motivations of the end-users when investing in HVAC/controls?	Sample Size (n)
End-users (About Themselves)	1 st : More comfort (thermal comfort or IAQ) – <i>with a solid lead</i> 2 nd : Quick installation/Compliance with deadline 3 rd : Expectation of monetary savings because of the electricity savings 4 th : Low initial cost of retrofit 5 th : Environmental considerations 6 th : Obtain rebate, discount, or other incentive	5
HVAC Designer	1 st : Initial cost – <i>with a solid lead.</i> 2 nd : Reduction of operation and maintenance work load and costs 3 rd : Monetary savings because of the energy savings	2
HVAC Contractors	1 st : Initial cost 2 nd : Monetary savings because of the energy savings 3 rd : Reduction of operation and maintenance work load and costs	4

All supply-chain actors indicated that the initial cost is the main purchase motivation of the end-users. The end-users reported “more comfort” as their main motivation. This is contradictory in appearance only. As we will see it in Exhibit 18, end-users have also reported that higher initial cost of the services and equipment is the most important barrier to investing in HVAC/Controls energy conservation retrofits.

Our interpretation of what end-users meant is they will not do a HVAC/Controls retrofit project to gain energy savings, they will do a project to gain more comfort. If the technology can be obtained in the Yukon within a reasonable timeframe, then they will be interested in implementing a project that can generate monetary savings. The higher cost of energy efficient equipment will still be an issue, but they can be convinced. Environmental considerations seem to be a relatively minor driver. It is interesting to see that they do not value or consider the maintenance cost savings. These are significant and informing them about this advantage could be an opportunity.

According to designers, the concept of cost of ownership is still relatively foreign to the end-users.

All the market actors were asked about the purchase barriers to invest in energy efficient retrofit. Their answers are reported in Exhibit 18.

Exhibit 18 Main Investment Barriers of End-Users

According to:	What are the most important purchase barriers to the end-users investing in EE HVAC/controls?	Sample Size (n)
End-users (About Themselves)	1st: Higher initial cost of the services and equipment / Higher impact on rent – <i>with a solid lead</i> 2nd: Electricity bills are rolled in the rent, thus occupants/tenants don't pay them directly.* 3rd: Don't know / Not aware of the existence of this type of service	5
HVAC Designer	1st: Initial cost of the services and equipment – <i>with a solid lead</i> 2nd, 3rd and 4th: Don't know/not aware of the existence of this type of service <i>tied with</i> Direct client will not pay the energy bills* <i>tied with</i> Lack of knowledge on how to operate energy efficient systems (e.g. DDC systems)	2
HVAC Contractors	1st: Initial cost of the services and equipment – <i>with a solid lead</i> 2nd: Don't know/not aware of the existence of this type of service 3rd: Not convinced of the benefits	2

Where EE means Energy Efficiency or Energy Efficient.
Where * mark indicators of the split-incentive barrier.

Supply-chain actors as well as end-users unanimously reported the higher initial cost of energy efficient HVAC/control as being the most important barrier to energy efficiency. It is similar in other jurisdictions, but what is striking in the Yukon is the high degree of importance attached to this barrier relative to the other choices that were suggested.

Discussion on the Split-Incentive Barriers

The split-incentive barrier has ranked 2nd twice (end-users and designers). The split-incentive barrier is particularly difficult to address, and it can be a show stopper in some sub-sectors of the commercial sector. So, it was worth more investigation and, in some cases, it was a direct question. This barrier is found in all jurisdictions. What we need to understand better is the extent to which it exists in the Yukon.

More specifically, the split-incentive barriers (or principal-agent barriers) treat the difficulties that arise under conditions of divergent interests when a party/individual is in charge of paying the energy bills and another party/individual makes the purchase/investment decision. For the sake of our analysis, we will divide it in four cases – as shown in Exhibit 19.

Exhibit 19 Discussion on the Extend of Split-Incentive Barriers Applicable to Retrofit Projects in the Yukon

Cases	Findings and Discussion
S.-I. Barrier A: Internal to an organization: one person or department is in charge of the management, operation and maintenance of a building; and another person/department makes decisions regarding investment.	The extent of this barrier is significant in the Yukon because a large share of the buildings are government owned and operated (approx. 40%) and no “Leading by example” program has been rolled out so far. Most of interviewees referred to Barrier A when asked about the split-incentive barrier. Designers told us that the extent of the double-agent barrier was 25% of their clients – and specified that these clients were mostly government. Government property managers confirmed that this barrier fully applies in the Yukon – and that it does apply to Crown corporations as well. A respondent mentioned that the requirement for all new government buildings to be LEED certified is being by-passed in some cases to reduce the initial cost. There is a disconnection between the people who issued the LEED certification requirement, and the people who are authorizing capital budgets. Program tactics exist to tackle S.-I. Barrier A.
S.-I. Barrier B: Tenants pay directly the energy bills but will not invest: Tenants pay the energy bills directly for the commercial space that they rent. Neither the renters nor the tenants will invest in energy efficiency.	Most of the property managers we spoke with told us that their tenants cannot make changes to the HVAC and control systems (3 times <i>No</i>, 1 time <i>It depends</i>, and 1 time <i>yes</i>, n=5) in their commercial space if they want. However, they tend not to – even those who do pay for their electricity bills directly (1 time <i>Never</i>, 1 times <i>Sometimes</i>). Convincing tenants to invest might not be possible because they cannot make any change. Convincing the owner will be challenging.
S.-I. Barrier C: Landlords pay the energy bills but will not invest: Landlords own the buildings and pay the electrical bills. Neither the landlords nor the tenants will invest in energy efficiency.	This issue should be less stringent in nature than S.-I. A and B. because it would make sense for the landlord to invest in their building(s) and then benefit directly from the savings – and at the same time increase tenant satisfaction and retention. The issue is that some owners perceive that they are being repaid the electricity cost through the rent. We might be able to change this perception. By reducing their operation cost they can either increase their bottom line, or their competitiveness.

Tenants in the Yukon do not frequently ask for changes and investments to the HVAC and controls systems (2 times *Sometimes*, 1 time *Not Much* and 2 times *Rarely*, on the following scale: *Rarely-not much-Sometimes-Often*, n=5). One respondent who said “Sometimes” also said that these are temporary adjustments. This specific answer in addition to a few side conversations during the directed interviews led us to believe that Yukoners might be accustomed to a lower level of services and indoor air quality than in other North American jurisdictions.

As a result of the discussion in Exhibit 19, we conclude that the split-incentive barriers should be accounted for in the design, but should not prevent program uptake and the realization of savings.

7. Practices and Motivations of the Market Actors

In this section, we map out the motivations and interests that exist within the chain of distribution and how these interests influence the market penetration of energy efficient technologies and practices. This will give us some hints on how these natural drivers can be used to influence the market to become more energy efficient.

Reasons for making special efforts with regard to energy efficiency

A large majority of interviewees – as seen in Exhibit 20 – make special efforts to offer, sell, install or purchase energy efficient products and systems. This does not come as a surprise because: 1) energy efficiency generally has high merit; and 2) potential respondents with a relatively low level of interest in energy efficiency probably self-screened themselves out of our samples.

Exhibit 20 Occurrence of Special Efforts for Energy Efficiency Among All Market Actors

Does your organization make special efforts for energy efficiency?				
Number of Responses:	Never: 0	Sometimes: 2	Often: 3	Always: 4
Where the sample size is n=9 among which 3 are end-users, 2 are designers, and 4 are contractors.				

The contractor who answered “Sometimes” told us that he was worried about pricing himself out of the bid since price is often the determining factor. The end-user who answered “Sometimes” told us that he relied on the contractor to let him know what is needed in term of energy efficiency.

What is probably more important from a program design standpoint are the reasons market actors make a special effort regarding energy efficiency. Exhibit 21 presents their motivations.

Exhibit 21 Reasons for Making Special Efforts Regarding Energy Efficiency

Motivations of:	What are the greatest motivations of your organization regarding energy efficiency?	Sample Size (n)
End-users <i>About themselves.</i>	1 st : Operation cost reduction – <i>with a solid lead</i> 2 nd : Good corporate citizenship 3 rd : Increase buildings’ ability to retain or attract tenants	5
HVAC Designer <i>About themselves.</i>	1 st : Good corporate citizenship – <i>with a solid lead</i> 2 nd and 3 rd : Maintenance or gain of competitive advantage <i>tied with</i> Utility incentives or rebate	2
HVAC Contractors <i>About themselves.</i>	1 st : Reactiveness to customer demand 2 nd : Maintenance or gain of competitive advantage 3 rd : Motivation of staff	4

The end-users focus on the operation cost reduction and as also seen in Exhibit 22. It seems that this is more of a focus in the Yukon than in other jurisdictions.

Supply-side actors do not have a main common driver. They all pursue different goals.

- Designers see energy efficient design as part of their duty as citizens and as professionals.

- Three contractors out of four were mostly reactive to what the clients ask for and to the maintenance of their competitive edge. It might indicate that they could be interested in using energy efficiency as a business development tool.
- The last of the four contractors was mostly driven by curiosity and personal challenges.

Exhibit 22 shows the interviewee answers when they were asked about reasons not to do more.

Exhibit 22 Reasons for NOT Making More Efforts Regarding Energy Efficiency

Motivations of:	What are the reasons why your organization would not make more effort to promote energy efficiency?	Sample Size (n)
End-users <i>About themselves.</i>	1 st : Energy efficiency is cost-High – <i>with a solid lead</i> 2 nd : Don't know what to do / Don't know what products 3 rd and 4 th : Return on investment is too low <i>tied with</i> Maintenance is reactive rather than being preventive Came after (in no specific order): lack of capacity to build the business case, EE does not improve tenant retention, EE does not increase the property value, split-incentive barrier, reliability concerns, shipping cost	5
HVAC Designer <i>About themselves.</i>	1 st : When it's not the right application No other responses	2
HVAC Contractors <i>About themselves.</i>	1 st and 2 nd : Difficult sale, i.e., EE more difficult to sell <i>tied with</i> No or little support from governments or utilities 3 rd : Against the market trend, i.e., not what customers demand	3

Where EE means Energy Efficiency or Energy Efficient.
Where * mark indicators of the split-incentive barrier.

What is particularly interesting about the end-users answers is that almost all did not pick from the choices that were presented to them. *Energy efficiency is cost-High* was not even among the choices; neither was *Return on investment is too low* nor *Maintenance is reactive rather than being preventive*. This reinforces the idea that end-users do focus a lot on the initial cost of energy efficient systems rather than having a more holistic vision.

The actual choices presented to end-users during the interview were designed to test what investment they value more than energy efficiency – i.e., what are they currently spending money on instead of spending money on energy conservation. For example, we suggested that they could invest in increasing the value of their property, or increase tenant retention and satisfaction. Because they insisted on creating their own answer – in this specific case they created *Energy efficiency is cost-High* –, thus we believe that energy efficiency is not perceived as an investment or a sound use of taxpayer money and treated as such.

Likely, end-users are thinking in terms of the cost of replacing failed equipment with energy efficient equivalent equipment rather than purchasing the standard equipment or fixing the old equipment. They are not thinking in terms of asset management and preventive maintenance and might not plan investment as much as has been seen in other jurisdictions.

Practices That Are Specific to HVAC/Controls Contractors

Contractors are often identified as the weakest link in the distribution chain in many jurisdictions. This is why we asked a few additional questions about HVAC/Controls contractors designers, end-users and to the contractors themselves.

Exhibit 23 presents the results of questions we asked regarding the influence of local contractors on the HVAC and controls design.

Exhibit 23 Influence of the HVAC Contractors on the Lighting Design

Occurrence of the HVAC contractors to decide (or exert heavy influence) on what equipment to install during retrofit projects? n=10

	Rarely:	Not much:	Sometimes:	Often:
Number of Responses:	0	0	3	7

Occurrence of the HVAC contractors to decide (or exert heavy influence) on what equipment to install during new construction projects? n=5 because of 3 N/A or Don't Know among end-users.

	Rarely:	Not much:	Sometimes:	Often:
Number of Responses:	1	2	2.5	1.5

Occurrence of the HVAC contractors to substitute equipment after the design phase of a project. n=8

	Rarely:	Not much:	Sometimes:	Often:
Number of Responses:	2	0	1	2

Where the sample size is n=10 among which 5 are end-users, 2 are designers, and 3 are contractors.

Based on Exhibit 23:

- HVAC/Controls contractors in the Yukon partake in the design of project.
- Contractors have more influence on retrofit projects than on new construction projects. Still, as one of the contractors eloquently said: *It's a close-knit community so contractors can get involved with engineers – better jobs get done that way.*
- Contractors do suggest some minor changes after the design phase of a project but this does not seem to be a significant or problematic situation.

8. Policy, Program and Regulatory Framework

This section lists and explains policy, program and characteristics of the regulatory framework that have a significant influence on energy conservation in the HVAC and Controls Retrofit Sector.

Based on our research, we found no organizations, programs or pieces of regulation – except for the building electrical code – that would have or had any form of influence positively or negatively on the commercial HVAC/ Controls Retrofit Sector sector, particularly in the past five years.

The Federal Government used to have the EcoEnergy program for commercial buildings; however this program did not target HVAC and controls in particular and the program has been discontinued. A desktop energy auditing and benchmarking program has recently been started by the Yukon Government's Energy Solutions Centre.

Currently, the Energy Solutions Centre –responsible for energy efficiency on the behalf of the Yukon Government – does not have any programs specifically targeting the commercial HVAC sector, but can help to provide guidance if requested. Commercial customers are eligible for the heating

appliance rebates offered through the Energy Solutions Centre’s Good Energy Program. This rebate program is designed for residential scale systems, but may be applicable to smaller businesses.

9. YEC & YECL Credibility and Visibility

This section reports on the interviewees' perception of YEC & YECL with regard to energy conservation. Exhibit 24 shows the results of the set of credibility questions.

Exhibit 24 Level of Credibility of Selected Stakeholders

What is the level of credibility of the following organizations with regard to electricity conservation? Where: 1 = No Credibility, and 10 = High Level of Credibility.

Yukon Energy Corporation (YEC) as seen by:

Manufacturers: N/A	
HVAC Contractors: 5.0/10, n=4	HVAC Designers: 8.0/10, n=1
Property Managers: 8.2/10, n=5	<u>Grand Average: 6.9/10, n=10</u>

Yukon Electrical Company Limited (YECL) as seen by:

Manufacturers: N/A	
HVAC Contractors: 5.5/10, n=4	HVAC Designers: 8.0/10, n=2
Property Managers: 7.6/10, n=5	<u>Grand Average: 6.9/10, n=11</u>

Yukon Government Organization such as Energy Solutions Centre as seen by:

Manufacturers: N/A	
HVAC Contractors: 6.3/10, n=4	HVAC Designers: 5.5/10, n=2
Property Managers: 7.6/10, n=5	<u>Grand Average: 6.7/10, n=11</u>

Other Energy Efficiency Program Administrators (BC Hydro, MB Hydro, etc.) as seen by:

Manufacturers: N/A	
HVAC Contractors: 7.5/10, n=4	HVAC Designers: 9.0/10, n=1
Property Managers: 8.3/10, n=3	<u>Grand Average: 8.0/10, n=8</u>

Equipment Suppliers of Any Sort as seen by:

Manufacturers: N/A	
HVAC Contractors: 8.5/10, n=4	HVAC Designers: 5.5/10, n=2
Property Managers: 5.6/10, n=5	<u>Grand Average: 6.6/10, n=11</u>

Hypothetical Third-party Energy Efficiency Program Delivery Contractor as seen by:

Manufacturers: N/A	
HVAC Contractors: 6.0/10, n=3	HVAC Designers: 7.0/10, n=1
Property Managers: 6.6/10, n=5	<u>Grand Average: 6.4/10, n=9</u>

Based on the results shown in Exhibit 24:

- The credibility of YEC and YECL are the same.
- The credibility of YEC and YECL is lower than what we observed in the commercial lighting sector.
- The credibility of the Energy Solutions Centre seems to be approximately equivalent to that of YECL and YEC.

- One interviewee provided the following relevant explanation: YEC – as for YEC – has never operated programs, from his/her perspective, while the Energy Solutions Centre has. Thus YECL would have to prove itself.
- The least trusted group is the suppliers, particularly among the property managers (end-users). Respondents were suspicious of vested interests.
- What is interesting is the relatively low level of trust that suppliers have in designers. Contractors seem to find them more credible. It might be because of the working relationship that they have.
- The level of credibility of other energy efficiency program administrators (BC Hydro, MB Hydro, Office of Energy Efficiency, etc) is higher than that of YEC and of YECL. Again, this is significant because the property managers were the same as for the commercial lighting sector. Again, the contractors made a difference. We venture the following explanation: because property managers have more time and interest to do research than electrical contractors, they have more time to form an opinion. The opinion of electrical contractors might not be as informed.
- The credibility of a hypothetical third-party energy efficiency program delivery contractor is relatively low. A common explanation provided by two people who answered was that a third party delivery contractor has vested interest and will be ill adapted to the Yukon for not being local. Interviewees saw the nature of the work for a third party energy efficiency program delivery contractor as that of an ESCO.

It appears to us that Yukoners in the commercial HVAC and control retrofit sector are open to the idea that YEC, YECL or both, could deliver energy conservation programs. There is no clear preference between YEC and YECL. YEC and YECL credibility is not much higher than that of the Energy Solutions Center. There would be a certain level of trust in YEC and YECL and this trust would be above that of an equipment supplier.

Finally, YEC and YECL would probably do better using their own branding rather than that of a third-party delivery agent.

10. Market Stakeholders

The following section describes the primary groups or organizations active in the Yukon and relevant to the market segment being researched. The following exhibits describe these groups, along with their strengths and weaknesses.

Exhibit 25 Market Actor: Association of Professional Engineers of Yukon (APEY)

Market Role	Association of Professional Engineers of the Yukon (APEY) is a non-profit trade association representing professional engineers. Like all other professional engineering associations, the role of APEY is to certify and control the quality of professional engineers in the Yukon and to protect the public. Engineering is a restricted practice reserved to Professional Engineers by federal law; backed by a territorial law. APEY can use a certain degree of discretion through deciding who can or cannot bare the title of “Professional Engineer”, and by removing the title from those who fail to comply with the Professional Engineer code of ethics. They can prosecute incompetence as well. APEY also has the mission to enhance quality through capacity building, dissemination of information, a system of mentorship of engineers-in-training, organization of meetings and congresses, etc.
Strengths and Resources	▪ Authority and legitimacy backed by a federal law ▪ Small office in Whitehorse ▪ APEY has one part-time staff and one full-time staff ▪ APEY has a stable source of revenue: membership payments ▪ APEY has 150 members in the Yukon, and 600 members across Canada. ▪ Established communication activities: a website, two newsletters per year, one annual meeting. ▪ APEY would agree to publish messages regarding training from YEC/YECL in its newsletters. ▪ APEY has an education committee. ▪ APEY has an annual member survey
Weaknesses	▪ APEY serves a membership that has interests beyond energy-using equipment and energy efficiency. They have no particular interest in energy efficiency. For example, APEY does not have an energy committee. ▪ APEY did not show a high degree of interest in being an active stakeholder in YEC/YECL programs. ▪ APEY finds it challenging to find volunteers to sit on its boards. ▪ However APEY has very limited resources. So far, APEY has only channeled “messages” about training offerings in the Yukon. ▪ APEY has a dated website – but is in the process of building a new one. ▪ APEY does not have trade event.

Exhibit 26 Market Actor: Yukon Contractor Association

Market Role	A contractor association's primary objective is the overall improvement of the industry and the provision of services to their members. The YCA works on increasing contractors' knowledge and efficiency through promoting the interchange of thoughts and ideas among all industry sectors relating to electrical contracting. In addition, YCA acts as the government liaison for apprenticeship training, qualifications and regulations. NOTE: YCA has not been interviewed. It is a relevant actor to consider in our analysis nevertheless.
Strengths and Resources	▪ Authority, credibility and visibility among contractors ▪ Several communication channels with members, who are hard-to-reach contractors
Weaknesses	▪ No website ▪ Hard to reach

Exhibit 27 Market Actor: Yukon College

Market Role	Yukon College is the only post-secondary provider in the Yukon. Yukon College has 13 campuses in the Yukon. YC works with communities, Yukon First Nations, local governments, business and industry to enhance the Yukon's capacity through education and training.
Strengths and Resources	▪ Facilities and resources: classroom, labs, etc. ▪ Webinar tools ▪ One large campus in Whitehorse and 12 other community campuses ▪ Visibility
Weaknesses	▪ Limited resources because it is a small college

Exhibit 28 Market Actor: Yukon Technology Innovation Center

Market Role

Technology Innovation (TI) encourages the development of innovative technologies and technology-based capacity in the Yukon. Its goals are to assist innovators in the development of commercial products and services that will contribute to the social and economic prosperity of the Yukon. TI provides financial assistance to a wide range of innovative Yukon projects, ranging from software development to mechanical engineering.

TI currently works on the following R&D projects: Insulation Testing on Huts, Northern Greenhouse Research Project, Petrolink Cardlock System, Plastovac: Removing Plastics From Compost, Research Into the Use of Biochar in Yukon Mine Reclamation, and Three-Purpose Biochar Machine.

TI supports business development for the projects stated above. TI involves providing business development assistance to start-up enterprises, and to existing enterprises which have growth and export potential that remains unrealized because of inhibiting factors. No money is provided to the companies, but the advice of custom-tailored business advisory boards, plus the assistance of the program's expert business advisor, are provided to qualifying companies free of charge. TI serves on the selection and steering committee for this project.

The manager of TI also manages the Cold Climate Innovation (CCI). The CCI is focused on the development, commercialization and export of sustainable cold climate technologies and related solutions for subarctic regions around the world.

The CCI works on the following projects: Drilling Hot Water Supply Heater and Pump, Dual Frequency Ice Penetrating Radar, Effectiveness of Biochar on Northern Soils, Infinia Stirling Engine Project, Insulated Communication Shed, and the Vacuum Insulated Panels Testing.

Strengths and Resources

- Research and development
- Metrology technicians, and stock of measurement instrument
- Access to R&D federal funding, and internship grants
- Students and interns
- Interest in research, statistics, mathematics and –maybe– program evaluations
- Capacity to work with private firms either as lead contractor or sub-contractor

Weaknesses

- They focus on R&D: not on consulting, not on market adoption of mature technology, and not on business

Exhibit 29 Market Actor: Whitehorse Chamber of Commerce

Market Role

The Whitehorse Chamber of Commerce is a local organization of businesses whose goal is to further the interests of businesses. The Chamber advocates on behalf of the business community. Local businesses are members, and they elect a board of directors to set policy for the chamber. The Chamber lobbies both the municipal and Territorial governments on behalf of the business community. The Chamber represents small business interests on various committees and stakeholder groups including: City of Whitehorse Downtown Planning Committee, Land Development Committee Yukon Government, Stakeholders Advisory Committee of the Yukon Workers' Compensation Board, and economic development.

The board has 14 members who do not change very often, because the pool of people who volunteer is not very large. The Chamber is financed through membership fees and projects. One money-making project is the advertisement highway signs that the Chamber manages on the behalf of the City.

The Chamber works on several projects and manages several programs on the behalf of others (federal or territorial government, for example): support to business ventures, courses, programs to improve customer service, business training, the “partnering for success” – a program aiming at fostering the private sector.

Strengths and Resources

- The chamber has 2 full-time equivalent staff + program or project managers based on the level of funding. They currently have 3 of them.
- The board has a monthly meeting. The next one is on May 8th.
- The Chamber organizes or promotes “business after-hours”. Approximately 150 people show up. For example, YEC could organize an after-hour event to promote its DSM programs. But YEC would have to find something to attract people. For example, people might be interested to visit the dam, or the diesel plant.
- The Chamber also organizes discussion breakfasts. They can gather 60 to 80 people.
- The Chamber has 500 members
- The Chambers has a newsletter (bimonthly)
- The Chamber has a website with an extensive news feed, an activity calendar, member-only access (through sign-up), specific program-related features like –for example– an online survey, an online library, etc.
- The Chamber organizes many events. One that is of particular interest would be the “small business week”; either to advertise on commercial program offering, or else to engage with business owners (contractors, E&A firms, etc.) who could benefit from program training offering.
- They have an energy committee that has discussions, mainly on the supply-side. Four board members are on the energy committee. The committee is relatively stable.

Weaknesses

- The Chamber serves a membership that has interests beyond energy-using equipment and energy efficiency. They have no particular interest in energy efficiency.

Exhibit 30 Market Actor: American Society of Heating, Refrigerating and Air Conditioning Engineers (ASHRAE)

Market Role	ASHRAE, founded in 1894, is a North American non-governmental non-profit organization of 51,000 persons. ASHRAE fulfills its mission of advancing heating, ventilation, air conditioning and refrigeration through research, standards writing, publishing and continuing education. (ASHRAE Website) ASHRAE has an extended network of Chapters in the United States and Canada. ASHRAE does not have a chapter in Yukon, but has several chapters in Western Canada.
Strengths and Resources	- ASHRAE seems to be the focal association of building professionals among the service providers. They seem to have the largest membership of all trade associations (compared with IES). - They have a high level of credibility, and visibility. It is seen as unbiased in the market.
Weaknesses	- ASHRAE does not have a chapter in Yukon - Typically, - although we have not checked – ASHRAE gathers services providers mostly, and few Owner/Managers or building operators. - The ASHRAE Chapters do not have staff or an office. They operate based on the volunteer work of the members. They have very few resources.

Exhibit 31 Market Actor: Building Owners and Managers Association (BOMA)

Market Role	BOMA Canada's Mission is to represent the Canadian commercial real estate industry on matters of national concern, to develop a strong communications network between its local associations, BOMA International and other real estate associations and promote professionalism of its members through education programs and effective public relations activities. (Source: BOMA Canada's website). This is typically achieved through seminars, and an email newsletter. BOMA does not have a Chapter in the Yukon, but has several Chapters in the West: in British Columbia, Alberta and Saskatchewan.
Strengths and Resources	- BOMA publishes a magazine in print, advertises in newspapers, and organizes events on a regular basis (seminars, career fairs, etc). - BOMA runs the popular building excellence certification program "BOMABest".
Weaknesses	- There is no BOMA Chapter in the Yukon. - The Yukon population is too small to sustain a Chapter. - BOMA serves a membership that has interests beyond energy-using equipment and energy efficiency.

Exhibit 32 Market Actor: Association of Energy Engineers (AEE)

Market Role	The Association of Energy Engineers is a United States-based non-governmental non-profit organization representing engineers and tradespeople working in the energy efficiency and renewable energy fields. They have a network of chapters in the United States. The main activities carried out by the Association of Energy Engineers are related to training, training materials (e.g. books), professional certification, newsletters, printed publication, and industry consultation and monitoring. The AEE manages an extensive list of training offerings. Since 1981, AEE has certified over 15,000 professionals within the energy industry. To our knowledge, among the most well known offerings in Canada are the “Certified Energy Manager – CEM” and the “Certified Measurement and Verification Professional – CMVP” training course and certification.² AEE’s network of chapters is in the early development stage in Canada. There is no chapter in the Yukon.
Strengths and Resources	▪ The AEE will have a good level credibility. ▪ Course and certification from the AEE will be attractive to professionals because they have visibility and they are trusted throughout North America. ▪ The reputation of the AEE is to be flexible, easy to do business with and keen on growing to better serve its membership and its cause. The AEE makes several partnerships with smaller organizations to maintain and disseminate courses on their behalf. For example, Energy Valuation Organization, the organization that maintains and promotes the International Performance Measurement and Verification Protocol, has a deal with the AEE to handle the CMVP course and certification process. ▪ The AEE has infrastructure to manage multiple courses, professional certifications and events: IT, employees, office in Atlanta Georgia, etc.
Weaknesses	▪ The AEE has currently no presence or visibility in the Yukon.

11. Qualitative Assessment of the Baseline

This section presents a qualitative assessment of the market adoption of technologies and services in the absence of DSM programming in the Yukon.

The approach used in this section had the following four objectives: 1st be a warm up at the beginning of the interviews, 2nd get to know the interviewee and his/her level of familiarity with the technologies, 3rd become a baseline for future program evaluation, and 4th retrieve information on market adoption. We believe that the three first objectives were achieved, but not the fourth.

The results presented in Exhibit 33 should be interpreted as an indication of which conservation measure has the highest penetration in the market compared to the others.

² Source: AEE Website, [ONLINE] as seen on October 11, 2011,
[URL:http://www.aeecenter.org/i4a/pages/index.cfm?pageid=1](http://www.aeecenter.org/i4a/pages/index.cfm?pageid=1)

Exhibit 33 shows the level of familiarity of actors in the market with HVAC/controls retrofit measures that were deemed ready for widespread market adoption at the beginning of the market characterization study.

Exhibit 33 Familiarity of Supply-chain Actors with Mature Lighting Technologies

Typical Technologies	A few times (# of Hits)	Often (# of Hits)	Score (See below)	Some Upward trend? (# of Hits)
Convert a building to direct digital control	1	5	11	4
Implement a building energy management information system	1	1	3	0
Install a heat exchanger between the fresh air intake and the exhaust	1	5	11	5
Install a ground-source heat pump (geothermal heat pump)	3	1	5	1
Install an Energy Star heat pump	2	3	8	2
Install a cold-climate heat pump	3	2	7	2
Install a variable refrigerant volume system	3	1	5	1
Retrofit a refrigeration system to improve efficiency	1	1	3	0
Install and use a variable frequency drive on the ventilation system	3	3	9	2
Install and use a variable frequency drive on the hot water loop	1	3	7	0
Modify the control sequence and/or modify the ventilation system to use free cooling	0	6	12	2
Convert a mono-zone ventilation system to a multi-zone system	2	3	8	1
Modify the control sequence to use night setback	0	6	12	1
Insulate hot water tank or install a high-efficiency hot water storage tank	2	3	8	0
Install programmable thermostats	0	5	10	1
Other: open-loop geothermal				

Sample Size: n=6 --> 2 designers and 4 contractors
Scoring system: A few times = 1, Often = 2

Most of our conclusions actually come from the discussions that surrounded the questions on the set of technologies presented in Exhibit 33.

- We would not rely on the actual score to assess market penetration of the technologies on an absolute basis. But we can draw conclusions regarding how certain measures or sets of measures compare to others.

- Overall, controls measures and in particular low-cost controls measures scored higher than equipment installation; like *Modify the control sequence and/or modify the ventilation system to use free cooling* and *Modify the control sequence and/or modify the ventilation system to use free cooling*
- Heat pump penetration seems relatively low. A designer mentioned that *Heat pumps are much easier in new builds than retrofits*.
- There seems to be an upward trend on the two following measures: *Convert a building to direct digital control* and *Install a heat exchanger between the fresh air intake and the exhaust*.
- Penetration of *Install programmable thermostats* is high. However, there is no upward trend. Two respondents (one designer and one contractor) responded that they have become standard. The market might be saturated.

Exhibit 34 shows the level of familiarity of actors in the market with selected energy conservation services or practices.

Exhibit 34 Current Market Penetration of Energy Conservation Services or practices

Typical Technologies	A few times (# of Hits)	Often (# of Hits)	Score (See below)	Some upward trend? (# of Hits)
Energy efficiency audits	7	2	11	3
Advertisement from HVAC or control contractors using energy efficiency / conservation as a selling point	2	5	12	1
Advertisement from equipment suppliers using energy efficiency / conservation as a selling point	2	6	14	2
Advertisement from designer using energy efficiency / energy conservation as a selling point	2	4	10	0
New-building commissioning	3	6	15	3
Existing-building retrocommissioning	5	1	7	0
Energy performance contracting	5	0	5	1
Energy savings measurement and verification services	4	2	8	3

Sample Size: n=11 --> 5 property managers, 2 designers and 4 contractors
Scoring system: A few times = 1, Often = 2

Comments on Exhibit 34:

- Some energy efficiency audits are being completed in the Yukon. As mentioned above, there was a previous commercial energy audit program that was discontinued, but more commercial audits have been performed in the last few years. There is potential for growth in this sector.
- Contractors and suppliers are pushing energy efficiency through advertisements.
- Penetration of commissioning is much higher than retrocommissioning.
- Penetration of energy performance contracting is the lowest of all practices shown in Exhibit 34. There is little evidence of any upward trend.
- Energy savings measurement and verification services (w/o live metering) is low as well, but trending upward.

12. Preferred Approaches of the Market Actors

We asked interviewees about their preferred DSM program approach, tactics and activities. There were three objectives: 1st to test for consistency between answers; 2nd to increase their satisfaction with the interview process – assuming that most people like to give their opinion on what should be done collectively; and, 3rd to gain a superficial idea of what the program uptake might be depending on the set of program tactics employed.

Exhibit 35 presents the answers with regard to the preferred program approach.

Exhibit 35 Preferred Program Tactics and Activities

Preferred tactics of:	What are the energy conservation program activities you are the most likely to participate in?	Sample Size (n)
Property Managers (end-users)	1 st and 2 nd : Training for trades people and/or professionals <i>tied with</i> Financing of preliminary studies to identify buildings with potential 3 rd and 4 th : Pilot projects <i>tied with</i> Dissemination of information to clients through brochures endorsed by the utility	5
HVAC Designers	1 st : Pilot projects 2 nd : Financing of preliminary studies to identify buildings with potential 3 rd : Incentives for customers	2
HVAC Contractors	1 st : Training for trades people and/or professionals 2 nd : Pilot projects 3 rd : Incentives for customers	4

Where EE means Energy Efficiency or Energy Efficient.

Notes on Exhibit 35:

- Incentive is not the preferred approach of property managers and it did not even make the top three. They are not being consistent with the rest of their answers. They did rank the incentive very high for lighting, but did not for HVAC/controls. We think it might be because of how the choice was formulated in the questionnaire. In the lighting part of the questionnaire, the exact wording of the choice was *Direct incentive to you in exchange for choosing better-than-code products for your buildings*. In the HVAC/Controls part the exact wording of the choice was *Incentives for the customers*. – when by “customer”, we meant them.
- It is interesting to see that there is interest in *Financing of preliminary studies to identify buildings with potential* (i.e. energy auditing) and *Training for trades people and/or professionals*. They were popular among end-users, contractors and designers.
- Pilot projects were popular among designers and contractors.

13. Barrier Analysis

Barriers which emerged as themes during the market research activities were identified and categorized through a barrier analysis. This analysis will be used to support program design in terms of informing the type(s) of program(s) that should be created as well as pertinent activities that should be included. For our purposes, we divide barriers and hurdles into five types: informational, financial, technical, institutional/cultural, and market.

We believe that there are four main barriers to energy efficiency in the Commercial HVAC and Control Retrofit Sector in the Yukon. Exhibit 36 presents these four barriers.

Exhibit 36 Key Market Defects

Identification	Hurdle or Barrier ³	Type	Substantiation
High cost of energy conservation measures	Hurdle	Financial	As seen in Exhibit 17, all designers and contractors indicated that the initial cost is the main purchase motivation of end-users. As seen in Exhibit 17 and in Exhibit 18, end-users (property managers) will do a project to gain more comfort. If the technology can be obtained in the Yukon within a reasonable timeframe, then they will be interested in buying equipment that can generate monetary savings. The higher cost of the conservation measures will still be an issue, but they could be convinced. Environmental considerations seem to be a relatively minor driver. As seen in Exhibit 18, supply-chain actors as well as end-users unanimously reported the higher initial cost of energy efficient equipment as being the most important barrier to energy efficiency – and based on our experience it is not the case in all jurisdictions. As seen in Exhibit 22, energy end-users told us that Energy efficiency is high is the main reason not to make more effort promoting energy efficiency. What is particularly interesting about the answer of the end-users is that they did not choose the answers presented to them. Energy efficiency is high cost was not even among the choices that were presented to them. As seen in Exhibit 35, incentive is definitely the preferred approach of property managers.
Split-incentive barriers inside governmental or municipal organizations (See S.-I. Barrier A in Exhibit 19)	Barrier	Cultural/ Institutional	The extent of this barrier is significant in the Yukon because a large share of the buildings are government owned and operated (approx. 40%) and no “Leading by example” program has been rolled out so far. Most of interviewees referred to <i>Split-incentive barriers inside governmental or municipal organizations</i> when inquired about the split-incentive barrier. Designers told us that the extent of the principal-agent barrier was 50% of their clients – and specified that these clients were mostly government. 50% is more than what was reported by the lighting designer. One contractor told us that 60% to 70% of his clients were in this situation. Government property managers confirmed that this barrier fully applies in the Yukon – and that it does apply to Crown corporations as well.

³ Hurdles and barriers are words to distinguish market defects. Hurdles are considered easier to address and – eventually– to overcome. Barriers are more difficult to mitigate; and change is slower. Some barriers are externalities that cannot be changed and have to be lived with. Programs generally focus on implementing activities to tackle hurdles.

Identification	Hurdle or Barrier ³	Type	Substantiation
Limited offering in energy engineering	Barrier	Informational	ESCO activity is minimal in the Yukon. The largest ESCOs (Siemens, Honeywell, Johnson Controls) do not actively offer EPCs in the Yukon. The Yukon has skilled and knowledgeable HVAC and control contractors. End-users and designers agreed that they do a good job at promoting energy efficiency. (see Exhibit 7) However: they are busy, and they probably do not go the extra length to actively offer energy efficiency audit to those end-users have not asked for it; and even if they asked for it, it is not clear that they would be able to supply the services in a timely manner. The engineering firm we had a meeting with do not have engineers that are solely dedicated to energy engineering. They probably have the knowledge and skills but may not have not conducted a lot of energy audits. In addition, they are busy working on new construction projects. ASHRAE and AEE do not have chapters in the Yukon. There are very few training opportunities in the Yukon. There are no local trade events, shows, local publications or newsletters on HVAC/controls. <i>Don't know/not aware of the existence of this type of service</i> came second or third as an investment barrier according to all market actors. The local energy services engineers are not actively informing the end-users about the opportunities, again probably because they are busy working on new construction projects.
Reactive building maintenance rather than preventive building maintenance	Barrier	Cultural/Institutional	Property managers in the Yukon generally seem to have a short term view and apply a reactive maintenance style to managing their assets. During the interviews, we tested the motivations of the end-users. We asked them why they would NOT do more energy efficiency in the buildings and facilities that they own. Results are shown in Exhibit 22. The actual choices presented to end-users during the interview were designed to identify what are they currently spending on rather than spending on energy conservation. For example, we suggested that they could invest in increasing the value of their property, or increase tenant retention and satisfaction. Because they chose to create their own answer– in this specific case they created <i>Energy efficiency is cost-prohibitive</i>–, thus we believe that energy efficiency is not perceived as an investment or a sound use of taxpayer money and treated as such. End-users focus on extra cost. They do not think in terms of asset management and preventive maintenance. They do not plan their investments as much as typically occurs in other jurisdictions.

There are other barriers to energy efficiency in the Commercial HVAC and Control Retrofit Sector than those presented in Exhibit 36. Nevertheless, the barriers presented appear to be the most significant. A justification has been provided in the same exhibit. We believe that these barriers should be addressed first.

Yukon Demand Side Management Guiding Document (January 2011)

Prepared by the Demand Side Management Working Group: Yukon government (YG), the Yukon Development Corporation (YDC), the Yukon Energy Corporation (YEC), and the Yukon Electrical Company Ltd. (Yukon Electrical)

1. Introduction

Within the electrical industry context Demand Side Management (DSM) can be defined as initiatives that influence consumer patterns of energy consumption. Key DSM initiatives relevant to the Yukon include, but are not limited to, actions to reduce energy use (energy conservation) as well as shifting energy use from peak times to periods when less energy is required (load shifting).

As electrical demand and the cost of building additional infrastructure to meet that demand increases, there is renewed interest to investigate the potential for DSM in the Yukon. The Yukon Utilities Board has ordered both Yukon Energy Corporation (YEC) and the Yukon Electrical Company Limited (YECL) to develop DSM plans (working with the Energy Solutions Centre, a branch of the Department of Energy, Mines and Resources as needed) for filing with their next general rate application. In the interests of efficient and effective DSM policy development, the Yukon government (YG), Yukon Development Corporation (YDC), YEC, and YECL, have agreed to work collaboratively to examine the opportunities and challenges that relate to DSM within the Yukon context. This document summarizes the research conducted by YEC in its initial scan of current DSM activities/mandates in the territories as well as serving as a guiding document, developed by all the parties, in an effort to move forward collaboratively with future DSM policy initiatives.

2. Yukon Commitments on DSM and Energy Efficiency

2.1. Yukon Electrical Utilities (YEC/YDC, YECL)

Both YECL and YEC have recently received direction (Board order 2009-2 and 2009-8 respectively) from the Yukon Utilities Board to consult with stakeholders and jointly develop a DSM policy paper (Plan) to be presented as part of their next general rate applications. The board order also directs the Utilities to be cognizant of and work with the Yukon government (specifically the Energy Solutions Centre) so as not to duplicate DSM efforts in the territory.

YEC has included Demand Side Management in its 2010 strategic plan (2010-2012) and is examining the potential for DSM's role as a supply option in a 5 year update of its 20 Year Resource Plan scheduled to be completed in 2011.

2.2. Yukon government

After significant public consultation in 2008, the YG, as part of its *Energy Strategy for Yukon*, committed to support DSM as a priority action item.

Specifically addressed in the *Energy Strategy for Yukon* is a commitment to "Develop and implement demand management programs and incentives to promote energy efficiency and conservation". The document identifies the role that reducing or changing the demand for electricity could play in reducing the need for additional energy infrastructure and for decreasing diesel use. The strategy clearly states that "demand management improves the efficiency of the electricity sector". The following priorities and initiatives related to DSM are described within the Strategy:

- Increase energy efficiency in Yukon by 20 percent by 2020
- Reduce energy consumption in Yukon buildings
- Promote the use of energy efficient products by providing incentives for products that meet energy performance standards

- Improve energy efficiency for Yukon government operations
- Energy efficiency improvements for major energy consumers such as government buildings
- Electricity rates that encourage people to use less energy and shift their energy use away from peak times of the day
- Opportunities for a greater number of customers to make use of surplus hydroelectricity when it is available
- Creating a program like Power Smart to reduce demand and assist in achieving the energy efficiency target for the Yukon (increase energy efficiency in Yukon by 20 percent by 2020).

The Yukon government has also made commitments to energy efficiency in its *Yukon government Climate Change Action Plan*, released in early 2009. The Plan includes a commitment to improve energy efficiency, conduct energy analyses of all Yukon government buildings (and complete energy savings retrofits) and develop pilot projects to demonstrate home and commercial energy efficiency and heating technology.

3. The Yukon Context

3.1. Yukon's Electrical Demand Summary

The following statistics were provided by YECL as part of the upcoming Part II joint filing with the YUB and are intended to provide a breakdown of electrical consumption in the territory between sectors, seasonally, and by zone.

The customer breakdown for the Yukon is as follows: 82percent residential, 18percent general service and 0percent (1) Industrial. The 2009 load forecast for both Utilities was 345.7MWh (49 percent General Service, 40 percent Residential, 8 percent Industrial and 2 percent Secondary Sales¹). Of that, 94 percent was generated by hydro, 6 percent by diesel and less than 1percent by wind.

In general, demand in the Yukon is highest during the winter months and also has a daily AM and PM peak. In 2009², the highest average sales occurred in January (1398 kWh) and the lowest were in August (573 kWh). Residential energy usage has a traditional bowl shape with a high in January and a low in August. On an annual basis for residential customers (non-government), 79 percent of energy used is in the block one (up to 1000 kW) and 21 percent is in block two (over 1000 kW). During the summer months, 88 percent of residential demand is in block one, compared to 73 percent during winter months (October to March). The highest average monthly usage per customer on a per community basis is in Carmacks followed by Whitehorse, Pelly Crossing and Ross River.

3.2. Current Yukon government DSM activities

DSM initiatives identified within the Energy Strategy are intended to build on existing Yukon DSM initiatives, primarily the work of the Yukon Housing Corporation (YHC) and the Energy Solutions Centre (ESC) for which DSM makes up a significant portion of their mandate.

3.2.1. Energy Solutions Centre (ESC)

ESC was founded in 2001, under YDC ownership, as a "sister" corporation to YEC from which DSM (and other) programming was delivered. In 2006 ESC operations were transferred from YDC to the Yukon government and currently operate as a branch of the Department of Energy, Mines and Resources. DSM programs continue to be an important part of ESC mandate and the Branch currently offers various DSM initiatives in the Yukon. Some of these key initiatives include:

1. Energy Efficient Product Rebate Program ("Good Energy")
2. Community Based Social Marketing Campaigns (Project Porchlight, etc.)

¹ Street lights and space lights make up the additional 1percent.

² The information that follows is based on data provided by YECL and references YECL customer sales only.

3. Awareness Building and Public Outreach (EASY\$, Storefront/library, etc.)
4. Public Building Energy Accounting (PBETS)
5. DSM Focused Pilots/Demonstration Projects (Parking Lot Controller, Water timers, PV systems demonstration, building construction, etc.)

3.2.2. Yukon Housing Corporation (YHC)

The Yukon Housing Corporation (YHC) provides an integrated approach to the issue of energy efficiency; from existing homes, to new home construction to rental properties, to social and staff housing. YHC's approach ensures spectrum-wide results in the ongoing challenge to improve the energy efficiency of Yukon's housing stock. Some of these key initiatives include:

1. Home Repair Program
2. Rental Rehabilitation Program
3. Residential Energy Evaluations
4. SuperGreen Standards
5. Home Builders Self Help Course

3.3. Current YEC DSM Activities:

Yukon Energy Corporation's mandate is to generate, transmit and distribute a continuing and adequate supply of cost-effective and reliable electrical energy for customers in the Yukon. Although the bulk of DSM related programming was transferred to the Yukon government when ESC became part of EMR in 2006, YEC views DSM as an important clean energy supply option and will be assessing its potential as part of the Corporation's 20 Year Resource Plan update. Current DSM programming within YEC is focussed on pilot projects and continuing public education until a DSM plan is completed and approved by the YEC Board of Directors and the YUB. Education is one way Yukon Energy is helping raise awareness of the need to conserve electricity. The Corporation routinely updates winter forecasts to let customers know when the corporation predicts diesel will be required for peak electricity demand. YEC also maintains a web based energy efficiency house on its website which can be used as a tool for households unsure of which areas/types of electrical infrastructure are higher electricity users.

YEC, with the financial assistance of ESC, installed 6 LED streetlights in Dawson City this fall to test LED performance in extreme winter conditions. Results of this pilot project will be reviewed to assess the streetlight performance and determine what the energy savings and payback periods are. The lights selected for the project have back light shields to reduce light pollution and are INSA certified. These lights have been successfully tested in several Alaskan communities and are now being installed in Anchorage, Haines, Fairbanks and Valdez with funding from the US Federal government.

3.4. Current YECL DSM Activities:

In partnership with ESC, the City of Whitehorse, and YEC, YECL is conducting an LED streetlight pilot project to test 24 LED streetlights – six lights from each of four different manufacturers – around Whitehorse. For each type of light, the project will (i) compare luminance to minimum RTAC standards, (ii) determine energy savings, (iii) determine operational costs and payback periods, and (iv) gather customer feedback concerning the lights.

YECL is assessing electronic meters in the Yukon. These meters (i) facilitate automatic meter reading, (ii) have Time-of-Use capability, (iii) have bi-directional capability to accommodate net metering, and (iv) are compatible with in-home monitoring & operating devices. In January 2010, YECL conducted a preliminary assessment of this technology's ability to address load pickup issues, underfrequency and undervoltage events, and peak shaving. In July 2010, YECL hosted a seminar for local stakeholder groups to explain the limitations & benefits of the technology. In addition, this technology can be used for water meter reading.

YECL provides energy efficiency and DSM information on the internet by hyperlinking to the EnergySense website. There, homeowners and businesses can find articles and tools to help improve their energy efficiency. EnergySense also has the 'Energy Efficiency Mobile' which travels through Alberta and educates elementary students on energy efficiency (as well as provides general information for all customers looking to reduce their energy use.) Although the Energy Efficiency Mobile has been well-received and is currently booked for the foreseeable future, YECL believes the traveling classroom would be a good tool to raise DSM awareness given the outspread nature of Yukon communities.

When designing new projects, YECL considers electrical losses to choose the best life cycle value of transformers and main power lines.

3.5. Current Joint YEC/YECL DSM Activities:

The current electrical rate structure for Residential and General Services customers applies an inverted block rate system where energy charges per kilowatt hour are higher in the second block than in first block one. General Service customers are also assessed a ratchet charge for the subsequent 11 months if they exceed their predicted energy use in any given month. These types of rates are generally referred to as conservation rates in that they are intended to promote energy efficiency and conservation.

YEC and YECL jointly filed an application to the Yukon Utilities Board in Feb of 2010 to change the current two block inverted rated to be 3 inverted blocks for residential customers and 4 inverted blocks for general service customer in order to reflect the costs of service to serve the higher consumption customers. A decision on this application is pending by the YUB.

4. New DSM Implementation Mechanisms for the Yukon

DSM is not a new concept for the Yukon but rather one that needs to be reassessed, given past experience, from a utility, government and customer perspective in order to ensure that new DSM initiatives are cost-effective and target the most appropriate customer groups, at the appropriate times.

4.1. Principles

The Working group have agreed that the following principles should guide any new DSM initiative development moving forward.

1. Measurable reduction in energy use and energy demand
2. Cost-effective for rate payers vs. new generation options
3. Equitable/Inclusive Programming
4. Promote partnerships and cooperation between Utilities, governments and stakeholders

4.2. Working Group Joint Commitments on DSM

In an effort to further identify the potential for DSM in the territory and move forward with an effective and comprehensive DSM strategy the working group have committed to undertake the following actions as a group in 2011.

1. Undertake an electrical sector baseline study that identifies the conservation potential in the territory and specifies areas of focus.
2. Confirm and further develop roles and responsibilities of government, YUB, YEC and YECL.
3. Participate in a stakeholder consultation and negotiations. The Utilities will jointly seek advice from interveners/stakeholders on issue identification and how they see their role in the YUB ordered DSM plan development process. The Utilities will include YG in this process and advise YG on the outcome of those discussions.
4. Seek opportunities to partner on DSM focused pilot projects such as the current LED street light work currently underway.

These actions will lead to the development of a DSM Plan to be implemented in 2012.

4.3. Roles and Responsibilities

With the understanding that roles and responsibilities may be revised as the DSM plan is further refined (as per 4.2.2); the working group has proposed the following current roles and responsibilities for its participants.

4.3.1. Yukon government

Continue to develop and participate in DSM initiatives as they relate to the varying mandates of the organization with consideration for DSM activities being undertaken by other Yukon agencies. This includes, but is not limited to:

The Energy Solutions Centre: The promotion and implementation of energy efficiency and renewable energy initiatives through consumer information, market transformation programming, technical pilots/demonstrations and capacity building initiatives.

The Yukon Housing Corporation: to provides an integrated approach to improve the energy efficiency of Yukon's housing stock; from existing homes, to new home construction to rental properties, to social and staff housing.

Property Management Division (PMD): Assist government departments and publicly funded agencies meet their objectives by procuring and managing facilities that will provide affordable, comfortable, and appropriate accommodation for their program activities. PMD is responsible for developing and managing Energy Efficiency/DSM initiative in all building space required by government departments and agencies.

The Climate Change Secretariat: Government-wide leadership and coordination on Yukon's response to climate change and the implementation of the Yukon's Climate Change Action Plan.

- Look for opportunities to partner with YEC and YECL on initiatives where appropriate.
- ESC/EMR Policy to represent the above interests at joint working group meetings.

4.3.2. Electrical Utilities (YEC/YECL):

- Consultation with interveners and stakeholders regarding DSM as ordered by the YUB.
- Develop a DSM plan for YUB approval as ordered by the YUB
- Continue to implement DSM pilot projects as part of the DSM program development phase and partner with YG as appropriate.
- Implement DSM projects with consideration for DSM activities being undertaken by YG. These projects must be within the Utilities' mandate as set out by the Electric Service Regulations and YUB direction.

4.3.3. YUB:

- Review and make recommendations to the Minister of Justice regarding DSM priorities.
- Provide the Utilities with Board Orders regarding DSM.
- Review the prudence of utility costs and benefits to ratepayers after implementation of DSM projects. Approve of prudent cost into electrical rates.

4.3.4. DSM Joint Working Group Members:

- Provide information on DSM related initiatives to the Working Group so as to avoid duplicating efforts and to capitalize on opportunities to share resources.

Yukon government Energy Conservation Programs and Activities

Energy Efficiency Outreach and Education

Energy Solutions Storefront

Yukoners are encouraged to stop by the Energy Solutions Storefront for program information and discuss energy questions and projects with Senior Energy Advisors. The storefront includes a borrowing library and other client focused resources.

Energy Efficiency Training

The Energy Solution Centre offers regular industry training opportunities focused on building capacity within the territory in the area of energy efficiency.

Education Programs – Industry Professionals

Yukon Housing Corporation offers a variety of courses and workshops on topics ranging from R2000 Building standards, HRAI Heating and Ventilation Design, Oil Burner and Tank Maintenance to EnerGuide Evaluator Training workshops and certification programs.

Easy\$ Tips Sheets

Easy\$ Tip Sheets present energy advice on a variety of topics, including: Indoor Lighting for Comfort and Savings, Draft-Proofing your Home, Simple Energy Efficiency Tips, Residential Water Heating and Building an Energy Efficient Home. The sheets are available as handouts and on line at the Energy Solutions Centre web site.

Energy Efficient Product Market Transformation

***Good Energy* Rebate Program**

The Energy Solutions Centre developed the Good Energy Rebate Program in 2007 as a tool to encourage people to purchase the most energy efficient products available. This market transformation program is focused on working with local retailers and consumers to offer education and incentives that will encourage the purchase of energy efficient products. The program currently offers rebates for the following purchases:

- A. Energy Star® household appliances, for all major Energy Star® household appliances including: refrigerators, freezers, clothes washers and dish washers.
- B. Energy efficient (non-electric) heating appliances, for energy efficient furnaces, boilers, space heaters and clean wood burning appliances.
- C. Solar hot water heaters because on average 40 percent of a non-electrically heated household's electrical load comes from hot water heating and solar hot water heating systems can reduce the amount of grid-provided electricity required to meet this load.
- D. Residential Energy Audits for home owners who have energy audits conducted on their homes from a Yukon Housing Corporation certified Energy Assessor.

Second Refrigerator Buy Back Program

This program is being conducted in partnership with the Yukon Energy Corporation and focuses on encouraging Yukon residents to safely dispose of any older second refrigerators they are currently using by offering a rebate, free pick-up and disposal of old refrigerators.

QuickStart Program

Quick Start Energy Saver Kits are a collection of easy-to-install energy saving products that improve energy efficiency and home comfort. Items in the kit include: foam gaskets for electrical outlets, low-flow shower heads and CFL light bulbs.

Energy Efficient Lighting Technology Demonstration/Evaluation

The Energy Solutions Centre is currently working with various local associations and businesses to pilot new lighting technologies and evaluate their performance in the Yukon.

Commercial / Institutional Building Energy Efficiency

StartPoint Energy Audit Service

The StartPoint Energy Audit service is delivered by Energy Solutions Centre staff who provide commercial and institutional building owners with a free desktop audit based on the building owners' heating bills and building information.

Commercial/Institutional Building Energy Plan Program (CIBEP)

CIBEP is an Energy Solutions Centre program where qualified contractors, hired by the Energy Solutions Centre, work with institutional and commercial building managers to conduct comprehensive (ASHREA level III) energy audits, and in consultation with building managers, develop building efficiency plans. Currently this program is focused on institutional buildings.

Public Building Energy Tracker (PBET)

PBET is a system developed by the Energy Solutions Centre in partnership with the Yukon government's Property Management Division (Department of Highways and Public Works) as a tool to track the energy use of all Yukon government buildings and assess the potential for energy efficiency improvements.

Community Energy Planning

The Energy Solutions Centre is working with the Yukon government's Community Services Department to assist Yukon communities in developing community energy plans that will lead to increased levels of energy efficiency within the communities.

Residential Building Thermal Efficiency

Residential Building Efficiency Incentive Program

The Energy Solutions Centre is currently in the process of working with the Yukon Housing Corporation to develop a comprehensive existing and new home incentive program which will be targeted at making homes more thermally efficient.

Low Interest Rate Loan

This Yukon Housing Corporation program provides homeowners with a loan of up to \$35,000 to repair their principal residence. Loans are amortized over 12 years at a reduced interest rate. A Yukon Housing Corporation technical officer provides the homeowner with a home assessment and a list of eligible repair/upgrade options.

Self-Help Course

The Yukon Housing Corporation Self-Help Course provides technical support to prospective home builders in the form of twelve, three hour class sessions and a Self-Help Manual. Topics include financing,

designing, operation of mechanical and electrical systems, construction management and costing and contracting. The course is co-sponsored by Yukon College.

Building Science Research

Yukon Housing Corporation supports research of advanced insulation technology and techniques, super-efficient building design development, and new heating technologies.

Industrial Sector Energy Efficiency

Best Practices for Energy Conservation in the Industrial Sector

The Department of Energy, Mines and Resources is developing best practices for the Yukon industrial sector that will focus on conserving energy.



Demand-Side Management Program Portfolio for the Yukon

FINAL REPORT

Date: April 17, 2013

Submitted to:
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1 Introduction

Yukon residents rely on electricity not only to live meaningful, healthy lives but also to support and strengthen the economy. Given the concerns over environmental implications including climate change, and the limited generating capacity in Yukon, there is growing interest not only in how electricity is generated, transmitted and distributed but also how efficiently it is used at the customer's end. In Yukon, as well as in a growing number of North American jurisdictions, how electricity is generated and used is being closely analyzed to find innovative ways of meeting individual and corporate energy service needs while minimizing pollution and the creation of greenhouse gases.

In response to the above conditions, the Yukon Energy Corporation (YEC), Yukon Electrical Company Limited (YECL) and the Yukon Government collaboratively commissioned a comprehensive study of the opportunities for electricity demand-side management (DSM) within the Yukon. That study, entitled *Conservation and Demand Management Potential for the Yukon 2011*, was completed in January 2012 and revealed a significant cost-effective potential for electricity demand-side management (DSM) in the Yukon.

Given the identification of a significant Yukon DSM potential, the current challenge is to design a suite of electricity DSM programs to best capture this potential.

1.1 Objectives & Scope

In response to the challenge noted above, the Yukon Energy Corporation (YEC) and Yukon Electrical Company Limited (YECL) engaged ICF Marbek to design and develop a suite of residential and commercial sector program offerings designed to enhance the Yukon's electricity DSM program portfolio and provide incremental annual electricity savings of at least 5 GWh/yr by Y5.

If the proposed electricity DSM program portfolio is approved by the Yukon Utilities Board, the next steps in this process will be the development of a program implementation plan, including definition of the program operational and transactional infrastructure, followed by program launch.

The scope of this current assignment extends to the preparation of a complete program design report suitable for submission to the Yukon Utilities Board.

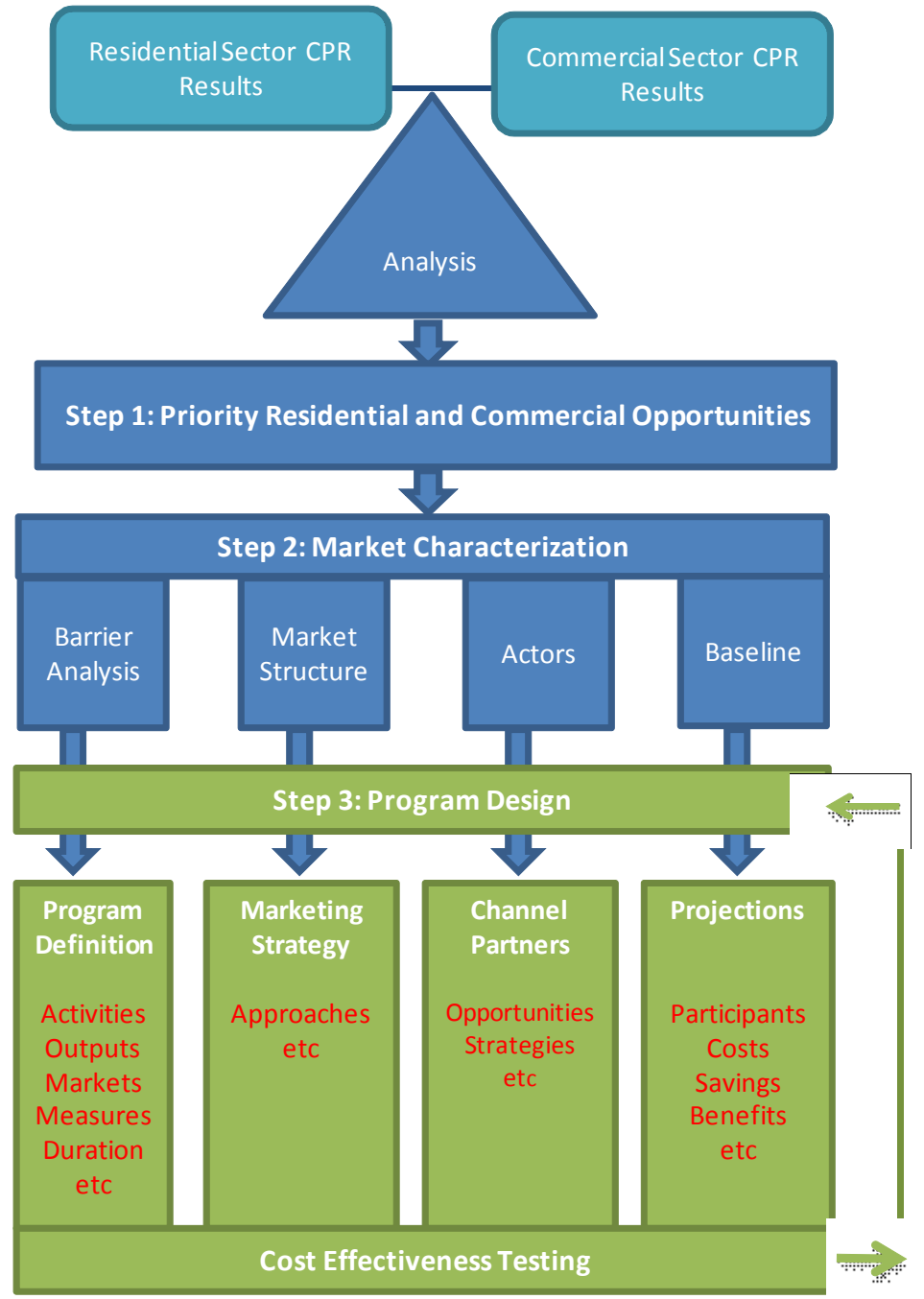
1.2 The Planning Process

The DSM program portfolio proposed in this report is the product of a multi-step process. Designed to gather and analyze the data necessary to determine optimum program structure and cost-effective design, the planning process was organized into 3 major steps:

- Identification of Priority Opportunities
- Market Characterization
- Program Design

Exhibit 1 provides a graphic representation of the steps involved in this program design process and its relationship to the Yukon CPR results.

Exhibit 1: Program Design Process



A brief description of the main steps shown in Exhibit 1 is provided below. More detailed information is provided in the appendices that accompany this report.

Step 1: Priority Opportunities

This first task in the planning process was to determine which of the several hundred technologies and measures analyzed in the Yukon CPR 2011 should provide the initial program focus.

As a starting point the extensive listing of individual measures and technologies contained in the CPR results were screened using a 7 step process, as outlined below in Exhibit 2.

Exhibit 2: Priority Opportunities Screening Process

Step 1: The Economic Potential and Achievable Potential results for the residential and commercial sectors were sorted on the basis of the following criteria:

- Measures providing the largest electricity savings potential by Y3 and by 2020
- Measures providing electricity savings at the lowest levelized cost
- Measures providing electricity savings with the shortest customer payback

Step 2: Based on the results of Step 1, individual measures were assigned priority, with highest priority assigned to those measures that provided the largest savings potential in the period at the lowest levelized cost of electricity under the total resource cost test (see 1.3.3 below).

Step 3: Priority measures from Step 2 were grouped into “opportunity areas” e.g., multiple individual commercial lighting measures were combined into a single aggregate “commercial lighting” opportunity. As applicable, complementary measures with smaller savings potential and/or higher levelized costs of electricity were added to the applicable opportunity area. The composition of the package of measures contained in the selected opportunity areas also considered factors such as: commonality of market delivery channels, information flows, typical purchase decision making processes etc.

Step 4: The qualitative notes from the CPR achievable potential workshops were reviewed to determine if participants had noted any compelling technology or market considerations, either positive or negative, that would potentially affect the priorities established in Step 3. Customer payback periods, as generated in Step 1, were also considered at this time. The assigned priority for each “opportunity area” was adjusted, as applicable.

Step 5: A brief scan of DSM program experience in other jurisdictions was conducted with the objective of identifying potential program delivery experience that would affect the priorities established in Step 3. The assigned priority for each “opportunity area” was adjusted, as applicable.

Step 6: The estimated upper and lower achievable potential electricity savings for the resulting combined residential and commercial sector opportunity areas was calculated, together with an approximate weighted average CCE for each opportunity area. The results were compared with the notional 5 GWh/year savings target.

Step 7: A select number of opportunity areas were recommended for this initial set of DSM programs.

A summary of the results of the above screening is presented in Exhibit 3. Additional information is provided in Appendix A.

Exhibit 3: Priority Opportunities

Residential

- Appliances and lighting, including CFL and LEDs
- Relatively low-cost, easy-to-install measures including: low flow showerheads and pipe insulation, programmable thermostats
- Technologies providing significant potential savings but requiring further performance proofing in Yukon conditions including: automotive heater timers, cold climate heat pumps
- New home construction

General Service (Commercial)

- Lighting including: LED, high performance T8, pulse start MH, high output T5, etc
- Building optimization – operations and HVAC
- Refrigeration and computer equipment

Step 2: Market Characterization

The priority opportunities identified in Step 1 were bundled into potential program elements and each was subjected to further detailed market research. The detailed market research provided the program design team with a comprehensive understanding of the key factors influencing market penetration of the electricity efficiency technologies and measures which, as outlined in further detail in later sections of this report, informed the design of the specific programs and activities.

The detailed market research employed a variety of data collection methods and involved a broad range of Yukon personnel involved in the supply, service, purchase and use of electricity efficiency technologies and measures. The research focused on developing clarity around four key areas, namely:

Market Barriers:

- Are there financial, informational, technical, etc., constraints that prohibit or restrict customer use of the electricity efficiency technologies and measures?

Market Structure:

- How do the electricity efficiency products and services get to the customer?
- What is the policy & regulatory context?
- Are there market drivers such building codes or certifications?

Actors:

- Who are the providers of the products, installation and services?
- Where are decisions made and who are the key decision makers?
- What are the key decision criteria?

Baseline Conditions:

- What is the current practice regarding sales of electricity efficiency models?
- What are the trends?

The market research results are summarized in Sections 3 and 4, which present a description of the proposed programs; additional detail on the research methodology is provided in Appendix C.

Step 3: Program Design

The knowledge gained from the above market research provided key design inputs into the programs presented in the following sections of this report. For example, as illustrated previously in Exhibit 1, the understanding of market barriers is critical to the selection of appropriate activities or program offerings; similarly, a thorough knowledge of the market structure and major actors within the supply chain provides insight into potential partners and marketing strategies that will be most effective.

Finally, the collection of data on baseline conditions provides important inputs to the cost effectiveness testing that is critical to the program design process, and to the eventual program evaluation requirements.

The mapping of market research findings to the proposed programs structure is represented by a series of logic models that are contained in Section 0 and 4.3 in the “Program Theory” section of each program element.

Cost Effectiveness Defined

Program design is developed with the constraint of ensuring that the electricity savings are achieved in a cost-effective manner and with minimum impact on ratepayers and electricity rates. As illustrated previously in Exhibit 1, program design and the determination of program cost effectiveness is an iterative process. Differing levels of program expenditures on incentives as well as program promotion and administration costs affect program participation rates and electricity savings. Increased program expenditures increase participation rates but typically at diminishing rates of cost effectiveness.

The cost effectiveness results that are presented in this report are consistent with industry best practice and are based on the methods outlined in the California Standard Practice Manual. The four standard tests used were originally developed by the California Public Utilities Commission (CPUC) and defined by the California Standard Practice Manual. The four tests used are presented in Exhibit 4. Together, these tests were used to screen opportunities, adjust incentive levels and to set program administration costs as well as related education, training and promotional activities.

Exhibit 4: Four Standard Cost-Effectiveness Tests Used in Energy Efficiency

Test	Acronym	Key Question Answered	Summary Approach
Participant Cost Test	PC	Will the participant benefit over the measure life?	Comparison of costs and benefits to the customer that installs the measure or implements the project
Program Administrator Cost Test	PAC	How much will the DSM program administrator pay for savings?	Comparison of program administrator costs to supply-side resource costs
Ratepayer Impact Measure	RIM	Will utility rates increase?	Comparison of administration costs and lost revenue to supply-side resource costs If the RIM test is "passed" then the rates will decrease as a result of the program/measure. ¹
Total Resource Cost Test	TRC	Will the total costs of electricity in the utility service territory decrease?	Comparison of program administration and customer costs to utility resource savings

Based on: US-EPA, *Understanding Cost-Effectiveness of Energy Efficiency Program: Best Practices, Technical Methods, and Emerging Issues for Policy-Makers*, USA, 2008, available at <http://www.epa.gov/cleanenergy/documents/suca/cost-effectiveness.pdf>.

The RIM and the PAC tests noted above in Exhibit 4 were computed from the perspective of the utilities, regardless of the cash flows between YEC and YECL. Some key assumptions employed are provided below.

- The lost revenue was computed based on the rate paid by end users: residential consumers, non-government, and government.
- The avoided cost of supply that was used is 21 cents/kWh. This value is based on a portfolio cost approach that averages the near term supply options including two hydro enhancements (Marsh Lake and Gladstone), liquefied natural gas, biomass, and wind as described in YEC's 20-year resource plan. The transmission and distribution (T&D) losses were assumed to be 8.3%.
- When calculated separately, the RIM test shows a net benefit to YEC and a net loss to YECL. However, the benefit-cost ratios throughout the portfolio assume utility cooperation and therefore display the RIM test as a blended value.

1.3 Report Presentation

The remainder of this report is organized and presented in the following sections:

- Section 2 introduces the programs proposed for the Utilities' initial electricity efficiency portfolio
- Section 3 presents the proposed General Service Program
- Section 4 presents the proposed Residential Program
- Section 5 provides a Summary of the key conclusions and recommendations

¹ This statement assumes that rates would be adjusted based on econometric and financial analyses of the program impacts.

2 Portfolio Summary

This section introduces the programs that are recommended for the Utilities' initial electricity efficiency portfolio, and describes the design philosophy that was used to select them.

Consistent with best practice program design principles, two broad solutions-based programs are presented, each with multiple program elements: General Service Program and Residential Program. The objective is to offer customers a broad suite of options to meet their electricity management needs, rather than forcing customers to sort through a variety of individual programs. Grouping program elements under these solutions-based umbrellas also enables the Utilities to design sector-based branding, marketing and awareness building initiatives that encourage customers to take action to manage their energy service needs rather than trying to promote participation in a variety of individual programs.

Several specific design guidelines were applied to the programs presented. They are:

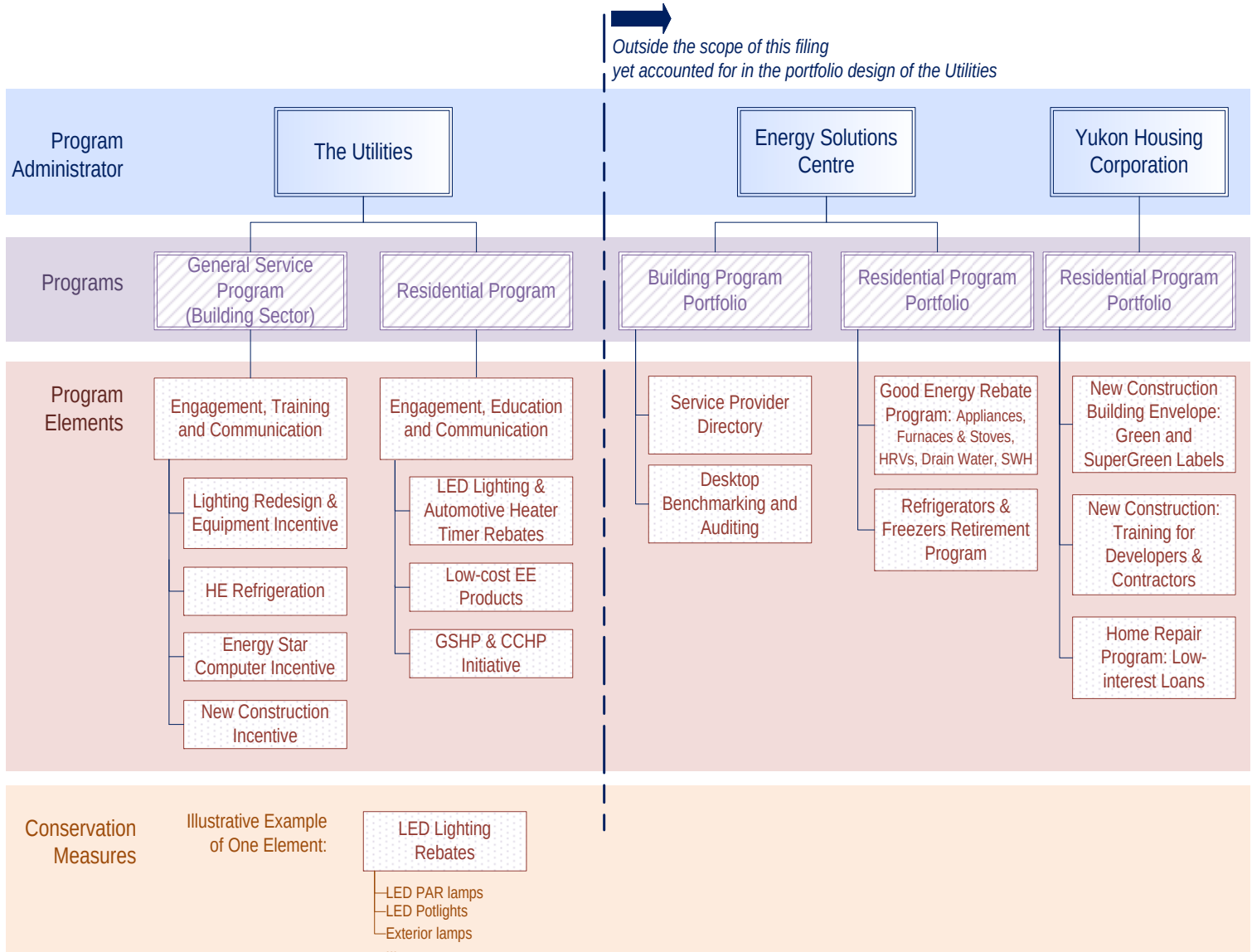
- Minimize the number of program offerings to reduce the costs of program administration and the market confusion that can arise from too many program requirements.
- Minimize program design complexity in the interest of speeding up time-to-market, reducing administrative costs, and encouraging participation.
- Retain design flexibility to enable program implementers to adjust specific designs as dictated by customer response and evaluation results.
- Balance the need to quickly acquire significant electricity savings with the need to lay a foundation for continued program scale-up and foster a transformation in customer electricity management.
- Ensure that the program offerings complement existing Yukon energy initiatives and minimize duplication or potential customer confusion. To this end, there has been extensive collaboration with local entities such as the Energy Solutions Centre, Yukon Housing, City of Whitehorse and others.

This portfolio should be viewed as the starting point for the Utilities. It is anticipated that timely adjustments will be made in response to feedback from customers and trade allies, and based on the performance of individual programs.

2.1 Portfolio Structure

Exhibit 5 presents the proposed overall portfolio of the Utilities' electricity programs. It also shows the current complementary energy programs offered by the Energy Solutions Centre and Yukon Housing.

Exhibit 5: Portfolio Structure



The portfolio shown in Exhibit 5 is built around two broad programs – the General Service Program and the Residential Program; each program contains several program elements designed to provide a range of electricity efficiency options for commercial and residential customers. As noted previously, the selection of specific program elements carefully considered existing Yukon initiatives, which are energy-focused as opposed to electricity-focused.

2.2 Overview of Portfolio Benefit/Cost Results

Exhibit 6 and Exhibit 7 present an overview of the portfolio Benefit/Cost results. The results are presented for the five year period Year 1 to Year 5, inclusive, by individual program element as well as for the portfolio as a whole. The results are also organized within two scenarios:

- **Without Government Buildings:** This assumes that government owned buildings are not eligible to participate in the programs. Government buildings include buildings from all levels of government: federal, territorial, first nation, and municipal.
- **With Government Buildings²:** This assumes that all Yukon buildings are eligible to participate in the programs.

In each case, the results presented include:

- **Net Savings - Lifetime MWh:** These are the lifetime electricity savings attributed to (only) the measures implemented in the year shown and are inclusive of T&D losses.
- **Net Savings - Annual MWh:** These are the electricity savings that would occur in the milestone year shown due to the impacts of the measures implemented to date under the program. They are inclusive of T&D losses.
- **Utility Expenditure:** These show the associated incentive and non-incentive program costs that would be incurred in each milestone year.
- **Benefit/Cost Ratios:** These are the results of the benefit-cost tests described previously in Exhibit 4. Values greater than 1 indicate net positive benefits.

Benefit/Cost Highlights

As illustrated in Exhibit 6³ and Exhibit 7:

- All of the proposed programs provide positive net benefits to the Yukon, to the electric utilities and to program participants.
- Benefit/Cost results are not calculated for program elements that are promotional or educational in nature; however, their associated costs are captured and distributed among those program elements that do create electricity savings.
- The selected occurrences where the RIM results are less than 1 indicates that rates may be affected negatively (i.e., they may increase in the short term as a result of the program expenses).
- Results are moderately more positive under the scenario that includes government participation.

More detailed descriptions of the programs and program elements shown in Exhibits 6 and 7 are presented in the following Section 3 (General Service) and Section 4 (Residential). Additional details are also provided in Appendix C (Budget) and Appendix D (Incentive).

² For example, the DSM plan could include a caveat that some level(s) of government will not participate in DSM programs that are funded from rate-base.

³ Program-level evaluation, measurement and verification costs are included in the utility expenditures presented in Exhibit 6 and Exhibit 7.

Savings Highlights

As illustrated in Exhibit 6 and Exhibit 7:

- Over the course of the 5-year program period and under the scenario that includes government buildings, the General Service Program and the Residential Program will generate 98.9 GWh of measure-lifetime net savings, 9.3 GWh of annual net savings, and 2.3 MW of coincident peak savings.
- Under the with-government scenario, the General Service Program will generate 67% of the measure-lifetime net savings and the Residential Program will generate 33% of the net savings.
- Under the scenario that excludes government buildings, the programs will generate 75.1 GWh of measure-lifetime net savings, 7.1 GWh of annual net savings, and 1.8 MW of coincident peak savings.
- Under the without-government scenario, the General Service Program will generate 56% of the measure-lifetime net savings and the Residential Program will generate 44% of the net savings.

In Exhibit 6 and Exhibit 7, “Net Savings – Lifetime MWh” are lifetime electricity savings attributed to (only) the measures implemented in the year shown and are inclusive of transmission and distribution losses; “Net Savings – Annual MWh” are the electricity savings that would occur in the milestone year shown due to the impacts of the measures implemented to date under the program and are inclusive of transmission and distribution losses. An asterisk is included in the ENERGY STAR computer element because there is no incremental cost to the participant to purchase an ENERGY STAR computer.

Exhibit 6: Portfolio Results Excluding Government Buildings

Program Elements	Net Savings with T&D Losses							Utility Expenditure (\$1,000s)							Benefit/Cost Ratios for the 5-Year Period			
	Year 1	Year 2	Year 3	Year 4	Year 5	Total		Year 1	Year 2	Year 3	Year 4	Year 5	Total	TRC	PAC	PC	RIM	
Lighting Redesign and Equipm't Incentive - excluding gov. buildings	Lifetime MWh:	0	2,476	6,240	7,132	7,132	22,981	Incentive:	\$4	\$96	\$213	\$239	\$222	\$773	1.1	2.8	2.5	0.9
	Annual MWh:	0	333	1,140	2,062	2,985	N/A	Non-Incen.:	\$77	\$78	\$81	\$85	\$111	\$432				
	Coincident kW:	0	79	269	486	703	N/A	Total:	\$81	\$175	\$294	\$323	\$333	\$1,205				
New Construction Incentive - excluding gov. buildings	Lifetime MWh:	0	306	1,377	2,142	2,448	6,273	Incentive:	\$0	\$4	\$19	\$30	\$34	\$87	4.2	4.9	6.3	1.0
	Annual MWh:	0	15	84	191	314	N/A	Non-Incen.:	\$4	\$31	\$5	\$31	\$12	\$82				
	Coincident kW:	0	3	19	44	72	N/A	Total:	\$4	\$35	\$24	\$60	\$46	\$169				
High-Efficiency Refrigeration Incentive - excluding gov. buildings	Lifetime MWh:	0	0	6,301	0	6,301	12,602	Incentive:	\$0	\$0	\$122	\$0	\$122	\$243	3.2	4.5	4.2	1.0
	Annual MWh:	0	0	630	630	1,260	N/A	Non-Incen.:	\$10	\$91	\$17	\$54	\$42	\$214				
	Coincident kW:	0	0	72	72	143	N/A	Total:	\$10	\$91	\$138	\$54	\$163	\$458				
Energy Star Computer - excluding gov. buildings	Lifetime MWh:	32	205	335	0	0	573	Incentive:	\$2	\$10	\$17	\$0	\$0	\$29	1.8	1.2	*	0.6
	Annual MWh:	8	59	143	143	135	N/A	Non-Incen.:	\$26	\$12	\$15	\$2	\$5	\$60				
	Coincident kW:	1	11	26	26	24	N/A	Total:	\$28	\$22	\$32	\$2	\$5	\$89				
Engagement, Education and Communication - excluding gov. buildings	Lifetime MWh:	N/A	N/A	N/A	N/A	N/A	N/A	Incentive:	\$0	\$0	\$0	\$0	\$0	\$0	N/A	N/A	N/A	N/A
	Annual MWh:	N/A	N/A	N/A	N/A	N/A	N/A	Non-Incen.:	\$167	\$251	\$224	\$175	\$217	\$1,034				
	Coincident kW:	N/A	N/A	N/A	N/A	N/A	N/A	Total:	\$167	\$251	\$224	\$175	\$217	\$1,034				
Total General Service Program excl. gov. buildings	Lifetime MWh:	32	2,988	14,253	9,274	15,881	42,428	Incentive:	\$5	\$111	\$371	\$268	\$377	\$1,132	1.3	2.1	3.2	0.8
	Annual MWh:	8	408	1,997	3,027	4,693	N/A	Non-Incen.:	\$284	\$463	\$341	\$346	\$387	\$1,822				
	Coincident kW:	1	93	385	627	942	N/A	Total:	\$290	\$574	\$712	\$615	\$764	\$2,954				
LED Lighting and Automotive Heater Timer Rebates	Lifetime MWh:	718	3,149	3,207	3,207	3,207	13,487	Incentive:	\$12	\$51	\$52	\$52	\$52	\$217	1.9	3.0	2.5	1.0
	Annual MWh:	36	199	368	537	705	N/A	Non-Incen:	\$82	\$84	\$55	\$59	\$107	\$387				
	Coincident kW:	13	71	131	191	252	N/A	Total:	\$94	\$135	\$106	\$111	\$159	\$604				
Low-cost Energy Efficient Products	Lifetime MWh:	1,849	3,969	3,672	3,540	3,342	16,371	Incentive:	\$34	\$48	\$43	\$36	\$30	\$192	1.8	2.7	2.8	1.0
	Annual MWh:	169	543	896	1,236	1,558	N/A	Non-Incen:	\$165	\$179	\$145	\$153	\$169	\$811				
	Coincident kW:	60	194	319	441	556	N/A	Total:	\$199	\$227	\$188	\$189	\$199	\$1,003				
New-construction CCHP and GSHP Initiative	Lifetime MWh:	148	188	188	1,223	1,075	2,821	Incentive:	\$5	\$9	\$9	\$24	\$19	\$65	0.9	1.7	1.2	0.8
	Annual MWh:	7	17	26	87	141	N/A	Non-Incen:	\$18	\$34	\$28	\$39	\$24	\$144				
	Coincident kW:	3	6	9	31	50	N/A	Total:	\$23	\$43	\$37	\$63	\$43	\$209				
Engagement, Education and Communication	Lifetime MWh:	N/A	N/A	N/A	N/A	N/A	N/A	Incentive:	\$0	\$0	\$0	\$0	\$0	\$0	N/A	N/A	N/A	N/A
	Annual MWh:	N/A	N/A	N/A	N/A	N/A	N/A	Non-Incen:	\$113	\$130	\$134	\$138	\$142	\$657				
	Coincident kW:	N/A	N/A	N/A	N/A	N/A	N/A	Total:	\$113	\$130	\$134	\$138	\$142	\$657				
Total for the Residential Program	Lifetime MWh:	2,715	7,306	7,066	7,969	7,623	32,679	Incentive:	\$51	\$108	\$104	\$112	\$100	\$474	1.4	2.0	2.4	0.9
	Annual MWh:	213	759	1,289	1,860	2,405	N/A	Non-Incen:	\$379	\$427	\$361	\$389	\$443	\$1,999				
	Coincident kW:	76	271	460	664	858	N/A	Total:	\$429	\$535	\$465	\$501	\$543	\$2,473				
Grand Total All Programs Portfolio	Lifetime MWh:	2,747	10,294	21,319	17,243	23,504	75,108	Incentive:	\$56	\$219	\$474	\$380	\$477	\$1,606	1.3	2.1	2.9	0.8
	Annual MWh:	221	1,167	3,287	4,887	7,098	N/A	Non-Incen.:	\$706	\$824	\$670	\$703	\$815	\$3,718				
	Coincident kW:	77	363	845	1,290	1,800	N/A	Total:	\$762	\$1,043	\$1,145	\$1,083	\$1,292	\$5,325				

Exhibit 7: Portfolio Results Including Government Buildings

Program Elements	Net Savings with T&D Losses						Utility Expenditure (\$1,000s)						Benefit/Cost Ratios for the 5-Year Period					
	Year 1	Year 2	Year 3	Year 4	Year 5	Total	Year 1	Year 2	Year 3	Year 4	Year 5	Total	TRC	PAC	PC	RIM		
Lighting Redesign and Equipm't Incentive - including gov. buildings	Lifetime MWh:	0	4,314	10,711	12,241	12,241	39,506	Incentive:	\$6	\$135	\$294	\$327	\$299	\$1,062	1.2	3.8	2.4	0.9
	Annual MWh:	0	507	1,731	3,128	4,526	N/A	Non-Incen.:	\$81	\$77	\$66	\$72	\$127	\$425				
	Coincident kW:	0	127	432	781	1,129	N/A	Total:	\$88	\$213	\$360	\$400	\$427	\$1,487				
New Construction Incentive - including gov. buildings	Lifetime MWh:	0	471	2,118	3,295	3,766	9,651	Incentive:	\$0	\$6	\$25	\$39	\$45	\$115	4.7	6.1	6.7	1.0
	Annual MWh:	0	24	129	294	483	N/A	Non-Incen.:	\$28	\$9	\$6	\$33	\$16	\$93				
	Coincident kW:	0	5	30	67	110	N/A	Total:	\$28	\$15	\$32	\$72	\$61	\$208				
High-Efficiency Refrigeration Incentive - including gov. buildings	Lifetime MWh:	0	0	7,580	0	7,580	15,161	Incentive:	\$0	\$0	\$132	\$0	\$132	\$263	3.2	4.3	4.6	1.0
	Annual MWh:	0	0	694	694	1,388	N/A	Non-Incen.:	\$36	\$100	\$19	\$86	\$49	\$290				
	Coincident kW:	0	0	80	80	161	N/A	Total:	\$36	\$100	\$151	\$86	\$180	\$553				
Energy Star Computer - including gov. buildings	Lifetime MWh:	107	681	1,111	0	0	1,899	Incentive:	\$6	\$35	\$57	\$0	\$0	\$98	2.0	1.3	*	0.6
	Annual MWh:	27	197	475	475	448	N/A	Non-Incen.:	\$36	\$52	\$74	\$6	\$17	\$185				
	Coincident kW:	5	35	85	85	80	N/A	Total:	\$41	\$88	\$131	\$6	\$17	\$284				
Engagement, Education and Communication - including gov. buildings	Lifetime MWh:	N/A	N/A	N/A	N/A	N/A	N/A	Incentive:	\$0	\$0	\$0	\$0	\$0	\$0	N/A	N/A	N/A	N/A
	Annual MWh:	N/A	N/A	N/A	N/A	N/A	N/A	Non-Incen.:	\$202	\$290	\$255	\$200	\$252	\$1,199				
	Coincident kW:	N/A	N/A	N/A	N/A	N/A	N/A	Total:	\$202	\$290	\$255	\$200	\$252	\$1,199				
Total General Service Program incl. gov. buildings	Lifetime MWh:	107	5,466	21,520	15,536	23,587	66,217	Incentive:	\$12	\$176	\$508	\$367	\$476	\$1,538	1.3	2.5	3.2	0.8
	Annual MWh:	27	728	3,029	4,591	6,845	N/A	Non-Incen.:	\$383	\$529	\$420	\$398	\$461	\$2,192				
	Coincident kW:	5	167	627	1,013	1,480	N/A	Total:	\$395	\$705	\$928	\$765	\$937	\$3,730				
LED Lighting and Automotive Heater Timer Rebates	Lifetime MWh:	718	3,149	3,207	3,207	3,207	13,487	Incentive:	\$12	\$51	\$52	\$52	\$52	\$217	1.9	3.0	2.5	1.0
	Annual MWh:	36	199	368	537	705	N/A	Non-Incen:	\$82	\$84	\$55	\$59	\$107	\$387				
	Coincident kW:	13	71	131	191	252	N/A	Total:	\$94	\$135	\$106	\$111	\$159	\$604				
Low-cost Energy Efficient Products	Lifetime MWh:	1,849	3,969	3,672	3,540	3,342	16,371	Incentive:	\$34	\$48	\$43	\$36	\$30	\$192	1.8	2.7	2.8	1.0
	Annual MWh:	169	543	896	1,236	1,558	N/A	Non-Incen:	\$165	\$179	\$145	\$153	\$169	\$811				
	Coincident kW:	60	194	319	441	556	N/A	Total:	\$199	\$227	\$188	\$189	\$199	\$1,003				
New-construction CCHP and GSHP Initiative	Lifetime MWh:	148	188	188	1,223	1,075	2,821	Incentive:	\$5	\$9	\$9	\$24	\$19	\$65	0.9	1.7	1.2	0.8
	Annual MWh:	7	17	26	87	141	N/A	Non-Incen:	\$18	\$34	\$28	\$39	\$24	\$144				
	Coincident kW:	3	6	9	31	50	N/A	Total:	\$23	\$43	\$37	\$63	\$43	\$209				
Engagement, Education and Communication	Lifetime MWh:	N/A	N/A	N/A	N/A	N/A	N/A	Incentive:	\$0	\$0	\$0	\$0	\$0	\$0	N/A	N/A	N/A	N/A
	Annual MWh:	N/A	N/A	N/A	N/A	N/A	N/A	Non-Incen:	\$113	\$130	\$134	\$138	\$142	\$657				
	Coincident kW:	N/A	N/A	N/A	N/A	N/A	N/A	Total:	\$113	\$130	\$134	\$138	\$142	\$657				
Total for the Residential Program	Lifetime MWh:	2,715	7,306	7,066	7,969	7,623	32,679	Incentive:	\$51	\$108	\$104	\$112	\$100	\$474	1.4	2.0	2.4	0.9
	Annual MWh:	213	759	1,289	1,860	2,405	N/A	Non-Incen:	\$379	\$427	\$361	\$389	\$443	\$1,999				
	Coincident kW:	76	271	460	664	858	N/A	Total:	\$429	\$535	\$465	\$501	\$543	\$2,473				
Grand Total All Programs Portfolio	Lifetime MWh:	2,822	12,772	28,586	23,505	31,210	98,896	Incentive:	\$63	\$284	\$612	\$478	\$576	\$2,012	1.4	2.3	2.9	0.8
	Annual MWh:	240	1,487	4,318	6,451	9,250	N/A	Non-Incen.:	\$762	\$957	\$782	\$787	\$904	\$4,191				
	Coincident kW:	81	438	1,087	1,677	2,338	N/A	Total:	\$824	\$1,240	\$1,393	\$1,266	\$1,480	\$6,203				

3 Proposed General Service Program

This section presents a description of the proposed General Service Program (GSP)⁴ as well as a detailed description of each of the proposed program elements. The proposed program offerings set out in this section have been developed based on the results of market information collected during the research phase of this program design study.

The remainder of this section is organized and presented as follows:

- Market Research Results
- Program Overview
- Description of Program Elements

The Utilities made the working assumption that all general-service ratepayers would be eligible to participate in the General Service Program.

3.1 Market Research Results

This section presents a summary of the information gathered during the market characterization phase of this study. The market characterization was primarily focused on lighting systems and HVAC systems: lighting systems are by far the most electricity-intensive end use in existing buildings in the Yukon. HVAC systems are the second most electricity-intensive end use in existing building and first in new construction.

Further detail on the research methodology employed is presented in Appendix C. The main research findings, which form the basis for the proposed program design, are presented below.

Lighting Distribution Chain

The main findings with regard to the current Yukon lighting distribution chain are:

- There are no manufacturer representatives or agents in the Yukon. Distributors do business with representatives or agents in BC and Alberta, or even in the US, in the case of OSRAM/Sylvania. However, there seem to be no ordering or shipping difficulties, and no limitations regarding the types of items that can be procured.
- There are only two electrical distributors in the Yukon: EECOL and Guillevin. However, these distributors are key market actors. Electrical contractors buy primarily from local vendors rather than from vendors located outside of the Yukon, who are primarily distributors, although there are some purchases from retailers. Electrical distributors sell a variety of electrical equipment, of which lighting equipment is a large portion.
- Electrical distributors often maintain relationships with a variety of market actors situated both upstream and downstream in the supply chain, including lighting designers, building owners, electrical contractors and manufacturer agents and representatives.
- Electrical distributors are keen to participate in programs and are easier to engage than electrical contractors because new incremental projects mean increased sales.
- Yukon-based electrical distributors are slightly less prone than distributors in the South to offer “value added” services such as creating the lighting layout and equipment specifications, perhaps because of staffing limitations and market size. It could be assumed

⁴ General Service Program and GSP are, respectively, a preliminary name and acronym.

that if the electricity efficiency market started to grow, distributors could agree to offer these services in order to increase their market share.

- There are a few independent lighting distributors selling to the Yukon residential and building sectors.
- Electrical contractors are typically the last step in the building lighting supply chain before the end user. Their role is to be “the installers”. Depending on the type of project, electrical contractors may have a contractual relationship with a general contractor, or directly with the building owner.
- Electrical contractors active in the territory are smaller regional firms with a handful of employees. They are a hard-to-reach group of people as they are very busy and are on the road much of the time. Electrical contractors typically have a business model that promotes quick project turnaround with an emphasis on short lead times and few callbacks. This tends to discourage design changes and, in some instances, creates a barrier to the uptake of electricity-efficient lighting.
- According to electrical distributors and contractors, 50% of the equipment is sold for new construction projects and 50% is sold for retrofit projects. Approximately 60% of the equipment is sold to the commercial sector and 40% to the government sector.
- Most of the lighting designer business (80%) is for new construction projects. Much less business is with retrofit project (20%). Lighting designers sell services mostly to the government (60%) and to the commercial sector (40%). In the commercial sector, they primarily sell services for offices lighting designs.
- A significant share of the retrofit projects is done without a formal designer, particularly in the non-governmental sector. Electrical contractors in the Yukon frequently create simple designs for customers during retrofit projects. However, electrical contractors are not as involved in the design of new buildings unless it is a design-build situation.
- An important share of retail lighting equipment sales is to commercial end-users (approximately 55%). This is an important finding. It could indicate that retailers are an important channel serving the commercial and governmental buildings sectors, more so than in other jurisdictions.

The drivers and motivations of the supply-chain actors are:

- Electrical distributors seek higher profit margin. Energy efficiency is a tool to gain market share. Energy efficiency is consistent with their business model. Their stocking practices are strictly dictated by headquarters and based on customer feedback. The main motivation of the sales people is monetary recognition such as commissions or bonuses.
- Lighting designers seek a feeling of achievement or a sensation of a job well done.
- Electrical contractors react to clients requests. Providing the best customer service is their main driver. Providing information on newer products to their customers is not a priority.

HVAC Distribution Chain

The main findings with regard to the current Yukon HVAC distribution chain are:

- Manufacturers are multinational corporations headquartered outside of the Yukon – and outside Canada most of the time. For the purposes of this study, we divided these into three categories: control hardware, control software and equipment.
- For the most part, there is no distributor in the distribution chain. Control and HVAC contractors are dealers for specific manufacturers.
- The control system of a building significantly influences with whom the building owner/manager will do business. Once a specific system is selected, it is difficult to change to another system, and it is difficult maintain more than one system in the same building or even in many buildings. In theory, systems should be capable of working together, but in practice, this is often challenging. For this reason, customer loyalty is high.

- There are a large number of equipment manufacturers: Rheem, Cleaver-Brooks, Viessmann, Bryant, York, Carrier, Mitsubishi, Lennox, and many others. There are fewer control system manufacturers: Honeywell, Siemens, Johnson Controls, Delta Controls and few others share the market.
- There are only a few large manufacturers of control hardware and software. They are often horizontally and vertically integrated: they offer equipment, installation services and design directly to the end-users. They often sell HVAC equipment as well. Examples of large manufacturers of this sort are Siemens and Honeywell. Other examples of major providers in North America with little to no presence in the Yukon are: Trane, and Delta Controls.
- The two control contractors in the Yukon consist of a Honeywell dealer and a Siemens dealer.
- Approximately 50 to 60% of the control contractor business is in government buildings and 40% to 50% is in commercial buildings. Results are similar for HVAC and control designers: 50 to 60% in the government sector; and, 40% to 50% in the commercial sector.
- Among commercial buildings, approximately 60% of the control contractors' business is in office space and, the remainder is in warehouse and wholesale facilities. Results are similar for HVAC and control designers: 50 to 60% in office space, and 10 to 15% in non-food retail.
- For control contractors, 60% of the business is new construction projects and 40% is retrofit projects. Results are similar for HVAC and control designers: approximately 55% in new construction office space, and 45% in retrofit projects.

Building Owners/Managers Investment Barriers and Drivers

The following observations helped the program designers understand the building owners/managers' investment decision making process:

- All supply-chain actors cited initial cost as the main purchase decision criteria for end-users. Supply-chain actors and end-users unanimously reported higher initial cost of as the most important barrier to the purchase of electricity-efficient equipment.
- Building owners/managers will not do a retrofit project to gain electricity savings. They will do a project to gain more comfort. If the technology can be obtained in the Yukon within a reasonable timeframe, then they will be interested in buying equipment that can generate monetary savings. The higher cost of electricity-efficient equipment will still be an issue, but they could be willing to proceed regardless.
- Environmental considerations seem to be a relatively minor driver.
- Building owners/managers focus on the initial cost of capital investment. They rejected other potential drivers such as increasing the value of their property, or increasing tenant retention and satisfaction. They will fix equipment if it breaks, and perhaps then they could agree to go with an electricity efficiency option rather than the standard. HVAC/Control contractors in the Yukon take part in the design of projects.
- Contractors have more influence in retrofit projects than in new construction. As one of the contractors eloquently said: *It's a close-knit community so contractors can get involved with engineers – better jobs get done that way.*

Current Institutional, Regulatory and Programmatic Framework

The key findings regarding the current stakeholders and market framework were:

- It appears that Yukoners in the building retrofit sector are open to the idea that YEC, YECL or both could deliver electricity conservation programs. There is no clear preference between YEC and YECL. YEC and YECL credibility is about the same as that of Energy Solutions Centre. There would be a significant level of trust in YEC and YECL and this trust would be greater than for equipment suppliers.

- No organization, program or piece of regulation other than the City of Whitehorse's Building and Plumbing Bylaw has had any form of influence, positively or negatively, on the electricity efficiency of the building sector in the past five years.
- Currently, the Energy Solutions Centre (ESC), responsible for electricity efficiency on the behalf of the Yukon Government, has had very little activity specifically targeting the building sector other than maintaining a list of service providers. However the ESC can help to provide guidance if requested and has recently starting a benchmarking and auditing program for commercial and institutional buildings.
- There are no trade organizations to gather people from the building industry as there are in the South. ASHRAE does not have a chapter in the Yukon, nor do the IES, the AEE, BOMA, etc. The Association of Professional Engineers of the Yukon does not actively promote energy efficiency.

Existing and Prospective Information Dissemination Mechanisms

The key findings regarding existing and prospective information dissemination mechanisms were:

- Information needed to install electricity-efficient equipment and systems generally comes from the manufacturers of the equipment, either through printed or website documentation, or the salespeople of the manufacturers. Information flows through the chain: manufacturers to distributors, distributors to contractors and then contractors to building owners/managers. Designers are another key intermediary for information and education to the customers.
- The fact that there are no manufacturer representatives or agents in the Yukon limits the interaction and the dissemination of information on innovation.
- In the building lighting channel, it was found that manufacturers and distributors do not attempt to reach out directly to building owners/managers as much as typically occurs in other jurisdictions. Electrical contractors are reluctant to spend as much time educating their customers about innovative equipment as is typical in other jurisdictions.
- There is a general distrust in suppliers among building owners/managers. Owners/managers would have a higher level of trust in a third party such as the Utilities.
- All supply-chain actors generally agree that they have all the information they need if they want it; they obtain it either through the manufacturer websites or through the widely available engineering handbooks. This information is applicable and they agreed that no "adaptation" of the information to the Yukon context is required. However, Yukon supply-chain actors do need to know about successful installations of specific technologies. News about good or bad installations is disseminated quickly and is remembered for a long time.
- Generally speaking, market actors preferred the direct engagement approach to providing information to them. If short in-person information sessions were to be held, they showed no preference for morning, lunch time or after hours. All three options would probably work. They agreed that if full-day training were offered, it would probably be successful given the limited offering of continuous education. They generally liked the idea of trade events and ranked it second after direct engagement as a mean to convey information to them.

Barrier Analysis

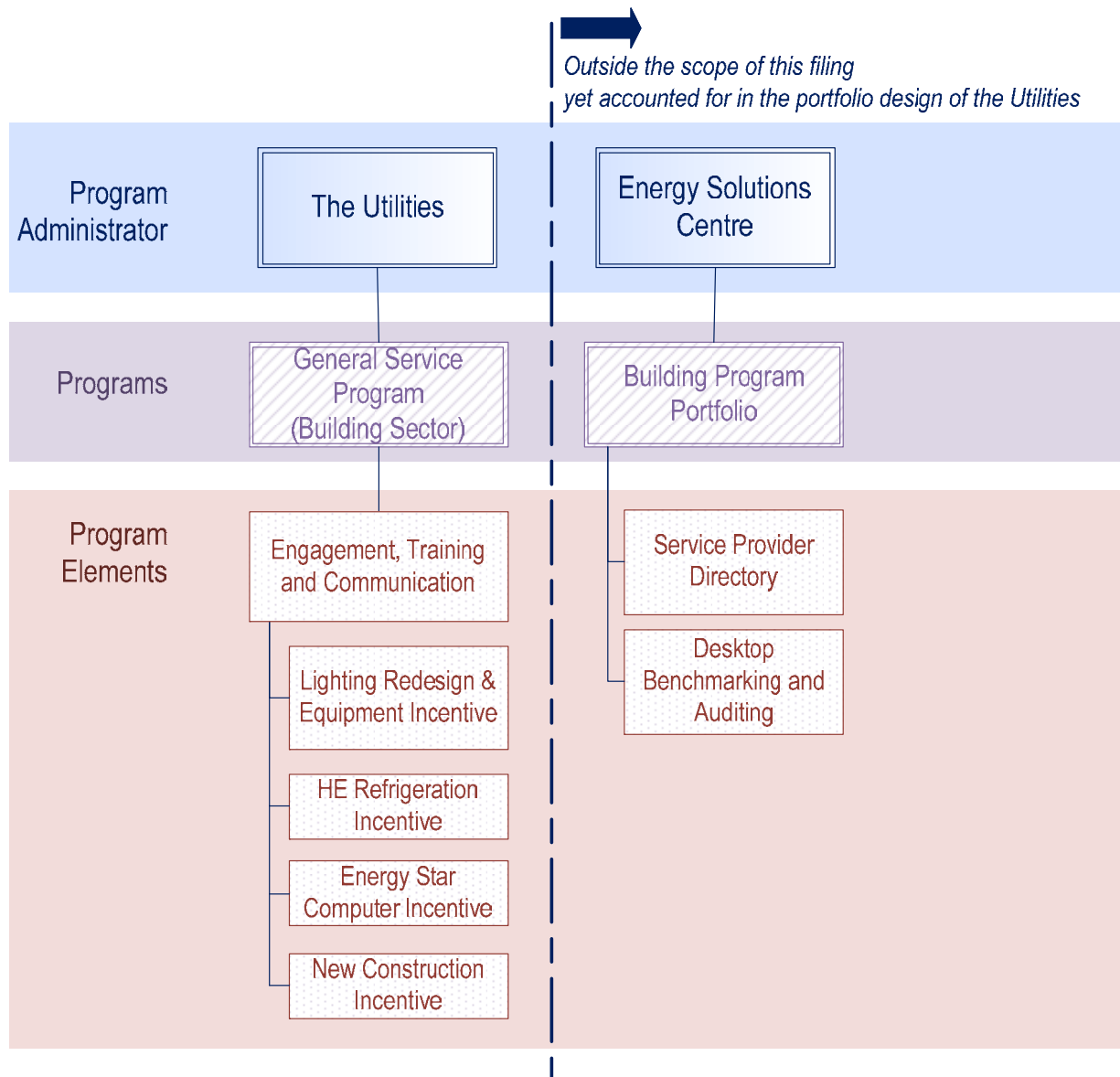
Barriers which emerged as themes during the market research activities include, in priority order:

- Prohibitive cost of electricity efficiency equipment both in retrofit and new construction
- Split-incentive barriers inside governmental or municipal organizations
- Clogged information channel between manufacturers in and end-users in the Yukon
- Limited offerings in energy engineering
- Reactive building maintenance rather than preventive building maintenance.

3.2 General Service Program: An Overview

The General Service Program and its components are presented in a schematic format on the left hand side of Exhibit 8. Other energy conservation building programs offered in the Yukon are presented on the right hand side of the exhibit. As shown in this exhibit, the General Service Program avoids overlaps and exploits potential for synergy.

Exhibit 8: Portfolio View of the Utilities', and Energy Solutions Centre Building Programs



The General Service Program will integrate resource acquisition and market transformation offerings and activities aimed at building owner/managers, and at building industry actors. Through this program, the Utilities will increase the demand and the supply of electricity efficiency systems, with a focus on lighting systems in existing buildings, and both lighting and HVAC systems in new construction.

The General Service Program consists of four distinct program elements, as presented below:

Lighting Redesign and Equipment Incentive: The Utilities will pay an incentive to building owners/managers to have their lighting systems retrofitted. The total incentive will be the sum of three layers:

- Lighting redesign incentive
- Custom lighting incentive
- Prescriptive LED lighting incentive

The Utilities will pay an incentive to building owners/managers to have a lighting redesign conducted in their building. The purpose of the lighting redesign will be to design the optimal lighting system in term of visual comfort, ease of maintenance, and electricity savings considering the existing spaces, windows and fixtures. The incentive for the redesign work will be determined using a dollar-per-square foot rate. The lighting designers will be required to develop designs that meet minimum power density thresholds.

The custom lighting incentive includes a base incentive for the equipment and installation determined using a dollar per kilowatt-hour of annual savings rate. This approach provides flexibility in choice of lighting technologies and also allows contractors and designers to be innovative.

For the prescriptive LED incentive layer, the Utilities will add a flat amount of money per unit for LED products selected from a prescriptive list of eligible products.

Building owners/managers will be able to combine the custom incentive layer, the LED prescriptive incentive layer, and the lighting redesign incentive layer to best suit their needs and to generate a larger incentive for LED technologies: the initial-cost hurdle is higher for the LED technologies and the Utilities have a goal of accelerating market penetration of these products. The prescriptive list of eligible LED products will be consistent with that used in the Residential Program.

High Efficiency Refrigeration Incentive: The Utilities will pay an incentive to building owners/managers who retrofit their refrigeration systems. This will be a custom incentive for equipment and installation, i.e. it will be determined using a dollar per kilowatt-hour rate for each kilowatt-hour of savings realized annually as compared with the pre-retrofit consumption and demand level. In addition to the incentive, the Utilities will provide extensive refrigeration-specific technical assistance to identify the opportunities, to develop the projects, to manage the construction works, and to measure and monitor the performance of the projects. It is expected that this program element will aim at hockey and curling arenas and grocery stores in particular.

ENERGY STAR Computers Incentive: The Utilities will pay an incentive to participating Yukon-based companies or organizations that purchase computers and computer equipment that meet ENERGY STAR requirements. The incentive will be prescriptive i.e., it will be determined using a fixed amount per piece of equipment installed. The rebate will be offered year-round. However, it will be advertised and offered for a limited period of time i.e., until the end of Y3, to create a sense of urgency and cause early replacement of non-ENERGY STAR computers.

New-Construction Incentive: The Utilities will pay an incentive to building owners/managers for high performance new buildings. The incentive will have two paths: a prescriptive path for small buildings and a custom path for large buildings. On a preliminary basis, the Utilities are considering using a threshold of 600 square meters (6,458 square feet) to decide whether a building should use the prescriptive or custom path.

Under the prescriptive path, the incentive might be determined using a dollar-per-square foot rate if the building complies with a certain standard. Under the custom path (or performance path), the incentive will be determined using a dollar per kilowatt-hour of annual savings rate for

each kilowatt-hour of savings realized above a minimum level. Savings under the custom path will be determined through building modeling.

Engagement, Training and Communication: The Utilities will disseminate information, train and receive feedback from building owner/managers and other building industry actors through the following methods:

- Direct engagement with building industry actors: emails, phone calls and in-person meetings with electrical distributors, lighting designers, electrical contractors, as well as HVAC contractors, architects, building controls contractors, and HVAC designers
- Hands-on, in-person courses for local building industry actors, including course on advanced electricity efficiency lighting design, electricity efficiency project business cases, and energy performance contract (EPC) project implementation approach
- Project-specific, in-person or distance advanced lighting design or advanced HVAC design technical support to building industry actors
- Trade events supported by the Utilities and gathering local building owners/managers and building industry actors, with a focus on building electricity conservation, advanced lighting design and/or advanced HVAC design
- Direct engagement and key-account management for building owners/managers. In particular, the Utilities will leverage their partnerships with retail store managers
- Support for building owners/managers to do asset management planning and to identify in which buildings to develop projects
- Support to building owners/managers on optimizing decisions about implementation and procurement
- Support to building owners/managers before and during the tendering of project design services, particularly if the procurement approach is EPC.
- Public relation activities including press releases to the local newspapers and radio, web content, joint events with interested applicable trade, commerce, non-profit and community organizations, engagement with electrical contractors during the health and safety training of the Utilities.

The Utilities hope to work with the Energy Solutions Centre (ESC) to advertise and maintain the Service Provider Directory.

3.3 Description of Program Elements

As noted above, the General Service program offers four distinct program elements in addition to engagement, training and communication. This section provides a description of each program element; in each case the discussion is organized and presented as follows:

- Objective
- Target market
- Description
- Participation process
- Duration and milestones
- Eligible measures
- Marketing and communications strategy
- Incentive strategy
- Program theory
- Projected participation
- Budget
- Cost effectiveness

Program Theory – Definition

The program theory explains how the program's actions are expected to achieve the intended outcomes. It is designed to build a common understanding among program staff and stakeholders related to the program's choice of activities and their intended outputs and expected impacts.

Program evaluators will also use the program theory to assess whether the theory is plausible, to suggest improvements, and to establish hypotheses to test during process and impact evaluation. Program theory is a central component of a program-level evaluation, measurement and verification plan.

3.3.1 Lighting Redesign and Equipment Incentive

Objective

The objective of this program element is to achieve optimized lighting systems in terms of visual comfort, ease of maintenance, and electricity and demand savings. Electricity savings will be achieved by increasing the number of lighting retrofit projects and the savings from each project by improving the quality of the lighting design. Participation will be facilitated by reducing the initial-cost hurdle of the lighting design study.

The program component will emphasize LED lamps and fixtures by increasing the incentive amount if LED products are used in the lighting design.

Target Market

The primary target market is existing buildings in the Yukon including Whitehorse and the communities. The non-governmental sector is of primary interest but the eligibility of government and institutional customers will be determined with direction from the regulator.

Description

The Utilities will pay an incentive to building owners/managers to have their lighting systems retrofitted. The total incentive will be the sum of three layers: a lighting redesign study layer, a custom incentive layer, and a prescriptive LED incentive layer.

Lighting Redesign Incentive

The Utilities will pay an incentive to building owners/managers to have lighting redesign conducted in their building. The purpose of the lighting redesign will be to design an optimized lighting system in term of visual comfort, ease of maintenance, and electricity savings, given the

existing spaces, windows and fixtures. The incentive for the redesign might be determined using a dollar-per-square foot rate with a cap. The lighting designers will have to meet defined maximum power density limits.

The redesign should include replacement and/or relocation of fixtures, optimal use of daylighting and dimming, change in wall colours, specification of high performance lamps and fixtures, reduction of the light level to meet but not exceed the Illuminating Engineering Society standards, motion detectors, and task lighting.

The main deliverables of the designer will be the business case for the proposed solution, as well as the lighting layouts, equipment specifications ready to be inserted in tendering documents; and perhaps a large portion of the content of the application form for the lighting incentive component.

Custom Incentive

The custom incentive for the equipment and installation will be determined using a dollar per kilowatt-hour of annual savings rate. This approach provides flexibility in choice of lighting technologies and also pushes contractors and designers to be innovative.

The Utilities will provide a tool (most likely a simple spreadsheet) that will compute the incentive amount when baseline and retrofit lighting system characteristics are input. The standardized tool will be designed to be used as a “job aid.”

Prescriptive LED Incentive

There will also be a prescriptive incentive for LED lamps and fixtures. The Utilities will pay a flat dollar amount per unit to owners/managers when LED lighting lamps or fixtures are purchased from a prescriptive list of eligible products. The prescriptive amount will be rolled into the total lighting incentive.

The purpose of the prescriptive LED incentive is to increase the incentive amount if LED lamps are used, because the initial-cost hurdle is higher for LED technologies than for other technologies, and because the Utilities would like to accelerate the market penetration of LED technologies. Subject matter experts generally agree that the LED technology is (or will soon be) more efficient, longer-lasting, more resilient to power quality issues, and easier to dispose of than fluorescent technologies.

The incentive will be available at any time of the year. We propose reviewing the incentive level once per year, at the end of the year. All market actors will be made aware of this. The incentive can be increased or decreased to modulate uptake and react to market circumstances.

Participation Process

The participation process for the lighting redesign study and equipment incentive program element is shown in Exhibit 9. As shown:

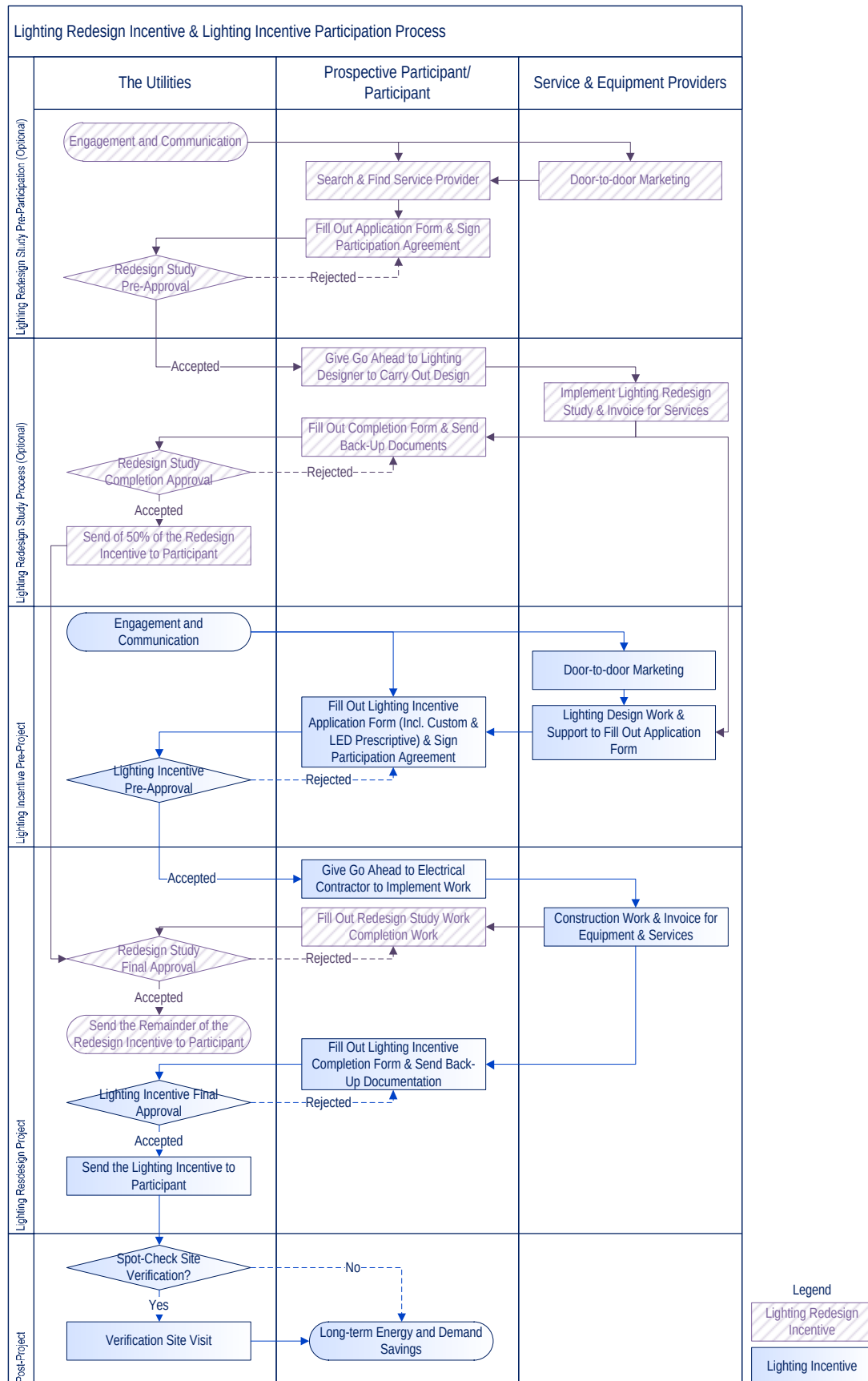
- The participation processes for the custom and prescriptive lighting incentives are synchronized with that of the lighting redesign incentive.
- Participation in the lighting redesign incentive element is optional. Participants can skip directly to the implementation of a lighting retrofit project. This might happen if the participant and supplier(s) feel comfortable with a simple design (e.g., one-to-one replacement) without a formal study or business case and if they want to move quickly.
- The outcome of the lighting redesign should flow well into the application for the lighting incentive component.
- There will be a “pre-approval” step to the redesign incentive component to check eligibility criteria and estimate the incentive amount for a certain building or set of buildings. The

lighting equipment incentives will also require pre-approval. The Utilities will track application-processing time and will make sure it meets application turnaround targets.

- After completion of the lighting redesign, the participant will submit a simple redesign completion form and provide backup documentation (eg. invoices and deliverables) to receive his/her first incentive payment.
- After completion of installation work, the participant will submit a simple project completion form and provide backup documentation (e.g. invoices) to receive their incentive payment.
- There might be two incentive payments for the lighting redesign component: one payment after the completion of the redesign (most likely 50%), and the second payment after the completion of the work (most likely 50%). Consequently, once the lighting installation work is complete, the participant will submit a simple work completion form to get his/her payment. In principle, this approach should increase the rate of implementation after the redesign work.
- If and when any application or form is rejected by the Utilities, the applicant will be informed and provided with information on what is missing and/or what to change. Applicants will be able to talk to their account manager to get support.
- A sample of projects will be selected for site verification. The verification will check a significant portion of the information that was provided in the application form, completion form and in the backup documentation. Incentives may be clawed back if errors, omission or fraud are uncovered.
- The site verification selection will be made based on a sampling plan that will be prepared during the implementation planning. In general, it is expected that larger projects will be more likely to be visited.

The tasks and responsibilities of the parties involved (i.e., the Utilities, the participant and the suppliers) will be clearly defined, consistent with the processes set out in Exhibit 9.

Exhibit 9: Participation Process for the Lighting Program Element



Duration & Milestones

The Utilities propose to launch and operate the program for a period of five years (20 quarters) before going through a new program design, filing and approval process.

Assuming that this program begins in the first quarter of Year 1 (Y1) and finishes in the last quarter of Y6, the main milestones of this component are:

- Q1 of Y1: Program preparation, including engagement and communication planning
- Q2 of Y1: Creation of the lighting incentive calculation tool and finalization of the incentive levels
- Q3 of Y1: Program launch, including the first incentive advertisement campaign
- Q3 of Y1: Incentive level for the next year is planned and then disseminated
- Q1 of Y2: Report on the impacts of the incentive
- Y3, Y4, Y5, and Y6: Repeat the same cycle as described above
- Q3 of Y6: Draft impact evaluation report is filed with the YUB
- Q4 of Y6: New program portfolio design is filed with the YUB
- Q1 of Y7: Program component is either terminated or updated to fit new market circumstances

Eligible Measures

The proposed incentive layers as well as archetype projects are presented in Exhibit 10 to Exhibit 13. Exhibit 10 and Exhibit 11 also include the lighting redesign study incentive.

Exhibit 10: Archetype Lighting Conservation Projects – Custom Incentive Layer for Non-Government Buildings

ID	Measure Short Name	Gross Annual Consumption Savings	Gross Coincident Peak Savings	Net-to-Gross Ratio	Measure Cost	Measure Lifetime	Level of Incentive	Size of Archetype Building
ECM91	Lighting Redesign Study	0.00 kWh/ft ²	.00000 kW/ft ²	110%	\$1.20/ft ²	16.0 yr	\$0.40/ft ²	11,759 ft ²
ECM80	Typical Lighting Project in	1.99 kWh/ft ²	.00060 kW/ft ²	95%	\$1.40/ft ²	15.4 yr	\$0.16/ft ²	15,000 ft ²
ECM81	Typical Lighting Project in Existing Bldg - Food Retail	4.85 kWh/ft ²	.00092 kW/ft ²	95%	\$2.30/ft ²	15.4 yr	\$0.39/ft ²	30,000 ft ²
ECM82	Typical Lighting Project in Existing Bldg - Non Food Retail	3.64 kWh/ft ²	.00072 kW/ft ²	95%	\$1.90/ft ²	15.4 yr	\$0.29/ft ²	10,000 ft ²
ECM83	Typical Lighting Project in Existing Bldg - Hotel/Motel	1.84 kWh/ft ²	.00036 kW/ft ²	95%	\$2.10/ft ²	11.5 yr	\$0.15/ft ²	20,000 ft ²
ECM86	Typical Lighting Project in Existing Bldg - Restaurant	6.65 kWh/ft ²	.00140 kW/ft ²	95%	\$3.10/ft ²	13.0 yr	\$0.53/ft ²	4,000 ft ²
ECM87	Typical Lighting Project in Existing Bldg - Recreation	1.79 kWh/ft ²	.00043 kW/ft ²	95%	\$1.90/ft ²	15.7 yr	\$0.14/ft ²	25,000 ft ²
ECM88	Typical Lighting Project in Existing Bldg - Warehouse	1.85 kWh/ft ²	.00045 kW/ft ²	95%	\$2.00/ft ²	15.7 yr	\$0.15/ft ²	30,000 ft ²

Exhibit 11: Prescriptive LED Incentive Layer for Non-Government Buildings

ID	Measure Short Name	Level of Incentive
ECM92	Commercial 12W LED A19 Bulb	\$18.00/unit
ECM93	Commercial 8W LED A19 Bulb	\$12.00/unit
ECM94	Commercial LED MR16 Bulbs	\$10.00/unit
ECM95	Commercial LED PAR30 Bulbs	\$20.00/unit
ECM96	Commercial LED PAR38 Bulbs	\$20.00/unit
ECM97	Commercial Spot or task lighting	\$10.00/unit

Exhibit 12: Archetype Lighting Conservation Projects – Custom Incentive Layer for Government Buildings

ID	Measure Short Name	Gross Annual Consumption Savings	Gross Coincident Peak Savings	Net-to-Gross Ratio	Measure Cost	Measure Lifetime	Level of Incentive	Size of Archetype Building
ECM912	Gov. Lighting Redesign Study	0.00 kWh/ft ²	.00000 kW/ft ²	100%	\$1.20/ft ²	20.0 yr	\$0.24/ft ²	26,209 ft ²
ECM802	Gov. Typical Lighting Project in	1.99 kWh/ft ²	.00060 kW/ft ²	95%	\$1.40/ft ²	20.0 yr	\$0.10/ft ²	15,000 ft ²
ECM842	Gov. Typical Lighting Project in Existing Bldg - Health	2.45 kWh/ft ²	.00035 kW/ft ²	95%	\$1.40/ft ²	20.0 yr	\$0.12/ft ²	95,000 ft ²
ECM852	Gov. Typical Lighting Project in Existing Bldg - Education	1.15 kWh/ft ²	.00042 kW/ft ²	95%	\$1.40/ft ²	20.0 yr	\$0.06/ft ²	33,000 ft ²
ECM872	Gov. Typical Lighting Project in Existing Bldg - Recreation	1.79 kWh/ft ²	.00043 kW/ft ²	95%	\$1.90/ft ²	20.0 yr	\$0.09/ft ²	25,000 ft ²
ECM882	Gov. Typical Lighting Project in Existing Bldg - Warehouse	1.85 kWh/ft ²	.00045 kW/ft ²	95%	\$2.00/ft ²	20.0 yr	\$0.09/ft ²	30,000 ft ²

Exhibit 13: Prescriptive LED Incentive Layer for Government Buildings

ID	Measure Short Name	Level of Incentive
ECM922	Gov. Commercial 12W LED A19 Bulb	\$10.80/unit
ECM932	Gov. Commercial 8W LED A19 Bulb	\$7.20/unit
ECM942	Gov. Commercial LED MR16 Bulbs	\$6.00/unit
ECM952	Gov. Commercial LED PAR30 Bulbs	\$12.00/unit
ECM962	Gov. Commercial LED PAR38 Bulbs	\$12.00/unit
ECM972	Gov. Commercial Spot or task lighting	\$6.00/unit

The lighting redesign incentive will likely be calculated based on square footage of the building. The custom incentive will be calculated based on \$.080/kWh (i.e., dollars per annual savings) for the non-government buildings and \$.048/kWh for the government buildings. The prescriptive LED incentive will be added to the custom incentive, and will be computed based on a dollars per unit approach as shown above.

Archetype building sizes are an average given an assumed building type mix and are primarily used to estimate transaction costs. During program implementation, each transaction will be treated as a custom project having a specific square footage and a specific total eligible incentive amount.

The LED prescriptive incentives were added in the budget and accounted for in the cost-effectiveness tests. However the LED savings and measure costs were not accounted in the targets and the cost-effectiveness test because the savings are already included in the archetype lighting conservation projects shown above. If LED measure savings and costs were included in the targets and cost-effectiveness tests, it would be double-counting.

The lighting redesign incentive layer yields no direct savings; consequently, the projected transactions will be rolled into the program modeling as an incentive and program cost only. The benefit/cost ratio for this program element is not computed. It is assumed that the redesign studies will (1) increase the savings achieved through the lighting incentive component by improving the quality of the lighting designs, and will (2) increase the uptake of the lighting incentive by reducing the risk of investing in project preparation and by making it easier to complete the custom application.

The program performance will be modeled using the archetype projects presented in Exhibit 10. However, during program implementation, each transaction will be treated as a custom project, with a specific project cost, a specific level of consumption and demand savings, and a specific total incentive amount. Measure lifetime is assumed to be 15 years and net-to-gross ratio is assumed to be 95% in all cases.

Specific details on the minimum technical specifications for each of the items in Exhibit 11 (prescriptive LED lamps and fixtures) will be determined during the program preparation phase. The Utilities intend to use external equipment qualification agents instead of creating and maintaining a resource-intensive product qualification operation.

Prospective performance and safety qualification agents include, but are not limited to: the Office of Energy Efficiency's ENERGY STAR Program, the US Department of Energy's Solid State Lighting program, the Consortium for Energy Efficiency, the DesignLights Consortium, the Canadian Standards Association, and the Underwriters Laboratories of Canada.

The Utilities reserve the right to revise eligible measures and incentive level as needed in accordance with current market conditions, technology development, EM&V results, and program implementation experience. The Utilities propose to review the lighting incentive level on an annual basis. In addition, the Utilities reserve the right to recover the incentive money should fraud or omissions be identified.

Marketing & Communications Strategy

The Utilities will disseminate information, train and receive feedback from the building owner/managers and the building industry actors through multiple means as described in Section 3.4. To promote the uptake of the redesign element, the Utilities will focus primarily on the lighting supply-chain and building owners/managers channels.

Incentive Strategy

Lighting Re-design

The incentive for the study will be determined using a dollar-per-square foot-rate with a cap. We propose this approach, instead of using a percentage of the cost of the study, for the following reasons:

- It is easier for the building owners/managers to estimate the incentive level on a preliminary basis without waiting for a service provider to submit a price quote.
- It reduces the risk that service providers inflate their fees because the incentive covers part of the increase.

We assumed that smaller buildings, where doing a design is not economic, will not apply to the program because the low incentive amount will not justify the required paperwork.

To ensure that the redesign incentive will create additional impact, we will require lighting designers to propose designs that comply with the Illuminating Engineering Society minimum lighting level and that are equal or below a certain power density (W per square foot) threshold. Power density is relatively easy to verify based on lighting layouts and specifications.

On a preliminary basis, we propose the maximum power density threshold to be 0.83 W/sqft. The 2011 National Energy Code of Canada for Buildings (2011 NECB) suggests using the ASHRAE standard 90.1 of 2010; which recommends a lighting density of 1.11 W/sqft for a closed office; and 0.98 W/sqft for an open plan. Thus 0.83 W/sqft is 25% below is the value prescribed by the 2011 NECB for closed offices.

Custom Incentive

The custom incentive for the equipment and installation will be determined using a dollar per kilowatt-hour of annual savings rate.

This type of approach has the following benefits:

- Provides flexibility in choice of lighting technologies and also encourages contractors and designers to be innovative
- Allows for greater accuracy in tracking impact because the participants provide project baseline information with their application.

On the other hand, the Utilities acknowledge that the main disadvantages of the custom approach are:

- Requires a lengthier application form that is more resource-intensive to complete.
- Makes the incentive amount more challenging to compute

In order to address these hurdles:

- The Utilities will require pre-approval of projects before the installation is carried out to ensure that the participants properly estimate the incentive amount, thus reducing the risk of disappointing participants who have miscalculated their incentive.
- The Utilities will provide a standardized tool, most likely a simple spreadsheet, that will compute the incentive amount when baseline and retrofit lighting system characteristics are input.
- The Utilities created the lighting redesign incentive so that prospective participants can pay for support from external experts. The outcome of the lighting redesign study will flow into the application for the lighting incentive component.

The standardized tool will be designed to be used as a “job aid”. It should be seen as being useful to lighting designers rather than being an annoyance. The inputs and outputs of the standardized tool will provide most of the information required for the lighting incentive application form.

Prescriptive LED Incentive

There will also be a prescriptive incentive for LED lamps. The Utilities will pay a flat amount of money per unit to owners/managers when LED lighting lamps or fixtures from a prescriptive list of eligible products are purchased. The prescriptive amount will be rolled in the total lighting incentive amount.

The prescriptive list of eligible LED products will be consistent with that used in the Residential Program described below, which will allow the task of monitoring the LED market and reviewing the incentive levels to be leveraged for both programs. This also means that contractors will *not* start buying the LED products from retailers and will *not* pretend to be installing them in the residential sector. They will carry on doing business with the electrical distributors, their normal supply channel.

The standardized custom-incentive calculation tool will integrate the prescriptive LED incentive to make the total incentive calculation easier for applicants and their service providers.

Both the custom and the prescriptive LED incentives will be available at any time of the year. We propose reviewing the incentive level once per year, at the end of the year. All market actors will be made aware of this. The incentive can be increased or decreased to modulate uptake and react to market circumstances.

Program Theory

The theory of the lighting redesign and equipment incentives of the General Service Program has been graphically depicted in the form of a logic model in Exhibit 14.

Exhibit 14: Logic Model of the General Service Lighting Redesign and Equipment Incentive

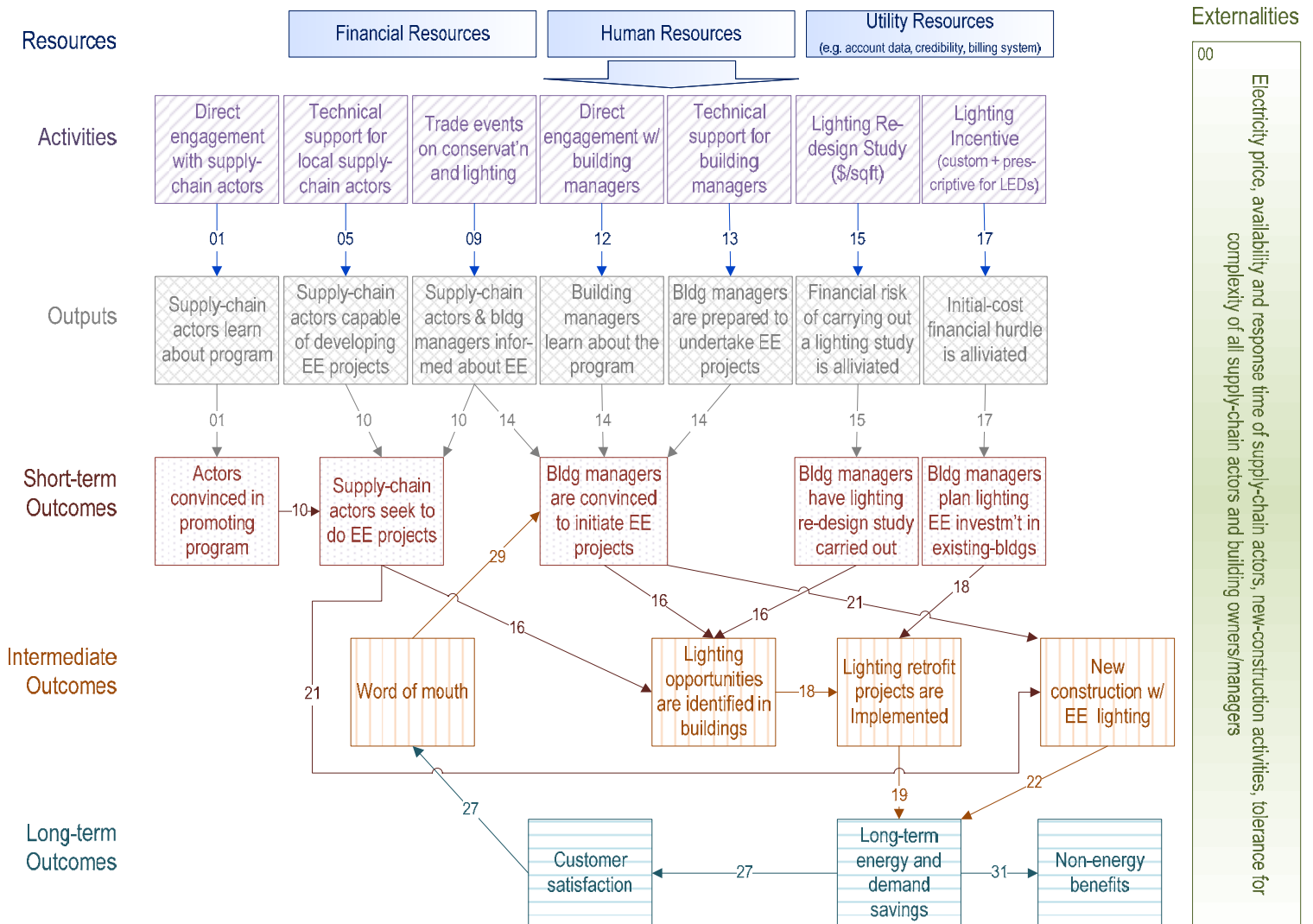


Exhibit 15 presents the narratives of the logic model shown in Exhibit 14.

Exhibit 15: Explanatory Note on the General Service Lighting Redesign and Equipment Incentive Theory

Link #	Narrative
00	The program effectiveness and impact will be influenced by the following externalities: Whitehorse bylaws on the obligation to bring all of the buildings up to code if and when deep retrofits are initiated, the price of electricity, the availability and response time of supply-chain actors, new-construction activities, and tolerance for complexity of all supply-chain actors and building owners/managers. The program administrator should monitor these externalities and adapt the implementation approach as necessary.

Link #	Narrative
01	The Utilities will carry out direct engagement with electrical distributors, lighting designers, electrical contractors, as well as with HVAC contractors, HVAC designers, control designers and architects through emails, phone calls and in-person meetings. The Utilities will present their incentive offerings and engage with supply-chain actors so that they promote them.
05	The Utilities will offer technical support to the supply-chain actors in two different forms: (1) hands-on training on the program tools, forms and procedures; on advanced electricity efficiency lighting design; and on the business aspects of electricity efficiency: energy audits, business cases, energy performance contracting, and electricity efficiency financing. (2) The Utilities will act as a broker to procure technical expertise from highly specialized lighting experts recruited throughout North America upon request from the local actors. In addition, the Utilities will disseminate information on recommended lighting equipment (brand-neutral, to the extent possible) in the form of printed brochures, newsletters or web content.
09	The Utilities propose to support any form of trade organizations or trade events by sponsoring and attending trade events that gather local building owners/managers and/or supply-chain actors. The Utilities intend to strengthen or create platforms that allow local energy conservation practitioners to present their success stories, and share their lessons learned.
10	Supply-side actors will actively seek to develop projects because they were engaged with by the Utilities, because they were trained and are capable of offering electricity-efficiency services, and because they were provided with networking opportunities with potential clients (building owners/managers) at trade events.
12	The Utilities will carry out direct engagement with building owners/managers through emails, phone calls and in-person meetings; and through public relations activities like press releases sent to the local newspapers and radio, web content, and joint events with the Whitehorse Chamber of Commerce. The Utilities will present their incentive offerings and make the owners/managers aware of the benefits so that they participate in the program.
13	The Utilities will offer customized technical support to building owners/managers to help them to initiate projects. The Utilities could include support to plan investment in assets, and to identify in which buildings to develop projects; support to make optimal decisions on implementation and procurement approach, and support before and during the tendering of project design services, particularly if the procurement approach is energy performance contracting (EPC).
14	Building owners/managers agree to initiate electricity efficiency projects because they were informed about the program components by the Utilities, because they were provided with technical support to decide where to start and how to do it, and because they networked with supply-side actors, perhaps at the trade events supported by the Utilities.
15	The Utilities will pay an incentive to building owner/managers to have a lighting redesign study conducted in their building. The purpose of the lighting redesign study will be to design an optimized lighting system in term of visual comfort, ease of maintenance, and electricity savings, considering the existing spaces, windows and fixtures. The incentive will reduce the financial risk of investing in a pre-investment study, and will reduce the initial-cost hurdle of doing business with designers. The building managers will have lighting redesign studies carried out.
16	Electricity-efficient lighting opportunities are identified in the building because the supply-chain actors were seeking to develop new lighting projects, because building owners/managers agreed to initiate an electricity efficiency project and because the financial risk of carrying out a redesign study was alleviated.
17	The Utilities will pay an incentive to building owners/managers to have their lighting systems retrofitted. This incentive will include a custom incentive layer and a prescriptive LED incentive layer. The custom incentive allows for flexibility in lighting technologies as well as the use of occupancy control, dimming and day lighting, etc. It pushes distributors, contractors and designers to be innovative. The purpose of the prescriptive LED incentive layer is to increase the level of incentive when LED technologies are used because the initial-cost hurdle is higher for LED technologies than for other technologies; and because LED lighting is a technology for which the Utilities would like to accelerate market penetration.
18	Electricity-efficient lighting retrofit projects are implemented because electricity-efficient lighting opportunities were identified and because the equipment and installation initial-cost financial hurdle was alleviated.
19	The electricity-efficient lighting retrofit projects will yield long-term electricity and demand savings.
21	Electricity-efficient new buildings constructions are implemented because the supply-chain actors were seeking to work on electricity-efficient new construction projects, and because the initial-cost hurdle of the construction of electricity-efficient buildings was alleviated.
22	The electricity-efficient new buildings will yield long-term electricity and demand savings.
27	Building owners/managers will be satisfied by the projects that they implemented. They will tell other people in the building industry; perhaps at the trade events supported by the utilities. This will generate word-of-mouth advertisement.
29	With time, word-of-mouth will become an important information channel that will cause building owners/managers and supply-chain actors to implement more projects.

Link #	Narrative
31	It is assumed that owners/managers will perceive new non-energy benefits; and/or the maintenance of benefits they used to have with baseline systems. For example, the Utilities will seek to make sure that participants perceive that their new systems are more comfortable, are less costly to maintain, have higher tenant satisfaction and retention, generate fewer complaints, and have increased property value.

Projected Participation

The projections shown in Exhibit 16 to Exhibit 19 have been used for planning purposes. However, the Utilities reserve the right to adjust savings targets as necessary in accordance with current market conditions, EM&V results, and program implementation experience.

Exhibit 16: Participation Projections – Lighting Redesign and Custom Lighting Incentive for Non-Government Buildings

ID	Measure Short Name	Year 1	Year 2	Year 3	Year 4	Year 5	Total
ECM91	Lighting Redesign Study	9,181 \$2	50,876 \$2	83,390 \$2	83,390 \$2	41,695 \$2	268,531 \$2
ECM80	Typical Lighting Project in	0 \$2	11,738 \$2	31,786 \$2	36,327 \$2	36,327 \$2	116,179 \$2
ECM81	Typical Lighting Project in Existing Bldg - Food Retail	0 \$2	2,702 \$2	7,139 \$2	8,159 \$2	8,159 \$2	26,160 \$2
ECM82	Typical Lighting Project in Existing Bldg - Non Food Retail	0 \$2	15,116 \$2	39,707 \$2	45,379 \$2	45,379 \$2	145,581 \$2
ECM83	Typical Lighting Project in Existing Bldg - Hotel/Motel	0 \$2	14,437 \$2	33,687 \$2	38,499 \$2	38,499 \$2	125,122 \$2
ECM86	Typical Lighting Project in Existing Bldg - Restaurant	0 \$2	3,982 \$2	9,291 \$2	10,618 \$2	10,618 \$2	34,510 \$2
ECM87	Typical Lighting Project in Existing Bldg - Recreation	0 \$2	0 \$2	0 \$2	0 \$2	0 \$2	0 \$2
ECM88	Typical Lighting Project in Existing Bldg - Warehouse	0 \$2	11,460 \$2	26,739 \$2	30,559 \$2	30,559 \$2	99,316 \$2

Exhibit 17: Participation Projections – Prescriptive LED Incentive for Non-Government Buildings

ID	Measure Short Name	Year 1	Year 2	Year 3	Year 4	Year 5	Total
ECM92	Commercial 12W LED A19 Bulb	0 units	555 units	1,295 units	1,480 units	1,480 units	4,810 units
ECM93	Commercial 8W LED A19 Bulb	0 units	1,184 units	2,763 units	3,157 units	3,157 units	10,261 units
ECM94	Commercial LED MR16 Bulbs	0 units	925 units	2,158 units	2,467 units	2,467 units	8,016 units
ECM95	Commercial LED PAR30 Bulbs	0 units	740 units	1,727 units	1,973 units	1,973 units	6,413 units
ECM96	Commercial LED PAR38 Bulbs	0 units	538 units	1,256 units	1,435 units	1,435 units	4,664 units
ECM97	Commercial Spot or task lighting	0 units	370 units	863 units	987 units	987 units	3,206 units

Exhibit 18: Participation Projections – Lighting Redesign and Custom Lighting Incentive for Government Buildings

ID	Measure Short Name	Year 1	Year 2	Year 3	Year 4	Year 5	Total
ECM912	Gov. Lighting Redesign Study	11,394 f2	59,232 f2	95,676 f2	95,676 f2	47,838 f2	309,815 f2
ECM802	Gov. Typical Lighting Project in	0 f2	11,738 f2	31,786 f2	36,327 f2	36,327 f2	116,179 f2
ECM842	Gov. Typical Lighting Project in Existing Bldg - Health	0 f2	4,421 f2	10,316 f2	11,789 f2	11,789 f2	38,315 f2
ECM852	Gov. Typical Lighting Project in Existing Bldg - Education	0 f2	32,136 f2	74,984 f2	85,696 f2	85,696 f2	278,512 f2
ECM872	Gov. Typical Lighting Project in Existing Bldg - Recreation	0 f2	5,798 f2	13,528 f2	15,461 f2	15,461 f2	50,247 f2
ECM882	Gov. Typical Lighting Project in Existing Bldg - Warehouse	0 f2	3,820 f2	8,913 f2	10,186 f2	10,186 f2	33,105 f2

Exhibit 19: Participation Projections – Prescriptive LED Incentive for Government Buildings

ID	Measure Short Name	Year 1	Year 2	Year 3	Year 4	Year 5	Total
ECM922	Gov. Commercial 12W LED A19 Bulb	0 units	299 units	697 units	797 units	797 units	2,590 units
ECM932	Gov. Commercial 8W LED A19 Bulb	0 units	638 units	1,488 units	1,700 units	1,700 units	5,525 units
ECM942	Gov. Commercial LED MR16 Bulbs	0 units	498 units	1,162 units	1,328 units	1,328 units	4,316 units
ECM952	Gov. Commercial LED PAR30 Bulbs	0 units	398 units	930 units	1,063 units	1,063 units	3,453 units
ECM962	Gov. Commercial LED PAR38 Bulbs	0 units	290 units	676 units	773 units	773 units	2,511 units
ECM972	Gov. Commercial Spot or task lighting	0 units	199 units	465 units	531 units	531 units	1,727 units

Budget

The budgets presented in Exhibit 20 and Exhibit 21 have been used for planning purposes. However, the Utilities reserve the right to adjust program budgets as necessary in accordance with current market conditions, EM&V results, and program implementation experience. Initial budget levels are set based on conservative estimates of participation given the current market.

Exhibit 20: Budget – Lighting Redesign and Equipment Incentive excluding Government Buildings

	\$1,000s					
	Year 1	Year 2	Year 3	Year 4	Year 5	Total
Incentive:	\$4	\$96	\$213	\$239	\$222	\$773
Non-Incentive:	\$72	\$56	\$46	\$50	\$91	\$314
Total:	\$76	\$152	\$259	\$289	\$312	\$1,087

Exhibit 21: Budget – Lighting Redesign and Equipment Incentive including Government Buildings

	\$1,000s					
	Year 1	Year 2	Year 3	Year 4	Year 5	Total
Incentive:	\$6	\$135	\$294	\$327	\$299	\$1,062
Non-Incentive:	\$81	\$77	\$66	\$72	\$127	\$425
Total:	\$88	\$213	\$360	\$400	\$427	\$1,487

Savings Target

The savings targets shown in Exhibit 22 and in Exhibit 23 have been used for planning purposes. However, the Utilities reserves the right to adjust savings targets as necessary in accordance with current market conditions, EM&V results, and program implementation

experience. Savings targets are not applicable to the lighting redesign study layer, as no savings will be attributed to this incentive layer.

Exhibit 22: Savings Targets – Lighting Redesign and Equipment Incentive excluding Government Buildings

Net Savings with T&D Losses															
	<----- Program Operation ----->					----- Ramp Down as Measure Lifetime Expires ----->									
	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	Year 11	Year 12	Year 13	Year 14	Year 15
Lifetime MWh:	0	2,476	6,240	7,132	7,132	0	0	0	0	0	0	0	0	0	0
Annual MWh:	0	333	1,140	2,062	2,985	2,985	2,985	2,985	2,985	2,985	2,985	2,968	2,922	2,833	2,689
Coincident kW:	0	79	269	486	703	703	703	703	703	703	703	697	682	658	622

Exhibit 23: Savings Targets – Lighting Redesign and Equipment Incentive including Government Buildings

Net Savings with T&D Losses															
	<----- Program Operation ----->					----- Ramp Down as Measure Lifetime Expires ----->									
	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	Year 11	Year 12	Year 13	Year 14	Year 15
Lifetime MWh:	0	4,314	10,711	12,241	12,241	0	0	0	0	0	0	0	0	0	0
Annual MWh:	0	507	1,731	3,128	4,526	4,526	4,526	4,526	4,526	4,526	4,526	4,510	4,463	4,375	4,231
Coincident kW:	0	127	432	781	1,129	1,129	1,129	1,129	1,129	1,129	1,129	1,124	1,108	1,084	1,049

Cost Effectiveness

The cost-effectiveness test results shown in Exhibit 24 and in Exhibit 25 were computed based on the assumptions presented above: level of incentive, budget, and projections. They are used for planning purposes. However, the Utilities reserve the right to adjust the assumptions as necessary in accordance with current market conditions, EM&V results, and program implementation experience; consequently, actual results may differ than those presented below. Savings targets are not applicable to the lighting redesign study layer, as no savings will be attributed to this incentive layer.

Exhibit 24: Cost Effectiveness – Lighting Redesign and Equipment Incentive excluding Government Buildings

	Total Resource Cost TRC	Program Adminis- trator Cost PAC	Participant Cost PC	Rate- Impact Measure RIM
Benefit/Cost Ratio	1.2	3.1	2.5	0.9
Net Present Value (1,000s)	\$411	\$1,947	\$1,759	-\$211
Levelized Cost:	\$.201/kWh	\$.075/kWh	N/A	N/A

Exhibit 25: Cost Effectiveness – Lighting Redesign and Equipment Incentive including Government Buildings

	Total Resource Cost TRC	Program Adminis- trator Cost PAC	Participant Cost PC	Rate- Impact Measure RIM
Benefit/Cost Ratio	1.2	3.8	2.4	0.9
Net Present Value (1,000s)	\$709	\$3,454	\$2,845	-\$408
Levelized Cost:	\$.202/kWh	\$.063/kWh	N/A	N/A

3.3.2 High Efficiency Refrigeration Incentive

Objective

The objective of this program element is to achieve electricity and demand savings by increasing the number of refrigeration retrofit projects and the savings from each project. This will be facilitated by identifying the opportunities, assisting participating owners and managers, and reducing the initial-cost hurdle.

This program element will encourage the early replacement of refrigeration equipment and systems by offering technical assistance and a relatively large incentive to reduce the customer's simple payback.

Target Market

The primary target market includes grocery stores as well as hockey and curling arenas in the Yukon, as these are the main users of refrigeration equipment. Convenience stores, smaller grocery stores, and restaurants may also be targeted during the second half of the program period.

Description

The utilities will pay an incentive to building owners/managers to have their refrigeration equipment retrofitted and/or to install refrigeration controls.

The incentive will be determined using a dollar per kilowatt-hour rate (based on annual savings). This approach will mainly account for savings generated by conservation measures to be identified and sized by energy engineers at each site. The conservation measures could include simple ENERGY STAR equipment purchases, more complicated refrigeration control implementation, or deep-retrofit projects.

In addition to the incentive, the Utilities will provide extensive refrigeration-specific technical assistance to identify the opportunities, to develop the projects, to manage the construction works, and to measure and monitor the performance of the projects. It is expected that this program element will target hockey and curling arenas and grocery stores in particular.

Given the relatively small number of potential participants, energy engineers employed by the Utilities will build tailor-made technical assistance packages for each participant. These packages may include an initial Walk-Through Audit, an Investment-Grade Audit, procurement support, project management and/or project performance measurement and verification. The technical assistance budget will be commensurate with the estimated impact potential.

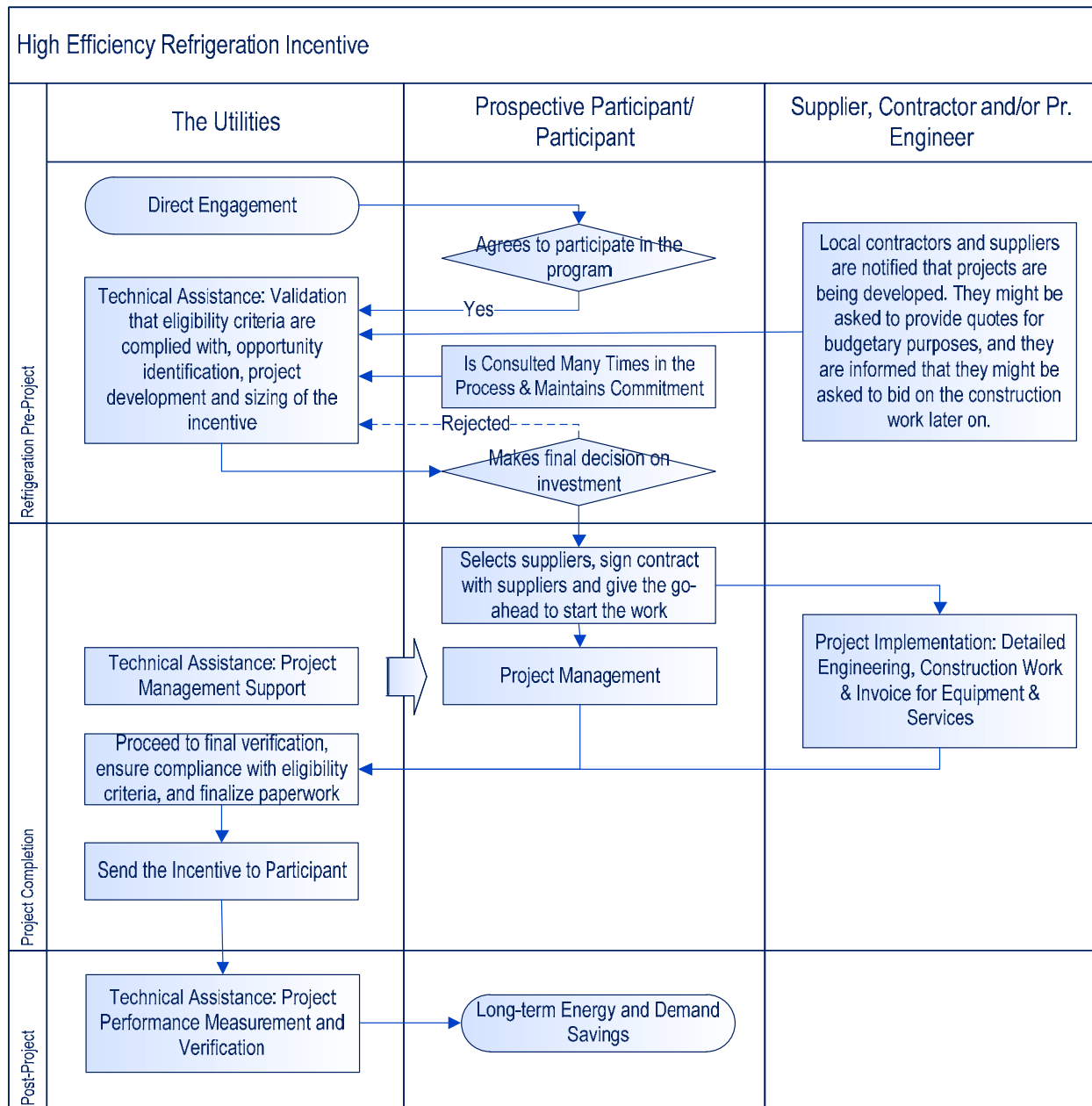
Participation Process

The participation process for the refrigeration incentive program component is shown in Exhibit 26. As shown:

- Extensive technical assistance will be provided by the Utilities at all stages of the projects. The technical assistance budget will be commensurate with the estimated impact potential.
- Relatively few projects are anticipated (5 to 10); therefore transactional infrastructure will be rudimentary (e.g., no forms, no program database). Consequently, the Utilities will take care of all the documentation and paperwork on a project-by-project basis. Project and participant data will be collected informally, through conversations, email exchanges, site visits, etc.
- Qualified energy engineers will estimate savings using best practice methodology. These estimates will then be validated by the Program Administration team. The same method will be used to calculate the total incentive amount. The incentive amount will be determined before the investment decision. To reduce the risk to the participant, the incentive will not be changed after the implementation unless major changes in the design occur during implementation. The outputs of the performance measurement and verification will not result in changes in the incentive amount.
- The Utilities will have the participant commit to and renew the commitment to implement the works under certain conditions agreed on at the project's outset. The details of this "commitment" will be worked out at the launch preparation stage. On a preliminary basis, the Utilities envision a participation agreement where the participants would commit to reimburse part of the cost of the technical assistance if they do not proceed with the implementation of a cost-effective project.

The tasks and responsibilities of the parties involved (i.e., the Utilities, the participant and the suppliers) will be clearly defined based on the steps shown previously in Exhibit 26.

Exhibit 26: Participation Process for the High Efficiency Refrigeration Program Element



Duration & Milestones

The Utilities propose to launch and operate the program over five years (20 quarters) before going through a new program design, filing and approval process.

Assuming that this program begins in the first quarter of Year 1 (Y1) and finishes in the last quarter of Year 5, the main milestones of this component are:

- Q1 of Y1: Program preparation, including engagement and communication planning
- Q2 of Y1: Selection of technical assistance providers
- Q3 of Y1: Prospective participants are engaged
- Q4 of Y1: Technical Assistance starts to be delivered

- Q1 to Q4 of Y2: Technical Assistance continues, Project Development, Start of the Implementation
- Q1 to Q4 of Y3: First batch of projects are completed, savings start being realized
- Q3 of Y3: New batch of prospective participants are engaged
- Q4 of Y3: Technical Assistance Starts to be Delivered to the second batch of participants
- Q1 to Q4 of Y4: Technical Assistance goes on, Project Development, Start of the Implementation
- Q1 to Q4 of Y5: First batch of projects are completed, savings start being realized
- Q3 of Y5: Draft impact evaluation report is filed with the YUB
- Q4 of Y5: New program portfolio design is filed with the YUB
- Q1 of Y8: Program component is either terminated or updated to fit new market circumstances

Eligible Measures

The proposed incentive levels and archetype refrigeration projects are presented in Exhibit 27 and Exhibit 28.

Exhibit 27: Archetype High Efficiency Refrigeration Projects – Custom Incentive Layer for Non-Government Buildings

ID	Measure Short Name	Gross Annual Consumption Savings	Gross Coincident Peak Savings	Net-to-Gross Ratio	Measure Cost	Measure Lifetime	Level of Incentive	Size of Archetype Building
ECM98	Typical Low-Cost No-Cost Refrigeration Project - Food	6.55 kWh/ft ²	.00074 kW/ft ²	95%	\$1.73/ft ²	10.0 yr	\$1.31/ft ²	30,000 ft ²
ECM99	Typical Deep Retrofit Refrigeration Project - Food	13.48 kWh/ft ²	.00153 kW/ft ²	95%	\$5.87/ft ²	10.0 yr	\$2.70/ft ²	30,000 ft ²

Exhibit 28: Archetype High Efficiency Refrigeration Projects – Custom Incentive Layer for Government Buildings

ID	Measure Short Name	Gross Annual Consumption Savings	Gross Coincident Peak Savings	Net-to-Gross Ratio	Measure Cost	Measure Lifetime	Level of Incentive	Size of Archetype Building
ECM1002	Typical Refrigeration Project - Ice Rink	2.49 kWh/ft ²	.00034 kW/ft ²	95%	\$0.72/ft ²	20.0 yr	\$0.40/ft ²	25,000 ft ²

The High Efficiency Refrigeration program element will focus primarily on custom refrigeration equipment and controls for ice rinks, curling rinks and grocery stores. However, the Utilities would like to retain the right to offer a prescriptive ENERGY STAR refrigeration rebate aimed at small commercial projects in the future.

The Utilities reserve the right to revise eligible measures and incentive levels as needed in accordance with current market conditions, technology development, EM&V results, and program implementation experience. In addition, the Utilities reserve the right to recover the incentive money should fraud errors or omissions be uncovered.

Marketing & Communications Strategy

The Utilities will disseminate information, train and receive feedback from the building owner/managers and the building industry actors through multiple means as described in

Section 3.4. Given the relatively small number of potential participants, the Utilities will contact these parties directly, while offering a customized package of technical assistance.

Incentive Strategy

The custom incentive for the equipment and installation will be determined using a dollar per kilowatt-hour rate (based on expected annual savings).

This type of approach has the following benefits:

- Provides flexibility in choice of refrigeration technologies and also encourages the energy engineers to be innovative.
- Allows for greater accuracy in tracking impact because the baseline information is collected and fewer assumptions are made.
- Provides customized technical assistance to maximize potential savings, and makes the computation of the incentive amount easy for the participants.

A qualified energy engineer will perform the incentive calculations. A second engineer will verify them to ensure accuracy.

Performance Measurement and Verification (M&V) will not be carried out for the purpose of establishing the incentive level. The reasons for offering M&V as technical assistance to the participant are:

- Savings can be clearly demonstrated and communicated to the participant; and then to prospective participants.
- Project-level M&V results can be fed in the program-level evaluation and thus make program-level evaluation more accurate.
- Remedies may be identified to rectify situations in which project performance is disappointing.
- The activities surrounding M&V will educate the building owners/managers about energy monitoring and energy management best practices.

Savings will be calculated using a whole-building approach and be based on the monthly measurements made by the utility main building meter as part of the normal billing activities. The routine adjustment model will be defined prior to implementation. This methodological approach is referred to as the Option-C approach in the International Performance Measurement and Verification Protocol (IPMVP). The IPMVP is the most widely-used best-practice manual governing the project-level M&V practice. The project-level M&V activities carried out by the Utilities will be done in coherence with it.

Program Theory

The theory of the High Efficiency Refrigeration Element within the General Service Program has been graphically depicted in the form of a logic model and is shown in Exhibit 29.

Exhibit 29: Logic Model of the General Service High Efficiency Refrigeration Element

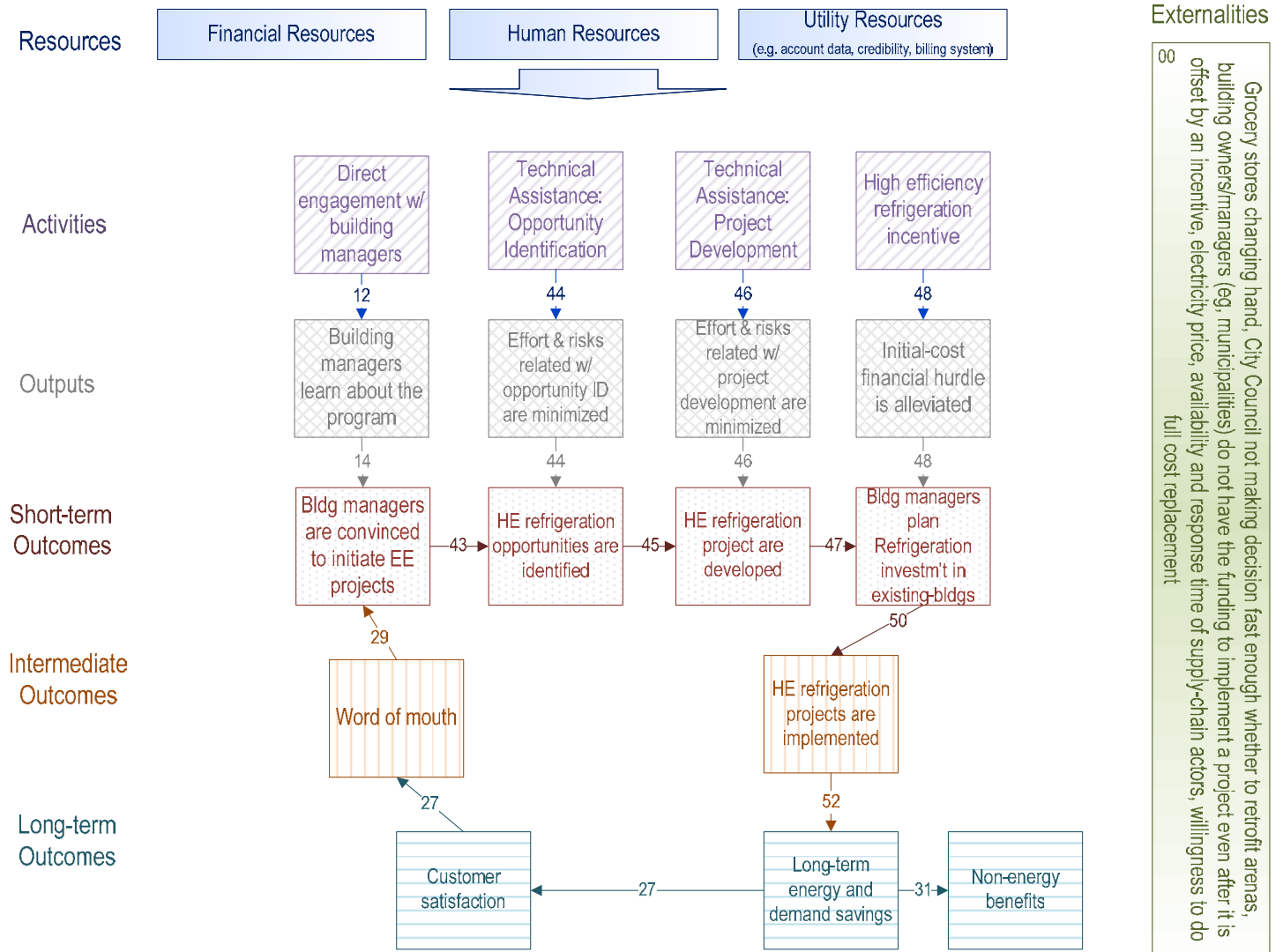


Exhibit 30 presents the narratives for the logic model shown in Exhibit 29.

Exhibit 30: Explanatory Note on the General Service High Efficiency Refrigeration Incentive Theory

Link #	Narrative
00	The program effectiveness and impact will be influenced by the following externalities: grocery store ownership changes, slow decision-making on the part of City Council regarding whether or not to retrofit arenas, a lack of funding for building owners/managers (e.g., municipalities) to implement a project even after it is offset by an incentive, the price of electricity, the availability and response time of supply-chain actors, and the willingness to do a full cost replacement.
12	The Utilities will carry out direct engagement with building owners/managers through emails, phone calls and in-person meetings, and through public relations activities like press releases sent to the local newspapers and radio stations, web content and joint events with the Whitehorse Chamber of Commerce. The Utilities will present their incentive offerings and make the owners/managers aware of the benefits so that they participate in the program.

Link #	Narrative
14	Building owners/managers agree to initiate electricity efficiency projects because they were informed about the program components by the Utilities.
43	Building owners/managers are offered the free services of energy engineers representing the Utilities to assess their refrigeration system to identify efficiency opportunities. They participate because their risk exposure and level of effort are minimized.
44	The Utilities provide technical assistance to the building owners/managers in the form of an assessment of the refrigeration system to identify energy efficiency opportunities. As a result, high efficiency refrigeration opportunities are identified. It is assumed that the Utilities are offering services NOT being offered for profit by other market actors because the target market niche is too small to be lucrative. It is not displacing or blocking free-market mechanisms (ie. not blocking an existing mechanism or mechanism in the making).
45	After the high efficiency refrigeration opportunities are identified, the participant is offered more support to develop the project. The participant is asked to make a commitment. If the resulting project is a cost-effective investment, the participant agrees to carry on and implement the project. Otherwise, the participant will have to pay part of the cost of the technical assistance. The participant accepts because the level of risk he/she is asked to take is fair.
46	The Utilities provide technical assistance to develop the high efficiency refrigeration project in the form of a feasibility study and/or an investment-grade audit. If the participant implements the proposed design, the feasibility study will be free of charge.
47	The participants are presented with investment- and implementation-ready high efficiency refrigeration projects.
48	The Utilities will pay an incentive to participants who implement the high efficiency refrigeration projects that are identified. The incentive will alleviate the initial-cost hurdle of the high-efficiency refrigeration retrofit projects.
50	Because high-efficiency projects will have been subsequently identified and then developed by the Utilities, and because the Utilities will alleviate the initial-cost hurdle, high-efficiency refrigeration retrofit projects will be implemented.
52	The high-efficiency refrigeration retrofit projects will yield long-term electricity and demand savings.
27	Building owners/managers will be satisfied by the projects that they implemented. They will tell other people in the building industry, perhaps at the trade events supported by the utilities. This will generate word-of-mouth advertisement.
29	With time, word-of-mouth will become an important information channel that will cause building owners/managers and supply-chain actors to implement more projects.
31	It is assumed that owners/managers will perceive new non-energy benefits and/or maintain the benefits they used to have with baseline systems. For example, the Utilities will seek to ensure that participants perceive that their new systems are more comfortable, are less costly to maintain, have higher tenant satisfaction and retention, generate fewer complaints, and increase property value.

Projected Participation

The projections shown in Exhibit 31 and Exhibit 32 have been used for planning purposes. However, the Utilities reserve the right to adjust savings targets as necessary in accordance with current market conditions, EM&V results, and program implementation experience.

Exhibit 31: Participation Projections – High Efficiency Refrigeration Incentive for Non-Government Buildings

ID	Measure Short Name	Year 1	Year 2	Year 3	Year 4	Year 5	Total
ECM98	Typical Low-Cost No-Cost Refrigeration Project - Food	0 ft2	0 ft2	30,582 ft2	0 ft2	30,582 ft2	61,163 ft2
ECM99	Typical Deep Retrofit	0 ft2	0 ft2	30,252 ft2	0 ft2	30,252 ft2	60,505 ft2

Exhibit 32: Participation Projections – High Efficiency Refrigeration Incentive for Government Buildings

ID	Measure Short Name	Year 1	Year 2	Year 3	Year 4	Year 5	Total
ECM1002	Typical Refrigeration Project - Ice Rink	0 ft2	0 ft2	24,760 ft2	0 ft2	24,760 ft2	49,520 ft2

Budget

The budgets presented in Exhibit 33 and Exhibit 34 have been used for planning purposes. However, the Utilities reserve the right to adjust program budgets as necessary in accordance with current market conditions, EM&V results, and program implementation experience. Initial budget levels are set based on conservative estimates of participation given the current market.

Exhibit 33: Budget – High Efficiency Refrigeration Incentive excluding Government Buildings

	\$1,000s					
	Year 1	Year 2	Year 3	Year 4	Year 5	Total
Incentive:	\$0	\$0	\$122	\$0	\$122	\$243
Non-Incentive:	\$34	\$69	\$17	\$55	\$43	\$218
Total:	\$34	\$69	\$139	\$55	\$165	\$461

Exhibit 34: Budget – High Efficiency Refrigeration Incentive including Government Buildings

	\$1,000s					
	Year 1	Year 2	Year 3	Year 4	Year 5	Total
Incentive:	\$0	\$0	\$132	\$0	\$132	\$263
Non-Incentive:	\$36	\$100	\$19	\$86	\$49	\$290
Total:	\$36	\$100	\$151	\$86	\$180	\$553

Savings Target

The savings targets shown in Exhibit 35 and Exhibit 36 have been used for planning purposes. However, the Utilities reserves the right to adjust savings targets as necessary in accordance with current market conditions, EM&V results, and program implementation experience.

Exhibit 35: Savings Targets – High Efficiency Refrigeration Incentive excluding Government Buildings

Net Savings with T&D Losses															
	<----- Program Operation ----->					----- Ramp Down as Measure Lifetime Expires ----->									
	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	Year 11	Year 12	Year 13	Year 14	Year 15
Lifetime MWh:	0	0	6,301	0	6,301	0	0	0	0	0	0	0	0	0	0
Annual MWh:	0	0	630	630	1,260	1,260	1,260	1,260	1,260	1,260	1,260	1,260	630	630	0
Coincident kW:	0	0	72	72	143	143	143	143	143	143	143	143	72	72	0

Exhibit 36: Savings Targets – High Efficiency Refrigeration Incentive including Government Buildings

Net Savings with T&D Losses															
	<----- Program Operation ----->					----- Ramp Down as Measure Lifetime Expires ----->									
	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	Year 11	Year 12	Year 13	Year 14	Year 15
Lifetime MWh:	0	0	7,580	0	7,580	0	0	0	0	0	0	0	0	0	0
Annual MWh:	0	0	694	694	1,388	1,388	1,388	1,388	1,388	1,388	1,388	1,388	758	758	128
Coincident kW:	0	0	80	80	161	161	161	161	161	161	161	161	89	89	17

Cost Effectiveness

The cost-effectiveness test results shown below in Exhibit 37 and Exhibit 38 were computed based on the assumptions presented above, namely: level of incentive, budget, and participant projections. These results are used for planning purposes. However, the Utilities reserve the right to adjust the assumptions as necessary in accordance with current market conditions, EM&V results, and program implementation experience. Consequently, actual results may differ from those presented in Exhibit 37 and in Exhibit 38.

Exhibit 37: Cost Effectiveness – High Efficiency Refrigeration Incentive excluding Government Buildings

	Total Resource Cost TRC	Program Adminis- trator Cost PAC	Participant Cost PC	Rate- Impact Measure RIM
Benefit/Cost Ratio	3.2	4.5	4.2	1.0
Net Present Value (1,000s)	\$1,183	\$1,341	\$1,197	\$36
Levelized Cost:	\$.072/kWh	\$.051/kWh	N/A	N/A

Exhibit 38: Cost Effectiveness – High Efficiency Refrigeration Incentive including Government Buildings

	Total Resource Cost TRC	Program Adminis- trator Cost PAC	Participant Cost PC	Rate- Impact Measure RIM
Benefit/Cost Ratio	3.2	4.3	4.6	1.0
Net Present Value (1,000s)	\$1,374	\$1,543	\$1,458	-\$22
Levelized Cost:	\$.073/kWh	\$.053/kWh	N/A	N/A

3.3.3 ENERGY STAR Computer Incentive

Objective

The objective of this program element is to achieve electricity and demand savings by increasing the volume of ENERGY STAR computers and computer equipment purchased and installed by reducing the initial-cost hurdle.

Target Market

The primary target market is existing office buildings in the Yukon, including Whitehorse and the smaller communities. As the territorial government already requires that new computers be ENERGY STAR qualified, the non-governmental sector is of primary interest. However, eligibility of government and institutional customers will be determined with direction from regulators.

Description

The Utilities will pay an incentive to companies and organizations to have their computer equipment replaced with ENERGY STAR computer equipment.

A prescriptive incentive approach will be as follows: the Utilities will pay a flat amount of money per unit to owners/managers when computers and computer equipment from a prescriptive list of eligible products are purchased.

Equipment eligibility is tracked using a prescriptive list, so a pre-approval step is not necessary. The participation process is therefore very straightforward: the participant will submit a simple application form and provide backup documentation (e.g. invoices) to receive the incentive payment.

Duration & Milestones

The Utilities propose to launch and operate the program over five years (20 quarters) before carrying out a new program design, filing and approval process.

The Utilities anticipate offering the ENERGY STAR Computer Incentive for a shorter period of time; perhaps up to three years. However, the Utilities retain the right to start and terminate this program element based on market conditions, and EM&V results.

The main milestones of this component are:

- Q1 of Y1: Program preparation, including engagement and communication planning
- Q3 of Y1: Program launch, including the first incentive advertisement campaign

- Q3 of Y1 to Q4 of Y3: Program Operation
- Q4 of Y3: Program is terminated
- Q3 of Y5: Draft impact evaluation report is filed with the YUB
- Q4 of Y5: New program portfolio design is filed with the YUB.

Eligible Measures

The proposed incentive level and archetype projects for the ENERGY STAR computer incentive are presented in Exhibit 39 and Exhibit 40.

Exhibit 39: Prescriptive List of ENERGY STAR Computer Conservation Measures for Non-Government Buildings

ID	Measure Short Name	Gross Annual Consumption Savings	Gross Coincident Peak Savings	Net-to-Gross Ratio	Measure Cost	Measure Lifetime	Level of Incentive
ECM101	ES Desktop Computer and Monitor	148.0 kWh/unit	0.027 kW/unit	95%	\$0.00/unit	4.0 yr	\$30.00/unit
ECM102	ES Laptop Computer	41.0 kWh/unit	0.007 kW/unit	95%	\$0.00/unit	4.0 yr	\$10.00/unit

Exhibit 40: Prescriptive List of ENERGY STAR Computer Conservation Measures for Government Buildings

ID	Measure Short Name	Gross Annual Consumption Savings	Gross Coincident Peak Savings	Net-to-Gross Ratio	Measure Cost	Measure Lifetime	Level of Incentive
ECM1012	Gov. ES Desktop Computer and Monitor	148.0 kWh/unit	0.027 kW/unit	55%	\$0.00/unit	4.0 yr	\$18.00/unit
ECM1022	Gov. ES Laptop Computer	41.0 kWh/unit	0.007 kW/unit	55%	\$0.00/unit	4.0 yr	\$6.00/unit

Prospective performance and safety qualification agents include, but are not limited to: the Office of Energy Efficiency's ENERGY STAR Program, the Canadian Standards Association, and the Underwriters Laboratories of Canada.

The Utilities reserve the right to revise eligible measures and incentive levels as needed in accordance with current market conditions, technology development, EM&V results, and program implementation experience. In addition, the Utilities reserve the right to recover the incentive money should fraud errors or omissions be identified.

Marketing & Communications Strategy

The Utilities will disseminate information, train and receive feedback from prospective participants through multiple means as described in Section 3.4.

Incentive Strategy

The Utilities will pay a flat dollar amount per unit to companies and organizations when computers and computer equipment are purchased and installed from a prescriptive list of eligible products.

The prescriptive list of eligible computer products will consist of ENERGY STAR qualified products.

The incentive will be available year-round. We propose reviewing the incentive level once per year, at the end of the year. All market actors will be made aware of the annual review. The incentive can be increased or decreased to modulate uptake and react to market circumstances.

The Utilities reserve the right to modify the incentive strategy based on initial results. For example, the Utilities may decide to direct the incentive toward the information technology suppliers rather than the shoppers. The rationale for this strategy change would be that the incentive levels, computed based on the cost-effectiveness tests, may prove to be insufficient to significantly influence shoppers. However, the incentive levels are sufficient to be a significant driver for the information technology suppliers to stock Energy Star Computers and to promote them to their customers. This is a market transformation approach that has been used successfully in other jurisdictions.

Program Theory

The theory of the ENERGY STAR computer element within the General Service Program is graphically depicted in the form of a logic model and is shown in Exhibit 41.

Exhibit 41: Logic Model of the General Service ENERGY STAR Computer Element

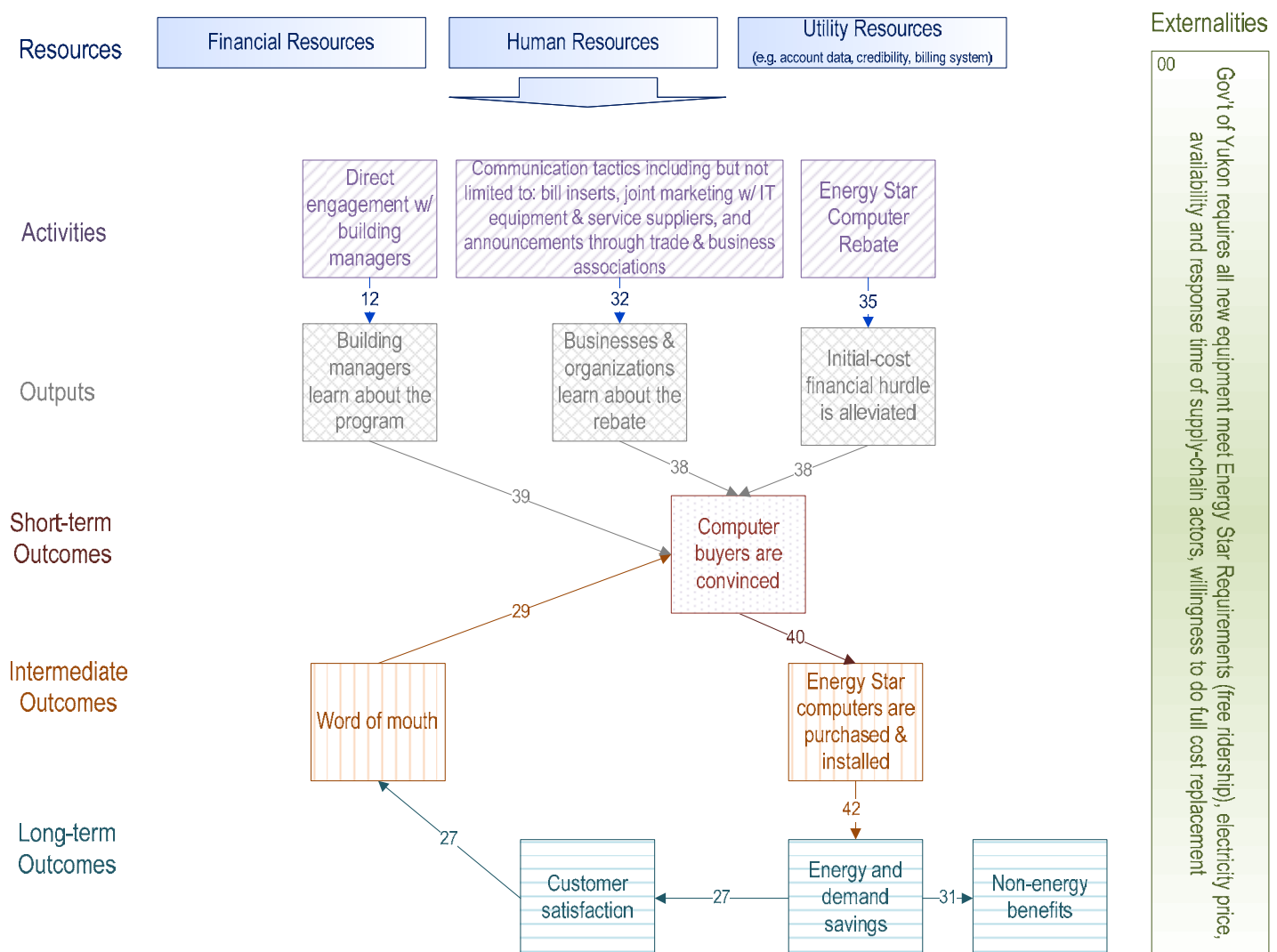


Exhibit 42 presents the narratives for the logic model shown in Exhibit 41.

Exhibit 42: Explanatory Note on the General Service ENERGY STAR Computer Incentive Theory

Link #	Narrative
00	The program effectiveness and impact will be influenced by the following externalities: the Gov't of Yukon's requirement that all new equipment meets ENERGY STAR standards (free ridership), the price of electricity, the availability and response time of supply-chain actors, and the willingness to do full cost replacements.
12	The Utilities will carry out direct engagement with building owners/managers through emails, phone calls and in-person meetings. The Utilities will present their incentive offerings and make the owners/managers aware of the benefits so that they participate in the program. Some building owners/managers also make IT equipment purchase decisions.
32	The Utilities carry out many tactics to inform computer buyers at businesses and organizations based in the Yukon. As a result, the computer buyers will learn about the incentive offering.
35	The Utilities will pay an incentive to computer buyers in exchange for the purchase of an ENERGY STAR Computer. The incentive will alleviate the initial-cost hurdle of the ENERGY STAR Computer and will be a convincing selling point.
38	Because computer buyers will know about the offering and because they are offered a rebate designed to influence them, they will buy ENERGY STAR computers.
40	ENERGY STAR computers are purchased instead of standard computers.
42	The ENERGY STAR computers will yield electricity and demand savings during their 4-year lifetime.
27	Participants will be satisfied with the ENERGY STAR computer that they purchased. They will relay their experiences to other computer buyers in the Yukon, generating word-of-mouth advertisement.
29	With time, word-of-mouth will become an important information channel that will cause computer buyers to buy more ENERGY STAR computers.
31	It is assumed that the staff using ENERGY STAR computers will have the same user-experience as with baseline systems. For example, the Utilities will seek to make sure that participants perceive that their new systems turn on and off as fast as non-ENERGY STAR computers, and that their processors are as fast, etc.

Projected Participation

The projections shown in Exhibit 43 and Exhibit 44 have been used for planning purposes. However, the Utilities reserve the right to adjust savings targets as necessary in accordance with current market conditions, EM&V results, and program implementation experience.

Exhibit 43: Participation Projections – ENERGY STAR Computer Incentive for Non-Government Buildings

ID	Measure Short Name	Year 1	Year 2	Year 3	Year 4	Year 5	Total
ECM101	ES Desktop Computer and Monitor	45 ft2	283 ft2	461 ft2	0 ft2	0 ft2	788 ft2
ECM102	ES Laptop Computer	30 ft2	188 ft2	307 ft2	0 ft2	0 ft2	525 ft2

Exhibit 44: Participation Projections – ENERGY STAR Computer Incentive for Government Buildings

ID	Measure Short Name	Year 1	Year 2	Year 3	Year 4	Year 5	Total
ECM1012	Gov. ES Desktop Computer and Monitor	178 ft2	1,130 ft2	1,844 ft2	0 ft2	0 ft2	3,153 ft2
ECM1022	Gov. ES Laptop Computer	119 ft2	754 ft2	1,229 ft2	0 ft2	0 ft2	2,102 ft2

Budget

The budgets presented in Exhibit 45 and Exhibit 46 have been used for planning purposes. However, the Utilities reserve the right to adjust program budgets as necessary in accordance with current market conditions, EM&V results, and program implementation experience. Initial budget levels are set based on conservative estimates of participation given the current market.

Exhibit 45: Budget – ENERGY STAR Computer Incentive without Government Buildings

	\$1,000s					
	Year 1	Year 2	Year 3	Year 4	Year 5	Total
Incentive:	\$2	\$10	\$17	\$0	\$0	\$29
Non-Incentive:	\$26	\$12	\$15	\$2	\$5	\$61
Total:	\$28	\$22	\$32	\$2	\$5	\$90

Exhibit 46: Budget – ENERGY STAR Computer Incentive with Government Buildings

	\$1,000s					
	Year 1	Year 2	Year 3	Year 4	Year 5	Total
Incentive:	\$6	\$35	\$57	\$0	\$0	\$98
Non-Incentive:	\$36	\$52	\$74	\$6	\$17	\$185
Total:	\$41	\$88	\$131	\$6	\$17	\$284

Savings Target

The savings targets shown in Exhibit 47 and Exhibit 48 have been used for planning purposes. However, the Utilities reserves the right to adjust savings targets as necessary in accordance with current market conditions, EM&V results, and program implementation experience.

Exhibit 47: Savings Targets – ENERGY STAR Computer Incentive Excluding Government Buildings

	Net Savings with T&D Losses														
	<----- Program Operation ----->					----- Ramp Down as Measure Lifetime Expires ----->									
	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	Year 11	Year 12	Year 13	Year 14	Year 15
Lifetime MWh:	32	205	335	0	0	0	0	0	0	0	0	0	0	0	0
Annual MWh:	8	59	143	143	135	84	0	0	0	0	0	0	0	0	0
Coincident kW:	1	11	26	26	24	15	0	0	0	0	0	0	0	0	0

Exhibit 48: Savings Targets – ENERGY STAR Computer Incentive Including Government Buildings

	Net Savings with T&D Losses														
	<----- Program Operation ----->					----- Ramp Down as Measure Lifetime Expires ----->									
	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	Year 11	Year 12	Year 13	Year 14	Year 15
Lifetime MWh:	107	681	1,111	0	0	0	0	0	0	0	0	0	0	0	0
Annual MWh:	27	197	475	475	448	278	0	0	0	0	0	0	0	0	0
Coincident kW:	5	35	85	85	80	50	0	0	0	0	0	0	0	0	0

Cost Effectiveness

The cost-effectiveness test results shown in Exhibit 49 and Exhibit 50 were computed based on the assumptions presented above, namely: level of incentive, budget, and projections. They are used for planning purposes. However, the Utilities reserve the right to adjust the assumptions as necessary in accordance with current market conditions, EM&V results, and program implementation experience. Consequently, actual results may differ from those presented below.

Exhibit 49: Cost Effectiveness – ENERGY STAR Computer Incentive excluding Government Buildings

	Total Resource Cost TRC	Program Adminis- trator Cost PAC	Participant Cost PC	Rate- Impact Measure RIM
Benefit/Cost Ratio	1.8	1.2	*	0.6
Net Present Value (1,000s)	\$44	\$18	\$106	-\$58
Levelized Cost:	\$.122/kWh	\$.178/kWh	N/A	N/A

*There is no incremental cost to the Participant to purchase an ENERGY STAR computer.

Exhibit 50: Cost Effectiveness – ENERGY STAR Computer Incentive including Government Buildings

	Total Resource Cost TRC	Program Adminis- trator Cost PAC	Participant Cost PC	Rate- Impact Measure RIM
Benefit/Cost Ratio	2.0	1.3	*	0.6
Net Present Value (1,000s)	\$166	\$78	\$560	-\$213
Levelized Cost:	\$.108/kWh	\$.166/kWh	N/A	N/A

*There is no incremental cost to the Participant to purchase an ENERGY STAR computer.

3.3.4 Building New Construction Incentive

Objective

This program element will achieve electricity and demand savings by improving the electrical performance of new buildings.

Target Market

The primary target market is new buildings in the Yukon including Whitehorse and the communities. The eligibility of government and institutional customers will be determined with direction from the regulator.

Description

The Utilities will pay an incentive to new building owners/managers for electricity-efficient new building construction. The incentive will have two paths: a prescriptive path for small buildings and a custom path for large buildings.

On a preliminary basis, the Utilities envision that there will be a minimum size eligibility requirement for these paths.

Prescriptive Path of the Electricity-Efficient New Construction Incentive

Under the prescriptive path, the incentive will be determined using a dollar-per-square foot rate if the building complies with a certain standard. The standard will be designed to be slightly more stringent than the Model National Energy Building Code minus 25% (MNEBC -25%) and the City of Whitehorse's Building and Plumbing Bylaw. The former includes more prescriptive requirements and covers more building systems, and the latter has more stringent insulation and infiltration requirements.

The Utilities are envisioning two different approaches to proving compliance with standard under the prescriptive path. The final decision on this will be made at the program preparation stage.

- A list of prescriptive requirements similar to but superior to the City of Whitehorse's Building and Plumbing Bylaw.
- Meeting a minimum performance threshold when using the NRCAN EE4 Screening Tool. The screening tool is a simple building energy model interface that is very accessible and

that was tested for the Yukon climate by the Yukon Energy Solutions Centre.⁵ Therefore, the Utilities believe that there will be a good level of acceptance and adoption of the tool.

Custom Path of the Electricity-Efficient New Construction Incentive

The custom incentive will be determined using a dollar per kilowatt-hour of annual savings rate for each kilowatt-hour of savings that are realized above a minimum level. Under the custom path, savings will be determined through building energy modeling.

The modeling requirements will be the same as for the Canadian Green Building Council's LEED building certification⁶. The LEED building endorsement label already has some penetration in the Yukon, therefore we believe that tying the program requirements to that of LEED will ease the acceptance of the program by the local building industry players and will reduce the level of effort required to file an application, while maintaining a high standard of quality.

Participation Process

The participation process for the building new construction program component is shown in Exhibit 51. As shown:

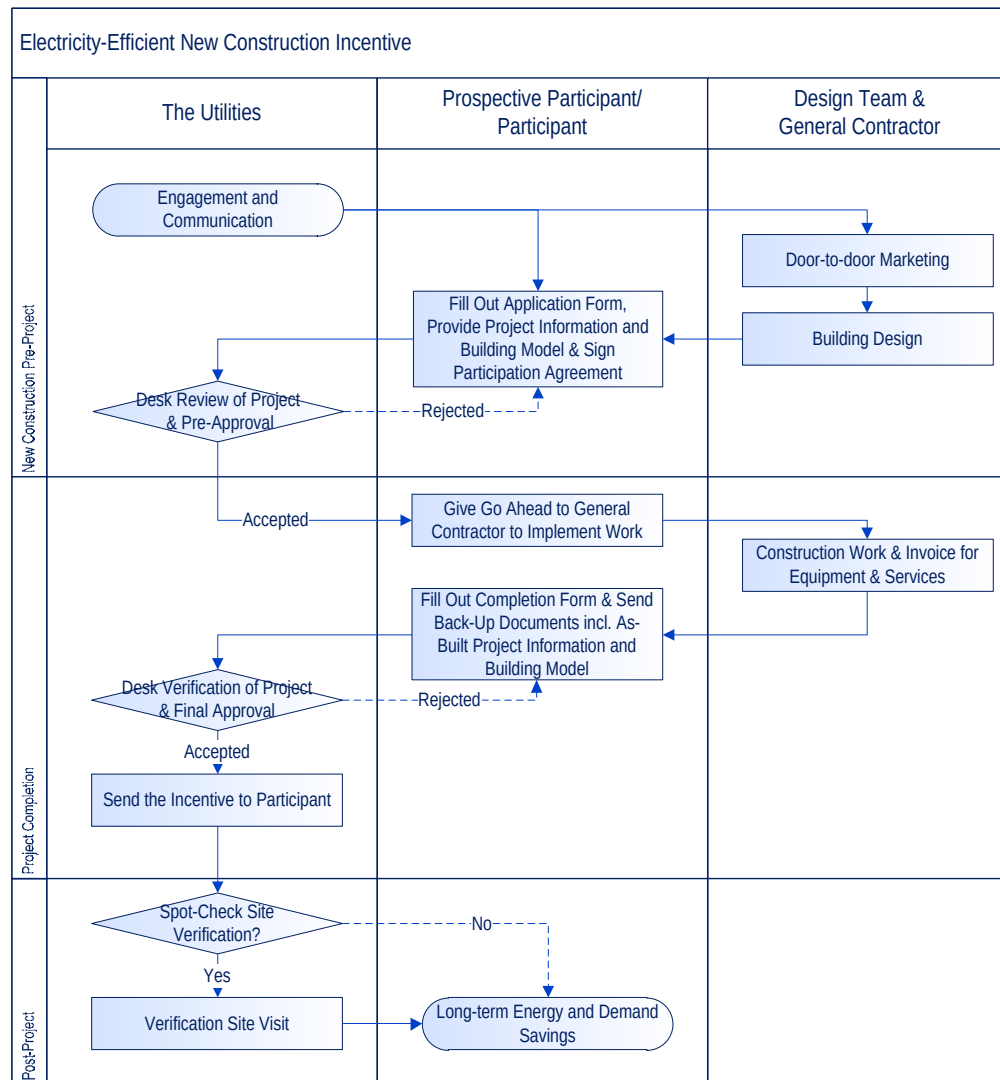
- There will be a "pre-approval" step in order to check eligibility criteria and estimate the incentive amount for a single building or set of buildings. The construction work will not start before the project is pre-approved. The Utilities will track application-processing time and will make sure it meets application turnaround targets.
- After completion of the installation work, the participant will submit a completion form and provide backup documentation, including the as-built project documentation and as-built building energy model, to receive his/her incentive payment.
- If and when any application or form is rejected by the Utilities, the applicant will be informed and provided with information on what is missing and/or what to change. Applicants will be able to talk to their account manager to get support.
- A sample of projects will be selected for site verification. The verification will check a significant portion of the information that was provided in the application form, completion form and in the backup documentation. Incentives may be recovered if errors, omission or fraud are uncovered.
- The site verification selection will be made based on a sampling plan that will be prepared during the implementation planning. As many of the projects as practical will be subjected to a site visit and as-built drawings will also be requested when appropriate. In general, larger projects will be more likely to be visited; but no projects will be off limit.

The task and responsibilities of the parties involved (i.e. the Utilities, the participant and the suppliers) will be clearly laid out and defined on the basis of Exhibit 51.

⁵ Hepting, Curt. *Verification Analysis of Natural Resources Canada's Screening Tool Follow Up Study*, Energy Solutions Centre, 31 March 2010. Available at http://www.energy.gov.yk.ca/pdf/screening_tool_followup_mar2010.pdf.

⁶ LEED certification will not be an eligibility criterion. However, the modeling requirements for this program will be consistent with those for the LEED New Construction Energy and Atmosphere Pre-Requisite 2 and Credit 1.

Exhibit 51: Participation Process for the New Construction Element



Duration & Milestones

The Utilities propose to launch and operate the program for a period of five years (20 quarters) before going through a new program design, filing and approval process.

Assuming that this program begins in the first quarter of Year 1 (Q1 of Y1), finishes in the last quarter of Y5, the main milestones of this component are:

- Q1 of Y1: Program preparation, including engagement and communication planning
- Q2 of Y1: Program launch, including the first incentive advertisement campaign
- Q3 of Y1: Incentive level for the next year is planned and then disseminated
- Q1 of Y2: Report on the impacts of the incentive
- Y2, Y3, Y4, and Y5: Repeat the same cycle as described above
- Q3 of Y5: Draft impact evaluation report is filed with the YUB
- Q4 of Y5: New program portfolio design is filed with the YUB
- Q1 of Y6: Program component is either terminated or updated to fit new market circumstances

Eligible Measures

The proposed incentive level as well as archetype projects are presented in Exhibit 52 and in Exhibit 53.

Exhibit 52: Archetype Electricity-Efficient Non-Government New Construction Projects

ID	Measure Short Name	Gross Annual Consumption Savings	Gross Coincident Peak Savings	Net-to-Gross Ratio	Measure Cost	Measure Lifetime	Level of Incentive	Size of Archetype Building
ECM89	Typical High-Performance New Building - 25% Better	5.93 kWh/ft ²	.00135 kW/ft ²	95%	\$2.00/ft ²	20.0 yr	\$1.50/ft ²	11,759 ft ²
ECM90	Typical High-Performance New Building - 40% Better	9.49 kWh/ft ²	.00217 kW/ft ²	95%	\$6.00/ft ²	20.0 yr	\$4.00/ft ²	11,759 ft ²

Exhibit 53: Archetype Electricity-Efficient Government New Construction Projects

ID	Measure Short Name	Gross Annual Consumption Savings	Gross Coincident Peak Savings	Net-to-Gross Ratio	Measure Cost	Measure Lifetime	Level of Incentive	Size of Archetype Building
ECM892	Gov. Typical High-Performance New Building - 25% Better	5.93 kWh/ft ²	.00135 kW/ft ²	95%	\$2.00/ft ²	20.0 yr	\$0.90/ft ²	26,209 ft ²
ECM902	Gov. Typical High-Performance New Building - 40% Better	9.49 kWh/ft ²	.00217 kW/ft ²	95%	\$6.00/ft ²	20.0 yr	\$2.40/ft ²	26,209 ft ²

The dollars per square foot rates are used for planning purposes. As per the incentive strategy, participants will be offered dollars per kWh of annual savings. The \$/ft² will be converted into a \$/kWh at the program launch preparation stage.

The program performance will be modeled using the archetype projects presented in Exhibit 52 and in Exhibit 53. However, during program implementation, each transaction will be treated as a custom project, with a specific level of electricity and demand savings, and a specific total incentive amount. Measure lifetime is assumed to be 15 years and net-to-gross ratio is assumed to be 95% in all cases.

The Utilities reserve the right to revise incentive level as needed in accordance with current market conditions, technology development, EM&V results, and program implementation experience. In addition, the Utilities reserve the right to recover the incentive money should fraud errors or omissions be identified.

Marketing & Communications Strategy

The Utilities will disseminate information, train and receive feedback from the building owner/managers, and the building industry actors through multiple means as described in Section 3.4. To promote uptake of the electricity-efficient new construction incentive component, the Utilities will focus primarily on the supply-chain and the building owners/managers channels.

Incentive Strategy

Prescriptive Path of the Electricity-Efficient New Construction Incentive

Under the prescriptive path, the incentive will be determined using a dollar-per-square foot rate *if* the building complies with a certain standard. The standard will be designed to be slightly more stringent than the Model National Energy Building Code minus 25% (MNEBC -25%) *and* the City of Whitehorse's Building and Plumbing Bylaw. The former includes more prescriptions and covers more building systems, and the latter has insulation and air tightens requirements that are more stringent.

The incentive level will be refined during the planning and preparation stage by the Utilities at the program set-up stage. The incentive level will be consistent with the incentive level achieved through the custom path although slightly lower and without the possibility to increase the incentive by realizing more savings.

Custom Path of the Electricity-Efficient New Construction Incentive

The custom incentive will be determined using a dollar per kilowatt-hour of annual savings rate for each kilowatt-hour of savings that are realized above a minimum level. Savings will be determined through building energy modeling.

The modeling requirements will be the same as those for the Canadian Green Building Council's LEED building certification⁷. The baseline used will be the same (MNEBC -25%), which means that buildings that comply with the Whitehorse's Building and Plumbing Bylaw should already generate savings when compared with the baseline. In order to correct for this, the Utilities will establish a certain minimum number of LEED Energy and Atmosphere Credit 1 points under which no incentive will be awarded.

The Utilities envision creating "brackets" based on the LEED energy-efficiency performance point system; and modulating the \$/kWh rate that is used to compute the incentive for each bracket. For example, the rate used to establish the amount of incentive for buildings achieving 13 to 15 EA CR 1 points would be higher than the rate used for buildings achieving 10 to 12 EA CR 1 points. Participants who invest in costly yet highly efficient and innovative systems such as cold climate heat pumps (CCHP) or ground source heat pumps (GSHP) will therefore get a larger incentive.

⁷ LEED certification will not be an eligibility criterion. However, the modeling requirements for this program will be consistent with those for the LEED New Construction Energy and Atmosphere Pre-Requisite 2 and Credit 1.

Program Theory

The theory of the lighting redesign and equipment incentives of the General Service Program has been graphically depicted in the form of a logic model in Exhibit 54.

Exhibit 54: Logic Model of the General Service New Construction Incentive

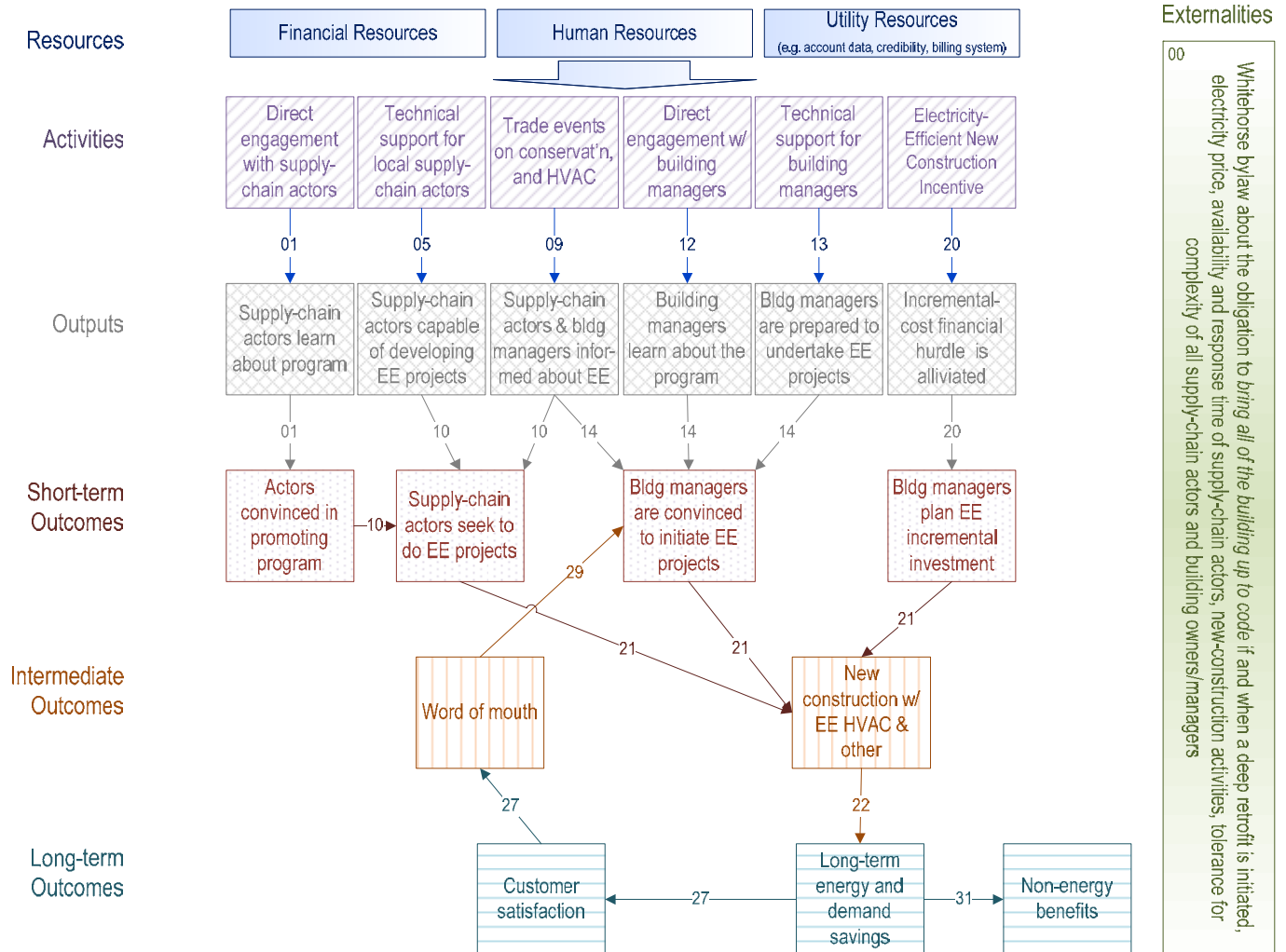


Exhibit 55 presents the narratives of the logic model shown in Exhibit 54.

Exhibit 55: Explanatory Note on the General Service New-Construction Incentives Theory

Link #	Narrative
00	The program effectiveness and impact will be influenced by the following externalities: Whitehorse bylaws on the obligation to bring all of the buildings up to code if and when deep retrofits are initiated, the price of electricity, the availability and response time of supply-chain actors, new-construction activities, and tolerance for complexity of all supply-chain actors and building owners/managers. The program administrator should monitor these externalities and adapt the implementation approach as necessary.
01	The Utilities will carry out direct engagement with electrical distributors, lighting designers, electrical contractors, as well as with HVAC contractors, HVAC designers, control designers and architects through emails, phone calls and in-person meetings. The Utilities will present their incentive offerings and engage with supply-chain actors so that they promote them.

Link #	Narrative
05	The Utilities will offer technical support to the supply-chain actors in two different forms: (1) hands-on training on the program tools, forms and procedures; on advanced electricity efficiency lighting design; and on the business aspects of electricity efficiency: energy audits, business cases, energy performance contracting, and electricity efficiency financing. (2) The Utilities will act as a broker to procure technical expertise from highly specialized lighting experts recruited throughout North America upon request from the local actors. In addition, the Utilities will disseminate information on recommended lighting equipment (brand-neutral, to the extent possible) in the form of printed brochures, newsletters or web content.
09	The Utilities propose to support any form of trade organizations or trade events by sponsoring and attending trade events that gather local building owners/managers and/or supply-chain actors. The Utilities intend to strengthen or create platforms that allow local energy conservation practitioners to present their success stories, and share their lessons learned.
10	Supply-side actors will actively seek to develop projects because they were engaged with by the Utilities, because they were trained and are capable of offering electricity-efficiency services, and because they were provided with networking opportunities with potential clients (building owners/managers) at trade events.
12	The Utilities will carry out direct engagement with building owners/managers through emails, phone calls and in-person meetings; and through public relations activities like press releases sent to the local newspapers and radio, web content, and joint events with the Whitehorse Chamber of Commerce. The Utilities will present their incentive offerings and make the owners/managers aware of the benefits so that they participate in the program.
13	The Utilities will offer customized technical support to building owners/managers to help them to initiate projects. The Utilities could include support to plan investment in assets, and to identify in which buildings to develop projects; support to make optimal decisions on implementation and procurement approach, and support before and during the tendering of project design services, particularly if the procurement approach is energy performance contracting (EPC).
14	Building owners/managers agree to initiate electricity efficiency projects because they were informed about the program components by the Utilities, because they were provided with technical support to decide where to start and how to do it, and because they networked with supply-side actors, perhaps at the trade events supported by the Utilities.
20	The Utilities will pay an incentive to new building owners/managers for electricity-efficient new buildings construction. The incentive will alleviate the initial-cost hurdle of the construction of electricity-efficient buildings. The incentive will be performance-based and be paid for buildings that are more electricity efficiency than the combination of the 2011 National Energy Code of Canada for Building and the City of Whitehorse's Building and Plumbing Bylaw.
21	Electricity-efficient new buildings constructions are implemented because the supply-chain actors were seeking to work on electricity-efficient new construction projects, and because the initial-cost hurdle of the construction of electricity-efficient buildings was alleviated.
22	The electricity-efficient new buildings will yield long-term electricity and demand savings.
27	Building owners/managers will be satisfied by the projects that they implemented. They will tell other people in the building industry; perhaps at the trade events supported by the utilities. This will generate word-of-mouth advertisement.
29	With time, word-of-mouth will become an important information channel that will cause building owners/managers and supply-chain actors to implement more projects.
31	It is assumed that owners/managers will perceive new non-energy benefits; and/or the maintenance of benefits they used to have with baseline systems. For example, the Utilities will seek to make sure that participants perceive that their new systems are more comfortable, are less costly to maintain, have higher tenant satisfaction and retention, generate fewer complaints, and have increased property value.

Projected Participation

The projections shown in Exhibit 56 and in Exhibit 57 have been used for planning purposes. However, the Utilities reserve the right to adjust savings targets as necessary in accordance with current market conditions, EM&V results, and program implementation experience.

Exhibit 56: Participation Projections – Electricity-Efficient New Construction Incentive for Non-Government Buildings

ID	Measure Short Name	Year 1	Year 2	Year 3	Year 4	Year 5	Total
ECM89	Typical High-Performance New Building - 25% Better	0 f2	1,992 f2	8,966 f2	13,947 f2	15,939 f2	40,844 f2
ECM90	Typical High-Performance New	0 f2	311 f2	1,401 f2	2,179 f2	2,490 f2	6,382 f2

Exhibit 57: Participation Projections – Electricity-Efficient New Construction Incentive for Government Buildings

ID	Measure Short Name	Year 1	Year 2	Year 3	Year 4	Year 5	Total
ECM892	Gov. Typical High-Performance New Building - 25% Better	0 f2	1,073 f2	4,828 f2	7,510 f2	8,583 f2	21,993 f2
ECM902	Gov. Typical High-Performance	0 f2	168 f2	754 f2	1,173 f2	1,341 f2	3,436 f2

Budget

The budgets presented in Exhibit 58 and in Exhibit 59 have been used for planning purposes. However, the Utilities reserve the right to adjust program budgets as necessary in accordance with current market conditions, EM&V results, and program implementation experience. Initial budget levels are set based on conservative estimates of participation given the current market.

Exhibit 58: Budget – Electricity-Efficient New Construction Incentive excluding Government Buildings

	\$1,000s					
	Year 1	Year 2	Year 3	Year 4	Year 5	Total
Incentive:	\$0	\$4	\$19	\$30	\$34	\$87
Non-Incentive:	\$27	\$7	\$5	\$31	\$13	\$83
Total:	\$27	\$12	\$24	\$61	\$47	\$170

Exhibit 59: Budget – Electricity-Efficient New Construction Incentive including Government Buildings

	\$1,000s					
	Year 1	Year 2	Year 3	Year 4	Year 5	Total
Incentive:	\$0	\$6	\$25	\$39	\$45	\$115
Non-Incentive:	\$28	\$9	\$6	\$33	\$16	\$93
Total:	\$28	\$15	\$32	\$72	\$61	\$208

Savings Target

The savings targets shown in Exhibit 60 and in Exhibit 61 have been used for planning purposes. However, the Utilities reserves the right to adjust savings targets as necessary in accordance with current market conditions, EM&V results, and program implementation experience.

Exhibit 60: Savings Targets – Electricity-Efficient New Construction Incentive excluding Government Buildings

	Net Savings with T&D Losses														
	<----- Program Operation ----->					----- Ramp Down as Measure Lifetime Expires ----->									
	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	Year 11	Year 12	Year 13	Year 14	Year 15
Lifetime MWh:	0	306	1,377	2,142	2,448	0	0	0	0	0	0	0	0	0	0
Annual MWh:	0	15	84	191	314	314	314	314	314	314	314	314	314	314	314
Coincident kW:	0	3	19	44	72	72	72	72	72	72	72	72	72	72	72

Exhibit 61: Savings Targets – Electricity-Efficient New Construction Incentive including Government Buildings

	Net Savings with T&D Losses														
	<----- Program Operation ----->					----- Ramp Down as Measure Lifetime Expires ----->									
	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	Year 11	Year 12	Year 13	Year 14	Year 15
Lifetime MWh:	0	471	2,118	3,295	3,766	0	0	0	0	0	0	0	0	0	0
Annual MWh:	0	24	129	294	483	483	483	483	483	483	483	483	483	483	483
Coincident kW:	0	5	30	67	110	110	110	110	110	110	110	110	110	110	110

Cost Effectiveness

The cost-effectiveness test results in Exhibit 62 and in Exhibit 63 were computed based on the assumptions presented above: level of incentive, budget, and projections. They are used for planning purposes. However, and since the Utilities reserve the right to adjust the assumptions as necessary in accordance with current market conditions, EM&V results, and program implementation experience; consequently, actual results may differ from those presented below.

Exhibit 62: Cost Effectiveness – Electricity-Efficient New Construction Incentive excluding Government Buildings

	Total Resource Cost TRC	Program Adminis- trator Cost PAC	Participant Cost PC	Rate- Impact Measure RIM
Benefit/Cost Ratio	4.2	4.8	6.3	1.0
Net Present Value (1,000s)	\$520	\$542	\$518	\$25
Levelized Cost:	\$.059/kWh	\$.051/kWh	N/A	N/A

Exhibit 63: Cost Effectiveness – Electricity-Efficient New Construction Incentive including Government Buildings

	Total Resource Cost TRC	Program Adminis- trator Cost PAC	Participant Cost PC	Rate- Impact Measure RIM
Benefit/Cost Ratio	4.7	6.1	6.7	1.0
Net Present Value (1,000s)	\$832	\$881	\$848	\$21
Levelized Cost:	\$.051/kWh	\$.040/kWh	N/A	N/A

3.4 Engagement, Training and Communication

Engagement, training and communication will generate uptake among building owner/managers and occupants in the Yukon for all of the General Service Program, and thereby enable long-term electricity and demand savings.

Communication, training, and engagement are key components of DSM programs, and it is a good practice to resource these activities properly. Proper communications, training, and engagement are essential to stimulate program uptake and therefore DSM incentive performance. Communication, training and engagement also contribute to the incentive to establish a real causal effect between the DSM program and the accelerated adoption of electricity-efficient technologies and services. In other words: without communications, education and engagement, incentive claims (if any) are very likely to be made by the few building owners/managers who would have invested in electricity efficiency anyway – the so-called “freeriders”.

Target Market

The target market includes all of the building owners/managers and occupants in the Yukon, including those in Whitehorse and in other communities.

In order to serve the purpose of the GSP, the engagement, training and communication activities and tactics will focus primarily on:

- Yukon lighting equipment and service supply-chain actors: primarily electrical distributors and lighting designers, but also electrical contractors
- Yukon HVAC equipment and service supply-chain actors: primarily HVAC designers, control contractors and HVAC contractors
- Yukon New Building developers, general contractors and architects
- Building owners/managers, including primarily non-governmental owners/managers, but also governmental owner/managers. The same market actors are involved in both retrofit and new construction.
- Building occupants (renters), including the people who make decisions related to equipment purchases as well as work space renovation and interior design investment.

Description

The Utilities will disseminate information and receive feedback from the building industry and building occupants through five main channels: the lighting supply chain, the HVAC supply chain, the new construction developers, the building owners/managers and the building

occupants. The number of actors in Yukon in the first four channels is fairly small, and thus the proposed approach is primarily based on direct engagement and account management. The number of actors in the fifth channel is larger and, therefore, the Utilities plan on utilizing communication tactics such as bill inserts, email blast, and joint marketing with information technology equipment and service suppliers.

Lighting Supply Chain Channel

Reaching out to the lighting supply chain channel is particularly important because lighting is the electricity end use with the largest share of achievable potential in buildings. Consequently, the main components aimed at the existing building sector focus on lighting. The Utilities intend to use the following tactics to reach out to the lighting supply chain channel:

- Direct engagement with electrical distributors and lighting designers: emails, phone calls and in-person meetings
- Engagement with hard-to-reach electrical contractors through the following tactics:
 - Collaboration with electrical distributors: for instance, early morning breakfast training sessions on program offerings in the showroom of electrical distributors.
 - Through the health and safety training from the Utilities for electrical contractors.
- Technical support in the form of hands-on training, in particular at the beginning of the program:
 - On the use of the standardized incentive calculation tool, and the program forms and procedures.
 - On advanced electricity efficiency lighting design.
 - On the business aspect of electricity efficiency: energy audits, business cases, energy performance contracting, and energy efficiency financing.
- Customized technical support: Upon request from the local actors, the Utilities will act as a broker to procure technical expertise from highly specialized lighting experts recruited from throughout North America. The local actors will be able to consult with these experts to work on specific projects and improve their design skills and professional competencies.
- Dissemination of information on recommended lighting equipment (brand-neutral, to the extent possible) in the form of printed brochures, newsletters or web content. The Utilities will provide information on relevant equipment electricity efficiency labels, equipment qualification agents, and the sort of equipment that they qualify. For example, the types of equipment could be: high-performance T8 fluorescents & ballast, qualified LED products, and high-performance fixture retrofit kits. Relevant agents and labels include: the Office of Energy Efficiency's EnergyStar Program, the DesignLights Consortium or, the Consortium for Energy Efficiency.
- With permission, the Utilities will leverage publicly-available educational materials created by other DSM program administrators such as BC Hydro, SaskPower or Manitoba Hydro.

HVAC and New-Construction Supply Chain Channels

The Utilities will reach out to the supply-chain channels, in particular, to increase the uptake of the new-construction program and to promote comprehensive projects in buildings. The Utilities intend to use the following tactics to reach out to the HVAC and New-Construction supply-chain channel:

- Direct engagement with HVAC designers, HVAC contractors, control contractors, general contractors and architects
- Engagement with hard-to-reach contractors through the following tactics:
 - Collaboration with distributors: for instance, short early morning breakfast training sessions on program offerings.
 - Through the health and safety training of the Utilities to electrical contractors

- Technical support in the form of hands-on training, in particular at the beginning of the program:
 - On building modeling requirements, and on the program forms and procedures.
 - On business aspects of electricity efficiency: energy audits, business cases, energy performance contracting, and energy efficiency financing
- Customized technical support: Upon request from the local actors, the Utilities will act as a broker to procure technical expertise from highly specialized HVAC experts recruited throughout North America. The local actors will be able to consult with these experts to work on specific projects and improve their design skills.

Building Owners/Managers Channel

The Utilities will offer personalized support and key-account management to building owners/managers who are among the largest customers in the Yukon. The owners/managers are the prospective participants in all program components; thus, engaging them is critical to the success of the program. The Utilities intend to use the following tactics to engage them:

- Customized support to plan investment in assets, and to identify which buildings to develop projects in
- Customized support to optimize decisions on implementation and procurement approaches
- Support before and during the tendering of project design services, particularly if the procurement approach is energy performance contracting (EPC)
- Public relation activities including press releases to the local newspapers and radio stations, web content, and joint events with applicable trade, commerce, non-profit and community organizations.

The Utilities will adapt their technical support offering to both non-government and government owner/managers.

The Utilities will use their direct-engagement activities to disseminate info about the Energy Solutions Centre list of providers to increase value for the owners/managers and create synergy between stakeholders.

The Utilities acknowledge the benefit of comprehensive electricity efficiency retrofit projects in buildings. The Utilities will encourage such projects when relevant and seek collaboration with the ESC on projects that involve heating oil. Participation in the lighting redesign incentive and the lighting incentive can easily be integrated in a comprehensive project.

Trade Events

Currently, there are very few trade associations and trade events that gather personnel from the energy efficiency and building industries in the Yukon. In Southern jurisdictions, the industries gather around chapters of associations such as the American Society of Heating, Refrigerating and Air Conditioning Engineers (ASHRAE), the Building Owners and Managers Association (BOMA), or the Illuminating Engineering Society (IES). None of these organizations have chapters in the Yukon.

The Utilities propose to address this hurdle by supporting some form of trade organizations or trade events by sponsoring and attending trade events that gather local building owners/managers and/or supply-chain actors.

Initially, the utilities will support existing trade events that have to do with lighting design or advanced HVAC design. With time and if early initiatives are successful, the Utilities will explore the possibility of financing and organizing an annual stand-alone trade event in Whitehorse.

The Utilities intend to strengthen or create platforms that allow local energy conservation practitioners to present their success stories and share their lessons learned. Practitioners

should be able to network within the Yukon and also with manufacturer reps and agents from outside the Yukon. The Utilities will also use the trade events to advertise all of their programs.

To support the events, the Utilities envision using one or several of the following tactics:

- Small grants to support the logistics of the events
- Attendance and presentation of content at the events – case studies, information on program offerings, etc.
- Dissemination of information about the events through other media used by the Utilities (email blast, newsletter, website content, direct engagement, etc.)
- Support for well-known experts in the lighting or HVAC field to come to the Yukon (perhaps representatives from the IES or from ASHRAE) in the form of an allocation to pay for transportation and accommodations
- Engagement with manufacturer reps or agents in Northern BC and Northern Alberta with the intention of convincing them to attend the events. (For example, the Utilities could invite reps from OSRAM/Sylvania, GE, Philips, Canlite, Lithonia, Cooper, Mitsubishi, Honeywell, Siemens, Johnson Controls, Lennox, etc.).

Building Occupants

The Utilities need to reach out to building occupants (renters) to promote the ENERGY STAR Computer Rebate. In particular, the Utilities need to inform the people involved in the purchase of information technology equipment. In order to achieve this, Utilities plan on utilizing communication tactics such as:

- Bill inserts
- Email blasts
- Joint marketing with information technology equipment and service suppliers
- Documentation related to the program (e.g., brochure) passed on to occupants by the building owners/managers.

It is assumed that some participating building owners/managers will also make purchase decisions related to information technology equipment.

Duration & Milestones

The Utilities propose to launch and operate the program for a period of five years (20 quarters) before going through a new program design, filing and approval process.

Assuming that this program begins in the first quarter of Year 1 (Q1 of Y1), and finishes in the last quarter of Y5, the main milestones of this component are:

- Q1 of Y1: Lay out engagement, training and communication strategy for the year
- Q2, Q3 and Q4 of Y1: Ramp up the communication and direct engagement activities
- Q3 and Q4 of Y1: Training offerings
- Q1 of Y2: Report on the impacts of the engagement, education and communication component
- Y2, Y3, Y4, and Y5: Repeat the same cycle as described above
- Q3 of Y5: Draft impact evaluation report is filed with the YUB
- Q4 of Y5: New program portfolio design is filed with the YUB
- Q1 of Y6: Program component is either terminated or updated to fit new market circumstances.

Budget

The budgets presented in Exhibit 62 and Exhibit 63 have been used for planning purposes. However, the Utilities reserve the right to adjust program budgets as necessary in accordance with current market conditions, EM&V results, and program implementation experience. Initial budget levels are set based on conservative estimates of participation given the current market.

Exhibit 64: Budget – Engagement, Training and Communication excluding Government Buildings

	\$1,000s					
	Year 1	Year 2	Year 3	Year 4	Year 5	Total
Incentive:	\$0	\$0	\$0	\$0	\$0	\$0
Non-Incentive:	\$169	\$253	\$225	\$176	\$221	\$1,043
Total:	\$169	\$253	\$225	\$176	\$221	\$1,043

Exhibit 65: Budget – Engagement, Training and Communication including Government Buildings

	\$1,000s					
	Year 1	Year 2	Year 3	Year 4	Year 5	Total
Incentive:	\$0	\$0	\$0	\$0	\$0	\$0
Non-Incentive:	\$202	\$290	\$255	\$200	\$252	\$1,199
Total:	\$202	\$290	\$255	\$200	\$252	\$1,199

4 Proposed Residential Program

This section presents a description of the proposed Residential Program as well as a detailed description of each of the proposed program elements. The proposed program offerings set out in this section have been developed based on the results of market information collected during the research phase of this program design study.

The remainder of this section is organized and presented as follows:

- Market Research Results
- Program Overview
- Description of Program Elements

The Utilities made the working assumption that all residential ratepayers would be eligible to participate in the Residential Program.

4.1 Market Research Results

This section presents a summary of the information gathered during the market characterization phase. The market characterization was primarily focused on retailers and shoppers for lighting equipment and domestic appliances; and on housing developers. Lighting products and domestic appliances were selected because of the predominance of rebates as the preferred tool to increase the penetration of electricity efficiency among these items. Rebates were perceived as being an essential component of a program implemented with retail channel partners.

The detailed reports of the characterization studies can be found in Appendix C. The main conclusions of these studies, which form the basis for the proposed program design, are presented below

Existing Residential Energy Conservation Programs

The main findings with regard to existing residential energy conservation programs in the Yukon are:

- The Yukon residential sector currently has a number of conservation program elements. As illustrated in Exhibit 66, they include: the Good Energy Program and the Refrigerators and Freezer Retirement Program by the ESC, the Green and SuperGreen home, the engagement and training for housing developers, and the House Repair programs by Yukon Housing. These initiatives provide value to the Yukon; however, they do restrict the DSM playing field for the Utilities in the residential sector if overlaps are to be avoided.
- Retailers and shoppers like the ESC Good Energy Rebate program for domestic appliances. ENERGY STAR appliances penetration is high, likely because of the program. There seems to be very little space left for the Utilities in this portion of the retail distribution channel.

Characteristics of the Retail Distribution Channel

Highlights of key characteristics of the Yukon retail distribution channel that are most relevant to this program include:

- Lighting equipment is mostly sold through big-box retail stores and home renovation stores, and, to a lesser extent by appliance stores. There is no specialized residential lighting store/distributor in the Yukon.
- Big-box retail stores, home renovation stores and appliance store managers are keen to participate in joint initiatives with the Utilities.
- Store managers already use information from other DSM programs (BC Hydro, etc.)
- Store managers are dealing with a human resource shortage. If the Utilities partner with stores, they will need to minimize additional demands on store staff.
- “Green” corporate positioning (messages and banners) is already in stores. However, we observed no messaging or merchandizing strategies targeting specific products or efficiency measures.
- The Utilities could be seen by shoppers as a credible independent party that could endorse certain products or provide information. Information provided by stores without the Utilities’ brand might be received with natural scepticism by consumers.
- An independent lighting supplier selling LED products could be engaged and offered the same support as big-box stores and home renovation stores.
- Sales of lighting products to businesses and government buildings by retailers are significant. Both the Residential Program and the GSP program will need to have coherent offerings and tactics. The education materials created for the Residential Program could be used for the GSP program and vice versa.
- Yukon retailers select and order products from national or regional warehouses as if they were located in large southern Canadian cities like Toronto or Vancouver. On the other hand, it seems to be common knowledge among Yukoners that fewer products are offered in the stores and that there is a one- to five-year lag time between new products appearing on the shelves in the South and the same products arriving on the shelves in the Yukon. The reasons for this could be lower demand, less space (thus fewer stock-keeping units), simple oversight, or limited interaction with other store managers or exposure to other stores.
- If store managers foresee an increase in demand or if the Utilities are able to partner and work with them that it is likely to occur, many managers would agree to stock newer electricity efficiency products faster than they would in the absence of a program.

Shoppers’ Purchase Barriers and Drivers

The following observations provide insight into shoppers’ purchase decision making process:

- Even if shoppers are sceptical of the information received, the primary source of information used to make purchase decisions is from the store where the purchase is made.
- The second and third preferred sources of information for shoppers are friends and relatives, and websites displaying user-generated content.
- The Utilities’ research on the effectiveness of social media indicated that social media is not as effective in the Yukon as they are in other jurisdictions.
- Supply-chain actors all agreed that the main purchase drivers for lighting equipment and domestic appliances is price point; and thus that the main purchase barrier is the high initial cost barrier.
- End-users report that *environmental considerations* and *monetary savings on energy bills* are their top purchase drivers – far in front of *lower/lowest price*. Although these answers may be tainted with the social-desirability bias, *environmental considerations* and *monetary savings on energy bills* are drivers that should nevertheless be emphasized.

- Shoppers were concerned that no proper waste handling facilities exist in the Yukon for compact fluorescent lamps given the hazardous mercury content of the lamps. This is a valid concern and the Utilities are sensitive to it.
- In the lighting section of a Yukon store, we observed significant shelf space dedicated to CFL lamps; in most cases more than the shelf space dedicated to incandescent or halogen equivalents. Energy-Star CFLs and CFL PAR lamps have significantly less shelf space, but were sold in all stores that we visited. It could be concluded that CFLs are on their way to saturation without a push from any form of DSM program.
- LED lamps consistently represented less than 10% of the shelf space in the stores we visited. Market penetration is limited; the cost barrier is significant. Globally, solid state lighting products are currently experiencing rapid price decline, together with continued improvements in performance efficacy and functionality. Average year-over-year price reductions are expected to be approximately 13% for commercial solid state lighting lamps and fixtures between 2011 and 2021, yielding a price reduction of approximately 75% over the 10 year period⁸. We believe that the implementation of effective DSM programs can provide substantial incremental lighting electricity savings.

Landlords and Tenants

The relationship between landlords and tenants was examined. The key findings were:

- The split-incentive barrier between landlords and tenants is real and significant in the Yukon. The landlords and retail managers that were interviewed indicated that landlords consistently buy the cheapest domestic appliances and lighting equipment. They do not buy new equipment until the very end of the appliance or equipment lifetime.
- Although tenants often have the right to replace appliances and lighting, and would benefit from it because they pay the electricity bills, the reality is that they rarely do.
- Many apartment blocks in the Yukon were built in the 70s and they were paid for a long time ago. The owners do not need electricity efficiency to remain price competitive. The Good Energy Rebates, for instance, seemed insufficient to tackle this barrier.

For now, the approach suggested is to steer away from this hard-to-reach segment because of the heavy split-incentive barrier. The one mechanism that might work is a refrigerator/freezer retirement program, where landlords would get an incentive to retire their old refrigerator and another incentive to buy a new one. (ENERGY STAR refrigerators do not have a perceptible price increment.) The Energy Solutions Centre is currently running such a program, so the Utilities are not proposing a similar program.

Residential New Construction

The researchers and program designers explored the new housing construction market. The key findings were:

- The developers confirmed that standard construction practices in Whitehorse, in terms of insulation and air tightness, are fairly high because of the City of Whitehorse Building and Plumbing Bylaw. It is challenging to build an affordable home in the Yukon under these circumstances.
- Developers confirmed that electrical baseboard heating is often installed instead of central heating systems to reduce the cost of the houses and condo units.
- When baseboard heating is installed in a new house in place of a central heating system, it makes it very challenging in the future to improve the efficiency of the heating system by

⁸ ICF Marbek, *Profile of the Canadian Solid State Lighting (SSL) Industry*. Prepared for the Office of Energy Efficiency, Natural Resources Canada; August 2012.

installing a CCHP or GSHP, for example. It becomes a lost opportunity for the lifetime of this house. SuperGreen houses, for example, are expected to last a hundred years.

- Developers and real estate agents indicated that there is a category of new home buyers interested in buying environmentally-friendly houses. Words such as SuperGreen, electricity efficiency, energy conservation and ENERGY STAR are commonly used in sales pitches and collateral materials.
- Developers told us that most appliances provided with the units are ENERGY STAR as they are readily available and the extra cost is not prohibitive.
- Developers told us that the lighting equipment being put in new houses is not the most efficient available because of the need to lower cost. Halogen and incandescent screw-in bulbs are most common. However, it should be highlighted that efficient lighting equipment in a home heated with electric baseboards in the Yukon will yield reduced savings because of the interactive relationship between heating and lighting.
- Commercial HVAC contractors confirmed that the penetration of the CCHP or GSHP is currently very low, although they also indicated that they are familiar with these technologies.
- Between CCHP and GSHP, CCHP is more likely to go down in price in the years to come because the installation is almost as simple as conventional air-to-air heat pumps and does not require digging site wells. This could be the most accessible high performance heating technology in the medium term. However, there have been a few bad installations of CCHPs in the Yukon and the public perception of this technology is mixed; consequently, additional technology demonstration and performance verification is required.

Barrier Analysis

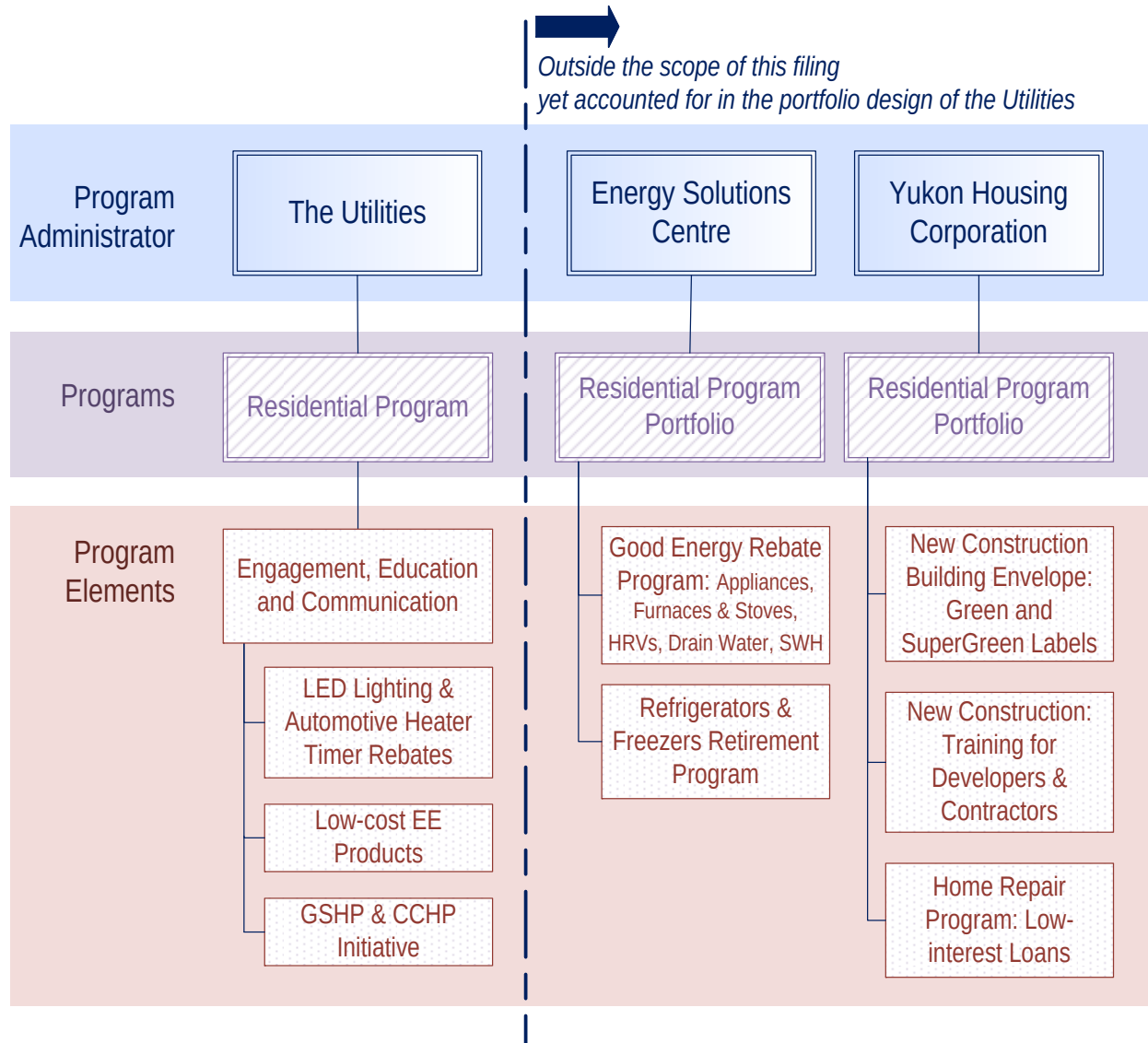
Barriers which emerged as themes during the market research activities include, in order of priority:

- The high cost of some lighting equipment, LED in particular
- The lack of information, or confused information and beliefs of end-users with regard to electricity efficiency equipment in stores
- The missing lighting products on the shelves of retailers in the Yukon, LED in particular
- Few CCHP and GSHP projects in the Yukon, a few poor installations and the resulting lack of information resulting from the situation
- The high cost of central heating, CCHP or GSHP systems in new housing construction.

4.2 Residential Program: An Overview

The Residential Program and its elements are presented on the left side of Exhibit 66. Other residential energy conservation programs offered in the Yukon are presented on the right side of Exhibit 66. As shown in this exhibit, the Residential Program avoids overlaps and exploits potential for synergy.

Exhibit 66: Portfolio View of the Utilities', Energy Solutions Centre, and Yukon Housing Residential Programs



Where: EE is "electricity efficiency" or "electricity efficient," HRV is heat recovery ventilation, SWH is solar water heating, LED is light-emitting diode, GSHP is ground-source heat pump, and CCHP is cold-climate heat pump

The Residential Program will integrate resource acquisition and market transformation tactics, offerings and activities which mean that it will aim at both the end-users and the supply-chain actors. The Utilities will increase the demand and the supply of electricity efficiency products and equipment.

The Residential Program consists of three program elements, as presented below:

LED Lighting & Automotive Heater Timer Rebates: The Utilities will pay a flat amount of money per unit to shoppers after they purchase LED lighting lamps or fixtures selected from a prescriptive list of eligible products. The Utilities will also provide a flat rebate per unit to shoppers and housing developers after they purchase a timer for an automotive heater, car warmer and/or battery blanket selected from a prescriptive list of eligible products.

Low-cost Energy Efficient Products: The Utilities will prepare and disseminate information on products that generate electricity savings but do not have a perceptible price increment as compared with the baseline equipment. The Utilities will disseminate information through point of purchase displays and brochures in retail stores, and through community engagement. Certain low-cost items will be provided by the Utilities to community volunteers to test and showcase: for example certain LED lamps, low-flow showerheads, faucet aerators, etc. The Utilities will give out a limited number of these items free of charge; volunteers will try them out, fill out a scorecard and send it back. The results will be fed back first to the store managers, and then to the consumers through point of purchase displays and brochures and through community engagement.

CCHP and GSHP Initiative:

The Utilities will pilot cold climate heat pumps (CCHPs) and ground-source heat pumps (GSHPs). The pilot systems will be subsidized, not provided free of charge, and the results will be disseminated through different channels, such as HVAC contractors, electrical contractors, housing developers and municipalities.

After the completion of these pilot projects, the Utilities will provide a flat amount of money to buyers of new houses or condominium units if they buy a home with a cold climate heat pump (CCHP) or a ground-source heat pump (GSHP) system, or to owners of homes with electric central air heating systems to retrofit their home with a CCHP or a GSHP.

Public Engagement, Education and Communication: The Utilities will disseminate information and receive feedback from residents of Whitehorse and the communities through multiple means:

- Partnership and direct engagement with retail store managers.
- Point-of-purchase displays and brochures.
- Partnership with applicable non-profit and community organizations.
- Outreach and participation in community events.
- Identification and enrolment of community electricity efficiency (EE) “ambassadors”.
- EE workshops taking place in EE ambassadors’ homes.
- Direct engagement with HVAC contractors, electrical contractors and house developers.
- Dissemination of information, in particular about the seasonal LED rebates, in local newspapers, radio stations, cooperative advertisements, and bill inserts.
- Information on rebates and electricity efficiency products on the Utilities’ website.

Many of the engagement initiatives carried out by the Utilities will also be used to disseminate information about the Yukon Housing conservation programs and the ESC energy conservation programs to increase value for the audience and create synergy between stakeholders.

4.3 Description of Program Elements

As noted above, the Residential program offers three distinct program elements in addition to engagement, education and communication tactics. This section provides a description of each program element; in each case the discussion is organized and presented as follows:

- Objective
- Target market
- Description
- Duration and milestones
- Eligible measures
- Marketing and communications strategy
- Incentive strategy
- Program theory
- Projected participation
- Budget
- Cost effectiveness

4.3.1 LED Lighting & Automotive Heater Timer Rebates

Objective

This program element will achieve electricity and demand savings through accelerating the penetration of LED products and timers (indoor or outdoor) for automotive heaters, car warmers and battery blankets in the Yukon through the use of a financial rebate to encourage increased consumer participation.

Target Market

The primary target market is the owners of detached house, town/row houses, condominium units and mobiles homes located in the Yukon who are shopping in Yukon retail stores.

LED Lighting Rebate

The eligibility criteria will be designed to include developers and contractors because it was found that the high cost of LED fixtures and lamps is also a significant hurdle for them.

The eligibility criteria will be designed NOT to exclude: online shoppers, landlords and renters. These are in the target market.

Building owners/managers buying LED lighting products at retail stores will be able to participate in Business Electricity Solutions Programs. The participation process will be consistent with that of the Residential Program.

Automotive Heater Timer Rebate

The primary target market is:

- **Outdoor Timer Prospective Buyers and Users:** Owners of detached houses, town/row houses, condominium units and mobile homes located in the Yukon who shop in Yukon retail stores
- **Indoor Timer Prospective Installers:** Housing developers and contractors who can install an interior timer in new detached houses, town/row houses, and condominium units and mobiles homes located in the Yukon

The eligibility criteria will be designed to include online shoppers, landlords and renters. Owners or renters of existing dwellings will be eligible for the indoor-timer incentive even though it is expected that this measure will be more costly and thus less attractive to them.

Description

The Utilities will provide a flat incentive per unit to shoppers and housing developers after they purchase LED lighting lamps or fixtures or a timer for an automotive heater, car warmer and/or battery blanket selected from a prescriptive list of eligible products.

The Utilities will explore three possible rebate delivery mechanisms: (1) instant rebate at the point of purchase, (2) mail-in rebate, or (3) both. Instant-rebates are generally preferred by participants and will, therefore, be pursued first. However, the Utilities retain the option to complete a mail in rebate if market or regulatory conditions preclude from using instant rebates.

The Utilities retain the right to modulate the rebate though the same fiscal year to be able to react to market conditions and use marketing tactics to drive up the demand. In addition, the Utilities retain the right to update the incentive levels, the list of eligible products and the LED incentive budget on an annual basis.

Automotive heater timers gained a bad reputation in the Yukon because they reportedly failed. In order to address this, the Utilities envision applying the following tactics:

- The Utilities will start by promoting indoor automotive heater timers with the housing developers. Indoor timers are not subjected to cold weather and are therefore more reliable.
- The Utilities know that outdoor car automotive heater timers are being promoted by utilities in Alaska. The Utilities intend to research the automotive heater timers that the Alaskan utilities are promoting, to test them in the Yukon. The Utilities will start promoting these automotive heater timers once the reliability issue is resolved.

Duration & Milestones

The Utilities propose to launch and operate the program for a duration of five years (20 quarters) before going through a new program design, filing and approval process.

Assuming that this program begins in the first quarter of Year 1 (Q1 of Y1) and finishes in the last quarter of Y5, the main milestones of this component are:

- Q1 of Y1: Program preparation
- Q2 of Y1: Program launch, including first rebate advertisement campaign
- August Y1 to July Y2: First set of LED and automotive heater timer rebate offerings
- Q3 and Q4 of Y1: LED and automotive heater timer rebate advertisement campaign
- Q2 of Y2: Report on the impacts of the Y1 rebate campaign
- Q2 of Y2, Y3, Y4 and Y5: Update of incentive list and incentive levels
- Q3 and Q4 of Y2, Y3, Y4 and Y5: Advertisement Campaign
- Q2 of Y3, Y4, and Y5: Report on the impacts of the rebate campaigns
- Q3 of Y5: Draft impact evaluation report is filed with the YUB
- Q4 of Y5: New program portfolio design is filed with the YUB
- Q1 of Y6: Program component is either terminated or updated to fit new market circumstances

Eligible Measures

The first list of prescriptive measures will include the items presented in Exhibit 67.

Exhibit 67: Prescriptive List of Residential LED Lighting and Automotive Heater Timer Energy Conservation Measures

ID	Measure Short Name	Gross Annual Consumption Savings	Gross Coincident Peak Savings	Net-to-Gross Ratio	Measure Cost	Measure Lifetime	Level of Incentive
ECM151	Automotive Heater Timer	130 kWh/unit	0.046 kW/unit	100%	\$37.50/unit	10.0 yr	\$20.00/unit
ECM24	12W LED A19 Bulb	48 kWh/unit	0.017 kW/unit	110%	\$44.00/unit	20.0 yr	\$18.00/unit
ECM60	8W LED A19 Bulb	32.0 kWh/unit	0.011 kW/unit	110%	\$30.00/unit	20.0 yr	\$12.00/unit
ECM61	LED MR16 Bulbs	15.0 kWh/unit	0.005 kW/unit	110%	\$20.00/unit	20.0 yr	\$10.00/unit
ECM62	LED PAR30 Bulbs	40.0 kWh/unit	0.014 kW/unit	110%	\$51.00/unit	20.0 yr	\$20.00/unit
ECM63	LED PAR38 Bulbs	55.0 kWh/unit	0.020 kW/unit	110%	\$43.00/unit	20.0 yr	\$20.00/unit
ECM44	Spot or Task Lighting	40.0 kWh/unit	0.014 kW/unit	80%	\$25.00/unit	10.0 yr	\$10.00/unit

Specific details on the minimal technical specifications for each of the items in Exhibit 67 will be worked out during the program preparation phase. The Utilities intend to use external equipment qualification resources. Prospective performance and safety qualification resources for LED lighting include but are not limited to: the Office of Energy Efficiency's ENERGY STAR Program, the US Department of Energy's Solid State Lighting program, the Consortium for Energy Efficiency, the DesignLights Consortium, the Canadian Standards Association, and the Underwriters Laboratories of Canada. Resources for automotive heater timers include but are not limited to: the Canadian Standards Association, and the Underwriters Laboratories of Canada.

The Utilities reserve the right to revise eligible measures as needed in accordance with current market conditions, technology development, EM&V results, and program implementation experience. The Utilities propose to review the lighting incentive level on an annual basis. In addition, the Utilities reserve the right to recover the incentive money should fraud or omissions be identified.

Marketing & Communications Strategy

The rebates will be extensively advertised through a media campaign starting in August of each year. Media channels will include local radio stations, local newspapers, co-operative advertisement with retailers and in stores, email blasts, and electricity bill inserts.

Shoppers and retail store salespeople will be provided with information about the benefits of LED lighting products, automotive heater timers, and the rebates through brochures and displays at the point of purchase.

The Utilities will also use direct community engagement and a network of community ambassadors to stream information about the LED rebate to their communities. This approach is discussed further in Section 4.3.2.

Incentive Strategy

The Utilities propose a “prescriptive” approach for this incentive: a fixed amount per unit sold by brick-and-mortar or online retailers.

The Utilities will explore three possible rebate delivery mechanisms: (1) instant rebate at the point of purchase, (2) mail-in rebate, or (3) both. Instant-rebates are generally preferred by participants and will, therefore, be pursued first. However, the Utilities want to retain the option to complete a mail in rebate if retail outlets are not able to manage instant rebates; or, if the EM&V approach requires information on participants that can only be collected through a short mail-in application form.

The Utilities retain the right to modulate the rebates through the same fiscal year to be able to react to market conditions and use marketing tactics to drive up the demand. For example, the Utilities could have a constant year-round rebate level, and double the rebate for a short period of time during the last quarter of the year when the sales of residential lighting equipment or automotive heater timers peak. The rebate “doubling approach” will create a sense of urgency and is expected to increase the uptake significantly.

In addition, the Utilities retain the right to update the incentive levels, the list of eligible products and the LED/automotive heater timer incentive budget on an annual basis to reflect changing prices of products; new products introduced; and perhaps “older” products reaching saturation. The list will be updated during the second quarter of the year when the sales are low because the warm season and increasingly longer daylight period.

Program Theory

As presented previously, the program theory explains how the program's actions are expected to achieve the intended outcomes. Evaluators will also use the program theory during program evaluation.

The theory of the LED Lighting & Automotive Heater Timer Rebates within the Residential Program has been graphically depicted in the form of a logic model and is shown in Exhibit 68.

Exhibit 68: Logic Model of the Residential LED Lighting & Automotive Heater Timer Rebates

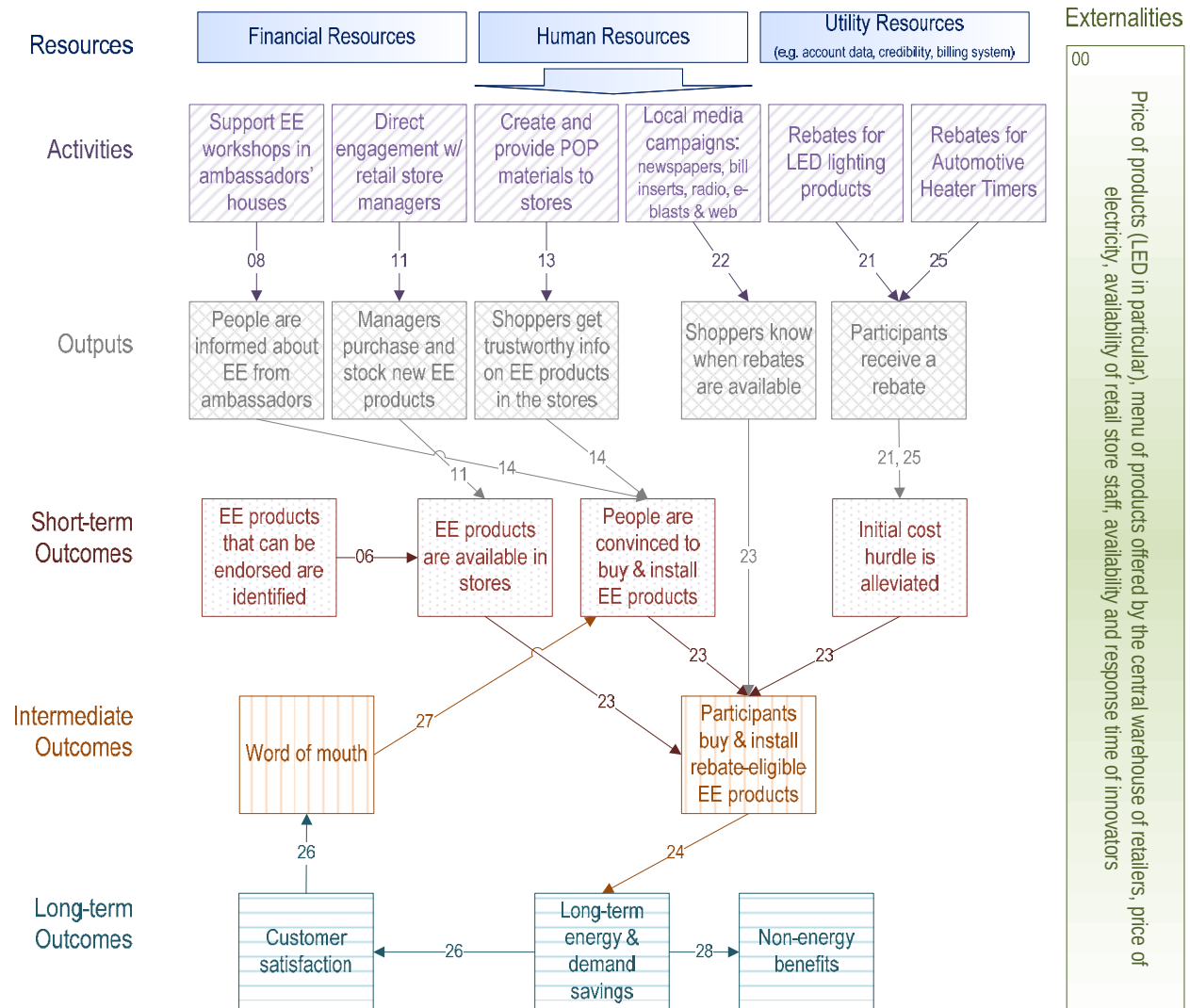


Exhibit 69 presents the narratives of the logic model shown in Exhibit 68.

Exhibit 69: Explanatory Note on the Residential LED Lighting & Automotive Heater Timer Rebates Theory

Link #	Narrative
00	The program effectiveness and impact will be influenced by the following externalities: price of products (LED technologies, in particular), menu of products offered by the central warehouse of retailers, price of electricity, availability of retail store staff, availability and response time of innovators. The program administrator should monitor these externalities and adapt the implementation approach based on them.

Link #	Narrative
06	The consumer responses provided on the scorecards will be aggregated, analyzed and provided to the store managers. The Utilities will be able to endorse certain EE products because customer satisfaction will be good. The results will be presented to the retail store managers, and feed the communication and POP materials. It is expected that store managers will react by stocking more of these products and allocate more shelf space.
08	The Utilities will support EE workshops in the homes of EE ambassadors or nearby community venues with approximately ten friends and relatives. The Utilities will send facilitator(s), provide communication materials and low-cost EE products to give away, and perhaps provide food and beverages. The Utilities' skilled facilitator(s) will have a few key messages regarding low-cost EE products, LED lighting products, automotive heater timers and innovative heating systems. The facilitator will encourage the participants to share tips and information on electricity conservation. The facilitator will seek to eliminate potential sources of confusion and false beliefs in the communities by presenting hard facts.
11	The Utilities will establish partnerships with Yukon retail store managers and establish two-way communication. The Utilities will suggest new products to stock; perhaps by providing the results of the low-cost EE product piloting, by revealing in advance what products will be eligible for the LED lighting rebate and automotive heater timer rebate, or by indicating what POP materials will be created and offered to the shops.
13	The Utilities will design and procure educational Point Of Purchase (POP) materials for Yukon retail managers to display in their stores. These materials might include (but not be limited to): brochures, presentation boxes, posters, and displays stands.
14	Yukon shoppers will be informed on EE products through the community direct engagement, and through the POP materials. This will cause them to buy and install these products.
21	The Utilities will provide a flat amount of money per unit to Yukon shoppers after they purchase LED lighting lamps or fixtures selected from a prescriptive list of eligible products. The initial-cost hurdle will be alleviated which will contribute to the items being purchased and installed.
22	The "rebate" period will be extensively advertised through a media campaign starting in June of each year through local radio, local newspapers, coop advertisement with retailers and in stores, email blast, and electricity bill inserts. Consequently, shoppers will know when the rebates are going to be available. The marketing tactics used will create a sense of urgency and push Yukon shoppers to make the right purchase decision; it is expected to boost overall program uptake as compared a continuously available.
23	Participating Yukon shoppers (ie. participants) will buy and install LED lighting products or automotive heater timers and receive a rebate because these products will be available in the stores, because they were made aware of the benefits of these products, because they know when the rebate is available, and because the initial cost hurdle was alleviated by the rebate.
24	The LED lighting product installs and automotive heater timer installs will yield long-term electricity and demand savings.
25	The Utilities will provide a flat amount of money per unit to Yukon shoppers for the purchase of automotive heater timers (indoor or outdoor) from selected from a prescriptive list of eligible products. The initial-cost hurdle will be alleviated and/or the rebate will make the purchase of an automotive heater timer much more enticing. This will contribute to the purchase and installation of these items.
26	Shoppers who bought low-cost EE products, LED lighting products or automotive heater timers will be satisfied by the products that they bought. They will tell their friends and relatives. This will generate word-of-mouth advertisement.
27	With time, word-of-mouth will become an important information channel that will cause Yukon residents to buy and install EE products.
28	It is assumed that shoppers will perceive new non-energy benefits; and/or the maintenance of benefits they used to have with systems. For example, the Utilities will seek to make sure that participants will perceive that their new LED products last longer, are less sensitive to power quality issues, are more reliable, cast better light (color rendering, intensity, and visual acuity), and easier and less hazardous to dispose of than CFLs. The Utilities will seek to make sure that participants will perceive that automotive heater timers are reliable and that the use of a timer does not have negative impact on their car.

Projected Participation

The following projections have been used for planning purposes. However, the Utilities reserve the right to adjust savings targets as necessary in accordance with current market conditions, EM&V results, and program implementation experience.

Exhibit 70: Participation Projections – LED Lighting and Automotive Heater Timer Rebates

ID	Measure Short Name	Year 1	Year 2	Year 3	Year 4	Year 5	Total
ECM151	Automotive Heater Timer	0 units	68 units	109 units	109 units	109 units	395 units
ECM24	12W LED A19 Bulb	349 units	1,455 units	1,455 units	1,455 units	1,455 units	6,167 units
ECM60	8W LED A19 Bulb	349 units	1,455 units	1,455 units	1,455 units	1,455 units	6,167 units
ECM61	LED MR16 Bulbs	55 units	259 units	259 units	259 units	259 units	1,089 units
ECM62	LED PAR30 Bulbs	14 units	79 units	79 units	79 units	79 units	328 units
ECM63	LED PAR38 Bulbs	10 units	59 units	59 units	59 units	59 units	246 units
ECM44	Spot or Task Lighting	9 units	41 units	41 units	41 units	41 units	172 units

Budget

The budget presented in Exhibit 71 has been used for planning purposes. However, the Utilities reserve the right to adjust program budgets as necessary in accordance with current market conditions, EM&V results, and program implementation experience. Initial budget levels are set based on conservative estimates of participation given the current market.

Exhibit 71: Budget – LED Lighting and Automotive Heater Timer Rebates

	\$1,000s					
	Year 1	Year 2	Year 3	Year 4	Year 5	Total
Incentive:	\$12	\$51	\$52	\$52	\$52	\$217
Non-Incentive:	\$82	\$84	\$55	\$59	\$107	\$387
Total:	\$94	\$135	\$106	\$111	\$159	\$604

Savings Target

The savings targets shown in Exhibit 72 have been used for planning purposes. However, the Utilities reserves the right to adjust savings targets as necessary in accordance with current market conditions, EM&V results, and program implementation experience.

Exhibit 72: Savings Targets – LED Lighting and Automotive Heater Timer Rebates

	Net Savings with T&D Losses														
	<----- Program Operation ----->					----- Ramp Down as Measure Lifetime Expires ----->									
	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	Year 11	Year 12	Year 13	Year 14	Year 15
Lifetime MWh:	718	3,149	3,207	3,207	3,207	0	0	0	0	0	0	0	0	0	0
Annual MWh:	36	199	368	537	705	705	705	705	705	705	705	694	677	660	643
Coincident kW:	13	71	131	191	252	252	252	252	252	252	252	248	242	236	230

Cost Effectiveness

The cost-effectiveness test results shown in Exhibit 73 were computed based on the assumptions presented above: level of incentive, budget, and projections. They are used for planning purposes. However, and since the Utilities reserve the right to adjust the assumptions as necessary in accordance with current market conditions, EM&V results, and program implementation experience; consequently, actual results may differ from those presented below.

Exhibit 73: Cost Effectiveness – LED Lighting and Automotive Heater Timer Rebates

	Total Resource Cost TRC	Program Adminis- trator Cost PAC	Participant Cost PC	Rate- Impact Measure RIM
Benefit/Cost Ratio	1.9	3.0	2.5	1.0
Net Present Value (1,000s)	\$743	\$1,047	\$649	\$52
Levelized Cost:	\$.128/kWh	\$.081/kWh	N/A	N/A

4.3.2 Low-Cost Electricity Efficient Products

Objective

This program element will achieve electricity and demand savings by increasing the sales of selected low-cost electricity efficiency products in the Yukon. This will be achieved through demonstrations and the dissemination of credible and locally-applicable information to shoppers and the general public on the electricity savings and the non-energy benefits that can be achieved by using these products.

This element will generate some direct savings, such as the savings corresponding to the products or systems that will be given out free of charge or heavily subsidized. However, this component should be evaluated based on the potential for replication through other program components rather than on its direct savings.

Target Market

This program component targets residential innovators who reside in the Yukon, and who will agree to use low-cost electricity efficient (EE) products in their home in exchange for filling out and sending back a scorecard. (See the definition of low-cost EE products as part of the Program Component Description)

The “residential innovators” are volunteers that will be recruited through direct community engagement. These individuals will be selected based on their interest in electricity conservation and perhaps environmental conservation; as well as their leadership and influence among their peers. The Utilities intend to develop relationships with these individuals and, eventually, involve them in a network of electricity efficiency ambassadors. It is expected that distributing low-cost EE products free of charge will be a draw to initiate and build the relationship with prospective EE ambassadors, and possibly an attraction for friends and relatives of the ambassadors to attend the workshops on energy conservation.

The education program component also targets anyone who purchases and uses low-cost EE products in the Yukon.

Description

The Utilities will prepare and disseminate information on specific products that generate electricity savings if they are purchased and installed, and that do not have a perceptible price increment as compared with the baseline equipment. The Utilities will disseminate information through point of purchase displays and brochures in the retail stores, and through community engagement.

The low-cost EE products that the Utilities intend to target could include (but is not limited to): ENERGY STAR TVs, ENERGY STAR printers and fax, ultra-low flow showerheads, power bars, programmable thermostats, Domestic Hot Water (DHW) recirculation system, three-element water heater system (mostly a peak-shaving measure), DHW tank insulation, and DHW pipe insulation.

All of these products were selected because they are available or might be available in stores in the Yukon (rather than, for example, through a contractor or at a specialized store); they are easy to install on a *do-it-yourself* mode; and they are considered to be *low-cost*.⁹

By “low-cost,” the Utilities means that the incremental or even the full cost of these products are imperceptible, ignored by the consumers considering the benefits, and/or does not constitute the most significant purchase barrier. The Utilities postulate that there is no need to offer an incentive for these products. Education and information should be sufficient to boost the sales and installation of these products. It should be noted that all of these products were assigned a certain “cost” for the purpose of computing the benefit/cost ratio.

The Utilities will prepare educational materials that will highlight the monetary savings and the environmental gains that are possible to achieve with these products. The educational material will take the form of information brochures, point of purchase materials (eg. posters, presentation box, stands, displays, etc.), and static or interactive web content.

It is assumed that as a result of the education and information activities, the sales of the targeted products will increase, which will yield incremental savings.

⁹ Only the three-element water heaters do not pertain to the do-it-yourself category, thus the approach to testing this line of products might have to be different. A contractor will need to be involved.

The Utilities will also create point-of-purchase displays and brochures for equipment that is not considered to be “low-cost” i.e., LED lighting and automotive heater timers. The educational material will support uptake of the program element related to these two types of equipment.

In addition, the Utilities will have low-cost EE products tested by volunteers and/or electricity efficiency ambassadors in the communities. The Utilities will give out a limited number of these items at no cost; the ambassadors will try them, fill out a simple scorecard and send the scorecard back. The Utilities will collect the scorecards, aggregate and analyze the results, and apply the conclusions about consumer satisfaction in other program components such as the LED rebate component and the low-cost EE product education component.

The results will be fed back to the store managers, then to the consumers through point of purchase materials and community engagement activities.

The Utilities will identify low-cost products of interest through jurisdictional scans. Two examples are provided below:

- The Utilities know that car automotive heater timers are being promoted by utilities in Alaska. Automotive heater timers gained a bad reputation in the Yukon because they reportedly failed. The Utilities intend to research the automotive heater timers that the Alaskan utilities are promoting and to test them in the Yukon.
- One important issue with low-flow or ultra-low flow showerheads is persistence. Many models do not provide a sensation in the shower that is sufficiently pleasing for the user to keep them. Many users are annoyed and reinstall the old full-flow showerheads. The Utilities have learned that many models have been tested by natural gas utilities in Ontario; and some with higher customer satisfaction than others have been identified. The Utilities intends to communicate with the program administrators, obtain information about the high customer satisfaction models and test them out in the Yukon.

In addition to conducting jurisdictional scans, the Utilities will also be open to suggestions from store managers. Store managers will be able to suggest low-cost EE products or models for the Utilities to test. The Utilities will take the suggestions into consideration and, if the suggestions make sense (i.e., if the products effectively save electricity), the Utilities will proceed to piloting them. However, the Utilities will not rely on suggestions from store managers because they might be too busy or only slightly interested at the early stages of the program. Instead, the opportunity for managers to make suggestions is a measure that is taken to address potential frustrations from managers who see competing models being promoted.

Duration & Milestones

The Utilities propose to launch and operate the program for a duration of five years (20 quarters) before going through a new program design, filing and approval process.

Assuming that this program begins in the first quarter of Year 1 (Q1 of Y1) and finishes in the last quarter of Y5, the main milestones of this component are:

- Q1 of Y1: Lay out communication and marketing strategy for the year, including the low-cost EE products to focus on during Y1
- Q2 of Y1: Produce collateral materials and web content on the products of interest, initiate tests on certain products of interest, and collect sales data baseline
- Q2 of Y1: Initiate community direct engagement activities. The distribution of low-cost EE products should start with the beginning of the direct engagement activities.

- Q3 of Y1: Both home buyers, home owners, contractors and developers willing to test 3-element water heaters should be identified.¹⁰
- Q4 of Y1: The 3-element water heaters should be installed.
- Q1 to Q4 of Y2: Post-retrofit period of the 3-element heaters. Satisfaction surveys are carried out.
- Q1 of Y3: Report on the 3-element water heaters pilots.
- Q3 and Q4 of Y1: Ramp up the communication and direct engagement activities
- Q3 of Y1 to Q2 of Y2: Collect and aggregate scorecards.
- Q1 of Y2: Report on the impacts of the education component
- Q3 of Y2: Report on customer satisfaction of low-cost EE products tested in Y1.
- Repeat the cycle during Y2, Y3, Y4 and Y5
- Q3 of Y5: Draft impact evaluation report is filed with the YUB
- Q4 of Y5: New program portfolio design is filed with the YUB
- Q1 of Y6: Program component is either terminated or updated to fit new market circumstances

¹⁰ The incremental cost of 3-element water heaters is very low (approximately \$200) and the impact on comfort is reported to be imperceptible. Thus, finding home owners and developers that are willing to test them should not be challenging.

Eligible Measures

The preliminary list of low-cost EE products that the Utilities intend to promote includes the items presented in Exhibit 74.

Exhibit 74: List of Energy Conservation Measures Based on Low-cost EE Products

ID	Measure Short Name	Gross Annual Consumption Savings	Gross Coincident Peak Savings	Net-to-Gross Ratio	Measure Cost	Measure Lifetime	Level of Incentive
ECM242	Pilot 12W LED A19 Bulb	48 kWh/unit	0.017 kW/unit	100%	\$44.00/unit	20.0 yr	\$44.00/unit
ECM602	Pilot 8W LED A19 Bulb	32 kWh/unit	0.011 kW/unit	100%	\$31.00/unit	20.0 yr	\$31.00/unit
ECM612	Pilot LED MR16 Bulbs	15.0 kWh/unit	0.005 kW/unit	100%	\$25.00/unit	20.0 yr	\$25.00/unit
ECM622	Pilot LED PAR30 Bulbs	40.0 kWh/unit	0.014 kW/unit	100%	\$64.00/unit	20.0 yr	\$64.00/unit
ECM632	Pilot LED PAR38 Bulbs	55.0 kWh/unit	0.020 kW/unit	100%	\$53.00/unit	20.0 yr	\$53.00/unit
ECM442	Pilot Spot or Task Lighting	40.0 kWh/unit	0.014 kW/unit	100%	\$25.00/unit	10.0 yr	\$25.00/unit
ECM092	Pilot Ultra Low-flow Showerheads	325.0 kWh/unit	0.116 kW/unit	100%	\$16.01/unit	10.0 yr	\$16.01/unit
ECM112	Pilot Smart, Surge Protected Power Bars for PCs and TVs	67.8 kWh/unit	0.024 kW/unit	100%	\$50.00/unit	10.0 yr	\$50.00/unit
ECM182	Pilot DHW Tank Insulation	62.0 kWh/unit	0.022 kW/unit	100%	\$37.58/unit	14.0 yr	\$37.58/unit
ECM202	Pilot DHW Pipe Insulation	34.0 kWh/unit	0.012 kW/unit	100%	\$0.79/unit	15.0 yr	\$0.79/unit
ECM482	Pilot Motion Detectors - Indoor and Outdoor	66.0 kWh/unit	0.024 kW/unit	100%	\$22.94/unit	10.0 yr	\$22.94/unit
ECM152	Pilot Auto Heater Timers	129.8 kWh/unit	0.046 kW/unit	100%	\$37.50/unit	10.0 yr	\$37.50/unit
ECM142	Pilot Prog. Thermostats (Central)	827.0 kWh/unit	0.295 kW/unit	100%	\$62.50/unit	11.0 yr	\$62.50/unit
ECM212	Pilot Prog. Thermostats	826.0 kWh/unit	0.295 kW/unit	100%	\$285.43/unit	11.0 yr	\$285.43/unit
ECM062	Pilot E-Star TVs	69.0 kWh/unit	0.025 kW/unit	100%	\$1,125.00/unit	10.0 yr	\$1,125.00/unit
ECM082	Pilot ESTAR Printers and Fax	31.7 kWh/unit	0.011 kW/unit	100%	\$200.00/unit	6.0 yr	\$200/unit
ECM091	Ed. Ultra Low-flow Showerheads	325.0 kWh/unit	0.116 kW/unit	100%	\$8.62/unit	10.0 yr	\$0/unit
ECM111	Ed. Smart, Surge Protected Power Bars for PCs and TVs	68 kWh/unit	0.024 kW/unit	100%	\$25.00/unit	10.0 yr	\$0/unit
ECM181	Ed. DHW Tank Insulation	62 kWh/unit	0.022 kW/unit	100%	\$37.58/unit	14.0 yr	\$0/unit
ECM201	Ed. DHW Pipe Insulation	34.0 kWh/unit	0.012 kW/unit	100%	\$0.79/unit	15.0 yr	\$0.00/unit

The Utilities reserve the right to revise measures to be promoted as needed in accordance with current market conditions, technology development, piloting results, EM&V results, and program implementation experience.

The pilot conservation measures and projects that the Utilities intend to support include the items presented in Exhibit 74.

Marketing & Communications Strategy

The Utilities will leverage the partnerships that will be developed with retail store managers to:

- Work with them to add low-cost EE items on their shelves if they aren't already
- Identify certain models that yield higher customer satisfaction and thus provide an incentive to increase the shelf space for these models
- Have the retailers install the point-of-purchase materials
- Have the retailers share sales data (on a confidential basis) to monitor the impact of the program

The Utilities will leverage the community direct engagement activities (i.e., booths at local sporting or community events, booths at local retail stores, home electricity conservation shows, etc.), the partnership with the applicable non-profit and community organizations, and the network of electricity efficiency ambassadors to:

- Provide information to the communities on the low-cost EE products in a direct fashion
- Disseminate the educational and informational materials on low-cost EE products
- Test certain low-cost products and gather customer satisfaction feedback
- Extend the advertisement on the low-cost EE products through word-of-mouth marketing
- Distribute low-cost EE products and scorecards at community events
- Send additional free products when residents previously provided with free products fill out and send back scorecards to the Utilities,
- If and when a stronger relationship is established with a few people, referred to as electricity efficiency ambassadors, set up workshops at their homes in the communities to distribute more low-cost EE products as well as information on electricity efficiency behaviors and products.

Incentive Strategy

The Utilities believe that there is no need to offer an incentive for the low-cost EE products.

The Utilities will distribute many EE products free of charge (eg. low-flow showerhead, faucet aerators, DHW tank insulation, DHW pipe insulation, etc.); hence the incentive will be equivalent to the full cost of the measure.

Certain higher-priced items (e.g., EnergyStar TVs, EnergyStar printers, programmable thermostats, powerbars, etc) could be given away to winners drawn at random as part of an energy conservation contest. The incentive will still be equivalent to the full cost of the measure; however fewer of these items will be given away.

Program Theory

The theory of the Low-Cost Energy Efficient Products within the Residential Program has been graphically depicted in the form of a logic model and is shown in Exhibit 68.

Exhibit 75: Logic Model of the Residential Low-Cost Energy Efficient Products

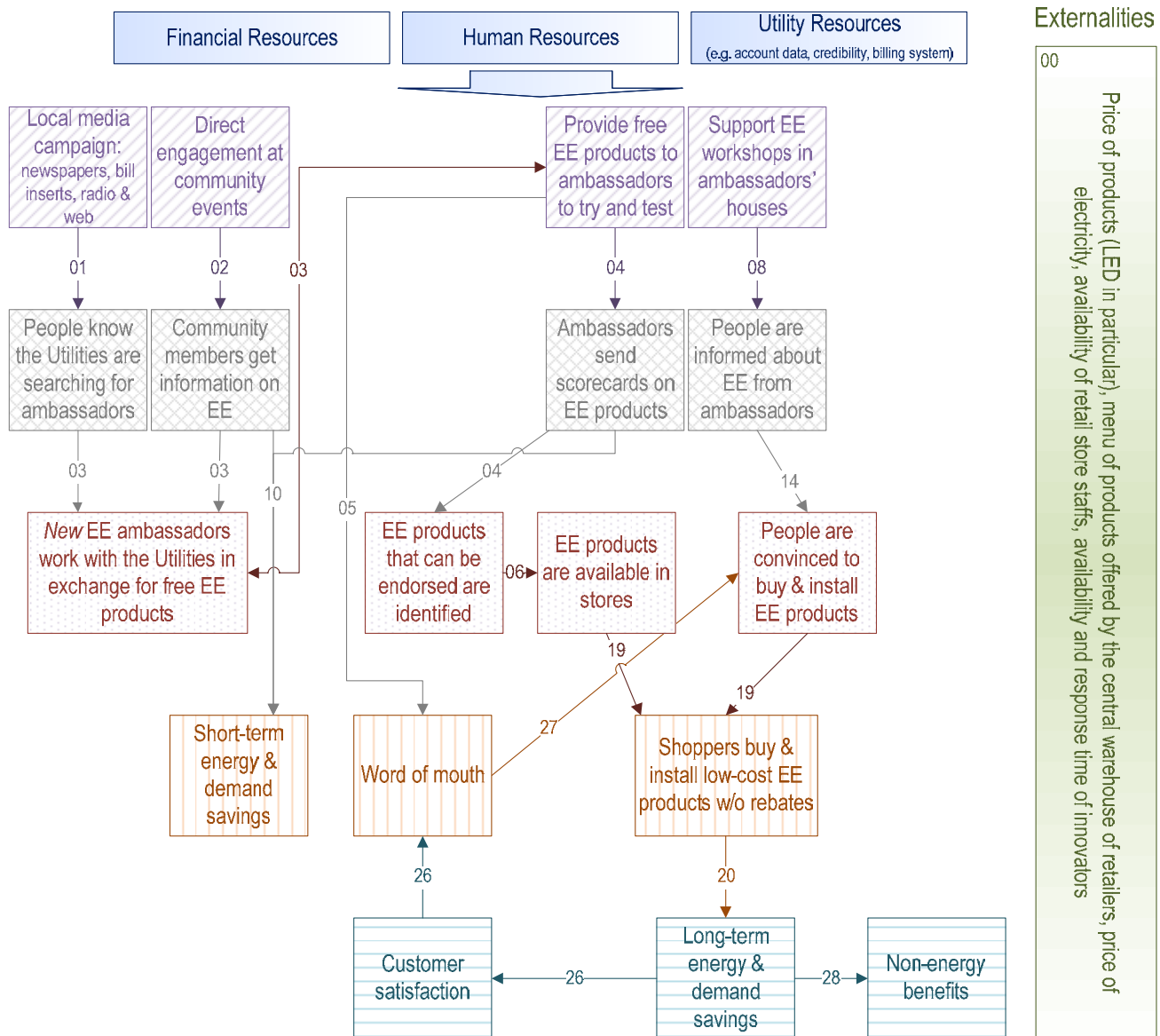


Exhibit 76 presents the narratives of the logic model shown in Exhibit 75.

Exhibit 76: Explanatory Note on Low-Cost Energy Efficient Products Theory

Link #	Narrative
00	The program effectiveness and impact will be influenced by the following externalities: price of products (LED technologies, in particular), menu of products offered by the central warehouse of retailers, price of electricity, availability of retail store staff, availability and response time of innovators. The program administrator should monitor these externalities and adapt the implementation approach based on them.

Link #	Narrative
01	The Utilities will advertise their intention of building a network of EE ambassadors through the local press, and applicable non-profit and community organizations. It is expected that this tactic will ease the development of the network.
02	The Utilities will carry out outreach activities in community events (eg. sport events, cultural events, town hall meetings, etc.), engage with organization and people who have a natural interest in electricity conservation; hook individuals with a continuous stream of free low-cost EE products or contests; do personalized follow-ups; offer to new home buyers to pilot CCHPs, or GSHPs; and promote the idea of supporting an EE workshop at their home or a at local venue.
03	The Utilities will build new relationships and a network of EE ambassadors that the Utilities will be able to use to extend its communication and community direct engagement footprint.
04	The Utilities will have low-cost EE products tested through volunteers and/or electricity efficiency ambassadors in the communities. The Utilities will give out a limited number of these items free of charge; the ambassadors will try them out, fill out a simple scorecard and send the scorecard back. The Utilities will collect all of the scorecards, aggregate and analyze the results, and use the results on consumer satisfaction in other program components such as the LED rebate component, the automotive heater timer rebate component and the low-cost EE product education component.
05	It is expected that the volunteers and EE ambassadors will like the low-cost EE products and will tell their friends and relatives. This will feed the word of mouth feedback loop.
06	The consumer responses provided on the scorecards will be aggregated, analyzed and provided to the store managers. The Utilities will be able to endorse certain EE products because customer satisfaction will be good. The results will be presented to the retail store managers, and feed the communication and POP materials. It is expected that store managers will react by stocking more of these products and allocate more shelf space.
08	The Utilities will support EE workshops in the homes of EE ambassadors or nearby community venues with approximately ten friends and relatives. The Utilities will send facilitator(s), provide communication materials and low-cost EE products to give away, and perhaps provide food and beverages. The Utilities' skilled facilitator(s) will have a few key messages regarding low-cost EE products, LED lighting products, automotive heater timers and innovative heating systems. The facilitator will encourage the participants to share tips and information on electricity conservation. The facilitator will seek to eliminate potential sources of confusion and false beliefs in the communities by presenting hard facts.
10	The information and tips provided to residents of the Yukon as part of the Utilities direct community engagement activities will influence their behavior and cause them to use less electricity and reduce their peak demand. However, quantifying "behavior-based" electricity and demand savings is challenging and perhaps cost-prohibitive for a small jurisdiction like the Yukon. Moreover, the persistence of "behavior-based" conservation measures is notoriously bad. It is commonly believed to be less than one year by DSM experts. Consequently, the short-term benefits of behavior-based conservation measures will not be quantified. They are considered to be outcomes that are "nice-to-have" yet not necessary to make the program viable.
14	Yukon shoppers will be informed on EE products through the community direct engagement, and through the POP materials. This will cause them to buy and install these products.
19	Yukon shoppers will buy and install low-cost EE products (even in the absence of rebate) because these products will be available in the stores, and because they were made aware of the benefits of these products. The low-cost EE products might have a certain price increment; however it is assumed that the price increment (if any) is too small to constitute the most important purchase barrier.
20	The low-cost EE product installs will yield long-term electricity and demand savings.
26	Shoppers who bought low-cost EE products, LED lighting products or automotive heater timers will be satisfied by the products that they bought. They will tell their friends and relatives. This will generate word-of-mouth advertisement.
27	With time, word-of-mouth will become an important information channel that will cause Yukon residents to buy and install EE products.
28	It is assumed that shoppers will perceive new non-energy benefits; and/or the maintenance of benefits they used to have with systems. For example, the Utilities will seek to make sure that participants will perceive that their new LED products last longer, are less sensitive to power quality issues, are more reliable, cast better light (color rendering, intensity, and visual acuity), and easier and less hazardous to dispose of than CFLs. The Utilities will seek to make sure that participants will perceive that automotive heater timers are reliable and that the use of a timer does not have negative impact on their car.

Projected Participation

The projections shown in Exhibit 77 have been used for planning purposes. However, the Utilities reserve the right to adjust savings targets as necessary in accordance with current market conditions, EM&V results, and program implementation experience.

Exhibit 77: Participation Projections –Low-cost Energy Efficient Products¹¹

ID	Measure Short Name	Year 1	Year 2	Year 3	Year 4	Year 5	Total
ECM242	Pilot 12W LED A19 Bulb	60 units	60 units	60 units	60 units	60 units	300 units
ECM602	Pilot 8W LED A19 Bulb	60 units	60 units	60 units	60 units	60 units	300 units
ECM612	Pilot LED MR16 Bulbs	40 units	40 units	40 units	40 units	40 units	200 units
ECM622	Pilot LED PAR30 Bulbs	30 units	30 units	30 units	30 units	30 units	150 units
ECM632	Pilot LED PAR38 Bulbs	20 units	20 units	20 units	20 units	20 units	100 units
ECM442	Pilot Spot or Task Lighting	6 units	6 units	6 units	6 units	6 units	30 units
ECM092	Pilot Ultra Low-flow Showerheads	30 units	40 units	30 units	20 units	20 units	140 units
ECM112	Pilot Smart, Surge Protected Power Bars for PCs and TVs	60 units	60 units	40 units	40 units	30 units	230 units
ECM182	Pilot DHWTank Insulation	40 units	60 units	60 units	40 units	40 units	240 units
ECM202	Pilot DHWPipe Insulation	40 units	60 units	60 units	40 units	40 units	240 units
ECM482	Pilot Motion Detectors - Indoor and Outdoor	60 units	60 units	40 units	40 units	30 units	230 units
ECM152	Pilot Auto Heater Timers	30 units	60 units	60 units	60 units	60 units	270 units
ECM142	Pilot Prog. Thermostats (Central)	10 units	20 units	15 units	10 units	10 units	65 units
ECM212	Pilot Prog. Thermostats	50 units	90 units	80 units	60 units	40 units	320 units
ECM062	Pilot E-Star TVs	2 units	2 units	2 units	2 units	2 units	10 units
ECM082	Pilot ESTAR Printers and Fax	4 units	4 units	4 units	4 units	4 units	20 units
ECM091	Ed. Ultra Low-flow Showerheads	45 units	92 units	102 units	112 units	112 units	464 units
ECM111	Ed. Smart, Surge Protected Power Bars for PCs and TVs	117 units	505 units	525 units	525 units	535 units	2,207 units
ECM181	Ed. DHWTank Insulation	102 units	192 units	192 units	212 units	212 units	909 units
ECM201	Ed. DHWPipe Insulation	162 units	300 units	300 units	320 units	320 units	1,401 units

¹¹ Some conditions may apply. See the Incentive Strategy for details.

Budget

The budget presented in Exhibit 78 has been used for planning purposes. However, the Utilities reserve the right to adjust program budgets as necessary in accordance with current market conditions, EM&V results, and program implementation experience. Initial budget levels are set based on conservative estimates of participation given the current market.

Exhibit 78: Budget – Low-cost Energy Efficient Products

	\$1,000s					
	Year 1	Year 2	Year 3	Year 4	Year 5	Total
Incentive:	\$34	\$48	\$43	\$36	\$30	\$192
Non-Incentive:	\$165	\$179	\$145	\$153	\$169	\$811
Total:	\$199	\$227	\$188	\$189	\$199	\$1,003

Savings Target

The savings targets shown in Exhibit 79 have been used for planning purposes. However, the Utilities reserves the right to adjust savings targets as necessary in accordance with current market conditions, EM&V results, and program implementation experience.

Exhibit 79: Savings Targets – Low-cost Energy Efficient Products

	Net Savings with T&D Losses														
	<----- Program Operation ----->					----- Ramp Down as Measure Lifetime Expires ----->									
	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	Year 11	Year 12	Year 13	Year 14	Year 15
Lifetime MWh:	1,849	3,969	3,672	3,540	3,342	0	0	0	0	0	0	0	0	0	0
Annual MWh:	169	543	896	1,236	1,558	1,558	1,542	1,509	1,466	1,422	1,313	1,092	782	512	244
Coincident kW:	60	194	319	441	556	556	550	538	523	507	469	390	279	183	87

Cost Effectiveness

The cost-effectiveness test results shown in Exhibit 80 were computed based on the assumptions presented above: level of incentive, budget, and projections. They are used for planning purposes. However, and since the Utilities reserve the right to adjust the assumptions as necessary in accordance with current market conditions, EM&V results, and program implementation experience; consequently, actual results may differ from those presented below.

Exhibit 80: Cost Effectiveness – Low-cost Energy Efficient Products

	Total Resource Cost TRC	Program Adminis- trator Cost PAC	Participant Cost PC	Rate- Impact Measure RIM
Benefit/Cost Ratio	1.8	2.7	2.8	1.0
Net Present Value (1,000s)	\$1,031	\$1,453	\$1,057	-\$26
Levelized Cost:	\$.128/kWh	\$.086/kWh	N/A	N/A

4.3.3 CCHP and GSHP Initiative

Objective

The pilot phase of this program element will demonstrate and obtain credible information on the electricity savings and the non-energy benefits that can be achieved through innovative house heating and domestic hot water (DHW) systems such as cold climate heat pump (CCHP), and ground-source heat pump (GSHP).

Following the pilot phase, this program element will achieve electricity and demand savings through accelerating the penetration of cold-climate heat pumps (CCHPs) and the ground-source heat pumps (GSHPs) in the Yukon as a result of reducing the initial cost hurdle.

Target Market

The pilot phase of this program component targets:

- New-home buyers who are early adopters and are interested in building a home with an innovative heating system (referred to as “leading” home buyers)
- Yukoners who own homes that are heated with electric central-air or hydronic systems, who are early adopters and are interested in retrofitting their homes with an innovative heating system (also referred to as “leading” home owners)

Similar to the “residential innovators” identified for the low-cost EE products program element, “leading” home buyers and home owners are volunteers that will be recruited through direct community engagement. These individuals will be selected based on their interest in electricity conservation and perhaps environmental conservation, as well as their leadership and influence among their peers. The Utilities intend to develop relationships with these individuals and, eventually, involve them in a network of electricity efficiency ambassadors. The pilot install of either a CCHP or a GSHP will be heavily (but not fully) subsidized by the Utilities, which will make the proposal very attractive. The pilot incentives will be allocated on a first-come, first-serve basis. They will be announced officially in local media. The pilot incentives will be offered in Year 2 and Year 3 while the mass-market incentive will be offered more than one year later, in Year 4 and Year 5.

The results of the CCHP and GSHP pilot projects will be used to improve the design of the CCHP and GSHP incentive, to advertise the incentive and to provide better advice to the participants with respect to the incentive. While the support for a limited number of pilot projects was available on a first-come, first-served basis; the CCHP and GSHP incentive will be available to anyone who complies with the eligibility criteria without restrictions.

The Utilities will primarily target new homes due to the significant price increment for the CCHP and GSHP systems. It is assumed that the new-home segment will be where program uptake will be the easiest to generate. However, eligibility criteria will not preclude owners of existing homes to participate in the program if the existing homes have an electric central-air or hydronic heating system.

Description

The Utilities will select specific technologies of interest (e.g., CCHPs and GSHPs) to be installed in a few “pilot” homes in the Yukon.

The Utilities will recruit leading home buyers or home owners through community direct engagement activities and its network of electricity efficiency ambassadors. The Utilities will also engage with HVAC contractors and housing developers to find market actors who are interested

in installing the innovative systems. The Utilities will match leading home buyers with innovative developers; and leading home owners with innovative HVAC contractors.

The Utilities will provide a pilot incentive to developers that will significantly decrease the incremental cost of the technologies of interest. The pilot incentives will be allocated on a first-come, first-served basis. They will be announced officially in local media. They will be offered in Year 1 and Year 2, while the mass-market incentive will be offered more than one year later in Year 3 and Year 4.

The Utilities will plan and execute the performance measurement and verification of the pilot houses to collect credible, validated, and high-quality data. The participating households will also be surveyed about their satisfaction with the technologies.

The results of the pilot studies will be disseminated through different channels, e.g. through HVAC contractors, electrical contractors, housing developers and municipalities. The results will validate the design, inform the implementation approach, and feed the communication and marketing strategy of a full-fledged incentive program component.

For the mass-market incentive, the Utilities will provide a flat amount of money, adjusted by the capacity of the CCHP or the GSHP (e.g. per unit of heating capacity), installed and attributed to buyers of new houses or condominium units heated with a CCHP or a GSHP system. The incentive level of CCHP and GSHP will differ.

The Utilities will use the information and case studies generated by the piloting of CCHP and the GSHP to tune the incentive level and to advertise the incentive offering.

The incentive will be available throughout the year. The participation process will resemble the following:

- The Utilities match home buyer(s) and developers, or innovative home owners and contractors
- The new home must comply with the Yukon Housing SuperGreen standard and have a central-heat air ducts or hot water piping
- The developer will install the CCHP or the GSHP system
- The sale of the house will be completed
- The home owner will file an incentive application
- The Utilities will review the application and, if the participating home owner complied with all of the criteria, then
- The Utilities will send the incentive to the participant.

For GSHP systems, the Utilities may ask (1) the installer to be certified by the Canadian GeoExchange Coalition, and (2) the newly installed system to be certified by the Canadian GeoExchange Coalition. Certified installers may not be available in the Yukon at the moment; however, the Utilities will provide time for installers in the Yukon to prepare.

Duration & Milestones

The Utilities propose to launch and operate the program for a period of approximately five years (20 quarters) before going through a new program design, filing and approval process.

Assuming that this program begins in the first quarter of Year 1 (Q1 of Y1) and finishes in the last quarter of Y5 and that the report on the CCHP and GSHP pilot projects are issued on the first quarter of Y4, the main milestones of this component are:

- Q1 of Y1: Validate the levels of incentives to be offered for the CCHP and GSHP systems.
- Q2 of Y1: Initiate community direct engagement activities and direct engagement with housing developers. The identification of home owners and developers should start along with the direct engagement activities.

- Q1 of Y2: Both home buyers, home owners, contractors and developers willing to test the CCHP and the GSHP are identified. The M&V plan for the CCHP and the GSHP installations should be finalized.
- Q3 of Y2: The pilot CCHP and the GSHP system should be operating.
- Q1 to Q4 of Y3: Post-retrofit period of the CCHP and the GSHP systems. Satisfaction surveys are carried out.
- Q1 of Y4: Report on the CCHP and the GSHP system pilots.
- Q1 of Y4: Program preparation
- Q2 of Y4: Program launch: first direct engagement and communication campaign about the CCHP and GSHP incentives
- Q4 of Y4: Report on the impacts of the Y4 participation.
- Q1 of Y5: Update of incentive levels and collateral materials.
- Q4 of Y5: Report on the impacts of the CCHP and GSHP incentive.
- Q3 of Y5: Draft impact evaluation report is filed with the YUB
- Q4 of Y5: New program portfolio design is filed with the YUB
- Q1 of Y6: Program component is either terminated or updated to fit new market circumstances

Eligible Measures

The preliminary list of technologies that the Utilities intend to promote includes the items presented in Exhibit 81.

Exhibit 81: Inputs and Assumptions of Residential New-Construction CCHP and GSHP Initiative

ID	Measure Short Name	Gross Annual Consumption Savings	Gross Coincident Peak Savings	Net-to-Gross Ratio	Measure Cost	Measure Lifetime	Level of Incentive
ECM032	Pilot Cold Temp Heat Pumps	6,780 kWh/unit	2.421 kW/unit	100%	\$8,498.44/unit	20.0 yr	\$5,000.00/unit
ECM372	Pilot Ground Heat Pumps - Closed	8,605 kWh/unit	3.070 kW/unit	100%	\$34,245.24/unit	20.0 yr	\$9,000.00/unit
ECM03	Cold Temp Heat Pumps	6,780.0 kWh/unit	2.421 kW/unit	100%	\$8,498.44/unit	20.0 yr	\$2,500.00/unit
ECM37	Ground Heat Pumps - Closed	8,605.0 kWh/unit	3.070 kW/unit	100%	\$34,245.24/unit	20.0 yr	\$3,500.00/unit

The Utilities reserve the right to revise measures to be promoted as needed in accordance with current market conditions, technology development, EM&V results, and program implementation experience. In addition, the Utilities reserve the right to recover the incentive money and/or products that were handed out for free or as pilot incentives should fraud errors or omissions be uncovered.

Marketing & Communications Strategy

The Utilities will leverage the direct community engagement activities, the partnership with applicable non-profit and community organizations, and the network of electricity efficiency ambassadors (see description in section 4.3.2) to find individuals among electricity ambassadors, and their friends & relatives, who are planning to buy new houses and are interested in piloting CCHPs and GSHPs. Following the pilot phase, similar a similar approach will be used to find individuals about to buy new houses and are interested in buying a house with a CCHP or a GSHP system.

The Utilities will engage directly with HVAC contractors and housing developers in the Yukon. The Utilities will help match developers and prospective new home buyers who are both interested in CCHP or GSHP system, and residential HVAC contractors with innovative home owners. There are only a few of these individuals, so it is realistic to speak with all of them.

Incentive Strategy

During the pilot phase, Utilities will provide an incentive to developers or to HVAC contractors that will significantly reduce the total incremental cost of the technologies, in the case of heat pumps, this will include not only the cost of the heat pump and the bore wells (if applicable), but also the cost of the central air ductwork.

However, although the Utilities' offer to the developers and contractors will cover a significant percentage of the measure cost, it will nevertheless be a flat amount so that developers and contractors do not inflate the incremental cost. The Utilities envision a quasi-prescriptive incentive based on the capacity of the water tank or the capacity of the heat pump.

There will be a limited amount of incentive available. The incentive will be attributed on a first-come, first-served basis to participating developer(s) or contractor(s) who comply with the eligibility criteria. When ready, the pilot incentive will be announced through local media.

For the mass-market incentive program, the Utilities will provide an incentive to the developers or contractors to alleviate the initial cost hurdle of the CCHP and GSHP technologies (including the cost of the heat pump the borewells, and the central air ductwork).

The incentive will be a flat amount so that developers or contractors do not inflate the incremental cost. The Utilities envision a quasi-prescriptive incentive based on the capacity of the heat pump (tons of refrigeration).

In the case of a multi-family building, if one system supplies the entire building with heat, each condominium buyer or owner will have to file an application. The *eligible tons of refrigeration* for a given buyer will be established by prorating the capacity of the central equipment using the square footage of the unit.

Program Theory

The theory of the Residential CCHP and GSHP Initiative has been graphically depicted in the form of a logic model and is shown in Exhibit 82.

Exhibit 82: Logic Model of the Residential CCHP and GSHP Initiative

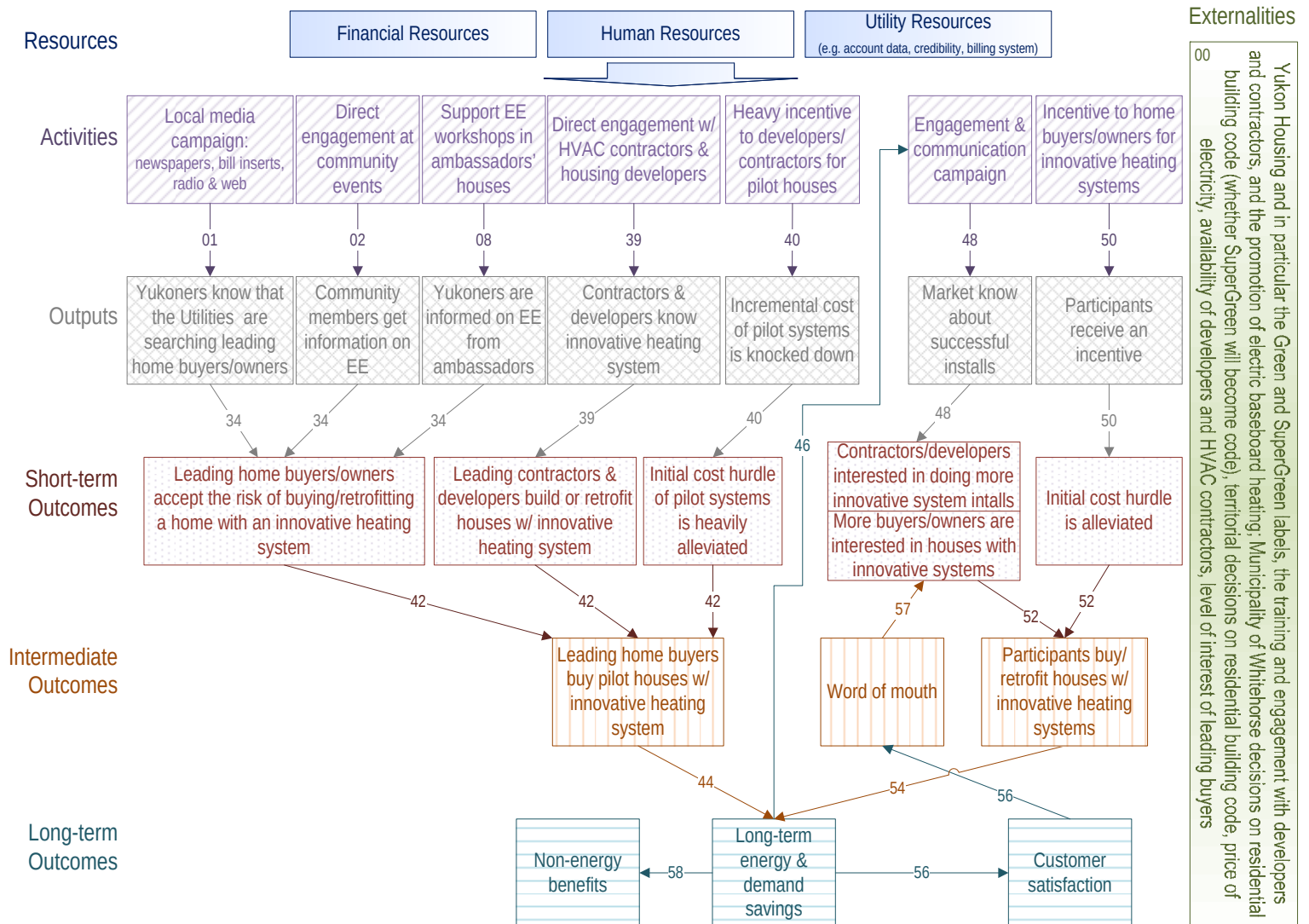


Exhibit 83 presents the narratives of the logic model shown in Exhibit 82.

Exhibit 83: Explanatory Note on the Residential CCHP and GSHP Initiative

Link #	Narrative
00	The program effectiveness and impact will be influenced by the following externalities: Yukon Housing, in particular the Green and SuperGreen labels, the training and engagement with developers and contractors, and the promotion of electric baseboard heating; Municipality of Whitehorse decisions on residential building code (whether SuperGreen will become code); territorial decisions on residential building code; price of electricity; availability of developers and HVAC contractors and level of interest of leading buyers. The program administrator should monitor these externalities and adapt the implementation approach accordingly.
01	The Utilities will advertise their intention to build a network of EE ambassadors through the local press and applicable non-profit and community organizations. It is expected that this tactic will ease the development of the network.

Link #	Narrative
02	The Utilities will carry out outreach activities in community events (e.g., sport events, cultural events, town hall meetings, etc.), engage with organization and people who have a natural interest in electricity conservation; hook individuals with a continuous stream of free low-cost EE products or contests; do personalized follow-ups; offer to new home buyers to pilot CCHPs or GSHPs; and promote the idea of supporting a EE workshop at their home or at a local venue.
08	The Utilities will support EE workshops in the homes of EE ambassadors or nearby community venues with approximately ten friends and relatives. The Utilities will send facilitator(s), provide communication materials and low-cost EE products to give away, and perhaps provide food and beverages. The Utilities' skilled facilitator(s) will have a few key messages regarding low-cost EE products, LED lighting products, and innovative heating systems. The facilitator will encourage the participants to share tips and information on electricity conservation. The facilitator will seek to eliminate potential sources of confusion and false beliefs in the communities by presenting hard facts.
34	Through community direct engagement tactics as detailed in links #01, #02 & #03, the Utilities will find leading home buyers or leading home owners who will accept the risk of buying a home with an innovative heating system.
39	The Utilities will engage directly with all of the HVAC contractors and housing developers in the Yukon. Because there only a few, it is realistic to speak with all of them. The Utilities will find leading developers and HVAC contractors who are willing take on the risk of building houses with innovative heating systems; or to retrofit existing homes with CCHP and GSHP systems. Their risk exposure will be reduced because the Utilities will help them find clients.
40	The Utilities will provide an incentive to the developers and contractors that will significantly reduce the total incremental cost of the technologies: not only the cost of the heat pump and the borewells, but also the cost of the central air ductwork. The initial-cost hurdle of pilot houses will be heavily alleviated.
42	Developers will build pilot houses with innovative heating systems; and new home buyers will buy them because the Utilities will have found the buyers, matched them with the developers/contractors, and heavily subsidized the projects to address the initial-cost hurdle. Alternatively, innovative contractors will retrofit existing homes with innovative heating systems. The home owners will be willing to have their house pilot the system because the Utilities will have found leading home owners, matched them with innovative contractors, and heavily subsidized the projects to address the initial-cost hurdle.
44	The pilot houses with innovative heating systems will yield long-term electricity and demand savings. This electricity and demand savings will be verified and documented through state-of-the art project performance measurement and verification (M&V) activities.
46	The results of the pilot projects and of the M&V activities will feed the program planning; and will feed the engagement and communication campaign of the CCHP and GSHP incentive program component.
48	The Utilities deliver an engagement and communication campaign primarily through already-established channels: community direct engagement; and HVAC contractors and developers engagement. In addition, the Utilities will launch a local media campaign through local newspapers, local radios, brochures to be passed to prospective buyers by developers and contractors, email blasts, bill inserts and web content development. The Utilities will publicize the results of the pilot projects so that the market knows that the installations were successful and that CCHP and GSHP are viable technologies in the Yukon. As a result, developers and contractors will be interested in doing more CCHP and GSHP system installations, more home buyers will be interested in houses with these heating systems; and more home owners will be interested in retrofitting their houses with CCHP and GSHP systems.
50	The Utilities will provide a flat amount of money adjusted based on the capacity of the CCHP or the GSHP (per tons of refrigeration) installed and attributed to buyers of new houses or condominium units heated with a CCHP or a GSHP system; or to home owners willing to retrofit their houses with a CCHP or a GSHP system. The incentive level of CCHP and GSHP will differ. The incentive will alleviate the initial cost hurdle of CCHP and GSHP systems.
52	Because the supply and the demand will be stimulated, and because the initial-cost hurdle is alleviated, the participating home buyers or home owners (the participants) will buy houses with CCHP or GSHP systems.
54	The houses of participants in the CCHP and GSHP incentive program component will yield long-term electricity and demand savings.
56	Participants will be satisfied by the products that they bought. They will tell their friends and relatives. This will generate word-of-mouth advertisement.
57	With time, word-of-mouth will become an important information channel that will cause Yukon residents to buy new houses with CCHP or GSHP systems; or to retrofit their houses with CCHP or GSHP systems.

Link #	Narrative
58	It is assumed that the participants (pilot projects and incentive) will perceive new non-energy benefits; and/or the maintenance of benefits they used to have with baseline systems. The Utilities will seek to see the participants perceive that the comfort provided by CCHPs, and GSHPs is equivalent to what would be provided by baseboards heating.

Project Participation

The projections shown in Exhibit 84 have been used for planning purposes. However, the Utilities reserve the right to adjust savings targets as necessary in accordance with current market conditions, EM&V results, and program implementation experience.

Exhibit 84: Participation Projections – CCHP and GSHP Initiatives¹²

ID	Measure Short Name	Year 1	Year 2	Year 3	Year 4	Year 5	Total
ECM032	Pilot Cold Temp Heat Pumps	1 units	0 units	0 units	1 units	0 units	2 units
ECM372	Pilot Ground Heat Pumps - Closed	0 units	1 units	1 units	0 units	0 units	2 units
ECM03	Cold Temp Heat Pumps	0 units	0 units	0 units	6 units	6 units	12 units
ECM37	Ground Heat Pumps - Closed	0 units	0 units	0 units	1 units	1 units	2 units

Budget

The budget presented in Exhibit 85 has been used for planning purposes. However, the Utilities reserve the right to adjust program budgets as necessary in accordance with current market conditions, EM&V results, and program implementation experience. Initial budget levels are set based on conservative estimates of participation given the current market.

Exhibit 85: Budget – CCHP and GSHP Initiative

	\$1,000s					
	Year 1	Year 2	Year 3	Year 4	Year 5	Total
Incentive:	\$5	\$9	\$9	\$24	\$19	\$65
Non-Incentive:	\$18	\$34	\$28	\$39	\$24	\$144
Total:	\$23	\$43	\$37	\$63	\$43	\$209

¹² Some conditions may apply. See the Incentive Strategy for details.

Savings Target

The savings targets shown in Exhibit 86 have been used for planning purposes. However, the Utilities reserves the right to adjust savings targets as necessary in accordance with current market conditions, EM&V results, and program implementation experience.

Exhibit 86: CCHP and GSHP Initiative

	Net Savings with T&D Losses														
	<----- Program Operation ----->					----- Ramp Down as Measure Lifetime Expires ----->									
	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	Year 11	Year 12	Year 13	Year 14	Year 15
Lifetime MWh:	148	188	188	1,223	1,075	0	0	0	0	0	0	0	0	0	0
Annual MWh:	7	17	26	87	141	141	141	141	141	141	141	141	141	141	141
Coincident kW:	3	6	9	31	50	50	50	50	50	50	50	50	50	50	50

Cost Effectiveness

The cost-effectiveness test results shown in Exhibit 87 were computed based on the assumptions presented above: level of incentive, budget, and projections. They are used for planning purposes. However, the Utilities reserve the right to adjust the assumptions as necessary in accordance with market conditions, EM&V results, and program implementation experience.

Exhibit 87: Cost Effectiveness – CCHP and GSHP Initiative

	Total Resource Cost TRC	Program Adminis- trator Cost PAC	Participant Cost PC	Rate- Impact Measure RIM
Benefit/Cost Ratio	0.9	1.7	1.2	0.8
Net Present Value (1,000s)	-\$25	\$131	\$40	-\$65
Levelized Cost:	\$.263/kWh	\$.140/kWh	N/A	N/A

4.4 Engagement, Education and Communication

Engagement, education and Communication will generate uptake for the Residential Program in Whitehorse and in the communities, which will increase long-term electricity and demand savings.

It will achieve short-term electricity and demand savings by educating Yukon residents about behaviors at home that influence their electricity consumption and demand.¹³

Communication, education, and engagement are key components of DSM programs, and it is a good practice to resource these activities properly. Proper communications, education, and engagement are essential to stimulate program uptake and therefore DSM rebates

¹³ The short-term electricity consumption and demand savings generated by the engagement, education and communication program element will not be claimed because of the challenges and costs related with the demonstration of such savings. The program must be cost-effective without having to claim these savings.

performance. Communication, education and engagement also contribute to the rebates to establish a real causal effect between the DSM program and the accelerated adoption of electricity-efficient technologies and services. In other words: without communications, education and engagement, rebate claims (if any) are very likely to be made by the few consumers who would have selected the electricity-efficient technologies and services anyway – the so-called “freeriders”.

Target Market

The target market comprises all Yukon residents, including residents of Whitehorse and residents of the communities.

In order to serve the purpose of the Residential Program, the public engagement, education and communication activities and tactics will focus primarily on:

- Shoppers
- Yukon residents who attend community events and/or are involved in applicable non-profit and community organizations
- Yukon residents who agree to assume a leadership role and become electricity efficiency ambassadors
- New Yukon home buyers
- EE ambassadors
- housing developers

EE ambassadors will be people who showed interest in the first place by sending back the scorecards). The Utilities staff will do personalized follow-ups (emails, phone calls, perhaps some in-person meetings); offer new home buyers opportunities to pilot a CCHP or GSHP system; and promote the idea of supporting a EE workshop at their home or a at local venue.

The EE workshops will be highly participative and engaging. It is expected that the EE ambassadors will gather a group of approximately ten people among their friends and relatives. The Utilities will send facilitator(s), provide communication materials and low-cost EE products to give away, and perhaps provide food and beverages. The Utilities’ skilled facilitator(s) will have a few key messages regarding low-cost EE products, LED lighting products, and innovative heating and DHW systems. The facilitator will encourage participants to share tips and information on electricity conservation. The facilitator will also seek to eliminate potential sources of confusion and false beliefs in the communities by presenting information on topics such as for instance CFL mercury content and disposal facilities in the Yukon, and the relevance of opening windows in the winter to improve indoor air quality.

New-Housing Construction Channel

The Utilities intend to use the following tactics to reach out to Yukon residents:

- Direct engagement with HVAC contractors, electrical contractors and house developers.
- Display information on rebates and electricity efficiency products on the Utilities’ website.

The Utilities will use all of its direct-engagement activities to disseminate information about the Yukon Housing conservation programs and the ESC energy conservation programs to increase value for the audience and create synergy among stakeholders.

Duration & Milestones

The Utilities propose to launch and operate the program for a duration of five years (20 quarters) before going through a new program design, filing and approval process.

Assuming that this program begins in the first quarter of Y1 and finishes in the last quarter of Y5, the main milestones of this component are:

- Q1 of Y1: Lay out communication and marketing strategy for the year.
- Q2 of Y1: Produce communication materials
- Q3 and Q4 of Y1: Ramp up the communication and direct engagement activities
- Q1 of Y2: Report on the impacts of the engagement, education and communication component
- Repeat the cycle during Y2, Y3, Y4 and Y5
- Q3 of Y2: First “EE workshop” in the home of an EE ambassador.
- Q3 of Y5: Draft impact evaluation report is filed with the YUB
- Q4 of Y5: New program portfolio design is filed with the YUB
- Q1 of Y6: Program component is either terminated or updated to fit new market circumstances

Budget

The budget presented in Exhibit 88 has been used for planning purposes. However, the Utilities reserve the right to adjust program budgets as necessary in accordance with current market conditions, EM&V results, and program implementation experience. Initial budget levels are set based on conservative estimates of participation given the current market and uncertainty.

Exhibit 88: Budget – Engagement, Education and Communication

	\$1,000s					
	Year 1	Year 2	Year 3	Year 4	Year 5	Total
Incentive:	\$0	\$0	\$0	\$0	\$0	\$0
Non-Incentive:	\$113	\$130	\$134	\$138	\$142	\$657
Total:	\$113	\$130	\$134	\$138	\$142	\$657

5 Summary

The information presented in this Yukon Electricity DSM Program Portfolio provides:

- A comprehensive suite of DSM programs that will increase electricity efficiency within the Yukon's Residential and General Service (commercial) sectors.
- A full reporting of the rationale and cost-effectiveness of those programs at the level of individual program element, sector program, and total portfolio under two scenarios - one that includes and one that excludes the participation of government customers.

The proposed electricity DSM program portfolio will capture a significant share of the cost-effective opportunities for Yukon electricity efficiency that were identified in the recently completed study entitled *Yukon Electricity Conservation and Demand Management Potential Review (CPR 2011)*. The proposed programs were designed to: minimize program design complexity in the interests of speeding up time-to-market; provide program implementers with the flexibility needed to respond to customer needs and program monitoring results; and, transform the electricity market by setting the foundation for a more electricity-conscious Yukon.

Overall, the proposed programs provide positive net benefits to the Yukon and to program participants under both scenarios i.e., with and without the participation of government customers. Results are moderately more positive under the scenario that includes the participation of government customers; this scenario also lowers program risk because a broader market of eligible participants means more flexibility for program implementers.

With government participation over the 5-year program period the Residential and General Service Programs will generate a total of 98.9 GWh of measure-lifetime net savings, 9.3 GWh of annual net savings, and 2.3 MW of coincident peak demand savings. The General Service Program will generate 67% of the measure-lifetime net savings and the Residential Program will generate the remaining 33%.

In the scenario that includes government participation, the results of the cost-effectiveness tests for the proposed DSM program portfolio are:

- A Total Resource Cost Benefit/Cost ratio of 1.4 i.e., the portfolio will yield economic benefits to the Yukon and contribute to decreased electricity costs in the long term.
- A Program Administrator Cost ratio of 2.3 i.e., the program portfolio will yield "negative kWh" that are less expensive than kWh obtained from planned new generation, transmission and distribution capacity.
- A Participant Cost ratio of 2.9 i.e., the portfolio will generate net benefits to Yukon electricity customers who participate in the programs.
- A blended Rate-Impact Measure ratio of 0.8 i.e., the portfolio will result in a modest reduction of revenue to the Utilities unless the electricity rates are adjusted upward. The blended RIM ratio assumes utility cooperation and, therefore, presents the RIM results as a blended value. When calculated separately, the RIM test shows a net benefit to YEC and a net loss to YECL.

If the proposed electricity DSM program portfolio is approved by the Yukon Utilities Board, the next step in this process will be the development of a program implementation plan, including the definition of the program operational and transactional infrastructure, followed by program launch.

Appendix A Program Focus Paper

Appendix B Market Characterization Methodology

Appendix C Detailed Budgets

Appendix D Incentive Level Justification

Appendix F: Cost Effectiveness Tests

Program design is developed with the constraint of ensuring that the electricity savings are achieved in a cost-effective manner and with minimum impact on ratepayers and electricity rates. As illustrated in the Demand Side Management Program Portfolio for the Yukon (Sept, 2012), program design and the determination of program cost effectiveness is an iterative process. Differing levels of program expenditures on incentives as well as program promotion and administration costs affect program participation rates and electricity savings. Increased program expenditures increase participation rates but typically at diminishing rates of cost effectiveness. The cost effectiveness results presented in Demand Side Management Program Portfolio for the Yukon (Sept, 2012) report are consistent with industry best practice and are based on the methods outlined in the California Standard Practice Manual. The four standard tests used, were originally developed by the California Public Utilities Commission (CPUC) and defined by the California Standard Practice Manual. The four tests used are presented below in section 7.2.2. Together, these tests were used to screen opportunities, adjust incentive levels and to set program administration costs as well as related education, training and promotional activities.

Four Standard Cost-Effectiveness Tests Used in Energy Efficiency:

Test	Acronym	Key Question Answered	Summary Approach
Participant Cost Test	PC	Will the participant benefit over the measure life?	Comparison of costs and benefits to the customer installing the measure or implementing the project
Program Administrator Cost Test	PAC	How much will the DSM program administrator pay for savings?	Comparison of program administrator costs to supply-side resource costs
Ratepayer Impact Measure	RIM	Will utility rates increase?	Comparison of administration costs and lost revenue to supply-side resource costs If the RIM test is “passed” then the rates will decrease as a result of the program/measure. ¹
Total Resource Cost Test	TRC	Will the total costs of electricity in the utility service territory decrease?	Comparison of program administration and customer costs to utility resource savings

Based on: US-EPA, *Understanding Cost-Effectiveness of Energy Efficiency Program: Best Practices, Technical Methods, and Emerging Issues for Policy-Makers*, USA, 2008, available at <http://www.epa.gov/cleanenergy/documents/suca/cost-effectiveness.pdf>.

The RIM and the PAC tests noted above were computed from the perspective of the Utilities; regardless of the cash flows between YEC and YECL. Some key assumptions employed are provided below.

The lost revenue was computed based on the rate paid by the end users: residential consumers, non-government, and government.

The avoided cost of supply that was used is 21 cents/kWh. This value is based on a portfolio cost approach that averages the near term supply options including two hydro enhancements, liquefied natural gas, biomass, and wind as described in the Yukon Energy 20 Year Resource Plan Update. The transmission and distribution (T&D) losses were assumed to be 8.3percent.

When calculated separately, the RIM test shows a net benefit to Yukon Energy and a net loss to YECL. However, the benefit-cost ratios throughout the portfolio assume utility cooperation and therefore display a RIM test as a blended value.

¹ This statement assumes that rates would be adjusted based on econometric and financial analyses of the program impacts.



Yukon Electricity Conservation and Demand Management Potential Review (CPR 2011)

Residential Sector Final Report

9 January 2012

Submitted to:
Yukon Energy, Yukon Electrical Company,
Government of Yukon

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Executive Summary

Background and Objectives

Yukon residents rely on electricity not only to live meaningful, healthy lives but also to support and strengthen the economy. Given the concerns over environmental implications including climate change, and the limited generating capacity in Yukon, there is growing interest not only in how electricity is generated, transmitted and distributed, but also in how efficiently it is used on the customer's end. In Yukon, as well as in a growing number of North American jurisdictions, how electricity is generated and used is being closely analyzed to find innovative ways of meeting individual and corporate energy service needs while minimizing pollution and the creation of greenhouse gases.

Experience throughout many North American jurisdictions has demonstrated that energy efficiency, conservation and customer-supplied alternative energy technologies all have a significant potential to reduce energy consumption, energy costs and emissions. The 2009 *Energy Strategy for the Yukon* also recognizes this potential and notes the following efficiency and conservation priorities:

- Avoid the cost and environmental impact of building new generation
- Increase energy efficiency in Yukon by 20% by 2020
- Reduce energy consumption in Yukon buildings
- Reduce energy consumption for transportation in Yukon
- Promote the use of energy efficient products by providing incentives for products that meet energy performance standards
- Improve energy efficiency for Yukon government operations.

Efficient use of electricity through conservation, peak demand control and alternative energy sources can assist greatly in the path forward for the electrical supply industry. This conservation potential review study, referenced as CPR 2011, will provide a resource for Yukon Energy Corporation (YEC), Yukon Electrical Company Limited (YECL), and the Government of Yukon to develop a comprehensive vision of the territory's future electricity service needs.

More specifically, the objective for this study is to provide:

"...a necessary reference point to determine the potential for (electricity) demand-side management (DSM) in the Yukon."¹

Scope

The scope of this study is summarized below:

- **Sector Coverage:** This study addresses two sectors: residential households (Residential sector), and commercial and institutional buildings (Commercial sector). Yukon's industrial sector consists primarily of a small number of operating mines on the grid, which are not

¹ Yukon Energy Corporation Request For Proposals #2010-045, "Consulting Services for Electricity Conservation and Demand Management Potential Study," 2011.

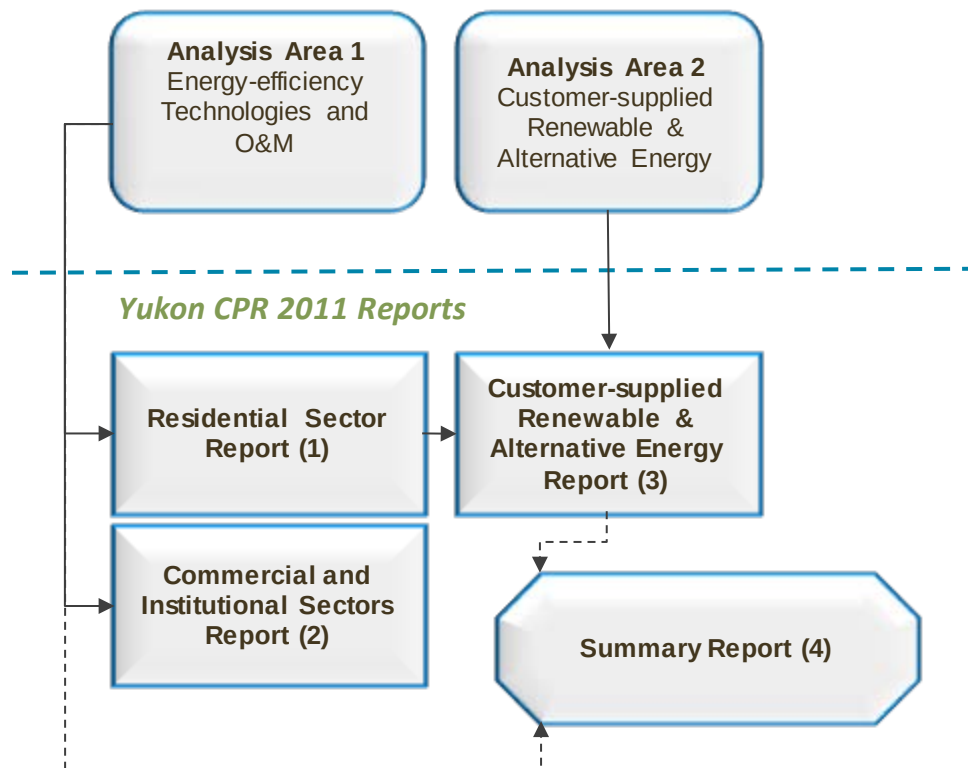
appropriate to be included in this type of study. Efficiency opportunities within these sites are being addressed outside this study.

- **Geographical Coverage:** The study addresses all regions of Yukon that are served by either YEC or YECL. Customers served by both the hydroelectric grid and the stand-alone diesel grids are included. Note that the hydroelectric grid is remote, not connected to other grids, and dependent on trucked fuel to meet demand above the existing hydro/ wind capacity, while the stand-alone diesel grids rely on fuel that is trucked or flown in at all times.
- **Study Period:** This study covers a 20-year period. The Base Year is the calendar year 2010, with milestone periods at five-year increments: 2015, 2020, 2025 and 2030. The Base Year of 2010 was selected to enable this study's results to be aligned with the most recent Yukon load forecast.²
- **Technologies:** This study addresses a comprehensive range of demand-side management (DSM) measures. This includes all electrical efficiency technologies or measures that are expected to be commercially viable by the year 2015, as well as peak load reduction technologies and customer-side renewable energies.

Conservation Potential Review 2011 (CPR 2011) has been organized into four analysis areas and the results are presented in four reports, as show in Exhibit ES 1, below.

Exhibit ES 1 Overview of CPR 2011 Organization – Analysis Areas and Reports

Yukon CPR 2011 Analysis Areas



² Yukon Energy Corporation, *20-Year Resource Plan – 2011, First Draft*, April 2011.

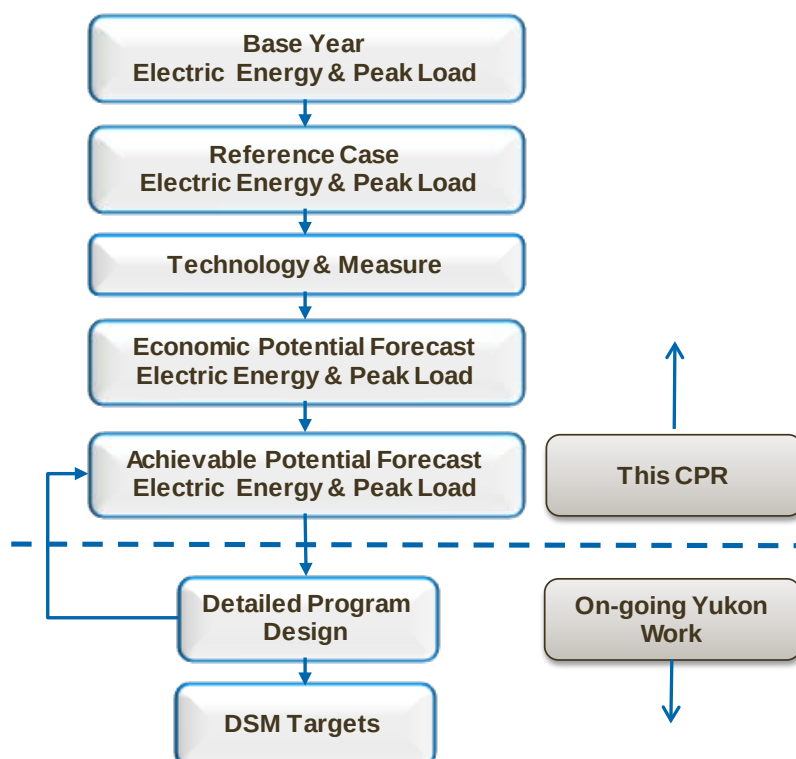
This report presents the results of Analysis Area 1: Energy-efficiency Technologies and O&M, for Residential sector customers (Report 1 in Exhibit ES 1 above). This report addresses all commercially available electric energy-efficiency and peak load reduction measures that are applicable to Yukon's Residential sector.

Approach

The detailed end-use analysis of electrical efficiency opportunities in the Residential sector employed two linked modelling platforms: HOT2000,³ a commercially supported, residential building energy-use simulation software, and RSEEM (Residential Sector Energy End-use Model), an ICF Marbek in-house spreadsheet-based macro model. Peak load savings were modelled using Lopes Consulting Services, Inc.'s Cross-Sector Load Shape Library Model (LOADLIB).

The major steps involved in the analysis are shown in Exhibit ES 2 and are discussed in greater detail in Section 2 of this report. As illustrated in Exhibit ES 2, the results of CPR 2011, and in particular the estimation of Achievable Potential,⁴ support on-going demand-side management (DSM) work; however, it should be emphasized that the estimation of Achievable Potential is not synonymous with either the setting of specific DSM targets or with program design.

Exhibit ES 2 CPR 2011: Main Analytic Steps



³ Natural Resources Canada. *HOT2000 Software*. Download from: http://canmetenergy-canmetenergie.nrcan-rncan.gc.ca/eng/software_tools/hot2000.html

⁴ The proportion of savings identified that could realistically be achieved within the study period.

Overall Residential Study Findings

As in any study of this type, the results presented in this report are based on a number of important assumptions. Assumptions such as those related to the current penetration of efficient technologies and the rate of future growth in the building stock are particularly influential. Wherever possible, the assumptions used in this study are consistent with those used by the Yukon utilities and government. However, the reader is referred to a number of caveats throughout the main text of the report. Given these assumptions, the CPR 2011 findings confirm the existence of significant potential cost-effective opportunities for electric energy⁵ and peak load savings in Yukon's Residential sector.

Electric energy savings from electrical efficiency improvements would provide between 22,000 and 37,000 MWh/yr. of electricity savings by 2030 in, respectively, the lower and upper Achievable scenarios. The most significant Achievable Savings opportunities were in the actions that addressed space heating. Significant savings were also found in domestic hot water systems, clothes dryers,⁶ standby load in household electronics (e.g., computers and their peripherals, televisions, and other home entertainment electronics), and 13 other end uses.

The electric energy savings noted above would provide peak load savings of approximately 6.4 to 10.5 MW during Yukon's annual system peak hour by 2030 in, respectively, the lower and upper Achievable scenarios.⁷

Summary of Electric Energy Savings in the Residential Sector

A summary of the levels of annual electricity consumption contained in each of the forecasts addressed by CPR 2011 is presented in Exhibit ES 3 and Exhibit ES 4, by milestone year.

Exhibit ES 3 Electricity Savings by Milestone Year for Three Scenarios (MWh/yr.)

Year	Economic Potential Scenario		Upper Achievable Potential Scenario		Lower Achievable Potential Scenario	
	Potential Savings (MWh/yr.)	% Savings Relative to Ref Case	Potential Savings (MWh/yr.)	% Savings Relative to Ref Case	Potential Savings (MWh/yr.)	% Savings Relative to Ref Case
2015	37,234	24%	5,114	3%	2,711	2%
2020	42,572	25%	13,554	8%	7,792	5%
2025	49,415	25%	23,598	12%	13,539	7%
2030	57,246	25%	37,097	16%	22,239	10%

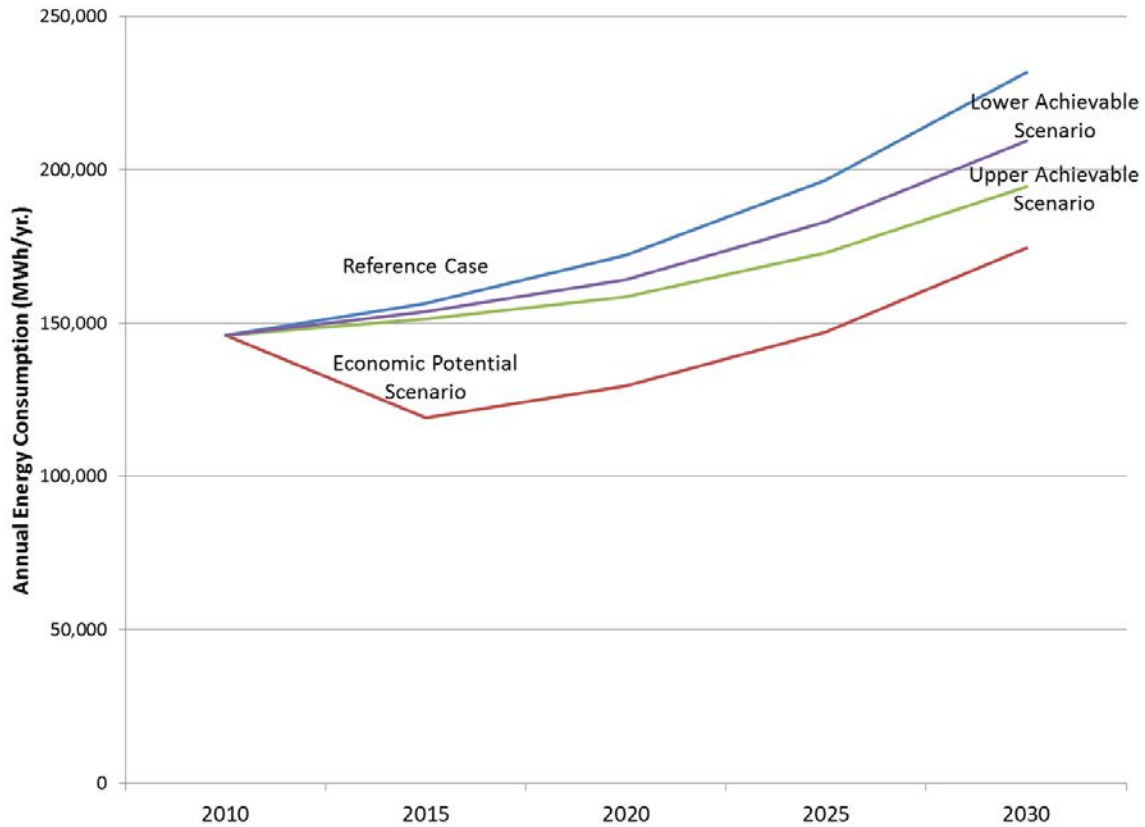
*Results are measured at the customer's point-of-use and do not include line losses.

⁵ The term "electric energy" is used in this report to distinguish electricity consumption (in units of kWh or MWh) from electricity demand during a specific period (in units of MW).

⁶ Savings in the clothes dryers result from the faster spin cycle in energy-efficient clothes washers. Spinning the clothes more thoroughly in the washer reduces the runtime of the clothes dryer.

⁷ These reduction estimates do not include the change in load shape that results when timers are used on block heaters. In fact, if timers are used, close to 90% of the peak load caused by block heaters would be eliminated because the block heater load at most homes with timers would not begin until the early hours of the morning. At the same time, the figures include an overestimate of peak impact from space heating measures because the heat pump measures do not offer demand reductions. These effects almost cancel out: the range of peak savings is between 6.6 MW and 9.9 MW if they are included.

Exhibit ES 4 Annual Electricity Consumption—Energy-efficiency Achievable Potential Relative to Reference Case and Economic Potential Forecast for the Residential Sector, (MWh/yr.)



Base Year Electricity Use

In the Base Year of 2010, Yukon's Residential sector consumed about 146,000 MWh. Exhibit ES 5 shows that domestic hot water and space heating each account for about 19% of total residential electricity use. These are followed by spa heaters and pumps with about 9%, indoor lighting with 8%, and computers (with their peripherals) and clothes dryers with about 7% each. Refrigerators account for 6%, followed by cooking, ventilation/circulation, and freezers with 4% each. Other end uses account for 3% or less of the total. The same exhibit also presents the Reference Case consumption by end use in 2030, at the end of the study period, for comparison.

Exhibit ES 6 shows the distribution of Base Year electricity consumption by dwelling type. As illustrated, single detached housing dwellings account for the largest share (72%) of Residential sector Base Year electricity use. The same exhibit also presents the Reference Case consumption by dwelling type in 2030, at the end of the study period, for comparison.

Reference Case – Electric Energy

In the absence of new DSM initiatives, CPR 2011 estimates that electricity consumption in the Residential sector will grow from 146,000 MWh/yr. in 2010 to about 232,000 MWh/yr. by 2030. This represents an overall growth of about 59% in the period and is higher than the forecast set

out in YEC's 20-Year Resource Plan – 2011. This is largely because projections of construction of electrically heated residential dwellings have been revised since the publication of that forecast.

Exhibit ES 5 below shows the expected change in energy consumption by end use by 2030, in the absence of new DSM initiatives. Space heating is expected to rise to 24% of residential electricity consumption, while domestic hot water is expected to fall to 13%. These will be followed by computers (with their peripherals) at 10%, small appliances and other (including as yet unknown end uses), also at 10%, clothes dryers at 6%, home entertainment electronics and indoor lighting at 5% each, and refrigerators at 4%. Other end uses each account for 3% or less of the total.

Exhibit ES 6 below shows the expected change in energy consumption by dwelling type in 2030, in the absence of new DSM initiatives. As illustrated, single detached housing dwellings are expected to account for a somewhat smaller share (65%) of overall residential consumption. The biggest increase is expected to be in apartment buildings, because of their higher rate of construction and because so many of them are expected to be electrically heated. Over the study period, they are expected to rise from approximately 9% of residential consumption in 2010 to approximately 17% in 2030.

Exhibit ES 5 Base Year Electricity Use by End Use, Residential Sector

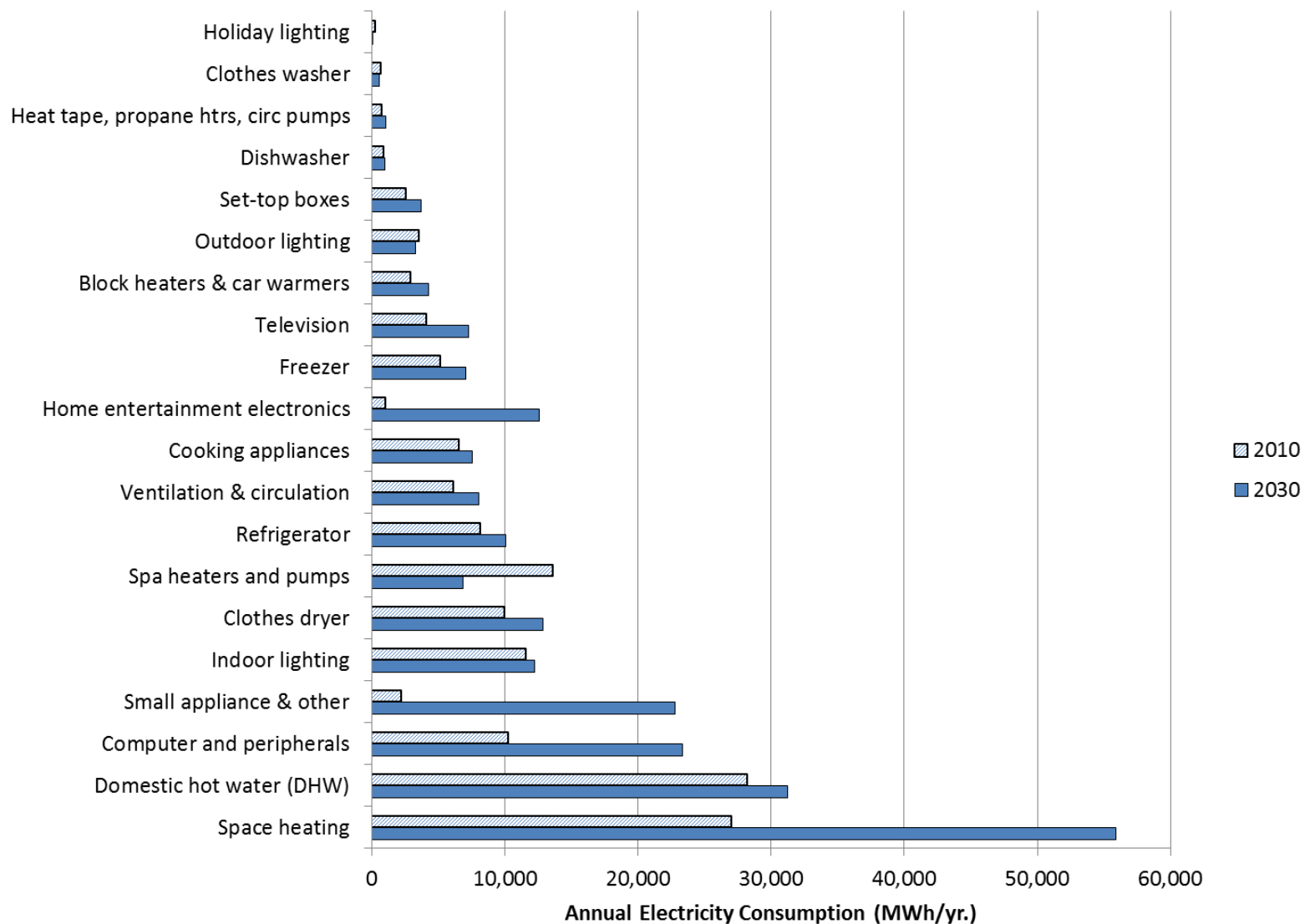
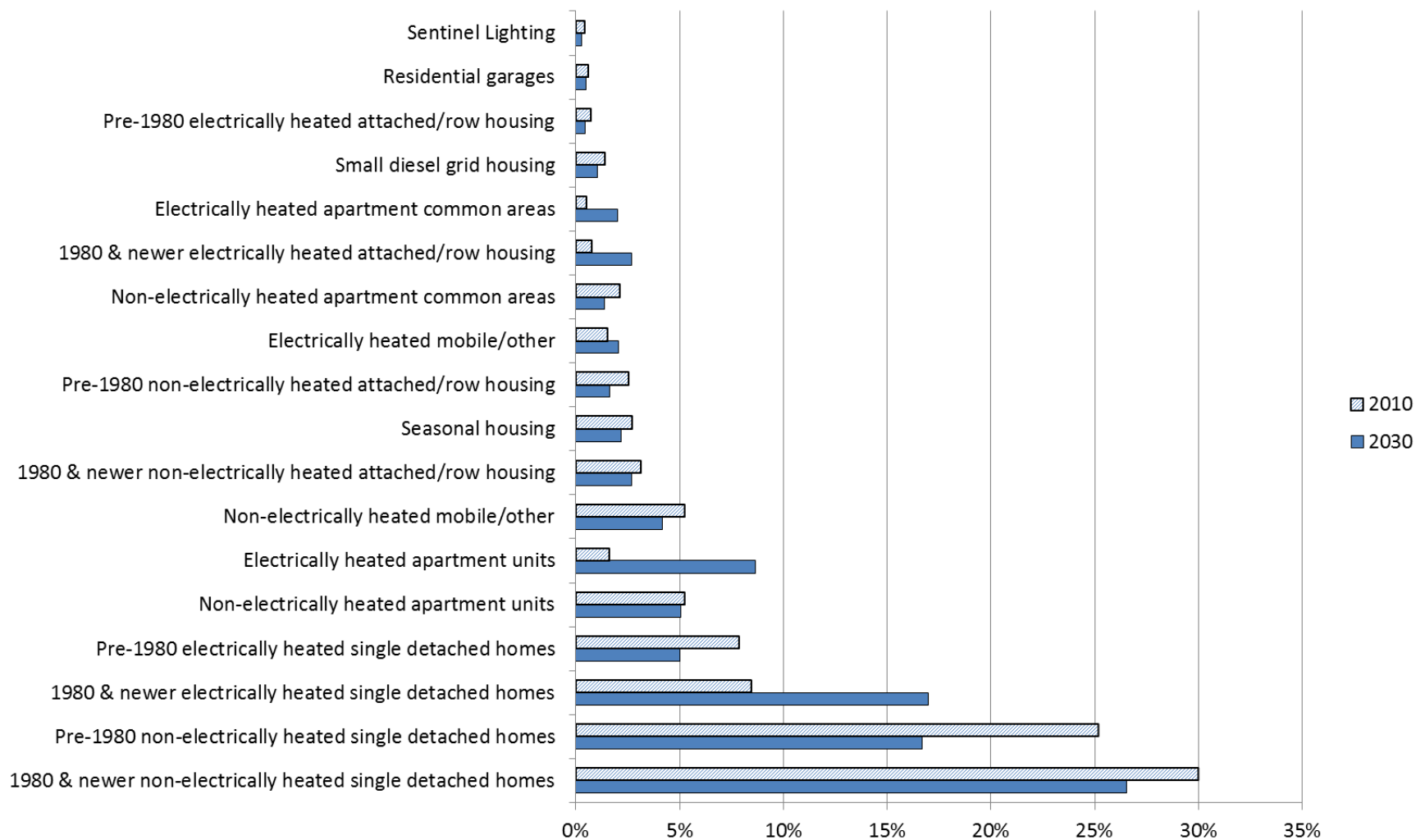


Exhibit ES 6 Base Year Electricity Use by Dwelling Type, Residential Sector



Economic Potential Forecast – Electric Energy

Under the conditions of the Economic Potential Forecast,⁸ the study estimated that electricity consumption in the Residential sector would grow to about 174,000 MWh/yr. by 2030. Annual savings relative to the Reference Case are 57,000 MWh/yr. or about 25%. The Economic Potential annual savings in the intermediate milestone years are 37,000 MWh/yr. in 2015, 43,000 MWh/yr. in 2020, and 49,000 MWh/yr. in 2025.

Achievable Potential – Electric Energy

The Achievable Potential is the proportion of the economic electric energy savings (as noted above) that could realistically be achieved within the study period. In the Residential sector, the Achievable Potential for electric energy savings through technology adoption was estimated to be 22,000 MWh/yr. and 37,000 MWh/yr. by 2030 in, respectively, the lower and upper scenarios.

Consistent with the results in the Economic Potential Forecast, the most significant Achievable savings opportunities were in the actions that addressed space heating. Significant savings can also be found in domestic hot water, clothes dryers, standby load in household electronics (e.g., computers and their peripherals, televisions and other home entertainment electronics), and 13 other end uses.

Summary of Peak Load Savings

Based on discussions with utility personnel, the following three peak period definitions were selected for inclusion in this study:

- **Peak Period 1: Annual System Peak Hour** – This has traditionally been the hour ending at 6 pm on a day in December; it is highly correlated with the coldest day of the year when occurring in December, although it has sometimes occurred in January.
- **Peak Period 2: Annual Weekday System Evening Peak Period** – The 4-8 pm period on the coldest four days of the year when occurring in December or January (total 16 hours).
- **Peak Period 3: Annual Weekday System Morning Peak Period** – The 7-9 am period on the 10 coldest days of the year when occurring in December or January (total 20 hours).

Exhibit ES 7 provides a summary of the peak load savings from the electric energy savings, for the Annual Peak Hour. Details for the other two peak periods are provided in the main body of the report. In each case, the reductions are an average value over the peak period and are defined relative to the Reference Case.

⁸ The level of electricity consumption that would occur if all equipment and building envelopes were upgraded to the level that is cost effective against future avoided electricity costs.

Exhibit ES 7 Residential Peak Load Reductions for Annual Peak Hour, from Electric Energy Savings Measures, Reference Case, Economic and Achievable Scenarios (MW)

Milestone Year	Period 1: Annual Peak Hour							
	Base Year	Reference Case	Peak Load Reduction from Electric Energy Savings					
			Economic		Upper Achievable		Lower Achievable	
2010	34.5	34.5						
2015		37.3	10.0	27%	1.3	3%	0.8	2%
2020		41.2	11.3	28%	3.6	9%	2.3	6%
2025		46.6	13.0	28%	6.5	14%	3.9	8%
2030		54.0	14.9	28%	10.5	19%	6.4	12%

Highlights of the peak load savings shown in Exhibit ES 7 above are presented below:

- In the Base Year 2010, the peak load for Yukon's total Residential sector was approximately 34.5 MW for the Annual Peak Hour.
- The study estimates that the Residential sector peak load in the Annual Peak Hour will grow to 54 MW by 2030, an increase of about 57%.
- Electric energy savings would provide peak load savings of approximately 6.4 to 10.5 MW (12% to 19%) during Yukon's Annual Peak Hour by 2030 in, respectively, the lower and upper Achievable scenarios.

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1 Introduction

1.1 Background and Objectives

Yukon residents rely on electricity not only to live meaningful, healthy lives but also to support and strengthen the economy. Given the concerns over environmental implications including climate change, and the limited generating capacity in Yukon, there is growing interest not only in how electricity is generated, transmitted and distributed but also how efficiently it is used at the customer's end. In Yukon as well as in a growing number of North American jurisdictions how electricity is generated and used is being closely analyzed to find innovative ways of meeting individual and corporate energy service needs while minimizing pollution and the creation of greenhouse gases.

Experience throughout many North American jurisdictions has demonstrated that energy efficiency, conservation and customer-supplied alternative energies all have a significant potential to reduce energy consumption, energy costs and emissions. The 2009 *Energy Strategy for the Yukon* also recognizes this potential and notes the following efficiency and conservation priorities:

- Avoid the cost and environmental impact of building new generation
- Increase energy efficiency in Yukon by 20% by 2020.
- Reduce energy consumption in Yukon buildings.
- Reduce energy consumption for transportation in Yukon.
- Promote the use of energy-efficient products by providing incentives for products that meet energy performance standards.
- Improve energy efficiency for Government of Yukon operations.

Efficient use of electricity through conservation, peak demand control and alternative energy sources can assist greatly in the path forward for the electrical supply industry. This conservation potential review study, referenced as CPR 2011, will provide a resource for Yukon Energy Corporation (YEC), Yukon Electrical Company Limited (YECL), and the Government of Yukon to develop a comprehensive vision of the territory's future energy service needs.

More specifically, the objective for CPR 2011 is to provide:

"...a necessary reference point to determine the potential for (electricity) demand-side management (DSM) in the Yukon."⁹

⁹ Yukon Energy Corporation Request For Proposals #2010-045, "Consulting Services for Electricity Conservation and Demand Management Potential Study," 2011.

1.2 Study Scope

The scope of this study is summarized below:

- **Sector Coverage:** This study addresses two sectors: residential households (Residential sector), and commercial and institutional (Commercial sector). Yukon's industrial sector consists primarily of a small number of operating mines on the grid, which are not appropriate to be included in this type of study. Efficiency opportunities within these sites are being addressed outside this study.
- **Geographical Coverage:** The study addresses all regions of Yukon that are served by either YEC or YECL. Customers served by both the hydroelectric grid and the stand-alone diesel grids are included. Note that the hydroelectric grid is remote, not connected to other grids, and dependent on trucked fuel to meet demand above the existing hydro/ wind capacity, while the stand-alone diesel grids rely on fuel that is trucked or flown in at all times.
- **Study Period:** This study covers a 20-year period. The Base Year is the calendar year 2010, with milestone periods at five-year increments: 2015, 2020, 2025 and 2030. The Base Year of 2010 was selected to enable this study's results to align with the most recent Yukon load forecast.¹⁰
- **Technologies:** This study addresses a comprehensive range of electric demand-side management (DSM) measures. This includes all electrical efficiency technologies or measures that are expected to be commercially viable by the year 2015 as well as peak load reduction technologies and customer-side renewable energies.

1.2.1 Data Caveat

As in any study of this type, the results presented in this report are based on a large number of important assumptions. Assumptions such as those related to the current penetration of energy-efficient technologies, the rate of future growth in the stock of residential buildings and customer willingness to implement new energy-efficiency measures are particularly influential. Wherever possible, the assumptions used in this study are consistent with those used by YEC, YECL, and the Government of Yukon and are based on best available information, which in many cases includes the professional judgment of the consultant team, client personnel and local experts. The reader should, therefore, use the results presented in this report as best available estimates; major assumptions, information sources and caveats are noted throughout the report.

1.3 Study Organization

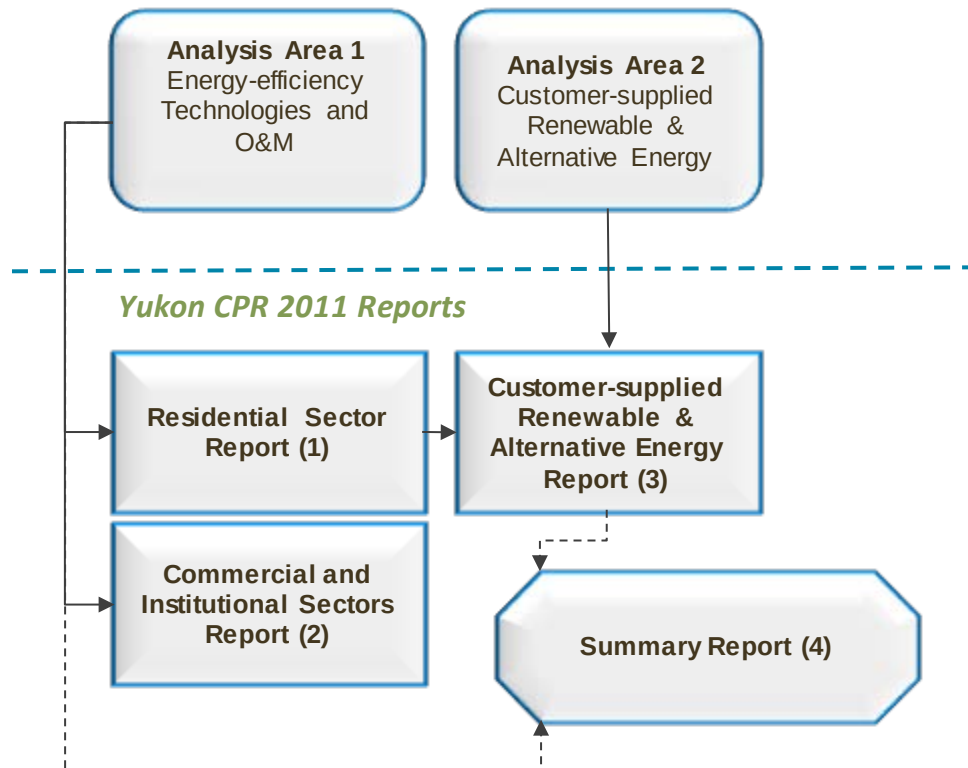
Exhibit 1 presents an overview of the study's organization; as illustrated, the study has been organized into two analysis areas and four individual reports.

A brief description of each analysis area and its report content is provided below.

¹⁰ Yukon Energy Corporation, *20-Year Resource Plan – 2011, First Draft*, April 2011.

Exhibit 1 Overview of CPR 2011 Organization – Analysis Areas and Reports

Yukon CPR 2011 Analysis Areas



1.3.1 Analysis Area 1 – Energy-efficiency and Peak Load Technologies and O&M

This area of the CPR 2011 assesses electric energy¹¹ and peak load reduction opportunities that could be provided by electrical efficiency and peak load reduction technologies that are expected to be commercially viable by the year 2015; operation and maintenance (O&M) practices are also addressed. The results of Analysis Area 1 are presented in two individual sector reports and summarized in a Summary Report.

1.3.2 Analysis Area 2 – Customer-Supplied Renewable Energies

This area of the CPR 2011 assesses electric energy and peak load reduction opportunities that could be provided by customer-supplied renewable energies. The results of Analysis Area 2 are presented in a single report and summarized in a Summary Report.

1.4 Report Organization

This report presents the Residential sector results. It is organized and presented as follows:

- Section 2 presents an overview of the study methodology, including a definition of key terms and an outline of the major analytic steps involved.

¹¹ The term “electric energy” is used in this report to distinguish electricity consumption (in units of kWh or MWh) from electricity demand during a specific period (in units of MW).

- Section 3 presents a profile of Residential sector Base Year electricity use in Yukon.
- Section 4 presents a profile of Residential sector Base Year electric peak load, including the definition of peak periods that are included in this study.
- Section 5 presents the Reference Case, which provides a detailed estimate of electricity use in Yukon's Residential sector over the study period 2010 to 2030, in the absence of new utility DSM program initiatives.
- Section 6 presents the Reference Case electric peak loads, which provide a detailed estimate of peak load requirements in Yukon's Residential sector over the study period 2010 to 2030, in the absence of new utility DSM program initiatives.
- Section 7 identifies and assesses the economic attractiveness of the selected energy-efficiency technology measures for the Residential sector.
- Section 8 presents the Residential sector Economic Potential Electricity Forecast for the study period 2010 to 2030.
- Section 9 identifies and assesses the economic attractiveness of selected Residential sector electric capacity-only peak load reduction measures, which in this study are defined as those measures that affect electric peak but have minimal or no impact on daily, seasonal or annual electricity use.
- Section 10 presents the estimated upper and lower Achievable Potential for electric energy savings for the study period 2010 to 2030.
- Section 11 lists sources and references.
- Section 12 is the Glossary.

1.5 Results Presentation

The preparation of Conservation Potential Reviews involves the compilation and analysis of an enormous amount of market and technology data and a nearly infinite number of ways of organizing and presenting the results. It is recognized that readers will have differing levels of needs with respect to the level of detail provided. Consequently, the results of this CPR are presented at three levels of detail.

- **Main report body.** The main body of the report provides a relatively high-level reporting of the main steps involved in undertaking each stage of the study together with a concise summary of results, including comments and interpretation of key findings. It is assumed that the content and level of detail in the main report body is suitable for the majority of readers who wish to gain an understanding of the potential contribution of DSM options to Yukon's long-term electricity requirements.
- **Appendices.** A separate appendix accompanies each major section of the main report. Each appendix provides more detailed information on the methodology employed, including major assumptions or sample calculations as applicable, together with additional levels of results. It is assumed that this presentation is better suited to DSM analysts and managers wishing a more thorough understanding of the study results.

- **Software.** All of the data generated by the study is provided in two custom-designed Excel models: Data Manager and the measure TRC (total resource cost) model.
 - **Data Manager** is a custom-designed Excel workbook with query protocols that enable the user to search and report the study results in a virtually infinite number of combinations. Data Manager is intended to support the most detailed level of DSM activity such as program design, preparation of regulatory submissions, etc.
 - **The measure TRC model** is a custom-designed model that provides comprehensive profiles of the DSM measures assessed within the study. Because the information is provided in software form, any changes to economic, financial or performance data inputs can be easily accommodated and revised results generated automatically.

2 Study Methodology

This section provides an overview of the methodology employed for this study. More specifically, it addresses:

- Definition of terms
- Major analytic steps
- Analytic models.

2.1 Definition of Terms

This study uses numerous terms that are unique to analyses such as this one and consequently it is important to ensure that readers have a clear understanding of what each term means when applied to this study.

A brief description of some of the most important terms and their application within this study is included below.

Base Year Electricity Use The Base Year is the starting point for the analysis. It provides a detailed description of where and how electrical energy is currently used in the existing building stock. Building electricity use simulations were undertaken for the major sub sector types and calibrated to actual utility customer billing data for the Base Year. As noted previously, the Base Year for this study is the calendar year 2010.

Base Year Electric Peak Load Profile Electric peak load profiles refer to specific time periods throughout the year when Yukon's generation, transmission and distribution system experiences particularly high levels of electricity demand. These periods are of particular interest to system planners; improved management of electricity demand during these peak periods may enable deferral of costly system expansion. This study addresses three specific peak periods, as outlined in the main text.

Reference Case Electricity Use (includes "natural" conservation) The Reference Case electricity use estimates the expected level of electrical energy consumption that would occur over the study period in the absence of new (post-2010) utility-based DSM initiatives. It provides the point of comparison for the subsequent calculation of Economic and Achievable electricity savings potentials. Creation of the Reference Case required the development of profiles for new buildings in each of the sub sectors, estimation of the expected growth in building stock, and finally an estimation of "natural" changes affecting electricity consumption over the study period. The Reference Case is calibrated to YEC's most recent load forecast, minus the impacts of new, future DSM initiatives.

Reference Case Electric Peak Load Profile

The Reference Case peak load profile estimates the expected electric peak loads in each of the three defined peak periods over the study period in the absence of new utility DSM program initiatives. It provides the point of comparison for the subsequent calculation of Economic and Achievable Potentials for peak load reduction.

Demand-Side Management (DSM) Measures

DSM measures can include energy efficiency (use more efficiently), energy conservation (use less), demand management (use less during peak periods), fuel switching (use a different fuel to provide the energy service) and customer-side generation (displace load off of grid). Fuel switching is not included in this study.

The Cost of Conserved Energy (CCE)

The CCE is calculated for each energy-efficiency technology measure. The CCE is the annualized incremental capital and O&M cost of the upgrade measure divided by the annual energy savings achieved, excluding any administrative or program costs. The CCE represents the cost of conserving one kWh of electricity; it can be compared directly to the cost of supplying one new kWh of electricity.

The Cost of Electric Peak Reduction (CEPR)

The CEPR for a peak load reduction measure is defined as the annualized incremental capital and O&M cost of the measure divided by the annual peak reduction achieved, excluding any administrative or program costs. The CEPR represents the cost of reducing one kW of electricity during a peak period; it can be compared to the cost of supplying one new kW of electric capacity during the same period.

Electric Capacity-Only Peak Load Reduction Measures

Capacity-only measures are technologies or activities that result in the shifting of certain electrical loads from periods of peak system demand to periods of lower system demand.

Economic Potential Electricity Forecast

The Economic Potential Electricity Forecast is the level of electricity consumption that would occur if all equipment and building envelopes were upgraded to the level that is cost effective against the economic threshold value¹², which has been set at different prices per kWh for the different supply system types. (One kWh from the hydroelectric grid is much less expensive than one kWh from the diesel grid in Old Crow.) All the energy-efficiency upgrades included in the technology assessment that had a CCE equal to, or less than, the economic threshold value for a given supply system were incorporated into the Economic Potential Forecast.

¹² The economic threshold value is related to the cost of new avoided electrical supply. The values for each supply system were selected to provide the CPR with a reasonably useful time horizon (life) to allow planners to examine options that may become more cost effective over time. Further discussion is provided in Section 7 of this report.

Economic Potential Electric Peak Load Forecast

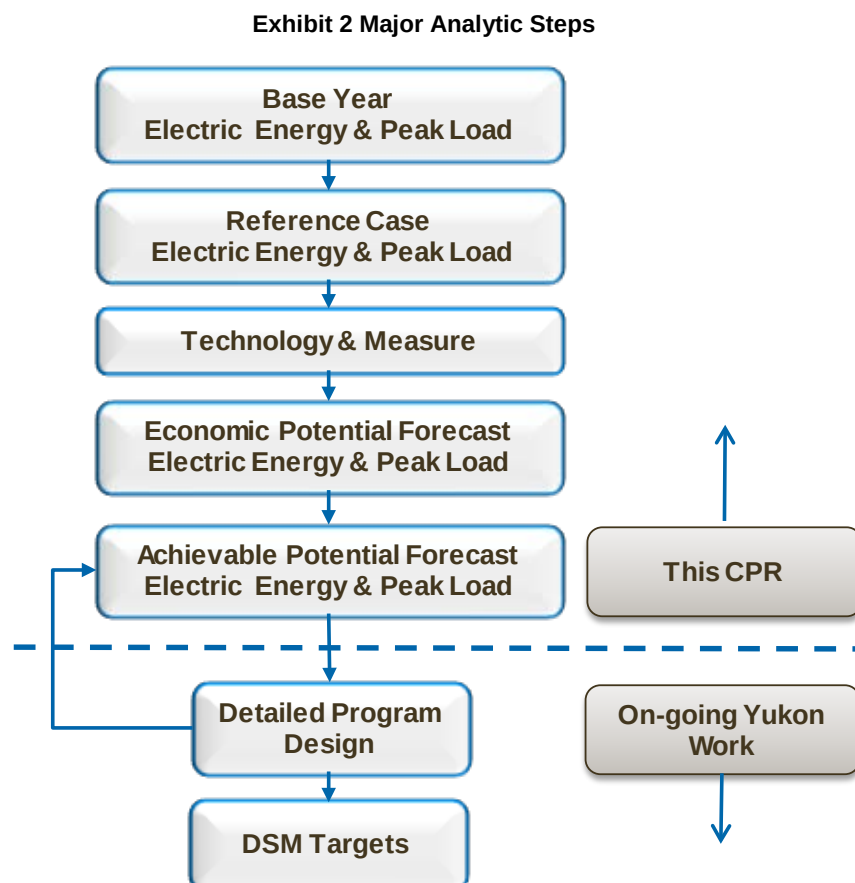
The Economic Potential Electric Peak Load Forecast is the expected electric peak loads that would occur in each of the three defined peak periods if all peak load reduction measures that are cost effective against the future avoided cost of new capacity in Yukon were fully implemented.

Achievable Potential

The Achievable Potential is the proportion of the savings identified in the Economic Potential Forecasts that could realistically be achieved within the study period. The achievable Potential recognizes that it is difficult to induce customers to purchase and install all the electrical efficiency technologies that meet the criteria defined by the Economic Potential Forecast. The results are presented as a range, defined as lower and upper.

2.2 Major Analytic Steps

The study was conducted within an iterative process that involved a number of well-defined steps, as illustrated in Exhibit 2.



A summary of the steps is presented below.

Step 1: Develop Base Year Electric Energy and Peak Load Calibration Using Actual Utility Billing Data

Build a model of electric energy and demand for the sector, disaggregated to all the building types and end uses, calibrated to sales of electricity in Yukon. This includes the following sub-steps:

- Compile and analyze available data on Yukon's existing building stock.
- Develop detailed technical descriptions of the existing building stock.
- Undertake computer simulations of electricity use in each building type and compare these with actual building billing and audit data.
- Compile actual utility billing data.
- Create sector model inputs and generate results.
- Calibrate sector model results using actual utility billing data.
- Use end-use load shape data to convert electric energy use to electric demand in each selected peak period.

Step 2: Develop Reference Case Electric Energy Use and Peak Load Profile

Extend the base year model to the end of the study period, based on forecast building stock growth and expected natural changes in construction practices, equipment efficiency levels and/or practices. This includes the following sub-steps:

- Compile and analyze building design, equipment and operations data and develop detailed technical descriptions of the new building stock.
- Develop computer simulations of electricity use in each new building type.
- Compile data on forecast levels of building stock growth and "natural" changes in equipment efficiency levels and/or practices.
- Define sector model inputs and create forecasts of electricity use for each of the milestone years.
- Compare sector model results with load forecasting data provided by YEC for the study period.
- Use end-use load shape data to convert electric energy use to electric demand in each selected peak period over the study period.

Step 3: Identify and Assess Energy-efficiency and Peak Load Reduction Measures

Compile information on upgrade measures that can save electric energy and/or reduce peak demand, and assess them for technical applicability and economic feasibility. This includes the following sub-steps:

- Develop list of energy-efficiency upgrade and peak load reduction measures.
- Compile detailed cost and performance data for each measure.
- For energy-efficiency measures, identify the baseline technologies employed in the Reference Case, develop energy-efficiency upgrade options and associated electricity savings for each option, and determine the CCE for each upgrade option.
- For each peak load reduction measure, identify the affected end use, the potential load reduction or off-peak shifting and determine the CEPR.
- Based on the above results, prepare summary tables that show the amount of potential peak load reduction provided by each measure and at what cost (\$/kW/yr.).

- Apply each peak load reduction measure to the affected end use, regardless of cost, and determine total peak reduction.
- Summarize the peak load reduction impacts in a supply curve.

Step 4: Estimate Economic Electric Energy Savings Potential

Develop an estimate of the electric energy savings potential that would result from implementing all of the economically feasible measures in all the buildings where they are applicable. This includes the following sub-steps:

- Compile utility economic data on the forecast cost of new electricity generation and set an economic threshold value; different economic threshold values were selected for each supply system (hydroelectric and diesel grids).
- Identify the combinations of energy-efficiency upgrade options and building types where the cost of saving one kilowatt of electricity is equal to, or less than, the cost of new electricity generation.
- Apply the economically attractive electrical efficiency measures from Step 3 within the energy-use simulation model developed previously for the Reference Case.
- Determine annual electricity consumption in each building type and end use when the economic efficiency measures are employed.
- Compare the electricity consumption levels when all economic efficiency measures are used with the Reference Case consumption levels and calculate the electricity savings.

Step 5: Estimate Achievable Potential Electricity Savings

Develop an estimated range for the portion of economic potential savings that would likely be achievable within realistic DSM programs. This includes the following sub-steps:

- Bundle the electric energy and peak load reduction opportunities identified in the Economic Potential Forecasts into a set of opportunities.
- For each of the identified opportunities, create an Opportunity Profile that provides a high-level implementation framework, including measure description, cost and savings profile, target sub sectors, potential delivery allies, barriers and possible synergies.
- Review historical achievable program results and prepare preliminary Assessment Worksheets.
- Conduct a full day workshop involving the client, the consultant team, trade allies and technical experts to reach general agreement on the upper and lower range of Achievable Potential.

Step 6: Estimate Peak Load Impacts of Electricity Savings

Develop an estimate for the peak load impacts associated with the measures that save electric energy. This includes the following sub-steps:

- The electricity (electric energy) savings (MWh) calculated in the preceding steps were converted to peak load (electric demand) savings (kW).¹³

¹³ Peak load savings were modelled using the Cross-Sector Load Shape Library Model (LOADLIB).

- The conversion of electricity savings to hourly demand drew on a library of specific sub sector and end-use electricity load shapes. Using the load shape data, the following steps were applied:
 - Annual electricity savings for each combination of sub sector and end use were disaggregated by month
 - Monthly electricity savings were then further disaggregated by day type (weekday, weekend day and peak day)
 - Finally, each day type was disaggregated by hour.

2.3 Analytical Models

The analysis of the Residential sector employed two linked modelling platforms:

- HOT2000,¹⁴ a commercially supported, residential building energy-use simulation software
- RSEEM (Residential Sector Energy End-use Model), an ICF Marbek in-house spreadsheet-based macro model.

HOT2000 was used to define household heating, cooling and domestic hot water (DHW) electricity use for each of the residential building archetypes. HOT2000 uses state-of-the-art heat loss/gain and system modelling algorithms to calculate household electricity use. It addresses:

- Electric, natural gas, oil, propane and wood space heating systems
- DHW systems from conventional to high-efficiency condensing systems
- The interaction effect between space heating appliances and non-space heating appliances, such as lights and refrigerators.

The outputs from HOT2000 provide the space heating/cooling energy-use intensity (EUI) inputs for the thermal archetype module of RSEEM.

RSEEM consists of three modules:

- A general parameters module that contains general sector data (e.g., number of dwellings, growth rates, etc.)
- A thermal archetype module, as noted above, which contains data on the heating and cooling loads in each archetype
- An appliance module that contains data on appliance saturation levels, fuel shares, unit electricity use, etc.

RSEEM combines the data from each of the modules and provides total use of electricity by service region, dwelling type and end use. RSEEM also enables the analyst to estimate the impacts of the electrical efficiency measures on a utility's on-peak system demand.

¹⁴ Natural Resources Canada. *HOT2000 Software*. Download from: http://canmetenergy-canmetenergie.nrcan-rncan.gc.ca/eng/software_tools/hot2000.html

3 Base Year (2010) Electric Energy Use

3.1 Introduction

This section provides a profile of Base Year (2010) electricity use in Yukon's Residential sector. The discussion is organized into the following sub sections:

- Base Year housing stock
- End uses
- Average electricity use per unit
- Summary of model results.

3.2 Base Year Housing Stock

The first major task in developing the profile of Base Year electricity use involved the segmentation of the residential building stock on the basis of five factors:

- Dwelling type
- Supply system (hydro versus three diesel supply systems)
- Government of Yukon versus non-government accounts
- Vintage
- Heating category (electrically heated versus non-electrically heated).

Based on discussions with YEC, YECL and Government of Yukon personnel, it was agreed that Yukon's existing residential stock would be segmented into the following dwelling types:

- Pre-1980 electrically heated single detached homes
- 1980 & newer electrically heated single detached homes
- Pre-1980 non-electrically heated single detached homes
- 1980 & newer non-electrically heated single detached homes
- Pre-1980 electrically heated attached/row housing
- 1980 & newer electrically heated attached/row housing
- Pre-1980 non-electrically heated attached/row housing
- 1980 & newer non-electrically heated attached/row housing
- Existing electrically heated apartment/condo units
- Existing electrically heated apartment/condo common areas
- Existing non-electrically heated apartment/condo units
- Existing non-electrically heated apartment/condo common areas
- Existing electrically heated mobile/other
- Existing non-electrically heated mobile/other
- Seasonal housing
- Residential garages
- Sentinel lighting.

As much as possible, utility customer billing data was used to develop a breakdown of the Residential sector into the above dwelling types. Where billing data did not provide sufficient detail to subdivide accounts into these groups, it was augmented with housing data from the Yukon Housing Corporation and the results of Yukon's Residential Electrical End-Use Survey (REEUS).

Seasonal housing accounts were separated from the remaining population of housing by identifying accounts that had consumption of less than 3,000 kWh/yr. These accounts were separated in order to develop a more realistic average consumption for the dwellings that are fully occupied throughout the year.

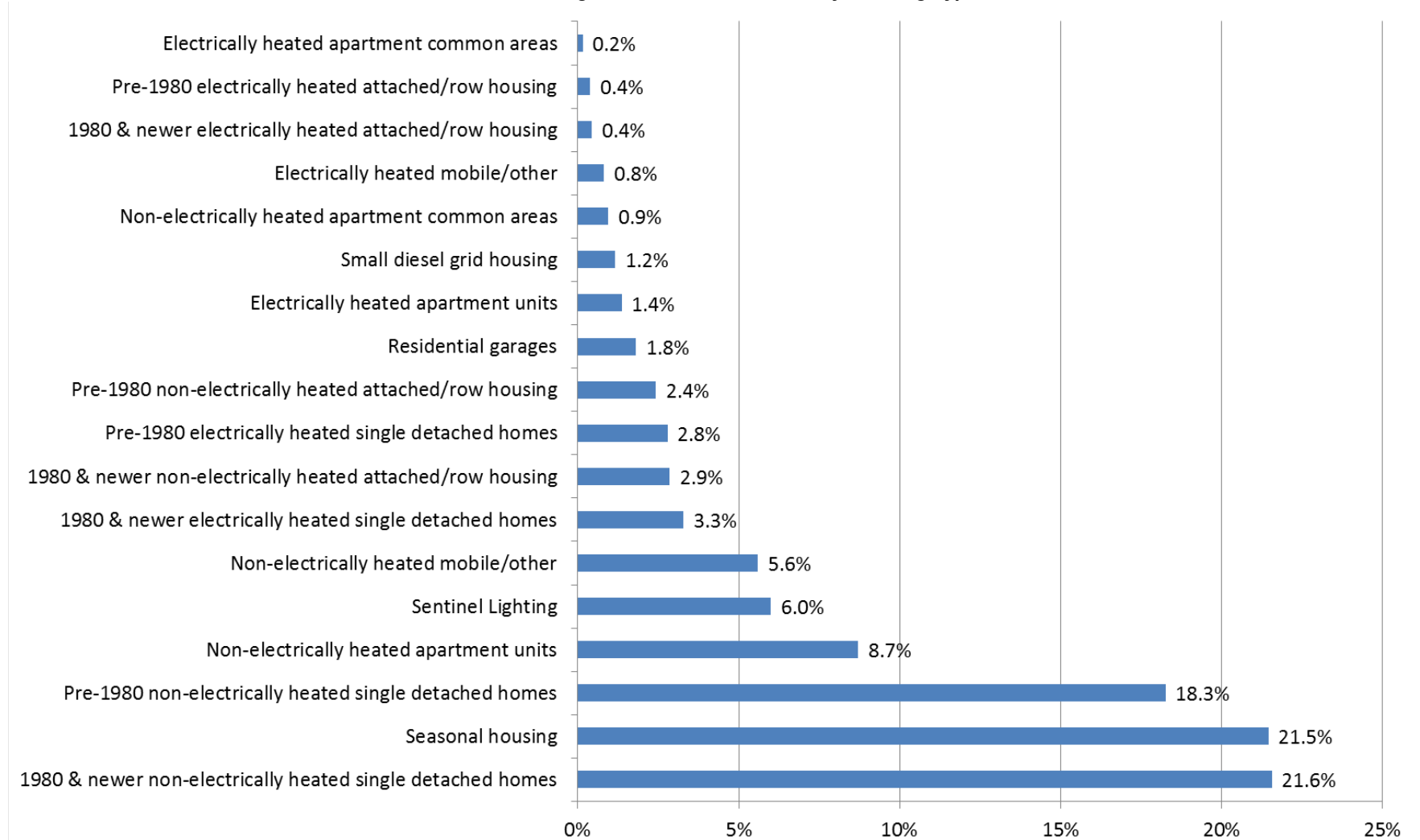
In two of the supply system categories (Small Diesel and Old Crow), the number of dwellings was too small to permit the detailed division outlined above. In those two categories, except for the garages identified in the billing data and the seasonal houses separated as above, the remaining dwellings were grouped in a category called Small Grid Housing.

A summary of the distribution of Yukon's residential dwellings is provided in Exhibit 3 and Exhibit 4. The first exhibit provides details of the estimated breakdown by dwelling type, supply system type and Government of Yukon versus non-government accounts. The bar chart shows the breakdown by dwelling type graphically, sorted from the most numerous to least numerous dwelling types.

Exhibit 3 Existing Yukon Residential Units by Dwelling Type, Supply System, and Government versus Non-government Categories

Dwelling Types	Dwelling Units								
	Hydro Grid		Large Diesel		Small Diesel		Old Crow		Total
	Non-government	Government	Non-government	Government	Non-government	Government	Non-government	Government	
1980 & newer non-electrically heated single detached homes	3,177	38	179	11	-	-	-	-	3,405
Pre-1980 non-electrically heated single detached homes	2,691	33	151	9	-	-	-	-	2,884
1980 & newer electrically heated single detached homes	513	6	-	-	-	-	-	-	519
Pre-1980 electrically heated single detached homes	434	5	-	-	-	-	-	-	439
1980 & newer non-electrically heated attached/row housing	421	5	24	1	-	-	-	-	451
Pre-1980 non-electrically heated attached/row housing	356	4	20	1	-	-	-	-	381
1980 & newer electrically heated attached/row housing	68	1	-	-	-	-	-	-	69
Pre-1980 electrically heated attached/row housing	58	1	-	-	-	-	-	-	59
Non-electrically heated apartment units	1,271	61	42	2	-	-	-	-	1,376
Non-electrically heated apartment common areas	132	15	2	1	-	-	-	-	150
Electrically heated apartment units	205	10	-	-	-	-	-	-	215
Electrically heated apartment common areas	21	3	-	-	-	-	-	-	24
Non-electrically heated mobile/other	802	3	79	0	-	-	-	-	884
Electrically heated mobile/other	129	-	-	-	-	-	-	-	129
Small diesel grid housing	-	-	-	-	88	19	64	12	184
Seasonal housing	3,041	44	171	11	56	-	65	-	3,388
Residential garages	263	1	16	-	4	-	-	-	284
Sentinel Lighting	798	-	85	-	62	-	2	-	947
Grand Total	14,378	231	769	37	211	19	131	12	15,787

Exhibit 4 Existing Yukon Residential Units by Dwelling Type



Totals may not add to 100% due to rounding.

As illustrated in Exhibit 3:

- The Yukon electric utilities currently service about 15,787 residential accounts.
- Approximately 92.5% of residential accounts are connected to the hydro grid and just over 5% are connected to large diesel systems. Approximately 1.5% are connected to small diesel systems and an additional nearly 1% of dwellings are located in Old Crow, a fly-in community also served by a small diesel system.
- Nearly 2% of residential accounts are Government of Yukon accounts. The other 98% are not.
- 46% of the residential accounts are single detached homes, just over 10% are apartment units (and approximately 1% are accounts for the common areas of apartment buildings), approximately 6% are attached dwellings such as duplexes, row houses or townhouses, and 6.5% are mobile homes. Approximately 6% are separate accounts for sentinel lighting, nearly 2% are detached garages with separate accounts, and just over 1% are in the small grid housing category. The percentages for single detached homes and small grid housing are reduced by the removal of the accounts under 3,000 kWh/yr., which account for 21.5% of the accounts and are considered part of the seasonally-occupied housing category (cottages or cabins).
- The single-family detached and attached homes are divided into older and newer dwellings using 1980 as a dividing line. Approximately 46% of the dwellings were built before that year.
- Electricity is a relatively uncommon heating fuel in Yukon. In fact, in diesel grid communities, using electricity as the main heating fuel in a dwelling is not permitted. Consequently, only approximately 13% of dwellings in Yukon use electricity as their main heating fuel. The remaining 87% mainly use oil, propane or wood. The use of electricity for heating in the areas served by the hydro grid is rapidly increasing, as discussed in Section 5.

3.3 End Uses

Electricity use within each of the dwelling types noted above is defined on the basis of specific end uses. In this study, an end use is defined as, “the final application or final use to which energy is applied. End uses are the services of economic value to the users of energy.”

A summary of the major Residential sector end uses used in this study is provided in Exhibit 5, together with a brief description of each.

Exhibit 5 Residential Electric End Uses

End Use	Description
Space heating	All space heating, including both central heating and supplementary heating
Ventilation and circulation	Primarily the furnace fan, but also includes the fan in heat recovery ventilators as well as kitchen and bathroom fans. Also includes pumps in hydronic heating systems
Domestic hot water (DHW)	Heating of water for DHW use. Does not include hydronic space heating
Indoor lighting	Interior lighting, excluding indoor holiday lighting
Outdoor lighting	Exterior lighting, excluding outdoor holiday lighting
Holiday lighting	Holiday lighting, including both indoor and outdoor
Cooking	Includes ranges, separate ovens and cook tops and microwave ovens
Refrigerator	
Freezer	
Dishwasher	
Clothes washer	
Clothes dryer	
Spa heaters and pumps	Includes both indoor and outdoor spas, both the heating systems and the pumps
Computer and peripherals	Computers, both desktop and laptop, printers, scanners, modems, faxes, PDA and cell phone chargers, security systems, etc.
Television	
Set-top boxes	Includes digital cable converters, satellite converters, and PVRs
Home entertainment electronics	Stereos, DVD players, VCRs, boom boxes, radios, video gaming systems
Block heaters & car warmers	Electric plug-in devices for pre-heating the engine block of a car for ease of starting, and for warming up the passenger compartment of the car. Also includes car battery warmers.
Heat tape, propane heaters, circulation pumps	Electric plug-in devices for preventing water lines from freezing, including both heat tape and circulation pumps, and devices for warming outdoor propane tanks so the propane will flow easily
Small Appliance & Other	There are hundreds of additional items within this category, each accounting for a fraction of a percent of household electricity use, e.g., hair dryers, doorbells, garage door openers, home medical equipment, electric lawnmowers, etc.

3.4 Average Electricity Use per Dwelling Unit

Exhibit 6 provides a profile of average electricity use within each of the dwelling types that were identified previously. The values shown in Exhibit 6 combine three factors:

- **Unit Energy Consumption (UEC).** This is the average amount of electricity that one appliance (e.g., a hot water tank) consumes annually in a given dwelling type.
- **Saturation.** This is the percentage of households within each dwelling type that have the given appliance. For example, in the case of a hot water tank, every household has one and, therefore, the saturation is 100%. However, for some appliances such as refrigerators or televisions, the saturation is often greater than 100%, as many households have more than one refrigerator or television.
- **Electric Fuel Share.** Several appliances, such as hot water tanks, clothes dryers, cooking ranges, etc., can operate on propane gas or other fuels as well as electricity. Electric fuel share, therefore, refers to the percentage of each appliance that operates with electricity.

A sample calculation is provided below for DHW use in pre-1980 single detached homes, as shown in Exhibit 6. The exhibits referenced below are contained in Appendix A, which accompanies this report.

**Sample Calculation of Annual DHW Electricity Consumption for
Pre-1980 Single Detached Non-electrically Heated Homes**

UEC, see Exhibit A 2	3,453 kWh/yr.
Saturation, see Exhibit A 12	100%
Electric Fuel Share, see Exhibit A 13	79% ¹⁵

Annual DHW Electricity Consumption = $3,453 \times 100\% \times 79.4\% = 2,742$ kWh/yr.
(as shown in Exhibit 6.)

¹⁵ DHW electric share for these houses is lower than the overall DHW electric share found in the Yukon REEUS. This is because the electrically heated houses are assumed to have 100% electric DHW, and the remaining electric DHW share is distributed among the non-electrically heated houses.

Exhibit 6 Average Electricity Use per Dwelling Unit, (kWh/yr.)

Dwelling Types	Space heating	Ventilation & circulation	Domestic hot water (DHW)	Indoor lighting	Outdoor lighting	Holiday lighting	Cooking appliances	Refrigerator	Freezer	Dishwasher
1980 & newer non-electrically heated single detached homes	1,047	600	2,742	1,029	288	28	651	862	543	100
Pre-1980 non-electrically heated single detached homes	1,466	609	2,742	1,029	288	28	651	785	495	91
1980 & newer electrically heated single detached homes	12,075	100	3,453	1,029	288	28	716	784	494	91
Pre-1980 electrically heated single detached homes	14,856	100	3,453	1,029	288	28	716	715	450	83
1980 & newer non-electrically heated attached/row housing	669	462	2,164	698	189	14	434	669	422	63
Pre-1980 non-electrically heated attached/row housing	916	468	2,164	698	189	14	434	592	373	56
1980 & newer electrically heated attached/row housing	6,602	100	2,724	698	189	14	478	609	384	58
Pre-1980 electrically heated attached/row housing	9,045	100	2,724	698	189	14	478	539	340	51
Non-electrically heated apartment units	516	357	1,181	497	54	6	373	524	330	42
Non-electrically heated apartment common areas	1,268	4,370	-	6,067	657	72	-	-	-	-
Electrically heated apartment units	5,719	50	1,483	499	54	6	411	526	332	42
Electrically heated apartment common areas	13,935	611	-	6,101	660	72	-	-	-	-
Non-electrically heated mobile/other	887	489	2,177	702	190	14	444	524	330	50
Electrically heated mobile/other	9,345	100	2,724	698	189	14	478	521	328	49
Small diesel grid housing	676	443	2,746	989	276	27	636	687	433	80
Seasonal housing	34	15	242	174	49	-	56	54	34	6
Residential garages	487	363	-	601	168	-	-	-	-	-
Sentinel Lighting	-	-	-	-	643	-	-	-	-	-
Weighted Average	1,714	389	1,789	736	224	16	416	519	327	57

Dwelling Types	Clothes washer	Clothes dryer	Spa heaters and pumps	Computer and peripherals	Television	Set-top boxes	Home entertainment electronics	Block heaters & car warmers	Heat tape, propane htrs, circ pumps	Small appliance & other	Total
1980 & newer non-electrically heated single detached homes	81	1,091	1,466	1,025	412	260	106	282	71	186	12,870
Pre-1980 non-electrically heated single detached homes	74	995	1,336	934	376	237	106	257	65	186	12,748
1980 & newer electrically heated single detached homes	73	1,024	1,505	933	375	237	106	257	65	186	23,819
Pre-1980 electrically heated single detached homes	67	934	1,372	850	342	216	106	234	59	186	26,083
1980 & newer non-electrically heated attached/row housing	51	692	1,395	975	392	248	72	269	68	126	10,072
Pre-1980 non-electrically heated attached/row housing	45	613	1,235	863	347	219	72	238	60	126	9,723
1980 & newer electrically heated attached/row housing	47	650	1,432	888	357	226	72	244	62	126	15,959
Pre-1980 electrically heated attached/row housing	41	575	1,267	786	316	200	72	216	54	126	17,832
Non-electrically heated apartment units	17	231	-	755	304	192	61	-	-	107	5,544
Non-electrically heated apartment common areas	208	2,817	2,168	-	-	-	-	2,539	639	-	20,805
Electrically heated apartment units	17	239	-	758	305	193	61	-	-	107	10,803
Electrically heated apartment common areas	209	2,917	2,447	-	-	-	-	2,553	643	-	30,149
Non-electrically heated mobile/other	40	545	558	763	307	194	72	210	53	127	8,676
Electrically heated mobile/other	40	555	612	758	305	193	72	209	53	126	17,368
Small diesel grid housing	64	875	1,195	818	329	208	101	225	57	179	11,045
Seasonal housing	5	69	278	64	26	16	18	-	-	32	1,173
Residential garages	-	-	-	-	-	-	-	228	57	1,169	3,074
Sentinel Lighting	-	-	-	-	-	-	-	-	-	-	643
Weighted Average	46	631	863	650	261	165	69	186	47	142	9,247

3.5 Summary of Residential Base Year Electricity Use

This section combines the data on average annual electricity use by dwelling type, shown in the preceding exhibit, with data on the number of each dwelling type to produce a summary of the total electricity use in Yukon's Residential sector in the Base Year. The results are measured at the customer's point-of-use and do not include line losses; they are presented in five separate exhibits:

- Exhibit 7 presents the results in tabular form by dwelling type and end use
- Exhibit 8, Exhibit 9, and Exhibit 10 present the model results graphically by dwelling type, by supply type and government versus non-government, and by end use, respectively
- Exhibit 11 presents the model results as a series of stacked bars, showing the percentage consumed by end use for each dwelling type.

Additional highlights are provided below.

By Dwelling Type

Single detached dwellings account for the majority of residential electricity use in Yukon, with approximately 72% of residential electricity consumed. Apartment buildings, including both the suites and common areas, account for the next largest share, using 9% of residential electricity. Attached houses (duplexes, row houses, and townhouses) and mobile homes each account for 7% of residential electricity.

Seasonal houses (using less than 3,000 kWh/yr. each) account for nearly 3% of total residential electricity consumption. The dwellings in the Small Grid Housing category account for just over 1% of residential electricity. Residential garages also consume approximately 1% of residential electricity. Sentinel lighting uses less than 0.5% of residential electricity.

By Supply Type and Government versus Non-government Accounts

The accounts connected to the hydro grid consume approximately 94% of residential electricity. Accounts connected to large diesel grids consume approximately 4.5% of residential electricity. Accounts connected to small diesel grids consume less than 1% of residential electricity, as do accounts in the fly-in community of Old Crow.

Government of Yukon accounts consume less than 2%¹⁶ of residential electricity, with non-government accounts consuming the other 98%.

By End Use

HVAC accounts for 23% of consumption, with 19% of that being electric space heating and the remainder being fans and pumps, including furnace fans, boiler circulation pumps, HRV fans, and bathroom and kitchen exhaust.

Domestic appliances (white goods) consume approximately 22% of total residential electricity. Of this, clothes dryers account for 7% and refrigerators for 6%. Cooking appliances and freezers each consume approximately 4%. Dishwashers and clothes washers consume approximately

¹⁶ Other categories of rental customers will be considered in the Achievable Potential chapter (Section 10).

1% each, but this does not include the associated DHW consumption if DHW is heated electrically.

Domestic water heating accounts for approximately 19% of residential electricity consumption.

Household electronics consume approximately 12% of residential electricity, including 7% by computers and their peripherals, 3% by televisions, 2% by the various set-top boxes associated with televisions, and 1% by other home entertainment electronics.

Indoor, outdoor, and holiday lighting together account for 11% of residential electricity consumption; 8% of this is indoor lighting and 2% is outdoor lighting. Holiday lighting is well under 1%.

Other end uses account for 13% of residential electricity consumption. Of this, 9% is consumed by spa heaters and pumps and 2% is consumed by block heaters and car warmers.

By Dwelling Type and End Use

The last exhibit in this section highlights the differences among dwelling types. In general, for example, attached dwellings show a lower percentage of consumption for HVAC and a higher percentage for electronics and appliances than single detached houses.

The exhibit also highlights how much more of the electricity is used for HVAC in an electrically heated dwelling.

Finally, in apartment buildings, the common area consumption is dominated by lighting, while the consumption in the suites is dominated by appliances and electronics. Most of the “other” end uses in an apartment building, such as spas or block heaters, are likely in the common areas of the building.

Data Manager – Final Edition

As part of this report, an Excel application called Data Manager is provided. This Excel workbook includes all the exhibits that were produced using Excel for Chapters 3, 4, 5, 6, 7, 8 and 10, and the corresponding Appendices. It also has the ability to produce charts and tables looking at the data filtered and segmented in other ways. For example:

- The user can produce a pie chart of electricity consumption by end use for an individual dwelling type of interest, such as the electrically heated older detached house.
- The user can produce a column chart showing the electricity consumption for kitchen and laundry appliances in each of several dwelling types, with each dwelling type as a separate column and the different appliance consumption values shown stacked on top of each other.
- The user can produce a line chart showing consumption for a particular dwelling type by year under both the reference case and the economic potential.
- The user can produce a column chart showing the savings of individual measures for a particular type of dwelling, broken up by supply system.

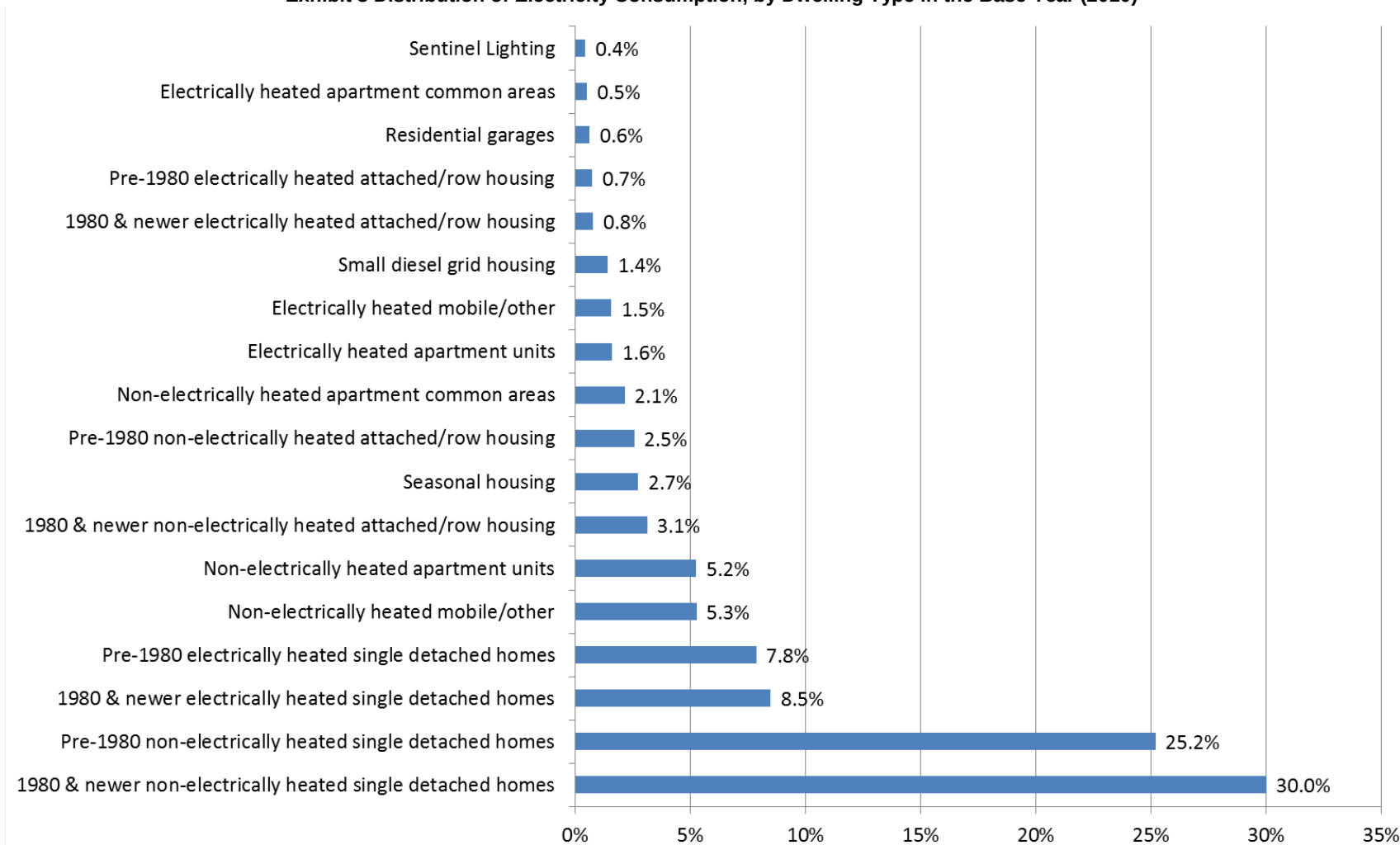
Data Manager has a user interface designed for someone with basic knowledge of Excel.

Exhibit 7 Electricity Consumption by End Use and Dwelling Type in the Base Year (2010), (MWh/yr.)

Dwelling Types	Space heating	Ventilation & circulation	Domestic hot water (DHW)	Indoor lighting	Outdoor lighting	Holiday lighting	Cooking appliances	Refrigerator	Freezer	Dishwasher
1980 & newer non-electrically heated single detached homes	3,566	2,045	9,337	3,504	979	95	2,216	2,934	1,848	340
Pre-1980 non-electrically heated single detached homes	4,228	1,755	7,907	2,968	829	81	1,877	2,265	1,426	263
1980 & newer electrically heated single detached homes	6,267	52	1,792	534	149	15	372	407	256	47
Pre-1980 electrically heated single detached homes	6,522	44	1,516	452	126	12	315	314	198	36
1980 & newer non-electrically heated attached/row housing	302	208	976	315	85	6	196	302	190	29
Pre-1980 non-electrically heated attached/row housing	349	179	825	266	72	5	165	226	142	21
1980 & newer electrically heated attached/row housing	456	7	188	48	13	1	33	42	26	4
Pre-1980 electrically heated attached/row housing	534	6	161	41	11	1	28	32	20	3
Non-electrically heated apartment units	710	491	1,624	683	74	8	513	721	454	58
Non-electrically heated apartment common areas	190	654	-	908	98	11	-	-	-	-
Electrically heated apartment units	1,230	11	319	107	12	1	88	113	71	9
Electrically heated apartment common areas	334	15	-	146	16	2	-	-	-	-
Non-electrically heated mobile/other	784	432	1,924	621	168	13	392	463	292	44
Electrically heated mobile/other	1,205	13	351	90	24	2	62	67	42	6
Small diesel grid housing	124	81	504	182	51	5	117	126	79	15
Seasonal housing	117	50	820	591	165	-	190	183	115	21
Residential garages	138	103	-	171	48	-	-	-	-	-
Sentinel Lighting	-	-	-	-	609	-	-	-	-	-
Grand Total	27,056	6,145	28,244	11,627	3,530	258	6,563	8,195	5,160	896

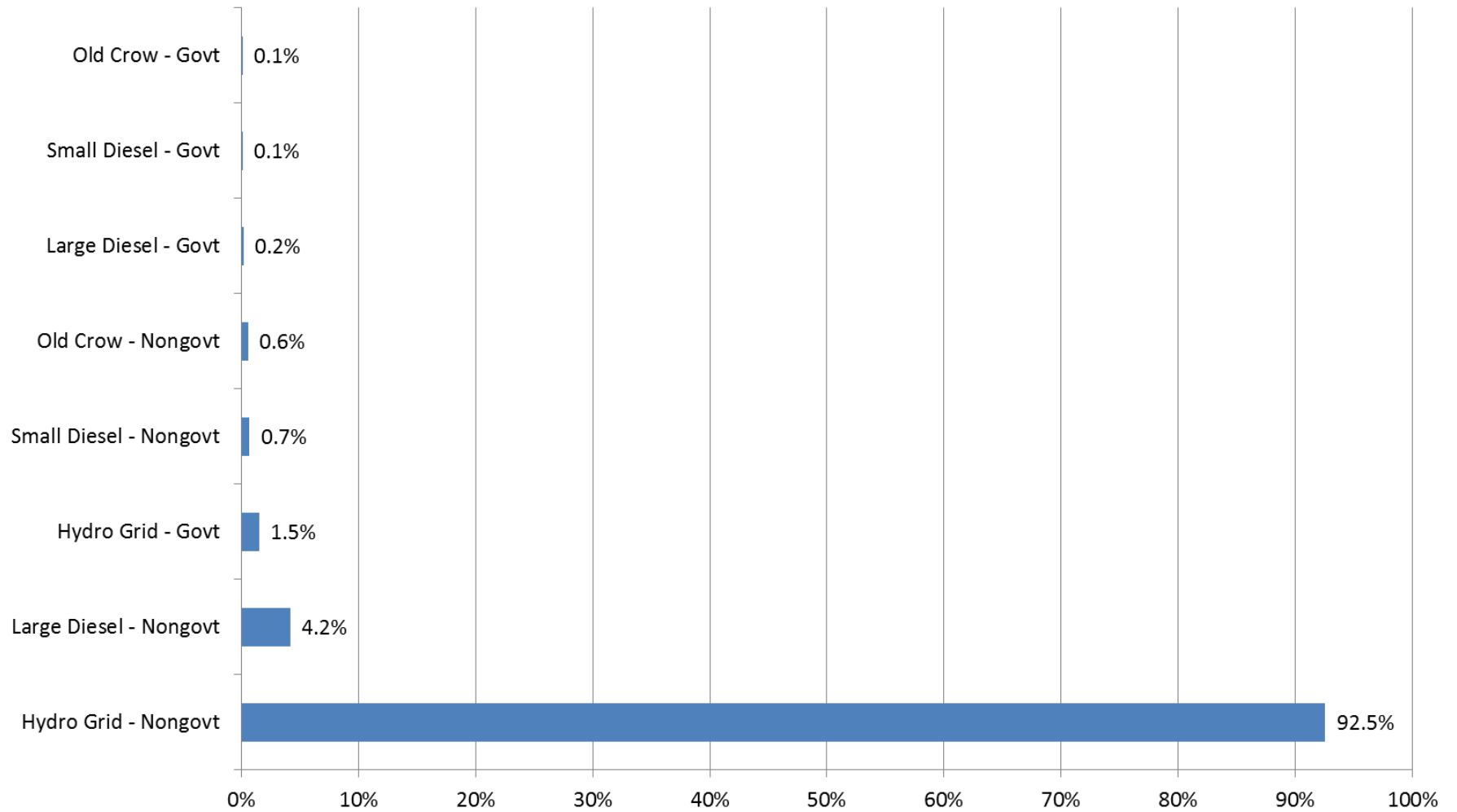
Dwelling Types	Clothes washer	Clothes dryer	Spa heaters and pumps	Computer and peripherals	Television	Set-top boxes	Home entertainment electronics	Block heaters & car warmers	Heat tape, propane htrs, circ pumps	Small appliance & other	Total	Percentage of Total
1980 & newer non-electrically heated single detached homes	275	3,717	4,993	3,490	1,404	887	359	961	242	634	43,826	30%
Pre-1980 non-electrically heated single detached homes	212	2,869	3,854	2,694	1,084	684	304	742	187	537	36,766	25%
1980 & newer electrically heated single detached homes	38	532	781	484	195	123	55	133	34	97	12,362	8%
Pre-1980 electrically heated single detached homes	29	410	602	373	150	95	46	103	26	82	11,450	8%
1980 & newer non-electrically heated attached/row housing	23	312	629	440	177	112	32	121	30	57	4,542	3%
Pre-1980 non-electrically heated attached/row housing	17	234	471	329	132	84	27	91	23	48	3,707	3%
1980 & newer electrically heated attached/row housing	3	45	99	61	25	16	5	17	4	9	1,101	1%
Pre-1980 electrically heated attached/row housing	2	34	75	46	19	12	4	13	3	7	1,052	1%
Non-electrically heated apartment units	23	317	-	1,038	418	264	83	-	-	147	7,626	5%
Non-electrically heated apartment common areas	31	422	324	-	-	-	-	380	96	-	3,114	2%
Electrically heated apartment units	4	51	-	163	66	41	13	-	-	23	2,323	2%
Electrically heated apartment common areas	5	70	59	-	-	-	-	61	15	-	724	0.5%
Non-electrically heated mobile/other	35	481	493	675	271	171	64	186	47	112	7,668	5%
Electrically heated mobile/other	5	72	79	98	39	25	9	27	7	16	2,241	2%
Small diesel grid housing	12	161	219	150	60	38	19	41	10	33	2,029	1%
Seasonal housing	17	233	942	218	88	55	61	-	-	107	3,973	3%
Residential garages	-	-	-	-	-	-	-	65	16	332	873	1%
Sentinel Lighting	-	-	-	-	-	-	-	-	-	-	609	0.4%
Grand Total	733	9,959	13,620	10,260	4,128	2,606	1,082	2,940	740	2,241	145,984	100%

Exhibit 8 Distribution of Electricity Consumption, by Dwelling Type in the Base Year (2010)



Totals may not add to 100% due to rounding.

Exhibit 9 Distribution of Electricity Consumption, by Supply Type and Government versus Non-government in the Base Year (2010)



Totals may not add to 100% due to rounding.

Exhibit 10 Distribution of Electricity Consumption, by End Use in the Base Year (2010)

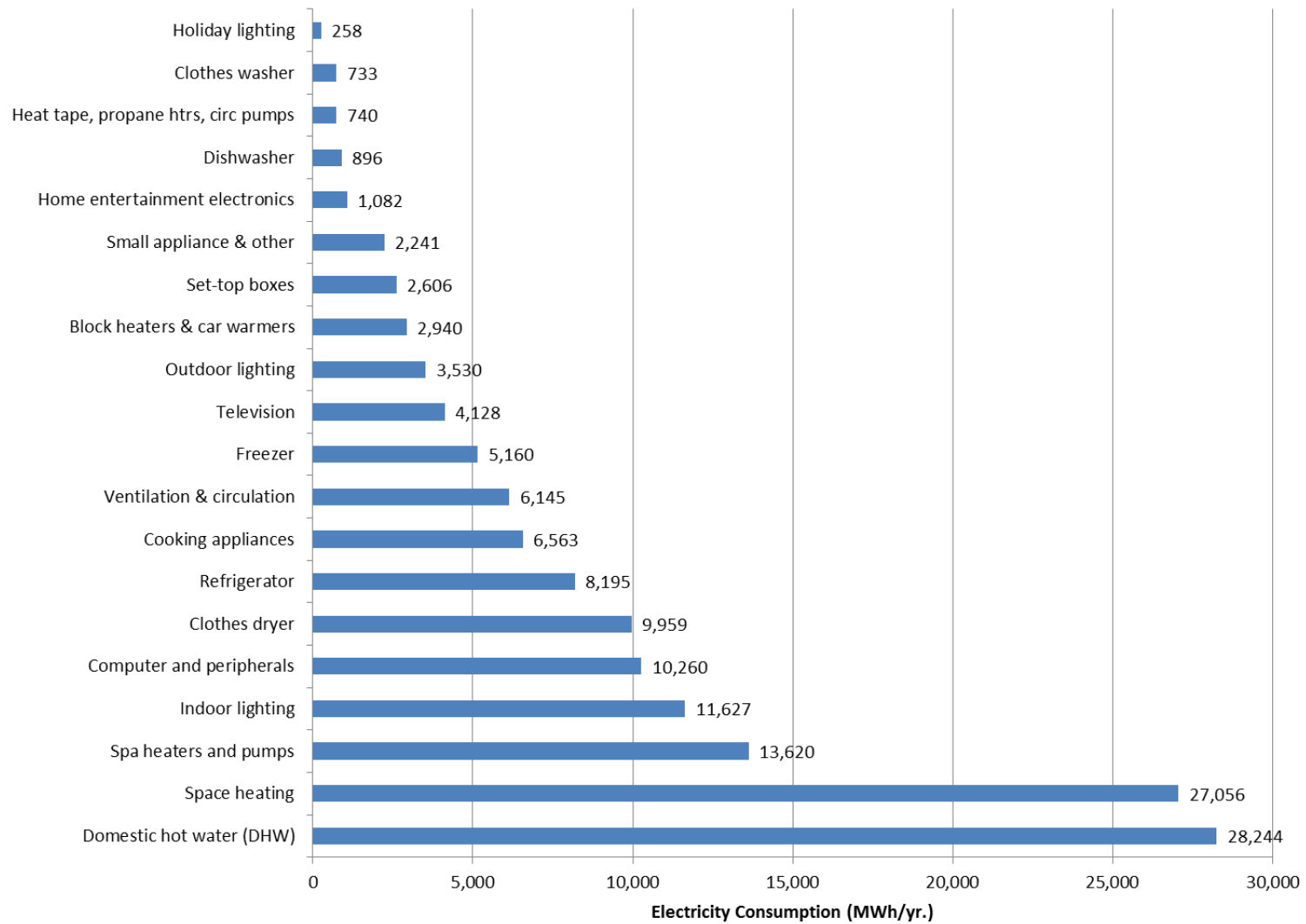
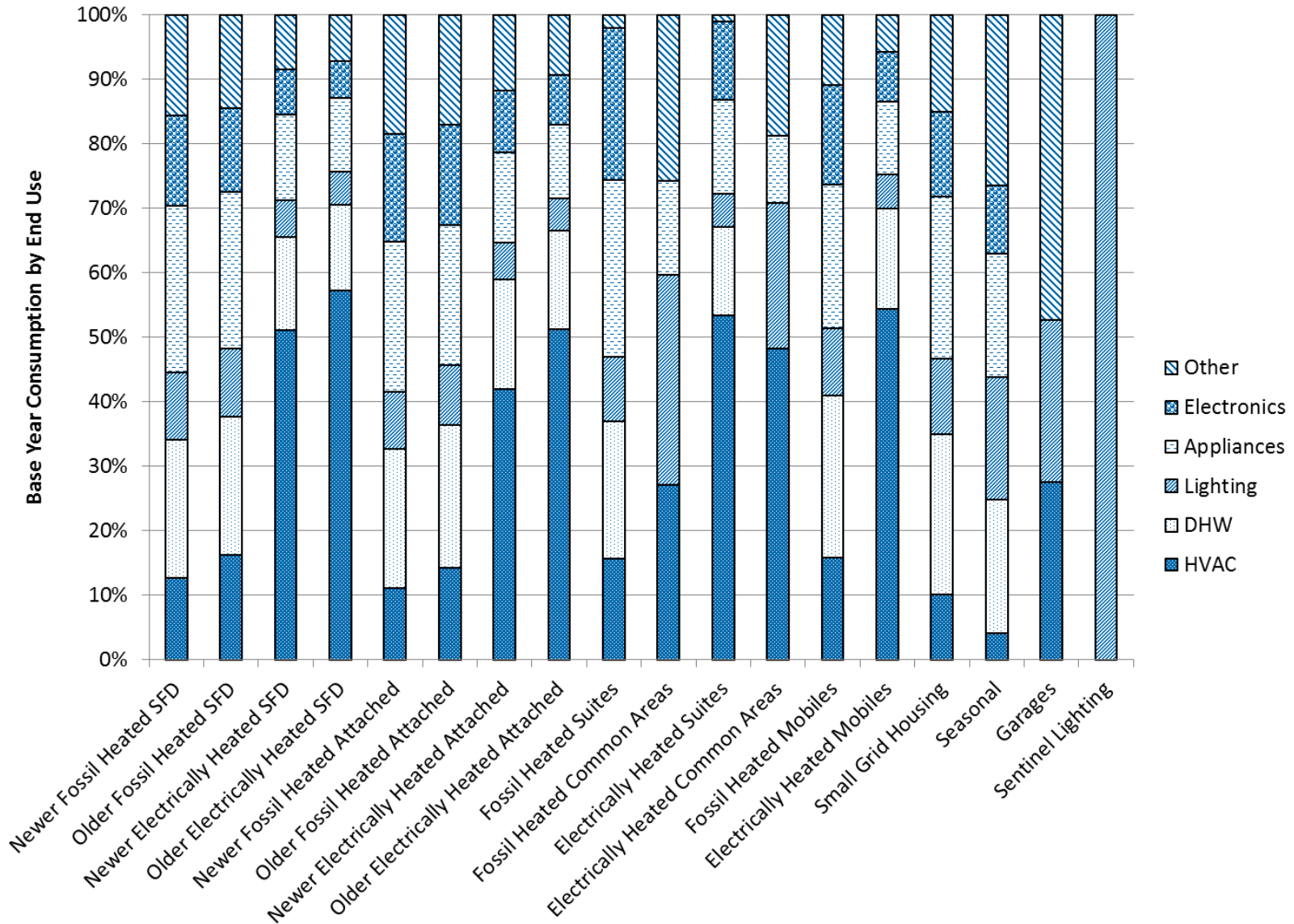


Exhibit 11 Distribution of Electricity Consumption, by Dwelling Type and End Use in the Base Year (2010)



4 Base Year (2010) Electric Peak Load

4.1 Introduction

This section provides a profile of the Base Year electric peak load for Yukon's Residential sector. The discussion is organized into the following sub sections:

- Peak period definitions
- Methodology
- Summary of results.

Additional details are provided in Appendix B.

4.2 Peak Period Definitions

Based on discussions with utility personnel, the following three peak period definitions were selected for inclusion in this study:

Peak Period 1: Annual System Peak Hour – This has traditionally been the hour ending at 6 pm on a day in December; it is highly correlated with the coldest day of the year when occurring in December, although it has sometimes occurred in January.

Peak Period 2: Annual Weekday System Evening Peak Period – The 4-8 pm period on the coldest four days of the year when occurring in December or January (total 16 hours).

Peak Period 3: Annual Weekday System Morning Peak Period – The 7-9 am period on the 10 coldest days of the year when occurring in December or January (total 20 hours).

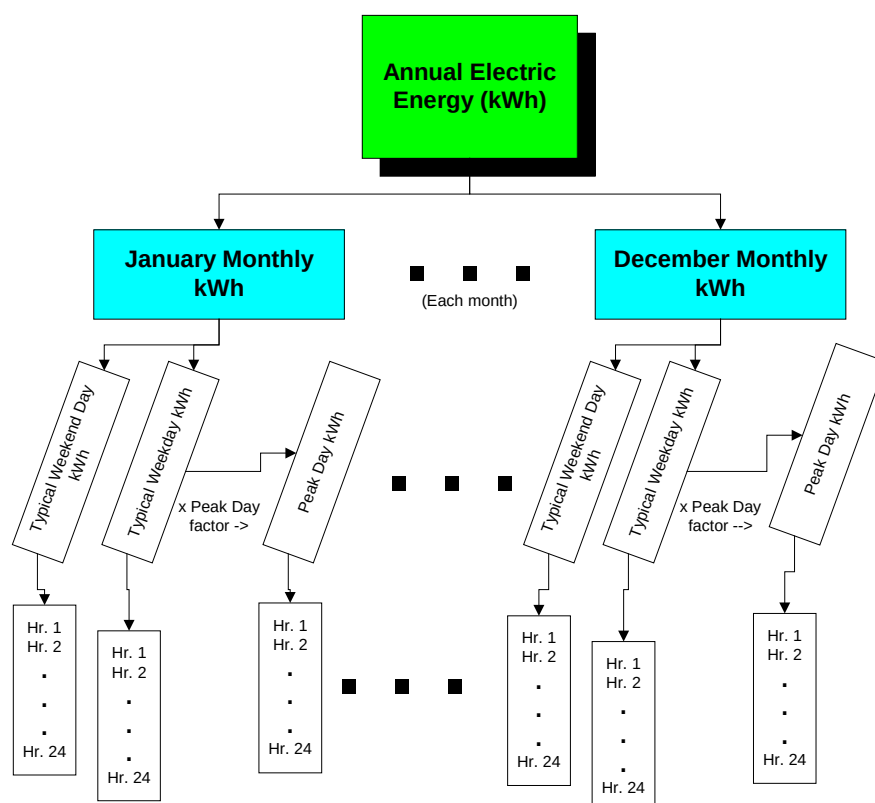
4.3 Methodology

The electric peak load profile converts the annual electric energy use (MWh) presented in Section 3 to hourly demand (MW). Development of the electric peak load estimates employs four specific factors, which are described below and shown graphically in Exhibit 12.

- **Monthly Usage Allocation Factor:** This factor represents the percent of annual electric energy usage that is allocated to each month. This set of monthly fractions (percentages) reflects the seasonality of the load shape, whether a facility, process or end use, and is dictated by weather or other seasonal factors. In decreasing order of priority, this allocation factor can be obtained from either:
 - Monthly consumption statistics from end-use load studies
 - Monthly seasonal sales (preferably weather normalized) obtained by subtracting a "base" month from winter and summer heating and cooling months, or
 - Heating or cooling degree days applied to an appropriate base.
- **Weekend to Weekday Factor:** This factor is a ratio that describes the relationship between weekends and weekdays, reflecting the degree of weekend activity inherent in the facility or end use. This may vary by month or season. Based on this ratio, the average electric energy per day type can be computed from the corresponding monthly electric energy.

- **Peak Day Factor:** This factor reflects the degree of daily weather sensitivity associated with the load shape, particularly heating or cooling; it compares a peak (e.g., hottest or coldest) day to a typical weekday in that month.
- **Per Unit Hourly Factor:** This factor reflects the operating hours of the residential electric equipment or end uses among different hours of the day for each day type (weekday, weekend day, peak day) and for each month. For example, for lighting, this would be affected by time of day and season (affected by daylight).

Exhibit 12 Overview of Peak Load Profile Methodology



4.4 Summary of Results

The three factors (sets of ratios) defined above provided the basis for converting the annual residential electricity use presented in Section 3 to aggregate peak loads in each of the three peak periods identified for this study.

Exhibit 13 presents the results for the Residential sector Base Year. The results are presented for the total Yukon service territory, by dwelling type. In each case, the results show the contribution of Residential sector demand that is coincident with the total Yukon demand in each of the three peak periods selected for this study.

Exhibit 13 Residential Sector Base Year (2011) Aggregate Peak Demand by Peak Period (MW)¹⁷

Dwelling Types	Period 1 Annual Peak Hour	Period 2 Evening Peak Period	Period 3 Morning Peak Period
Single Detached Houses	24.8	23.2	17.4
Apartments	3.4	3.3	2.0
Attached/Row Houses	2.3	2.2	1.6
Mobile/Other	2.3	2.2	1.7
Seasonal & Garage	1.0	0.9	0.7
Small Grid Housing	0.3	0.4	0.3
Sentinel Lighting	0.1	0.1	0.1
Grand Total	34.3	32.4	23.9

Exhibit 14, Exhibit 15 and Exhibit 16 show the contribution, by end use, to the residential component of the peak demand, for the Annual Peak Hour, the Evening Peak, and the Morning Peak, respectively. Some key observations may be made:

- Space heating is the largest residential component of peak demand for Peak Periods 1 and 2 and is the second largest in the Morning Peak. As shown in the previous section, space heating is one of the largest end uses in terms of annual electrical consumption. It also tends to be concentrated in the winter when the Yukon system peaks.
- Cooking appliances are the second largest residential component of the Annual Peak Hour demand and are in the top six for the other two peak periods. This is largely because cooking is so concentrated during the evening and morning system peak periods.
- Indoor lighting is the second largest residential component of the Evening Peak and is in the top five for the other two peak periods. As shown in the previous section, indoor lighting is a large end use in terms of annual electrical consumption. It also tends to be used heavily during the evening and morning hours when the Yukon system peaks.
- Domestic hot water is the largest residential component of the Morning Peak and is in the top five for the other two peak periods. It is a large end use and is heavily used during the morning hours when the Morning Peak occurs.
- Clothes dryers are the fourth largest residential contributor to the Annual Peak Hour demand, but are smaller components of both of the other peak periods. The peak use of clothes dryers coincides fairly closely with the system peak hour.
- Block heaters and car warmers make the fourth largest residential contribution to the Evening Peak, but are not as significant a contributor to the Annual Peak Hour demand and do not contribute significantly to the morning peak at all. Block heaters and car warmers account for only an estimated 2% of annual residential electrical consumption, but they are highly coincident with the winter evening hours when Peak Periods 1 and 2 occur.

¹⁷ For readability, the dwelling types are aggregated into larger categories in this exhibit than in other parts of the report. The more detailed breakdown is available in the Data Manager workbook, submitted at the same time as this report.

Exhibit 14 Contribution by End Use to Residential Aggregate Peak Demand, Annual Peak Hour (%)

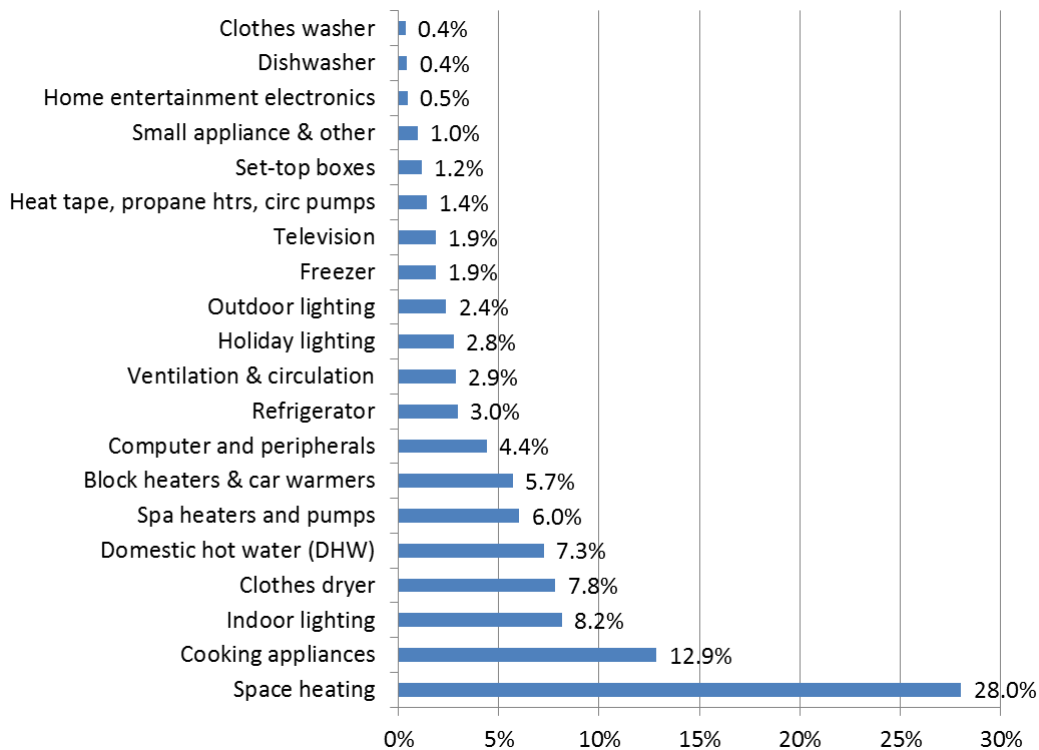


Exhibit 15 Contribution by End Use to Residential Aggregate Peak Demand, Evening Peak (%)

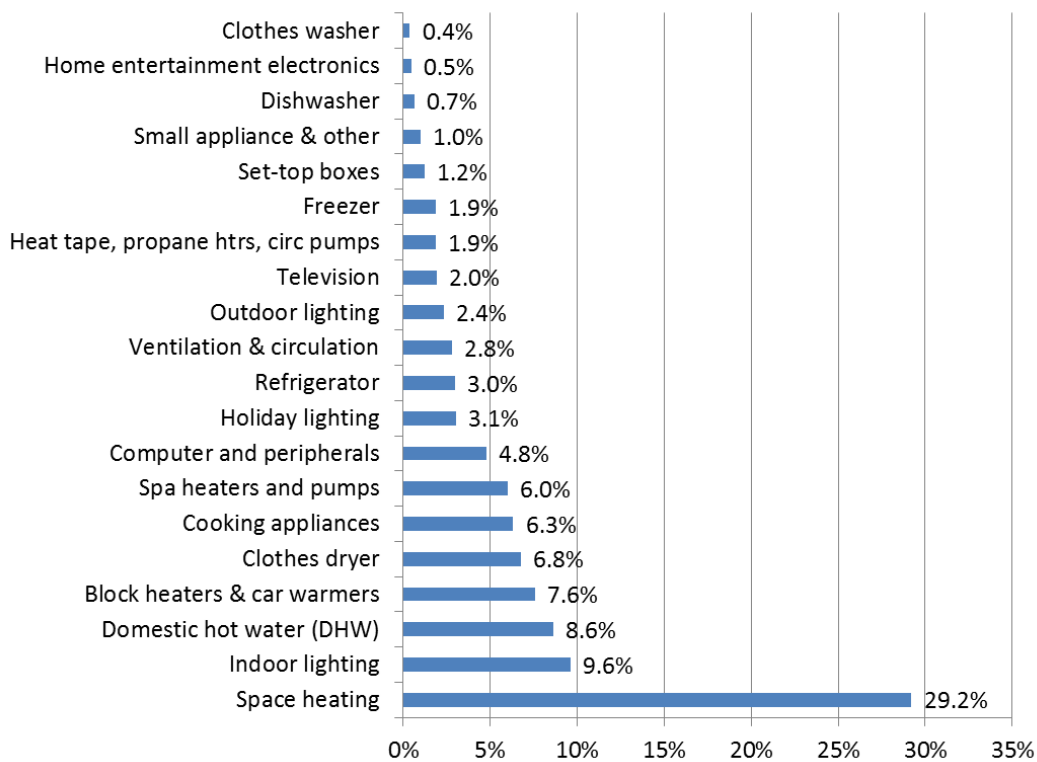
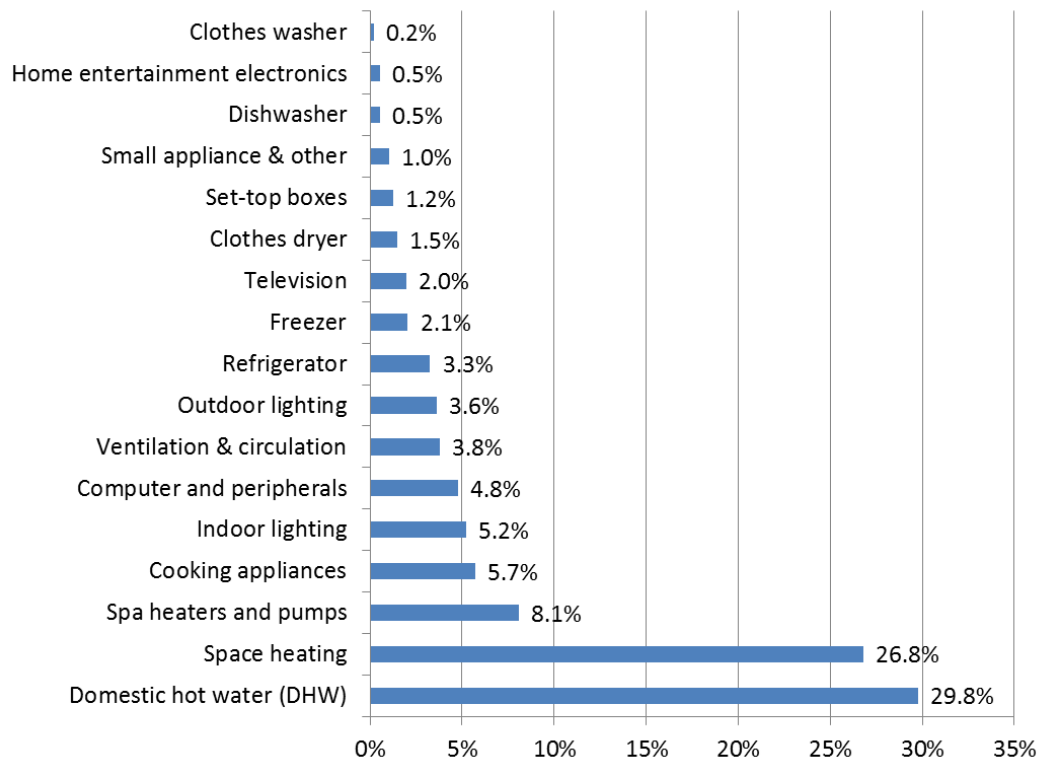


Exhibit 16 Contribution by End Use to Residential Aggregate Peak Demand, Morning Peak (%)



Additional detail is provided in Appendix B.

5 Reference Case Electric Energy Forecast

5.1 Introduction

This section presents the Residential sector Reference Case for the study period (2010 to 2030). The Reference Case estimates the expected level of electricity consumption that would occur over the study period in the absence of new utility-based DSM initiatives. The Reference Case, therefore, provides the point of comparison for the calculation of electricity saving opportunities associated with each of the scenarios that are assessed within this study.

The Reference Case discussion is presented within the following sub sections:

- Methodology
- Summary of model results.

5.2 Methodology

Development of the Reference Case involved the following six steps:

- Step 1:** The growth in the number of residential dwellings was estimated for each type of dwelling.
- Step 2:** The net space heating and cooling loads for each new dwelling type were estimated. New dwellings are those built after the base year, 2010.
- Step 3:** Naturally-occurring changes in net space heating and cooling loads were estimated for existing dwelling types.
- Step 4:** Naturally-occurring changes in annual electricity use were estimated for the evolving stock of major residential appliances.
- Step 5:** Future appliance saturation trends were estimated for each dwelling type.
- Step 6:** Changes in electricity share for each appliance were estimated for each dwelling type.

Exhibit 17 shows the estimated number of residential units in each milestone period, by dwelling type. The estimates shown are derived from YEC's 20-Year Resource Plan – 2011.

Higher rates of growth have been applied to both the attached houses and the apartments, compared to the rate of growth for single detached houses. The attached houses are assumed to increase in number 1.5 times as fast as the single detached houses, and the apartments are assumed to increase in number three times as fast as single detached houses, with the overall growth rate calibrated to the expected increase in number of accounts assumed in the load forecast.¹⁸ These ratios are approximately consistent with the ratios in recent construction in Yukon, and are similar to those found in other parts of Canada.

¹⁸ Note that growth in number of accounts does not translate directly into growth in consumption because the dwelling types have different overall consumption and different mixes of end uses.

Growth rates for electrically heated dwellings are assumed to be much larger than for non-electrically heated dwellings, based on both recent and planned construction.¹⁹ For detached dwellings, construction is expected to result in approximately equal numbers of electrically and non-electrically heated new dwellings during the study period. For attached houses (including both row/townhouses and apartments), 75% of the new dwellings during the study period are expected to be electrically heated. This applies only to the hydro grid areas of the territory, not to areas supplied by diesel grids.

Exhibit 17 Residential Accounts by Dwelling Type and Milestone Year

Dwelling Types	Number of Dwellings			
	2015	2020	2025	2030
1980 & newer non-electrically heated single detached homes	3,724	4,021	4,291	4,535
Pre-1980 non-electrically heated single detached homes	2,884	2,884	2,884	2,884
1980 & newer electrically heated single detached homes	769	1,044	1,336	1,635
Pre-1980 electrically heated single detached homes	439	439	439	439
1980 & newer non-electrically heated attached/row housing	495	535	573	606
Pre-1980 non-electrically heated attached/row housing	381	381	381	381
1980 & newer electrically heated attached/row housing	128	202	291	392
Pre-1980 electrically heated attached/row housing	59	59	59	59
Non-electrically heated apartment units	1,501	1,622	1,736	1,841
Non-electrically heated apartment common areas	163	176	188	200
Electrically heated apartment units	400	697	1,133	1,731
Electrically heated apartment common areas	44	76	123	187
Non-electrically heated mobile/other	927	968	1,005	1,038
Electrically heated mobile/other	163	200	239	280
Small diesel grid housing	189	195	202	209
Seasonal housing	3,558	3,717	3,863	3,995
Residential garages	298	312	324	334
Sentinel Lighting	990	1,031	1,068	1,101
Grand Total	17,114	18,561	20,134	21,849

A detailed discussion of the methodology employed in each of the remaining steps is provided in Appendix C.

5.3 Summary of Results

This section presents the results of the model runs for the entire study period. The results are measured at the customer's point-of-use and do not include line losses. They are presented in four exhibits:

- Exhibit 18 presents the model results in tabular form, by dwelling type, end use and milestone year

¹⁹ The primary source of information was local utility knowledge of planned subdivisions and commercial construction. Yukon utility personnel are in regular contact with the construction industry and with Yukon Housing Corporation, to maintain up-to-date information on expected new loads on the system.

- Exhibit 19 presents the model results for 2030 by dwelling type
- Exhibit 20 presents the model results for 2030 by supply type and government versus non-government
- Exhibit 21 presents the model results for 2030 by end use
- Exhibit 22 shows the evolving relative contribution of different summary end uses towards the total consumption in different dwelling types.

Selected highlights of electricity use in 2030 are provided below.

By Dwelling Type

Single detached dwellings will continue to account for the majority of residential electricity use in Yukon, but will decline to approximately 65% of residential electricity consumed in 2030. Apartment and condo buildings, including both the suites and the common areas, are expected to rise to 17% of residential electricity by 2030. Attached houses (duplexes, row houses, and townhouses), are expected to remain at approximately 7% of residential electricity. Mobile homes will also consume approximately 6% of residential electricity.

Seasonal houses are expected to use approximately 2% of residential electricity. The dwellings in the Small Grid Housing category (accounts connected to small diesel grids and the Old Crow system) will continue to account for approximately 1% of residential electricity by 2030. Residential garages are expected to consume just over 0.5% of residential electricity. Sentinel lighting is expected to use less than 0.5% of residential electricity.

By Supply Type and Government versus Non-government Accounts

The accounts connected to the hydro grid are expected to consume approximately 96% of residential electricity in 2030. Accounts connected to large diesel grids will consume approximately 3% of residential electricity. Accounts connected to small diesel grids are expected to consume less than 1% of residential electricity, as will accounts in the fly-in community of Old Crow.

Government of Yukon accounts are expected to consume approximately 2% of residential electricity in 2030, with non-government accounts consuming the other 98%.

By End Use

HVAC is expected to account for 28% of consumption in 2030, a modest decline from the current level; 24% of that will be electric space heating and the remainder will be fans and pumps, including furnace fans, boiler circulation pumps, HRV fans, and bathroom and kitchen exhaust.

Household electronics are expected to consume approximately 20% of residential electricity in 2030, which is a substantial increase. Of this, approximately 10% will be used by computers and their peripherals, 5% by various home entertainment electronics, 3% by televisions, and 2% by the various set-top boxes associated with televisions. The most substantial growth in this broad category is in the general home entertainment electronics. Much of this significant increase represents the introduction of unknown new end uses in the future.

Domestic appliances (white goods) are expected to consume approximately 17% of residential electricity altogether, by 2030, a modest decline from current levels. Of this, clothes dryers are

expected to account for 6% and refrigerators for 4%. Cooking appliances and freezers are each expected to consume approximately 3%. Dishwashers and clothes washers will consume less than 1% each, but this does not include the associated DHW consumption if DHW is heated electrically.

Domestic water heating is expected to account for approximately 13% of residential electricity consumption by 2030, a substantial decline from current values. This decrease is expected to occur primarily because of improved efficiency of devices in the home that use hot water, such as dishwashers, clothes washers, showerheads and faucet aerators.

Indoor, outdoor, and holiday lighting together are expected to account for 7% of residential electricity consumption in 2030, a substantial decrease from the present level. Indoor lighting accounts for 5% of expected 2030 consumption and outdoor lighting accounts for 1%. The holiday lighting portion becomes vanishingly small by 2030.

Other end uses are expected to account for 15% of residential electricity consumption in 2030, a substantial increase. Of this, 3% is expected to be consumed by spa heaters and pumps, a substantial decrease from current levels. Block heaters and car warmers are expected to consume 2%, largely the same percentage as presently. The remaining 9% is expected to be consumed by the small appliances and other category. The latter is another end use with many unknowns, increasing to represent the introduction of new end uses.

By Dwelling Type and End Use

The last exhibit in this section shows the trends in consumption by major end-use groupings. The following key observations can be made:

- Heating, ventilation and circulation, and cooling are expected to maintain a relatively stable share of residential electricity consumption between now and 2030.
- DHW will account for a moderately reduced share of residential electricity consumption, largely because of reduced consumption in dishwashers, clothes washers and low-flow fixtures.
- Lighting is expected to account for a steadily diminishing share of residential electricity consumption between now and 2030, even without new DSM intervention, largely because of the growing use of compact fluorescent lamps and LED holiday strings.
- The overall consumption of appliances will account for a modestly reduced share of consumption, because the forecast increase in the number of appliances per home will likely be more than cancelled out by gains in efficiency.
- Electronics in the home, including computers, televisions and set-top boxes, and other electronics, are expected to account for an increasing share of residential consumption. Even though some of these devices are becoming more efficient, their increasing numbers will more than cancel out any efficiency gains.
- Past experience suggests that electricity consumption per household remains remarkably stable over long periods. As more efficient equipment is introduced for some of the older end uses, new uses for electricity tend to emerge. This is reflected in the increase in consumption for “other” between now and 2030.
- The exhibit also permits comparisons of end-use consumption proportions from one dwelling type to another. These patterns are expected to remain relatively consistent through the study period.

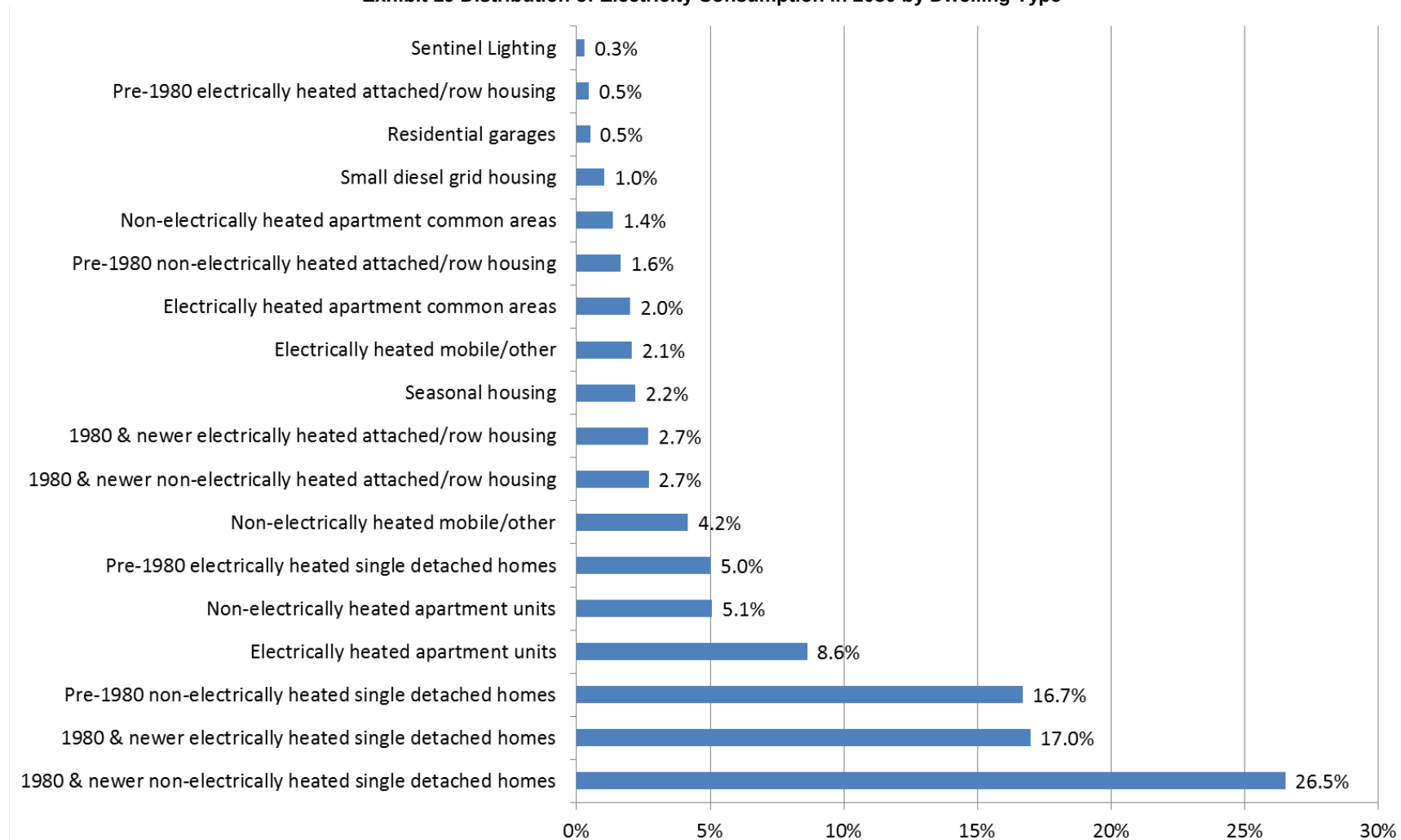
Exhibit 18 Reference Case Electricity Consumption, Modelled by End Use, Dwelling Type and Milestone Year (MWh/yr.)

Dwelling Types	Milestone Years	HVAC	Appliances	Electronics	DHW	Other	Lighting	TOTAL
Single Detached House	2010	24,479	23,194	12,428	20,552	14,007	9,744	104,403
	2015	27,942	23,657	15,590	20,520	13,193	9,772	110,674
	2020	31,696	24,843	19,436	20,511	12,845	9,697	119,029
	2025	35,609	26,330	23,788	20,975	16,096	9,503	132,301
	2030	39,582	28,003	29,950	21,404	22,968	9,185	151,092
Apartment/Condo Suites and Common Areas	2010	3,634	2,951	2,087	1,943	1,106	2,066	13,786
	2015	5,185	2,647	2,879	2,142	1,345	2,246	16,444
	2020	7,542	3,074	4,033	2,465	1,786	2,464	21,363
	2025	10,906	3,707	5,627	2,988	2,777	2,705	28,711
	2030	15,445	4,559	8,129	3,691	4,764	2,943	39,531
Attached Dwelling	2010	2,040	2,130	1,521	2,149	1,697	865	10,403
	2015	2,469	2,238	1,942	2,203	1,600	879	11,331
	2020	3,000	2,394	2,470	2,284	1,533	887	12,568
	2025	3,624	2,634	3,078	2,441	1,897	885	14,560
	2030	4,330	2,901	3,931	2,620	2,693	870	17,345
Mobile	2010	2,435	1,962	1,352	2,276	966	918	9,908
	2015	2,777	1,933	1,684	2,267	973	919	10,553
	2020	3,126	2,011	2,083	2,262	1,041	911	11,435
	2025	3,477	2,116	2,524	2,309	1,374	893	12,693
	2030	3,825	2,238	3,137	2,352	2,021	863	14,436
Garages and Seasonal Housing	2010	408	760	421	820	1,462	975	4,846
	2015	428	757	529	797	1,387	956	4,853
	2020	446	772	679	772	1,356	927	4,952
	2025	462	794	878	763	1,624	889	5,410
	2030	478	820	1,189	752	2,155	843	6,237
Small Grid Housing	2010	206	510	267	504	304	237	2,029
	2015	213	507	322	483	274	228	2,027
	2020	221	512	389	463	256	218	2,058
	2025	229	525	465	455	306	207	2,187
	2030	238	543	579	449	416	195	2,421
Sentinel Lighting	2010	-	-	-	-	-	609	609
	2015	-	-	-	-	-	623	623
	2020	-	-	-	-	-	634	634
	2025	-	-	-	-	-	657	657
	2030	-	-	-	-	-	678	678
TOTAL	2010	33,201	31,506	18,076	28,244	19,542	15,414	145,984
	2015	39,013	31,739	22,946	28,412	18,771	15,623	156,505
	2020	46,031	33,606	29,092	28,756	18,817	15,738	172,039
	2025	54,308	36,107	36,360	29,931	24,074	15,739	196,519
	2030	63,898	39,064	46,915	31,268	35,017	15,577	231,739

Notes:

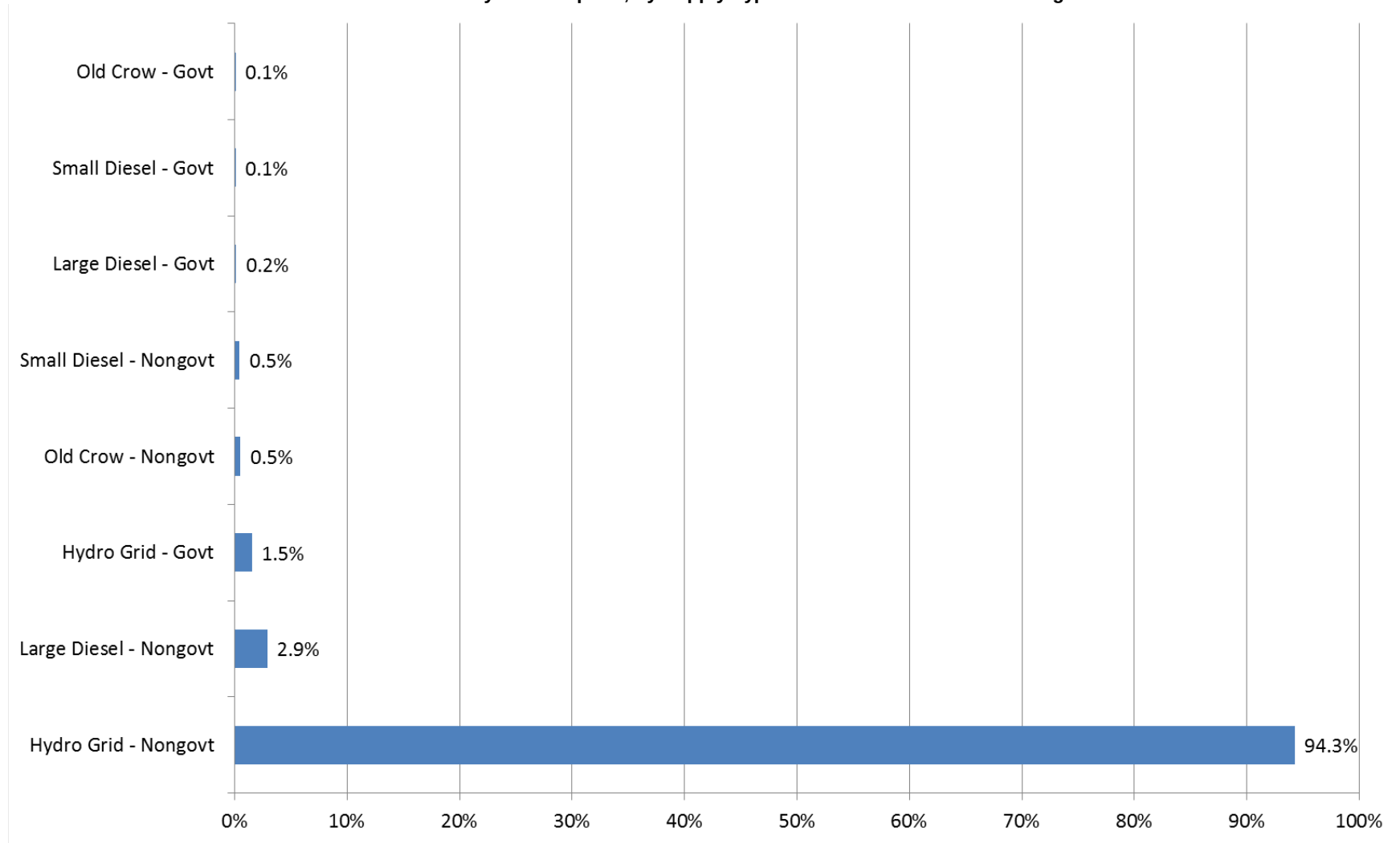
- 1) Results are measured at the customer's point-of-use and do not include line losses.
- 2) Any differences in totals are due to rounding.
- 3) Rounding reduces many non-zero values in this table to apparent zeroes.
- 4) Both the dwelling types and end uses in this exhibit are summary groupings. Data Manager can be used to display the more disaggregated results.

Exhibit 19 Distribution of Electricity Consumption in 2030 by Dwelling Type



Totals may not add to 100% due to rounding.

Exhibit 20 Distribution of Electricity Consumption, by Supply Type and Government versus Non-government in 2030



Totals may not add to 100% due to rounding.

Exhibit 21 Distribution of Electricity Consumption in 2030 by End Use

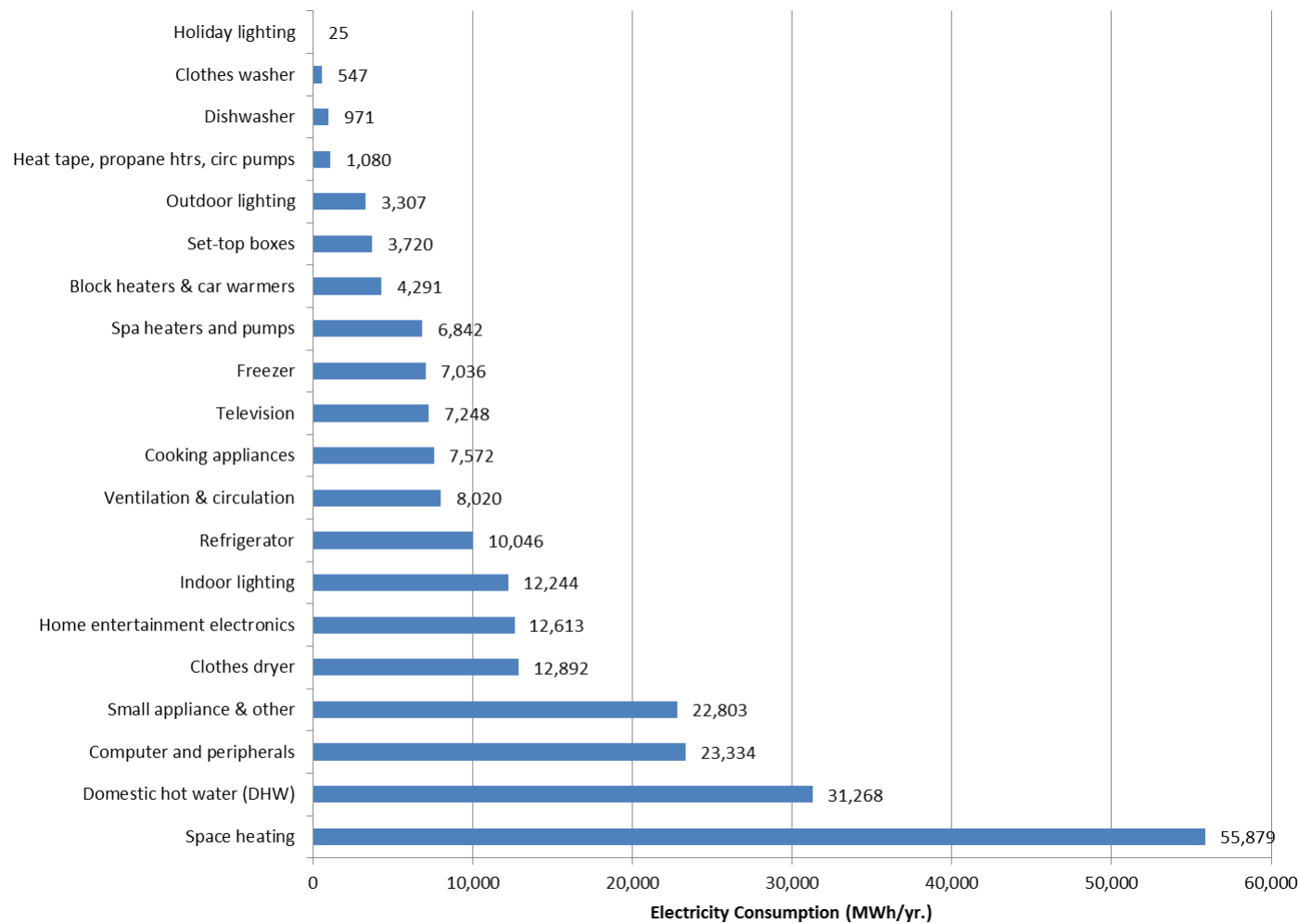
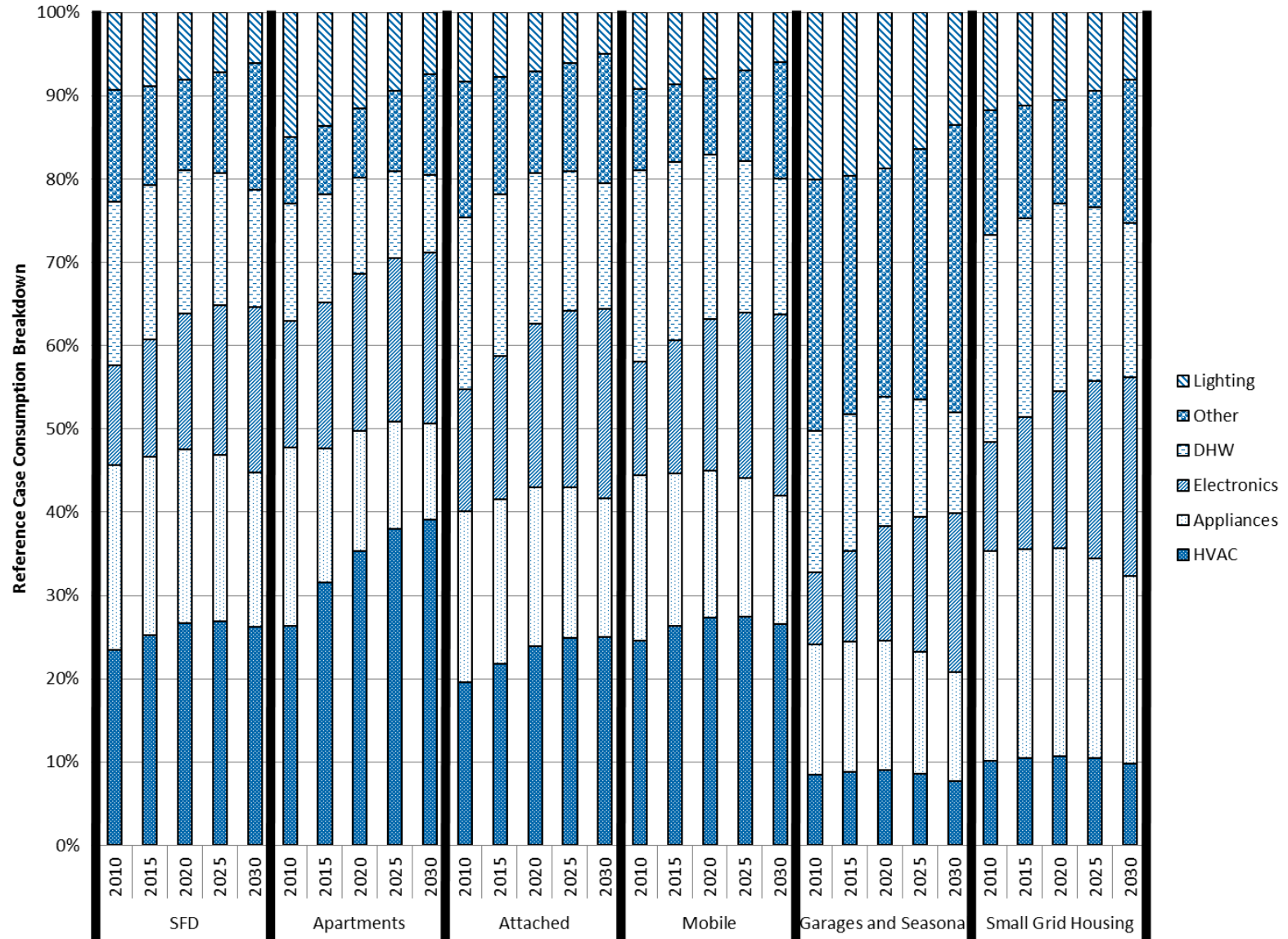


Exhibit 22 Distribution of Electricity Consumption, by Dwelling Type and End Use, Trends to 2030



6 Reference Case Electric Peak Load Forecast

6.1 Introduction

This section provides a profile of the electric peak load for Yukon's Residential sector over the Reference Case period of 2010 to 2030. The Reference Case peak load profile estimates the expected level of demand in each of the three peak periods that would occur over the study period in the absence of new DSM initiatives or rate changes. The Reference Case, therefore, provides the point of comparison for the calculation of peak load savings associated with each of the subsequent scenarios that are assessed within this study.

The discussion is organized into the following sub sections:

- Methodology
- Summary of results.

6.2 Methodology

The electric peak loads for each combination of end use, dwelling type and milestone year were calculated in exactly the same manner as shown in Section 4, which presented the Base Year peak load profiles.

For this Reference Case, the electric energy consumption (from Section 5) is converted to a demand value for each of the three peak period definitions by dividing the applicable electric energy value for each dwelling type and end use by the corresponding Residential sector load shape hours-use factors, as presented in Appendix B.

6.3 Summary of Results

A summary of the Reference Case peak load profiles is presented in Exhibit 23.

Exhibit 23 Electric Peak Loads, by Milestone Year, Peak Period and Dwelling Type (MW)

Dwelling Type	Milestone Year	Period 1 Annual Peak Hour	Period 2 Evening Peak Period	Period 3 Morning Peak Period
Single Detached Houses	2010	24.8	23.2	17.4
	2015	26.5	24.9	18.4
	2020	28.5	26.8	19.6
	2025	31.2	29.5	21.6
	2030	34.8	33.0	24.2
Apartments	2010	3.4	3.3	2.0
	2015	4.1	4.0	2.5
	2020	5.4	5.3	3.3
	2025	7.4	7.2	4.4
	2030	10.1	9.9	6.1
Attached/Row Houses	2010	2.3	2.2	1.6
	2015	2.6	2.5	1.8
	2020	2.9	2.8	2.0
	2025	3.3	3.2	2.2
	2030	3.9	3.8	2.6
Mobile/Other	2010	2.3	2.2	1.7
	2015	2.6	2.4	1.8
	2020	2.8	2.6	2.0
	2025	3.1	2.8	2.2
	2030	3.4	3.2	2.4
Seasonal & Garage	2010	1.0	0.9	0.7
	2015	1.0	0.9	0.7
	2020	1.0	1.0	0.7
	2025	1.1	1.0	0.8
	2030	1.2	1.2	0.9
Small Grid Housing	2010	0.4	0.4	0.3
	2015	0.4	0.4	0.3
	2020	0.4	0.4	0.3
	2025	0.5	0.4	0.3
	2030	0.5	0.5	0.3
Sentinel Lighting	2010	0.1	0.1	0.1
	2015	0.1	0.1	0.2
	2020	0.1	0.1	0.2
	2025	0.2	0.1	0.2
	2030	0.2	0.1	0.2
Grand Total	2010	34.5	32.4	23.9
	2015	37.3	35.2	25.6
	2020	41.2	39.0	28.0
	2025	46.6	44.4	31.7
	2030	54.0	51.6	36.7

Selected highlights include:

- Since the hours-use factors applied are not assumed to change during the study period, trends in peak demand contributions for specific dwelling types are expected to follow the electricity consumption trends for those dwelling types. Single detached houses, for example, will continue to make the largest residential contribution to peak demand for all three demand periods, throughout the study period.
- Similarly, peak demand contributions for specific end uses are expected to follow the electricity consumption trends for those end uses. Lighting, because of natural gains in efficiency as compact fluorescent lamps are adopted, will make a gradually declining contribution towards the peak demand. In particular, the contribution of holiday lighting to the peak will diminish substantially as LED strings achieve market dominance by 2030.

The overall electricity consumption of both Home Entertainment Electronics and Small Appliance & Other trend upwards during the study period, so they would be expected to make a gradually larger contribution towards the peak demand over the course of the study period.

7 Technology Assessment: Energy-efficiency Measures

7.1 Introduction

This section identifies and assesses the economic attractiveness of the selected energy-efficiency technology measures for the Residential sector. The discussion is organized and presented as follows:

- Methodology
- Energy-efficiency technologies
- Summary of “unbundled” results
- Energy-efficiency supply curves.

7.2 Methodology

The following steps were employed to assess the energy-efficiency measures:

- Select candidate energy-efficiency measures
- Establish technical performance for each option
- Establish the capital, installation and operating costs for each option
- Calculate the cost of conserved energy (CCE) for each technology and O&M measure.

A brief description of each step is provided below.

Step 1 Select Candidate Measures

The candidate measures were selected in close collaboration with client personnel based on a combination of a literature review and previous study team experience. The selected measures are all considered to be technically proven and commercially available, even if only at an early stage of market entry. Technology costs, which will be addressed in this section, were not a factor in the initial selection of candidate technologies.

Step 2 Establish Technical Performance

Information on the performance improvements provided by each measure was compiled from available secondary sources, including the experience and on-going research work of study team members.

Step 3 Establish Capital, Installation and Operating Costs for Each Measure

Information on the cost of implementing each measure was also compiled from secondary sources, including the experience and on-going research work of study team members.

The incremental cost is applicable when a measure is installed in a new facility, or at the end of its useful life in an existing facility; in this case, incremental cost is defined as the cost difference for the energy-efficiency measure relative to the baseline technology. The full cost is applicable when an operating piece of equipment is replaced with a more efficient model prior to the end of its useful life.²⁰

²⁰ With some exceptions, many measures could conceivably be applied as either a full-cost measure (applicable immediately) or as an incremental cost measure (upon end of service life), depending on how financially attractive it

In both cases the costs and savings are annualized, based on the number of years of equipment life and the discount rate, and the costs incorporate applicable changes in annual O&M costs. All costs are expressed in constant 2010 dollars.

Step 4 Calculate CCE for Each Measure

One of the important sets of information provided in this section is the CCE associated with each energy-efficiency measure. The CCE for an energy-efficiency measure is defined as the annualized incremental cost of the upgrade measure divided by the annual energy savings achieved, excluding any administrative or program costs required to achieve full use of the technology or measure. All cost information presented in this section and in the accompanying measure TRC model are expressed in constant 2010 dollars.

The CCE provides a basis for the subsequent selection of measures to be included in the Economic Potential Forecast (see Section 8). The CCE is calculated according to the following formula:

$$\frac{C_A + M}{S}$$

Where:

C_A is the annualized installed cost

M is the incremental annual cost of operation and maintenance (O&M)

S is the annual kWh electricity savings

And A is the annualization factor

$$A = \frac{i(1+i)^n}{(1+i)^n - 1}$$

Where:

i is the discount rate

n is the life of the measure

The detailed CCE tables (see measure TRC model) show both “incremental” and “full” installed costs for the energy-efficiency measures, as applicable. If the measure or technology is installed in a new facility or at the point of natural replacement in an existing facility, then the incremental cost of the measure versus the cost of the baseline technology is used. If, prior to the end of its life, an operating piece of equipment is replaced with a more efficient model, then the full cost of the efficient measure is used.

The annual saving associated with the efficiency measure is the difference in annual electricity consumption with and without the measure.

is. Therefore, for all but a few measures, the TRC model is configured to evaluate the measure at full cost and include it on that basis if it passes the screen, then roll to evaluating it on an incremental basis, and only fail it completely if it fails both tests. Where a measure is always full cost (such as the block heater timer, where the baseline technology is the “do nothing” option), the incremental cost option is excluded. Where a measure is always incremental cost (such as high-performance homes, where the baseline technology has to be a standard construction home, not no home at all), the full cost option is excluded.

It is recognized that some measures can be implemented prior to the end of their useful life, that is, early retirement. This intermediate option between full and incremental cost could increase the rate of adoption for some of the incremental measures, raising the Economic Potential savings modestly. However, in this study early retirement is treated as a program option.

The CCE calculation is sensitive to the chosen discount rate. In the CCE calculations that accompany this document, a discount rate of 5.25% (real) is used.

Step 5 Estimate Approximate “Unbundled” Electric Energy Savings Potential for Each Measure

The next step in the assessment was to prepare an approximate estimate of the potential “unbundled” electric energy savings that could theoretically be provided by each measure over the study period. The term “unbundled” means that the savings for each measure are calculated in isolation of other important factors that ultimately determine the potential for real life savings. The strength of this approach is that it provides insight into the relative size of the potential electric energy savings associated with individual measures; this perspective is often of particular value to utility DSM program design personnel who may need to consider combinations of energy-efficiency measures that differ from those selected for the CPR analysis.

However, it should be noted that the savings from individual measures cannot be used directly to calculate total savings potential. This is due primarily to two factors:

- **More than one upgrade may affect a given end use.** For example, improved insulation reduces space heating electricity use, as does the installation of new energy-efficient windows. On its own, each measure will reduce overall space heating electricity use. However, the two savings are not additive. The order in which some upgrades are introduced is also important. In this study, the approach has been to select and model the impact of “bundles of measures” that reduce the load for a given end use (e.g., wall insulation and window upgrades that reduce the space heating load) and then to introduce measures that meet the remaining load more efficiently (e.g., a high-efficiency space heating system).
- **There are interactive effects among end uses.** For example, the electricity savings from more efficient appliances and lighting result in reduced waste heat. During the space heating season, appliance and lighting waste heat contributes to the building's internal heat gains, which lower the amount of heat that must be provided by the space heating system. The magnitude of the interactive effects can be significant. Based on selected building energy use simulations, a 100 kWh savings in appliance or lighting electricity use results, on average, in an increased space heating load of 59 kWh to 66 kWh, depending on housing detachment type, vintage and geographical location.

The above factors are incorporated in later stages of the analysis.

Step 6 Prepare Energy-efficiency Supply Curves

The final step in the assessment of the selected energy-efficiency measures was the generation of a set of energy-efficiency supply curves. Supply curves are built up based on the conserved electricity and the CCE for each measure. The RSEEM model was used to model the application of all technically feasible measures, accumulating the electricity savings and associated implementation costs for each dwelling type.

Measures were applied sequentially to account, at least approximately, for interaction between measures. The impact of building shell measures was modelled using HOT2000, but only individually. The full package of measures was not modelled together, nor was the impact of

internal gains on space heating and cooling included. These effects will be modelled more thoroughly for the Economic Potential calculation, when all the measures that pass the economic screen will be modelled together.

The accumulated savings and costs for each measure were added together to present the overall supply curve for the province. They were sorted in order from lowest cost per kWh saved to highest cost, and presented on a graph showing CCE versus electricity savings.

7.3 Energy-efficiency Technology Assessment

Exhibit 24 shows the energy-efficiency technologies and measures that are included in this study. A description and detailed financial and economic assessment of each measure is provided in the measure TRC model that accompanies this report.

Exhibit 24 Energy-efficiency Technologies Included in this Study

Heating: Equipment ▪ Cold temperature heat pumps ▪ Ductless mini-split systems ▪ Ground-source heat pumps (closed loop) ▪ Programmable thermostats (central heating) ▪ Programmable thermostats (baseboard heating) ▪ Outdoor temperature reset ▪ Zone heating ▪ Solar pre-heat makeup air ▪ High-efficiency heat recovery ventilators (HRVs) ▪ Efficient furnace motors Heating: Shell Measures ▪ Attic insulation ▪ Wall insulation ▪ Slab insulation ▪ Basement (foundation) insulation ▪ Crawl space insulation ▪ Air sealing/weather stripping/caulking ▪ Air leakage sealing and insulation (old homes) ▪ High-performance (triple-paned) windows ▪ Super high-performance (quad-paned) windows ▪ Optimizing glazing for passive solar heat Heating: Shell (New Homes) ▪ High-performance new homes (EGH 85) ▪ Near-zero/Net-zero energy homes ▪ LEED certified apartment buildings Appliances ▪ Induction cooktops ▪ Convection ovens ▪ High-efficiency (ENERGY STAR®) refrigerators ▪ High-efficiency (ENERGY STAR®) freezers ▪ High-efficiency (ENERGY STAR®) clothes washers ▪ High-efficiency (ENERGY STAR®) dishwashers	Lighting ▪ Compact fluorescent lamps (CFL) – indoor ▪ Compact fluorescent lamps (CFL) – outdoor ▪ PAR compact fluorescent lamps ▪ Dimmable compact fluorescent lamps ▪ Spot or task lighting ▪ LED lamps ▪ LED holiday lighting (indoor) ▪ LED holiday lighting (outdoor) ▪ Efficient fluorescent lamps (replace T12s with T8s) ▪ Motion detectors for outdoor lighting ▪ Motion detectors for indoor lighting ▪ Timers for outdoor lighting Water Heating ▪ DHW tank insulation ▪ DHW pipe insulation ▪ Ultra low-flow showerheads ▪ Wastewater heat recovery systems ▪ DHW recirculation systems (e.g. Metlund D'MAND™) ▪ DHW piping optimization Other ▪ Hot tub pump timers ▪ High-efficiency spa pumps ▪ Insulating hot tub covers ▪ Heat pump spa heaters ▪ Solar spa pre-heat ▪ Timer/thermostat for vehicle block heaters/interior car warmers/battery blankets ▪ Energy-efficient (ENERGY STAR®) printers and faxes ▪ Energy-efficient (ENERGY STAR®) televisions ▪ Smart power bars (computers and peripherals) ▪ Smart power bars (televisions and home entertainment) ▪ ENERGY STAR® ceiling fans

7.3.1 Technology Screening Results

A summary of the results is provided in Exhibit 25. For each of the measures reviewed, the exhibit shows:

- The name of the measure
- The cost basis²¹ for the CCE that is shown, e.g., full versus incremental
- The measure's average CCE when applied to existing dwellings and to new dwellings.

Measures analyzed on the basis of full cost have been placed towards the top of Exhibit 25 because they are qualitatively different from the measures that pass only on an incremental basis. A measure that passes on a full-cost basis can be applied immediately, even if the piece of equipment it replaces or improves is currently working properly. That means the rate at which the measure can be implemented as a utility DSM measure is limited by market and program constraints. A measure that passes only on an incremental basis, on the other hand, is limited by the rate of natural replacement (due to failure or obsolescence) or purchase of the piece of equipment it replaces. A measure that passes on a full-cost basis in some dwelling types and on an incremental cost basis in others is shown as "Full/Incr."

Exhibit 25 Residential Sector Energy-efficiency Technology Measures, Screening Results²²

Measure Name	Basis (Full/ Incremental)	Average CCE (¢/kWh)	
		Existing Homes	New Homes
DHW Pipe Insulation	Full	0.23	0.29
Ultra Low-Flow Showerheads	Full	0.77	1.10
Hot Tub Pump Timers	Full	0.90	1.23
Programmable Thermostats (Central Heating)	Full	1.04	1.23
Compact Fluorescent Lamps (CFL) - Indoor	Full	1.09	1.09
Compact Fluorescent Lamps (CFL) - Outdoor	Full	1.64	1.64
Insulating Hot Tub Covers	Full	1.85	2.52
Timers for Electric Car Warmers	Full	2.42	2.44
Programmable Thermostats (Baseboard Heating)	Full	4.55	5.20
Motion Detectors for Outdoor Lighting	Full	4.80	4.80
Solar Spa Pre-heat	Full	4.84	6.58
Motion Detectors for Indoor Lighting	Full	5.06	5.06
Heat Pump Spa Heaters	Full	5.31	7.18
Timer/Thermostat for Block Heaters	Full	5.54	5.48
LED Holiday Lighting (Outdoor)	Full	7.75	6.54
Dimmable Compact Fluorescent Lamps	Full	6.62	6.62
DHW Tank Insulation	Full	6.89	9.04
Outdoor Temperature Reset	Full	8.08	9.53
Spot/Task Lighting	Full	8.28	8.28
Smart Power Bars (Computers and Peripherals)	Full	8.32	8.47
Dimmable PAR Compact Fluorescent Lamps	Full	8.83	8.83
Attic Insulation	Full	8.94	
SuperGreen Homes (EGH rating of 85)	Full		9.51
Basement (Foundation) Insulation	Full	10.30	

²¹ See Step 4 in Section 7.2 for a fuller description.

²² Average CCE does not include program costs.

Measure Name	Basis (Full/ Incremental)	Average CCE (¢/kWh)	
		Existing Homes	New Homes
LEED Certified Apartment Buildings	Full		10.43
LED Lamps	Full	11.37	11.37
Air Leakage Sealing and Insulation (Old Homes)	Full	11.97	
Smart Power Bars (Televisions and Home Entertainment)	Full	14.64	12.25
DHW Recirculation Systems (e.g. Metlund D'MAND)	Full	12.51	16.91
Ductless Mini-Split Systems	Full	13.37	13.75
Zone Heating	Full	13.56	15.98
Air Sealing/Weather Stripping/Caulking	Full	13.90	
Wastewater Heat Recovery Systems	Full	14.07	18.13
Cold Climate Air Source Heat Pumps	Full	16.99	20.77
DHW Piping Optimization	Full	22.94	20.23
High-efficiency Spa Pumps	Full	21.53	29.27
Wall Insulation	Full	21.92	
Crawlspace Insulation	Full	24.56	
Timers for Electric Battery Blankets	Full	26.75	26.46
Slab Insulation (Unfinished Basements)	Full	27.08	
Solar Pre-heated Make-Up Air Systems (e.g., SolarWall®)	Full	27.94	31.40
LED Holiday Lighting (Indoor)	Full	29.06	29.06
Near-zero/Net-zero Energy Homes	Full		36.40
Timers for Outdoor Lighting	Full	64.72	64.72
High-Efficiency Furnace Blower Motors (ECPM)	Full/Incr.	21.13	15.37
High-Efficiency (ENERGY STAR®) Clothes Washers	Full/Incr.	17.55	17.97
Ground Source Heat Pumps (Closed Loop)	Full/Incr.	35.77	38.91
High-Efficiency (ENERGY STAR®) Refrigerators	Incr.	6.32	6.56
Future Improvements to Electronics	Incr.	11.63	10.89
Triple-glazed Windows	Incr.	23.27	10.94
High-Efficiency (ENERGY STAR®) Dishwashers	Incr.	12.38	16.44
High-Efficiency (ENERGY STAR®) Freezers	Incr.	13.37	13.88
Efficient Fluorescent Fixtures (Replace T12s with T8s)	Incr.	14.67	14.67
Energy Efficient (ENERGY STAR®) Printers and Faxes	Incr.	15.76	16.04
Quadruple-glazed Windows	Incr.	33.81	20.56
Energy Efficient (ENERGY STAR®) Televisions	Incr.	23.94	23.94
High-efficiency Heat Recovery Ventilators (HRVs)	Incr.	28.32	32.54
Optimizing of Glazing for Passive Solar Heating	Incr.	29.04	89.65
Convection Ovens - Electric	Incr.	48.18	61.41
ENERGY STAR® Ceiling Fans	Incr.	178.26	178.26
High-Efficiency Cooktops (Induction)	Incr.	492.13	627.23

7.4 Energy-efficiency Supply Curves

A supply curve was constructed based on the approximate Technical Potential savings associated with the above measures. The following approach was used:

- Measures were introduced in sequence
- Where more than one measure affected the same end use, the savings shown for the second measure are incremental to those already shown for the first

- Sequence was determined by listing first the items that reduce the electrical load, then those that meet residual load with the most efficient technology. It includes consideration of CCE results from the preceding exhibit
- Items appear in order, starting with the lowest average CCE, but do not stop at a specified CCE level. Hence, it presents a type of Technical Potential scenario.

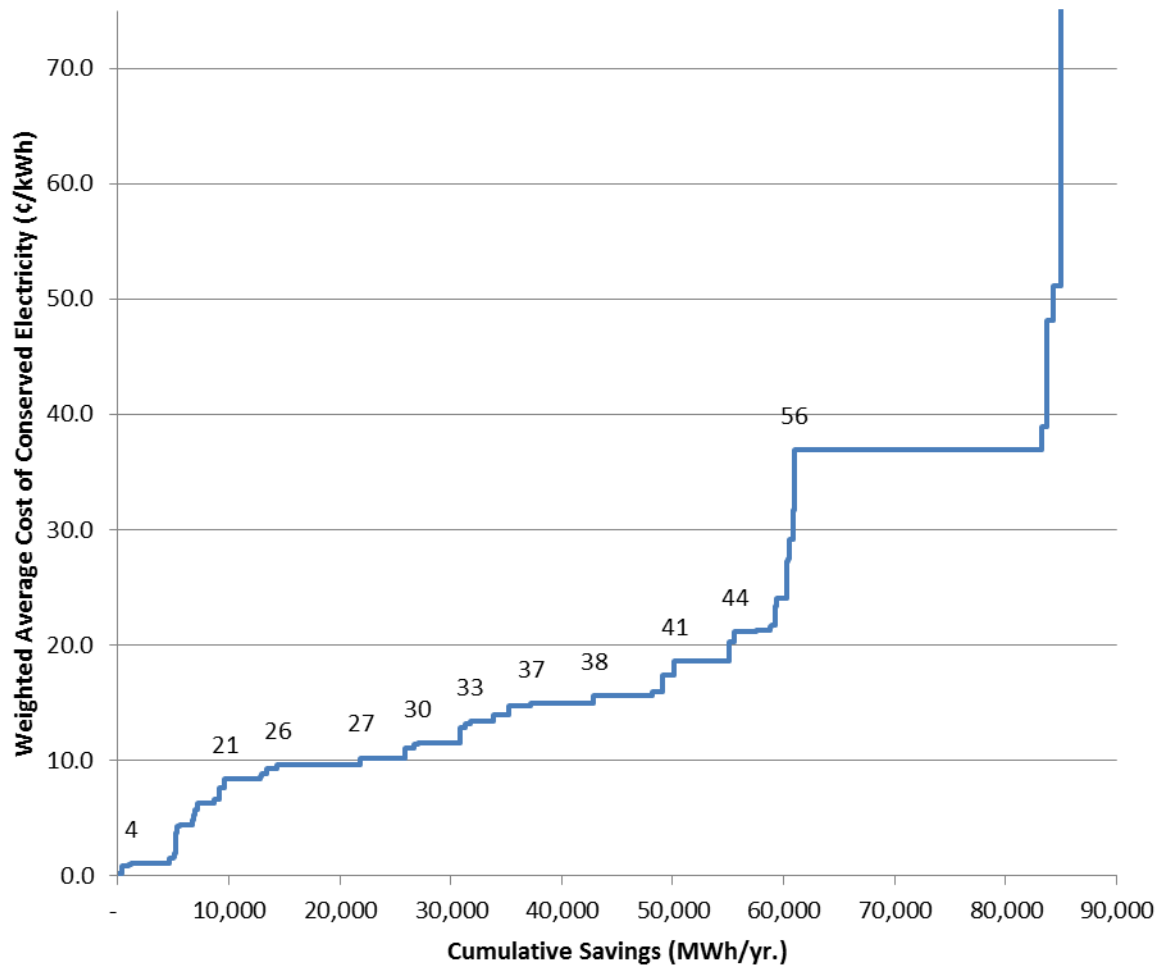
Exhibit 26 shows the measures included in the supply curve and Exhibit 27 shows the supply curve. A few of the reference numbers in the left hand column of Exhibit 26 have been placed on the supply curve as landmarks.

Exhibit 26 Summary of Residential Sector Energy-efficiency Measures, 2030

Ref #	Measure	Technical Potential Savings (MWh/yr.)	Accumulated CCE (\$)	Weighted Average CCE (¢/kWh)
1	DHW Pipe Insulation	306	757	0.2
2	Showerheads	645	5,427	0.8
3	Hot Tub Pump Timers	252	2,469	1.0
4	CFLs - Indoor	3,467	37,878	1.1
5	Prog. Thermostats (Central)	323	4,884	1.5
6	CFLs - Outdoor	33	546	1.7
7	Car Warmer Timers	148	2,887	1.9
8	Hot Tub Covers	22	433	2.0
9	Pulse start metal halide sentinel lights	137	5,194	3.8
10	Prog. Thermostats	217	9,316	4.3
11	Block Heater Timers	1,190	52,949	4.4
12	Motion Detectors - Outdoor	32	1,532	4.8
13	Motion Detectors - Indoor	47	2,406	5.1
14	Solar Spa Pre-heat	81	4,290	5.3
15	Heat Pump Spa Heaters	290	16,780	5.8
16	ESTAR Refrigerators	1,452	91,010	6.3
17	Dimmable CFLs	501	33,416	6.7
18	DHW Tank Insulation	389	29,719	7.6
19	LED Holiday - Outdoor	5	415	7.8
20	Spot or Task Lighting	55	4,586	8.3
21	Power Bars (PCs)	2,548	214,572	8.4
22	Attic Insulation	718	60,676	8.4
23	Basement Insulation	83	7,184	8.6
24	PAR CFLs	430	38,284	8.9
25	Outdoor Temp Reset	924	86,194	9.3
26	High-Perf. New Homes	7,551	725,056	9.6
27	LEED Apartments	4,031	412,843	10.2
28	Sealing & Insul. - Old Homes	752	83,762	11.1
29	LED Lamps	343	39,281	11.5
30	Future Elec Improvement	3,819	438,572	11.5
31	ESTAR Dishwashers	462	59,710	12.9
32	ESTAR Freezers	467	61,841	13.2
33	Ductless Mini-Splits	2,127	285,854	13.4
34	Power Bars (TVs)	1,424	199,155	14.0
35	DHW Recirculation	1,700	251,370	14.8
36	T8 Fixtures	261	38,708	14.8

Ref #	Measure	Technical Potential Savings (MWh/yr.)	Accumulated CCE (\$)	Weighted Average CCE (¢/kWh)
37	ESTAR Clothes Washers	5,593	835,820	14.9
38	Zone Heating	5,358	837,799	15.6
39	ESTAR Printers and Fax	849	135,453	15.9
40	Wastewater Heat Recovery	1,074	187,483	17.5
41	Cold Temp Heat Pumps	4,979	929,743	18.7
42	Furnace Motors	458	92,743	20.3
43	Crawl Space Insulation	7	1,467	21.0
44	Wall Insulation	1,925	407,357	21.2
45	DHW Piping Optimization	1,327	282,148	21.3
46	Battery Blanket Timers	114	24,611	21.6
47	Triple-glazed Windows	303	66,064	21.8
48	Spa Pumps	121	28,292	23.4
49	ESTAR TVs	905	217,876	24.1
50	Slab Insulation	79	19,436	24.6
51	HRVs	87	23,728	27.3
52	Optimizing Glazing for Passive	131	36,042	27.5
53	Solar Pre-heat Makeup Air	287	83,914	29.2
54	LED Holiday - Indoor	4	1,077	29.3
55	Quadruple-glazed Windows	85	27,040	31.7
56	Net Zero Homes	22,300	8,230,487	36.9
57	Ground Heat Pumps - Closed	536	208,849	39.0
58	Air Sealing	516	248,310	48.1
59	Convection Ovens	665	340,660	51.2
60	Timers - Outdoor	1	505	65.3
61	ESTAR Ceiling Fans	1,391	2,496,983	179.6
62	Induction Cooktops	342	1,787,433	523.0
Grand Total		86,670	20,861,280	24.1

Exhibit 27 Technical Energy-efficiency Supply Curve for Residential Sector, 2030



8 Economic Potential: Electric Energy Forecast

8.1 Introduction

This section presents the Residential sector Economic Potential Forecast for electric energy for the study period 2010 to 2030. The Economic Potential Forecast estimates the level of electricity consumption that would occur if all equipment and building envelopes were upgraded to the level that is cost effective against the economic threshold values for electricity in the four supply system areas in Yukon. In this study, “cost effective” means that the technology upgrade cost, referred to as the cost of conserved energy (CCE) in the preceding section, is equal to or less than the economic threshold value for a given supply system.

The discussion in this section covers the following:

- Avoided cost used for screening
- Major modelling tasks
- Technologies included in Economic Potential Forecast
- Presentation of results
- Interpretation of results
- Energy-efficiency supply curves
- Summary of peak load reductions.

8.2 Avoided Cost Used For Screening

YECL, YEC, and the Government of Yukon agreed on a set economic threshold values for electricity supply to be used in this study. The values vary by supply system, as follows:

- Residential accounts on the Hydro Grid: \$0.35/kWh
- Residential accounts on Large Diesel and Small Diesel systems: \$0.30/kWh
- Residential accounts on the Old Crow system: \$0.64/kWh.

The Economic Potential Forecast then incorporates all the electric energy-efficient upgrades that the technology assessment found to have a CCE equal to or less than these thresholds.

The purpose for establishing these thresholds as the economic cut-off values for new avoided electrical supply is to provide the CPR with a reasonably useful time horizon (life) to allow planners to examine options that may become more cost effective over time.

Emerging end-use technology measures are becoming cheaper over time as these markets become more cost effective. This is apparent by examining a range of measures that have become very low cost (e.g., CFLs reduced by a factor of 5-10x since introduction; the same applies to more efficient motors, light sources and appliances). Including these apparently more costly measures in this study allows the review of these measures in the near future, as programs are effective in introducing more competitiveness within these markets.

In addition, electrical supply costs are rising as more expensive generating sources are used to lower the carbon content of electricity either through the use of new fossil fuel technologies, such as carbon capture and storage (CCS), or the use of renewable (e.g., wind) or alternative energy sources (e.g., combined heat and power [CHP]).

8.3 Major Modelling Tasks

By comparing the results of the Residential sector Economic Potential Electric Energy Forecast with the Reference Case, it is possible to determine the aggregate level of potential electricity savings within the Residential sector, as well as identify which specific building sub sectors and end uses provide the most significant opportunities for savings.

To develop the Residential sector Economic Potential Forecast, the following tasks were completed:

- The CCE for each of the energy-efficient upgrades presented in Exhibit 25 were reviewed, using the 5.25% (real) discount rate.
- Technology upgrades that had a CCE equal to, or less than, the threshold values for each supply system were selected for inclusion in the Economic Potential scenario, either on a full-cost or incremental basis. It is assumed that technical upgrades having a full-cost CCE that met the cost threshold were implemented in the first forecast year. It is assumed that those upgrades that only met the cost threshold on an incremental basis are being introduced more slowly as the existing stock reaches the end of its useful life.
- Electricity use within each of the building sub sectors was modelled with the same energy models that were used to generate the Reference Case. However, for this forecast, the remaining baseline technologies included in the Reference Case forecast were replaced with the most efficient technology upgrade option and associated performance efficiency that met the cost thresholds for each supply system.
- When more than one upgrade option was applied to a given end use, the first measure selected was the one that reduced the electrical load. For example, measures to reduce the overall space heating load (e.g., attic insulation and more efficient windows) were applied before the ground-source heat pump.

8.4 Technologies Included in Economic Potential Forecast

Exhibit 28 provides a listing of the technologies selected for inclusion in this forecast. In each case, the exhibit shows the following:

- End use affected
- Upgrade option(s) selected
- Dwelling types to which the upgrade options were applied
- Rate at which the upgrade options were introduced into the stock.

Exhibit 28 Technologies Included in Economic Potential Forecast

End Use	Upgrade Option	Applicability	Rate of Introduction
Heating and Ventilation Equipment	Cold Temp Heat Pumps	Electrically Heated Detached, Attached, Mobile	Viable to install immediately
	Ductless Mini-Splits	Electrically Heated Detached, Attached, Mobile	Viable to install immediately
	Furnace Motors	Detached, Attached, Mobile	Immediate in some dwelling types; at rate of replacement in others
	Ground Heat Pumps - Closed	All Electrically Heated Residential	Immediate in some dwelling types; at rate of replacement in others
	HRVs	Electrically Heated Detached, Attached, Mobile	At natural rate of equipment replacement
	Outdoor Temp Reset	All Electrically Heated Residential	Viable to install immediately
	Prog. Thermostats	All Electrically Baseboard Residential	Viable to install immediately
	Prog. Thermostats (Central)	All Electrically Forced Air Residential	Viable to install immediately
	Solar Pre-heat Makeup Air	Electrically Heated Detached, Attached, Mobile	Viable to install immediately
Existing Building Shell Measures	Zone Heating	All Electrically Heated Residential	Viable to install immediately
	Air Sealing	Electrically Heated Detached, Attached, Mobile	Viable to install immediately
	Attic Insulation	Electrically Heated Detached, Attached, Mobile	Viable to install immediately
	Basement Insulation	Electrically Heated Detached, Attached	At rate of renovation
	Optimizing Glazing for Passive	All Electrically Heated Residential	At rate of renovation
	Quadruple-glazed Windows	All Electrically Heated Residential	At rate of renovation
	Sealing & Insul. - Old Homes	Electrically Heated Older Detached, Attached, Mobile	At rate of renovation
	Slab Insulation	Electrically Heated Detached, Attached	At rate of renovation
	Triple-glazed Windows	All Electrically Heated Residential	At rate of renovation
New Whole Building Measures	Wall Insulation	Electrically Heated Detached, Attached, Mobile	At rate of renovation
	High-Perf. New Homes	New Electrically Heated Detached, Attached	Viable for new construction
Crawl Space Insulation	LEED Apartments	New Apartment Buildings	Viable for new construction
	ESTAR Dishwashers	All Residential	At natural rate of equipment replacement
	DHW Recirculation	All Residential	Viable to install immediately
	ESTAR Clothes Washers	All Residential	Immediate in some dwelling types; at rate of replacement in others
	High-Perf. New Homes	New Electrically Heated Detached, Attached	Viable to install immediately
	DHW	Electrically Heated Detached, Attached, Mobile	Viable to install immediately
	DHW Tank Insulation	All Residential	Viable to install immediately
	DHW Piping Optimization	All Residential	Viable to install immediately
	Showerheads	All Residential	Viable to install immediately

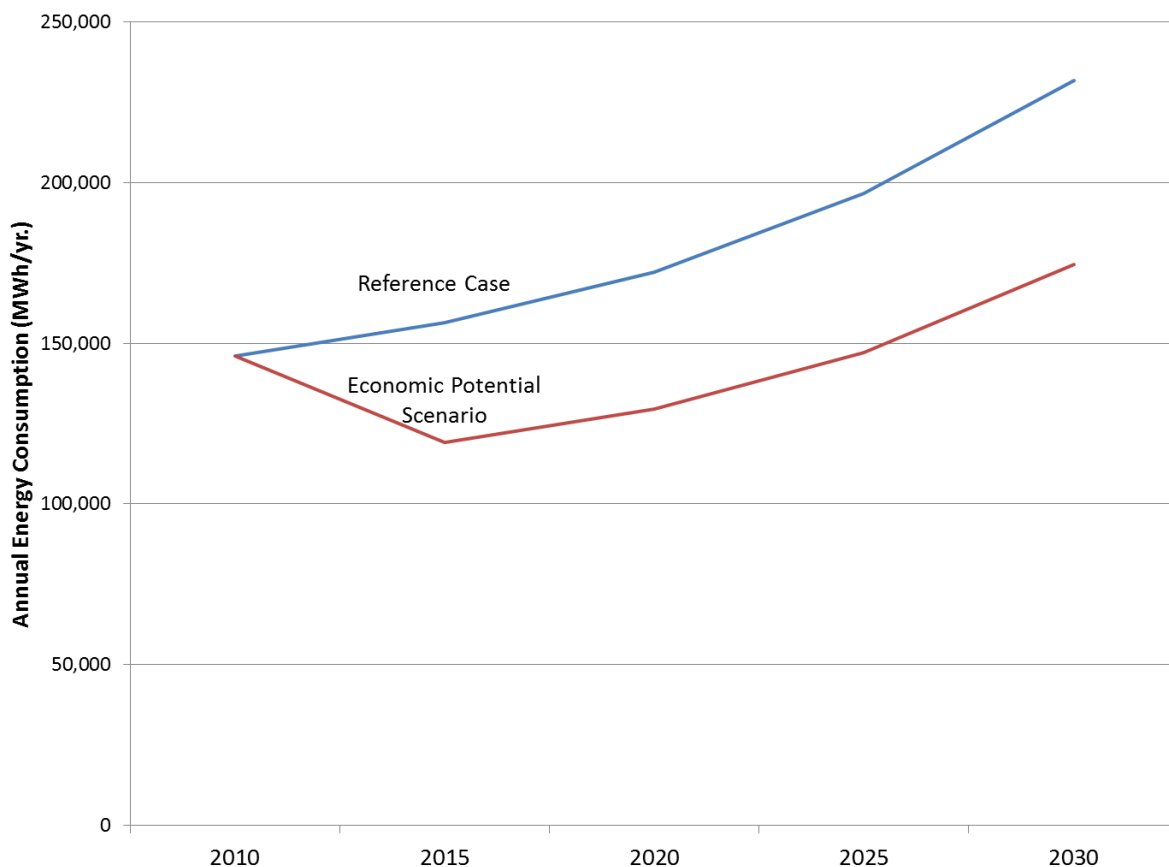
End Use	Upgrade Option	Applicability	Rate of Introduction
ESTAR Printers and Fax	Lighting	New Apartment Buildings	Viable to install immediately
	LED Lamps	All Residential	Viable to install immediately
	CFLs - Indoor	All Residential	Viable to install immediately
	Motion Detectors - Outdoor	All Residential	Viable to install immediately
	Motion Detectors - Indoor	All Residential	Viable to install immediately
	PAR CFLs	All Residential	Viable to install immediately
	Spot or Task Lighting	All Residential	Viable to install immediately
	LED Holiday - Outdoor	All Residential	Viable to install immediately
	Dimmable CFLs	All Residential	Viable to install immediately
	T8 Fixtures	All Residential	At natural rate of equipment replacement
	Pulse start metal halide sentinel lights	Sentinel Lighting	Viable to install immediately
	CFLs - Outdoor	All Residential	Viable to install immediately
LED Holiday - Indoor	Appliances	Electrically Heated Detached, Attached, Mobile	Viable to install immediately
	ESTAR Freezers	All Residential	At natural rate of equipment replacement
	ESTAR Refrigerators	All Residential	At natural rate of equipment replacement
	ESTAR Clothes Washers	All Residential	Immediate in some dwelling types; at rate of replacement in others
LEED Apartments	ESTAR TVs	All Residential	At natural rate of equipment replacement
	Power Bars (TVs)	All Residential	Viable to install immediately
	Power Bars (PCs)	All Residential	Viable to install immediately
	Electronics	All Residential	Immediate in some dwelling types; at rate of replacement in others
	Future Elec Improvement	All Residential	At natural rate of equipment replacement
ESTAR Dishwashers	Car Warmer Timers	All Residential	Viable to install immediately
	Other	All Electrically Heated Residential	At natural rate of equipment replacement
	Spa Pumps	All Residential	Viable to install immediately
	Block Heater Timers	All Residential	Viable to install immediately
	Solar Spa Pre-heat	All Residential	Viable to install immediately
	Heat Pump Spa Heaters	All Residential	Viable to install immediately
	Battery Blanket Timers	All Residential	Viable to install immediately
	Hot Tub Pump Timers	All Residential	Viable to install immediately

8.5 Summary of Electric Energy Savings

Exhibit 29 compares the Reference Case and Economic Potential Electric Energy Forecast levels of residential electricity consumption.²³ As illustrated, under the Reference Case residential electricity use would grow from the Base Year level of 146,000 MWh/yr. to approximately 232,000 MWh/yr. by 2030. This contrasts with the Economic Potential Forecast in which electricity use would increase to approximately 174,000 MWh/yr. for the same period, a difference of approximately 57,000 MWh/yr., or about 25%.

Most measures pass the economic screen for at least some dwelling types and supply systems. 25% is a larger economic potential than is usually seen for the residential sector. This is due mainly to more severe climate and higher costs for new generation options.

Exhibit 29 Reference Case versus Economic Potential Electric Energy Consumption in Residential Sector (MWh/yr.)



²³ All results are reported at the customer's point-of-use and do not include line losses.

8.5.1 Electric Energy Savings

Further detail on the total potential electric energy savings provided by the Economic Potential Forecast is provided in the following exhibits:²⁴

- Exhibit 30 presents the results by end use, dwelling type and milestone year
- Exhibit 31 provides a further disaggregation of the savings by end use, technology, milestone year and cost
- Exhibit 32 presents savings by major end use, milestone year and supply system
- Exhibit 33 presents savings by major end use, milestone year and dwelling type
- Exhibit 34 presents 2030 savings by major end use and vintage.

²⁴ MWh/yr. savings shown in the following exhibits are not incremental. For example, the space heating savings in 2030 are not in addition to the space heating savings from the previous milestone years. Rather, they are the difference between the Reference Case space heating consumption in 2030 and the space heating consumption if all the measures included in the Economic Potential scenario are implemented.

Exhibit 30 Total Economic Potential Electricity Savings by End Use, Dwelling Type and Milestone Year (MWh/yr.)

Dwelling Type	Milestone Year	Space heating	Domestic hot water (DHW)	Indoor lighting	Computer and peripherals	Clothes dryer	Television	Block heaters & car warmers	Refrigerator	Ventilation & circulation
Single Detached House	2015	10,903	4,172	3,825	1,810	2,223	815	708	295	972
	2020	13,063	4,661	3,575	2,069	2,493	1,196	761	629	813
	2025	15,296	5,159	3,262	2,667	2,785	1,276	812	954	628
	2030	17,635	5,582	2,836	3,369	2,949	1,417	861	1,039	396
Apartment/Con do Suites and Common Areas	2015	609	513	1,178	342	211	154	179	39	7
	2020	1,365	748	1,237	445	259	257	217	90	19
	2025	2,455	1,086	1,291	665	336	318	268	154	35
	2030	3,934	1,527	1,315	986	418	415	333	192	58
Attached Dwelling	2015	885	478	406	231	209	104	91	31	96
	2020	1,196	569	390	273	231	158	100	67	83
	2025	1,558	675	367	365	255	175	111	106	68
	2030	1,962	793	334	479	281	202	123	119	50
Mobile	2015	958	469	392	198	130	89	77	23	157
	2020	1,113	505	369	226	138	130	83	50	140
	2025	1,266	543	340	290	147	139	88	75	120
	2030	1,416	577	300	366	155	154	94	81	96
Small Grid Housing	2015	2	-	381	-	-	-	23	-	1
	2020	3	-	346	-	-	-	24	-	1
	2025	3	-	308	-	-	-	25	-	1
	2030	4	-	261	-	-	-	26	-	0
Garages and Seasonal Housing	2015	-	80	89	37	18	17	14	6	14
	2020	-	88	80	41	37	23	15	13	15
	2025	-	94	71	51	53	24	15	19	17
	2030	-	95	60	63	55	26	16	20	13
Sentinel Lighting	2015	-	-	-	-	-	-	-	-	-
	2020	-	-	-	-	-	-	-	-	-
	2025	-	-	-	-	-	-	-	-	-
	2030	-	-	-	-	-	-	-	-	-
Totals	2015	13,357	5,712	6,271	2,618	2,791	1,179	1,092	394	1,247
	2020	16,739	6,571	5,998	3,053	3,157	1,765	1,200	849	1,071
	2025	20,577	7,558	5,640	4,038	3,575	1,932	1,320	1,308	870
	2030	24,951	8,574	5,105	5,262	3,857	2,214	1,453	1,452	613

Notes:

- 1) Results are measured at the customer's point-of-use and do not include line losses.
- 2) Any differences in totals are due to rounding.
- 3) In the above exhibit a value displays as 0 if it is between 0 and 0.5. Totals are calculated using the actual numerical value.
- 4) MWh/yr. savings are not incremental. The space heating savings in 2030 are not in addition to the savings from the previous milestone years. Rather, they are the difference between the Reference Case space heating consumption in 2030 and the space heating consumption if all the measures included in the Economic Potential scenario are implemented.

Exhibit 30 Continued: Total Economic Potential Electricity Savings by End Use, Dwelling Type and Milestone Year (MWh/yr.)

Dwelling Type	Milestone Year	Spa heaters and pumps	Home entertainment electronics	Outdoor lighting	Freezer	Clothes washer	Set-top boxes	Dishwasher	Holiday lighting	Grand Total
Single Detached House	2015	1,091	114	365	63	134	-	25	84	27,605
	2020	714	185	264	139	127	-	53	56	30,803
	2025	609	495	150	229	127	105	63	30	34,650
	2030	596	1,198	24	336	125	223	69	6	38,663
Apartment/Condo Suites and Common Areas	2015	46	16	58	8	12	-	2	16	3,390
	2020	34	29	55	20	13	-	5	13	4,806
	2025	34	91	47	36	15	26	7	8	6,874
	2030	39	260	34	60	18	65	9	2	9,666
Attached Dwelling	2015	140	11	36	7	12	-	2	6	2,745
	2020	95	18	26	15	12	-	5	4	3,239
	2025	84	49	14	25	12	14	6	2	3,886
	2030	86	123	2	38	12	32	6	1	4,640
Mobile	2015	61	11	38	5	8	-	1	6	2,624
	2020	40	18	27	11	7	-	3	4	2,863
	2025	34	47	16	18	7	11	3	2	3,146
	2030	33	113	2	26	7	24	4	0	3,449
Small Grid Housing	2015	-	-	35	-	-	-	-	-	441
	2020	-	-	25	-	-	-	-	-	398
	2025	-	-	14	-	-	-	-	-	350
	2030	-	-	2	-	-	-	-	-	293
Garages and Seasonal Housing	2015	22	3	1	1	1	-	1	2	306
	2020	14	4	1	3	2	-	1	1	338
	2025	12	11	1	5	2	2	1	1	379
	2030	11	25	1	7	2	4	1	0	400
Sentinel Lighting	2015	-	-	127	-	-	-	-	-	127
	2020	-	-	129	-	-	-	-	-	129
	2025	-	-	134	-	-	-	-	-	134
	2030	-	-	137	-	-	-	-	-	137
Totals	2015	1,359	155	660	85	167	-	32	114	37,239
	2020	897	253	527	187	160	-	67	78	42,577
	2025	773	693	375	313	163	159	80	43	49,419
	2030	765	1,719	202	467	164	349	89	9	57,248

Exhibit 31 Economic Potential Electricity Savings by Measure and Milestone Year (MWh/yr.)

Measure	Applicability	Cost Basis (Full vs Incremental)	Annual Savings, 2015, MWh/yr.	Annual Savings, 2020, MWh/yr.	Annual Savings, 2025, MWh/yr.	Annual Savings, 2030, MWh/yr.
ESTAR Clothes Washers	All Residential	Full/Incr.	4,229	4,678	5,241	5,593
High-Perf. New Homes	New Electrically Heated Detached, Attached	Full	1,694	3,558	5,525	7,551
CFLs - Indoor	All Residential	Full	4,561	4,272	3,911	3,467
Zone Heating	All Electrically Heated Residential	Full	2,710	3,442	4,324	5,370
Cold Temp Heat Pumps	Electrically Heated Detached, Attached, Mobile	Full	2,952	3,583	4,267	4,997
Power Bars (PCs)	All Residential	Full	2,127	2,358	2,507	2,548
LEED Apartments	New Apartment Buildings	Full	497	1,286	2,442	4,031
Wall Insulation	Electrically Heated Detached, Attached, Mobile	Full	2,183	2,097	2,011	1,925
Ductless Mini-Splits	Electrically Heated Detached, Attached, Mobile	Full	1,254	1,525	1,819	2,134
DHW Recirculation	All Residential	Full	1,092	1,264	1,472	1,699
Future Elec Improvement	All Residential	Incr.	-	-	1,418	3,819
Power Bars (TVs)	All Residential	Full	983	1,142	1,240	1,424
DHW Piping Optimization	All Residential	Full	893	1,013	1,163	1,326
Block Heater Timers	All Residential	Full	895	984	1,082	1,190
ESTAR Refrigerators	All Residential	Incr.	394	849	1,308	1,452
Furnace Motors	Detached, Attached, Mobile	Full/Incr.	1,183	982	751	456
Showerheads	All Residential	Full	974	834	732	645
Sealing & Insul. - Old Homes	Electrically Heated Older Detached, Attached, Mobile	Full	818	795	774	752
Attic Insulation	Electrically Heated Detached, Attached, Mobile	Full	849	805	762	718
Wastewater Heat Recovery	All Residential	Full	474	658	859	1,074
ESTAR TVs	All Residential	Incr.	351	876	877	905
ESTAR Printers and Fax	All Residential	Incr.	491	695	779	849
Outdoor Temp Reset	All Electrically Heated Residential	Full	468	594	746	927
Dimmable CFLs	All Residential	Full	654	609	558	501
Air Sealing	Electrically Heated Detached, Attached, Mobile	Full	553	537	522	506
PAR CFLs	All Residential	Full	585	538	486	430
Heat Pump Spa Heaters	All Residential	Full	616	386	314	290
DHW Tank Insulation	All Residential	Full	353	358	372	389
ESTAR Dishwashers	All Residential	Incr.	185	378	437	462

Measure	Applicability	Cost Basis (Full vs Incremental)	Annual Savings, 2015, MWh/yr.	Annual Savings, 2020, MWh/yr.	Annual Savings, 2025, MWh/yr.	Annual Savings, 2030, MWh/yr.
Prog. Thermostats (Central)	All Electrically Forced Air Residential	Full	395	372	348	324
LED Lamps	All Residential	Full	264	290	316	343
Hot Tub Pump Timers	All Residential	Full	395	271	243	252
DHW Pipe Insulation	All Residential	Full	277	281	293	306
CFLs - Outdoor	All Residential	Full	499	364	208	33
ESTAR Freezers	All Residential	Incr.	85	187	313	467
Basement Insulation	Electrically Heated Detached, Attached	Full	370	275	180	83
Prog. Thermostats	All Electrically Baseboard Residential	Full	217	217	217	218
T8 Fixtures	All Residential	Incr.	86	173	258	261
Solar Pre-heat Makeup Air	Electrically Heated Detached, Attached, Mobile	Full	126	165	213	272
Triple-glazed Windows	All Electrically Heated Residential	Incr.	76	152	228	303
Ground Heat Pumps - Closed	All Electrically Heated Residential	Full/Incr.	97	143	208	292
Spa Pumps	All Residential	Full	189	130	117	121
Pulse start metal halide sentinel lights	Sentinel Lighting	Full	127	129	134	137
Car Warmer Timers	All Residential	Full	112	123	135	148
Battery Blanket Timers	All Residential	Full	86	94	104	114
Solar Spa Pre-heat	All Residential	Full	125	86	78	81
Slab Insulation	Electrically Heated Detached, Attached	Full	107	97	87	77
Optimizing Glazing for Passive	All Electrically Heated Residential	Incr.	30	60	89	117
Spot or Task Lighting	All Residential	Full	78	72	64	55
HRVs	Electrically Heated Detached, Attached, Mobile	Incr.	26	52	80	74
Motion Detectors - Indoor	All Residential	Full	43	45	46	47
LED Holiday - Outdoor	All Residential	Full	66	46	25	5
Motion Detectors - Outdoor	All Residential	Full	34	34	33	32
Quadruple-glazed Windows	All Electrically Heated Residential	Incr.	12	24	35	46
LED Holiday - Indoor	All Residential	Full	47	32	18	4
Hot Tub Covers	All Residential	Full	34	23	21	22
Crawl Space Insulation	Electrically Heated Detached, Attached, Mobile	Full	14	12	9	7
HVAC Interaction from Internal Load Reduction	Electrically Heated Detached, Attached, Mobile	Incr.	(1,797)	(2,467)	(3,378)	(4,427)
Grand Total	All Residential	Incr.	37,239	42,577	49,419	57,248

Exhibit 32 Economic Potential Savings by Major End Use, Year and Supply System (MWh/yr.)

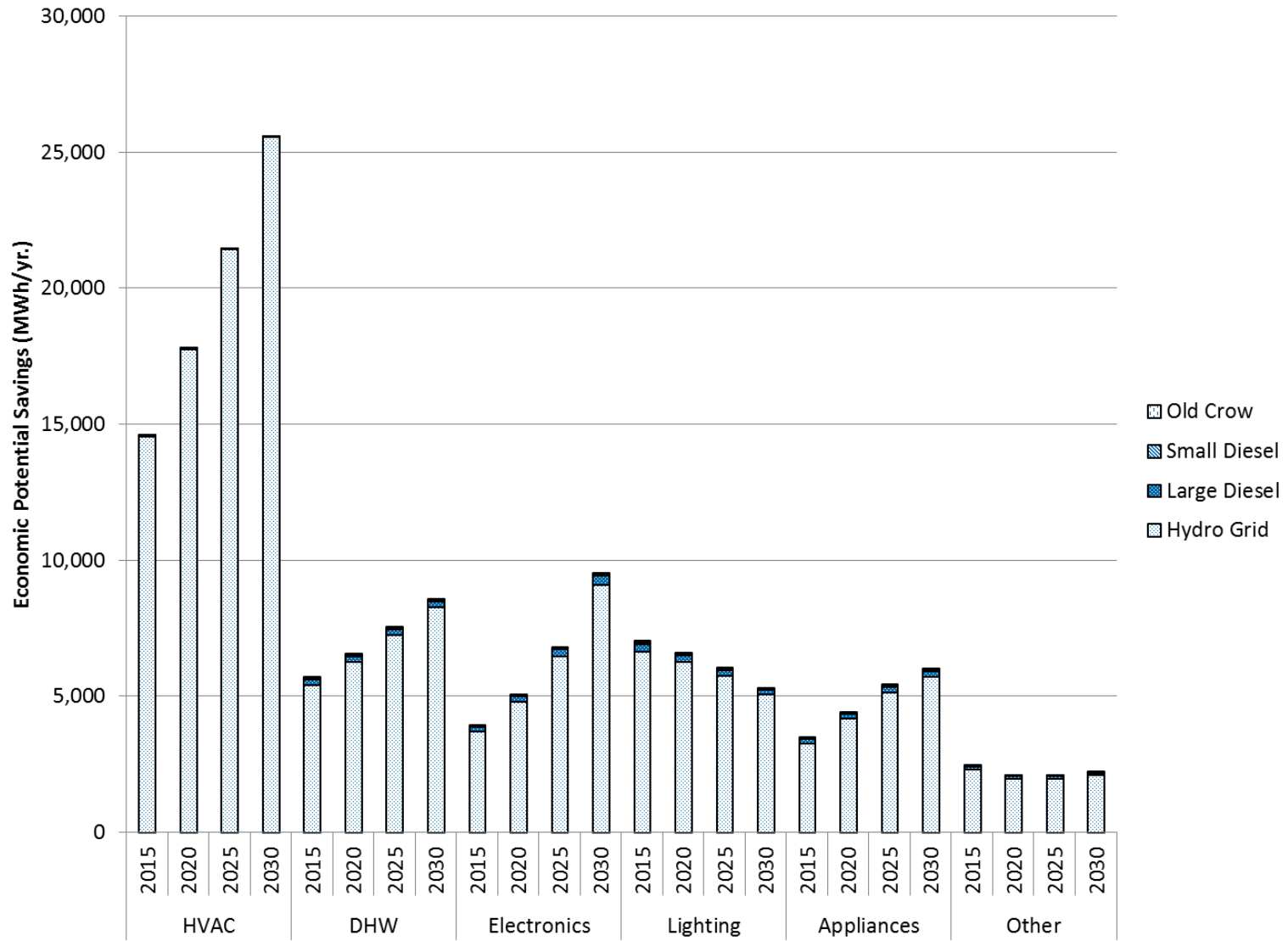


Exhibit 33 Economic Potential Savings by Major End Use, Year and Dwelling Type (MWh/yr.)

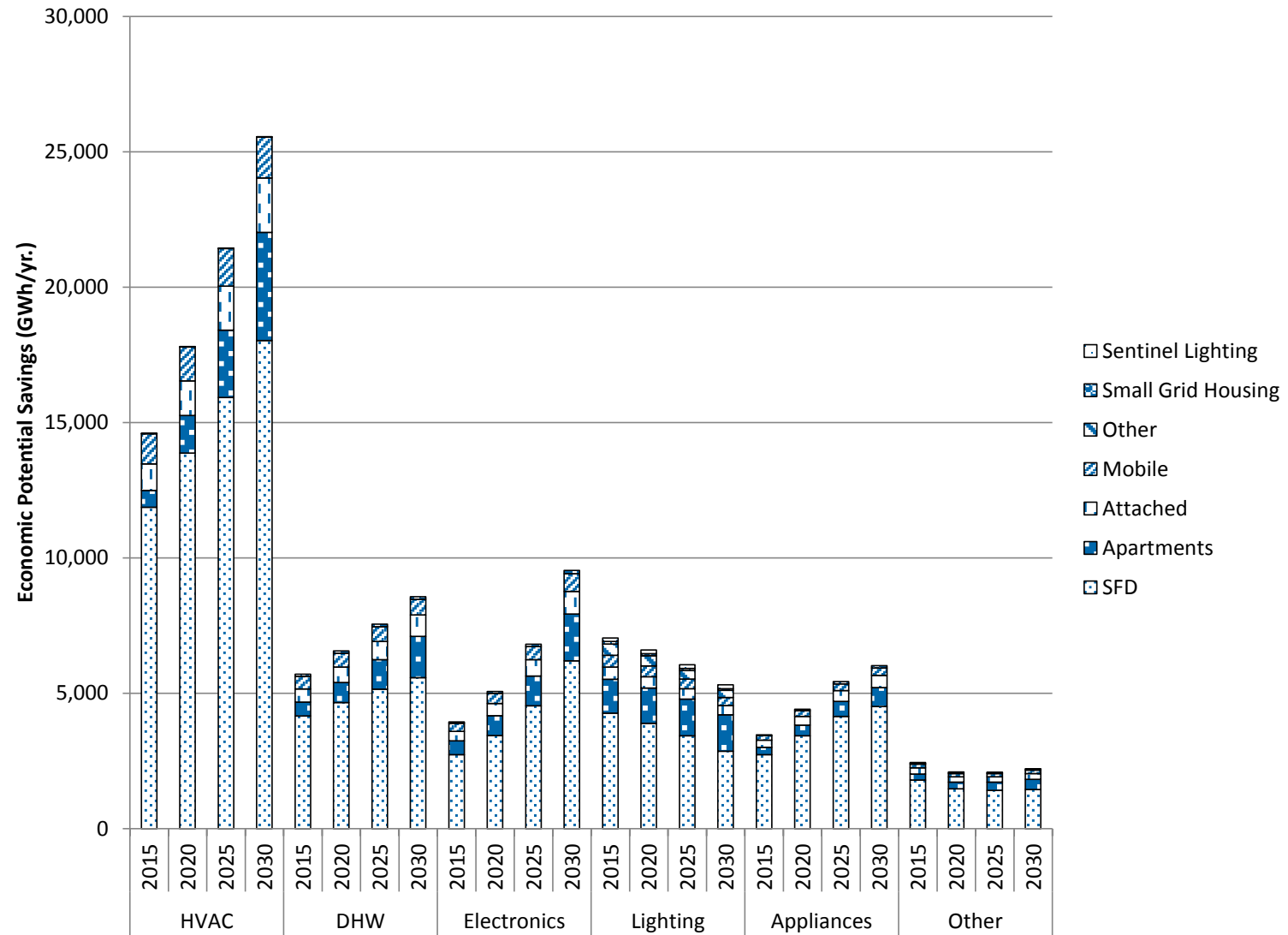
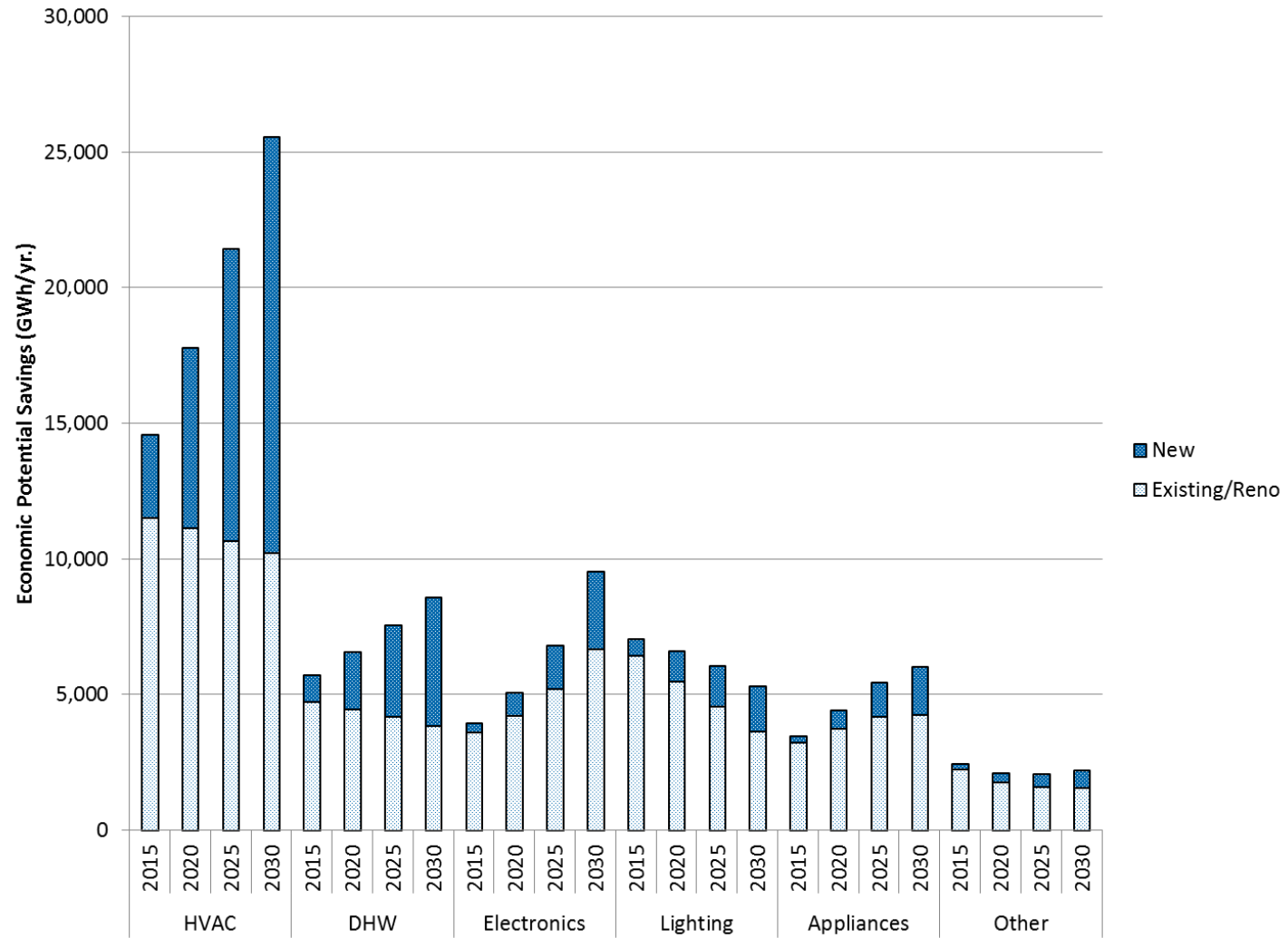


Exhibit 34 Economic Potential Savings by Major End Use, Year and Vintage (MWh/yr.)



8.5.2 Interpretation of Results

Highlights of the results presented in the preceding exhibits are summarized below:

Electric Energy Savings by Milestone Year

The Economic Potential savings increase modestly from 37,000 MWh/yr. in 2015 to 57,000 MWh/yr. in 2030. More than 65% of the savings possible at the end of the study period are already economically viable within the first milestone period. While there are end uses where the opportunities for savings expand, such as space heating and DHW, there are other end uses where the opportunities contract, such as lighting. Lighting in the Reference Case includes the assumption that 50% of the market moves to lamps as efficient as CFLs by 2030, and that almost all holiday lighting moves to LEDs. The difference between the Reference Case and the Economic Potential scenario therefore narrows with time for the lighting end uses.

Electric Energy Savings by Dwelling Type

Single detached houses and duplexes account for 68% of the potential savings; this reflects their larger market share and their generally higher level of electrical intensity per dwelling. Savings in apartments account for 17% of the potential savings in 2030. This is a much larger share than they account for in the earlier milestones, and reflects the higher level of anticipated construction of apartments relative to detached houses. Attached dwellings account for 8% of potential savings in 2030 and mobile homes account for approximately 6% of potential savings. Small grid housing accounts for 1% of potential savings in 2030, and garages and seasonal houses account for 1%. Sentinel lighting accounts for approximately 0.2% of the savings.

By Supply Type and Government versus Non-government Accounts

The accounts connected to the hydro grid are expected to account for 98% of potential savings in 2030. Large diesel accounts account for 2% and accounts on the Old Crow and small diesel grids systems account for 0.4% and 0.3%, respectively. Government accounts provide 2% of the 2030 savings and non-government accounts the remaining 98%.

By Existing Dwellings versus New Construction

Savings in existing dwellings account for 53% of potential savings in 2030, while savings in dwellings that are expected to be built during the study period account for 47% of potential savings.

Electric Energy Savings by End Use

Space heating and ventilation savings from upgrades to the building envelope and space heating systems account for approximately 45% of the total electricity savings in the Economic Potential Forecast for 2030. Of this, 13% is from high-performance new homes, 9% is from zone heating controls, 9% is from cold climate heat pumps, 7% is from LEED certified apartment buildings, 4% is ductless mini-split systems, and 3% is from wall insulation. Other measures account for 2% or less of the savings. It should be noted that the reduction in internal heat loads

Space heating measures dominate the results, including new construction, equipment options, and deep retrofits of existing homes.

resulting from measures that save electricity in other end uses will tend to increase heating energy consumption. This increase is subtracted from the overall potential savings, reducing it by approximately 8% overall by 2030.

DHW measures account for 20% of the total electricity savings in the Economic Potential Forecast for 2030. Of this, 10% is from the DHW savings associated with more efficient clothes washers and 3% is from DHW recirculation systems. Efficient piping design in new homes accounts for 2% of savings and wastewater heat recovery accounts for another 2%. Other measures account for 1% or less of the 2030 potential savings.

Electronic end uses account for about 17% of the total electricity savings in the Economic Potential Forecast in 2030. Of this, 4% is from power bars for PCs and their peripherals and 2% is from power bars for televisions and their peripherals. An additional 2% is from ENERGY STAR® televisions. The largest component of the 2030 savings is a placeholder measure called “Future Electronic Improvement.” This measure was added to the study in recognition that the other electronics measures are likely to be superseded by technical changes in electronics products, but that the end use as a whole is growing very rapidly and needs to be addressed by electric utilities.

Appliances account for approximately 14% of the total electricity savings in the Economic Potential Forecast for 2030. Of this, the 10% savings from ENERGY STAR® clothes washers have already been mentioned above under DHW. An additional 3% is from ENERGY STAR® refrigerators, and about 1% each is from ENERGY STAR® freezers and ENERGY STAR® dishwashers.

The lighting end uses, including indoor, outdoor and holiday lighting, account for about 9% of the total electricity savings in 2030 in the Economic Potential Forecast. Of this, approximately 8% is from indoor and outdoor CFLs, including PAR and dimmable CFLs. Lighting potential is actually larger near the beginning of the study period because the natural adoption of CFLs is not assumed to be as large in the first milestone periods. In 2015, lighting end uses account for approximately 19% of the total electricity savings potential.

The “other” category of end uses, which includes, spas, block heaters and car warmers, and small appliances and other, account for 4% of the electricity savings in the Economic Potential Forecast for 2030. Of this, approximately 2% is from block heater timers. Other measures within this category account for 1% or less of the savings.

8.5.3 Caveats on Interpretation of Results

A systems approach was used to model the energy impacts of the efficiency upgrades presented in the preceding section. In the absence of a systems approach, there would be double counting of savings and an accurate assessment of the total contribution of the energy-efficient upgrades would not be possible. More specifically, there are two particularly important considerations:

- **More than one upgrade may affect a given end use.** For example, improved insulation reduces space heating electricity use, as does the installation of a heat pump. On its own, each measure will reduce overall space heating electricity use. However, the two savings are not additive. The order in which some upgrades are introduced is also important. In this study, the approach has been to select and model the impact of “bundles of measures” that reduce the load for a given end use (e.g., wall insulation and window upgrades that reduce

the space heating load) and then to introduce measures that meet the remaining load more efficiently (e.g., a high-efficiency space heating system).

- **There are interactive effects among end uses.** For example, the electricity savings from more efficient appliances and lighting result in reduced waste heat. During the space heating season, appliance and lighting waste heat contributes to the building's internal heat gains, which lower the amount of heat that must be provided by the space heating system. The magnitude of the interactive effects can be significant. Based on selected building energy-use simulations, a 100 kWh savings in appliance or lighting electricity use results, on average, in an increased space heating load of up to 75 kWh, depending on dwelling type.

75% is a higher rate of interaction between internal loads and space heating than seen in other studies. It is related mainly to the length of the heating season, rather than its severity.

8.6 Energy-efficiency Supply Curves

A supply curve was constructed based on the approximate Economic Potential savings associated with the above measures. The following approach was followed:

- Measures are introduced in sequence to show incremental impact and cost
- Sequence was determined by listing first the items that reduce the electrical load, then those that meet residual load with the most efficient technology
- Items appear in order, beginning with those that have the lowest average CCE.

Exhibit 35 shows the measures included in the supply curve and Exhibit 36 shows the supply curve for Yukon as a whole in the 2030 milestone year. Similar exhibits are provided for the four supply systems in Appendix F. The annual savings shown for measures in this section will, in most cases, differ from the savings amounts shown in Exhibit 26.

- In most cases, values are reduced by the economic screens applied. If they fail to pass the screen for specific dwelling types the savings will be reduced and some measures are eliminated entirely.
- Values that increase in this exhibit do so because of a decrease in the energy penalty associated with space heating. Measures that save electricity within the building envelope reduce the contribution that the end use makes towards space heating. If the heating system or building envelope is made more efficient (as is the case in the Economic Potential scenario) this effect is reduced.

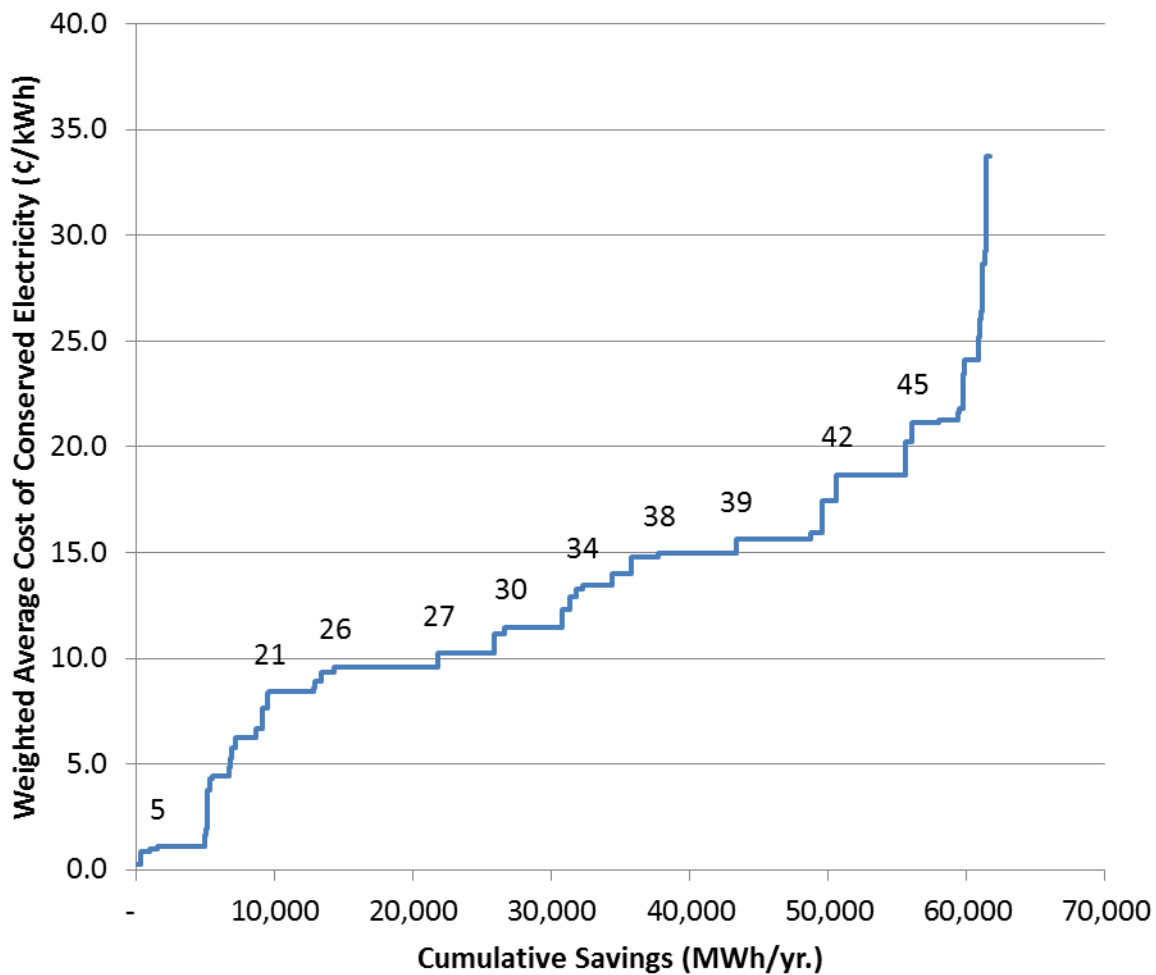
Exhibit 35 Summary of Residential Sector Energy-efficiency Measures, 2030²⁵

Ref #	Measure	Economic Potential Savings (MWh/yr.)	Cost of Savings (\$)	Weighted Average CCE (¢/kWh)
1	DHW Pipe Insulation	306	757	0.2
2	Showerheads	645	5,427	0.8
3	Prog. Thermostats (Central)	324	3,129	1.0
4	Hot Tub Pump Timers	252	2,469	1.0
5	CFLs - Indoor	3,467	37,878	1.1
6	CFLs - Outdoor	33	546	1.7
7	Car Warmer Timers	148	2,887	1.9
8	Hot Tub Covers	22	433	2.0
9	Pulse start metal halide sentinel lights	137	5,194	3.8
10	Prog. Thermostats	218	9,383	4.3
11	Block Heater Timers	1,190	52,949	4.4
12	Motion Detectors - Outdoor	32	1,532	4.8
13	Motion Detectors - Indoor	47	2,406	5.1
14	Solar Spa Pre-heat	81	4,290	5.3
15	Heat Pump Spa Heaters	290	16,780	5.8
16	ESTAR Refrigerators	1,452	91,010	6.3
17	Dimmable CFLs	501	33,416	6.7
18	DHW Tank Insulation	389	29,719	7.6
19	LED Holiday - Outdoor	5	415	7.8
20	Spot or Task Lighting	55	4,586	8.3
21	Power Bars (PCs)	2,548	214,572	8.4
22	Attic Insulation	718	60,676	8.4
23	Basement Insulation	83	7,184	8.6
24	PAR CFLs	430	38,284	8.9
25	Outdoor Temp Reset	927	86,417	9.3
26	High-Perf. New Homes	7,551	725,056	9.6
27	LEED Apartments	4,031	412,843	10.2
28	Sealing & Insul. - Old Homes	752	83,762	11.1
29	LED Lamps	343	39,281	11.5
30	Future Elec Improvement	3,819	438,572	11.5
31	Air Sealing	506	62,113	12.3
32	ESTAR Dishwashers	462	59,690	12.9
33	ESTAR Freezers	467	61,841	13.2
34	Ductless Mini-Splits	2,134	287,081	13.5
35	Power Bars (TVs)	1,424	199,155	14.0
36	DHW Recirculation	1,699	251,208	14.8

²⁵ The total savings in this exhibit does not match the 2030 total in Exhibit 31 because the HVAC interaction from internal load reduction is omitted from this exhibit.

Ref #	Measure	Economic Potential Savings (MWh/yr.)	Cost of Savings (\$)	Weighted Average CCE (¢/kWh)
37	T8 Fixtures	261	38,708	14.8
38	ESTAR Clothes Washers	5,593	835,820	14.9
39	Zone Heating	5,370	839,962	15.6
40	ESTAR Printers and Fax	849	135,453	15.9
41	Wastewater Heat Recovery	1,074	187,484	17.5
42	Cold Temp Heat Pumps	4,997	933,749	18.7
43	Furnace Motors	456	92,320	20.2
44	Crawl Space Insulation	7	1,467	21.0
45	Wall Insulation	1,925	407,357	21.2
46	DHW Piping Optimization	1,326	281,686	21.2
47	Battery Blanket Timers	114	24,611	21.6
48	Triple-glazed Windows	303	66,064	21.8
49	Spa Pumps	121	28,241	23.4
50	ESTAR TVs	905	217,876	24.1
51	Slab Insulation	77	18,684	24.1
52	HRVs	74	18,667	25.2
53	Optimizing Glazing for Passive	117	30,546	26.0
54	Quadruple-glazed Windows	46	12,194	26.4
55	Solar Pre-heat Makeup Air	272	78,005	28.7
56	LED Holiday - Indoor	4	1,077	29.3
57	Ground Heat Pumps - Closed	292	98,681	33.8
	Grand Total	61,675	7,681,596	12.5

Exhibit 36 Energy-efficiency Supply Curve for Residential Sector, 2030



8.7 Summary of Electric Peak Load Reductions

Exhibit 37 presents a summary of the peak load reductions that would occur as a result of the electric energy savings contained in the Economic Potential Forecast. The reductions are shown by milestone year and peak period. In each case, the reductions are an average value over the peak period and are defined relative to the Reference Case presented previously in Sections 4 and 6. Exhibit 38 shows the same information graphically for the Annual Peak Hour.

Exhibit 37 and Exhibit 38 only approximate the potential demand impacts associated with the energy-efficiency measures because they are based on the assumption that the measures do not change the load shape of the end uses they affect. In fact, the block heater timer measure is expected to substantially change the load shape for that end use, because users would be encouraged to set the timers to switch on in the middle of the night, after the utility peak period is over. As an approximation, block heater timers are assumed to reduce the peak load for the block heater end use by 90% overall.

Exhibit 39 shows the demand reductions associated with each electric energy savings measure contained in the Economic Potential Forecast for the milestone year 2030. The total 2030 demand reductions in Exhibit 39 do not match those shown in the previous exhibits because it

includes the assumption that block heater timers reduce block heater demand in the first two peak periods by 90%. The block heater timer measure, whose demand reduction was already disproportionately large compared to its electric energy savings, now accounts for 19% of the potential reduction in peak hour demand (Period 1) and 24% of the potential reduction in demand during the system peak period (Period 2).

Electric peak load reductions related to capacity-only measures are presented separately in Sections 9 and 10.

Exhibit 37 Electric Peak Load Reductions from Economic Energy Savings Measures, by Milestone Year, Peak Period and Dwelling Type (MW)

Dwelling Type	Milestone Year	Period 1 Annual Peak Hour	Period 2 Evening Peak Period	Period 3 Morning Peak Period
Single Detached Houses	2015	7.48	7.53	4.92
	2020	8.29	8.32	5.57
	2025	9.22	9.22	6.31
	2030	10.19	10.17	7.08
Apartments	2015	0.89	0.94	0.47
	2020	1.26	1.32	0.73
	2025	1.80	1.86	1.10
	2030	2.51	2.58	1.60
Attached/Row Houses	2015	0.70	0.71	0.44
	2020	0.83	0.84	0.53
	2025	0.99	1.01	0.65
	2030	1.18	1.19	0.78
Mobile/Other	2015	0.68	0.69	0.47
	2020	0.74	0.75	0.52
	2025	0.80	0.81	0.58
	2030	0.87	0.88	0.63
Seasonal & Garage	2015	0.12	0.13	0.05
	2020	0.11	0.12	0.04
	2025	0.10	0.11	0.04
	2030	0.08	0.09	0.03
Small Grid Housing	2015	0.07	0.07	0.04
	2020	0.07	0.07	0.05
	2025	0.07	0.08	0.05
	2030	0.07	0.08	0.05
Sentinel Lighting	2015	0.03	0.03	0.03
	2020	0.03	0.03	0.03
	2025	0.03	0.03	0.03
	2030	0.03	0.03	0.03
Grand Total	2015	9.96	10.11	6.43
	2020	11.33	11.46	7.48
	2025	13.02	13.12	8.75
	2030	14.95	15.03	10.21

Exhibit 38 Electric Peak Load Reductions from Economic Energy Savings Measures, by Milestone Year Dwelling Type and End Use, Annual Peak Hour (MW)

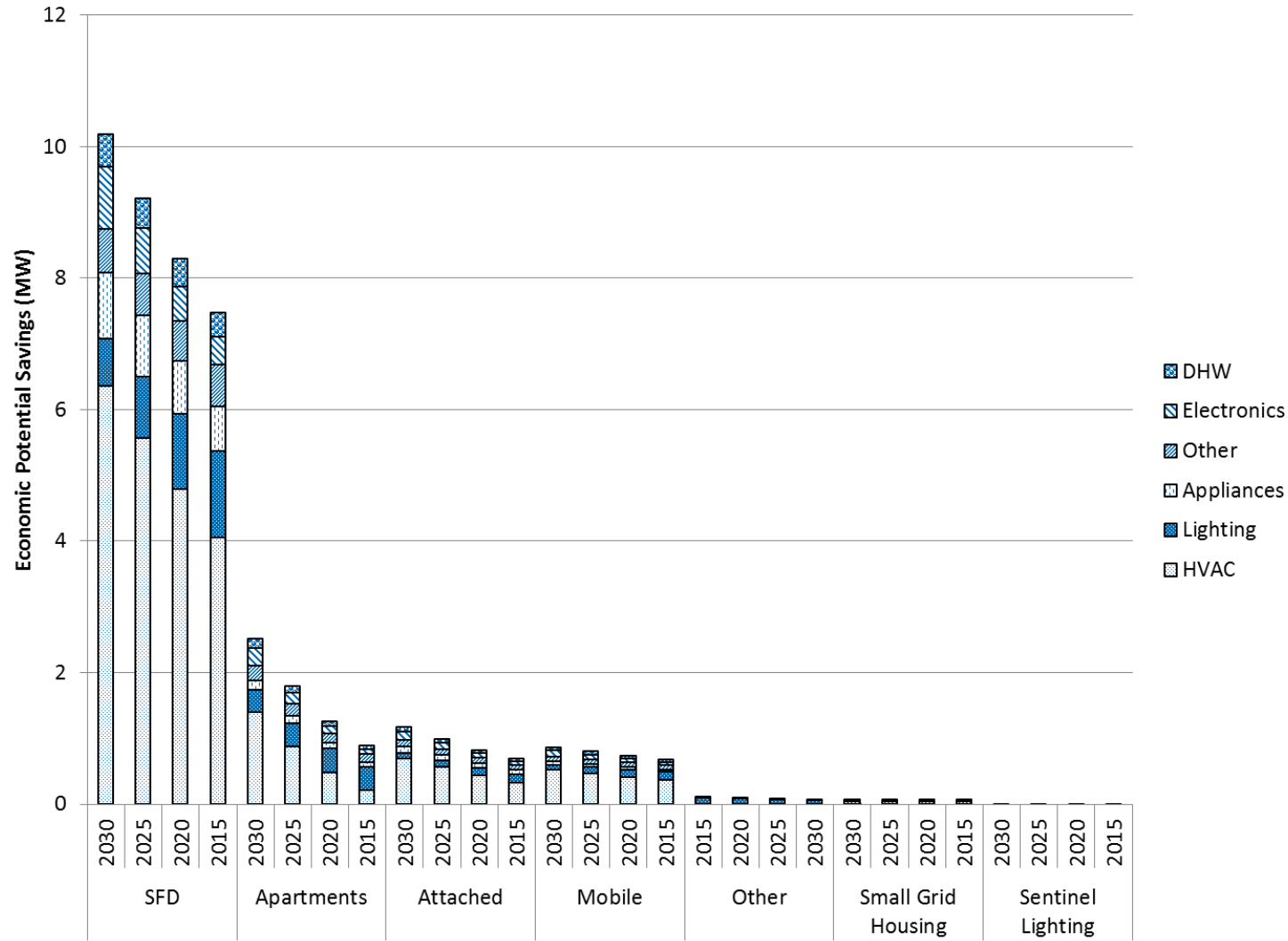


Exhibit 39 Electric Peak Load Reductions from Economic Energy Savings Measures, 2030 (MW)

Measure	Period 1 Annual Peak Hour	Period 2 Evening Peak Period	Period 3 Morning Peak Period
Block Heater Timers	2.587	3.234	0.000
High-Perf. New Homes	2.499	2.452	1.797
Zone Heating	1.915	1.878	1.237
LEED Apartments	1.287	1.278	0.853
ESTAR Clothes Washers	1.216	1.039	0.544
CFLs - Indoor	0.838	0.931	0.372
Wall Insulation	0.687	0.672	0.462
Future Elec Improvement	0.582	0.584	0.430
Power Bars (PCs)	0.377	0.386	0.283
Outdoor Temp Reset	0.330	0.324	0.214
Sealing & Insul. - Old Homes	0.268	0.262	0.180
Attic Insulation	0.257	0.251	0.172
Power Bars (TVs)	0.223	0.220	0.162
ESTAR Refrigerators	0.183	0.173	0.138
Air Sealing	0.175	0.171	0.119
DHW Recirculation	0.151	0.168	0.428
ESTAR TVs	0.141	0.140	0.103
ESTAR Printers and Fax	0.126	0.129	0.094
Dimmable CFLs	0.121	0.135	0.054
DHW Piping Optimization	0.117	0.131	0.334
Prog. Thermostats (Central)	0.116	0.113	0.077
Triple-glazed Windows	0.108	0.105	0.072
Ground Heat Pumps - Closed	0.104	0.102	0.071
PAR CFLs	0.104	0.116	0.046
Car Warmer Timers	0.099	0.124	0.000
Solar Pre-heat Makeup Air	0.096	0.094	0.063
Wastewater Heat Recovery	0.095	0.106	0.271
LED Lamps	0.083	0.092	0.037
Prog. Thermostats	0.078	0.076	0.052
Battery Blanket Timers	0.076	0.095	0.000
Furnace Motors	0.073	0.068	0.067
T8 Fixtures	0.063	0.070	0.028
ESTAR Freezers	0.059	0.056	0.044
Showerheads	0.057	0.064	0.162
ESTAR Dishwashers	0.048	0.058	0.107
Heat Pump Spa Heaters	0.044	0.042	0.041
Optimizing Glazing for Passive	0.042	0.041	0.028
Hot Tub Pump Timers	0.038	0.036	0.036
DHW Tank Insulation	0.034	0.038	0.098
Pulse start metal halide sentinel lights	0.032	0.030	0.033
Basement Insulation	0.030	0.029	0.020
Slab Insulation	0.028	0.027	0.019
DHW Pipe Insulation	0.027	0.030	0.077
HRVs	0.026	0.026	0.018
LED Holiday - Outdoor	0.020	0.020	0.000
Spa Pumps	0.018	0.017	0.017
Quadruple-glazed Windows	0.016	0.016	0.011
LED Holiday - Indoor	0.014	0.014	0.000
Spot or Task Lighting	0.013	0.015	0.006
Solar Spa Pre-heat	0.012	0.012	0.012
Motion Detectors - Indoor	0.011	0.013	0.005
CFLs - Outdoor	0.008	0.007	0.008
Motion Detectors - Outdoor	0.007	0.007	0.008
Hot Tub Covers	0.003	0.003	0.003
Crawl Space Insulation	0.002	0.002	0.002
Grand Total	15.768	16.324	9.512

9 Technology Assessment: Peak Load Measures

9.1 Introduction

This section identifies and assesses the economic attractiveness of selected Residential sector electric capacity-only peak load reduction measures, which in this study are defined as those measures that affect electric peak but have minimal or no impact on daily, seasonal or annual electric energy use. The discussion is organized and presented as follows:

- Methodology
- Electric peak load reduction measures
- Summary of results.

9.2 Methodology

The following steps were employed to assess the peak load reduction measures:

- Select candidate peak load reduction measures
- Establish technical performance for each option
- Establish the capital, installation and operating costs for each option
- Calculate the cost of electric peak load reduction (CEPR) for each option.

A brief description of each step is provided below.

Step 1 Select Candidate Measures

The candidate measures were selected in close collaboration with YEC, YECL and Government of Yukon personnel based on a combination of a literature review and previous study team experience. The selected measures are all considered to be technically proven and commercially available, even if only at an early stage of market entry. Technology costs, which will be addressed in this section, were not a factor in the initial selection of candidate technologies.

Step 2 Establish Technical Performance

Information on the performance improvements provided by each measure was compiled from available secondary sources, including documented experience and on-going research work by other utilities and study team members. In some cases, comfort may be affected and the trade-off between benefits (e.g., cost savings) and costs (including reduction in comfort) were judged based on past experience with similar technologies and customer acceptance.

Step 3 Establish Capital, Installation and Operating Costs for Each Measure

Information on the cost of implementing each measure was also compiled from secondary sources, including the experience and on-going research work of study team members.

Unlike energy-efficiency measures, in which major equipment, such as heating and water heating systems are typically replaced, or thermal envelope measures such as insulation upgrades affect systems directly, capacity-only measures are typically implemented via add-on

control equipment, although some built-in control equipment exists. The incremental cost is thus defined as the control equipment itself or incremental cost for a controllable appliance or device relative to the baseline appliance cost (e.g., remote accessible thermostat vs. standard thermostat), plus any required infrastructure (e.g., automatic meter reading or communications gateways). In cases where a more efficient appliance with peak control functions replaces a standard appliance, both electric energy and electric peak reduction are achieved, with some splitting of incremental costs attributable to each function. Where a new or replacement end use is installed that operates off peak, thus achieving electric peak reduction without significant energy impacts, incremental costs for the electric peak reduction device will be compared with standard equipment without assuming any early replacement and, thus, salvage value.

In all cases, the costs and savings are annualized, based on the number of years of equipment life and the discount rate. The costs incorporate applicable changes in annual O&M costs and all costs are expressed in constant (2010) dollars.

Step 4 Calculate CEPR for Each Measure

The CEPR for a peak load reduction measure is defined as the annualized incremental cost of the measure divided by the annual peak reduction achieved, excluding any administrative or program costs required to achieve full use of the technology or measure. All cost information presented in this section and in the accompanying tables (see Appendix G) is in constant (2010) dollars.

The CEPR provides a basis for the subsequent selection of measures to be included in the Economic Potential Forecast (see Section 8). The CEPR is calculated according to the following formula:

$$\frac{C_A + M}{S_p}$$

Where:

CA is the annualized installed cost

M is the incremental annual cost of operation and maintenance (O & M)

S_p is the annual kW load reduction associated with peak definition p.

A is the annualization factor.

$$A = \frac{i(1+i)^n}{(1+i)^n - 1}$$

Where: i is the discount rate; n is the life of the measure.

Note that the annual O&M cost will include, in some cases, amortized costs associated with infrastructure considered a prerequisite for implementation of the measure. This could include automated metering infrastructure (AMI), such as advanced metering, communications gateways and other related system investments. These costs would typically support multiple applications (e.g., communications gateways could enable control of heating, air conditioning, water heating, pool pumps, spas and small appliances), as well as facilitate time-differentiated rates that would be required for a feasible and cost-effective program implementation (e.g., thermal energy storage). It should also be noted that the measure lifetime is for the control device, function or feature, rather than that of the unit it is controlling. The study does not presume any specific technology or infrastructure, but does assume that a marketplace will

develop for such systems, whether or not Yukon utilities adopt them, or develops access directly or indirectly to customer control equipment.

The CEPR can be compared to benefits, which include the value of reduced peak for the utility (avoided capacity and transmission and distribution (T&D) investment or purchase costs), the customer (e.g., bill savings) and society (e.g., value of environmental benefits) to determine its cost effectiveness from various perspectives (societal, utility, participant and non-participant).

As with the CCE for energy savings, the CEPR calculation is sensitive to the chosen discount rate, which, as for the CCE, used a 5.25% (real) discount rate. Higher discount rates will tend to reduce savings and decrease cost effectiveness where costs are incurred upfront and benefits accrue over many years.

9.3 Electric Peak Reduction Measures

The selected electric peak load reduction measures are presented in Exhibit 40. It should be noted that some measures included in Exhibit 40 could be implemented as behavioural in the short term, until—and if—the technology to automate these measures becomes cost effective. For example:

- A utility program that appeals to customers to conserve on a particular day or span of hours could be implemented as a behavioural measure where customers voluntarily shut off unnecessary lights manually.
- Similarly, home automation devices now available would enable customers to shut selected lights automatically or even remotely on demand.
- Finally, utility access, via communications with in-home control systems could enable utilities to shut devices, with customer approval, remotely during system critical times. This approach is often done using remote thermostat control systems for heating and cooling.

Thus, some measures identified in Exhibit 40 as technical potential may be initially implemented as behavioural and evolve into technical measures as technology and economics advance.

Exhibit 40 Summary of Residential Electric Peak Load Reduction Measures

Residential End Use	Capacity-only Measure	Description	Applicability of Measures By Sub sector
Water heating	Switch-based water heating unit control	Control switch installed on water heating system circuits or unit for remote shut off or cycling control (typically utility controlled)	Electric water heating with separate tanks
Engine block heaters	Switch-based timer control	Remote control switch activated by utilities to force unit operation (with or without timers) to avoid system peak period	All
Lighting	Non-essential lighting control	Control switch installed on non-essential lighting plug loads and circuits (e.g., holiday lights) for utility control during system critical events	All

Residential End Use	Capacity-only Measure	Description	Applicability of Measures By Sub sector
Multiple (whole house)	Voluntary remote plug load control	Switches on voluntary, non-essential plug loads for utility control during system critical events (e.g., clothes washers, clothes dryers, dishwashers, computers, peripherals, set-top boxes, electronics chargers, pool/spa heaters), remotely controlled with plug switches – can be locally overridden	All customers – facilitated by time-of-use rates and/or critical peak rate structure
Space heating	Electric thermal storage (ETS)	ETS units to replace electric supplemental units	Dwelling units with electrical supplemental heating

9.4 Technology Screening Results

A summary of the results is provided in Exhibit 41. For each of the measures reviewed, the exhibit shows:

- The name of the measure
- The cost basis for the CEPR that is shown, e.g., full versus incremental
- The measure's average CEPR.

Measures analyzed on the basis of full cost have been placed towards the top of Exhibit 41 as they are qualitatively different from the measures that pass only on an incremental basis. A measure that passes on a full-cost basis can be applied immediately, while incremental measures presume the adoption of other technologies as a condition of their cost effectiveness (e.g., home area network gateways).

Exhibit 41 Residential Sector Electric Peak Load Reduction Measures, Screening Results

Measure Name	Basis (Full/Incremental)	CEPR Ranges (\$/kW)
One-way switch for engine block heater	Full	\$52 - \$65
Electric central thermal storage	Full	\$99 - \$101
One-way switch for pools and spas	Full	\$72 - \$77
One-way switch for water heating control	Full	\$83 - \$106
Electric room thermal storage for supplemental heat	Full	\$85 - \$87
One-way switch for plug loads	Full	\$168 - \$229
One-way switch for lighting control	Full	\$256 - \$285
One-way switch for engine block heater	Incremental	\$45 - \$56
One-way switch for pools and spas	Incremental	\$34 - \$36
One-way switch for plug loads	Incremental	\$47 - \$64
One-way switch for lighting control	Incremental	\$73 - \$81
One-way switch for water heating control	Incremental	\$73 - \$81

9.5 Electric Peak Supply Curves

A supply curve was constructed based on the approximate Economic Potential savings associated with the above measures. The following approach was used:

- Measures are introduced in sequence to show incremental impact and cost
- Sequence was determined by listing the items that reduce the electrical peak first, then those that meet residual load with the most efficient technology
- Items appear in order, beginning with those that have the lowest average CEPR.

Exhibit 42 shows the measures included in the supply curve. Exhibit 43 and Exhibit 44 show the supply curves under two scenarios: with and without existing gateways.

Note that since there was no threshold established for maximum cost effectiveness, all measures are listed and there are no exclusions based on lack of cost effectiveness.

Exhibit 42 Total Applicable Dwelling Types and MW Impact by Measure

Electric Peak Reduction Measures	Dwelling Saturation	Applicable Count 2010	Avg MW	Avg CEPR \$/kW/yr.
Space Heating				
One-way switch for engine block heater - utility load control – stand-alone	65%	10,172	2.0	\$52 - \$65
One-way switch for engine block heater - utility load control - incremental	65%	10,172	2.0	\$45 - \$56
Electric thermal storage (central)	14%	2,180	6.9	\$99 - \$101
Electric thermal storage (room/supplemental)	8.9%	1,384	1.7	\$85 - \$87
Electric Water Heating				
One-way switch-based utility load control – stand-alone	73%	11,326	2.9	\$100-\$112
One-way switch-based utility load control - incremental	73%	11,326	2.9	\$73 - \$81
Lighting				
One-way switch-based utility load control - stand-alone	100%	14,622	1.3	\$256 - \$285
One-way switch-based utility load control - incremental	100%	14,622	1.3	\$73 - \$81
Plug Loads				
One-way switch-based utility load control - stand-alone	100%	14,622	1.0	\$168 - \$229
One-way switch-based utility load control – incremental	100%	14,622	1.0	\$47 - \$64
Electric Pools and Spas				
One-way switch-based utility load control - stand-alone	7.2%	1,120	0.7	\$72 - \$77
One-way switch-based utility load control – incremental	7.2%	1,120	0.7	\$34 - \$36

The supply curves below illustrate the cumulative electric peak load reduction available based on two scenarios. Scenario 1 (Exhibit 43) assumes that each measure cost would require new installation of gateways for communications between utility and devices, i.e., no existing communications gateways are in place. Scenario 2 (Exhibit 44) assumes that there are existing gateways so only incremental costs for additional control devices would be included.

Exhibit 43 Cumulative Supply Curve Including Gateway Costs

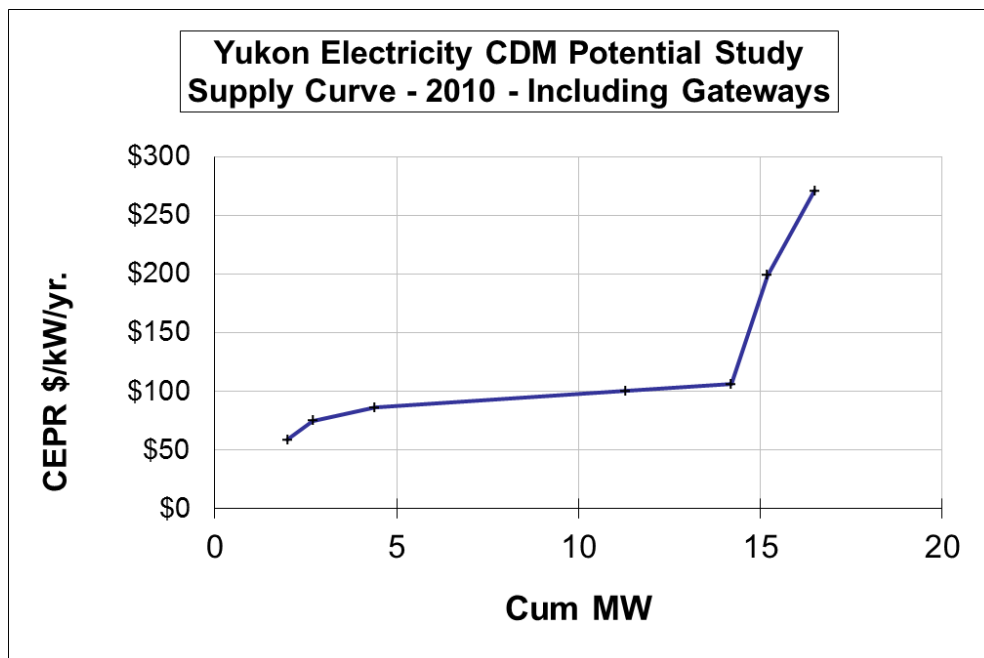
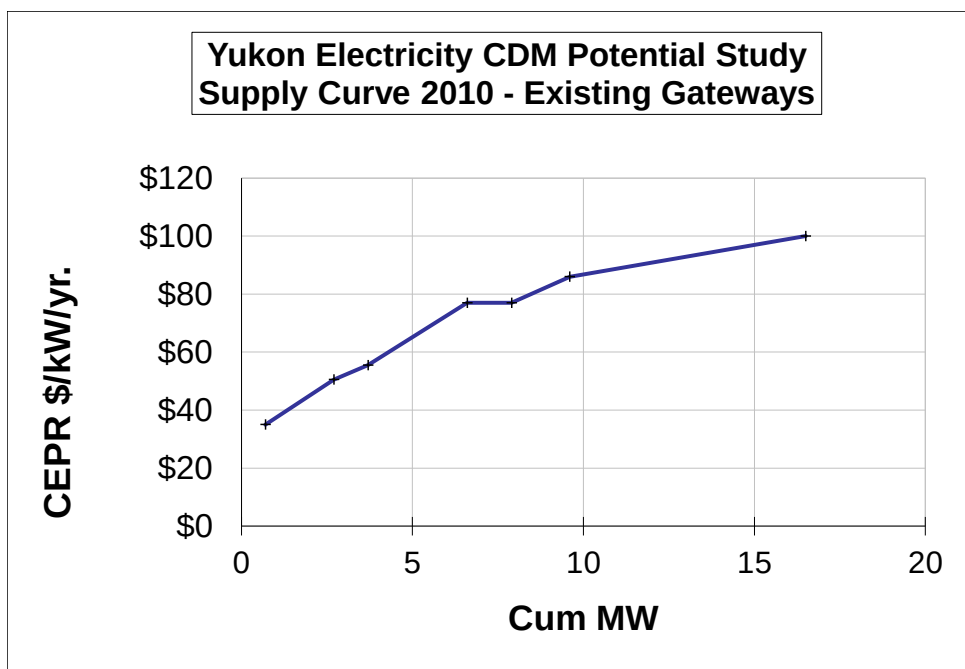


Exhibit 44 Cumulative Supply Curve with Existing Gateways (no cost)



As illustrated, without existing gateways, about 14 MW are technically available for under \$106/kW/yr., after which another 3 MW (17 MW total) would be available for under \$256/kW/yr. With existing gateways in place, approximately 10 MW would be available for under \$90/kW/yr. and all 17 MW available for under \$100/kW/yr.

It should be noted that there is a point beyond which electric peak load reductions, defined in terms of the Annual Peak Hour (6 pm on system peak day), become uneconomic if they result in the creation of a new peak after those time periods as a result of deferral of the loads during the peak until other periods, such as immediately following the peak period.

In theory, this concept is applicable. However, in practice (i.e., applying Achievable Potential), it is highly unlikely that the saturation of electric peak load measures would be sufficient to cause such a shift. The application of electric thermal storage (ETS) would be the type of electric peak load measure that would have the greatest potential to create a new (later) peak if the full off-peak charging operation of the units were implemented immediately after the end of the peak period. As a result, it has been assumed that the off-peak charging period would begin at 11 pm, rather than earlier, such as 9 pm, right after the Evening Peak ends. For both space and water heating load control, it would be expected that some degree of “recovery” would follow load control periods in order to restore the temperature of the air/water to the pre-determined comfort levels. For lighting, plug loads and pool pumps/spas, the “recovery” would be minimal to negligible.

10 Achievable Potential: Electric Energy Forecast

10.1 Introduction

This section presents the Residential sector Achievable Potential for the study period (2010 to 2030). The Achievable Potential is defined as the proportion of the energy-efficiency opportunities identified in the Economic Potential Forecast that could realistically be achieved within the study period.

The remainder of this discussion is organized into the following subsections:

- Description of Achievable Potential
- Approach to the estimation of Achievable Potential
- Results – energy-efficient technologies.

10.2 Description of Achievable Potential

Achievable Potential recognizes that, in many instances, it is difficult to induce all customers to purchase and install all the energy-efficiency technologies that meet the criteria defined by the Economic Potential Forecast. For example, customer decisions to implement energy-efficient measures can be constrained by important factors such as:

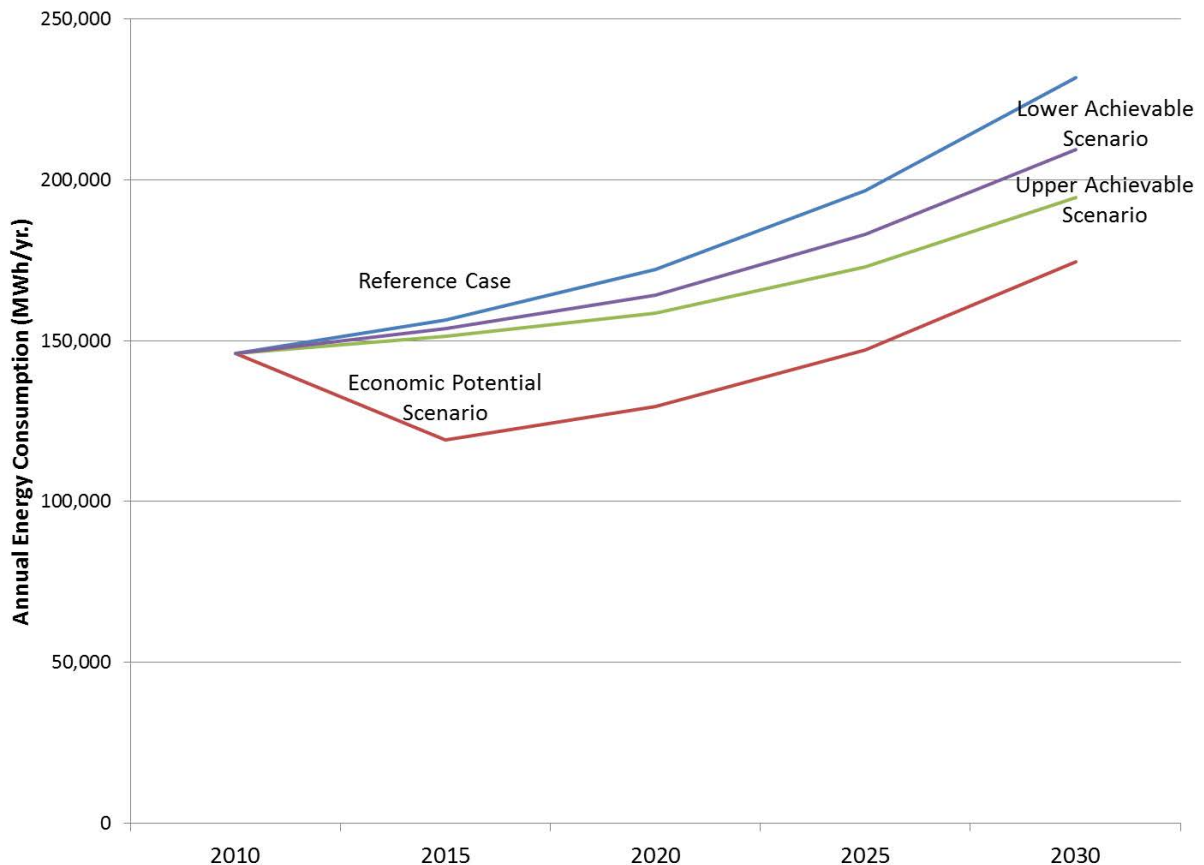
- Higher first cost of efficient product(s)
- Need to recover investment costs in a short period (payback)
- Lack of product performance information
- Lack of product availability.

The rate at which customers accept and purchase energy-efficiency products will be influenced by the level of financial incentives, information and other measures put in place by YECL, YEC, the Government of Yukon, other levels of government, and the private sector to remove barriers such as those noted above.

Exhibit 45 presents the levels of electricity consumption that are estimated in the Achievable Potential scenario. As illustrated, the Achievable Potential scenarios are banded by the two forecasts presented in previous sections: the Economic Potential Forecast and the Reference Case.

As illustrated in Exhibit 45 electric energy savings under the Achievable Potential scenario are less than in the Economic Potential Forecast. In this CPR, the primary factor that contributes to the outcome shown in Exhibit 45 is the rate of market penetration. In the Economic Potential Forecast, efficient new technologies are assumed to fully penetrate the market as soon as it is economically attractive to do so. However, the Achievable Potential recognizes that under real world conditions, the rate at which customers are likely to implement new technologies will be influenced by additional practical considerations and will, therefore, occur more slowly than under the assumptions employed in the Economic Potential Forecast.

Exhibit 45 Annual Electricity Consumption—Energy-efficiency Achievable Potential Relative to Reference Case and Economic Potential Forecast for the Residential Sector, (MWh/yr.)



As also illustrated in Exhibit 45 the Achievable Potential results are presented as a band of possibilities, rather than a single line. This is because any estimate of Achievable Potential over a 20-year period is necessarily subject to uncertainty. Consequently, two Achievable Potential scenarios are presented: lower and upper.

The **lower Achievable Potential** assumes Yukon market conditions that are similar to those contained in the Reference Case. That is, the customers' awareness of energy-efficiency options and their motivation levels remain similar to those in the recent past, technology improvements continue at historical levels, and new energy performance standards continue as per current known schedules. It also assumes that the ability of the Yukon utilities and government to influence customers' decisions towards increased investments in energy-efficiency options remains roughly in line with previous company DSM experience.

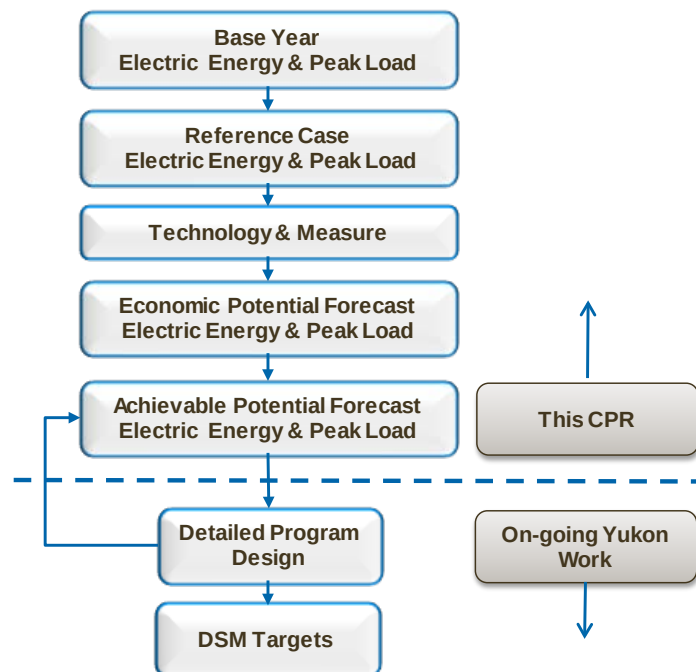
The **upper Achievable Potential** assumes Yukon market conditions that aggressively support investment in energy efficiency. For example, this scenario assumes that real electricity prices increase over the study period. It also assumes that federal and territorial government actions to mitigate climate change result in increased levels of complementary energy-efficiency initiatives. The upper Achievable Potential typically does not reach economic potential levels; this recognizes that some portion of the market is typically constrained by barriers that cannot realistically be affected by DSM programs within the study period.

10.2.1 Achievable Potential Versus Detailed Program Design

It should also be emphasized that the estimation of Achievable Potential is not synonymous with either the setting of specific program targets or with program design. While both are closely linked to the discussion of Achievable Potential, they involve more detailed analysis that is beyond the scope of this study.

Exhibit 46 illustrates the relationship between Achievable Potential and the more detailed program design.

Exhibit 46 Achievable Potential versus Detailed Program Design



This study examined more than 60 technologies applicable to residential electric end uses. Although considerable effort has been made to obtain up-to-date information on each technology and to tailor it to the local market in Yukon, this is not a substitute for the type of detailed groundwork needed to prepare a utility program. For each of the technologies selected for further investigation, it will be important to obtain further information on the technical viability and durability of the products in the Yukon climate, on the costs in the Yukon marketplace, and on real savings under local conditions. If the viability of the technology is confirmed, an assessment of the market barriers is required, leading to the development of program strategies to overcome these barriers.

10.3 Approach to the Estimation of Achievable Potential

Achievable Potential was estimated in a five-step approach.

- Priority opportunities were selected
- Opportunity profiles were created
- Opportunity worksheets were prepared

- A full-day workshop was held
- Workshop results were aggregated and applied to the remaining opportunities.

Further discussion is provided below.

Step 1 Select Priority Opportunities

The first step in developing the Achievable Potential estimates required selection of the energy-saving opportunities identified in the Economic Potential Forecasts to be discussed during the Achievable workshop. Several criteria determined selection, including:

- The priority measures should represent a substantial fraction of the overall economic potential
- The priority measures should represent several different energy end uses
- The priority measures should have a variety of different likely patterns of market adoption, so the discussions will be widely varied.

A summary of the selected energy-efficiency actions, along with the approximate percentage that it represents in the Economic Potential Forecast, is provided in Exhibit 47.²⁶

Exhibit 47 Residential Sector Actions – Energy Efficiency

Measure #	Measure	End Use	Fraction of 2030 Economic Potential (%)
R1	ESTAR Clothes Washers	Washers, Dryers, & DHW	10%
R2	Block Heater Timers	Block heaters & car warmers	2%
R3	Power Bars (PCs)	Computer and peripherals	4%
R4	LED Lamps	Lighting	1%
R5	DHW Recirculation	Space heating	3%
F6	Wall Insulation	DHW	3%
R7	Cold Temp Heat Pumps	HVAC & DHW	9%
R8	High-Perf. New Homes	Space heating	13%
R9	Sealing & Insul. - Old Homes	Space heating	1%
R10	ESTAR TVs	Television	2%
Grand Total			48%

Step 2 Create Opportunity Assessment Profiles

The next step involved the development of brief profiles for each of the opportunities noted above in Exhibit 47, in the form of PowerPoint slides. The slides are presented in Appendix H.

The purpose of the opportunity profiles was to provide a high-level logic framework that would serve as a guide for participant discussions in the Achievable workshop (see Step 4 below). The intent was to define a broad rationale and direction without getting into the much greater detail

²⁶ Measures R9 and R10 were not discussed in the workshop. In a one-day workshop of this type there is normally time to discuss eight energy-efficiency actions. Two additional measures were included in case there was extra time.

required of program design, which, as noted previously, is beyond the scope of this project. As illustrated in Appendix H, each opportunity profile addresses the following areas:

- **Technology Description** – provides a summary statement of the broad goal and rationale for the action.
- **Target Dwelling Type and Typical Application** — highlights the dwelling types and applications offering the most significant opportunities, and which provide a good starting point for discussion of the technology.
- **Financial and Economic Indicators** — provides estimates of average simple payback, cost of conserved electricity (CCE) and basis of assessment (full-cost versus incremental).
- **Eligible Participants** — provides an estimate of the number of dwellings or appliances that could be affected during the study period if the entire Economic Potential were to be captured.
- **Economic Potential versus Time** — shows the pattern of the changing size of the opportunity over the study period, for existing and new dwellings. Some opportunities grow steadily through the study period, as more and more appliances reach the age when they would be replaced. Other opportunities are economic to capture immediately, and after that the growth over time is limited to opportunities in new dwellings being built. Still other opportunities decline with time as they are eroded by natural conservation activities.

Step 3 Prepare Opportunity Worksheets

A draft assessment worksheet was also prepared for each opportunity profile in advance of the Achievable workshop. The assessment worksheets complemented the information contained in the opportunity profiles by providing quantitative data on the potential electric energy savings for each opportunity as well as providing information on the size and composition of the eligible population of potential participants. Energy impacts and population data were taken from the detailed modelling results contained in the Economic Potential Forecast.

The worksheets, including the results recorded during the workshop discussions, are provided in Appendix I. As illustrated in Appendix I, each opportunity assessment worksheet addresses the following areas:

- **Approximate Cost of Conserved Electricity** — shows the approximate levelized cost of saving each kWh of electricity saved by the measure. For the purposes of the workshop, this information provided participants with an indication of the scope for using financial incentives to influence customer participation rates.
- **Customer Payback** — shows the simple payback from the customer's perspective for the package of energy-efficiency measures included in the opportunity. This information provided an indication of the level of attractiveness that the opportunity would present to customers. This provided an important reference point for the workshop participants when considering potential participation rates. When combined with the preceding CCE information, participants were able to roughly estimate the level of financial incentives that could be employed to increase the opportunity's attractiveness to customers without making it economically unattractive to the Yukon utilities.

- **Economic Potential in Terms of Applicable Participants (e.g., number of dwellings)** — shows the total number of potential participants in terms of either dwellings or appliances (as appropriate) that could theoretically take part in the opportunity. Numbers shown are from the eligible populations used in the Economic Potential Forecasts.
- **Participation Rates (%)** — these fields were filled in during the workshops (described below in the following step), based on input from the participants. They show the percentage of economic savings that workshop participants concluded could be achievable in the last milestone period (usually 2030, but may be earlier for measures that peak earlier).
- **Achievable Potential in Terms of Applicable Participants (e.g., number of dwellings)** — these fields were calculated by the spreadsheet based on the participation rates provided by the participants.
- **Participation Rates Relative to the Discussion Scenario** — these fields were filled in during the workshops to provide guidance to the consulting team on how participation might differ in other regions or dwelling types, or for related or similar technologies.
- **Other Parameters** — these fields were filled in during the workshop to capture highlights of the discussion.

Step 4 Conduct Achievable Workshop

The most critical step in developing the estimates of Achievable Potential was a one-day Achievable Potential workshop that was held on November 15, 2011. Workshop participants consisted of core members of the consultant team, DSM program and technical personnel from YECL, YEC and the Government of Yukon, industry representatives, and representatives of other stakeholders. Together, the participating personnel brought many years of experience to the workshop related to the technologies and markets.

The purpose of this workshop was to:

- Promote discussion regarding the technical and market constraints confronting the identified energy-efficiency opportunities
- Identify potential strategies for addressing the identified constraints, including potential partners and delivery channels
- Compile participant views related to how much of the identified economic savings could realistically be achieved over the study period.

Following a brief consultant presentation that summarized the Residential sector study results to date, the workshop provided a structured assessment of each of the selected opportunities. Opportunity assessment consisted of a facilitated discussion of the key elements affecting successful promotion and implementation of the DSM opportunity. More specifically:

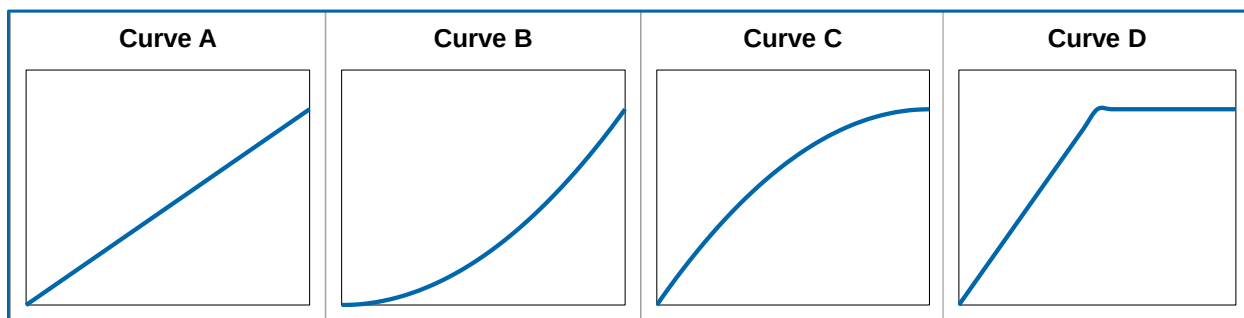
- What are the major constraints/challenges constraining customer adoption of the identified energy-efficiency opportunities?
 - How big is the “won’t” portion of the market for this opportunity?
- Preferred strategies and potential partners for addressing the identified constraints (high level only)
 - Key criteria that determine customers’ willingness to proceed

- Key potential channel partners
- Optimum intervention strategies e.g., push, pull, combination
- How sensitive is this opportunity to incentive levels?

Following discussion of market constraints and potential intervention strategies, the participants' views on potential participation rates were recorded. The process involved the following steps:

- The participation rate for the upper Achievable scenario in 2030 was estimated.
- The shape of the adoption curve was selected for the upper Achievable scenario. Rather than seek consensus on the specific values to be employed in each of the intervening years, workshop participants selected one of four curve shapes that best matched their view of the appropriate “ramp-up” rate for each opportunity (see Exhibit 48 below).
- The process was then repeated for the lower Achievable scenario.
- Once participation rates had been established for the specific technology, sub sector and service region selected for the opportunity discussion, workshop participants provided the consultants with guidelines for extrapolating the discussion results to the other sub sectors and service regions included in the opportunity, but not discussed in detail during the workshop. Where time permitted, participants also discussed how the adoption of similar, related technologies might differ from the technology being discussed.

Exhibit 48 Participation Rate “Ramp Up” Curves



Curve A represents a steady increase in the expected participation rate over the study period

Curve B represents a relatively slow participation rate during the first half of the study period followed by a rapid growth in participation during the second half of the 20-year study period

Curve C represents a rapid initial participation rate followed by a relatively slow growth in participation during the remainder of the study period

Curve D represents a very rapid initial participation rate that results in virtual full saturation of the applicable market during the first half of the study period.

Step 5 Aggregate and Extend Opportunity Results

The final step involved aggregating the results of the individual opportunities to provide a view of the potential Achievable in both the Residential and Commercial sectors.

10.4 Achievable Workshop Results

The following sub sections present a summary of the workshop discussions for each of the residential opportunities listed in Exhibit 47 above. The adoption rates and curves selected by the participant are summarized in Section 10.4.9. Included for each opportunity are:

- Participation estimates (for 2030) made by workshop participants, with comments, where needed, about values assumed in the calculations (presented in Section 10.5)
- Where needed, additional participation estimates made after the workshop for the purposes of the calculations (presented in Section 10.5)
- Selected highlights that attempt to capture key discussion themes related to the opportunity.

Appendix I provides copies of the assessment worksheets used during the workshop.

10.4.1 ENERGY STAR® Clothes Washers

Achievable workshop participants provided 2030 participation rate estimates of 80% for the upper Achievable Potential scenario and 65% for the lower Achievable Potential scenario. Participants thought the most likely adoption curve in the upper Achievable Potential scenario would be C, while in the lower Achievable Potential scenario it would most likely be B.

Barriers that tend to lower adoption included the split incentives that operate in rental housing situations, and the high first-cost barrier in the lower income market. There is an active market in used appliances – the incremental cost from a used clothes washer to a new high-efficiency model is very large. There may be some disincentive for people to invest in more expensive clothes washers because of the relatively short time people tend to stay in the same home in Yukon, and the tendency to sell the major appliances along with the home.

Potential strategies for addressing the market barriers include working with the retailers, offering incentives to sales people or point-of-sale rebates, and working with important partners, such as municipalities, the Yukon Energy Solutions Centre, First Nations, and the Yukon Housing Corporation. The water conservation aspect of the efficient washers will be important in some communities, and some municipalities may be willing to include washer performance standards in their sewer/water bylaws. Education to both retailers and consumers is potentially an important element in programs, to overcome reluctance to adopt a new technology.

The initial discussion focused on existing single detached homes on the hydro grid. Participants believed participation would be somewhat lower in apartments and somewhat higher in new homes. In Old Crow and the small diesel communities, participation would be lower because of the difficulty of transporting the appliances to those communities. Participants also discussed some of the other large appliance measures briefly. Adoption of refrigerators was thought likely to proceed somewhat more slowly than adoption of clothes washers, while dishwashers were thought likely to be adopted more quickly.

10.4.2 Block Heater Timers

Achievable workshop participants provided 2030 participation rate estimates of 70% for the upper Achievable Potential scenario and 50% for the lower Achievable Potential scenario. Participants thought the most likely adoption curve in the upper Achievable Potential scenario

would be a shallow version of B (halfway between A and B), while in the lower Achievable Potential scenario it would most likely be B.

Barriers that tend to lower adoption included concerns about the usability of the product – difficulty of programming, risk of failure in the event of a power outage or surge, and the high cost of failure in the event that the timer failed to turn the block heater on at the right time. Many people do not know about or believe the evidence that after four hours a block heater is no longer raising the temperature of the engine block. Consumers also do not consider the savings from block heater timers to be significant. Some people have jobs that require them to be “on call” and therefore they do not have the option of using a block heater timer. There is some concern that the block heater timers currently on the market may not have all the quality and features needed for use in Yukon. Some product testing may be required.

The block heater timer offers disproportionately large peak demand reduction opportunities compared to its electric energy savings. As a measure, it therefore likely has greater value to the utilities than its capital cost. Nonetheless, any direct rebates on the block heater itself should not be sufficient to reduce the consumer’s cost to zero – people may not see its value if it costs them nothing. More important elements of a program will likely include educational materials, media communications, testimonials, point-of-sale materials, and bundling of other products with the block heater. In new homes, block heater controls can be built into a control switch inside the house. Program activity could also include programming the timers for people, and following up to make sure they are working well. Possibly the most important initial activity may be product testing, to determine whether there are adequate products for the Yukon market.

Block heater timers offer very significant peak reduction potential for relatively small cost. This leaves a lot of room for spending on program support for them. Testing will be needed to make sure there are products suitable for the Yukon.

The initial discussion focused on existing single detached homes on the hydro grid. Participants believed participation would be somewhat lower in apartments. Participants also discussed some of the other measures in the “miscellaneous” categories. Timers for car warmers and battery blankets were expected to be adopted at a rate similar to that of block heater timers. Measure affecting spas were thought likely to be adopted somewhat slower.

10.4.3 Power Bars (PCs)

Achievable workshop participants provided 2030 participation rate estimates of 40% for the upper Achievable Potential scenario and 20% for the lower Achievable Potential scenario. Participants thought the most likely adoption curve for both scenarios would be a shallow version of B (halfway between A and B).

Barriers that tend to lower adoption included technical concerns about programming the devices, as well as the inconvenience of timing out the computer in communities where internet access is slow. Some power bars lack a battery backup to preserve the programming in the event of a power outage. Power bars also must incorporate surge protection. People are aware of the issue of phantom loads but it is not a high priority for them. There is some concern that the power bars currently on the market may not have all the quality and features needed for use in Yukon. Some product testing may be required.

There is some reduction in the potential as more people move from desktop computers to laptops. In addition, manufacturers are likely to incorporate better phantom load management in

computers and other electronics products, eventually reducing the potential contribution of smart power bars.

Strategies to encourage adoption of power bars would likely include partnerships with retailers, case studies of early adopters, and media communication. Education of consumers and retailers would also be important. Power bars could also be bundled with other measures. Information technology (IT) departments could be important partners; in addition to using the smart power bars in people's workplaces, the IT department could be a point of contact for encouraging people to use them at home. Possibly the most important initial activity may be product testing, to determine whether there are adequate products for the Yukon market.

The initial discussion focused on existing single detached homes on the hydro grid. Participants believed participation would be somewhat lower in homes on the diesel grids, because of the difficulty of obtaining the products in those communities. Participants also discussed some of the other electronics measures. Power bars for televisions were expected to be adopted at the same rate as power bars for computers. ENERGY STAR® televisions, printers, and faxes were expected to be adopted at similar rates to ENERGY STAR® large appliances.

The measure titled "Future Electronics Improvements" was included in the study as a placeholder to capture the need for North American utilities to work with electronics manufacturers to address the growing electricity consumption from electronics in homes.

10.4.4 LED Lamps

Achievable workshop participants provided 2030 participation rate estimates of 85% for the upper Achievable Potential scenario and 70% for the lower Achievable Potential scenario. Participants thought the most likely adoption curve both scenarios would be B.

Barriers that tend to lower adoption included technical concerns about light quality or radio frequency interference. The first cost of the products is high and there are not currently products available for all applications. LED lighting is currently financially competitive with incandescent lights, but is not as financially attractive as compact fluorescent lamps. Performance and cost are both improving rapidly, however, and by as early as 2020 this may have changed. LED products are not currently available in the market for some applications. Some product testing would help identify applications for which there are suitable products.

Strategies to encourage adoption of LED lighting could include qualification of products based on performance standards, including light quality and radio frequency interference standards. Educational materials could focus on the superiority of LEDs over compact fluorescents; many consumers prefer the quality of light from LEDs compared to compact fluorescents, and they do not have the same mercury disposal problems. Possibly the most important initial activity may be product testing, to determine what products are available and for what applications.

The initial discussion focused on existing single detached homes on the hydro grid. Participants believed participation would be somewhat lower in homes on the diesel grids because of the difficulty of obtaining the products in those communities. Participants also discussed some of the other lighting measures. Compact fluorescent lamps were expected to offer only limited opportunities for further adoption. There are no recycling facilities for them in Yukon, so people are reluctant to incur the disposal problem.

10.4.5 Wall Insulation

Workshop participants were more interested in discussing a “deep retrofit” approach rather than the doubling of wall insulation levels originally proposed as the measure to discuss. The deep retrofit involves adding approximately R-40 (RSI 7) to the outside of the walls. This deeper measure does pass the economic screen, so the previous wall insulation measure was replaced.

Achievable workshop participants provided 2030 participation rate estimates of 17% for the upper Achievable Potential scenario and 3% for the lower Achievable Potential scenario. Participants thought the most likely adoption curve both scenarios would be B.

The depth of the insulation measures considered in the study was greatly increased because of the discussions in the workshop. Several participants had direct experience with deep retrofits that had good results.

Barriers that tend to lower adoption included a lack of contractors experienced in doing this kind of retrofit; most are accustomed to installing far less insulation and will therefore charge more than necessary for this unfamiliar type of job.

Strategies to encourage adoption of deep retrofit wall insulation might include offering financing, demonstrations, education of homeowners and contractors, utility pre-qualification or certification of contractors, and partnerships with other entities such as the Climate Change Secretariat, the Yukon Energy Solutions Centre, and the Cold Climate Research Centre. The wall insulation measure should likely be considered as part of a package that would also improve the rest of the house envelope.

The initial discussion focused on existing single detached homes on the hydro grid. Participants believed participation would be somewhat lower in attached homes. The measure does not apply off the hydro grid because electric heating is negligible there. Participants also discussed some of the other building envelope measures. Most of them were thought to have similar adoption rates. Basement insulation might be adopted somewhat faster than wall insulation. Attic insulation would also likely be adopted somewhat faster.

10.4.6 DHW Recirculation

Achievable workshop participants provided 2030 participation rate estimates of 30% for the upper Achievable Potential scenario and 5% for the lower Achievable Potential scenario. Participants thought the most likely adoption curve both scenarios would be B.

Barriers that tend to lower adoption included a lack of familiarity with the technology and a lack of trades people who can install it. It may also be difficult to obtain the products in Yukon. Many recently-built homes have manifold plumbing systems, which would require more pumps than a system with several fixtures in series along the same run of pipe. The systems require an electrical supply to the location of the pump (e.g., under a sink in the bathroom), along with the installation and configuration of the controls.

Strategies to encourage adoption of DHW recirculation include marketing it as a luxury or convenience item that can differentiate high-end homes from the rest of the market, marketing the system with other DHW measures, or selling it based on its water conservation features for people on water delivery or well systems.

The initial discussion focused on existing single detached homes on the hydro grid. Participants believed participation would be somewhat lower in apartments, as some of them have central DHW systems. Participants thought adoption would be somewhat faster in the homes on the large diesel grid and higher still in homes on the small diesel and Old Crow systems, because of the larger number of homes that have their water supplied by truck.

Participants did not have time to discuss the other DHW measures. In extrapolating to the other measures, experience from other jurisdictions suggests that adoption of measures such as low-flow showerheads, pipe insulation and tank insulation would be faster than DHW recirculation. DHW piping optimization would likely be adopted at approximately the same rate as recirculation, and wastewater heat recovery would likely be adopted more slowly.

10.4.7 High-Performance New Homes

Achievable workshop participants provided 2030 participation rate estimates of 95% for both Achievable Potential scenarios. Participants thought the most likely adoption curve of both scenarios would be D, with the curve leveling off in 2017 in the upper Achievable Potential scenario but not until 2022 in the lower Achievable Potential scenario.

Barriers that tend to lower adoption include resistance in the contracting community and a perception of higher cost. Demand for housing is very high and there is urgency in building housing to meet this demand.

New construction in Yukon between now and 2030 is expected to include a great deal of electric heat. If efficiencies are not captured in these new homes when they are built, the opportunities will probably be lost for decades.

Strategies to encourage adoption of high-performance new homes may include working with other stakeholders, such as the Yukon Housing Corporation and municipalities. Whitehorse has very successfully implemented a building code that requires EGH-80 for new homes. A move to EGH-85 was seen as a strong option for implementing this measure. Other approaches might include contests among builders, green mortgages, labelling and branding, testimonials and free rating services. The high-performance homes could be marketed based on their comfort, simple mechanical systems, indoor air quality, and durability as well as their electric energy savings.

The initial discussion focused on existing single detached homes on the hydro grid. Participants did not note any likely differences in the adoption rate for attached homes or government homes. The measure does not apply in the diesel grid communities because of the lack of electric heat in those communities.

Participants did not discuss other new construction measures. The participation rates for LEED certified apartment buildings were drawn from the commercial sector discussions. Net zero homes likely rely on the cost-effectiveness of photovoltaic systems, which were a topic of discussion in the CSRAE workshop.

10.4.8 Cold Climate Heat Pumps

Achievable workshop participants provided 2030 participation rate estimates of 75% for the upper Achievable Potential scenario and 25% for the lower Achievable Potential Scenario. Participants thought the most likely adoption curve both scenarios would be B.

Barriers that tend to lower adoption include first cost, lack of installers, low awareness and customer understanding, and a perception that heat pumps do not work in northern climates.

Although there are some heat pumps operating well in Yukon, testing of different models in the Yukon climate will be important to demonstrate which ones are viable.

Other strategies to encourage adoption of cold climate heat pumps could include incentives, education programs aimed at both consumers and installers, third-party validation or certification of installers, development of Yukon-specific information on the real cost of heating in Yukon, and collaboration with other entities such as the Yukon Housing Corporation or the federal government.

The initial discussion focused on existing single detached homes on the hydro grid. Participants expected adoption to be higher in new homes. The measure does not apply in the diesel grid communities because of the lack of electric heat in those communities.

Participants discussed some of the other electric heating equipment measures. Adoption of ductless mini-splits was expected to be slower because it is more expensive to heat a whole house with those systems. Adoption of zone heating was also expected to be slower because it is such unfamiliar technology. Adoption of programmable thermostats and high-efficiency furnace motors was expected to be faster than that of heat pumps. Adoption of ground-source heat pumps and solar preheat of makeup air was expected to be much slower, because of their high capital cost and limited applicability.

Participants raised other approaches to using heat pumps in Yukon, most of which are highly promising but beyond the direct scope of this project. For example, cold climate heat pumps could be incorporated into new or existing homes with oil furnaces. The heat pump could operate through most of the heating season and the oil furnace would provide backup during the coldest days, instead of electric resistance heating. From the standpoint of operating costs, this would be one of the least expensive ways to heat a home in Yukon.

Another option would be to consider adding a standard heat pump to an oil-heated home. The standard heat pump would not operate for as many hours of the winter as the cold climate model, and the oil furnace would supply more of the heat, but the capital cost would be considerably lower. Using a standard heat pump in conjunction with an oil furnace would mean that the home would be heated by oil during the coldest periods when the utility is typically generating peak power using diesel generators.

Cold climate heat pumps, if local testing turns out well, have great potential for reducing consumption in homes with electric resistance heat. In homes with oil heat, standard heat pumps with no resistance backup might be a better choice. They are less expensive and would offer considerable savings without adding peak load to the grid. This would greatly increase the market for heat pumps, possibly offering savings due to sales volumes.

10.4.9 Aggregate Results

Exhibit 49 summarizes the participant rate and “ramp up” curve assumptions discussed above.

Exhibit 49 Summary of Achievable Potential Participation Rates and Curves

Technology	Lower Achievable Potential		Upper Achievable Potential	
	2030 Participation Factor	Adoption Curve	2030 Participation Factor	Adoption Curve
R1: ENERGY STAR® Clothes	65%	Curve B	80%	Curve C
R2: Block Heater Timers	50%	Curve B (shallow)	70%	Curve B
R3: Power Bars (PCs)	20%	Shallow Curve B	40%	Shallow Curve B
R4: LED Lamps	70%	Curve B	85%	Curve B
R5: Wall Insulation	3%	Curve B	17%	Curve B
R6: DHW Recirculation	5%	Curve B	30%	Curve B
R7: High-Performance New Homes	95%	Curve D (in 2022)	95%	D (in 2017) Whitehorse only
R8: Cold Climate Heat Pumps	25%	Curve B	75%	Curve B

As noted earlier, it was not possible to fully address all opportunities in the one-day workshop. Consequently, the workshop focused on opportunities selected based on the criteria described in Step 1. Estimated participation rates for the remaining opportunities were extrapolated from the workshop results shown above and an aggregate set of results was prepared that included all of the eligible technologies.

The results shown in the attached appendices and in the following summary section incorporate the results of all these inputs.

10.5 Summary of Potential Electric Energy Savings

This section presents a summary of the electric energy savings for the upper and lower achievable potential scenarios. The summary is organized and presented in the following sub sections:

- Overview and selected highlights
- Electric energy savings – Upper Achievable scenario
- Electric energy savings – Lower Achievable scenario.

10.5.1 Overview and Selected Highlights

Exhibit 50 presents an overview of the results for the total Yukon service territory by milestone year, for three scenarios: Economic Potential, upper Achievable Potential and lower Achievable Potential.

Exhibit 50 Electricity Savings by Milestone Year for Three Scenarios (MWh/yr.)

Year	Economic Potential Scenario		Upper Achievable Potential Scenario		Lower Achievable Potential Scenario	
	Potential Savings (MWh/yr.)	% Savings Relative to Ref Case	Potential Savings (MWh/yr.)	% Savings Relative to Ref Case	Potential Savings (MWh/yr.)	% Savings Relative to Ref Case
2015	37,239	24%	5,114	3%	2,711	2%
2020	42,577	25%	13,554	8%	7,792	5%
2025	49,419	25%	23,599	12%	13,539	7%
2030	57,248	25%	37,098	16%	22,240	10%

Selected Highlights – Potential Electric Energy Savings

Selected highlights of the potential electric energy savings for the upper and lower achievable potential scenarios shown in Exhibit 50 are summarized below. Further detail is provided in the following sub sections and in the accompanying appendices.

Savings by Milestone Year

Savings in both Achievable scenarios are achieved somewhat more steadily throughout the period than in the Economic Potential scenario. In the upper Achievable Potential scenario, 14% of the 2030 savings would be achieved by 2015, rising to 37% in 2020 and 64% by 2020. In the lower Achievable Potential scenario, 12% of the 2030 savings would be achieved by 2015, rising to 35% in 2020 and 61% by 2025. Although there are some measures in both scenarios that can be implemented early in the study period, the majority are expected to follow an adoption curve that starts slowly and builds up towards 2030.

Savings by Dwelling Type

Single-family dwellings account for approximately 68% of the upper Achievable Potential savings and 70% of the lower Achievable Potential savings; this reflects their larger market share and their generally higher level of energy intensity per dwelling. In fact, the subset of single-family dwellings built since 1980 account for 50% of the 2030 upper Achievable Potential and 57% of the 2030 lower Achievable Potential. This reflects the large amount of new construction expected during the study period and the substantial amount of electric heat these new dwellings are expected to include.

Savings by Supply Type and Government versus Non-government Accounts

The accounts connected to the hydro grid are expected to account for 98% of potential savings in 2030. Non-government accounts provide 97% of these savings and government accounts provide the other 1%. The large diesel, small diesel and Old Crow customers account for the remaining 2%. The diesel grid systems are a smaller portion of the potential savings than they are of the reference case consumption, because many of the most promising measures reduce electric space heating consumption and there is little or no electric space heating in those communities.

Savings by End Use

Space heating savings account for 56% of the upper Achievable Potential savings in 2030 and 55% of the lower Achievable Potential savings. The most significant measures that save space heating include high-performance new homes, heat pumps (both central units and ductless mini-splits), zone heating systems and LEED certified apartment buildings.

Space heating accounts for a very large percentage of the potential, but the space heating savings potential is also a very large percentage of the reference case space heating consumption. Between 22% and 37% of space heating could potentially be saved, respectively, in the lower and upper Achievable Potential scenarios. The potential in electrically-heated dwellings, as a percentage of their reference case consumption, is three to four times as large as it is in dwellings without electric heat.

Domestic hot water savings account for 13% of 2030 upper Achievable Potential savings and 14% of lower Achievable Potential savings. The measure that saves the most domestic hot water is the efficient clothes washer.

In the upper Achievable Potential scenario, clothes dryers account for 8% of 2030 savings and computers account for 6%. In the lower Achievable Potential scenario, clothes dryers account for 10% of 2030 savings and computers account for 5%. The reduction in clothes dryer electricity comes from the faster spin speeds in the high-efficiency clothes washers, which reduce drying time. The savings in computers and their peripherals are expected to come primarily from the use of smart power bars that reduce standby losses.

The remaining end uses are all under 5% in both scenarios. There are savings available in 13 other end uses. Together they account for 17% of upper Achievable Potential savings in 2030 and 16% of lower Achievable Potential savings in 2030.

Savings by Measure

The most significant savings in the Achievable Potential come from the following measures:

- High-performance new homes, which account for 18% of the upper Achievable Potential savings in 2030 and 31% of the lower Achievable Potential savings in 2030
- Cold temperature heat pumps, which account for 14% of the upper Achievable Potential savings in 2030 and 10% of the lower Achievable Potential savings in 2030
- ENERGY STAR® clothes washers, which account for 11% of the upper Achievable Potential savings in 2030 and 14% of the lower Achievable Potential savings in 2030
- LEED certified apartment buildings, which account for 10% of the upper Achievable Potential savings in 2030 and 8% of the lower Achievable Potential savings in 2030
- Zone heating systems, which account for 9% of the upper Achievable Potential savings in 2030 and 6% of the lower Achievable Potential savings in 2030
- Ductless mini-split systems, which account for 4% of the upper Achievable Potential savings in 2030 and 3% of the lower Achievable Potential savings in 2030
- Power bars for PCs and TVs, which account for 4% of the upper Achievable Potential savings in 2030 and 3% of the lower Achievable Potential savings in 2030.

There are numerous other smaller measures that contribute to the overall Achievable Potential results.

10.5.2 Electric Energy Savings – Upper Achievable Scenario

The following exhibits present the potential electricity savings²⁷ under the upper Achievable Potential scenario. The results shown are relative to the Reference Case. The results are broken down as follows:

- Exhibit 51 presents the results by supply system, by government versus non-government accounts, and by milestone year
- Exhibit 52 presents the results for the total Yukon service territory by dwelling type and milestone year

²⁷ Note: A value of “0” in the following exhibits means a relatively small number, not an absolute value of zero.

- Exhibit 53 presents the results for the total Yukon service territory by end use and milestone year
- Exhibit 54 presents the results for the total Yukon service territory by technology and milestone year.

Exhibit 51 Upper Achievable Electricity Savings by Supply System and Government vs Non-government Customers (MWh/yr.)

Supply System/Government vs Non-government	2015	2020	2025	2030	2030 Savings Relative to Ref Case (%)	Fraction of Total 2030 Savings (%)
Hydro Grid - Nongovt	4,836	12,958	22,732	35,893	16%	97%
Hydro Grid - Govt	71	185	323	534	15%	1%
Large Diesel - Nongovt	158	302	386	464	7%	1%
Large Diesel - Govt	9	17	21	25	7%	0%
Small Diesel - Nongovt	17	39	57	71	7%	0%
Small Diesel - Govt	4	8	11	14	7%	0%
Old Crow - Nongovt	17	38	58	83	7%	0%
Old Crow - Govt	3	7	11	15	8%	0%
Grand Total	5,114	13,554	23,599	37,098	16%	100%

Exhibit 52 Upper Achievable Electricity Savings by Dwelling Type and Milestone Year (MWh/yr.)

Dwelling Type	2015	2020	2025	2030	2030 Savings Relative to Ref Case (%)	Fraction of Total 2030 Savings (%)
1980 & newer non-electrically heated single detached homes	455	1,177	1,908	3,062	5%	14%
Pre-1980 non-electrically heated single detached homes	360	834	1,221	1,799	5%	8%
1980 & newer electrically heated single detached homes	1,185	3,622	6,212	9,481	24%	43%
Pre-1980 electrically heated single detached homes	126	385	756	1,233	11%	6%
1980 & newer non-electrically heated attached/row housing	48	123	198	318	5%	1%
Pre-1980 non-electrically heated attached/row housing	37	85	124	181	5%	1%
1980 & newer electrically heated attached/row housing	153	504	916	1,488	24%	7%
Pre-1980 electrically heated attached/row housing	11	33	64	104	10%	0%
Non-electrically heated apartment units	67	169	240	366	3%	2%
Non-electrically heated apartment common areas	52	122	125	166	5%	1%
Electrically heated apartment units	34	230	854	2,340	12%	11%
Electrically heated apartment common areas	8	51	167	453	10%	2%
Non-electrically heated mobile/other	85	199	292	436	5%	2%
Electrically heated mobile/other	30	113	274	542	11%	2%
Small diesel grid housing	18	42	64	91	4%	0%
Seasonal housing	25	51	31	21	0%	0%
Residential garages	9	19	18	21	2%	0%
Sentinel Lighting	8	32	75	137	20%	1%
Grand Total	2,711	7,792	13,539	22,240	10%	100%

Note: Any difference in totals is due to rounding.

Exhibit 53 Upper Achievable Electricity Savings by End Use and Milestone Year (MWh/yr.)

End Use	2015	2020	2025	2030	2030 Savings Relative to Ref Case (%)	Fraction of Total 2030 Savings (%)
Space heating	1,126	4,973	11,437	20,632	37%	56%
Ventilation & circulation	302	518	620	566	7%	2%
Domestic hot water (DHW)	977	2,153	3,475	4,972	16%	13%
Indoor lighting	662	1,413	882	600	5%	2%
Outdoor lighting	39	83	96	150	5%	0%
Holiday lighting	28	39	32	9	36%	0%
Refrigerator	120	362	677	837	8%	2%
Freezer	30	92	189	317	5%	1%
Dishwasher	13	37	51	64	7%	0%
Clothes washer	58	94	118	128	23%	0%
Clothes dryer	974	1,865	2,617	3,029	23%	8%
Spa heaters and pumps	133	210	316	476	7%	1%
Computer and peripherals	331	721	1,357	2,342	10%	6%
Television	194	650	934	1,236	17%	3%
Set-top boxes	-	-	35	111	3%	0%
Home entertainment electronics	10	37	172	647	5%	2%
Block heaters & car warmers	117	307	589	983	23%	3%
Grand Total	5,114	13,554	23,599	37,098	16%	100%

Note: DHW savings include savings from reduced DHW consumption by efficient clothes washers and dishwashers. Any difference in totals is due to rounding.

Exhibit 54 Upper Achievable Electricity Savings by Technology and Milestone Year (MWh/yr.)

End Use	Measure	2015	2020	2025	2030	Adoption Curve	Weighted Average CCE (¢/kWh)
Space Heating	High-Perf. New Homes	674	2,830	5,266	7,187	D-2017	9.6
Clothes Dryer/DHW/Washer	ESTAR Clothes Washers	1,475	2,757	3,823	4,381	C	15.5
Space Heating	Cold Temp Heat Pumps	286	1,238	2,929	5,465	B	18.2
Space Heating	Zone Heating	136	644	1,689	3,481	B	15.0
Space Heating	LEED Apartments	30	308	1,313	3,847	B	10.2
Space Heating	Ductless Mini-Splits	82	357	850	1,595	B	13.3
Computer and peripherals	Power Bars (PCs)	131	349	650	1,007	A/B	8.4
Television	ESTAR TVs	143	518	660	725	C	24.1
Indoor lighting	CFLs - Indoor	515	1,054	442	-	F	1.1
Refrigerator	ESTAR Refrigerators	120	362	677	837	C	6.2
Ventilation & circulation	Furnace Motors	296	489	556	449	A	21.0
Computer/Television/Electr.	Future Elec Improvement	-	-	350	1,392	B	11.5
Computer and peripherals	ESTAR Printers and Fax	200	372	518	647	C	15.9
Block heaters & car warmers	Block Heater Timers	96	252	482	806	A/B	4.7
Domestic hot water (DHW)	Showerheads	215	368	481	560	A	0.8
Space Heating	Prog. Thermostats (Central)	141	260	355	428	A	0.9
Television/Set top boxes	Power Bars (TVs)	61	169	321	563	A/B	14.1
Space Heating	Outdoor Temp Reset	23	108	284	591	B	8.9
Domestic hot water (DHW)	DHW Recirculation	23	106	271	540	B	14.2
DWH/Dishwasher	ESTAR Dishwashers	73	204	276	330	C	12.6
Domestic hot water (DHW)	DHW Tank Insulation	78	157	245	338	A	7.4
Indoor lighting	LED Lamps	26	99	241	451	B	11.4
Domestic hot water (DHW)	DHW Piping Optimization	20	92	233	458	B	21.1
Domestic hot water (DHW)	DHW Pipe Insulation	61	123	192	266	A	0.2
Freezer	ESTAR Freezers	30	92	189	317	C	13.2
Space Heating	Wall Insulation	22	85	183	311	B	21.0
Space Heating	Prog. Thermostats	58	114	166	215	A	4.2
Spa heaters and pumps	Heat Pump Spa Heaters	58	87	123	173	A/B	5.7
Spa heaters and pumps	Hot Tub Pump Timers	43	71	111	175	A/B	1.0

End Use	Measure	2015	2020	2025	2030	Adoption Curve	Weighted Average CCE (¢/kWh)
Space Heating	Attic Insulation	13	49	104	174	B	8.4
Space Heating	Ground Heat Pumps - Closed	7	31	85	163	B	33.4
Domestic hot water (DHW)	Wastewater Heat Recovery	5	26	74	159	B	17.6
Indoor lighting	PAR CFLs	66	133	55	-	F	8.9
Outdoor lighting	Pulse start metal halide sentinel lights	8	32	75	137	A	3.8
Space Heating	Solar Pre-heat Makeup Air	5	26	69	137	B	28.6
Space Heating	Sealing & Insul. - Old Homes	8	33	72	125	B	11.0
Block heaters & car warmers	Car Warmer Timers	12	31	60	100	A/B	2.0
Spa heaters and pumps	Spa Pumps	21	35	54	85	A/B	23.1
Indoor lighting	T8 Fixtures	4	23	63	84	B	14.8
Block heaters & car warmers	Battery Blanket Timers	9	24	46	77	A/B	22.7
Space Heating	Air Sealing	5	21	47	81	B	11.9
Indoor lighting	Dimmable CFLs	37	75	32	-	F	6.7
Indoor lighting	Spot or Task Lighting	9	18	28	35	A/B	8.3
Outdoor lighting	CFLs - Outdoor	29	45	12	-	F	1.7
Space Heating	Basement Insulation	6	17	25	21	B	9.2
Indoor lighting	Motion Detectors - Indoor	5	11	20	30	A/B	5.1
Spa heaters and pumps	Solar Spa Pre-heat	7	12	18	29	A/B	5.2
Holiday lighting	LED Holiday - Outdoor	17	23	19	5	A	7.9
Space Heating	HRVs	1	7	20	30	B	24.8
Space Heating	Triple-glazed Windows	1	6	16	34	B	21.5
Holiday lighting	LED Holiday - Indoor	12	16	13	4	A	29.3
Space Heating	Slab Insulation	2	6	12	19	B	24.2
Spa heaters and pumps	Hot Tub Covers	4	6	9	15	A/B	2.0
Outdoor lighting	Motion Detectors - Outdoor	3	6	9	13	A/B	4.8
Space Heating	Optimizing Glazing for Passive	0	2	4	9	B	26.0
Space Heating	Quadruple-glazed Windows	0	1	2	3	B	26.0
Space Heating	Crawl Space Insulation	0	0	1	1	B	20.7
Grand Total		5,410	14,378	24,923	39,105		12.5

Note: The grand totals are slightly higher than in the previous two exhibits because the interactive effects of the internal load reductions on space heating are omitted from this exhibit.

Curves A, B, and C in this exhibit are as presented in Exhibit 48. Curve D-2017 is the shape of curve D from Exhibit 48, with the curve levelling off after 2017. Curve A/B was called "shallow B" by the participants and is halfway between curves A and B. Curve F is shaped like a bell curve and is used because compact fluorescents are expected to be superseded in the marketplace by LEDs after approximately 2020.

10.5.3 Electric Energy Savings – Lower Achievable Scenario

The following exhibits present the potential electricity savings²⁸ under the lower Achievable Potential scenario. The results shown are relative to the Reference Case. The results are broken down as follows:

- Exhibit 55 presents the results by supply system, by government versus non-government accounts, and by milestone year
- Exhibit 56 presents the results for the total Yukon by dwelling type and milestone year
- Exhibit 57 presents the results for the total Yukon by end use and milestone year
- Exhibit 58 presents the results for the total Yukon by technology and milestone year.

Exhibit 55 Lower Achievable Electricity Savings by Supply System and Government vs. government Customers (MWh/yr.)

Supply System/Government vs Non-government	2015	2020	2025	2030	2030 Savings Relative to Ref Case (%)	Fraction of Total 2030 Savings (%)
Hydro Grid - Nongovt	2,602	7,514	13,094	21,537	10%	97%
Hydro Grid - Govt	35	99	173	301	9%	1%
Large Diesel - Nongovt	53	126	193	286	4%	1%
Large Diesel - Govt	3	7	10	15	4%	0%
Small Diesel - Nongovt	8	20	30	40	4%	0%
Small Diesel - Govt	2	4	5	7	3%	0%
Old Crow - Nongovt	8	19	29	45	4%	0%
Old Crow - Govt	1	3	5	8	4%	0%
Grand Total	2,711	7,792	13,539	22,240	10%	100%

²⁸ A value of "0" in the following exhibits means a relatively small number, not an absolute value of zero.

Exhibit 56 Lower Achievable Electricity Savings by Dwelling Type and Milestone Year (MWh/yr.)

Dwelling Type	2015	2020	2025	2030	2030 Savings Relative to Ref Case (%)	Fraction of Total 2030 Savings (%)
1980 & newer non-electrically heated single detached homes	455	1,177	1,908	3,062	5%	14%
Pre 1980 non-electrically heated single detached homes	360	834	1,221	1,799	5%	8%
1980 & newer electrically heated single detached homes	1,185	3,622	6,212	9,481	24%	43%
Pre-1980 electrically heated single detached homes	126	385	756	1,233	11%	6%
1980 & newer non-electrically heated attached/row housing	48	123	198	318	5%	1%
Pre 1980 non-electrically heated attached/row housing	37	85	124	181	5%	1%
1980 & newer electrically heated attached/row housing	153	504	916	1,488	24%	7%
Pre-1980 electrically heated attached/row housing	11	33	64	104	10%	0%
Non-electrically heated apartment units	67	169	240	366	3%	2%
Non-electrically heated apartment common areas	52	122	125	166	5%	1%
Electrically heated apartment units	34	230	854	2,340	12%	11%
Electrically heated apartment common areas	8	51	167	453	10%	2%
Non-electrically heated mobile/other	85	199	292	436	5%	2%
Electrically heated mobile/other	30	113	274	542	11%	2%
Small diesel grid housing	18	42	64	91	4%	0%
Seasonal housing	25	51	31	21	0%	0%
Residential garages	9	19	18	21	2%	0%
Sentinel Lighting	8	32	75	137	20%	1%
Grand Total	2,711	7,792	13,539	22,239	10%	100%

Note: Any difference in totals is due to rounding.

Exhibit 57 Lower Achievable Electricity Savings by End Use and Milestone Year (MWh/yr.)

End Use	2015	2020	2025	2030	2030 Savings Relative to Ref Case (%)	Fraction of Total 2030 Savings (%)
Space heating	1,195	3,851	7,294	12,272	22%	55%
Ventilation & circulation	121	217	268	266	3%	1%
Domestic hot water (DHW)	461	1,153	1,993	3,064	10%	14%
Indoor lighting	526	1,127	700	473	4%	2%
Outdoor lighting	32	71	89	144	4%	1%
Holiday lighting	25	35	29	8	32%	0%
Refrigerator	18	99	271	399	4%	2%
Freezer	4	26	80	184	3%	1%
Dishwasher	1	8	16	26	3%	0%
Clothes washer	7	25	55	97	18%	0%
Clothes dryer	113	498	1,229	2,285	18%	10%
Spa heaters and pumps	37	97	188	332	5%	1%
Computer and peripherals	89	240	552	1,087	5%	5%
Television	42	182	315	527	7%	2%
Set-top boxes	-	-	18	55	1%	0%
Home entertainment electronics	5	19	86	326	3%	1%
Block heaters & car warmers	33	145	356	693	16%	3%
Grand Total	2,711	7,792	13,539	22,240	10%	100%

Note: DHW savings include savings from reduced DHW consumption by efficient clothes washers and dishwashers. Any difference in totals is due to rounding.

Exhibit 58 Lower Achievable Electricity Savings by Technology and Milestone Year (MWh/yr.)

End Use	Measure	2015	2020	2025	2030	Adoption Curve	Weighted Average CCE (¢/kWh)
Space Heating	High-Perf. New Homes	1,158	3,406	5,286	7,211	D-2022	9.6
Clothes Dryer/DHW/Washer	ESTAR Clothes Washers	171	735	1,790	3,284	B	15.8
Space Heating	Cold Temp Heat Pumps	98	444	1,147	2,289	B	18.3
Space Heating	LEED Apartments	15	154	659	1,931	B	10.2
Space Heating	Zone Heating	48	240	686	1,506	B	15.6
Indoor lighting	CFLs - Indoor	412	843	354	-	F	1.1
Domestic hot water (DHW)	Showerheads	167	285	372	432	A	0.8
Space Heating	Ductless Mini-Splits	28	131	346	699	B	13.4
Computer and peripherals	Power Bars (PCs)	66	174	325	504	A/B	8.4
Block heaters & car warmers	Block Heater Timers	27	119	292	568	B	4.7
Computer/Television/Electr.	Future Elec Improvement	-	-	182	731	B	11.5
Refrigerator	ESTAR Refrigerators	18	99	271	399	B	6.3
Ventilation and circulation	Furnace Motors	112	186	214	178	A	20.8
Indoor lighting	LED Lamps	21	83	200	372	B	11.4
Domestic hot water (DHW)	DHW Tank Insulation	60	122	189	261	A	7.4
Television	ESTAR TVs	17	116	175	259	B	24.1
Television/Set top boxes	Power Bars (TVs)	30	85	161	281	A/B	14.1
Domestic hot water (DHW)	DHW Pipe Insulation	47	96	148	205	A	0.2
Space Heating	Prog. Thermostats (Central)	53	99	137	167	A	0.9
Computer and peripherals	ESTAR Printers and Fax	23	66	128	220	B	15.9
Space Heating	Outdoor Temp Reset	8	40	115	253	B	9.3
Freezer	ESTAR Freezers	4	26	80	184	B	13.3
DHW/Dishwasher	ESTAR Dishwashers	9	45	81	128	B	13.3
Outdoor lighting	Pulse start metal halide sentinel lights	8	32	75	137	A	3.8
Spa heaters and pumps	Heat Pump Spa Heaters	15	38	70	115	B	5.7
Spa heaters and pumps	Hot Tub Pump Timers	12	34	68	125	B	1.0
Indoor lighting	PAR CFLs	53	106	44	-	F	8.9
Space Heating	Prog. Thermostats	19	38	57	75	A	4.2
Domestic hot water (DHW)	DHW Recirculation	4	20	51	101	B	14.4

End Use	Measure	2015	2020	2025	2030	Adoption Curve	Weighted Average CCE (¢/kWh)
Domestic hot water (DHW)	DHW Piping Optimization	4	17	44	87	B	21.5
Space Heating	Ground Heat Pumps - Closed	2	12	39	93	B	33.6
Indoor lighting	T8 Fixtures	4	19	52	69	B	14.8
Block heaters & car warmers	Car Warmer Timers	3	15	36	71	B	2.1
Spa heaters and pumps	Spa Pumps	6	17	33	61	B	23.3
Indoor lighting	Dimmable CFLs	30	60	25	-	F	6.7
Space Heating	Solar Pre-heat Makeup Air	2	11	31	70	B	28.9
Space Heating	Wall Insulation	4	15	32	55	B	21.0
Block heaters & car warmers	Battery Blanket Timers	3	11	28	54	B	22.9
Indoor lighting	CFLs - Outdoor	23	36	10	-	F	1.7
Holiday lighting	LED Holiday - Outdoor	17	23	19	5	A	7.9
Space Heating	Attic Insulation	2	9	18	31	B	8.4
Domestic hot water (DHW)	Wastewater Heat Recovery	1	5	14	31	B	18.3
Indoor lighting	Spot or Task Lighting	5	9	14	18	A/B	8.3
Space Heating	Sealing & Insul. - Old Homes	1	6	13	22	B	11.0
Spa heaters and pumps	Solar Spa Pre-heat	2	6	11	21	B	5.2
Indoor lighting	Motion Detectors - Indoor	3	6	10	15	A/B	5.1
Holiday lighting	LED Holiday - Indoor	9	12	10	3	A	29.3
Space Heating	Air Sealing	1	4	8	14	B	11.9
Space Heating	HRVs	0	2	7	11	B	24.8
Spa heaters and pumps	Hot Tub Covers	1	3	6	11	B	2.0
Outdoor lighting	Motion Detectors - Outdoor	1	3	5	6	A/B	4.8
Space Heating	Basement Insulation	1	3	4	4	B	9.2
Space Heating	Triple-glazed Windows	0	1	3	6	B	21.5
Space Heating	Slab Insulation	0	1	2	3	B	24.2
Space Heating	Optimizing Glazing for Passive	0	0	1	2	B	26.0
Space Heating	Quadruple-glazed Windows	0	0	0	1	B	26.0
Space Heating	Crawl Space Insulation	0	0	0	0	B	20.7
Grand Total		4,843	10,186	16,205	25,407		11.3

Note: The grand totals are slightly higher than in the previous two exhibits because the interactive effects of the internal load reductions on space heating are omitted from this exhibit.

Curves A, B, and C in this exhibit are as presented in Exhibit 48. Curve D-2022 is the shape of curve D from Exhibit 48, with the curve levelling off after 2022. Curve A/B was called "shallow B" by the participants and is halfway between curves A and B. Curve F is shaped like a bell curve and is used because compact fluorescents are expected to be superseded in the marketplace by LEDs after approximately 2020.

10.6 Summary of Electric Peak Load Reductions

This section presents a summary of the electric peak load reductions that would result from the electric energy savings presented above for the upper and lower achievable scenarios. The summary is organized and presented in the following sub sections:

- Overview and selected highlights
- Electric peak load reductions – Upper Achievable scenario
- Electric peak load reductions – Lower Achievable scenario

10.6.1 Overview and Selected Highlights

Exhibit 59 presents an overview of the results for the total Yukon service territory by milestone year for each of the achievable potential scenarios. As illustrated, by 2030 peak load reductions resulting from implementation of the energy-efficiency measures are estimated to range from 10.5 MW to 6.4 MW (19% to 12% of Reference Case demand) for the upper and lower Achievable Potential scenarios, respectively. Additional highlights are provided below.

Exhibit 59 Electric Peak Load Reductions for Upper and Lower Achievable Potential Scenarios (MW)

Scenario	Milestone Year	Period 1 Annual Peak Hour		Period 2 Evening Peak Period		Period 3 Morning Peak Period	
Upper Achievable	2015	1.3	3%	1.3	4%	0.8	3%
	2020	3.6	9%	3.6	9%	2.3	8%
	2025	6.5	14%	6.4	15%	4.3	14%
	2030	10.5	19%	10.4	20%	7.0	19%
Lower Achievable	2015	0.8	2%	0.8	2%	0.5	2%
	2020	2.3	6%	2.3	6%	1.5	5%
	2025	3.9	8%	3.9	9%	2.6	8%
	2030	6.4	12%	6.4	12%	4.2	11%

Selected Highlights – Potential Electric Peak Load Reductions

Most measures contribute to the peak demand reductions approximately in proportion to their electric energy savings. There are some notable exceptions. Block heaters are used at times that coincide closely with the utility peak, so their demand reduction would be disproportionate to their share of the electricity consumption savings. The potential reduction from block heater timers is even more significant than this would suggest, however, because the timer measure changes the load shape by moving the consumption almost entirely off the utility peak. Block heater timers offer the second largest potential for reducing peak demand in the Residential sector.

In contrast, the central heat pump and ductless mini-split systems, which both offer considerable electric energy savings potential, provide no reduction in peak electrical demand. This is because the utility peak occurs during the coldest period of the heating season, when these systems cease to operate as heat pumps and make use of their electric resistance backup heating elements.

Further discussion of the electric peak load reductions under the upper Achievable Potential forecast and the lower Achievable Potential forecast are presented in the following sub sections.

10.6.2 Electric Peak Load Reductions Under the Upper Achievable Potential Scenario

Exhibit 60 presents a summary of the peak load reductions that would occur as a result of the electric energy savings contained in the upper Achievable Potential forecast. The reductions are shown by milestone year and peak period. In each case, the reductions are an average value over the peak period and are defined relative to the Reference Case presented previously in Section 4. Exhibit 61 shows the same information graphically for the Annual Peak Hour.

As discussed in Section 8.7, Exhibit 60 and Exhibit 61 approximate the potential demand impacts associated with the energy-efficiency measures because they are based on the assumption that the measures do not change the load shape of the end uses they affect. Exhibit 62, which shows the demand reductions associated with each electric energy savings measure, uses a more accurate estimate of block heater load reduction that accounts for the fact that use of the timer both reduces electric energy use and changes the shape of the block heater load.

Exhibit 60 Electric Peak Load Reductions from Upper Achievable Energy Savings Measures, by Milestone Year, Peak Period and Dwelling Type (MW)

Dwelling Type	Milestone Year	Period 1 Annual Peak Hour	Period 2 Evening Peak Period	Period 3 Morning Peak Period
Single Detached Houses	2015	1.0	1.0	0.6
	2020	2.8	2.7	1.8
	2025	4.8	4.7	3.2
	2030	7.1	7.0	4.9
Apartment/Condo Buildings	2015	0.1	0.1	0.0
	2020	0.3	0.3	0.2
	2025	0.8	0.8	0.5
	2030	1.9	1.9	1.2
Attached/Row Houses	2015	0.1	0.1	0.1
	2020	0.3	0.3	0.2
	2025	0.5	0.5	0.3
	2030	0.9	0.9	0.6
Mobile Homes	2015	0.1	0.1	0.0
	2020	0.2	0.2	0.1
	2025	0.3	0.3	0.2
	2030	0.5	0.5	0.4
Small Grid Housing	2015	0.01	0.01	0.01
	2020	0.02	0.02	0.01
	2025	0.03	0.03	0.02
	2030	0.03	0.03	0.02
Seasonal and Garages	2015	0.01	0.01	0.01
	2020	0.03	0.03	0.01
	2025	0.02	0.03	0.01
	2030	0.02	0.03	0.01
Sentinel Lighting	2015	0.00	0.00	0.00
	2020	0.01	0.01	0.01
	2025	0.02	0.02	0.02
	2030	0.03	0.03	0.03
Grand Total	2015	1.3	1.3	0.8
	2020	3.6	3.6	2.3
	2025	6.5	6.4	4.3
	2030	10.5	10.4	7.0

Exhibit 61 Electric Peak Load Reductions from Upper Achievable Energy Savings Measures, by Milestone Year and Dwelling Type, Annual Peak Hour (MW)

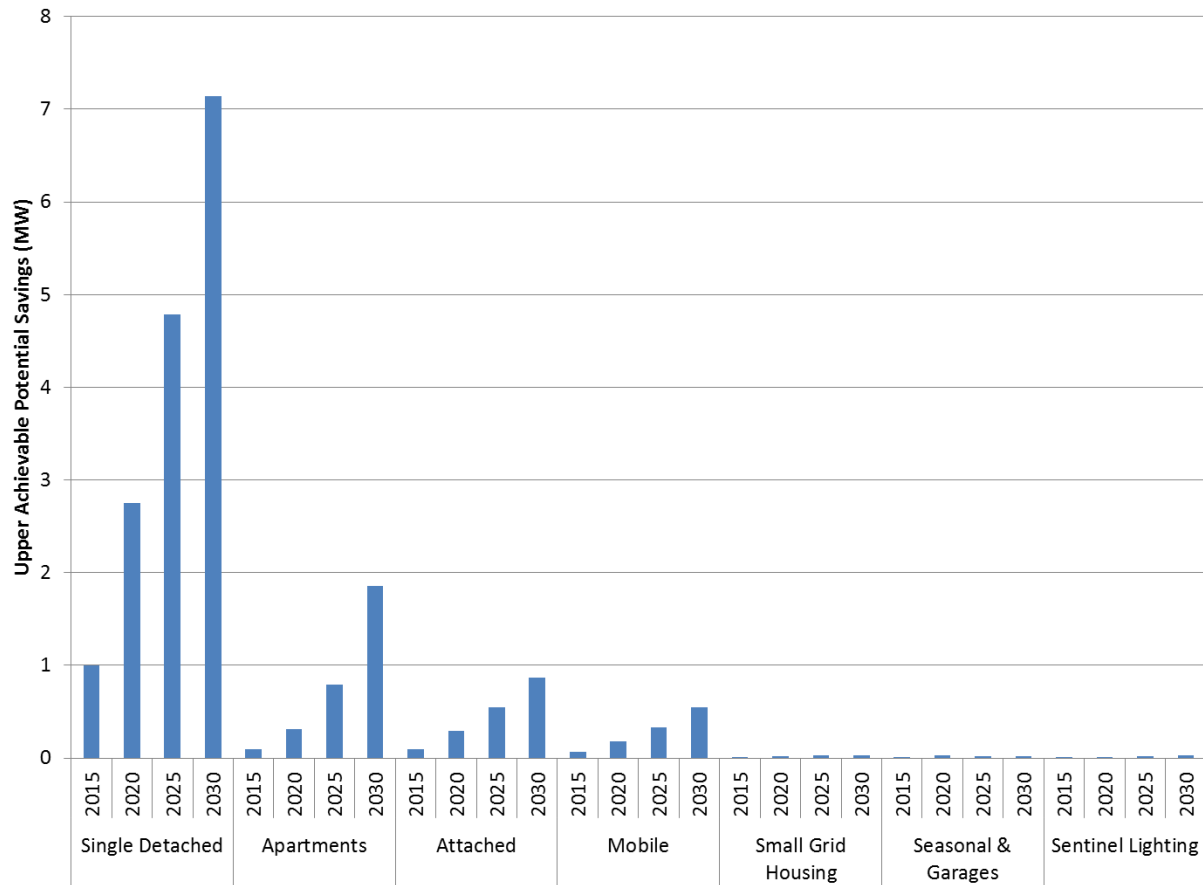


Exhibit 62 Electric Peak Load Reductions from Upper Achievable Energy Savings Measures, 2030 (MW)

Measure	Period 1	Period 2	Period 3
	Annual Peak Hour	Evening Peak Period	Morning Peak Period
High-Perf. New Homes	2.37	2.33	1.71
Block Heater Timers	1.75	2.19	0.00
Zone Heating	1.24	1.22	0.80
LEED Apartments	1.22	1.22	0.82
ESTAR Clothes Washers	0.95	0.81	0.42
Future Elec Improvement	0.21	0.21	0.16
Outdoor Temp Reset	0.21	0.21	0.14
Prog. Thermostats (Central)	0.15	0.15	0.10
Power Bars (PCs)	0.15	0.15	0.11
ESTAR TVs	0.11	0.11	0.08
Wall Insulation	0.11	0.11	0.07
LED Lamps	0.11	0.12	0.05
ESTAR Refrigerators	0.11	0.10	0.08
ESTAR Printers and Fax	0.10	0.10	0.07
Power Bars (TVs)	0.09	0.09	0.06
Prog. Thermostats	0.08	0.08	0.05
Furnace Motors	0.07	0.07	0.07
Car Warmer Timers	0.07	0.08	0.00
Attic Insulation	0.06	0.06	0.04
Ground Heat Pumps - Closed	0.06	0.06	0.04
Battery Blanket Timers	0.05	0.06	0.00
Showerheads	0.05	0.06	0.14
Solar Pre-heat Makeup Air	0.05	0.05	0.03
DHW Recirculation	0.05	0.05	0.14
Sealing & Insul. - Old Homes	0.04	0.04	0.03
DHW Piping Optimization	0.04	0.05	0.12
ESTAR Freezers	0.04	0.04	0.03
ESTAR Dishwashers	0.03	0.04	0.08
Pulse start metal halide sentinel lights	0.03	0.03	0.03
DHW Tank Insulation	0.03	0.03	0.09
Air Sealing	0.03	0.03	0.02
Hot Tub Pump Timers	0.03	0.03	0.02
Heat Pump Spa Heaters	0.03	0.02	0.02
DHW Pipe Insulation	0.02	0.03	0.07
T8 Fixtures	0.02	0.02	0.01
LED Holiday - Outdoor	0.02	0.02	0.00
Wastewater Heat Recovery	0.01	0.02	0.04
LED Holiday - Indoor	0.01	0.01	0.00
Spa Pumps	0.01	0.01	0.01
Triple-glazed Windows	0.01	0.01	0.01
HRVs	0.01	0.01	0.01
Spot or Task Lighting	0.01	0.01	0.00
Basement Insulation	0.01	0.01	0.00
Motion Detectors - Indoor	0.01	0.01	0.00
Slab Insulation	0.01	0.01	0.00
Solar Spa Pre-heat	0.00	0.00	0.00
Optimizing Glazing for Passive	0.00	0.00	0.00
Motion Detectors - Outdoor	0.00	0.00	0.00
Hot Tub Covers	0.00	0.00	0.00
Quadruple-glazed Windows	0.00	0.00	0.00
Crawl Space Insulation	0.00	0.00	0.00
Grand Total	9.90	10.17	5.80

10.6.3 Electric Peak Load Reductions Under the Lower Achievable Potential Scenario

Exhibit 63 presents a summary of the peak load reductions that would occur as a result of the electric energy savings contained in lower Achievable Potential forecast. The reductions are shown by milestone year and peak period. In each case, the reductions are an average value over the peak period and are defined relative to the Reference Case presented previously in Section 4. Exhibit 64 shows the same information graphically for the Annual Peak Hour.

As discussed in Section 8.7, Exhibit 63 and Exhibit 64 approximate the potential demand impacts associated with the energy-efficiency measures because they are based on the assumption that the measures do not change the load shape of the end uses they affect. Exhibit 65, which shows the demand reductions associated with each electric energy savings measure, uses a more appropriate estimate of block heater load reduction that accounts for the fact that use of the timer both reduces electric energy use and changes the shape of the block heater load.

Exhibit 63 Electric Peak Load Reductions from Lower Achievable Energy Savings Measures, by Milestone Year, Peak Period and Dwelling Type (MW)

Dwelling Type	Milestone Year	Period 1 Annual Peak Hour	Period 2 Evening Peak Period	Period 3 Morning Peak Period
Single Detached Houses	2015	0.6	0.6	0.4
	2020	1.8	1.8	1.2
	2025	3.0	2.9	2.0
	2030	4.5	4.5	3.0
Apartment/Condo Buildings	2015	0.0	0.1	0.0
	2020	0.2	0.2	0.1
	2025	0.4	0.4	0.2
	2030	1.0	1.0	0.6
Attached/Row Houses	2015	0.1	0.1	0.0
	2020	0.2	0.2	0.1
	2025	0.4	0.4	0.2
	2030	0.6	0.6	0.4
Mobile Homes	2015	0.0	0.0	0.0
	2020	0.1	0.1	0.1
	2025	0.1	0.1	0.1
	2030	0.3	0.3	0.2
Sentinel Lighting	2015	0.00	0.00	0.00
	2020	0.01	0.01	0.01
	2025	0.02	0.02	0.02
	2030	0.03	0.03	0.03
Seasonal and Garages	2015	0.01	0.01	0.00
	2020	0.02	0.02	0.01
	2025	0.01	0.02	0.00
	2030	0.02	0.02	0.00
Small Grid Housing	2015	0.00	0.00	0.00
	2020	0.01	0.01	0.01
	2025	0.01	0.01	0.01
	2030	0.02	0.02	0.01
Grand Total	2015	0.8	0.8	0.5
	2020	2.3	2.3	1.5
	2025	3.9	3.9	2.6
	2030	6.4	6.4	4.2

Exhibit 64 Electric Peak Load Reductions from Lower Achievable Energy Savings Measures, by Milestone Year and Dwelling Type, Annual Peak Hour (MW)

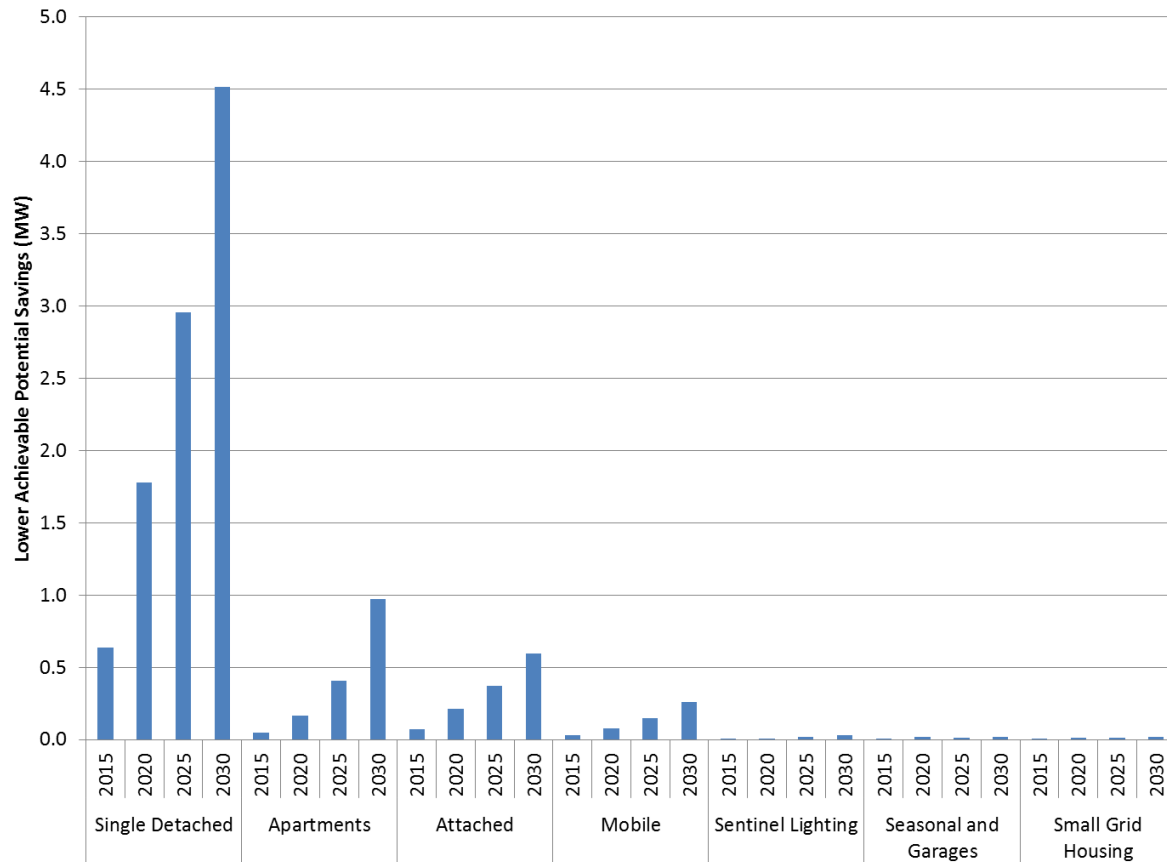


Exhibit 65 Electric Peak Load Reductions from Lower Achievable Energy Savings Measures, 2030 (MW)

Measure	Period 1 Annual Peak Hour	Period 2 Evening Peak Period	Period 3 Morning Peak Period
High-Perf. New Homes	2.38	2.33	0.02
Block Heater Timers	1.23	1.54	0.00
ESTAR Clothes Washers	0.72	0.61	0.17
LEED Apartments	0.61	0.61	0.41
Zone Heating	0.54	0.53	0.35
Future Elec Improvement	0.11	0.11	0.03
Outdoor Temp Reset	0.09	0.09	0.06
LED Lamps	0.09	0.10	0.04
Power Bars (PCs)	0.07	0.08	0.06
Prog. Thermostats (Central)	0.06	0.06	0.04
ESTAR Refrigerators	0.05	0.05	0.02
Car Warmer Timers	0.05	0.06	0.00
Power Bars (TVs)	0.04	0.04	0.03
ESTAR TVs	0.04	0.04	0.04
Showerheads	0.04	0.04	0.11
Battery Blanket Timers	0.04	0.05	0.00
Ground Heat Pumps - Closed	0.03	0.03	0.08
ESTAR Printers and Fax	0.03	0.03	0.02
Pulse start metal halide sentinel lights	0.03	0.03	0.03
Furnace Motors	0.03	0.03	0.03
Prog. Thermostats	0.03	0.03	0.02
Solar Pre-heat Makeup Air	0.02	0.02	0.02
ESTAR Freezers	0.02	0.02	0.03
DHW Tank Insulation	0.02	0.03	0.03
LED Holiday - Outdoor	0.02	0.02	0.00
Wall Insulation	0.02	0.02	0.01
Hot Tub Pump Timers	0.02	0.02	0.02
DHW Pipe Insulation	0.02	0.02	0.00
Heat Pump Spa Heaters	0.02	0.02	0.02
T8 Fixtures	0.02	0.02	0.01
ESTAR Dishwashers	0.01	0.02	0.31
Attic Insulation	0.01	0.01	0.00
LED Holiday - Indoor	0.01	0.01	0.00
Spa Pumps	0.01	0.01	0.01
DHW Recirculation	0.01	0.01	0.02
Sealing & Insul. - Old Homes	0.01	0.01	0.01
DHW Piping Optimization	0.01	0.01	0.05
Air Sealing	0.00	0.00	1.72
Spot or Task Lighting	0.00	0.00	0.00
HRVs	0.00	0.00	0.00
Motion Detectors - Indoor	0.00	0.00	0.00
Solar Spa Pre-heat	0.00	0.00	0.00
Wastewater Heat Recovery	0.00	0.00	0.01
Triple-glazed Windows	0.00	0.00	0.00
Hot Tub Covers	0.00	0.00	0.00
Motion Detectors - Outdoor	0.00	0.00	0.00
Basement Insulation	0.00	0.00	0.01
Slab Insulation	0.00	0.00	0.00
Optimizing Glazing for Passive	0.00	0.00	0.00
Quadruple-glazed Windows	0.00	0.00	0.00
Crawl Space Insulation	0.00	0.00	0.55
Grand Total	6.60	6.78	4.37

11 References

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12 Glossary

Achievable Potential:

The portion of the economic conservation potential that is achievable through government and utility interventions and programs given institutional, economic and market barriers.

Avoided Cost:

By reducing electricity consumption and capacity requirements through the implementation of demand-side management programs, the Yukon utilities avoid the cost of having to buy electricity on the open market, contract for long term supply, and/or build and run new generation facilities. This avoided cost is used to develop a benchmark against which the cost of energy efficiency measures can be compared.

Base Year:

The base year for the 2011 CPR is the 2010 sales for the two utilities. This number is derived from 2010 sales and forecast 2010 electric energy and capacity requirements as is explained in each report.

Benchmark for Economic Analysis:

The study established benchmarks for the economic cut-off for new avoided electrical supply on each of the four different supply systems in Yukon. These values were selected to provide the CPR study with a reasonably useful time horizon (life) to allow planners to examine options that may become more cost-effective over time. The following values were used:

- Residential accounts on the Hydro Grid: \$0.35/kWh
- Residential accounts on Large Diesel and Small Diesel systems: \$0.30/kWh
- Residential accounts on the Old Crow system: \$0.64/kWh.

Cost of Conserved Energy (CCE):

The CCE is calculated for each energy-efficiency measure. The CCE is the annualized incremental capital and operating and maintenance (O&M) cost of the upgrade measure divided by the annual energy savings achieved, excluding any administrative or program costs. The CCE represents the cost of conserving one kWh of electricity; it can be compared directly to the cost of supplying one new kWh of electricity.

Cost of Electric Peak Reduction (CEPR):

The CEPR for a peak load reduction measure is defined as the annualized incremental capital and O&M cost of the measure divided by the annual peak reduction achieved, excluding any administrative or program costs. The CEPR represents the cost of reducing one kW of electricity during a peak period; it can be compared to the cost of supplying one new kW of electric capacity during the same period.

Demand-side Management (DSM):

DSM is the influencing of customers' electricity use to obtain desirable and quantifiable changes in that use. For example, DSM comprises such cooperative joint customer and utility initiatives as peak clipping, valley filling, load shifting, strategic conservation, strategic load growth, flexible load shape, customer on-site generation and other similar activities.

Economic Potential:

The Economic Potential is the savings in electricity consumption due to energy efficient measures whose Cost of Conserved Energy (CCE) is less than or equal to the Benchmark for Economic Analysis.

Effective Measure Life (EML):

The estimated median number of years that the measures installed under a program are still in place and operable. EML incorporates: field conditions, obsolescence, building remodelling, renovation, demolition, and occupancy changes.

Electricity Audit:

An on-site inspection and cataloguing of electricity-using equipment/buildings, electricity consumption and the related end uses. The purpose is to provide information to the customer and the utility. Audits are useful for load research, for DSM program design, and identifying specific energy savings projects.

Electric Capacity:

The maximum electric power that a device or network is capable of producing or transferring.

Electricity Conservation:

Activities by utilities or electricity users that result in a reduction of electric energy use without adversely affecting the level or quality of energy service provided. Electricity conservation measures include substitution of high-efficiency motors for standard efficiency ones, occupancy sensors in office buildings, insulation in residences, etc.

Electricity Efficiency:

The ratio of the useful energy delivered by a dynamic system to the amount of electric energy supplied to it.

Electric Energy:

Energy in the form of electricity. Energy is the ability to perform work. Electric energy is different from electric power. Electric energy is measured in kilowatt-hours, megawatt-hours or gigawatt-hours.

Electricity Intensity:

Electric energy use measured per application or end use. Examples would include kilowatt-hours per square meter of lit office space per day, kilowatt-hours per tonne of potash produced, and kilowatt-hours per year per residential refrigerator. Electricity intensity increases as electricity efficiency decreases.

Electric Power:

The rate at which electric energy is produced or transferred, usually measured in watts, kilowatts and megawatts.

End use:

The services of economic value to the users of energy. For example, office lighting is an end use, whereas electricity sold to the office tenant is of no value without the equipment (light fixtures, wiring, etc.) necessary to convert the electricity into visible light. End use is often used interchangeably with energy service.

Energy Service:

An amenity or service supplied jointly by energy and other components such as buildings, motors and lights. Examples of energy services include residential space heating, commercial refrigeration, natural gas production, and lighting. The same energy service can frequently be supplied with different mixes of equipment and energy.

Financial Incentive:

Certain financial features in the utility's demand-side management programs designed to motivate customer participation. These may include features designed to reduce a customer's net cash outlay, pay-back period or cost of finance to participate in a specific demand-side management measure or technology.

Flexible Load Shape:

This is utility action to present customers with variations in service quality in exchange for incentives. Programs involved may be variations of interruptible or curtail-able load, concepts of pooled, integrated energy management systems, or individual customer load control devices offering service constraints.

Gigawatt-hour (GWh):

One gigawatt-hour is one million kilowatt-hours.

Integrated Planning or Integrated Resource Planning (IRP):

See Supply Planning.

Integrated Electricity Planning (IEP):

See Supply Planning.

Kilowatt (kW):

One thousand watts; the basic unit of measurement of electric energy. One kilowatt-hour represents the power of one thousand watts (one kilowatt) for a period of one hour. A typical non-electrically heated detached home in Yukon uses about 12,800 kWh per year. A four foot fluorescent lamp in an office might use about 100-200 kWh per year and a large coal-fired plant might produce about three billion kWh per year.

Levelized Cost of Conservation (LCC):

The LCC is calculated for each energy efficiency measure. The LCC is the annualized incremental capital and O&M cost of the measure divided by the annual energy conserved, excluding any administrative or program costs. The LCC represents the cost of generating or conserving one kWh of electricity; it can be compared directly to the cost of supplying one new kWh of electricity. In the context of residential energy efficiency measures, it is essentially the same as the cost of conserved energy (CCE), which is the term used in this report.

Load Forecast:

This is a forecast of electricity demand over a specified time period. Long-term load forecasts usually pertain to a 10 to 20-year period. In the case of Yukon, the load forecast assumes a specific set of rates or prices for electricity and competing energy forms, as well as many other economic variables. In addition, forecasts of electricity conserved through DSM programs are incorporated into the Supply Planning process.

Load Research:

Research to disaggregate and analyze patterns of electricity consumption by various sub-sectors and end uses is defined as load research. Load research supports the development of the load forecast and the design of demand-side management programs.

Load Shape:

The time pattern and magnitude of a utility's electrical demand.

Load Shifting:

Utility program activity to shift demand from peak to off-peak periods is defined as load shifting.

Measure Total Resource Cost (TRC):

The measure TRC calculates the net present value of energy savings that result from an investment in an energy-efficiency measure. The measure TRC is equal to its full or incremental capital cost (depending on application) plus any change (positive or negative) in the combined annual energy and O&M costs. This calculation includes, among others, the following inputs: the avoided electricity supply costs, the life of the technology, and the selected discount rate, which in this analysis has been set at 5.25%.

A measure with a positive measure TRC value is included in subsequent stages of the analysis, which consists of the Economic and Achievable Potential scenarios. A measure with a negative TRC value is not economically attractive and is therefore not included in subsequent stages of the analysis.

Megawatt (MW):

One thousand kilowatts.

Natural Change in Electricity Intensity:

The future change in electricity intensity in a given end use that is expected to occur in the absence of demand-side management programs. In developing an estimate of natural change in electricity intensity it is necessary to make an explicit assumption about the future prices of electricity and competing fuels.

Peak Clipping:

Utility program activity to reduce peak demand without reducing demand at other times of the day or year.

Peak Demand:

Peak demand is the maximum electric power required by a customer or electric system during a short time period, typically one hour. The peak is the time (usually of day or year) at which peak demand occurs.

Rate Structure:

The formulas used to calculate charges for the use of electricity. For example, the present rate structures for both Yukon utilities for residential customers consist of a fixed monthly charge and charges for electric energy usage, where the rate per kilowatt-hour depends on the level of consumption. Some rate structures charge for peak usage as well as electric energy usage.

Reference Case:

Provides a forecast of electricity sales that includes natural conservation (that which would occur in the absence of DSM programs) but no impacts of utility DSM programs. The reference case for the study is based on the 2010 YECL Load Forecast.

Sector:

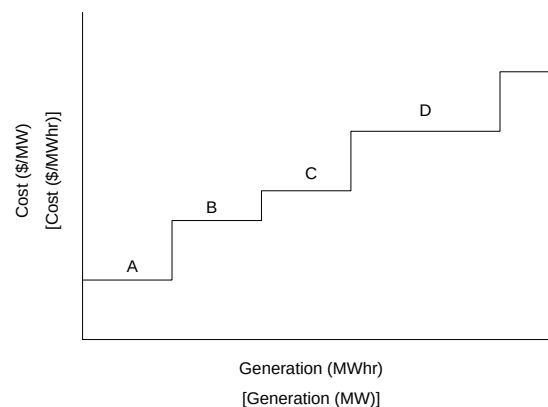
A group of customers having a common type of economic activity. This CPR studies the Residential and Commercial sectors.

Sub sectors:

A classification of customers within a sector by common features. Residential sub sectors are by type of home (single-family dwelling or apartment). Commercial sub sectors are generally by type of commercial service (retail and wholesale trade).

Supply Curves:

A graph that depicts the volume of energy at the appropriate screened price in ascending order of cost. Steps A through D below represent programs options, or technologies arranged as a supply curve.

**Supply Planning:**

The process of long-term planning of electricity generation and associated transmission facilities, in combination with supply reductions made possible through demand-side management, in order to meet forecast demands. Supply Planning in Yukon is done in a framework that recognizes economic, financial, environmental and social costs, risks, and impacts.

Supply System:

Electricity is supplied by YEC and YECL to customers using four different supply systems, which vary in terms of retail rates and generation costs. The four different systems are as follows:

- **Hydro Grid:** All customers of YEC and most customers of YECL are connected to a grid that is served primarily by hydroelectricity
- **Large Diesel:** YECL customers in Watson Lake are served by a large diesel grid
- **Small Diesel:** YECL customers in Destruction Bay/Burwash, Beaver Creek, and Swift River are served by three small diesel grids
- **Old Crow:** YECL customers in Old Crow are served by a diesel grid for which the fuel must be flown into the community.

Technical Efficiency:

Efficiency of a system, process, or device in achieving a certain purpose, measured in terms of the physical inputs required to produce a given output. In the context of electricity conservation the relevant input is electric energy.

Technology-Based Potential:

Energy and or capacity/demand savings realized through the implementation of energy-efficiency technologies.

Watt:

The basic unit of measurement of electric power.

Yukon Service Area:

Yukon Service Area is the territory of Yukon. This includes all customers served by YEC or YECL, including those connected to the hydro grid as well as customers on the large and small diesel supply systems, and the system serving the fly-in community of Old Crow.

Appendix A Background-Section 3: Base Year Electricity Use

Introduction

Appendix A provides additional detailed information related to each of the major steps employed to generate the profile of Residential sector Base Year electricity use. The major steps involved are:

- **Step 1:** Determine net space heating and cooling loads for each existing dwelling type
- **Step 2:** Determine annual electricity use for the existing stock of major residential appliances
- **Step 3:** Determine appliance saturation levels for each dwelling type
- **Step 4:** Determine electricity share for each appliance, by dwelling type
- **Step 5:** Calibrate to sales data for the study Base Year of 2010.

A.1 Step 1: Determine Net Space Heating Loads

Net space heating load is the space heating load of a building that must be met by the space heating system. This is equal to the total heat loss through the building envelope minus solar and internal gains. The net space heating loads for each dwelling type were developed based on the following combination of data sources:

- Marbek's database of residential energy consumption from other jurisdictions
- Current utility sales data combined with knowledge of the electricity consumption and saturation of other end uses.

The net space heating load for each dwelling type is given by the following equation:

$$\text{NetHL}_1 = \text{HL}_1 + a_{i,1} * s_{i,1}$$

Where:

NetHL₁ = Net heating load for dwelling type #1

HL₁ = Load on primary heating appliance for dwelling type #1

a_{i,1} = Average consumption for supplementary heating in dwelling type #1

s_{i,1} = Saturation of supplementary heating in dwelling type #1

HL₁ was estimated for each dwelling type and service region, based on utility customer sales data for electrically and non-electrically heated dwellings combined with data on the electricity consumption of non-space heating end uses. The values for a_{i,1} and s_{i,1} were developed based on the estimated share of space heating that is provided by electricity (versus supplementary fuels), as taken from the Residential Electrical End Use Survey (REEUS). The net space heating loads are presented in Exhibit A 1.

It should be noted that the values shown in Exhibit A 1 are not fuel specific; rather, they represent the total tertiary space heat load for each dwelling. The efficiency of the space heating appliances used to meet these loads is considered in subsequent stages of the analysis.

Exhibit A 1 Existing Residential Units, 2010, Net Space Heating Loads by Dwelling Type (kWh/yr.)

Dwelling Types	Tertiary Heating Load (kWh/yr.)			
	Hydro Grid	Large Diesel	Small Diesel	Old Crow
1980 & newer non-electrically heated single detached homes	20,538	19,866	-	-
Pre-1980 non-electrically heated single detached homes	28,753	27,813	-	-
1980 & newer electrically heated single detached homes	13,555	-	-	-
Pre-1980 electrically heated single detached homes	16,677	-	-	-
1980 & newer non-electrically heated attached/row housing	13,117	12,688	-	-
Pre-1980 non-electrically heated attached/row housing	17,971	17,383	-	-
1980 & newer electrically heated attached/row housing	7,411	-	-	-
Pre-1980 electrically heated attached/row housing	10,153	-	-	-
Non-electrically heated apartment units	10,380	8,535	-	-
Non-electrically heated apartment common areas	25,291	29,287	-	-
Electrically heated apartment units	6,021	-	-	-
Electrically heated apartment common areas	14,669	-	-	-
Non-electrically heated mobile/other	17,014	25,156	-	-
Electrically heated mobile/other	10,490	-	-	-
Small diesel grid housing	-	-	16,179	17,937
Seasonal housing	1,409	1,480	1,098	1,172
Residential garages	10,006	7,104	4,002	10,006

A.1.1 Development of Thermal Archetypes – Existing Stock

The next major step involved the development of a thermal archetype for each of the major dwelling types noted in Exhibit A 1 using HOT2000.

Each HOT2000 file contains a comprehensive physical description of the size, layout and thermal characteristics of each dwelling type. HOT2000 then uses these inputs to create a full computer model of the residence, calculating loads, interactive effects and energy consumption. In each case, the net heating and cooling loads simulated by HOT2000 were calibrated to the values shown in Exhibit A 1, which had been established on the basis of the sources described above. The process of calibrating simulation models to the loads estimated from available data served to further confirm the estimated loads. Adjustments were made to the estimates as required.

The physical and operating characteristics of each residential thermal archetype were researched using a number of sources, including:

- Database of EnerGuide for Houses (EGH) evaluations in Yukon provided by Yukon Housing Corporation
- Natural Resources Canada (NRCan) and Statistics Canada housing data
- Consultations with energy auditors and residential housing experts located in Yukon.

For the existing housing stock, archetypes were created for the two primary dwelling types in each service region: single-family detached and attached. A brief description of each housing archetype is provided below.

Single detached houses

A “typical” pre-1980 single-family detached dwelling can be defined as a single-story bungalow of approximately 170 m² (1,800 ft²), including a finished basement. This home has 16.5 m² (177.5 ft²) of windows, defined as double-glazed, mostly with wood or vinyl frames. Walls are represented by RSI-2.46 (R-14) insulation values, ceilings RSI-4.93 (R-28) and the basement is insulated to a value of RSI-2.29 (R-13) all the way to the basement floor. The houses are typically not very airtight, with an air change rate of about 6.0 ACH@50Pa (air changes per hour at 50 Pascal depressurization).

Typical newer dwellings (built since 1980) are approximately the same size as above. They tend to have more windows, approximately 19.0 m² (205 ft²) of window area, but these are typically of higher performance, typically defined as low-e, argon-filled, double-glazed, mostly with vinyl frames. Walls are represented by RSI-2.99 (R-17) insulation values, ceilings RSI-5.98 (R-34) and the basement is insulated to a value of RSI-2.99 (R-17) all the way to the basement floor. The houses are more airtight, with an air change rate of about 5 ACH@50Pa.

Attached Dwellings

An average attached dwelling can be defined as a one-story end unit of approximately 125 m² (1,350 ft²), including a finished basement. This home has 11.5 m² (125 ft²) of windows, defined as double-glazed, mostly with wood or vinyl frames. Walls are represented by RSI-2.81 (R-16) insulation values, ceilings RSI-5.98 (R-34) and the basement is insulated to a value of RSI-2.46 (R-14) all the way to the basement floor. The houses are somewhat airtight, with an air change rate of about 5 ACH@50Pa.

A.2 Step 2: Determine Annual Appliance Electricity Use

The next major task involved the development of estimated average annual unit electricity consumption (UEC) values for each of the major residential appliances.

Electrical consumption of appliances is related to age. According to NRCan data²⁹ most appliances have increased in efficiency over time. Estimates of the evolving energy consumption of the stock of appliances in Yukon were developed using an appliance stock model that takes into account the expected useful life of each type of appliance, the rate of purchase and retirement of appliances, the average annual consumption of newly purchased appliances in a given year, and the average annual consumption of appliances being retired in a given year. The stock average consumption thus evolves with time. In any specific year, the average age of appliances in place is assumed to be half of the expected useful life of the appliance and the stock average is built up of all the appliances purchased and installed up to that point.

There is some evidence of a correlation between age of dwelling and age of the appliances in it, but it is not a strong relationship. Older homes likely have had major appliances replaced several times and newer homes can have old appliances transferred from previous residences. The difference in appliance electrical consumption as related to the age of the home was judged small enough to be neglected for the purposes of this study.

A more important driver of appliance electricity consumption is the difference in average number of occupants in different types of homes. This influences the size of some appliances, such as

²⁹ NRCan, 2008. *Energy Consumption of Major Household Appliances Shipped in Canada: Trends for 1990-2006*.

refrigerators, and the intensity of use for others, such as laundry and cooking appliances. The estimated annual electricity consumption of appliances by dwelling type reflects these differences.

Exhibit A 2 summarizes the estimated average annual UEC for the current stock mix of major end-use appliances, for accounts connected with the hydro grid.

The space heating end use has been omitted from Exhibit A 2 because it was presented in Exhibit A 1.

Exhibit A 2 Annual Appliance Unit Electricity Consumption (UEC), Hydro Grid Accounts (kWh/yr.)

Dwelling Types	Ventilation & circulation	Domestic hot water (DHW)	Indoor lighting	Outdoor lighting	Holiday lighting	Cooking appliances	Refrigerator	Freezer	Dishwasher
1980 & newer non-electrically heated single detached homes	602	3,453	1,029	288	28	716	638	461	116
Pre-1980 non-electrically heated single detached homes	610	3,453	1,029	288	28	716	638	461	116
1980 & newer electrically heated single detached homes	100	3,453	1,029	288	28	716	638	461	116
Pre-1980 electrically heated single detached homes	100	3,453	1,029	288	28	716	638	461	116
1980 & newer non-electrically heated attached/row housing	463	2,724	698	189	14	478	521	376	77
Pre-1980 non-electrically heated attached/row housing	469	2,724	698	189	14	478	521	376	77
1980 & newer electrically heated attached/row housing	100	2,724	698	189	14	478	521	376	77
Pre-1980 electrically heated attached/row housing	100	2,724	698	189	14	478	521	376	77
Non-electrically heated apartment units	359	1,483	499	54	6	411	526	380	66
Non-electrically heated apartment common areas	4,385	24,119	6,101	660	72	-	-	-	-
Electrically heated apartment units	50	1,483	499	54	6	411	526	380	66
Electrically heated apartment common areas	611	18,134	6,101	660	72	-	-	-	-
Non-electrically heated mobile/other	469	2,724	698	189	14	478	521	376	77
Electrically heated mobile/other	100	2,724	698	189	14	478	521	376	77
Small diesel grid housing	610	3,453	1,029	288	28	716	638	461	116
Seasonal housing	30	583	174	49	-	121	108	78	20
Residential garages	366	-	617	173	-	-	-	78	-
Sentinel Lighting	-	-	-	645	-	-	-	-	-

Dwelling Types	Clothes washer	Clothes dryer	Spa heaters and pumps	Computer and peripherals	Television	Set-top boxes	Home entertainment electronics	Block heaters & car warmers	Heat tape, propane htrs, circ pumps	Small appliance & other
1980 & newer non-electrically heated single detached homes	65	990	12,468	394	178	225	106	258	258	186
Pre-1980 non-electrically heated single detached homes	65	990	12,468	394	178	225	106	258	258	186
1980 & newer electrically heated single detached homes	65	990	12,468	394	178	225	106	258	258	186
Pre-1980 electrically heated single detached homes	65	990	12,468	394	178	225	106	258	258	186
1980 & newer non-electrically heated attached/row housing	43	660	12,468	394	178	225	72	258	258	126
Pre-1980 non-electrically heated attached/row housing	43	660	12,468	394	178	225	72	258	258	126
1980 & newer electrically heated attached/row housing	43	660	12,468	394	178	225	72	258	258	126
Pre-1980 electrically heated attached/row housing	43	660	12,468	394	178	225	72	258	258	126
Non-electrically heated apartment units	37	567	-	394	178	225	61	-	-	107
Non-electrically heated apartment common areas	457	6,938	24,936	-	-	-	-	3,151	3,151	-
Electrically heated apartment units	37	567	-	394	178	225	61	-	-	107
Electrically heated apartment common areas	457	6,938	24,936	-	-	-	-	3,151	3,151	-
Non-electrically heated mobile/other	43	660	12,468	394	178	225	72	258	258	126
Electrically heated mobile/other	43	660	12,468	394	178	225	72	258	258	126
Small diesel grid housing	65	990	12,468	394	178	225	106	258	258	186
Seasonal housing	11	167	6,234	67	30	38	18	-	-	31
Residential garages	-	-	-	-	-	-	-	258	258	1,200
Sentinel Lighting	-	-	-	-	-	-	-	-	-	-

Occupancy

Occupancy rates³⁰ for each dwelling type were based on national Census data³¹. They are used, as applicable, to estimate electricity use for occupant-sensitive end uses, such as DHW, laundry and lighting. Exhibit A 3 summarizes the occupancy rates assumed for this study.

Exhibit A 3 Occupancy Rates by Dwelling Type

Household Sizes	Single Detached Houses	Double/Row Houses	Apartments	Mobile Homes
1 member	14%	23%	58%	36%
2 members	37%	36%	33%	64%
3 members	18%	18%	6%	0%
4 or more members	31%	23%	4%	0%
Approximate Average	2.7	2.4	1.6	1.6

Ventilation and Circulation

Ventilation electricity is associated with fan/blower electricity in heating systems, kitchen fans, bathroom fans and heat recovery ventilators.

A furnace fan UEC of approximately 510 kWh was assumed for single detached houses with forced air systems. This figure is consistent with estimates used in ICF Marbek's most recent studies in other jurisdictions and is somewhat lower than estimates used in earlier studies. This reflects the steady increase in the prevalence of ECM motors. The value is also consistent with the range of Canadian end-use metered data reported in a study conducted for Natural Resources Canada.³²

For the purpose of estimating kitchen and bathroom fan electricity, it was assumed that a typical exhaust fan is rated at 75 Watts and operates, on average, for two hours per day. In homes with heat supplied by baseboard electric or by hydronic systems, these exhaust fans are the predominant ventilation load. With two such fans in a typical house, consumption would be approximately 100-110 kWh/yr.

The UEC for a forced air system includes the electricity consumed by both the furnace fan and the exhaust fans. The UEC for a baseboard electric system includes only the electricity consumed by the latter.

Note: The ventilation and circulation UEC values shown previously in Exhibit A 2 reflect the mix between forced air systems and baseboard systems.

For the accounts connected to the Large Diesel, Small Diesel, and Old Crow systems, ventilation and circulation UEC was scaled according to tertiary heating load.

³⁰ Electricity use related to personal consumption increases with number of occupants in dwelling.

³¹ NRCan, 2007. *Survey of Household Energy Use 2007: Detailed Statistical Report*.

³² This area is the focus of extensive research efforts. See: Gusdorf, John, *Final Report on the Project to Measure the Effects of ECM Furnace Motors on Gas Use at the CCHT Research Facility*, Natural Resources Canada, January 2003. Current estimates of fan energy use vary widely; upper range estimates (heat mode only) exceed 1,000 kWh/yr. Continuous ventilation or use with space cooling equipment would increase fan motor consumption.

Domestic Hot Water

UEC estimates for DHW assume a per capita hot water consumption of 45 litres per person per day and a temperature rise of 45°C. Exhibit A 4 shows the distribution of DHW load by major end use.

Exhibit A 4 Distribution of DHW Electricity Use by End Use in Existing Stock, (kWh/yr.)

DHW Sub End Uses	Electricity per Sub End Use (kWh/yr.)	Electricity per Sub End Use (%)
Clothes Washer	631	18%
Showers	897	26%
Faucets	641	19%
Baths	128	4%
Dishwasher	451	13%
Leaks	192	6%
Tank (Standby) Losses	256	7%
Pipe Losses	256	7%
Total	3,453	100%

Note: Any differences in totals are due to rounding.

The DHW values shown in Exhibit A 4 are based on a combination of sources including available data from other jurisdictions, NRCan studies (NRCan, 2005) and the results of other recent ICF Marbek studies.

For the accounts connected to the Large Diesel, Small Diesel, and Old Crow systems, DHW and all the other non-HVAC UECs were scaled to best fit actual electricity sales to the accounts on those systems.

Indoor Lighting

The indoor lighting loads shown in Exhibit A 2 were developed from the following sources:

- Residential utility data on lighting types and usage patterns from other jurisdictions
- Yukon's REEUS
- NRCan's End Use Energy Data Handbook (NRCan, 2005).

Exhibit A 5 shows the estimated counts of different types of lighting based on the data from the REEUS and residential lighting data from other ICF Marbek studies. Lighting counts have increased as larger houses have been built in Canada, but the hours of use for each lighting fixture has decreased at the same time.

The average wattage and hours of use per year shown in the exhibit are based on Marbek's energy use database, developed during several previous conservation potential studies. They were adjusted for consistency with the sources listed above. The resulting calculation shown in the exhibit provides a basis for the estimate of overall indoor lighting energy consumption for different dwelling types.

For the accounts connected to the Large Diesel, Small Diesel, and Old Crow systems, lighting and all the other non-HVAC UECs were scaled to best fit actual electricity sales to the accounts on those systems.

Exhibit A 5 Indoor Lighting by Dwelling Type

Dwelling Types	Incandescent Lamps	Linear Fluorescent Tubes	Compact Fluorescent Lamps	Halogen Lamps	
SDH	23	6	16	3	(lamps)
Attached	17	2	12	2	(lamps)
Apartment	13	1	8	1	(lamps)
Average Wattage	60	48	15	50	(watts)
Average Hours/Year	500	500	500	500	(hr/yr.)
Total Base Year Energy Use (kWh/yr.)					Total
SDH	690	144	120	75	1029
Attached	510	48	90	50	698
Apartment	390	24	60	25	499

Outdoor Lighting

The outdoor lighting loads shown in Exhibit A 2 were developed from the following sources:

- Residential utility data on lighting types and usage patterns from other jurisdictions
- Yukon's REEUS
- NRCan's End Use Energy Data Handbook (NRCan, 2005).

Exhibit A 6 shows the estimated counts of different types of lighting based on the data from the REEUS and residential lighting data from other ICF Marbek studies.

The average wattage and hours of use per year shown in the exhibit are based on Marbek's energy use database, developed during several previous conservation potential studies. They were adjusted for consistency with the sources listed above. The resulting calculation shown in the exhibit provides a basis for the estimate of overall outdoor lighting energy consumption for different dwelling types.

For the accounts connected to the large and small diesel and Old Crow systems, lighting and all the other non-HVAC UECs were scaled to best fit actual electricity sales to the accounts on those systems.

Exhibit A 6 Outdoor Lighting by Dwelling Type

Dwelling Types	Incandescent Lamps	Linear Fluorescent Tubes	Compact Fluorescent Lamps	
SDH	4	1	2	(lamps)
Attached	3	0	1	(lamps)
Apartment	1	0	0	(lamps)
Average Wattage	60	48	15	(watts)
Average Hours/Year	900	365	1800	(hr/yr.)
Total Base Year Energy Use (kWh/yr.)				Total
SDH	216	18	54	288
Attached	162	0	27	189
Apartment	54	0	0	54

Holiday Lighting

The holiday lighting loads shown in Exhibit A 2 were developed from the following sources:

- Residential utility data on lighting types and usage patterns from other jurisdictions
- Yukon's REEUS
- NRCan's End Use Energy Data Handbook (NRCan, 2005).

Exhibit A 7 shows the estimated counts of different types of holiday lighting based on the data from the REEUS and residential lighting data from other ICF Marbek studies.

The average wattage and hours of use per year shown in the exhibit are based on Marbek's energy use database, developed during several previous conservation potential studies. They were adjusted for consistency with the sources listed above. The resulting calculation shown in the exhibit provides a basis for the estimate of overall holiday lighting energy consumption for different dwelling types.

For the accounts connected to the large and small diesel and Old Crow systems, lighting and all the other non-HVAC UECs were scaled to best fit actual electricity sales to the accounts on those systems.

Exhibit A 7 Holiday Lighting by Dwelling Type

Dwelling Types	Indoor Incandescent Holiday Strings	Indoor LED Holiday Strings	Outdoor Incandescent Holiday Strings	Outdoor LED Holiday Strings	
SDH	2	9	2	6	(lamps)
Attached	1	5	1	4	(lamps)
Apartment	1	2	0	0	(lamps)
Average Wattage	60	1	60	1	(watts)
Average Hours/Year	95	95	125	125	(hr/yr.)
Total Base Year Energy Use (kWh/yr.)					Total
SDH	11	1	15	1	28
Attached	6	0	8	1	14
Apartment	6	0	0	0	6

Cooking Appliances, Refrigerator, Freezer and Dishwasher

UEC estimates for the existing stock of this group of food preparation and storage appliances were obtained from *Energy Consumption of Major Household Appliances Shipped in Canada: Trends for 1990-2006* (NRCan, 2008). The values shown for dishwashers are for mechanical electricity only; hot water use is included with the DHW UEC.

For the accounts connected to the large and small diesel and Old Crow systems, appliances and all the other non-HVAC UECs were scaled to best fit actual electricity sales to the accounts on those systems.

Clothes Washer and Dryer

Appliance UEC data was obtained from *Energy Consumption of Major Household Appliances Shipped in Canada: Trends for 1990-2006* (NRCan, 2008). The values shown for clothes washers are for mechanical electricity only; hot water use is included with the DHW UEC.

For the accounts connected to the Large Diesel, Small Diesel, and Old Crow systems, appliances and all the other non-HVAC UECs were scaled to best fit actual electricity sales to the accounts on those systems.

Computers

UEC data for computers is based on calculations drawing on data from the *Survey of Household Energy Use 2007: Detailed Statistical Report* (NRCan, 2007) and is consistent with Marbek's previous work for BC Hydro.³³

For the accounts connected to the Large Diesel, Small Diesel, and Old Crow systems, electronics and all the other non-HVAC UECs were scaled to best fit actual electricity sales to the accounts on those systems.

³³ Marbek Resource Consultants, *Conservation Potential Review – 2007*. Prepared for BC Hydro. 2007.

Television

UEC data for televisions was obtained from *Technology and Market Profile: Consumer Electronics* (Marbek, 2006). Saturation of televisions (number of sets per household) is adjusted by dwelling type based on data from the REEUS but consumption per television is not varied by dwelling type in this study.

For the accounts connected to the large and small diesel and Old Crow systems, electronics and all the other non-HVAC UECs were scaled to best fit actual electricity sales to the accounts on those systems.

Television Peripherals

UECs, saturations and numbers per household for television peripherals were obtained from *Technology and Market Profile: Consumer Electronics* (Marbek, 2006) and other published data. In some parts of Canada, internet protocol television (IP-TV) is becoming a major player in the marketplace. The equipment for IP-TV uses about 40% less than the average cable or satellite system. IP-TV is assumed to occupy only a very small part of the Yukon market at this time, and has not been included in the calculations for this study. The weighted UEC for this end use as a whole was generated from the numbers shown in Exhibit A 8. UEC is not varied by dwelling type in this study.

For the accounts connected to the Large Diesel, Small Diesel, and Old Crow systems, electronics and all the other non-HVAC UECs were scaled to best fit actual electricity sales to the accounts on those systems.

Exhibit A 8 Derivation of UEC for Television Peripherals

	% of TV households	UEC kWh/yr.
Digital Cable Service	38%	
Digital Adaptor	38%	82
Standard Digital STB	31%	194
Advanced Digital STB	7%	325
Average UEC		299
Satellite Service	47%	
Standard Satellite STB	38%	141
Advanced Satellite STB	9%	273
Average UEC		166
Total Weighted UEC		226

Home Entertainment Electronics

Due to the large presence of electronic entertainment devices in many residential dwellings, this end use was separated from the general “other” category. UECs were obtained from *Technology and Market Profile: Consumer Electronics* (Marbek, 2006), *Residential Miscellaneous Electricity Use* (LBL) and other published data. A weighted UEC for the end use as a whole was generated based on recent ICF Marbek studies, as shown in Exhibit A 9.

For the accounts connected to the large and small diesel and Old Crow systems, electronics and all the other non-HVAC UECs were scaled to best fit actual electricity sales to the accounts on those systems.

Exhibit A 9 Derivation of UECs for Other Electronics

	Penetration	Number Per Household	UEC (kWh/yr.)	Weighted UEC (kWh/yr.)
DVD	72%	1.2	35	30
VCR	69%	1.3	55	49
Audio System	29%	1.3	55	21
Surround Sound	25%	1.0	50	13
Compact Audio	79%	1.5	25	30
Game Console	25%	1.3	55	18
Total Weighted UEC				160

Spas

This end use includes only spas. The incidence of swimming pools in Yukon is assumed to be small. The UEC includes the spa heater if it is electric, and also includes the consumption of the pump. Figures are derived from ICF Marbek's previous work in other jurisdictions and manufacturer literature on spa heater consumption. Exhibit A 10 shows the derivation of the UECs used in Exhibit A 2. The market penetration numbers in the exhibit are estimates of the shares of each technology within the subset of spas with that electric end use. For example, the estimate of 75% spa heaters using resistance heating elements is the share of electrically heated spas using resistance heat. Spas that are heated with propane or solar are not included. For the accounts connected to the large and small diesel and Old Crow systems, all non-HVAC UECs were scaled to best fit actual electricity sales to the accounts on those systems.

Exhibit A 10 Derivation of UECs for Spas

	UEC (kWh/yr.)	Market Penetration	Weighted UEC (kWh/yr.)
Spa Heaters			
Resistance	13,341	75%	10,006
Heat Pump	4,447	25%	1,112
Weighted UEC			11,118
Spa Pumps			
Standard	1,500	75%	1,125
High Efficiency	900	25%	225
Weighted UEC			1,350
Total Weighted UEC			12,468

Block Heaters and Car Warmers

Consumption for block heaters was based on previous studies in other jurisdictions. Block heaters typically draw 500 watts. They were assumed to be used an average of 6.7 hours/day for 90 days of the year. Approximately one-quarter of them were assumed to be on timers, which would reduce their runtime by 70%. The resulting total consumption of block heaters was estimated at 228 kWh/yr. The car warmers use more power, typically 1200 watts. They were assumed to be used for only about four hours per day, but over a longer season of 110 days.

More of them were assumed to be on timers – nearly half – with savings of about 50% of runtime. The resulting total consumption of car warmers was estimated at 400 kWh/yr. There are fewer car warmers than block heaters in use – approximately one car warmer for every 14 block heaters according to the Yukon REEUS. Therefore, the car warmers were assumed to add only about 30 kWh/yr. to the total consumption for this end use, bringing it to 258 kWh/yr.

Heat Tape, Propane Heaters, and Circulation Pumps

This end use includes electric plug-in devices for preventing water lines from freezing, including both heat tape and circulation pumps, and devices for warming outdoor propane tanks so the propane will flow easily. Because the devices included are so varied, it is difficult to estimate an overall annual consumption for the end use as a whole. The consumption for block heaters and car warmers, 258 kWh/yr., was used as an estimate.

Small Appliances and Other

“Other” end uses include a wide range of appliances and equipment found in most homes. Reliable data on the actual annual electricity use of this collection of appliances and equipment within Yukon is not available.

Exhibit A 11 illustrates the major items included in this end use and presents sample UEC data estimated in earlier studies undertaken in other jurisdictions.³⁴ It should be noted that actual UECs for individual appliances will vary from those shown in Exhibit A 11 and are affected by factors such as saturations by dwelling type and occupancy rates. Saturation information from LBL was not applied for this study because reliable information for Yukon was not available. The “other” category is not built up based on detailed analysis, but is an approximation only. The LBL data provided should be treated as being illustrative of the types of energy-using items in the category and how much electricity they typically use.

For the accounts connected to the large and small diesel and Old Crow systems, all non-HVAC UECs were scaled to best fit actual electricity sales to the accounts on those systems.

³⁴ Lawrence Berkeley National Laboratory (LBL), *Residential Miscellaneous Electricity Use*, 1997.

Exhibit A 11 Typical UECs for Selected “Other” Appliances

Appliance	UEC (kWh/yr.)	Appliance	UEC (kWh/yr.)
Home radio, small/clock	18	Timer	18
Battery Charger	21	Hot Plate	30
Clock	18	Stand Mixers	1
Power Strip	3	Hand-Held Rechargeable	16
Vacuum	31	Hand-Held Electric Vacuum	4
Hand Mixers	2	Air Corn Popper	6
Iron	53	Security System	195
Hair Dryer	36	Perc Coffee	65
Toaster	39	Deep Fryer	20
Auto Coffee Maker	116	Waterbed Heaters	900
Blender	7	Humidifier	100
Heating Pads	3	Electric Toothbrush	20
Doorbell	18	Hot Oil Corn Popper	2
Answering Machine	29	Women's Shaver	12
Can Opener	3	Aquariums	548
Slow Cooker	16	Espresso Maker	19
Curling Iron	1	Electric Lawn Mower	100
Food Slicer	1	Mounted Air Cleaner	500
Garbage Disposer	10	Multi-fcn Device	41
Electric Knife	1	Electric Kettle	75
Portable Fans	8	Bottled Water Dispenser	300
Men's Shaver	13	Central Vacuum	24
Waffle Iron/Sandwich Grill	25	Grow Lights	800
Electric Blankets	120	Home Medical Equipment	400
Garage Door Opener	30		
Hair Setter	10		

A.3 Step 3: Determine Appliance Saturation, by Dwelling Type

Exhibit A 12 summarizes the saturation levels that are used in the present analysis. The assumed saturation levels are developed from the most recent REEUS. End uses fall into several categories:

- Some end uses are present in 100% of fully-occupied dwellings, including space heating,³⁵ ventilation and circulation, DHW, indoor and outdoor lighting, cooking, home entertainment electronics, and small appliance and other. These end uses are analyzed on the basis of UEC per dwelling, rather than UEC per appliance. Some of these end uses are not assumed to be present in all of the seasonal accounts, as the exhibit shows. Sentinel lighting, of course, includes only the outdoor lighting end use.
- Most of the remaining end uses are analyzed on the basis of UEC per appliance. Their saturation, as indicated in the table, reflects the average number of appliances per household. For example, the average household includes more than one refrigerator, and the saturation values in the exhibit reflect that.

³⁵ Note that saturation of space heating, DHW, and cooking do not reflect how many households use electricity for those purposes. Electric share is discussed in the next section.

Exhibit A 12 Appliance Saturation Levels, (%)

Dwelling Types	Space heating	Ventilation & circulation	Domestic hot water (DHW)	Indoor lighting	Outdoor lighting	Holiday lighting	Cooking appliances	Refrigerator	Freezer	Dishwasher
1980 & newer non-electrically heated single detached homes	100%	100%	100%	100%	100%	100%	100%	135%	118%	86%
Pre-1980 non-electrically heated single detached homes	100%	100%	100%	100%	100%	100%	100%	123%	107%	79%
1980 & newer electrically heated single detached homes	100%	100%	100%	100%	100%	100%	100%	123%	107%	79%
Pre-1980 electrically heated single detached homes	100%	100%	100%	100%	100%	100%	100%	112%	98%	72%
1980 & newer non-electrically heated attached/row housing	100%	100%	100%	100%	100%	100%	100%	129%	112%	82%
Pre-1980 non-electrically heated attached/row housing	100%	100%	100%	100%	100%	100%	100%	114%	99%	73%
1980 & newer electrically heated attached/row housing	100%	100%	100%	100%	100%	100%	100%	117%	102%	75%
Pre-1980 electrically heated attached/row housing	100%	100%	100%	100%	100%	100%	100%	104%	90%	66%
Non-electrically heated apartment units	100%	100%	80%	100%	100%	100%	100%	100%	87%	64%
Non-electrically heated apartment common areas	100%	100%	20%	100%	100%	100%	0%	0%	0%	0%
Electrically heated apartment units	100%	100%	100%	100%	100%	100%	100%	100%	87%	64%
Electrically heated apartment common areas	100%	100%	0%	100%	100%	100%	0%	0%	0%	0%
Non-electrically heated mobile/other	100%	100%	100%	100%	100%	100%	100%	100%	87%	64%
Electrically heated mobile/other	100%	100%	100%	100%	100%	100%	100%	100%	87%	64%
Small diesel grid housing	100%	100%	100%	100%	100%	100%	100%	112%	98%	72%
Seasonal housing	50%	50%	50%	100%	100%	20%	50%	50%	44%	32%
Residential garages	100%	100%	0%	100%	100%	100%	0%	0%	0%	0%
Sentinel Lighting	0%	0%	0%	0%	100%	0%	0%	0%	0%	0%

Dwelling Types	Clothes washer	Clothes dryer	Spa heaters and pumps	Computer and peripherals	Television	Set-top boxes	Home entertainment electronics	Block heaters & car warmers	Heat tape, propane htrs, circ pumps	Small appliance & other
1980 & newer non-electrically heated single detached homes	124%	114%	13%	260%	232%	116%	100%	109%	28%	100%
Pre-1980 non-electrically heated single detached homes	113%	104%	12%	237%	211%	105%	100%	100%	25%	100%
1980 & newer electrically heated single detached homes	113%	103%	12%	237%	211%	105%	100%	100%	25%	100%
Pre-1980 electrically heated single detached homes	103%	94%	11%	216%	192%	96%	100%	91%	23%	100%
1980 & newer non-electrically heated attached/row housing	118%	108%	13%	248%	221%	110%	100%	104%	26%	100%
Pre-1980 non-electrically heated attached/row housing	104%	96%	11%	219%	195%	97%	100%	92%	23%	100%
1980 & newer electrically heated attached/row housing	107%	98%	11%	225%	201%	100%	100%	95%	24%	100%
Pre-1980 electrically heated attached/row housing	95%	87%	10%	200%	178%	89%	100%	84%	21%	100%
Non-electrically heated apartment units	46%	42%	0%	193%	172%	86%	100%	0%	0%	100%
Non-electrically heated apartment common areas	46%	42%	10%	0%	0%	0%	100%	81%	20%	100%
Electrically heated apartment units	46%	42%	0%	193%	172%	86%	100%	0%	0%	100%
Electrically heated apartment common areas	46%	42%	10%	0%	0%	0%	100%	81%	20%	100%
Non-electrically heated mobile/other	92%	84%	5%	193%	172%	86%	100%	81%	20%	100%
Electrically heated mobile/other	92%	84%	5%	193%	172%	86%	100%	81%	20%	100%
Small diesel grid housing	103%	94%	11%	216%	192%	96%	100%	91%	23%	100%
Seasonal housing	46%	42%	5%	96%	86%	43%	100%	0%	0%	100%
Residential garages	0%	0%	0%	0%	0%	0%	100%	91%	23%	100%
Sentinel Lighting	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%

A.4 Step 4: Determine Fuel Share, by End Use and Dwelling Type

Data on fuel shares, for all end uses except space heating and DHW, is taken from the most recent Yukon REEUS. In the case of space heating, the starting point was the distribution of space heating appliances, by fuel type, as reported in the surveys and in the REEUS and the EnerGuide for Houses database, but the actual fuel share includes not only the presence of different appliances but also how much they are used. In particular it is affected by supplementary heating appliances, such as:

- Electric space heaters in non-electrically heated dwellings
- Non-electric sources (e.g., wood stoves) in electrically heated dwellings.

The space heating fuel shares presented in the exhibit³⁶ have been selected on the basis that they provide a reasonable fit with:

- General market description (i.e., known distribution of heating appliances by fuel)
- Electricity sales to different categories of homes.

Exhibit A 13 summarizes the electricity fuel shares assumed for each of the end uses included in the present analysis.

³⁶ Adjustment of fuel shares for space heating was done in tandem with the adjustment of space heating loads described in Section 3.4 above.

Exhibit A 13 Electricity Fuel Shares, (%)

Dwelling Types	Space heating	Domestic hot water (DHW)	Cooking appliances	Clothes dryer	Spa heaters and pumps
1980 & newer non-electrically heated single detached homes	5%	79%	91%	97%	89%
Pre-1980 non-electrically heated single detached homes	5%	79%	91%	97%	89%
1980 & newer electrically heated single detached homes	89%	100%	100%	100%	100%
Pre-1980 electrically heated single detached homes	89%	100%	100%	100%	100%
1980 & newer non-electrically heated attached/row housing	5%	79%	91%	97%	89%
Pre-1980 non-electrically heated attached/row housing	5%	79%	91%	97%	89%
1980 & newer electrically heated attached/row housing	89%	100%	100%	100%	100%
Pre-1980 electrically heated attached/row housing	89%	100%	100%	100%	100%
Non-electrically heated apartment units	5%	100%	91%	97%	100%
Non-electrically heated apartment common areas	5%	0%	100%	97%	89%
Electrically heated apartment units	95%	100%	100%	100%	100%
Electrically heated apartment common areas	95%	100%	100%	100%	100%
Non-electrically heated mobile/other	5%	79%	92%	97%	91%
Electrically heated mobile/other	89%	100%	100%	100%	100%
Small diesel grid housing	4%	83%	92%	97%	91%
Seasonal housing	5%	83%	92%	97%	91%
Residential garages	5%	100%	100%	100%	100%

A.5 Step 5: Calibrate to sales data for the study Base Year of 2010

YEC and YECL provided electricity sales data for the year 2010, which was the latest year for which a complete year of data was available at the time of the study. Electricity sales were divided among the dwelling types and vintages according to the best information available from the utilities customer databases and from Marbek's energy end-use modelling. The RSEEM model was populated with data for UEC, saturation and electricity share and calibrated for a close match to the 2010 sales data.

A.6 Results by Supply System

This section of the appendix presents the base year electricity consumption for the hydro grid, large diesel, small diesel, and Old Crow supply systems. For each supply system, versions of Exhibit 6 and Exhibit 7 (which appear in Section 3 of the main body of the report) are provided below. The underlying assumptions such as unit energy consumption, saturation and electricity share are not presented by supply system. In general, the sample sizes for the diesel supply systems are too small to develop these detailed assumptions for the houses there. Instead, the end use consumptions are scaled to calibrate the model to the sales of electricity in those regions.

This section also does not replicate the pie charts and other graphs presented in Section 3. If those graphs are needed for each supply system, they can be created using the Data Manager.

Exhibit A 14 Average Electricity Use per Dwelling Unit, Hydro Grid Accounts (kWh/yr.)

Dwelling Types	Space heating	Ventilation & circulation	Domestic hot water (DHW)	Indoor lighting	Outdoor lighting	Holiday lighting	Cooking appliances	Refrigerator	Freezer	Dishwasher
1980 & newer non-electrically heated single detached homes	1,027	602	2,742	1,029	288	28	651	862	543	100
Pre-1980 non-electrically heated single detached homes	1,438	610	2,742	1,029	288	28	651	785	495	91
1980 & newer electrically heated single detached homes	12,075	100	3,453	1,029	288	28	716	784	494	91
Pre-1980 electrically heated single detached homes	14,856	100	3,453	1,029	288	28	716	715	450	83
1980 & newer non-electrically heated attached/row housing	656	463	2,164	698	189	14	434	669	422	63
Pre-1980 non-electrically heated attached/row housing	899	469	2,164	698	189	14	434	592	373	56
1980 & newer electrically heated attached/row housing	6,602	100	2,724	698	189	14	478	609	384	58
Pre-1980 electrically heated attached/row housing	9,045	100	2,724	698	189	14	478	539	340	51
Non-electrically heated apartment units	519	359	1,186	499	54	6	374	526	332	42
Non-electrically heated apartment common areas	1,265	4,385	-	6,101	660	72	-	-	-	-
Electrically heated apartment units	5,719	50	1,483	499	54	6	411	526	332	42
Electrically heated apartment common areas	13,935	611	-	6,101	660	72	-	-	-	-
Non-electrically heated mobile/other	851	469	2,164	698	189	14	441	521	328	49
Electrically heated mobile/other	9,345	100	2,724	698	189	14	478	521	328	49
Seasonal housing	35	15	241	174	49	-	56	54	34	6
Residential garages	500	366	-	617	173	-	-	-	-	-
Sentinel Lighting	-	-	-	-	645	-	-	-	-	-
Weighted Average	1,791	394	1,805	746	222	16	420	525	331	57

Dwelling Types	Clothes washer	Clothes dryer	Spa heaters and pumps	Computer and peripherals	Television	Set-top boxes	Home entertainment electronics	Block heaters & car warmers	Heat tape, propane htrs, circ pumps	Small appliance & other	Total
1980 & newer non-electrically heated single detached homes	81	1,091	1,466	1,025	412	260	106	282	71	186	12,851
Pre-1980 non-electrically heated single detached homes	74	995	1,336	934	376	237	106	257	65	186	12,721
1980 & newer electrically heated single detached homes	73	1,024	1,505	933	375	237	106	257	65	186	23,819
Pre-1980 electrically heated single detached homes	67	934	1,372	850	342	216	106	234	59	186	26,083
1980 & newer non-electrically heated attached/row housing	51	692	1,395	975	392	248	72	269	68	126	10,060
Pre-1980 non-electrically heated attached/row housing	45	613	1,235	863	347	219	72	238	60	126	9,706
1980 & newer electrically heated attached/row housing	47	650	1,432	888	357	226	72	244	62	126	15,959
Pre-1980 electrically heated attached/row housing	41	575	1,267	786	316	200	72	216	54	126	17,832
Non-electrically heated apartment units	17	232	-	758	305	193	61	-	-	107	5,571
Non-electrically heated apartment common areas	209	2,833	2,179	-	-	-	-	2,553	643	-	20,900
Electrically heated apartment units	17	239	-	758	305	193	61	-	-	107	10,803
Electrically heated apartment common areas	209	2,917	2,447	-	-	-	-	2,553	643	-	30,149
Non-electrically heated mobile/other	40	541	554	758	305	193	72	209	53	126	8,574
Electrically heated mobile/other	40	555	612	758	305	193	72	209	53	126	17,368
Seasonal housing	5	69	277	64	26	16	18	-	-	31	1,170
Residential garages	-	-	-	-	-	-	-	234	59	1,200	3,149
Sentinel Lighting	-	-	-	-	-	-	-	-	-	-	645
Weighted Average	47	638	870	658	265	167	69	189	48	144	9,401

Exhibit A 15 Average Electricity Use per Dwelling Unit, Large Diesel Accounts (kWh/yr.)

Dwelling Types	Space heating	Ventilation & circulation	Domestic hot water (DHW)	Indoor lighting	Outdoor lighting	Holiday lighting	Cooking appliances	Refrigerator	Freezer	Dishwasher
1980 & newer non-electrically heated single detached homes	1,391	582	2,742	1,029	288	28	651	862	543	100
Pre-1980 non-electrically heated single detached homes	1,947	590	2,742	1,029	288	28	651	785	495	91
1980 & newer non-electrically heated attached/row housing	888	448	2,164	698	189	14	434	669	422	63
Pre-1980 non-electrically heated attached/row housing	1,217	454	2,164	698	189	14	434	592	373	56
Non-electrically heated apartment units	427	295	1,008	424	46	5	318	448	282	36
Non-electrically heated apartment common areas	1,464	3,605	-	4,332	469	51	-	-	-	-
Non-electrically heated mobile/other	1,258	693	2,315	747	202	15	472	557	351	53
Seasonal housing	37	14	253	183	51	-	59	57	36	7
Residential garages	355	354	-	438	122	-	-	-	-	-
Sentinel Lighting	-	-	-	-	645	-	-	-	-	-
Weighted Average	943	388	1,657	650	242	15	385	488	307	54

Dwelling Types	Clothes washer	Clothes dryer	Spa heaters and pumps	Computer and peripherals	Television	Set-top boxes	Home entertainment electronics	Block heaters & car warmers	Heat tape, propane httrs, circ pumps	Small appliance & other	Total
1980 & newer non-electrically heated single detached homes	81	1,091	1,466	1,025	412	260	106	282	71	186	13,195
Pre-1980 non-electrically heated single detached homes	74	995	1,336	934	376	237	106	257	65	186	13,210
1980 & newer non-electrically heated attached/row housing	51	692	1,395	975	392	248	72	269	68	126	10,277
Pre-1980 non-electrically heated attached/row housing	45	613	1,235	863	347	219	72	238	60	126	10,009
Non-electrically heated apartment units	15	197	-	645	259	164	52	-	-	91	4,711
Non-electrically heated apartment common areas	149	2,011	1,547	-	-	-	-	1,813	456	-	15,897
Non-electrically heated mobile/other	43	579	593	812	326	206	77	223	56	135	9,713
Seasonal housing	5	72	291	67	27	17	19	-	-	33	1,227
Residential garages	-	-	-	-	-	-	-	166	42	852	2,330
Sentinel Lighting	-	-	-	-	-	-	-	-	-	-	645
Weighted Average	43	584	818	611	246	155	65	164	41	131	7,987

Exhibit A 16 Average Electricity Use per Dwelling Unit, Small Diesel Accounts (kWh/yr.)

Dwelling Types	Space heating	Ventilation & circulation	Domestic hot water (DHW)	Indoor lighting	Outdoor lighting	Holiday lighting	Cooking appliances	Refrigerator	Freezer	Dishwasher
Small diesel grid housing	647	424	2,627	947	265	26	609	658	414	76
Seasonal housing	11	11	235	170	47	-	55	53	33	6
Residential garages	160	199	-	227	63	-	-	-	-	-
Sentinel Lighting	-	-	-	-	619	-	-	-	-	-
Grand Total	308	205	1,285	488	304	12	298	320	202	37

Dwelling Types	Clothes washer	Clothes dryer	Spa heaters and pumps	Computer and peripherals	Television	Set-top boxes	Home entertainment electronics	Block heaters & car warmers	Heat tape, propane htrs, circ pumps	Small appliance & other	Total
Small diesel grid housing	62	837	1,143	782	315	199	97	215	54	171	10,567
Seasonal housing	5	67	270	63	25	16	17	-	-	31	1,114
Residential garages	-	-	-	-	-	-	-	86	22	442	1,200
Sentinel Lighting	-	-	-	-	-	-	-	-	-	-	619
Grand Total	30	408	600	381	153	97	50	102	26	96	5,401

Exhibit A 17 Average Electricity Use per Dwelling Unit, Old Crow Accounts (kWh/yr.)

Dwelling Types	Space heating	Ventilation & circulation	Domestic hot water (DHW)	Indoor lighting	Outdoor lighting	Holiday lighting	Cooking appliances	Refrigerator	Freezer	Dishwasher
Small diesel grid housing	717	470	2,912	1,050	293	29	675	729	459	85
Seasonal housing	12	11	251	181	51	-	58	56	35	6
Sentinel Lighting	-	-	-	-	477	-	-	-	-	-
Grand Total	388	256	1,666	641	186	15	386	414	261	48

Dwelling Types	Clothes washer	Clothes dryer	Spa heaters and pumps	Computer and peripherals	Television	Set-top boxes	Home entertainment electronics	Block heaters & car warmers	Heat tape, propane htrs, circ pumps	Small appliance & other	Total
Small diesel grid housing	68	928	1,267	867	349	220	108	239	60	190	11,715
Seasonal housing	5	71	288	67	27	17	19	-	-	33	1,188
Sentinel Lighting	-	-	-	-	-	-	-	-	-	-	477
Grand Total	39	527	806	492	198	125	66	127	32	116	6,788

Exhibit A 18 Electricity Consumption by End Use and Dwelling Type in the Base Year (2010), Hydro Grid Accounts (MWh/yr.)

Dwelling Types	Space heating	Ventilation & circulation	Domestic hot water (DHW)	Indoor lighting	Outdoor lighting	Holiday lighting	Cooking appliances	Refrigerator	Freezer	Dishwasher
1980 & newer non-electrically heated single detached homes	3,302	1,934	8,817	3,309	925	90	2,093	2,771	1,745	321
Pre-1980 non-electrically heated single detached homes	3,915	1,660	7,467	2,802	783	76	1,772	2,139	1,347	248
1980 & newer electrically heated single detached homes	6,267	52	1,792	534	149	15	372	407	256	47
Pre-1980 electrically heated single detached homes	6,522	44	1,516	452	126	12	315	314	198	36
1980 & newer non-electrically heated attached/row housing	279	197	921	297	80	6	185	285	180	27
Pre-1980 non-electrically heated attached/row housing	323	169	779	251	68	5	156	213	134	20
1980 & newer electrically heated attached/row housing	456	7	188	48	13	1	33	42	26	4
Pre-1980 electrically heated attached/row housing	534	6	161	41	11	1	28	32	20	3
Non-electrically heated apartment units	691	478	1,580	665	72	8	499	701	442	56
Non-electrically heated apartment common areas	186	644	-	896	97	11	-	-	-	-
Electrically heated apartment units	1,230	11	319	107	12	1	88	113	71	9
Electrically heated apartment common areas	334	15	-	146	16	2	-	-	-	-
Non-electrically heated mobile/other	684	377	1,740	561	152	11	355	419	264	40
Electrically heated mobile/other	1,205	13	351	90	24	2	62	67	42	6
Seasonal housing	109	46	744	536	150	-	172	166	105	19
Residential garages	132	96	-	163	45	-	-	-	-	-
Sentinel Lighting	-	-	-	-	515	-	-	-	-	-
Grand Total	26,170	5,749	26,375	10,900	3,239	241	6,129	7,669	4,829	838

Dwelling Types	Clothes washer	Clothes dryer	Spa heaters and pumps	Computer and peripherals	Television	Set-top boxes	Home entertainment electronics	Block heaters & car warmers	Heat tape, propane htrs, circ pumps	Small appliance & other	Total	Percentage of Total
1980 & newer non-electrically heated single detached homes	260	3,510	4,715	3,296	1,326	837	339	907	228	599	41,323	30%
Pre-1980 non-electrically heated single detached homes	200	2,709	3,640	2,544	1,023	646	287	700	176	507	34,644	25%
1980 & newer electrically heated single detached homes	38	532	781	484	195	123	55	133	34	97	12,362	9%
Pre-1980 electrically heated single detached homes	29	410	602	373	150	95	46	103	26	82	11,450	8%
1980 & newer non-electrically heated attached/row housing	22	295	594	415	167	106	30	114	29	54	4,284	3%
Pre-1980 non-electrically heated attached/row housing	16	221	445	311	125	79	26	86	22	45	3,494	3%
1980 & newer electrically heated attached/row housing	3	45	99	61	25	16	5	17	4	9	1,101	1%
Pre-1980 electrically heated attached/row housing	2	34	75	46	19	12	4	13	3	7	1,052	1%
Non-electrically heated apartment units	23	309	-	1,010	406	257	81	-	-	143	7,421	5%
Non-electrically heated apartment common areas	31	416	320	-	-	-	-	375	94	-	3,069	2%
Electrically heated apartment units	4	51	-	163	66	41	13	-	-	23	2,323	2%
Electrically heated apartment common areas	5	70	59	-	-	-	-	61	15	-	724	0.5%
Non-electrically heated mobile/other	32	435	446	610	245	155	58	168	42	102	6,896	5%
Electrically heated mobile/other	5	72	79	98	39	25	9	27	7	16	2,241	2%
Seasonal housing	16	212	855	198	80	50	55	-	-	97	3,610	3%
Residential garages	-	-	-	-	-	-	-	62	16	316	830	1%
Sentinel Lighting	-	-	-	-	-	-	-	-	-	-	515	0.4%
Grand Total	686	9,319	12,708	9,610	3,866	2,441	1,009	2,766	696	2,097	137,337	100%

Exhibit A 19 Electricity Consumption by End Use and Dwelling Type in the Base Year (2010), Large Diesel Accounts (MWh/yr.)

Dwelling Types	Space heating	Ventilation & circulation	Domestic hot water (DHW)	Indoor lighting	Outdoor lighting	Holiday lighting	Cooking appliances	Refrigerator	Freezer	Dishwasher
1980 & newer non-electrically heated single detached homes	264	110	520	195	55	5	123	163	103	19
Pre-1980 non-electrically heated single detached homes	313	95	440	165	46	4	105	126	79	15
1980 & newer non-electrically heated attached/row housing	22	11	54	18	5	0	11	17	11	2
Pre-1980 non-electrically heated attached/row housing	26	10	46	15	4	0	9	13	8	1
Non-electrically heated apartment units	19	13	44	18	2	0	14	20	12	2
Non-electrically heated apartment common areas	4	10	-	12	1	0	-	-	-	-
Non-electrically heated mobile/other	100	55	184	59	16	1	37	44	28	4
Seasonal housing	7	3	46	33	9	-	11	10	6	1
Residential garages	6	6	-	7	2	-	-	-	-	-
Sentinel Lighting	-	-	-	-	55	-	-	-	-	-
Grand Total	760	313	1,335	523	195	12	310	393	248	43

Dwelling Types	Clothes washer	Clothes dryer	Spa heaters and pumps	Computer and peripherals	Television	Set-top boxes	Home entertainment electronics	Block heaters & car warmers	Heat tape, propane htrs, circ pumps	Small appliance & other	Total	Percentage of Total
1980 & newer non-electrically heated single detached homes	15	207	278	194	78	49	20	54	13	35	2,503	39%
Pre-1980 non-electrically heated single detached homes	12	160	215	150	60	38	17	41	10	30	2,122	33%
1980 & newer non-electrically heated attached/row housing	1	17	35	25	10	6	2	7	2	3	258	4%
Pre-1980 non-electrically heated attached/row housing	1	13	26	18	7	5	2	5	1	3	213	3%
Non-electrically heated apartment units	1	9	-	28	11	7	2	-	-	4	205	3%
Non-electrically heated apartment common areas	0	6	4	-	-	-	-	5	1	-	45	1%
Non-electrically heated mobile/other	3	46	47	64	26	16	6	18	4	11	771	12%
Seasonal housing	1	13	53	12	5	3	3	-	-	6	223	3%
Residential garages	-	-	-	-	-	-	-	3	1	14	38	1%
Sentinel Lighting	-	-	-	-	-	-	-	-	-	-	55	1%
Grand Total	35	471	659	492	198	125	52	132	33	106	6,434	100%

Exhibit A 20 Electricity Consumption by End Use and Dwelling Type in the Base Year (2010), Small Diesel Accounts (MWh/yr.)

Dwelling Types	Space heating	Ventilation & circulation	Domestic hot water (DHW)	Indoor lighting	Outdoor lighting	Holiday lighting	Cooking appliances	Refrigerator	Freezer	Dishwasher
Small diesel grid housing	69	45	282	102	28	3	65	71	44	8
Seasonal housing	1	1	13	9	3	-	3	3	2	0
Residential garages	1	1	-	1	0	-	-	-	-	-
Sentinel Lighting	-	-	-	-	38	-	-	-	-	-
Grand Total	71	47	295	112	70	3	68	73	46	9

Dwelling Types	Clothes washer	Clothes dryer	Spa heaters and pumps	Computer and peripherals	Television	Set-top boxes	Home entertainment electronics	Block heaters & car warmers	Heat tape, propane htrs, circ pumps	Small appliance & other	Total	Percentage of Total
Small diesel grid housing	7	90	123	84	34	21	10	23	6	18	1,133	91%
Seasonal housing	0	4	15	4	1	1	1	-	-	2	62	5%
Residential garages	-	-	-	-	-	-	-	0	0	2	5	0%
Sentinel Lighting	-	-	-	-	-	-	-	-	-	-	38	3%
Grand Total	7	94	138	87	35	22	11	23	6	22	1,239	100%

Exhibit A 21 Electricity Consumption by End Use and Dwelling Type in the Base Year (2010), Old Crow Accounts (MWh/yr.)

Dwelling Types	Space heating	Ventilation & circulation	Domestic hot water (DHW)	Indoor lighting	Outdoor lighting	Holiday lighting	Cooking appliances	Refrigerator	Freezer	Dishwasher
Small diesel grid housing	55	36	223	80	22	2	52	56	35	6
Seasonal housing	1	1	16	12	3	-	4	4	2	0
Sentinel Lighting	-	-	-	-	1	-	-	-	-	-
Grand Total	56	37	239	92	27	2	55	59	37	7

Dwelling Types	Clothes washer	Clothes dryer	Spa heaters and pumps	Computer and peripherals	Television	Set-top boxes	Home entertainment electronics	Block heaters & car warmers	Heat tape, propane htrs, circ pumps	Small appliance & other	Total	Percentage of Total
Small diesel grid housing	5	71	97	66	27	17	8	18	5	15	895	92%
Seasonal housing	0	5	19	4	2	1	1	-	-	2	77	8%
Sentinel Lighting	-	-	-	-	-	-	-	-	-	-	1	0%
Grand Total	6	76	116	71	28	18	9	18	5	17	973	100%

Appendix B Background-Section 4: Base Year Peak Load

Introduction

Appendix B provides additional detailed information related to each of the major steps employed in the generation of the Residential sector Base Year peak loads. The discussion is organized as follows:

- Overview of peak load methodology
- Segmentation of residential dwellings
- Detailed results.

B.1 Overview of Peak Load Profile Methodology

As noted in the main text, development of the electric peak load estimates employs four specific factors as outlined below:

- **Monthly Usage Allocation Factor:** This factor represents the percent of annual electric energy usage that is allocated to each month. This set of monthly fractions (percentages) reflects the seasonality of the load shape, whether a facility, process or end use, and is dictated by weather or other seasonal factors. This allocation factor can be obtained from either (in decreasing order of priority): (a) monthly consumption statistics from end-use load studies; (b) monthly seasonal sales (preferably weather normalized) obtained by subtracting a “base” month from winter and summer heating and cooling months; or (c) heating or cooling degree days on an appropriate base.
- **Weekend to Weekday Factor:** This factor is a ratio that describes the relationship between weekends and weekdays, reflecting the degree of weekend activity inherent in the facility or end use. This may vary by month or season. Based on this ratio, the average electric energy per day type can be computed from the corresponding monthly electric energy.
- **Peak Day Factor:** This factor reflects the degree of daily weather sensitivity associated with the load shape, particularly heating or cooling; it compares a peak (e.g., hottest or coldest) day to a typical weekday in that month.
- **Per Unit Hourly Factor:** The relationship of load among different hours of the day for each day type (weekday, weekend day, peak day) and for each month reflects the operating hours of the electric equipment or end use within residences by sub sector. For example, for lighting, this would be affected by time of day, season (affected by daylight), and room type, where applicable. For the Base Year, lighting is treated on an aggregate basis by total residence.

The four factors (sets of ratios) defined above provide the basis for converting annual energy to any hourly demand specified including the grouping of hours used in the four peak periods defined in this study. Exhibit B 1, below, illustrates how each of the above four factors is applied sequentially to a known annual energy value to produce a peak load value, defined as a specific peak period. In the example, the Annual Peak Hour is used.

Exhibit B 1 Illustrative Application of Annual Energy to Peak Period Value Factors

The Annual Peak Hour demand is computed based on the December peak day at 6 pm. The Yukon peak is assumed to occur in December, although the model allows for a January peak, as well.

The following steps are required:

- **Step 1:** The monthly usage allocation factor for December is applied to the annual energy use to calculate December energy use.
- **Step 2:** The average weekday in December is calculated based on the formula shown below, which adjusts the average day type use to reflect any difference in typical weekend use versus typical weekday use.
$$1/[\text{Days in Month} * (5/7 + 2/7 * \text{Weekend Ratio})]$$
- **Step 3:** The peak day factor is then applied to the average weekday electric energy use to determine the peak day use (as defined by the Yukon utilities).
- **Step 4:** The peak hour is then calculated based on allocating the peak day use according to the per unit hourly load factor for a peak winter (December) day, using the percentage of use in that hour versus the daily usage for the December peak day.

It should be noted that the methodology shown in Exhibit B 1 produces aggregate diversified average loads for all customers or end uses in the defined sub sector.

Exhibit B 2 provides a specific numeric example for the calculation of Annual Peak Hour demand (kW). The example presented in Exhibit B 2 is for DHW use in pre-1980 single detached homes, prior to adjustment for fuel share. The example shows how the annual consumption of 2,989 kWh can be converted to a peak demand value for the Annual Peak Hour by the calculation of a corresponding hours-use value.

Exhibit B 2 Sample Hours-Use Calculation for Electric Water Heating

Annual Peak Hour: 6 pm Winter Peak

Annual kWh * Mo. Allocation * $1/(\text{Days in Month} * (5/7 + 2/7 * \text{Weekend Ratio}))$ * Peak Day Factor * Peak Hour % Daily kWh

7 pm Winter Peak = 2,989 [Annual kWh] * 8.72% [Mo. Allocation] * $1/(31 * (5/7 + 2/7 * \underline{1.0}$ [Dec. Weekend Ratio Calc])) * 1.0 [Dec. Peak Day Factor] * 0.035022 [Peak Hour % Day kWh] = 0.294 kW

Hours-Use Factor = 2,989 [annual kWh] / 0.294 [7 pm Winter Peak] = 10,153 [Annual Peak Hour Hours Use]

This means that any applicable single-family detached annual water heating kWh can be converted to demand at winter peak hour (6 pm) by dividing by 10,153.

For other peak periods, different sets of hours are used, with calculations corresponding to the above steps. The resulting relationship between annual use and peak can be defined in terms of an hours-use factor, the ratio of the annual energy to the peak, for each of the four defined peak periods.

B.2 Segmentation of Residential Dwellings

The Residential sector segmentation used to generate the electric peak load profiles is the same as that used for electric energy use. That is, there is a load profile that corresponds to each combination of dwelling type and end use.

Exhibit B 3 shows the residential dwelling types that were addressed.

Exhibit B 3 Residential Dwelling Types Used for Electric Peak Load Calculations

Dwelling Type (SDH/ Duplex, Farm House, First Nations, Row house, Condo low vs. high-rise, Mobile/Other)
Building Vintage (Pre- vs. Post-1980)
Heating Fuel (Electric vs. Non-electric)

Exhibit B 4 describes the assumptions and data sources for each of the four load profile factors that were used to develop the corresponding hours-use factors. To produce a demand for a combination of sub sector and end use, the corresponding annual energy is divided by the hours-use factor for each of the four peak periods for the applicable load shape. For certain end uses that are assumed to have no usage during the winter months (e.g., cooling) the hours-use values are considered infinite (noted by 1E+15), resulting in virtually zero demand when divided into annual energy.

Exhibit B 4 Residential End Use Load Shape Parameters

Load Shape #	End Use	Monthly Breakdown	Wkend / Wkday Ratio	Peak Day Factor	Hourly Profile
1001	Space Heating – Detached/Duplex, First Nations	10-yr average Whitehorse HDD	1.09 BC Hydro Res. Load Model - SDH ³⁷	10-yr average Whitehorse HDD	BCH Residential Premise Load Model - SDH
1002	Space Heating – Row Houses	10-yr average Whitehorse HDD	BC Hydro Res. Load Model - Row ³⁸	10-yr average Whitehorse HDD	BCH Residential Premise Load Model - Row
1003	Central A/C – All	10-yr average Whitehorse CDD	1.00 various studies	10-yr average Whitehorse CDD Ratio	RG&E 1991 Study
1004	Water Heating – All	RG&E 1991 Study	1.00 various studies	1.0 Assumed	RG&E 1991 Study
1005	Cooking – All	Mass. JUMP	Mass JUMP ^{39, 40}	1.0 Assumed	Mass. JUMP
1006	Refrigerator – All	Mass. JUMP	1.00 various studies	1.0 Assumed	Mass. JUMP
1007	Lighting – All	LILCO Direct Install Program 1991 adj. by DOE ⁴¹ Seasonality	LILCO ⁴²	1.0 Assumed	LILCO Direct Install Program 1991 adj. by DOE Seasonality
1008	Clothes Dryer – All	Mass. JUMP Refrigerator	Mass. JUMP	1.0 Assumed	Mass. JUMP
1009	Clothes Washer – All	LILCO DSM			
1010	Dishwasher – All	LILCO DSM Program Eval 1988-1991	1.00 various studies	1.0 Assumed	ELCAP DOE ⁴³
1011	General Plug Loads	USDOE Building America 2008 Misc. Electric Loads ⁶	1.00 Assumed	1.0 Assumed	USDOE Building America 2008 Misc. Electric Load
1012	Television – All	California Energy Commission			
1013	Room A/C – All	10-yr average Whitehorse CDD	1.00 various studies	10-yr average Whitehorse CDD Ratio	RG&E 1991 Study
1014	Pool Pumps, Hot Tubs	BCH REUS ⁴⁴ & SCE RAEUS ⁴⁵	SCE RAEUS	SCE RAEUS	Hr End 7pm SCE RAEUS

³⁷ BC Hydro FY 2005 (April 2004 – March 2005) Residential Load Research data by segment (SDH – Single Family; Row – Row Houses).

³⁸ BC Hydro FY 2005 (April 2004 – March 2005) Residential Load Research data by segment (SDH – Single Family; Row – Row Houses).

³⁹ Massachusetts JUMP Update and Analysis (Appliance Monitoring Project), AEIC Northeast Regional Conference and Proceedings; Hartford, CT; September 16, 1988; S. Chiara (ComEnergy) and J. Lopes (AEG).

⁴⁰ Massachusetts Joint Utility End Use Monitoring Project Final Report – Final Report; Applied Energy Group, Inc.; Feb 15, 1989.

⁴¹ Building America Research Benchmark Definition – Updated December 20, 2007; USDOE Renewable Energy Laboratory NREL/TP-550-42662; January 2008.

⁴² Long Island Lighting Company; DSM Program Evaluations; 1988 – 1991.

⁴³ Description of Electric Energy Use in Single-Family Residences in the Pacific Northwest (ELCAP), DOE/BP-13795-21, PNNL; ref. in “Building America Research Benchmark Definition”; Jan. 2008.

⁴⁴ BC Hydro REUS (Appliance Saturation Study) estimates of saturation of component appliances (outdoor and indoor pools, outdoor hot tubs and indoor Jacuzzis), and SCE RAEUS monthly energy use used to calculate weighted monthly energy use for monthly allocation averages.

Load Shape #	End Use	Monthly Breakdown	Wkend / Wkday Ratio	Peak Day Factor	Hourly Profile
1015	Engine Block Heater	10-yr average Whitehorse HDD < - 10HDD	1.00 assumed	10-yr average Whitehorse HDD	Flat, average 7.9 hrs/day for 90 days ⁴⁶
1016	Ventilation – Total Commercial	RG&E Total Commercial Ventilation	RG&E Total Commercial Ventilation	RG&E Total Commercial Ventilation	RG&E Total Commercial Ventilation
1017	Outdoor Lighting	Dusk-to-Dawn Model, with Whitehorse sunrise/sunset	1.00 Assumed	1.0 Assumed	Based on Dusk-to-Dawn Model, Whitehorse sunrise/sunset ⁴⁷
1018	Holiday Lighting	90% December 10% January	1.00 Assumed	1.0 Assumed	Dusk to Midnight model, similar to base lighting until midnight only

Exhibit B 5 shows the distinct hour-use values developed for each combination of peak period, sector, sub sector and end use employed in this study, as generated from the applicable load shape.

The hours-use value represents the divisor to convert annual energy (e.g., MWH) to that peak period demand. For example, dividing the annual electricity consumed for space heating in single detached houses by the hours-use value for the Annual Peak Hour (i.e., 2,798) will convert annual MWh to demand at the annual system peak hour (6 pm).

Exhibit B 5 Residential Sector Load Shape Hours-Use Values

CODE	Sector Type	SubSector	Region	End Use	End Use Sub	Measure	Hours-use Values		
							Peak1 Annual Peak Hour	Peak2 Evening Peak	Peak3 Morning Peak
1001	Res	SDH	All	Space Heat	All	Base	2,798	2,865	4,130
1002	Res	Row	All	Space Heat	All	Base	2,818	2,850	4,830
1003	Res	All	All	Central A/C	All	Base	1.00E+15	1.00E+15	1.00E+15
1004	Res	All	All	Water Heat	All	Base	11,285	10,114	3,969
1005	Res	All	All	Stove	All	Base	1,479	3,196	4,796
1006	Res	All	All	Refrigerator	All	Base	7,949	8,374	10,525
1007	Res	All	All	Lighting	All	Base	4,137	3,724	9,325
1008	Res	All	All	Dryer	All	Base	3,687	4,519	28,385
1009	Res	All	All	Clothes Washer	All	Base	5,403	5,412	13,836
1010	Res	All	All	Dishwasher	All	Base	5,787	4,208	6,944
1011	Res	All	All	General Plug Loads	All	Base	6,759	6,609	9,012
1012	Res	All	All	Television	All	Base	6,393	6,473	8,764
1013	Res	All	All	Room A/C	All	Base	1.00E+15	1.00E+15	1.00E+15
1014	Res	All	All	Pools and Hot tubs	All	Base	6,542	6,953	7,053
1015	Res	All	All	Engine Block Heaters	All	Base	1,493	1,194	1.00E+15
1016	Res	All	All	Ventilation	All	Base	6,245	6,698	6,824
1017	Res	All	All	Outdoor Lighting	All	Base	4,277	4,602	4,103
1018	Res	All	All	Holiday Lighting	All	Base	271	260	1.00E+15

⁴⁵ Southern California Edison 1988 RAEUS (End Use) Study – Indoor/outdoor Pool Pumps and Electric Spas/Jacuzzis.

⁴⁶ Ontario Power Authority – OPA Measures and Assumptions List (prescriptive) as of January 31, 2010; 1450 watts at 7.9 hours/day x 90 days.

⁴⁷ Based on Whitehorse sunrise/sunset times, with 5% during daylight hours.

Since YECL does not conduct regular class or end-use load analysis studies, there is no actual total (or dwelling type) end-use load profile upon which to calibrate the load profile models developed for this study. Class load studies have been performed for cost-of-service and rate design purposes, but results were not yet available. End-use data collection has not been performed. Summing all end uses would produce a total residential daily load profile, but the YECL class load profile to which it would be compared would still only be a statistical estimate and not an actual, in the same way that the annual kWh energy sales would be for the calibration of total annual kWh. The best option for calibrating Yukon-specific load profile parameters is the weather-sensitive loads, since that is the most area specific.

Since separately metered space heating end-use load data was not available from YECL, normal weather for the past 10 years was used to determine monthly allocations, and weekend/weekday ratios were developed from similar studies for another Canadian utility.

For peak day factors, analysis of the past 10 years' average vs. peak weather conditions (in heating degree days) for Whitehorse was analyzed to determine typical peak day factors for normal weather, which ranged from about 1.4 to 1.5 for winter months. For non weather-sensitive end uses, a factor of 1.0 was assumed, absent specific load study data.

B.3 Detailed Results

The next three exhibits show peak demand by dwelling type and end use for each of the three peak periods identified for this study. These first three exhibits are followed by twelve more showing the results by supply system.

Note that in each of the exhibits, the end uses are sorted from largest peak demand to smallest peak demand, so they do not appear in the same order in the three exhibits.

Exhibit B 6 Residential Sector Base Year (2010) Period 1, Peak Hour Demand, by Dwelling Type and End Use (MW)*

Dwelling Type	Space heating	Cooking appliances	Indoor lighting	Clothes dryer	Domestic hot water (DHW)	Spa heaters and pumps	Block heaters & car warmers	Computer and peripherals	Refrigerator	Ventilation & circulation
Single Detached Houses	7.36	3.23	1.80	2.04	1.82	1.56	1.30	1.04	0.74	0.62
Apartments	0.87	0.41	0.45	0.23	0.17	0.06	0.30	0.18	0.10	0.19
Attached/Row Houses	0.58	0.29	0.16	0.17	0.19	0.19	0.16	0.13	0.08	0.06
Mobile/Other	0.71	0.31	0.17	0.15	0.20	0.09	0.14	0.11	0.07	0.07
Seasonal & Garage	0.09	0.13	0.18	0.06	0.07	0.14	0.04	0.03	0.02	0.02
Small Grid Housing	0.04	0.08	0.04	0.04	0.04	0.03	0.03	0.02	0.02	0.01
Sentinel Lighting	-	-	-	-	-	-	-	-	-	-
Grand Total	9.66	4.44	2.81	2.70	2.50	2.08	1.97	1.52	1.03	0.98

Dwelling Type	Holiday lighting	Outdoor lighting	Freezer	Television	Heat tape, propane httrs, circ pumps	Set-top boxes	Small appliance & other	Home entertainment electronics	Dishwasher	Clothes washer	Grand Total
Single Detached Houses	0.75	0.49	0.47	0.44	0.33	0.28	0.20	0.12	0.12	0.10	24.82
Apartments	0.08	0.05	0.07	0.08	0.07	0.05	0.03	0.02	0.01	0.01	3.41
Attached/Row Houses	0.05	0.04	0.05	0.06	0.04	0.03	0.02	0.01	0.01	0.01	2.33
Mobile/Other	0.05	0.05	0.04	0.05	0.04	0.03	0.02	0.01	0.01	0.01	2.33
Seasonal & Garage	-	0.05	0.01	0.01	0.01	0.01	0.06	0.01	0.00	0.00	0.99
Small Grid Housing	0.02	0.01	0.01	0.01	0.01	0.01	0.00	0.00	0.00	0.00	0.44
Sentinel Lighting	-	0.14	-	-	-	-	-	-	-	-	0.14
Grand Total	0.95	0.83	0.65	0.65	0.50	0.41	0.33	0.17	0.15	0.14	34.46

*Results are measured at the customer's point-of-use and do not include line losses. Any differences in totals are due to rounding.

Exhibit B 7 Residential Sector Base Year (2010) Period 2, Annual System Peak, by Dwelling Type and End Use (MW)

Dwelling Type	Space heating	Indoor lighting	Domestic hot water (DHW)	Block heaters & car warmers	Clothes dryer	Cooking appliances	Spa heaters and pumps	Computer and peripherals	Holiday lighting	Refrigerator
Single Detached Houses	7.18	2.00	2.03	1.62	1.67	1.50	1.47	1.07	0.78	0.71
Apartments	0.86	0.50	0.19	0.37	0.19	0.19	0.06	0.18	0.08	0.10
Attached/Row Houses	0.58	0.18	0.21	0.20	0.14	0.13	0.18	0.13	0.05	0.07
Mobile/Other	0.69	0.19	0.23	0.18	0.12	0.14	0.08	0.12	0.06	0.06
Seasonal & Garage	0.09	0.20	0.08	0.05	0.05	0.06	0.14	0.03	-	0.02
Small Grid Housing	0.04	0.05	0.05	0.03	0.04	0.04	0.03	0.02	0.02	0.02
Sentinel Lighting	-	-	-	-	-	-	-	-	-	-
Grand Total	9.45	3.12	2.79	2.46	2.20	2.05	1.96	1.55	0.99	0.98

Dwelling Type	Ventilation & circulation	Outdoor lighting	Television	Heat tape, propane htrs, circ pumps	Freezer	Set-top boxes	Small appliance & other	Dishwasher	Home entertainment electronics	Clothes washer	Grand Total
Single Detached Houses	0.58	0.45	0.44	0.41	0.45	0.28	0.20	0.16	0.12	0.10	23.22
Apartments	0.17	0.04	0.07	0.09	0.06	0.05	0.03	0.02	0.01	0.01	3.28
Attached/Row Houses	0.06	0.04	0.05	0.05	0.05	0.03	0.02	0.01	0.01	0.01	2.22
Mobile/Other	0.07	0.04	0.05	0.04	0.04	0.03	0.02	0.01	0.01	0.01	2.19
Seasonal & Garage	0.02	0.05	0.01	0.01	0.01	0.01	0.07	0.01	0.01	0.00	0.93
Small Grid Housing	0.01	0.01	0.01	0.01	0.01	0.01	0.00	0.00	0.00	0.00	0.41
Sentinel Lighting	-	0.13	-	-	-	-	-	-	-	-	0.13
Grand Total	0.92	0.77	0.64	0.62	0.62	0.40	0.34	0.21	0.17	0.14	32.38

Exhibit B 8 Residential Sector Base Year (F2010) Period 3, Annual Morning Peak, by Dwelling Type and End Use (MW)

Dwelling Type	Domestic hot water (DHW)	Space heating	Spa heaters and pumps	Cooking appliances	Indoor lighting	Computer and peripherals	Ventilation & circulation	Outdoor lighting	Refrigerator	Freezer
Single Detached Houses	5.18	4.98	1.45	1.00	0.80	0.78	0.57	0.51	0.56	0.35
Apartments	0.49	0.51	0.05	0.13	0.20	0.13	0.17	0.05	0.08	0.05
Mobile/Other	0.57	0.48	0.08	0.09	0.08	0.09	0.07	0.05	0.05	0.03
Attached/Row Houses	0.54	0.34	0.18	0.09	0.07	0.10	0.06	0.04	0.06	0.04
Seasonal & Garage	0.21	0.06	0.13	0.04	0.08	0.02	0.02	0.05	0.02	0.01
Small Grid Housing	0.13	0.03	0.03	0.02	0.02	0.02	0.01	0.01	0.01	0.01
Sentinel Lighting	-	-	-	-	-	-	-	0.15	-	-
Grand Total	7.12	6.41	1.93	1.37	1.25	1.14	0.90	0.86	0.78	0.49

Dwelling Type	Television	Clothes dryer	Set-top boxes	Small appliance & other	Dishwasher	Home entertainment electronics	Clothes washer	Block heaters & car warmers	Heat tape, propane httrs, circ pumps	Holiday lighting	Grand Total
Single Detached Houses	0.32	0.27	0.20	0.15	0.10	0.09	0.04	0.00	0.00	0.00	17.35
Apartments	0.06	0.03	0.03	0.02	0.01	0.01	0.00	0.00	0.00	0.00	2.02
Mobile/Other	0.04	0.02	0.02	0.01	0.01	0.01	0.00	0.00	0.00	0.00	1.70
Attached/Row Houses	0.04	0.02	0.03	0.01	0.01	0.01	0.00	0.00	0.00	0.00	1.64
Seasonal & Garage	0.01	0.01	0.01	0.05	0.00	0.01	0.00	0.00	0.00	-	0.73
Small Grid Housing	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.32
Sentinel Lighting	-	-	-	-	-	-	-	-	-	-	0.15
Grand Total	0.47	0.35	0.30	0.25	0.13	0.12	0.05	0.00	0.00	0.00	23.91

Exhibit B 9 Residential Sector Base Year (2010) Period 1, Peak Hour Demand, by Dwelling Type and End Use, Hydro Grid Accounts (MW)

Dwelling Type	Space heating	Cooking appliances	Indoor lighting	Clothes dryer	Domestic hot water (DHW)	Spa heaters and pumps	Block heaters & car warmers	Computer and peripherals	Refrigerator	Ventilation & circulation
Single Detached Houses	7.15	3.08	1.72	1.94	1.74	1.49	1.24	0.99	0.71	0.59
Apartments	0.87	0.40	0.44	0.23	0.17	0.06	0.29	0.17	0.10	0.18
Attached/Row Houses	0.57	0.27	0.15	0.16	0.18	0.19	0.15	0.12	0.07	0.06
Mobile/Other	0.68	0.28	0.16	0.14	0.19	0.08	0.13	0.10	0.06	0.06
Seasonal & Garage	0.09	0.12	0.17	0.06	0.07	0.13	0.04	0.03	0.02	0.02
Sentinel Lighting	-	-	-	-	-	-	-	-	-	-
Grand Total	9.34	4.14	2.63	2.53	2.34	1.94	1.85	1.42	0.96	0.92

Dwelling Type	Holiday lighting	Outdoor lighting	Freezer	Television	Heat tape, propane htrs, circ pumps	Set-top boxes	Small appliance & other	Home entertainment electronics	Dishwasher	Clothes washer	Grand Total
Single Detached Houses	0.71	0.46	0.45	0.42	0.31	0.27	0.19	0.11	0.11	0.10	23.77
Apartments	0.08	0.05	0.06	0.07	0.07	0.05	0.02	0.01	0.01	0.01	3.36
Attached/Row Houses	0.05	0.04	0.05	0.05	0.04	0.03	0.02	0.01	0.01	0.01	2.23
Mobile/Other	0.05	0.04	0.04	0.04	0.03	0.03	0.02	0.01	0.01	0.01	2.15
Seasonal & Garage	-	0.05	0.01	0.01	0.01	0.01	0.06	0.01	0.00	0.00	0.91
Sentinel Lighting	-	0.12	-	-	-	-	-	-	-	-	0.12
Grand Total	0.89	0.76	0.61	0.60	0.47	0.38	0.31	0.16	0.14	0.13	32.54

Exhibit B 10 Residential Sector Base Year (2010) Period 2, Annual System Peak, by Dwelling Type and End Use, Hydro Grid Accounts (MW)

Dwelling Type	Space heating	Indoor lighting	Domestic hot water (DHW)	Block heaters & car warmers	Clothes dryer	Cooking appliances	Spa heaters and pumps	Computer and peripherals	Holiday lighting	Refrigerator
Single Detached Houses	6.98	1.91	1.94	1.54	1.58	1.42	1.40	1.01	0.74	0.67
Apartments	0.86	0.49	0.19	0.37	0.19	0.18	0.05	0.18	0.08	0.10
Attached/Row Houses	0.56	0.17	0.20	0.19	0.13	0.13	0.17	0.13	0.05	0.07
Mobile/Other	0.66	0.17	0.21	0.16	0.11	0.13	0.08	0.11	0.05	0.06
Seasonal & Garage	0.08	0.19	0.07	0.05	0.05	0.05	0.12	0.03	-	0.02
Sentinel Lighting	-	-	-	-	-	-	-	-	-	-
Grand Total	9.14	2.93	2.61	2.32	2.06	1.92	1.83	1.45	0.92	0.92

Dwelling Type	Ventilation & circulation	Outdoor lighting	Television	Heat tape, propane htrs, circ pumps	Freezer	Set-top boxes	Small appliance & other	Dishwasher	Home entertainment electronics	Clothes washer	Grand Total
Single Detached Houses	0.55	0.43	0.42	0.39	0.42	0.26	0.19	0.16	0.11	0.10	22.24
Apartments	0.17	0.04	0.07	0.09	0.06	0.05	0.03	0.02	0.01	0.01	3.23
Attached/Row Houses	0.06	0.04	0.05	0.05	0.04	0.03	0.02	0.01	0.01	0.01	2.12
Mobile/Other	0.06	0.04	0.04	0.04	0.04	0.03	0.02	0.01	0.01	0.01	2.03
Seasonal & Garage	0.02	0.04	0.01	0.01	0.01	0.01	0.06	0.00	0.01	0.00	0.86
Sentinel Lighting	-	0.11	-	-	-	-	-	-	-	-	0.11
Grand Total	0.86	0.70	0.60	0.58	0.58	0.38	0.32	0.20	0.16	0.13	30.59

Exhibit B 11 Residential Sector Base Year (F2010) Period 3, Annual Morning Peak, by Dwelling Type and End Use, Hydro Grid Accounts (MW)

Dwelling Type	Domestic hot water (DHW)	Space heating	Spa heaters and pumps	Cooking appliances	Indoor lighting	Computer and peripherals	Ventilation & circulation	Outdoor lighting	Refrigerator	Freezer
Single Detached Houses	4.94	4.84	1.38	0.95	0.76	0.74	0.54	0.48	0.53	0.34
Apartments	0.48	0.51	0.05	0.12	0.19	0.13	0.17	0.05	0.08	0.05
Mobile/Other	0.53	0.46	0.07	0.09	0.07	0.08	0.06	0.04	0.05	0.03
Attached/Row Houses	0.52	0.33	0.17	0.08	0.07	0.09	0.06	0.04	0.05	0.03
Seasonal & Garage	0.19	0.06	0.12	0.04	0.07	0.02	0.02	0.05	0.02	0.01
Sentinel Lighting	-	-	-	-	-	-	-	0.13	-	-
Grand Total	6.65	6.19	1.80	1.28	1.17	1.07	0.84	0.79	0.73	0.46

Dwelling Type	Television	Clothes dryer	Set-top boxes	Small appliance & other	Dishwasher	Home entertainment electronics	Clothes washer	Block heaters & car warmers	Heat tape, propane htrs, circ pumps	Holiday lighting	Grand Total
Single Detached Houses	0.31	0.25	0.19	0.14	0.09	0.08	0.04	0.00	0.00	0.00	16.62
Apartments	0.05	0.03	0.03	0.02	0.01	0.01	0.00	0.00	0.00	0.00	1.99
Mobile/Other	0.03	0.02	0.02	0.01	0.01	0.01	0.00	0.00	0.00	0.00	1.57
Attached/Row Houses	0.04	0.02	0.02	0.01	0.01	0.01	0.00	0.00	0.00	0.00	1.56
Seasonal & Garage	0.01	0.01	0.01	0.05	0.00	0.01	0.00	0.00	0.00	-	0.67
Sentinel Lighting	-	-	-	-	-	-	-	-	-	-	0.13
Grand Total	0.44	0.33	0.28	0.23	0.12	0.12	0.05	0.00	0.00	0.00	22.54

Exhibit B 12 Residential Sector Base Year (2010) Period 1, Peak Hour Demand, by Dwelling Type and End Use, Large Diesel Accounts (MW)

Dwelling Type	Space heating	Cooking appliances	Clothes dryer	Indoor lighting	Domestic hot water (DHW)	Spa heaters and pumps	Block heaters & car warmers	Computer and peripherals	Ventilation & circulation	Refrigerator
Single Detached Houses	0.21	0.15	0.10	0.09	0.09	0.08	0.06	0.05	0.03	0.04
Mobile/Other	0.04	0.03	0.01	0.01	0.02	0.01	0.01	0.01	0.01	0.01
Attached/Row Houses	0.02	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.00	0.00
Apartments	0.01	0.01	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00
Seasonal & Garage	0.00	0.01	0.00	0.01	0.00	0.01	0.00	0.00	0.00	0.00
Sentinel Lighting	-	-	-	-	-	-	-	-	-	-
Grand Total	0.27	0.21	0.13	0.13	0.12	0.10	0.09	0.07	0.05	0.05

Dwelling Type	Outdoor lighting	Holiday lighting	Freezer	Television	Heat tape, propane htrs, circ pumps	Set-top boxes	Small appliance & other	Home entertainment electronics	Dishwasher	Clothes washer	Grand Total
Single Detached Houses	0.02	0.04	0.02	0.02	0.02	0.01	0.01	0.01	0.01	0.01	1.05
Mobile/Other	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.17
Attached/Row Houses	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.10
Apartments	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.06
Seasonal & Garage	0.00	-	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.05
Sentinel Lighting	0.01	-	-	-	-	-	-	-	-	-	0.01
Grand Total	0.05	0.04	0.03	0.03	0.02	0.02	0.02	0.01	0.01	0.01	1.45

Exhibit B 13 Residential Sector Base Year (2010) Period 2, Annual System Peak, by Dwelling Type and End Use, Large Diesel Accounts (MW)

Dwelling Type	Space heating	Indoor lighting	Domestic hot water (DHW)	Block heaters & car warmers	Clothes dryer	Cooking appliances	Spa heaters and pumps	Computer and peripherals	Refrigerator	Ventilation & circulation
Single Detached Houses	0.20	0.10	0.09	0.08	0.08	0.07	0.07	0.05	0.03	0.03
Mobile/Other	0.03	0.02	0.02	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Attached/Row Houses	0.02	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.00	0.00
Apartments	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Seasonal & Garage	0.00	0.01	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00
Sentinel Lighting	-	-	-	-	-	-	-	-	-	-
Grand Total	0.27	0.14	0.13	0.11	0.10	0.10	0.09	0.07	0.05	0.05

Dwelling Type	Holiday lighting	Outdoor lighting	Television	Freezer	Heat tape, propane htrs, circ pumps	Set-top boxes	Small appliance & other	Dishwasher	Home entertainment electronics	Clothes washer	Grand Total
Single Detached Houses	0.04	0.02	0.02	0.02	0.02	0.01	0.01	0.01	0.01	0.01	0.98
Mobile/Other	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.16
Attached/Row Houses	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.10
Apartments	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.05
Seasonal & Garage	-	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.05
Sentinel Lighting	-	0.01	-	-	-	-	-	-	-	-	0.01
Grand Total	0.05	0.04	0.03	0.03	0.03	0.02	0.02	0.01	0.01	0.01	1.35

Exhibit B 14 Residential Sector Base Year (F2010) Period 3, Annual Morning Peak, by Dwelling Type and End Use, Large Diesel Accounts (MW)

Dwelling Type	Domestic hot water (DHW)	Space heating	Spa heaters and pumps	Cooking appliances	Indoor lighting	Computer and peripherals	Outdoor lighting	Ventilation & circulation	Refrigerator	Freezer
Single Detached Houses	0.24	0.14	0.07	0.05	0.04	0.04	0.02	0.03	0.03	0.02
Mobile/Other	0.05	0.02	0.01	0.01	0.01	0.01	0.00	0.01	0.00	0.00
Attached/Row Houses	0.03	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Seasonal & Garage	0.01	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Apartments	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Sentinel Lighting	-	-	-	-	-	-	0.01	-	-	-
Grand Total	0.34	0.18	0.09	0.06	0.06	0.05	0.05	0.05	0.04	0.02

Dwelling Type	Television	Clothes dryer	Set-top boxes	Small appliance & other	Dishwasher	Home entertainment electronics	Clothes washer	Block heaters & car warmers	Heat tape, propane httrs, circ pumps	Holiday lighting	Grand Total
Single Detached Houses	0.02	0.01	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.73
Mobile/Other	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.13
Attached/Row Houses	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.07
Seasonal & Garage	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-	0.04
Apartments	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.04
Sentinel Lighting	-	-	-	-	-	-	-	-	-	-	0.01
Grand Total	0.02	0.02	0.01	0.01	0.01	0.01	0.00	0.00	0.00	0.00	1.02

Exhibit B 15 Residential Sector Base Year (2010) Period 1, Peak Hour Demand, by Dwelling Type and End Use, Small Diesel Accounts (MW)

Dwelling Type	Cooking appliances	Indoor lighting	Domestic hot water (DHW)	Clothes dryer	Space heating	Spa heaters and pumps	Outdoor lighting	Block heaters & car warmers	Computer and peripherals	Holiday lighting
Small Grid Housing	0.04	0.02	0.02	0.02	0.02	0.02	0.01	0.02	0.01	0.01
Seasonal & Garage	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-
Sentinel Lighting	-	-	-	-	-	-	0.01	-	-	-
Grand Total	0.05	0.03	0.03	0.03	0.03	0.02	0.02	0.02	0.01	0.01

Dwelling Type	Refrigerator	Ventilation & circulation	Freezer	Television	Heat tape, propane htrs, circ pumps	Set-top boxes	Small appliance & other	Home entertainment electronics	Dishwasher	Clothes washer	Grand Total
Small Grid Housing	0.01	0.01	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.25
Seasonal & Garage	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01
Sentinel Lighting	-	-	-	-	-	-	-	-	-	-	0.01
Grand Total	0.01	0.01	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.27

Exhibit B 16 Residential Sector Base Year (2010) Period 2, Annual System Peak, by Dwelling Type and End Use, Small Diesel Accounts (MW)

Dwelling Type	Indoor lighting	Domestic hot water (DHW)	Space heating	Cooking appliances	Clothes dryer	Spa heaters and pumps	Block heaters & car warmers	Outdoor lighting	Computer and peripherals	Holiday lighting
Small Grid Housing	0.03	0.03	0.02	0.02	0.02	0.02	0.02	0.01	0.01	0.01
Seasonal & Garage	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-
Sentinel Lighting	-	-	-	-	-	-	-	0.01	-	-
Grand Total	0.03	0.03	0.02	0.02	0.02	0.02	0.02	0.02	0.01	0.01

Dwelling Type	Refrigerator	Ventilation & circulation	Freezer	Television	Heat tape, propane htrs, circ pumps	Set-top boxes	Small appliance & other	Dishwasher	Home entertainment electronics	Clothes washer	Grand Total
Small Grid Housing	0.01	0.01	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.23
Seasonal & Garage	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01
Sentinel Lighting	-	-	-	-	-	-	-	-	-	-	0.01
Grand Total	0.01	0.01	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.25

Exhibit B 17 Residential Sector Base Year (F2010) Period 3, Annual Morning Peak, by Dwelling Type and End Use, Small Diesel Accounts (MW)

Dwelling Type	Domestic hot water (DHW)	Spa heaters and pumps	Space heating	Outdoor lighting	Cooking appliances	Indoor lighting	Computer and peripherals	Refrigerator	Ventilation & circulation	Freezer
Small Grid Housing	0.07	0.02	0.02	0.01	0.01	0.01	0.01	0.01	0.01	0.00
Seasonal & Garage	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Sentinel Lighting	-	-	-	0.01	-	-	-	-	-	-
Grand Total	0.07	0.02	0.02	0.02	0.01	0.01	0.01	0.01	0.01	0.00

Dwelling Type	Television	Clothes dryer	Set-top boxes	Small appliance & other	Home entertainment electronics	Dishwasher	Clothes washer	Block heaters & car warmers	Heat tape, propane htrs, circ pumps	Holiday lighting	Grand Total
Small Grid Housing	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.18
Seasonal & Garage	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-	0.01
Sentinel Lighting	-	-	-	-	-	-	-	-	-	-	0.01
Grand Total	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.20

Exhibit B 18 Residential Sector Base Year (2010) Period 1, Peak Hour Demand, by Dwelling Type and End Use, Old Crow Accounts (MW)

Dwelling Type	Cooking appliances	Indoor lighting	Domestic hot water (DHW)	Clothes dryer	Space heating	Spa heaters and pumps	Block heaters & car warmers	Computer and peripherals	Holiday lighting	Refrigerator
Small Grid Housing	0.03	0.02	0.02	0.02	0.02	0.01	0.01	0.01	0.01	0.01
Seasonal & Garage	0.00	0.00	0.00	0.00	0.00	0.00	-	0.00	-	0.00
Sentinel Lighting	-	-	-	-	-	-	-	-	-	-
Grand Total	0.04	0.02	0.02	0.02	0.02	0.02	0.01	0.01	0.01	0.01

Dwelling Type	Outdoor lighting	Ventilation & circulation	Freezer	Television	Heat tape, propane htrs, circ pumps	Set-top boxes	Small appliance & other	Home entertainment electronics	Dishwasher	Clothes washer	Grand Total
Small Grid Housing	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.20
Seasonal & Garage	0.00	0.00	0.00	0.00	-	0.00	0.00	0.00	0.00	0.00	0.01
Sentinel Lighting	0.00	-	-	-	-	-	-	-	-	-	0.00
Grand Total	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.21

Exhibit B 19 Residential Sector Base Year (2010) Period 2, Annual System Peak, by Dwelling Type and End Use, Old Crow Accounts (MW)

Dwelling Type	Indoor lighting	Domestic hot water (DHW)	Space heating	Cooking appliances	Clothes dryer	Spa heaters and pumps	Block heaters & car warmers	Computer and peripherals	Holiday lighting	Refrigerator
Small Grid Housing	0.02	0.02	0.02	0.02	0.02	0.01	0.02	0.01	0.01	0.01
Seasonal & Garage	0.00	0.00	0.00	0.00	0.00	0.00	-	0.00	-	0.00
Sentinel Lighting	-	-	-	-	-	-	-	-	-	-
Grand Total	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.01	0.01	0.01

Dwelling Type	Outdoor lighting	Ventilation & circulation	Freezer	Television	Heat tape, propane htrs, circ pumps	Set-top boxes	Small appliance & other	Dishwasher	Home entertainment electronics	Clothes washer	Grand Total
Small Grid Housing	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.18
Seasonal & Garage	0.00	0.00	0.00	0.00	-	0.00	0.00	0.00	0.00	0.00	0.01
Sentinel Lighting	0.00	-	-	-	-	-	-	-	-	-	0.00
Grand Total	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.19

Exhibit B 20 Residential Sector Base Year (F2010) Period 3, Annual Morning Peak, by Dwelling Type and End Use, Old Crow Accounts (MW)

Dwelling Type	Domestic hot water (DHW)	Spa heaters and pumps	Space heating	Cooking appliances	Indoor lighting	Computer and peripherals	Outdoor lighting	Refrigerator	Ventilation & circulation	Freezer
Small Grid Housing	0.06	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.00
Seasonal & Garage	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Sentinel Lighting	-	-	-	-	-	-	0.00	-	-	-
Grand Total	0.06	0.02	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.00

Dwelling Type	Television	Clothes dryer	Set-top boxes	Small appliance & other	Home entertainment electronics	Dishwasher	Clothes washer	Block heaters & car warmers	Heat tape, propane htrs, circ pumps	Holiday lighting	Grand Total
Small Grid Housing	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.14
Seasonal & Garage	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-	-	-	0.01
Sentinel Lighting	-	-	-	-	-	-	-	-	-	-	0.00
Grand Total	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.15

Appendix C Background-Section 5: Reference Case Electricity Use

Introduction

Appendix C provides additional detailed information related to each of the major steps employed to generate the profile of Residential sector Reference Case electricity use. The major steps involved are:

- **Step 1:** Estimate net space heating and cooling loads for each new dwelling type
- **Step 2:** Estimate naturally-occurring changes in net space heating and cooling loads for existing dwelling types
- **Step 3:** Estimate naturally-occurring changes in annual electricity use for the evolving stock of major residential appliances
- **Step 4:** Estimate future appliance saturation trends for each dwelling type
- **Step 5:** Estimate changes in electricity share for each appliance, by dwelling type
- **Step 6:** Estimate the growth in number of residential dwellings, by type.

C.1 Step 1: Estimation of Net Space Heating and Cooling Loads—New Dwellings

The first task in building the Reference Case involved the development of estimates of the net space heating loads for new dwellings to be built over the study period. As was the case with the existing building stock, the study relied on several sources to prepare these estimates, including:

- Estimated electricity consumption per dwelling from the Yukon load forecast
- Consultation with housing experts at Yukon Housing Corporation
- Review of experience in other jurisdictions.

Based on consideration of the best available data from the above sources, this study assumes that the net space heating loads in new dwellings are likely to decrease slightly compared to existing dwellings. This conclusion recognizes that while thermal efficiencies are improving in new dwellings, they are being partially offset by changing construction practices.

Examples of these offsetting trends include:

- Overall, window, wall and roofing thermal efficiency levels have increased in new residential buildings and air leakage rates have been reduced by more than 40% compared to typical existing dwellings
- The amount of window area in new houses has increased by up to 20% compared to typical existing homes
- The new stock tends to have floor areas that are slightly larger, on average, than existing dwellings, though this trend has levelled off recently
- Buildings also feature an increase in exterior wall surface area of between 5%-20%. This reflects both the increased floor area and a tendency for homes to include architectural features with more corners and details that diverge from the standard rectangular shapes.

Exhibit C 1 summarizes the resulting new net space heating and cooling loads.

Exhibit C 1 New Residential Units—Net Space Heating Loads⁴⁸ by Dwelling Type, (kWh/yr.)

Dwelling Types	Tertiary Heating Load (kWh/yr.)			
	Hydro Grid	Large Diesel	Small Diesel	Old Crow
1980 & newer non-electrically heated single detached homes	19,922	19,270	-	-
1980 & newer electrically heated single detached homes	13,284	-	-	-
1980 & newer non-electrically heated attached/row housing	12,724	12,308	-	-
1980 & newer electrically heated attached/row housing	7,263	-	-	-
Non-electrically heated apartment units	10,380	8,535	-	-
Non-electrically heated apartment common areas	25,291	29,287	-	-
Electrically heated apartment units	6,021	-	-	-
Electrically heated apartment common areas	14,669	-	-	-
Non-electrically heated mobile/other	15,062	22,270	-	-
Electrically heated mobile/other	9,287	-	-	-
Small diesel grid housing	-	-	15,693	17,399
Seasonal housing	1,367	1,435	1,065	1,137
Residential garages	9,806	6,962	3,922	9,806

C.1.1 Development of Thermal Archetypes – New Stock

Although the study assumes that the net space heating loads decrease only slightly for new dwellings, the physical and thermal specifications of the new dwellings differ from the existing dwellings. Thus, as in the Base Year discussion, a thermal archetype for each of the major new dwelling types was developed using HOT2000.

For the new housing stock, archetypes were created for the two primary dwelling types in each service region: single-family detached and attached. A brief description of each housing archetype is provided below.

Single detached houses

A typical new single-family detached dwelling can be defined as a single-story bungalow of approximately 170 m² (1,800 ft²), including a finished basement. This home has approximately 19.0 m² (205 ft²) of window area, typically low-e, argon-filled, triple-glazed window units with vinyl frames. Walls are represented by RSI-4.9 (R-28) insulation values, ceilings RSI-8.8 (R-50) and the basement is insulated to a value of RSI-4.9 (R-28) all the way to the basement floor. The houses are reasonably airtight with about 1.5 ACH@50Pa (air changes per hour at 50 Pascal depressurization).

Attached Dwellings

A typical new attached dwelling can be defined as a one-story end unit of approximately 125 m² (1,350 ft²), including a finished basement. This home has 11.5 m² (125 ft²) of windows, typically

⁴⁸ Net space heating load is the space heating load of a building that must be met by the space heating system over a full year. This is equal to the total heat loss through the building envelope minus solar and internal gains. Values shown for non-electrically heated dwellings are shown in kilowatt hours for format consistency.

low-e, argon-filled, triple-glazed window units with vinyl frames. Walls are represented by RSI-4.9 (R-28) insulation values, ceilings RSI-8.8 (R-50) and the basement is insulated to a value of RSI-4.9 (R-28) all the way to the basement floor. The houses are reasonably airtight, with an air change rate of about 1.5 ACH@50Pa.

C.2 Step 2: Natural Changes to Space Heating Loads – Existing Dwellings

In addition to new dwellings, space heating loads in existing dwellings are also expected to change over the study period. However, no specific data are available and, as outlined in the preceding discussion of new dwellings, contrary trends⁴⁹ are occurring.

Examples of trends that tend to decrease the net space heating loads include:

- Insulation and other improvements that occur when renovation projects are undertaken
- Replacement of old windows with new models that provide comfort and aesthetic benefits as well as improved energy efficiency
- Installation of more efficient thermostatic controls.

Examples of trends that tend to increase net space heating loads include:

- Enlargement of houses with additions
- Reductions in internal gains due to more efficient appliances and lights.

Dwellings that undergo a major energy retrofit to the building shell are moved from the existing dwelling category into renovated dwellings. On average, these projects are assumed to include two building envelope retrofits (though they may not all happen in the same month), such as replacement of half the windows and the addition of insulation to the attic. In past projects, window replacement has been used as an indicator of the percentage of dwellings being renovated. Window sales are typically divided roughly evenly between installation in new homes and replacement in existing homes. A typical window replacement project involves approximately half the windows in the dwelling. Therefore, the rate of renovation is approximately double the rate of new construction.

Trial energy simulation runs were undertaken in HOT2000, assuming a variety of combinations of retrofit measures. The results varied widely, from a 2% to 15% reduction in space heat and cooling loads, depending on assumptions related to the number of windows replaced, or the part of the house being insulated. These decreases will be partly or wholly offset in those renovation jobs that also increase the floor area of the dwelling.

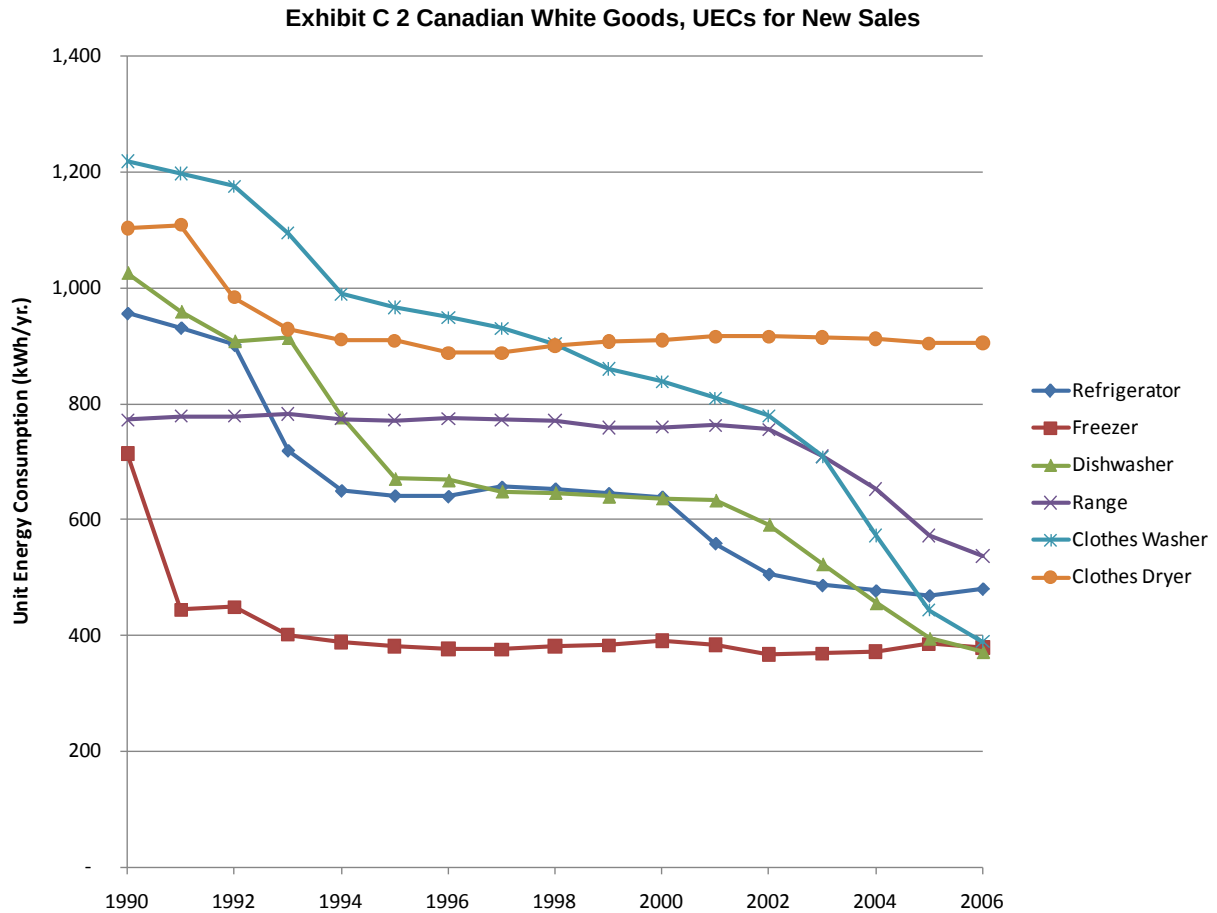
In the absence of more comprehensive data, this study assumes that a renovation to a home built after 1980 would experience a net reduction in space heating load of 3%. An older home (in which it was assumed more likely there would be an addition to the floor area) would experience a net reduction in space heating load of 2%.

⁴⁹ Replacement of the heating equipment itself is not one of these factors because it does not actually change the net heating load.

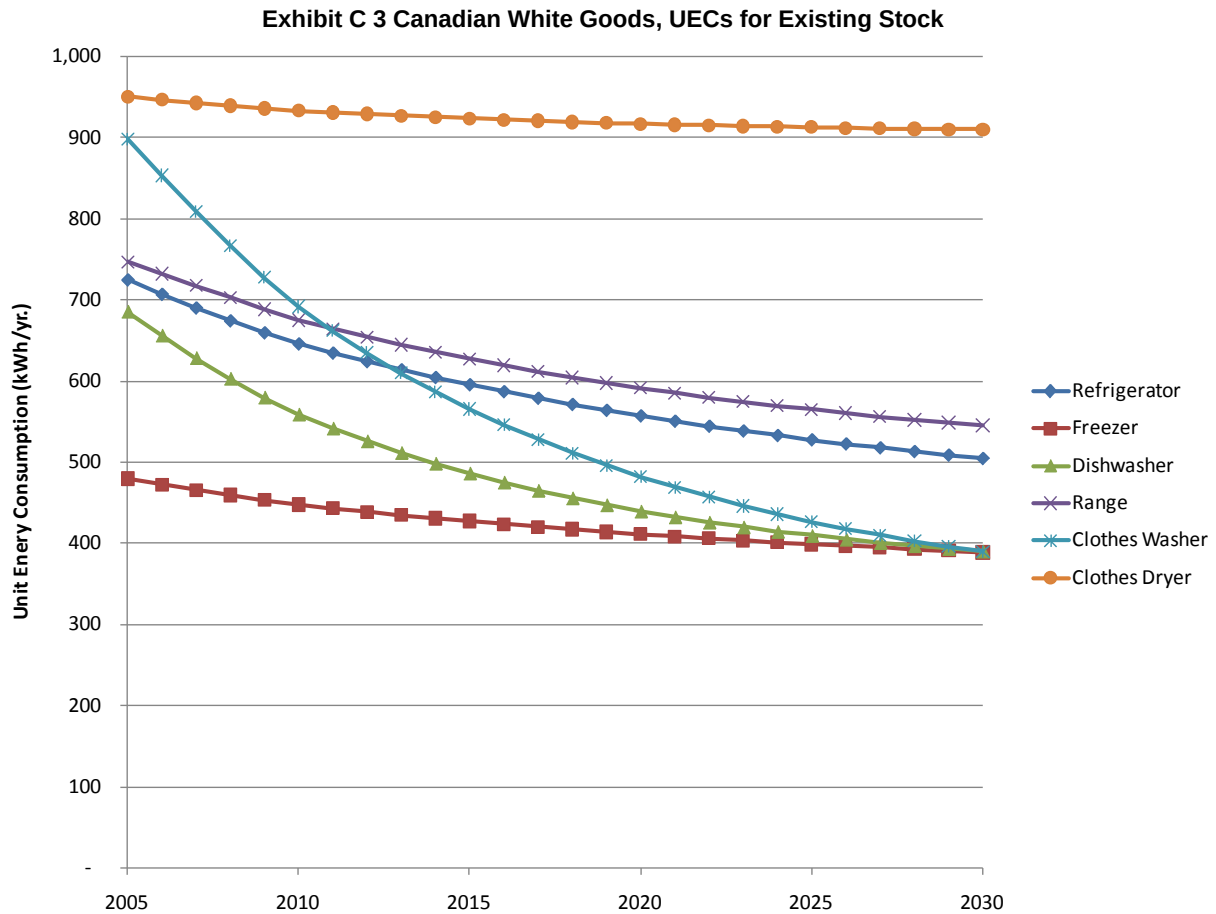
C.3 Step 3: Natural Changes to Electric Appliance UECs

This section identifies the annual unit electricity consumption (UEC) for the major household appliances and equipment for both “stock in place” and new sales for the period 2010 to 2030.

Exhibit C 2 shows Canadian trend information for the new sales of white goods for the period 1990 to 2006. Exhibit C 3 incorporates the average consumption data for new sales into ICF Marbek’s appliance stock model to develop forecasts for average consumption of the white goods appliances throughout the study period.



Source: NRCAN, *Energy Consumption of Major Household Appliances Shipped in Canada: Trends for 1990-2006*.



Source: Original NRCAN UEC data for new sales (see source note for previous exhibit), incorporated into Marbek's appliance stock model.

As shown in Exhibit C 3, the annual UEC for most major household white good type appliances in existing stock is expected to decline steadily until nearly 2020, due to stock turnover and to continuing improvements in new stock. Future regulations or innovations may bring additional improvements in the white goods in the later years of the study period, but no assumptions have been made to that effect. Instead, the consumption of the different appliances is permitted to level off.

Further discussion of the modelled assumptions applied to each of the major appliances follows.

Cooking

A UEC, which includes both ranges and microwave ovens, of 668 kWh/yr. is assumed in the Base Year, declining to 540 kWh/yr. in the final milestone year. The variation by dwelling type, mainly due to differences in occupancy (and therefore use of cooking appliances), follows the pattern shown in Exhibit A 2. In new dwellings, the appliances are assumed to be approximately 10 years newer than in existing dwellings. New homes built right after the Base Year are assumed to have a cooking UEC of 585 kWh/yr. on average, declining to 540 kWh/yr. by 2030.

Refrigerator

A UEC of 614 kWh/yr. is assumed in the Base Year, declining to 479 kWh/yr. in the final milestone year. The variation by dwelling type, mainly due to differences in occupancy (and therefore average size of refrigerators), follows the pattern shown in Exhibit A 2. In new dwellings, the appliances are assumed to be approximately 10 years newer than in existing dwellings. New homes built right after the Base Year are assumed to have a refrigerator UEC of 529 kWh/yr. on average, declining to 479 kWh/yr. by 2030.

Freezer

A UEC of 443 kWh/yr. is assumed in the Base Year, declining to 365 kWh/yr. in the final milestone year. The variation by dwelling type, mainly due to differences in occupancy (and therefore average size of freezers), follows the pattern shown in Exhibit A 2. In new dwellings, the appliances are assumed to be approximately 10 years newer than in existing dwellings. New homes built right after the Base Year are assumed to have a freezer UEC of 407 kWh/yr. on average, declining to 365 kWh/yr. by 2030.

Dishwasher

A UEC of 108 kWh/yr. is assumed in the Base Year, declining to 75 kWh/yr. in the final milestone year. The variation by dwelling type, mainly due to differences in occupancy (and therefore use of dishwashers), follows the pattern shown in Exhibit A 2. In new dwellings, the appliances are assumed to be approximately 10 years newer than in existing dwellings. New homes built right after the Base Year are assumed to have a dishwasher UEC of 85 kWh/yr. on average, declining to 75 kWh/yr. by 2030.

The values shown are for mechanical energy only. Mechanical energy is assumed to be approximately 19% of the values reflected in Exhibit C3. Hot water use is included with the DHW UEC.

Clothes Washer

A UEC of 61 kWh/yr. is assumed in the Base Year, declining to 34 kWh/yr. in the final milestone year. The variation by dwelling type, mainly due to differences in occupancy (and therefore use of clothes washers), follows the pattern shown in Exhibit A 2. In new dwellings, the appliances are assumed to be approximately 10 years newer than in existing dwellings. New homes built right after the Base Year are assumed to have a clothes washer UEC of 42 kWh/yr. on average, declining to 34 kWh/yr. by 2030.

The values shown are for mechanical energy only. Mechanical energy is assumed to be approximately 9% of the values reflected in Exhibit C3. Hot water use is included with the DHW UEC.

Clothes Dryer

A UEC of 924 kWh/yr. is assumed in the Base Year, declining to 901 kWh/yr. in the final milestone year. The variation by dwelling type, mainly due to differences in occupancy (and therefore use of clothes dryers), follows the pattern shown in Exhibit A 2. In new dwellings, the appliances are assumed to be approximately 10 years newer than in existing dwellings. New

homes built right after the Base Year are assumed to have a dryer UEC of 908 kWh/yr. on average, declining to 901 kWh/yr. by 2030.

Ventilation

Ventilation energy in existing stock is assumed to remain constant. This assumption recognizes that there are a number of competing trends that remain unresolved at this time. On the one hand, there is a trend towards manufacturers' use of larger fan motors (1/2-HP versus 1/3-HP) in new furnaces. This means that furnaces replaced in the study period may have a larger furnace fan motor. However, the trend towards larger fan motors is at least partially offset by efficiency improvements. For example, an earlier study for the Canadian Electricity Association (CEA) noted that improved fan design, combined with the use of permanent split capacitor fan motors, had improved furnace fan efficiency by between 13% and 19%.⁵⁰

In new stock, average ventilation energy was assumed to increase by nearly 40%, from the current average of approximately 573 kWh/yr. (including furnace fans, other fans such as exhaust fans in the kitchen, and pumps in boiler systems) to approximately 787 kWh/yr. This value was based on the HOT2000 modeling of newer homes with the furnace fan operating continuously. According to previous studies in other jurisdictions, occupants of newer dwellings are more likely to run their furnace blower fan continuously.

Domestic Hot Water

Exhibit C 4 summarizes the DHW UECs by end use for new dwellings. A comparison with the values presented previously for existing dwellings (see Appendix A) shows a significant reduction for hot water use in clothes washing, with slightly more modest changes for personal consumption.

DHW electricity for new and existing appliances is obtained from NRCan, as discussed above (see Exhibit C 3). For existing and retrofitted buildings, the DHW UEC is assumed to decrease as clothes washers are replaced in the appliance stock, but is otherwise assumed to be constant. The UEC for DHW in new buildings is assumed to be constant.

⁵⁰ Phillips, B. *Blower Efficiency in Domestic Heating Systems*, CEA Report No. 9202-U-921, 1995 and *Optimizing Heat and Air Distribution Systems when Retrofitting Houses with Energy Efficient Equipment*, Canada Mortgage and Housing Corporation, 2002. Ventilation UECs will be higher in dwellings that have air conditioning and/or continuous ventilation.

Exhibit C 4 Distribution of DHW Electricity Use by End Use in New Stock, (kWh/yr.)

DHW Sub End Uses	Electricity per Sub End Use (kWh/yr.)	Electricity per Sub End Use (%)
Clothes Washer	356	13%
Showers	690	26%
Faucets	493	18%
Baths	128	5%
Dishwasher	315	12%
Leaks	192	7%
Tank (Standby) Losses	256	10%
Pipe Losses	256	10%
Total	2,687	100%

Indoor Lighting

The lighting UEC was assumed to decrease as incandescent lamps are phased out and replaced by compact fluorescent lamps. It is assumed that approximately 50% of the remaining incandescent lamps would be replaced by the end of the study period if there was no utility involvement in DSM programming or revision of efficiency standards. Exhibit C 5 shows the assumed lighting counts, average wattage, and hours of use per year used to develop estimates of the overall indoor lighting energy consumption for different dwelling types in 2030.

Exhibit C 5 Indoor Lighting by Dwelling Type, 2030

Dwelling Types	Incandescent Lamps	CFL	Linear Fluorescent Tubes	Halogen Lamps	
SDH	11	28	6	3	(lamps)
Attached	8	21	2	2	(lamps)
Apartment	6	15	1	1	(lamps)
Average Wattage	60	15	48	50	(watts)
Average Hours/Year	500	500	500	500	(hr/yr.)
Total Base Year Energy Use (kWh/yr.)					Total
SDH	330	210	144	75	759
Attached	240	158	48	50	496
Apartment	180	113	24	25	342

Outdoor Lighting

The lighting UEC was assumed to decrease as incandescent lamps are phased out and replaced by compact fluorescent lamps. It is assumed that approximately 50% of the remaining incandescent lamps would be replaced by the end of the study period if there was no utility involvement in DSM programming or revision of efficiency standards. Exhibit C 6 shows the assumed lighting counts, average wattage, and hours of use per year used to develop estimates of the overall outdoor lighting energy consumption for different dwelling types in 2030.

Exhibit C 6 Outdoor Lighting by Dwelling Type, 2030

Dwelling Types	Incandescent Lamps	Compact Fluorescent Lamps (long hours)	Compact Fluorescent Lamps (short hours)	Linear Fluorescent Tubes	
SDH	2	2	2	1	(lamps)
Attached	1	1	2	0	(lamps)
Apartment	0	0	1	0	(lamps)
Average Wattage	60	15	15	48	(watts)
Average Hours/Year	900	1800	900	365	(hr/yr.)
Total Base Year Energy Use (kWh/yr.)					Total
SDH	108	54	27	18	207
Attached	54	27	27	0	108
Apartment	0	0	14	0	14

Holiday Lighting

The holiday lighting UEC was assumed to decrease as incandescent strings are phased out and replaced by LED strings. This transition is assumed to be complete by the end of the study period. Exhibit C 7 shows the assumed lighting counts, average wattage, and hours of use per year used to develop estimates of the overall holiday lighting energy consumption for different dwelling types in 2030.

Exhibit C 7 Holiday Lighting by Dwelling Type, 2030

Dwelling Types	Indoor Incandescent Holiday Strings	Indoor LED Holiday Strings	Outdoor Incandescent Holiday Strings	Outdoor LED Holiday Strings	
SDH	0	11	0	8	(lamps)
Attached	0	6	0	5	(lamps)
Apartment	0	3	0	0	(lamps)
Average Wattage	60	1	60	1	(watts)
Average Hours/Year	95	95	125	125	(hr/yr.)
Total Base Year Energy Use (kWh/yr.)					Total
SDH	0	1	0	1	2
Attached	0	1	0	1	1
Apartment	0	0	0	0	0

Televisions

The North American television industry has announced its commitment to convert all analog television to digital broadcasting within the next five years. The transition is occurring August 31, 2011, in the large southern television markets, but will take longer in the North. These broadcast changes are occurring at a time when television technology and programming options are also

rapidly changing. Some television technology changes, such as the introduction of liquid crystal display (LCD) and plasma models, may also have significant impacts on household electricity consumption. It is also possible that these changes will result in an increased rate of turnover in the current stock of televisions to models that are better able to take advantage of the high definition (HD) digital signal.

LCD is now the dominant television technology. Although LCD screens typically use less electricity per square inch of screen, consumers typically choose screens that are larger when purchasing an LCD screen compared to cathode ray tube screens (CRTs). When CRTs predominated, the most popular size was 27" but consumers are now more likely to buy a 40" widescreen TV, or even larger. This trend has the effect of reducing the electricity advantage that would be gained from a direct switch to the new LCD technology.

In addition to the increase in screen size, HD television models typically consume more power than equivalent standard definition televisions for all technology types. Since the trend with televisions is towards HD sets with greater resolution, television unit electricity use is expected to increase in the future.

In the long term, ENERGY STAR® and improved energy-efficiency standards for electronics will start to bring down the average electricity use per television, even in the absence of new DSM programs in Yukon. The effects of these improvements will likely be masked by the effects of increasing television size and resolution until after 2020.

In light of these changes, UECs for televisions are assumed to increase from 178 kWh/yr. to 210 kWh/yr. by 2020 and then begin to slowly decline, reaching 207 kWh/yr. by 2030. These assumptions draw on both a 2006 Marbek study, *Technology and Market Profile: Consumer Electronics*,⁵¹ and subsequent work for the Ontario Power Authority in 2009.

Television Peripherals

One implication of the pending changes towards digital television broadcasting is that new signal adaptors, commonly referred to as set-top boxes (STBs), will need to be added to nearly two-thirds of Canadian households to receive a television signal.

Industry representatives estimate that each Canadian subscriber household has, on average, 1.5 set-top boxes.⁵² They also note that the trend is towards a greater number of STBs per household and, by 2010, the industry estimates that the average will have increased to approximately two STBs per subscriber household. This is further discussed in the saturation section of this appendix (Section C.4).

When complete, the switch to digital broadcasting is expected to increase national STB electricity consumption by up to four times its current level due to the added requirement for STBs among those televisions currently operating on analog cable or over-the-air broadcast signals. Moreover, within these STBs, the most significant trend is towards greater functionality, which is directly associated with further increases in unit electricity consumption.

At the same time, ENERGY STAR® and improved energy-efficiency standards for electronics will begin to affect STBs. Currently, many of these products consume a substantial fraction of

⁵¹ Marbek Resource Consultants. *Technology and Market Profile: Consumer Electronics*, September 2006.

⁵² Ibid.

their electricity when no one is watching the television. Standards that specify maximum consumption in standby mode will therefore make a dramatic difference in the UEC for these devices.

In light of these changes, UECs for television peripherals are assumed to decrease from 225 kWh/yr. to 172 kWh/yr. over the study period.⁵³ The decrease is more than offset by the increasing saturation, as discussed in Section C.4.

Computers and Peripherals

Electricity consumption for personal computers is expected to decrease modestly, as monitors move to more energy-efficient flat screen technology and ENERGY STAR® increasingly predominates. This is somewhat counteracted by a growing preference for larger screens, a trend towards longer operating hours both in full operating mode and in idle mode, and the increasing numbers of peripherals. The growth in the number of computers per household is discussed in the saturation section of this appendix (Section C.4).

UECs for personal computers and their peripherals are assumed to decrease from 394 kWh/yr. to 384 kWh/yr. over the study period.

Spas

No increase in the size or heating load of spas has been assumed. In a previous Marbek study for the OPA in 2009, assumptions were developed on the trend towards the use of heat pumps to heat pools and spas. By 2030, the electric resistance heaters are assumed to be completely phased out, even in the absence of new DSM programs in Yukon.

The analysis also assumes that high-efficiency pumps will gradually become more popular in the market, without new DSM intervention, reaching a penetration of 60% by 2030.

UECs for spas, including both the electric heating units (resistance or heat pump) and the pumps, are expected to decline from 8,164 kWh/yr. in 2010 to 3,171 kWh/yr. in 2030.

Home Entertainment Electronics

As functionality increases, other entertainment devices, such as computer games and music systems are becoming more powerful. For example, the new PlayStation 3 games console uses 360 Watts compared to its predecessor, which uses only 45 Watts. One of the selling features of the Nintendo Wii and other next generation products is that they can be left on-line for 24 hours a day.

UECs for both the home entertainment electronics category and the small appliances and other category are likely to increase over the study period. UECs for home entertainment electronics are assumed to increase from 106 kWh/yr. to 1,074 kWh/yr. over the study period.

Block Heaters and Car Warmers

No change was assumed in the consumption of block heaters and car warmers over the study period, in the absence of new utility DSM initiatives.

⁵³ Ibid.

Heat Tape, Propane Heaters, and Circulation Pumps

No change was assumed in the consumption of heat tape, propane heaters and circulation pumps over the study period, in the absence of new utility DSM initiatives.

Small Appliances and Other

The UECs for the small appliances and other categories increase over the study period in anticipation of new end uses, but there is considerable uncertainty in the amount of this increase.

Based on the changes observed in previous studies, new end uses are constantly emerging, some of which are substantial consumers of electricity. One example is electric vehicle charging. Electric cars and plug-in hybrids could achieve substantial penetration by the end of the study period; charging of a typical electric vehicle would require approximately 7,000 kWh/yr.⁵⁴

The UEC for this category is assumed to increase from 186 kWh/yr. to 1,895 kWh/yr. over the study period. The growth rate in this end use was adjusted to improve the calibration between the model and the Yukon load forecast. Because there is so much uncertainty in the emergence of new “other” end uses and considerably more knowledge of trends in other end uses, this miscellaneous category was used to increase the consumption per account to match the forecast. The forecast changes in consumption per house vary among the four different supply systems. A growth rate of over 12% per year was applied to Small Appliances and Other in order to match the forecast increase in overall consumption per house on the hydro grid. For accounts on large and small diesel systems and the Old Crow system, the growth rates used for Small Appliances and Other were 9%, 4.5%, and 6%, respectively.

C.4 Step 4: Appliance Saturation Trends

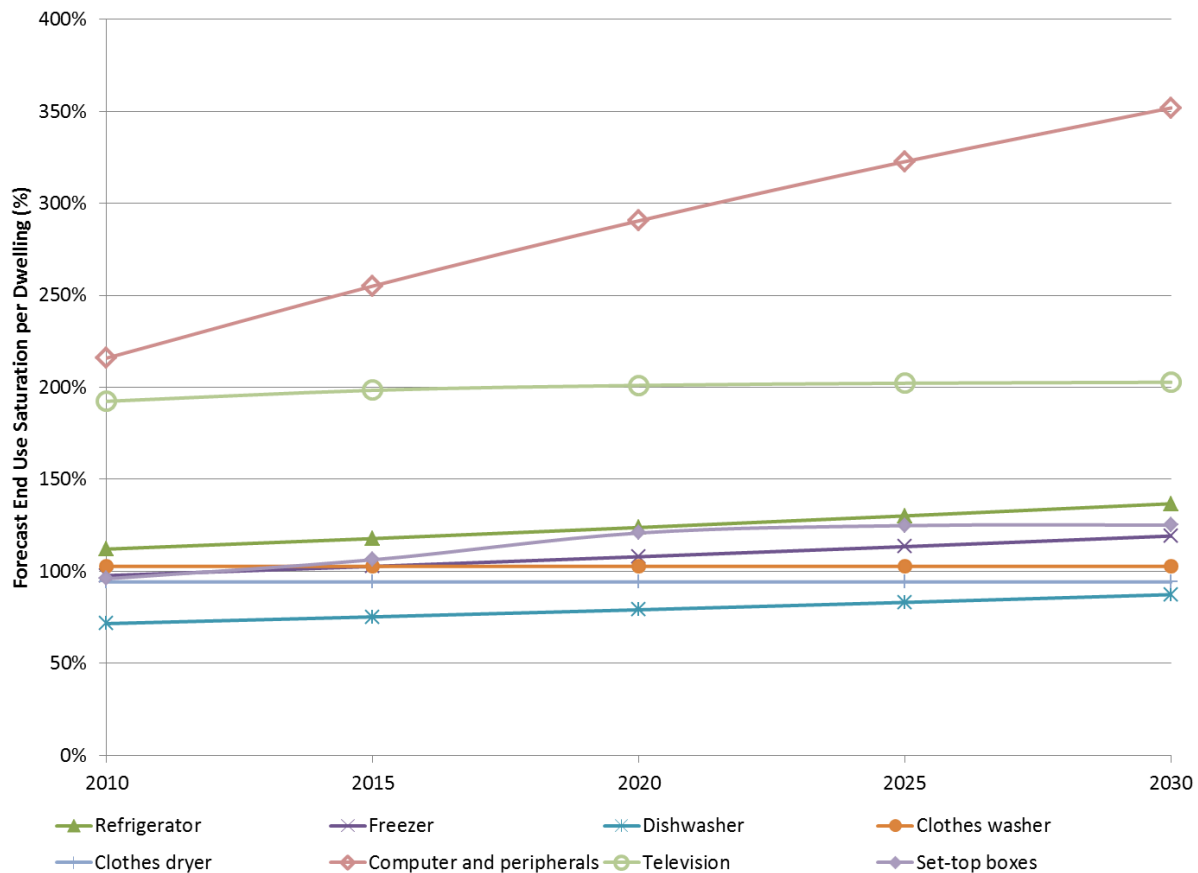
To develop estimates of the future saturation of residential equipment, references from Yukon and previous studies in other jurisdictions were reviewed along with data on trends in the increasing use of entertainment-based electronics.

We have applied the growth rates from these sources to estimate saturations to the end of the study period. Increases in the numbers of set-top boxes drew on Marbek’s 2006 study.⁵⁵ The results are shown in Exhibit C 8.

⁵⁴ California EPA, Air Resources Board. *Fact Sheet: Battery Electric Vehicles*, Sacramento, CA, 2003, http://www.arb.ca.gov/msprog/zevprog/factsheets/clean_vehicle_incentives.pdf.

⁵⁵ Op. cit. *Technology and Market Profile: Consumer Electronics*.

Exhibit C 8 Trends in Appliance Saturation, 2010 to 2030



All of the end-use appliances shown in Exhibit C 8 are forecast to increase in saturation per household. For the white goods end uses, this results in a relatively stable overall consumption per household because the increase in saturation is approximately cancelled out by the decrease in UEC that is expected to occur over the same period. For the three electronics end uses shown in the exhibit, the overall consumption is expected to rise during the period, as increases in saturation will likely have a larger effect than improvements in efficiency.

C.5 Step 5: Fuel Shares

No changes in the fuel shares for any end uses are assumed over the study period.

C.6 Step 6: Estimate Growth in Dwellings, by Type

This step involved the development and application of estimated levels of growth in each dwelling type over the study period.

YEC provided the forecast growth dwelling units as annual percentages for each supply system. The same growth rates were used for all of the dwelling types connected with a given supply system, with one key exception. Where a dwelling type was segmented by vintage, all the growth was applied to the newest vintage.

Exhibit C 9 presents a summary of the resulting percentage stock growth, by year and dwelling type, for Yukon as a whole.

Exhibit C 9 Residential Stock Growth Rates, 2010 to 2030

Dwelling Types	Annualized Stock Growth Rates by Period			
	2010-2015	2015-2020	2020-2025	2025-2030
1980 & newer non-electrically heated single detached homes	1.8%	1.5%	1.3%	1.1%
1980 & newer electrically heated single detached homes	8.2%	6.3%	5.0%	4.1%
Total SDH	1.5%	1.4%	1.3%	1.2%
1980 & newer non-electrically heated attached/row housing	1.9%	1.6%	1.4%	1.1%
1980 & newer electrically heated attached/row housing	13.1%	9.6%	7.6%	6.2%
Total Attached	2.0%	2.1%	2.1%	2.0%
Non-electrically heated apartment units	1.8%	1.6%	1.4%	1.2%
Non-electrically heated apartment common areas	1.7%	1.5%	1.3%	1.2%
Electrically heated apartment units	13.2%	11.7%	10.2%	8.9%
Electrically heated apartment common areas	13.0%	11.5%	10.0%	8.7%
Total Apartment	3.6%	4.0%	4.3%	4.5%
Non-electrically heated mobile/other	1.0%	0.9%	0.8%	0.7%
Electrically heated mobile/other	4.8%	4.2%	3.7%	3.2%
Total Mobile	1.5%	1.4%	1.3%	1.2%
Small diesel grid housing	0.6%	0.6%	0.6%	0.7%
Seasonal housing	1.0%	0.9%	0.8%	0.7%
Residential garages	1.0%	0.9%	0.8%	0.7%
Sentinel Lighting	0.9%	0.8%	0.7%	0.6%
Grand Total	1.6%	1.6%	1.6%	1.6%

The growth rates of different dwelling types differ because they are present in different proportions in the different supply systems. Exhibit C 10 provides growth rates by supply system.

Exhibit C 10 Residential Stock Growth Rates by Supply System, 2010 to 2030

Supply System	Annualized Stock Growth Rates by Period			
	2010-2015	2015-2020	2020-2025	2025-2030
Hydro Grid	1.7%	1.7%	1.7%	1.7%
Large Diesel	0.2%	0.2%	0.2%	0.2%
Small Diesel	0.0%	0.0%	0.0%	0.0%
Old Crow	1.4%	1.4%	1.4%	1.4%
Grand Total	1.6%	1.6%	1.6%	1.6%

C.6 Results by Supply System

This section of the appendix presents the base year electricity consumption for the hydro grid, large diesel, small diesel and Old Crow supply systems. For each supply system, a version of Exhibit 18 is provided below. The underlying assumptions such as unit energy consumption, saturation and electricity share are not presented by supply system. This section also does not replicate the pie charts and other graphs presented in Section 5. If those graphs are needed for each supply system, they can be created using the Data Manager.

Exhibit C 11 Reference Case Electricity Consumption, Modelled by End Use, Dwelling Type and Milestone Year, Hydro Grid Accounts (MWh/yr.)

Dwelling Types	Milestone Years	HVAC	Appliances	Electronics	DHW	Other	Lighting	TOTAL
Single Detached House	2010	23,697	22,067	11,820	19,591	13,330	9,273	99,778
	2015	27,153	22,580	14,877	19,617	12,597	9,330	106,154
	2020	30,901	23,778	18,601	19,665	12,299	9,285	114,529
	2025	34,807	25,266	22,821	20,164	15,449	9,120	127,627
	2030	38,773	26,931	28,792	20,627	22,089	8,833	146,045
Apartment/Condo Suites and Common Areas	2010	3,588	2,888	2,038	1,899	1,091	2,032	13,536
	2015	5,138	2,597	2,821	2,100	1,328	2,214	16,198
	2020	7,493	3,025	3,965	2,425	1,765	2,434	21,106
	2025	10,856	3,659	5,547	2,949	2,747	2,678	28,436
	2030	15,393	4,511	8,034	3,653	4,718	2,918	39,227
Attached Dwelling	2010	1,971	2,027	1,446	2,049	1,615	824	9,932
	2015	2,399	2,138	1,855	2,108	1,530	840	10,869
	2020	2,929	2,295	2,369	2,195	1,471	851	12,110
	2025	3,552	2,535	2,963	2,355	1,826	852	14,084
	2030	4,257	2,802	3,795	2,537	2,602	840	16,833
Mobile	2010	2,280	1,798	1,239	2,092	886	841	9,137
	2015	2,620	1,782	1,553	2,095	897	847	9,793
	2020	2,968	1,863	1,930	2,100	965	844	10,670
	2025	3,318	1,969	2,347	2,153	1,279	830	11,896
	2030	3,666	2,090	2,928	2,203	1,886	805	13,579
Garages and Seasonal Housing	2010	383	690	383	744	1,345	895	4,440
	2015	402	689	482	725	1,282	879	4,459
	2020	420	704	620	703	1,257	855	4,559
	2025	436	725	802	697	1,503	821	4,985
	2030	451	750	1,087	688	1,991	779	5,747
Sentinel Lighting	2010	-	-	-	-	-	515	515
	2015	-	-	-	-	-	530	530
	2020	-	-	-	-	-	543	543
	2025	-	-	-	-	-	565	565
	2030	-	-	-	-	-	585	585
TOTAL	2010	31,919	29,470	16,926	26,375	18,268	14,379	137,337
	2015	37,713	29,786	21,587	26,645	17,633	14,641	148,004
	2020	44,712	31,665	27,484	27,088	17,756	14,811	163,517
	2025	52,970	34,155	34,480	28,318	22,804	14,867	187,594
	2030	62,540	37,083	44,636	29,708	33,286	14,762	222,016

Exhibit C 12 Reference Case Electricity Consumption, Modelled by End Use, Dwelling Type and Milestone Year, Large Diesel Accounts (MWh/yr.)

Dwelling Types	Milestone Years	Appliances	Electronics	DHW	HVAC	Other	Lighting	TOTAL
Single Detached House	2010	1,127	608	961	782	677	471	4,625
	2015	1,077	713	903	788	596	442	4,519
	2020	1,065	835	846	795	546	413	4,500
	2025	1,064	967	811	802	647	383	4,675
	2030	1,072	1,158	777	809	879	352	5,047
Mobile	2010	163	113	184	155	80	77	771
	2015	151	132	173	156	76	72	760
	2020	149	154	162	158	76	67	766
	2025	148	177	155	159	96	62	796
	2030	148	209	149	160	134	58	857
Attached Dwelling	2010	104	74	100	69	82	42	471
	2015	100	87	95	70	71	39	462
	2020	98	101	89	71	62	36	458
	2025	99	116	86	72	70	33	476
	2030	99	136	83	73	92	30	512
Apartment/Condo Suites and Common Areas	2010	43	24	46	21	76	52	261
	2015	41	29	43	21	70	49	253
	2020	41	35	41	21	67	46	251
	2025	40	45	39	21	81	43	269
	2030	41	59	37	22	108	39	306
Garages and Seasonal Housing	2010	63	49	44	46	15	34	250
	2015	50	58	42	47	17	32	246
	2020	49	68	40	49	21	30	257
	2025	48	79	39	50	30	27	274
	2030	48	95	38	51	46	25	304
Sentinel Lighting	2010	-	-	-	-	-	55	55
	2015	-	-	-	-	-	54	54
	2020	-	-	-	-	-	53	53
	2025	-	-	-	-	-	54	54
	2030	-	-	-	-	-	54	54
TOTAL	2010	1,500	867	1,335	1,072	930	730	6,434
	2015	1,419	1,018	1,256	1,083	829	688	6,294
	2020	1,401	1,194	1,177	1,094	773	645	6,284
	2025	1,400	1,383	1,130	1,104	924	602	6,543
	2030	1,408	1,656	1,084	1,115	1,260	558	7,081

Exhibit C 13 Reference Case Electricity Consumption, Modelled by End Use, Dwelling Type and Milestone Year, Small Diesel Accounts (MWh/yr.)

Dwelling Types	Milestone Years	Appliances	DHW	Electronics	Other	Lighting	HVAC	TOTAL
Small Grid Housing	2010	285	282	149	170	133	115	1,133
	2015	275	263	174	147	123	115	1,098
	2020	269	244	204	130	114	115	1,076
	2025	266	232	236	146	105	115	1,099
	2030	265	219	283	183	95	115	1,161
Garages and Seasonal Housing	2010	12	13	7	19	13	3	67
	2015	12	12	8	17	12	3	64
	2020	11	11	10	15	12	3	62
	2025	11	11	12	18	11	3	66
	2030	11	10	16	23	10	3	74
Sentinel Lighting	2010	-	-	-	-	38	-	38
	2015	-	-	-	-	38	-	38
	2020	-	-	-	-	37	-	37
	2025	-	-	-	-	37	-	37
	2030	-	-	-	-	37	-	37
TOTAL	2010	297	295	156	189	184	118	1,239
	2015	287	275	182	164	173	118	1,199
	2020	281	255	213	146	162	118	1,175
	2025	277	242	248	164	152	118	1,201
	2030	276	230	299	206	142	118	1,271

Exhibit C 14 Reference Case Electricity Consumption, Modelled by End Use, Dwelling Type and Milestone Year, Old Crow Accounts (MWh/yr.)

Dwelling Types	Milestone Years	Appliances	DHW	Electronics	Other	Lighting	HVAC	TOTAL
Small Grid Housing	2010	225	223	118	134	105	91	895
	2015	232	220	148	127	105	98	929
	2020	243	219	185	125	104	106	982
	2025	259	224	230	160	102	114	1,089
	2030	278	230	296	233	100	123	1,260
Garages and Seasonal Housing	2010	15	16	8	21	15	2	77
	2015	15	16	11	19	15	2	78
	2020	16	16	14	17	15	2	80
	2025	17	16	19	21	15	2	91
	2030	18	17	27	32	15	2	110
Sentinel Lighting	2010	-	-	-	-	1	-	1
	2015	-	-	-	-	1	-	1
	2020	-	-	-	-	1	-	1
	2025	-	-	-	-	1	-	1
	2030	-	-	-	-	1	-	1
TOTAL	2010	240	239	126	155	121	92	973
	2015	248	236	158	145	121	100	1,008
	2020	259	235	199	142	120	107	1,063
	2025	276	240	249	181	118	116	1,180
	2030	296	246	323	265	116	125	1,371

Appendix D Background-Section 6: Reference Case Peak Load

Introduction

The following exhibits show the Reference Case peak load profiles for each supply system.

Exhibit D 1 Electric Peak Loads, by Milestone Year, Peak Period and Dwelling Type, Hydro Grid Accounts (MW)

Dwelling Type	Milestone Year	Period 1 Annual Peak Hour	Period 2 Evening Peak Period	Period 3 Morning Peak Period
Single Detached Houses	2010	23.8	22.2	16.6
	2015	25.4	23.9	17.6
	2020	27.4	25.9	18.9
	2025	30.2	28.6	20.9
	2030	33.7	32.0	23.4
Apartments	2010	3.4	3.2	2.0
	2015	4.1	4.0	2.4
	2020	5.4	5.3	3.2
	2025	7.3	7.2	4.4
	2030	10.0	9.9	6.1
Attached/Row Houses	2010	2.2	2.1	1.6
	2015	2.5	2.4	1.7
	2020	2.8	2.7	1.9
	2025	3.2	3.1	2.2
	2030	3.8	3.7	2.6
Mobile/Other	2010	2.2	2.0	1.6
	2015	2.4	2.2	1.7
	2020	2.6	2.4	1.8
	2025	2.9	2.7	2.0
	2030	3.2	3.0	2.3
Seasonal & Garage	2010	0.9	0.9	0.7
	2015	0.9	0.9	0.7
	2020	0.9	0.9	0.7
	2025	1.0	1.0	0.7
	2030	1.1	1.1	0.8
Sentinel Lighting	2010	0.1	0.1	0.1
	2015	0.1	0.1	0.1
	2020	0.1	0.1	0.1
	2025	0.1	0.1	0.1
	2030	0.1	0.1	0.1
Grand Total	2010	32.5	30.6	22.5
	2015	35.4	33.4	24.3
	2020	39.3	37.3	26.7
	2025	44.7	42.6	30.3
	2030	52.0	49.7	35.3

Exhibit D 2 Electric Peak Loads, by Milestone Year, Peak Period and Dwelling Type, Large Diesel Accounts (MW)

Dwelling Type	Milestone Year	Period 1 Annual Peak Hour	Period 2 Evening Peak Period	Period 3 Morning Peak Period
Single Detached Houses	2010	1.05	0.98	0.73
	2015	1.02	0.95	0.71
	2020	1.01	0.94	0.69
	2025	1.02	0.96	0.71
	2030	1.07	1.01	0.74
Mobile/Other	2010	0.17	0.16	0.13
	2015	0.18	0.16	0.13
	2020	0.18	0.16	0.12
	2025	0.18	0.16	0.13
	2030	0.19	0.17	0.13
Attached/Row Houses	2010	0.10	0.10	0.07
	2015	0.10	0.09	0.07
	2020	0.10	0.09	0.07
	2025	0.10	0.10	0.07
	2030	0.11	0.10	0.07
Apartments	2010	0.06	0.05	0.04
	2015	0.05	0.05	0.04
	2020	0.05	0.05	0.04
	2025	0.06	0.05	0.04
	2030	0.06	0.06	0.04
Seasonal & Garage	2010	0.05	0.05	0.04
	2015	0.05	0.05	0.04
	2020	0.05	0.05	0.04
	2025	0.05	0.05	0.04
	2030	0.06	0.06	0.04
Sentinel Lighting	2010	0.01	0.01	0.01
	2015	0.01	0.01	0.01
	2020	0.01	0.01	0.01
	2025	0.01	0.01	0.01
	2030	0.01	0.01	0.01
Grand Total	2010	1.45	1.35	1.02
	2015	1.42	1.32	0.99
	2020	1.40	1.31	0.97
	2025	1.43	1.34	0.99
	2030	1.49	1.41	1.04

Exhibit D 3 Electric Peak Loads, by Milestone Year, Peak Period and Dwelling Type, Small Diesel Accounts (MW)

Dwelling Type	Milestone Year	Period 1 Annual Peak Hour	Period 2 Evening Peak Period	Period 3 Morning Peak Period
Small Grid Houses	2010	0.25	0.23	0.18
	2015	0.24	0.22	0.17
	2020	0.23	0.21	0.16
	2025	0.23	0.21	0.16
	2030	0.24	0.22	0.17
Seasonal & Garage	2010	0.01	0.01	0.01
	2015	0.01	0.01	0.01
	2020	0.01	0.01	0.01
	2025	0.01	0.01	0.01
	2030	0.01	0.01	0.01
Sentinel Lighting	2010	0.01	0.01	0.01
	2015	0.01	0.01	0.01
	2020	0.01	0.01	0.01
	2025	0.01	0.01	0.01
	2030	0.01	0.01	0.01
Grand Total	2010	0.27	0.25	0.20
	2015	0.26	0.24	0.19
	2020	0.25	0.23	0.18
	2025	0.25	0.23	0.18
	2030	0.26	0.24	0.19

Exhibit D 4 Electric Peak Loads, by Milestone Year, Peak Period and Dwelling Type, Old Crow Accounts (MW)

Dwelling Type	Milestone Year	Period 1 Annual Peak Hour	Period 2 Evening Peak Period	Period 3 Morning Peak Period
Small Grid Houses	2010	0.20	0.18	0.14
	2015	0.20	0.19	0.14
	2020	0.21	0.19	0.15
	2025	0.23	0.21	0.16
	2030	0.25	0.24	0.18
Seasonal & Garage	2010	0.01	0.01	0.01
	2015	0.01	0.01	0.01
	2020	0.02	0.01	0.01
	2025	0.02	0.02	0.01
	2030	0.02	0.02	0.02
Sentinel Lighting	2010	0.00	0.00	0.00
	2015	0.00	0.00	0.00
	2020	0.00	0.00	0.00
	2025	0.00	0.00	0.00
	2030	0.00	0.00	0.00
Grand Total	2010	0.21	0.19	0.15
	2015	0.22	0.20	0.16
	2020	0.23	0.21	0.16
	2025	0.24	0.23	0.17
	2030	0.27	0.26	0.20

Appendix E Background-Section 7: Technology Assessment: Energy-efficiency Measures

Introduction

Exhibit E 1 provides an example of part of the worksheet that calculates the CCE for programmable thermostats, one of the analyzed measures. For more detail on this and all the other measures, refer to the measure TRC model Excel workbooks submitted with this deliverable.

Exhibit E 1 Sample Measure CCE Calculation Worksheet

YUKON: RESIDENTIAL SECTOR, HYDRO GRID, NON-GOVT EXISTING HOMES - ELECTRIC EFFICIENCY & FUEL SWITCHING							Back to Index
Cold Climate Air Source Heat Pumps							References/Notes
Description:	This measure assesses the installation of air source heat pumps (ASHP) to replace existing heating systems. In operation, the ASHP is used until the outdoor temperature falls below the heat pump's balance point. At this point, the heat pump shuts off and heating is provided by backup forced-air heating system. Recent						
Baseline:	Installing a standard forced-air electric resistance furnace in a home with ducting						
Upgrade:	Installing a 3 ton (~36,000 BTU/h) capacity air source heat pump in a home with ducting						
Baseline Reference:	1. Annual consumption, end use						
Heating Fuel Type:	All Fuels (Average Fuel Mix)						
Main End Use:	Space Heating						
Discount Rate:	7.50%						
GHG Adder Incl.?	No						
Resource Costs:	Baseload						
	Customer Cost	Avoided Costs (NPV)					
Electricity (\$/kWh)	\$0.102	\$1.918	\$1.918	\$1.918	\$1.918	\$1.918	
Electricity (\$/kW)	\$0.000	\$0.000	\$0.000	\$0.000	\$0.000	\$0.000	
Natural Gas (\$/m³)	\$0.267	\$3.096	\$3.096	\$3.096	\$3.096	\$3.096	
Oil (\$/L)	\$0.750	\$0.000	\$0.000	\$0.000	\$0.000	\$0.000	
Water (\$/1000L)	\$1.500	\$0.000	\$0.000	\$0.000	\$0.000	\$0.000	

Sub-sector		Detached Elec Heat (Pre-1980)	Detached Elec Heat (Post-1980)	Attached Elec Heat (Pre-1980)	Attached Elec Heat (Post-1980)	Mobile Elec Heat	Weighted Avg.	References/Notes
Baseline Consumption	Electricity (kWh/yr.)	10,221	8,308	6,820	4,978	9,186	8,826	
	Natural Gas (m3/yr.)	-	-	-	-	-	-	
	Oil (L/yr.)	-	-	-	-	-	-	
	Water (L/yr.)	-	-	-	-	-	-	
Upgrade Consumption	Electricity (kWh/yr.)	5,215	4,239	3,480	2,540	4,687	4,503	
	Natural Gas (m3/yr.)	-	-	-	-	-	-	
	Oil (L/yr.)	-	-	-	-	-	-	
	Water (L/yr.)	-	-	-	-	-	-	
Interactive Effects (Inputs)	Heating Penalty	0%	0%	0%	0%	0%	0%	Interactive effects neglected at measure level for Yukon study
	Cooling Benefits	0%	0%	0%	0%	0%	0%	Interactive effects neglected at measure level for Yukon study
Interactive Effects (Results)	Electricity, Heating (kWh/yr.)	-	-	-	-	-	-	
	Electricity, Cooling (kWh/yr.)	-	-	-	-	-	-	
	Electricity, Total (kWh/yr.)	-	-	-	-	-	-	
	Natural Gas (m3/yr.)	-	-	-	-	-	-	
	Oil (L/yr.)	-	-	-	-	-	-	
Winter Peak Hours-Use Factor		2,798	2,798	2,818	2,818	2,798	2,800	Based on main end use involved
Resource Savings	Electricity (kWh/yr.)	5,006	4,069	3,340	2,438	4,499	4,323	
	Electricity (kW peak)	1.789	1.454	1.185	0.865	1.608	1.544	
	Nat. Gas (m3/yr.)	-	-	-	-	-	-	
	Oil (L/yr.)	-	-	-	-	-	-	
	Water (L/yr.)	-	-	-	-	-	-	
Cost Parameters	Upgrade, Material (\$)	\$14,000.00	\$14,000.00	\$11,200.00	\$11,200.00	\$11,200.00	\$13,462.46	Based on communication with Roy Whiten \$14,000 (not including ductwork)
	Upgrade, Installation (\$)						\$0.00	
	Baseline, Material (\$)	\$5,125.00	\$5,125.00	\$4,100.00	\$4,100.00	\$4,100.00	\$4,928.22	Approximate installed cost of a standard central air conditioning system (based on discussions with an HVAC contractor)
	Baseline, Installation (\$)	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	Installation costs included above
	Total Measure Cost (\$)	\$8,875.00	\$8,875.00	\$7,100.00	\$7,100.00	\$7,100.00	\$8,534.24	
	Basis (Full/Incremental)	Incr.	Incr.	Incr.	Incr.	Incr.	Incr.	
Incremental O&M (\$/yr.)		\$20	\$20	\$20	\$20	\$20	\$20	Assuming increased O&M costs
Lifetimes	Upgrade (yrs.)	20	20	20	20	20	20	OPA, "2009 Mass Market Measures and Assumptions: v1.02", p. 62-63, April 2009.
	Baseline (yrs.)	20	20	20	20	20	20	Assuming a similar lifetime for electric furnaces
Cost Savings (\$/yr.)		\$491	\$395	\$321	\$229	\$439	\$421	
Simple Payback (yrs.)		18.1	22.5	22.1	31.0	16.2	20.79	
NPV of O&M Costs (\$)		\$204	\$204	\$204	\$204	\$204	\$204	
Total Benefits (\$)	Electric Energy	\$9,601	\$7,804	\$6,406	\$4,676	\$8,629	\$8,291	
	Electric Demand	\$0	\$0	\$0	\$0	\$0	\$0	
	Natural Gas	\$0	\$0	\$0	\$0	\$0	\$0	
	Oil	\$0	\$0	\$0	\$0	\$0	\$0	
	Water	\$0	\$0	\$0	\$0	\$0	\$0	
Measure TRC (\$)		\$522	-\$1,275	-\$898	-\$2,628	\$1,325	-\$448	
Benefit/Cost Ratio		1.06	0.86	0.88	0.64	1.18	0.95	
Cost of Conserved Electricity (CCE) (c/kWh)		17.79	21.89	21.45	29.38	15.92	20.27	

Appendix F

Background-Section 8: Economic Potential: Electric Energy Forecast

Introduction

The following four exhibits provide the economic potential results for the hydro grid, large diesel, small diesel and Old Crow accounts, respectively.

Exhibit F 1 Total Economic Potential Electricity Savings by End Use, Dwelling Type and Milestone Year, Hydro Grid Accounts (MWh/yr.)

Dwelling Type	Milestone Year	Space heating	Domestic hot water (DHW)	Indoor lighting	Computer and peripherals	Clothes dryer	Television	Block heaters & car warmers	Refrigerator	Spa heaters and pumps
Single Detached House	2015	10,933	4,000	3,652	1,727	2,111	778	676	281	1,042
	2020	13,094	4,497	3,423	1,980	2,380	1,145	728	602	684
	2025	15,326	5,004	3,131	2,559	2,672	1,224	779	916	585
	2030	17,665	5,434	2,727	3,238	2,835	1,362	828	1,001	574
Apartment/Condo Suites and Common Areas	2015	610	508	1,161	335	209	151	177	38	45
	2020	1,366	742	1,222	437	256	253	216	89	34
	2025	2,456	1,080	1,278	655	332	313	267	152	34
	2030	3,936	1,521	1,304	974	415	410	331	190	39
Attached Dwelling	2015	888	460	388	221	200	99	86	30	134
	2020	1,198	551	374	262	221	151	96	64	91
	2025	1,561	659	353	351	245	168	107	102	81
	2030	1,965	776	322	463	271	195	118	115	83
Mobile	2015	961	436	361	182	120	82	71	22	56
	2020	1,116	473	342	209	128	121	77	46	37
	2025	1,269	512	316	270	136	129	82	70	31
	2030	1,419	548	280	342	145	144	87	76	31
Garages and Seasonal Housing	2015	3	-	350	-	-	-	22	-	-
	2020	3	-	319	-	-	-	23	-	-
	2025	3	-	284	-	-	-	24	-	-
	2030	4	-	241	-	-	-	25	-	-
Sentinel Lighting	2015	-	-	-	-	-	-	-	-	-
	2020	-	-	-	-	-	-	-	-	-
	2025	-	-	-	-	-	-	-	-	-
	2030	-	-	-	-	-	-	-	-	-
Totals	2015	13,395	5,404	5,912	2,465	2,640	1,111	1,033	371	1,276
	2020	16,777	6,264	5,680	2,888	2,986	1,670	1,140	801	846
	2025	20,615	7,254	5,363	3,835	3,386	1,835	1,258	1,240	731
	2030	24,990	8,280	4,874	5,017	3,665	2,111	1,390	1,382	727

Exhibit F 1 Continued: Total Economic Potential Electricity Savings by End Use, Dwelling Type and Milestone Year, Hydro Grid Accounts (MWh/yr.)

Dwelling Type	Milestone Year	Ventilation & circulation	Home entertainment electronics	Outdoor lighting	Freezer	Clothes washer	Set-top boxes	Dishwasher	Holiday lighting	Grand Total
Single Detached House	2015	922	109	363	61	127	-	24	80	26,887
	2020	773	177	263	133	121	-	51	54	30,105
	2025	600	475	148	220	122	101	60	28	33,950
	2030	382	1,152	23	323	120	215	66	6	37,951
Apartment/Condo Suites and Common Areas	2015	7	16	58	8	12	-	2	15	3,353
	2020	19	29	55	19	13	-	5	13	4,766
	2025	35	90	47	36	15	26	7	8	6,832
	2030	58	257	34	60	17	65	9	2	9,621
Attached Dwelling	2015	96	10	36	6	12	-	2	6	2,674
	2020	83	17	26	14	11	-	4	4	3,169
	2025	68	47	14	24	11	14	6	2	3,813
	2030	49	119	2	37	11	31	6	1	4,564
Mobile	2015	141	10	37	5	7	-	1	6	2,499
	2020	126	16	27	10	6	-	3	4	2,741
	2025	109	44	15	17	6	11	3	2	3,023
	2030	88	106	2	25	6	23	3	0	3,326
Garages and Seasonal Housing	2015	1	-	35	-	-	-	-	-	410
	2020	1	-	24	-	-	-	-	-	370
	2025	1	-	13	-	-	-	-	-	326
	2030	0	-	2	-	-	-	-	-	273
Sentinel Lighting	2015	-	-	108	-	-	-	-	-	-
	2020	-	-	111	-	-	-	-	-	-
	2025	-	-	115	-	-	-	-	-	-
	2030	-	-	119	-	-	-	-	-	-
Totals	2015	1,167	145	637	80	158	-	30	107	35,823
	2020	1,002	239	505	177	152	-	63	74	41,151
	2025	813	656	354	297	154	151	76	40	47,944
	2030	578	1,633	181	444	156	333	85	9	55,735

Exhibit F 2 Total Economic Potential Electricity Savings by End Use, Dwelling Type and Milestone Year, Large Diesel Accounts (MWh/yr.)

Dwelling Type	Milestone Year	Domestic hot water (DHW)	Indoor lighting	Computer and peripherals	Clothes dryer	Television	Block heaters & car warmers	Ventilation & circulation	Spa heaters and pumps	Refrigerator
Single Detached House	2015	172	173	83	112	37	32	50	49	13
	2020	163	152	89	112	52	33	40	30	26
	2025	156	131	109	113	52	33	28	24	37
	2030	148	109	131	114	55	33	14	22	38
Mobile	2015	34	31	15	10	7	6	16	5	2
	2020	32	27	17	10	10	6	14	3	4
	2025	30	24	20	10	10	6	11	2	5
	2030	29	20	24	10	10	6	8	2	5
Attached Dwelling	2015	18	18	10	9	5	4	0	6	1
	2020	17	16	11	9	6	4	0	4	3
	2025	17	14	14	10	7	4	0	3	4
	2030	16	11	17	10	7	4	0	3	4
Apartment/Con do Suites and Common Areas	2015	5	17	7	2	3	2	-	0	1
	2020	6	15	8	3	4	2	-	0	1
	2025	6	13	9	4	4	2	-	0	2
	2030	6	11	11	4	5	2	-	0	2
Garages and Seasonal Housing	2015	-	19	-	-	-	1	-	-	-
	2020	-	17	-	-	-	1	-	-	-
	2025	-	15	-	-	-	1	-	-	-
	2030	-	12	-	-	-	1	-	-	-
Sentinel Lighting	2015	-	-	-	-	-	-	-	-	-
	2020	-	-	-	-	-	-	-	-	-
	2025	-	-	-	-	-	-	-	-	-
	2030	-	-	-	-	-	-	-	-	-
Totals	2015	229	258	116	133	52	45	66	60	17
	2020	219	228	124	135	72	46	54	37	34
	2025	209	197	152	136	73	46	39	30	48
	2030	199	163	183	137	77	47	23	28	49

Exhibit F 2 Continued: Total Economic Potential Electricity Savings by End Use, Dwelling Type and Milestone Year, Hydro Grid Accounts (MWh/yr.)

Dwelling Type	Milestone Year	Home entertainment electronics	Outdoor lighting	Freezer	Clothes washer	Set-top boxes	Dishwasher	Holiday lighting	Space heating	Grand Total
Single Detached House	2015	5	2	3	7	-	1	4 -	25	719
	2020	8	2	6	6	-	2	2 -	26	697
	2025	20	1	9	5	4	2	1 -	27	700
	2030	46	1	13	5	9	2	0 -	28	711
Mobile	2015	1	0	0	1	-	0	0 -	3	125
	2020	1	0	1	1	-	0	0 -	3	122
	2025	3	0	1	0	1	0	0 -	3	122
	2030	8	0	2	0	2	0	0 -	3	124
Attached Dwelling	2015	0	0	0	1	-	0	0 -	2	72
	2020	1	0	1	0	-	0	0 -	3	71
	2025	2	0	1	0	1	0	0 -	3	73
	2030	4	0	1	0	1	0	0 -	3	76
Apartment/Con do Suites and Common Areas	2015	0	0	0	0	-	0	0 -	1	37
	2020	0	0	0	0	-	0	0 -	1	40
	2025	1	0	0	0	0	0	0 -	1	42
	2030	3	0	1	0	1	0	0 -	1	45
Garages and Seasonal Housing	2015	-	0	-	-	-	-	- -	0	20
	2020	-	0	-	-	-	-	- -	0	18
	2025	-	0	-	-	-	-	- -	0	16
	2030	-	0	-	-	-	-	- -	0	13
Sentinel Lighting	2015	-	11	-	-	-	-	-	-	11
	2020	-	11	-	-	-	-	-	-	11
	2025	-	11	-	-	-	-	-	-	11
	2030	-	11	-	-	-	-	-	-	11
Totals	2015	7	14	4	8	-	1	5 -	33	984
	2020	10	13	8	7	-	3	3 -	33	959
	2025	26	13	12	6	6	3	2 -	34	964
	2030	61	12	16	6	12	3	0 -	36	980

Exhibit F 3 Total Economic Potential Electricity Savings by End Use, Dwelling Type and Milestone Year, Small Diesel Accounts (MWh/yr.)

Dwelling Type	Milestone Year	Indoor lighting	Domestic hot water (DHW)	Computer and peripherals	Clothes dryer	Television	Outdoor lighting	Block heaters & car warmers	Refrigerator	Spa heaters and pumps
Single Detached House	2015	48.3	41.6	20.0	9.7	9.0	0.6	7.8	3.7	12.1
	2020	42.1	42.8	21.3	19.2	12.3	0.5	7.8	7.2	7.3
	2025	36.0	42.9	25.7	26.8	12.3	0.3	7.8	10.1	5.9
	2030	29.5	39.6	30.6	26.7	12.9	0.2	7.8	10.1	5.4
Sentinel Lighting	2015	-	-	-	-	-	7.7	-	-	-
	2020	-	-	-	-	-	7.5	-	-	-
	2025	-	-	-	-	-	7.5	-	-	-
	2030	-	-	-	-	-	7.4	-	-	-
Garages and Seasonal Housing	2015	5.0	-	-	-	-	0.1	0.1	-	-
	2020	4.3	-	-	-	-	0.0	0.1	-	-
	2025	3.7	-	-	-	-	0.0	0.1	-	-
	2030	3.0	-	-	-	-	0.0	0.1	-	-
Totals	2015	53.3	41.6	20.0	9.7	9.0	8.3	7.9	3.7	12.1
	2020	46.4	42.8	21.3	19.2	12.3	8.0	7.9	7.2	7.3
	2025	39.7	42.9	25.7	26.8	12.3	7.8	7.9	10.1	5.9
	2030	32.5	39.6	30.6	26.7	12.9	7.7	7.9	10.1	5.4

Dwelling Type	Milestone Year	Ventilation & circulation	Home entertainment electronics	Freezer	Clothes washer	Set-top boxes	Dishwasher	Holiday lighting	Space heating	Grand Total
Single Detached House	2015	2.7	1.4	0.8	0.6	-	0.3	1.1	-	159.6
	2020	5.7	2.2	1.6	1.0	-	0.6	0.7	-	172.2
	2025	9.1	5.5	2.5	1.2	1.0	0.6	0.3	-	188.0
	2030	6.5	12.4	3.4	1.1	2.0	0.6	0.1	-	189.1
Sentinel Lighting	2015	-	-	-	-	-	-	-	-	7.7
	2020	-	-	-	-	-	-	-	-	7.5
	2025	-	-	-	-	-	-	-	-	7.5
	2030	-	-	-	-	-	-	-	-	7.4
Garages and Seasonal Housing	2015	-	-	-	-	-	-	-	0.1	5.1
	2020	-	-	-	-	-	-	-	0.1	4.4
	2025	-	-	-	-	-	-	-	0.1	3.8
	2030	-	-	-	-	-	-	-	0.0	3.1
Totals	2015	2.7	1.4	0.8	0.6	-	0.3	1.1	-	172.3
	2020	5.7	2.2	1.6	1.0	-	0.6	0.7	-	184.2
	2025	9.1	5.5	2.5	1.2	1.0	0.6	0.3	-	199.3
	2030	6.5	12.4	3.4	1.1	2.0	0.6	0.1	-	199.6

Exhibit F 4 Total Economic Potential Electricity Savings by End Use, Dwelling Type and Milestone Year, Old Crow Accounts (MWh/yr.)

Dwelling Type	Milestone Year	Domestic hot water (DHW)	Indoor lighting	Computer and peripherals	Clothes dryer	Television	Ventilation & circulation	Block heaters & car warmers	Spa heaters and pumps	Refrigerator
Single Detached House	2015	38.0	40.9	16.9	8.2	7.6	10.8	6.6	10.2	2.8
	2020	44.9	38.3	19.3	17.5	11.2	9.5	7.1	6.7	6.0
	2025	51.5	35.1	25.1	26.2	12.0	8.0	7.6	5.7	9.1
	2030	55.6	30.9	32.0	28.0	13.5	6.3	8.2	5.6	10.1
Garages and Seasonal Housing	2015	-	6.0	-	-	-	-	-	-	-
	2020	-	5.6	-	-	-	-	-	-	-
	2025	-	5.1	-	-	-	-	-	-	-
	2030	-	4.5	-	-	-	-	-	-	-
Sentinel Lighting	2015	-	-	-	-	-	-	-	-	-
	2020	-	-	-	-	-	-	-	-	-
	2025	-	-	-	-	-	-	-	-	-
	2030	-	-	-	-	-	-	-	-	-
Totals	2015	38.0	46.9	16.9	8.2	7.6	10.8	6.6	10.2	2.8
	2020	44.9	43.9	19.3	17.5	11.2	9.5	7.1	6.7	6.0
	2025	51.5	40.3	25.1	26.2	12.0	8.0	7.6	5.7	9.1
	2030	55.6	35.4	32.0	28.0	13.5	6.3	8.2	5.6	10.1

Dwelling Type	Milestone Year	Home entertainment electronics	Freezer	Clothes washer	Set-top boxes	Outdoor lighting	Dishwasher	Holiday lighting	Space heating	Grand Total
Single Detached House	2015	1.2	0.6	0.5	-	0.5	0.2	0.9	-	146.1
	2020	2.0	1.3	0.9	-	0.4	0.5	0.6	-	166.1
	2025	5.3	2.2	1.2	1.0	0.3	0.6	0.3	-	191.3
	2030	13.0	3.3	1.2	2.1	0.3	0.7	0.1	-	210.9
Garages and Seasonal Housing	2015	-	-	-	-	0.1	-	- -	0.1	6.0
	2020	-	-	-	-	0.1	-	- -	0.1	5.6
	2025	-	-	-	-	0.0	-	- -	0.1	5.1
	2030	-	-	-	-	0.0	-	- -	0.1	4.5
Sentinel Lighting	2015	-	-	-	-	0.2	-	-	-	0.2
	2020	-	-	-	-	0.2	-	-	-	0.2
	2025	-	-	-	-	0.2	-	-	-	0.2
	2030	-	-	-	-	0.2	-	-	-	0.2
Totals	2015	1.2	0.6	0.5	-	0.8	0.2	0.9 -	0.1	152.3
	2020	2.0	1.3	0.9	-	0.7	0.5	0.6 -	0.1	171.9
	2025	5.3	2.2	1.2	1.0	0.6	0.6	0.3 -	0.1	196.7
	2030	13.0	3.3	1.2	2.1	0.5	0.7	0.1 -	0.1	215.6

Appendix G Background-Section 9: Peak Load Measures

Introduction

Appendix G provides additional detailed information related to analysis of the electric peak load measures. For each of the measures considered, a description is provided, along with details on assumptions, factors included in the economic analysis, barriers and constraints, and program issues. Measure lifecycle costing worksheets for each measure are provided at the end of the appendix.

Overview

Electric peak load measures are typically implemented by utilities to avoid or defer the costs of capacity expansion. Capacity costs refer to all levels of capital-based investments, including generating stations (new and upgraded), transmission and distribution lines, along with substations, transformers and other infrastructure required to deliver power, primarily related to peak capacity driven requirements.

Supply capacity can be purchased, but infrastructure must still be available to deliver the supply to customers. DSM measures that reduce peak requirements avoid and/or defer these capital-intensive investments.

From the customer's side, adoption of electric peak reduction strategies is typically dependent on the overall benefits to them, including direct incentive payments or rate benefits. Under most current rates for residential (and small commercial) customers, customers are billed only for electric energy (kWh) regardless of when it is used, and not for "demand." Consequently, electric peak load measures that do not also reduce overall energy consumption do not provide any financial benefits to customers. However, the industry trend is towards more specific pricing, including time-of-use and even hourly pricing, or peak incentives that pass along some of the utility benefits to customers on a performance basis. These new pricing structures provide incentive for even residential customers to implement measures or to participate in utility peak load reduction programs, as long as the differential between peak and off-peak prices are sufficient to provide a noticeable bill saving potential. To date, these options have been limited by the availability and cost of suitable metering technology, both intra and remote house/facility data communications, and by energy measurement storage options that would enable remote and/or automated measurement and control of devices in the home.

Description of Electric Peak Reduction Measures

The following sub sections provide a description of each of the measures listed in Exhibit 40. The discussion is organized by major end use and is presented in the following sub sections:

- Water heating
- Block heater timers and storage
- Lighting
- Thermal energy storage for supplemental heating.

The discussion of each measure is organized as follows.

- Description
- Assumptions on applicability (dwelling type, unit types, vintage)

- Typical costs – one-time, incremental, operating costs
- Typical electric peak reductions
- Other benefits
- Useful life
- Barriers and constraints for economic and achievable implementation
- Program issues.

Water Heating

Switch-based Water Heating Unit Load Control Assumptions used for Analysis	
Applicable Dwelling Type(s)	▪ Single-family detached and attached, row houses, multi-family – all with individual dwelling unit control/circuits
Applicable Equipment Type	▪ Water heater with at least a 40-gallon tank
Vintage	▪ Existing and new
Costs	▪ \$200 incremental cost in existing and new homes ▪ \$125 incremental cost as a add-on to an existing control system ▪ Approximately \$10/site/yr. maintenance/evaluation
Electric Peak Reduction	▪ 100% reduction in water heating end use evening peaks ▪ About 80% of non-standby water heating energy reduction during curtailment is recovered
Useful Life	▪ 10 years

Description

Switch-based water heating load control is accomplished by the installation of a remote control switch on either the water heater itself or on the circuits controlling the water heater. In older systems, this type of control has been accomplished via radio frequency (RF) control, which allows remote shut off of the water heater under specific capacity-constrained conditions during a limited number of pre-specified hours during winter peak months. In the systems that are currently offered, pager-based communications are used. An even more economic solution is to piggyback off of an already existing communications system. For example, if space heat control already exists, water heat control can be added via a hard-wired or wireless connection. This can significantly reduce the total cost of the water heat control.

Depending upon the length of the control, when the control is operated, and the size of the water heater tank, units can be shut off for the entire control period or cycled to limit their on time to a predetermined number of minutes per control cycle. Water heat control is commercially available and implemented in hundreds of thousands of sites in the U.S., thus demonstrating the viability of the technology, success of the programs, customer acceptance and utility satisfaction.

Applicability

Applicable dwelling types are any dwelling units with a water heater that has at least a 40-gallon tank. The size of the tank is important because it provides hot water during times when the control is in effect. The larger the water heater tank, the longer the control can be in place without disrupting the customer's comfort and living conditions.

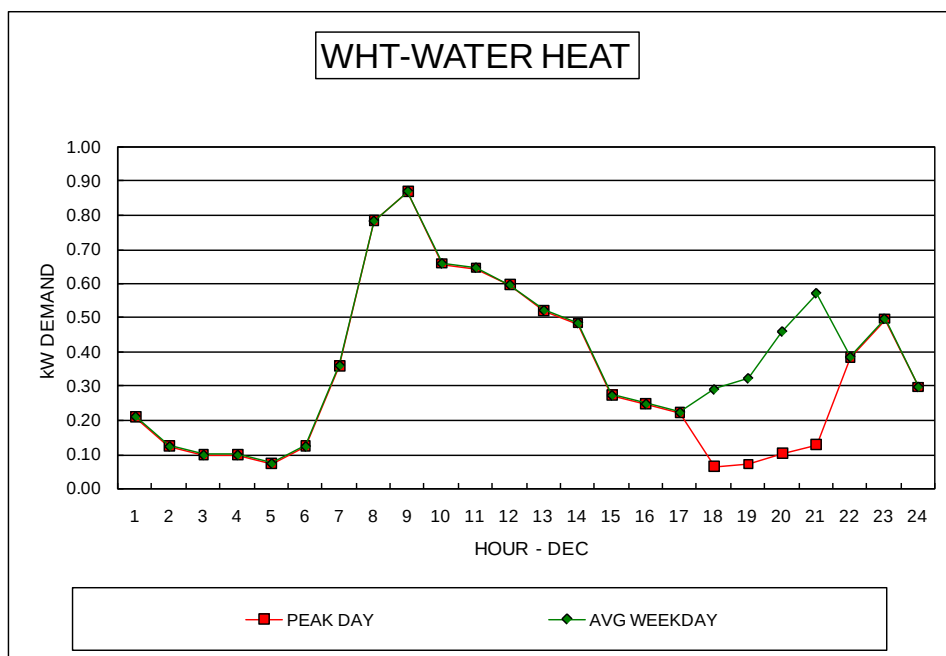
Costs

Switches cost about \$100 per unit, plus \$100 for installation, plus maintenance. Costs are reduced to \$125 (i.e., \$25 incremental installation) if the control switch can be added to an existing control system at the same time, including any remote system, which may include thermostat control, engine block heater control, lighting or other. There is no savings in installation costs for a new home.

Electric Peak Reduction

Assuming annual energy consumption per participant (with 100% electric fuel use) of 2,762 kWh, baseline electric peak period loads are estimated as 0.245 kW for the Annual Peak Hour (6 pm) and 0.273 kW for the Evening Peak (winter peak weekday 4-8 pm). Assuming 100% load control for evening peak hours, Exhibit G 1 below illustrates the baseline vs. control load profiles on the system peak day. This results in an estimated average of 0.245 kW per unit peak reduction for the Annual Peak Hour (at 6 pm) and an average of 0.273 kW per unit peak reduction for the Evening Peak (4-8 pm), assuming no overrides or switch failures. These estimates may erode over time due to a number of factors, including signal strength losses and disabling of switches (by customers and contractors). Since the water heater switch uses a one-way communications-based system, it will require support analyses including the need for signal propagation studies and periodic sampling, and re-estimation of reliability levels, accompanied by sufficient maintenance to maintain an adequate level and accurate estimate of losses. Experience in the utility industry has shown that performance could erode significantly over time if the system is not properly maintained.

Exhibit G 1 Residential Water Heater Baseline vs. Controlled Load



Other Benefits

The water heater control switch would not provide customers with any ancillary benefits and thus the only incentive for participation would be monetary in nature, likely on a per annum or per control event basis.

Useful Life

This technology has a long history, going back at least 30 years on various types of equipment, including central air conditioners, water heaters and pool pumps. For the costing analysis, a 10-year life has been assumed, although there are programs with switches in place for longer than that.

Cost-Effectiveness Summary

Based on a one-time cost of approximately \$200, ongoing maintenance of 5% (about \$10/yr.) and estimated annual impacts of 0.245 kW – 0.273 kW, a preliminary estimate of the CEPR is \$100-\$112 per kW, when applied to all potential homes, though expected to be predominantly single detached houses. As an incremental option (existing communications gateway), the installation costs would be reduced by \$75 and the resulting CEPR would be \$73-\$81 per kW.

Barriers and Constraints

Contractors are often the cause for lack of participation or dropouts since they may incorrectly blame the switches for system performance problems, dissuading participation or resulting in removals. New tenants or their contractors may not know what the switches are and have them removed. With one-way communications, there is no way to verify whether the switch is even in

place and an accurate count of actual switches in place cannot be reliably made without a systematic site verification plan.

Program Issues

Since there are no customer benefits inherent in the technology, a cash incentive would typically be expected for each season that the measure was needed, payable either by season or by event (or both). Additional work would be required to maintain, verify and evaluate the system performance to the same degree of accuracy as two-way systems due to the lack of confirmation and higher incidence of removals and failures.

Block Heater timers and storage

Engine Block Heater Load Control Assumptions used for Analysis	
Applicable Dwelling Type(s)	▪ All dwellings with individual unit control/ circuits
Applicable Equipment Type	▪ Block heaters and warmers
Vintage	▪ Existing and new
Costs	▪ \$50 cost in existing and new homes (new and incremental) ▪ \$25 installation cost, or \$10 as an add on to an existing control system install ▪ Approximately \$5/site/yr. maintenance/evaluation
Electric Peak Reduction	▪ 100% reduction in evening peaks ▪ 100% of energy reduction during curtailment is recovered
Useful Life	▪ 10 years

Description

Engine block heater timers and/or control are accomplished by the installation of a timer that could be monitored and/or controlled by the utility to ensure that it is not overridden. The critical component in this application is to defer any operation until after the 4-8 pm peak period (the Evening Peak, which includes the 6 pm Annual Peak Hour), especially in December, but including weekends as well. While timers can be used to reduce unnecessary energy consumption, reducing the heat cycle from 8-12 hours per day to the 2-3 hours per day that is required to ensure that the engines can be restored to warm enough temperatures to start, the timing of the operation is particularly key to the capacity control aspect. Ideally, operation should be staggered within local areas to prevent a local distribution peak, as well as to relieve the overall system peak associated with the 4-8 pm period for Yukon.

Applicability

Applicable dwelling types are any dwelling units with a garage or proximity of plug-in heaters to the home. This would include all but some multi-family dwellings where individual occupants do not have access to electricity for block heaters.

Costs

Switches cost about \$50 per unit, plus \$25 for installation, plus maintenance. Installation costs are reduced to \$10 for incremental installation if the timer switch can be installed during installation of other systems. There is no savings in installation costs for a new home.

Electric Peak Reduction

Assuming annual energy consumption per participant of 258 kWh, baseline electric peak period loads are estimated as 0.173 kW for the Annual Peak Hour (6 pm) and 0.216 kW for the Evening Peak (winter peak weekday 4-8 pm). Assuming 100% load control for evening peak hours, Exhibit G 2 below illustrates the baseline vs. control load profiles on the system peak day. This results in an estimated average of 0.173 kW per unit peak reduction for the Annual Peak Hour (at 6 pm) and an average of 0.216 kW per unit peak reduction for the Evening Peak (4-8 pm), assuming no overrides or switch failures. These estimates may erode over time due to a number of factors, e.g., disabling of switches (by customers and contractors) and malfunctioning timers, so some maintenance and ongoing monitoring should be expected.

In Exhibit G 2, the red line represents the timer control option (controlled peak day) while the green line (peak day) represents the baseline. None of these load profiles assumes the use of timers used solely to reduce energy, which would not necessarily reduce evening peak demand unless specifically programmed to do so. The degree to which timers are set to defer usage and also lock out operation during 4-8 pm would be considered duplicated savings.

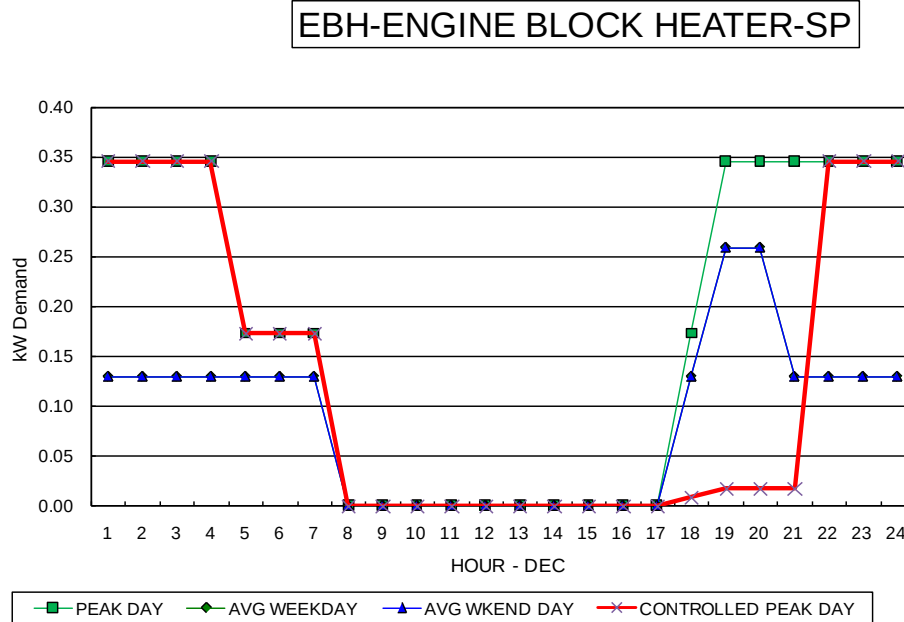
Other Benefits

The timers would also provide energy savings and, depending on any time-of-use rate in effect, could also be operated to maximize bill savings.

Useful Life

Timers are an established technology. For the costing analysis, a 10-year life has been assumed, although timers can be expected to last longer than that if maintained in clean working condition.

Exhibit G 2 Residential Block Heater Baseline vs. Controlled Load



Cost-Effectiveness Summary

Based on a one-time cost of approximately \$50, ongoing maintenance of 10% (about \$5/yr.) and estimated annual impacts of 0.173 kW – 0.216 kW per switch, a preliminary estimate of the CEPR is \$52-\$65 per kW when applied to most target sub sector homes. As an incremental option to other installations of switches, the installation costs could be reduced by \$15 and the resulting CEPR would be \$45-\$56 per kW.

Barriers and Constraints

Contractors or residents may disconnect the timers if their schedules are disrupted, such as in power outages, depending on the nature of the switches. Some switches may not maintain the correct time without some type of battery backup. New tenants or their contractors may not know what the switches are and have them removed.

Program Issues

Without time-of-use rates, customers have no particular incentive to maintain the lock out feature or timer operation to exclude the 4-8 pm period, so some monitoring may be necessary to ensure that block heater operation avoids system peaks. Additional monitoring and sampling would be required to maintain, verify and evaluate the system performance to a sufficient degree of accuracy due to the lack of confirmation and higher incidence of removals and failures unless the system is part of an integrated home control system.

Lighting Load Control

Switch-based Lighting Load Control Assumptions used for Analysis

Applicable Dwelling Type(s)	▪ All dwelling types
Applicable Equipment Type	▪ Non-essential lighting
Vintage	▪ Existing and new
Costs	▪ \$50 incremental cost in existing and new homes ▪ Approximately \$5/site/yr. maintenance/evaluation
Electric Peak Reduction	▪ 100% of non-essential lighting, assumed as 33% of baseline lighting usage (0.249 kW for the Annual Peak Hour) = 0.082 kW. ▪ No recovery energy is assumed
Useful Life	▪ 10 years

Description

In every home, there are a number of non-essential lighting and plug loads (including “phantom” loads⁵⁶) that could be controlled for limited periods, such as during system peak critical hours, including holiday lights (depending on when the system peak occurs). Switch-based lighting load control is accomplished by the installation of a remote control switch on non-essential lighting circuits, wall switches and plug-in lamps or decorative lighting. Existing home automation systems currently utilize plug-in modules with communication via power line carrier or short-run radio signals. These systems can also interface with PCs and through telephone interfaces so that remote control can be accomplished as well. In terms of technical capability, the improvements to these existing systems that will facilitate their use in utility electric peak load control would require some reduced cost and more standardized and reliable remote interfaces. Current home automation systems do not typically have the capability for remote programming for on-demand control use, so this capability would need to be developed. Most likely, this would be achieved as part of an add-on wireless communications control switch linked to the outside through a remote load control system already in place to maximize or even enable cost effectiveness. What is required is a “gateway” via broadband (e.g., broadband over power lines) or through the meter (these types of systems are all now being tested in the field) that would accept outside signals (such as from the utility) and convert them to short-run wireless (or wired) signals that would trigger switches placed on selected lights and appliances.

This section describes the lighting applications only, in order to determine effect on lighting load profiles. The next section addresses aspects of non-lighting loads, although lighting and non-lighting plug loads are not expected to require separate systems, but rather a single gateway that controls switches for any plug load or, for lighting, wall switch. This technology would be applicable for single-family homes and row houses, as well as for apartments, which could make effective use of total building communications through building wiring or a building wi-fi system, as is common for electrical sub metering applications today.

⁵⁶ Phantom loads are typically defined as standby loads on appliances, set-top boxes, televisions, electronics-charging units and other devices intended to facilitate instant-on capability or charging units/transformers that use electricity even when not being actively used for their intended purpose.

Applicability

This measure is applicable to all residential dwelling types, but would likely be most applicable to single-family homes with outdoor lighting.

Costs

Gateway systems are estimated at \$100-\$300 per site installed, although they would be expected to serve multiple purposes. For example, a programmable communicating thermostat or electric meter already in the house for other applications could include a relay board that would relay signals from a remote host over broadband or other remote communications to individual household devices for only this purpose. Switches are assumed to cost about \$5 per unit, which could control multiple lights and plug loads. There is no savings assumed for installation costs for a new home.

Electric Peak Reduction

Based on annual lighting loads per household of 1,029 kWh, the average lighting loads per household during the 6 pm Annual Peak Hour would be 0.249 kW, or for the 4-8 pm Evening Peak approximately 0.276 kW. Assuming 33% of the lighting could be reduced with two switches, this would result in a 0.082 - 0.091 kW per household electric peak load reduction, or just under 100 Watts. In Exhibit G 3, the red line represents the timer control option (controlled peak day) during the 4-8 pm period, while the green line (peak day) represents the baseline.

Other Benefits

The gateway systems and switches would provide customers with many ancillary benefits, such as remote shut off of lights and appliances for security, convenience and energy saving, although no energy savings has been assumed for this analysis.

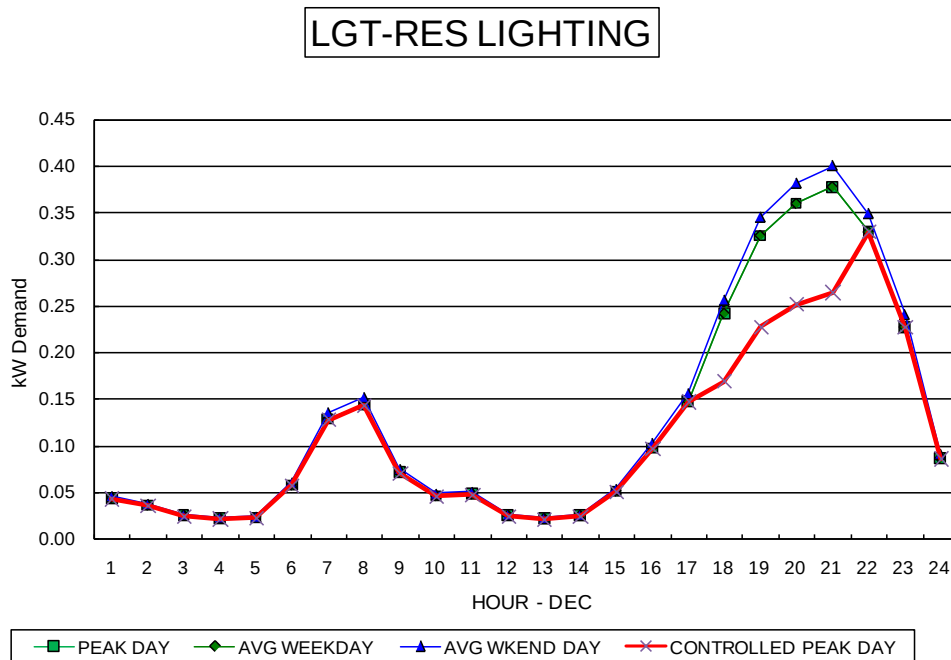
Useful Life

This technology has a fairly long history, going back at least 20 years for various protocols of home automation devices, including X-10 protocol units, which have been available through electronics stores under various brand names. For the costing analysis, a 10-year life has been assumed, although the units typically last 10-15 years.

Cost-Effectiveness Summary

There are two scenarios analyzed. Based on the inclusion of a modest (\$100) gateway system installation and two switches (at \$10 each), installation cost of approximately \$50, ongoing maintenance/support of 10% (about \$10/yr.) and estimated annual impacts of 0.082 kW – 0.091 kW, the estimated CEPR is \$256-\$285 per kW/yr. For practical and economic purposes, this type of system would not likely be used in stand-alone cases, so the second scenario assumes that the gateway is an existing device (e.g., meter, communicating thermostat, remote water heater control system) with no additional capital cost and only some costs (\$20) for installation of switches (plug switches can be easily installed by the customer while wall switches require some experience but no electrical license), and some annual support (\$5). Under this scenario, the lifecycle CEPR is \$73-\$81 per kW/yr.

Exhibit G 3 Residential Lighting Baseline vs. 30% Controlled Load



Barriers and Constraints

The technology for this application exists but is not quite ready for general use and would be greatly enhanced by the introduction of gateways that are only now being pilot tested. In addition, without some type of time-based rate, there would be little incentive for customers to purchase these devices, even as timers, without cash incentives.

Program Issues

In the short term, the utility could work with home electronics stores to encourage use of home automation and couple that with appeals to program the devices to shut off non-essential lighting during the defined peak period of 4-8 pm, especially holiday lighting during system critical periods. This would be facilitated by adoption of time-of-use rates that would be consistent with the peak periods, with critical peak pricing periods on a handful of system peak days providing the additional incentive for customers to utilize their systems during system peak critical periods. The switches can be overridden easily so programming them as a default to shut off certain lights for the peak winter months with the option to turn them back on if needed would be feasible.

Multiple (Whole House and Miscellaneous Plug Loads)

See the discussion on lighting (above) for description, applicability, and costs, which are the same.

Electric Peak Reduction

Based on annual plug loads and miscellaneous electronics loads per household for single-family detached houses, there are numerous devices to which this measure could be applied. Principal among these would be instant-on televisions, set-top boxes and electronic device chargers (many of which could be “ganged” on one power strip with a single switch). For the purposes of this analysis, it is assumed that 60 - 82 Watts of devices could be controlled, which represents 50% of the current peak contribution for computers, TVs, Set-top boxes, miscellaneous electronics and small appliances. The table below lists the best candidates, based on a study by LBNL,⁵⁷ as well as other sources and project team experience.

Appliance	Range of Power Consumption (Watts)
Compact Audio Components	1 – 15 W
Personal Computer	2 – 5 W
Ink Jet or Laser Printer	4 – 6 W
Large-screen television	5 – 22 W
Phone or answering machine	2 – 5 W
Set-top Box	5 – 25 W
DVD/VCR	4 – 22 W
Home Theatre ⁵⁸	12 – 56 W

Cost-Effectiveness Summary

Based on the 100% incremental scenario, whereby three switches (\$15) and \$5 for incremental installation costs, \$2.50/year for maintenance, and estimated annual impacts of 60 to 82 Watts on demand, encompassing a mix of the above devices being controlled, the estimated CEPR is \$168 - \$229 per kW/yr. For practical purposes, this type of system would not be used in stand-alone cases, only as an increment to an existing gateway system with lighting switches already in place. Adding stand-alone gateway installation (\$100 initial cost) would result in an estimated CEPR of \$47 - \$64 per kW/yr.

Swimming Pools and Spa Units

Description

Switch-based swimming pool and spa pump load control is accomplished by the installation of a remote control switch on either the pump itself or on the circuits controlling the pump. In older systems, this type of control has been accomplished via radio frequency (RF) control, which allows remote shut off of the pump under specific capacity-constrained conditions during a limited number of pre-specified hours during winter peak months. In some systems, broadband- / wi-fi-based communications can also be used. An even more economic solution is to piggyback off of an already existing communications system. For example, if space or water heat control already exists, pump control can be added via a hard-wired or wireless connection. This can reduce the total cost of the pump control by up to 50%.

⁵⁷ Stand-by Power <http://standby.lbl.gov> – Lawrence Berkeley National Labs.

⁵⁸ Standby Trends in Australia and Mandatory Standby Power Proposals, C. Edlington et al; 2006 ACEEE Summer Study on Energy Efficiency in Buildings.

Depending upon the length of the control, pumps can be shut off for the entire control period. Cycling is not recommended as it can damage the equipment. Pool and spa pump control is commercially available and implemented in hundreds of thousands of sites in the U.S., thus demonstrating the viability of the technology, success of the programs, customer acceptance and utility satisfaction.

Switch-based Swimming Pool Pump and Spa Pump Load Control Assumptions used for Analysis

Applicable Dwelling Type(s)	Single-family detached and attached, row houses, multi-family – all with individual dwelling unit control/circuits
Applicable Equipment Type	Swimming pool and spa pump at least ¾ HP
Vintage	Existing and new
Costs	\$265 incremental cost in existing and new homes \$140 incremental cost as an add on to an existing control system - Approximately \$12/site/yr. maintenance/evaluation
Electric Peak Reduction	Assume 50% of baseline loads, no energy recovery
Useful Life	10 years (comparable to lighting controls)

Applicability

Applicable dwelling types are any dwelling unit with a swimming pool or spa pumps at least ¾ HP in size. The minimum HP of the pump is necessary to ensure that enough load savings can be obtained. Swimming pools or spas that have automatic vacuum systems that run off the pump are not applicable for this control since turning off the pump while the automatic vacuum is operating can damage the vacuum.

Costs

Switches cost about \$115 per unit, plus \$150 for installation, plus maintenance. Costs are reduced to \$125 if the control can be added to an existing control system. There is no savings in installation costs for a new home.

Electric Peak Reduction

Based on annual consumption of pools and spas of 8,164 kWh per end use for single-family detached / duplex, the predominant target for this measure, the peak period average demands are as follows:

▪ Annual Peak Hour (peak day 6 pm)	1.25 kW
▪ Evening Peak (peak day 4-8 pm)	1.17 kW

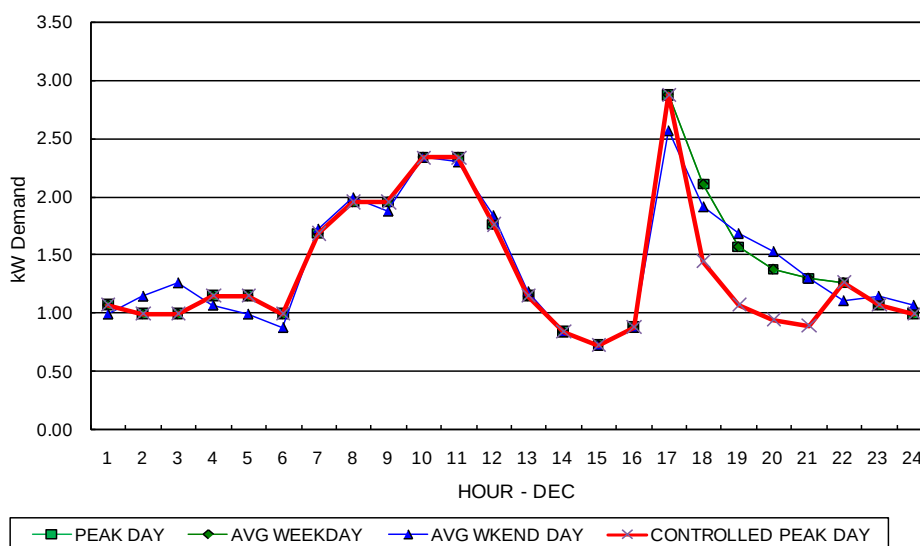
Assuming 50% reduction, electric peak impacts on a household basis would thus average about 0.587 – 0.624 kW per customer for the Evening Peak, equivalent to a ¾ HP motor draw. These estimates may erode over time due to a number of factors, including signal strength losses and disabling of switches (by customers and contractors). Since the pump switch uses a one-way communications-based system, it will require support analyses including the need for signal propagation studies and periodic sampling and re-estimation of reliability levels, accompanied by sufficient maintenance, to maintain an adequate level and accurate estimate of losses.

Experience in the utility industry has shown that performance could erode significantly over time if the system is not properly maintained.

Exhibit G 4 represents the average load profile impacts, assuming a net 0.6 kW per unit reduction for pool pumps and spas. The red line represents the controlled load, as compared the peak day load in green.

Exhibit G 4 Swimming Pools and Spas Baseline vs. Controlled Load

SPP - POOL PUMPS AND SPAS



Other Benefits

The pump control switch would not provide customers with any ancillary benefits and thus the only incentive for participation would be monetary in nature, unless time-of-use or critical peak pricing was instituted.

Useful Life

This technology has a long history, going back at least 30 years on various types of equipment, including central air conditioners, water heaters and pool pumps. For the costing analysis, a 10-year life has been assumed, comparable to lighting controls although there are programs with switches in place for longer than that.

Cost-Effectiveness Summary

Based on a one-time cost of approximately \$265, ongoing maintenance of 10% (about \$25/yr.) and estimated annual impacts of 0.587 – 0.624 kW, an estimate of the CEPR is \$72 - \$77 per kW/yr. For incremental installations, costing only \$125, the CEPR is approximately \$34 - \$36 per kW/yr.

Barriers and Constraints

Contractors are often the cause for lack of participation or dropouts, since they may incorrectly blame the switches for system performance problems, dissuading participation or resulting in removals. New tenants or their contractors may not know what the switches are and have them removed. With one-way communications, there is no way to verify whether the switch is even in place and an accurate count of actual switches in place cannot be reliably made without a systematic site verification plan.

Program Issues

Since there are no customer benefits inherent in the technology, a cash incentive would typically be expected for each season that the measure was needed, payable either by season or by event (or both). Additional work would be required to maintain, verify and evaluate the system performance to the same degree of accuracy as two-way thermostat systems due to the lack of confirmation and higher incidence of removals and failures. The program would need to ensure that customers who shut down their units during the winter are not included, which may be problematic without having two-way communications, or some type of inexpensive logger could be used, which would add to the maintenance costs.

Electric Thermal Storage (ETS) Central Units

Description

Electric thermal storage (ETS) is a technology that has been widely used in Europe and selectively used in North America for more than 40 years. The basic premise of the systems is to convert electricity into heat and store it in specially designed high-density ceramic bricks, capable of holding heat up to 1,650°C. Combined with a utility off-peak rate, operation in charging mode during low-cost off-peak hours can provide heat all day, if properly sized, by thermostat-controlled release of heat from the bricks through either forced air or hydronic systems. Units come in various sizes, from whole-house units to individual room units. Control systems to ensure proper heat distribution are typically included and systems can be retrofitted or installed in new construction applications. The principal manufacturer in North America is Steffes Corp.,⁵⁹ and marketing is principally accomplished through electric co-ops, as well as many northern U.S. and Canadian utilities, including Nova Scotia Power and Hydro-Quebec, where a sufficient differential between peak and off-peak prices during winter months makes it economical for residents. Many winter-peaking generation/Transmission & Distribution co-ops market the units in order to minimize their capacity requirements during peak winter times.

⁵⁹ <http://www.steffes.com>

Electric Thermal Storage (ETS) Central Units Assumptions used for Analysis

Applicable Dwelling Type(s)	Electrically heated single family, row houses and apartments – requires off-peak rate structure
Applicable Equipment Type	Central furnace units using forced air or hydronic systems for central furnace ETS units
Vintage	Existing and new
Costs	- Assuming 15-hour operation (9-hour overnight charge time): \$4,000-\$4,500 for central ETS units vs. \$1,500 for standard heating system (50,000 BTU); - Assume \$500 incremental installation costs; approximately \$100/site/yr. incremental maintenance
Electric Peak Reduction	- Assume 95% of current full electric loads (assuming 5% override), operating 100% off-peak otherwise, with only residual fan (same as baseline) during 15 daytime hours. Estimated 4.65 kW peak - Approximately 5% increase in space heating energy for losses
Useful Life	18 years (comparable to heat pump) for central

Applicability

With the various size units available, ETS can be installed in any size dwelling, either as a whole-house system or in selected (or all) rooms. It can therefore replace central furnace hot air or boiler/hydronic systems, or even baseboard systems. Often, a separate meter is used to measure just the central heating systems to best take advantage of the off-peak rate. Systems must be sized based on the time-of-use rate, with charging periods designed to virtually eliminate any operation during peak periods. For Yukon, a 15-hour peak rate period (7 am – 10 pm) and a nine-hour off-peak rate (10 pm – 7 am) would be used by the utility.

Costs

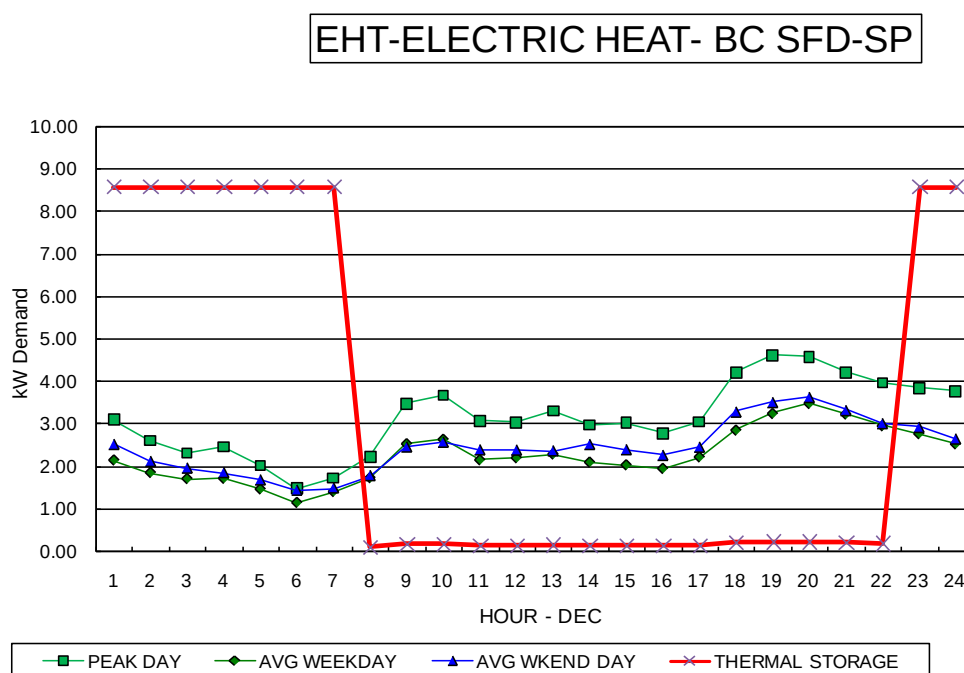
Initial costs for ETS systems are significantly higher than standard heating systems. For the economics to work for the customer, the rate differential must be significant, at least two-three to one for peak to off-peak. Initial costs are roughly proportional to the unit sizing, with an ETS system requiring two to three times the size of a standard system, and somewhat higher installation and maintenance costs. In addition, additional control equipment and sometimes wiring upgrades are necessary, as well as placement in the home (requires sufficient support for additional weight), making the specification of a system critical in terms of applicability. In general, larger homes work best. For the purpose of this study, preliminary costs have been developed based on a literature search and an interview with a representative of Steffes Corp.

Electric Peak Reduction

Electric peak load reduction would be theoretically 100% of the peak heating requirements of a standard electric space heater. Off-peak loads would be over twice the levels so it would be critical to size the systems properly for the expected charging period. For example, for a single detached house with 10,722 annual kWh for space heating, average 7 am – 10 pm loads would be about 3.5 kW, peaking at about 4.6 kW. For the costing analysis, it is assumed that 5% of the usage would still be on peak to account for minimal overrides or where units do not provide all heating requirements through off-peak charging (even though theoretically designed to do

so). For a central ETS unit, the comparable overnight (charging) on a peak day would be about 8.6 kW, as illustrated in Exhibit G 5. Peak load reduction would therefore be about 4.41 kW at the hour ending 7 pm system peak and average 4.21 kW during the 4-8 pm peak period.

Exhibit G 5 Electric Thermal Storage Heating – Central Units



Other Benefits

None.

Useful Life

This technology has a long history in Europe and the bricks are virtually indestructible, so the useful life is considered the same as comparable central or room heating systems (15-18 years). Electronic control systems are required, which involve some maintenance.

Cost-Effectiveness Summary

For central systems, analysis is based on a one-time incremental cost of approximately \$3,800 for the unit plus \$500 installation, plus \$150 for metering/control equipment and \$100 annual maintenance. Estimated annual impacts of about 3.6 kW were used, based on 95% of Peak Periods 1 and 2 loads. Under those assumptions, the estimate of the CEPR is \$99-\$101 per kW/yr.

Barriers and Constraints

The prerequisite for an off-peak rate with significant differential is a major consideration, which would require additional metering and infrastructure (priced at \$150 per site). Numerous

logistical and wiring issues would also need to be addressed, which would require significantly more effort in pre-inspection and which would only be feasible for the utility's assistance if the program was large enough to warrant maintaining the staff expertise required. Space requirements and sufficient weight-bearing floors for installation of the units, which are much heavier than standard heating equipment, would be potential constraining factors to feasible installations.

Program Issues

While many co-ops and several major Canadian utilities have programs for this application, and could be consulted to assist in designing the program and identifying barriers experienced in real implementation not just pilot programs, the programming infrastructure required would involve a significant commitment. In addition, the off-peak rate would need to be in place and tested, which would require some level of regulatory approval.

Electric Thermal Storage (ETS) Room Units

Description

See the description for central units above. Room units are sized and configured to replace baseboard systems, typically as supplemental heating or for rooms not otherwise heated.

Electric Thermal Storage (ETS) Room Units Assumptions used for Analysis	
Applicable Dwelling Type(s)	All dwelling types not already fully electrically heated – requires off-peak rate structure
Applicable Equipment Type	Baseboard systems compatible with replacement by stand-alone room unit ETS systems
Vintage	Existing and new
Costs	- Assuming 15-hour operation (9-hour overnight charge time): \$1,200-\$1,600 for room ETS units, vs. \$400 for standard room baseboard system - Assume \$200 incremental installation costs; approximately \$50/site/yr. incremental maintenance
Electric Peak Reduction	- Assume 95% of current full electric loads (assuming 5% override), operating 100% off-peak otherwise, with only residual fan (same as baseline) during 15 daytime hours. Estimated 35% of annual kWh attributable to target room - Approximately 5% increase in space heating energy for losses
Useful Life	15 years (comparable to heat pump)

Applicability

With the various size units available, ETS can be installed in any room to replace, or supplement, electric baseboard systems. Often, a separate meter is used to measure just the central heating systems to best take advantage of the off-peak rate but a separate meter would not be viable for room units. Systems would be configured to take advantage of rates, ideally a time-of-use rate, with charging periods designed to virtually eliminate any operation during peak periods. For Yukon, a 15-hour peak rate period (7 am – 10 pm) and nine-hour off-peak rate (10 pm – 7 am) would be used by the utility.

Costs

Initial costs for ETS systems are significantly higher than standard heating systems. For the economics to work for the customer, the rate differential must be significant, at least two-three to one for peak to off-peak. Initial costs are roughly proportional to the unit sizing, with an ETS system requiring two to three times the size of a standard system, and somewhat higher installation and maintenance costs. In addition, additional control equipment and sometimes wiring upgrades are necessary, as well as placement in the home (requires sufficient support for additional weight), making the specification of a system critical in terms of applicability. In general, larger homes work best. For the purpose of this study, preliminary costs have been developed based on a literature search and an interview with a representative of Steffes Corp.

Electric Peak Reduction

Electric peak load reduction would be theoretically 100% of the peak heating requirements of a standard electric space heater for the applicable room. Off-peak loads would be over twice the levels so it would be critical to size the systems properly for the expected charging period. For example, for a large room with 3,750 annual kWh requirements for space heating, average 7 am – 10 pm loads would be about 0.85 kW, peaking at about 1.12 kW. For the costing analysis, it is assumed that 5% of the usage would still be on peak to account for minimal overrides or where units do not provide all heating requirements through off-peak charging (even though theoretically designed to do so). For a room ETS unit, the comparable overnight (charging) on a peak day would be about 2.06 kW, as illustrated in Exhibit G 6. Peak load reduction would therefore be about 1.25 kW at the hour ending 6 pm system peak.

Other Benefits

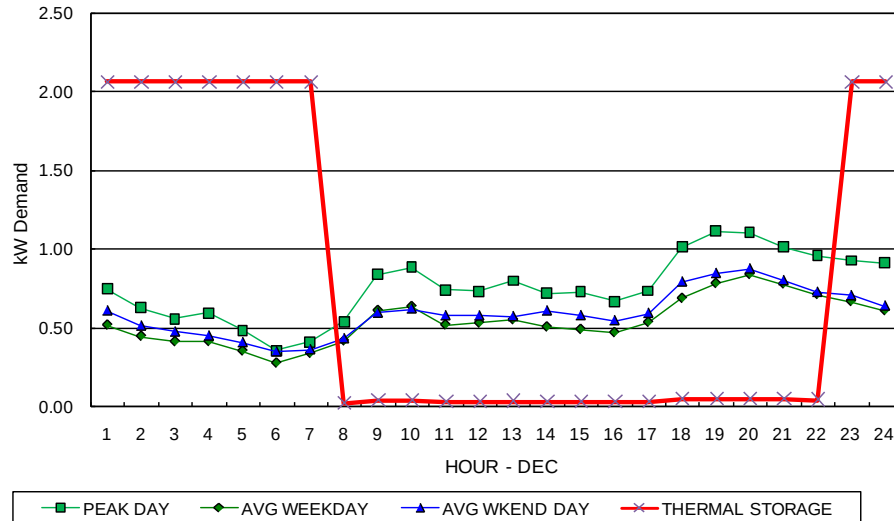
None.

Useful Life

This technology has a long history in Europe and the bricks are virtually indestructible, so the useful life is considered the same as comparable room heating systems (15 years). Electronic control systems are required, which involve some maintenance.

Exhibit G 6 Electric Thermal Storage Heating – Room Unit

EHT-ELECTRIC HEAT- BC SFD-SP



Cost-Effectiveness Summary

For central systems, analysis is based on a one-time incremental cost of approximately \$1,000 for the unit plus \$150 installation, plus \$50 annual maintenance. Estimated annual impacts of 1.24–1.27 kW were used, based on 95% of Peak Periods 1 and 2 loads. Under those assumptions, a preliminary estimate of the CEPR is \$85–\$87 per kW/yr.

Barriers and Constraints

The existence of an off-peak rate with significant differential is a major consideration, although additional metering and infrastructure (priced at \$150 per site) would not be justified solely for this purpose. Numerous logistical and wiring issues would also need to be addressed. Space requirements and sufficient weight-bearing floors for installation of the units, which are much heavier than standard heating equipment, would be potential constraining factors to feasible installations.

Program Issues

While many co-ops and several major Canadian utilities have programs for this application, which could be consulted to assist in designing the program and identifying barriers experienced in real implementation (not just pilot programs), the programming infrastructure required would involve a significant commitment.

Measure Lifecycle Costing Worksheets

The following worksheets detail the calculation of CEPR⁶⁰ for each of the electric peak measures listed.

⁶⁰ The lifecycle measure cost is the annualized capital, installation and operating cost of the measure over its useful life.

LIFECYCLE COSTING WORKSHEET					
One-Way Switch - Water Heating					
1	One-time Costs - Retrofit			2	Recurring Costs (\$/yr.)
	Capital/Device	\$100.00		Maintenance	\$10.00
	Installation	\$100.00		Support	\$0.00
	Other	\$0.00		Other	\$0.00
	Total	\$200.00		Total	\$10.00
3	Net present Value Cost (1)		\$273.79		
		Low		High	
4	Peak Reduction (kw/yr.)	0.245		0.273	
5	LIFECYCLE Peak reduction	2.45		2.73	
				11,326	count
6	Cost of Electric Peak Reduction (CEPR)			2.8	MW to
	(Rounded to \$)	\$112.00		\$100.00	3.1 MW
		Average		\$106.00	2.9 Avg MW
	(1) Discount Rate/yr.	7.5%			
	Device Lifetime (yr.s)	10			

LIFECYCLE COSTING WORKSHEET					
One-Way Switch - Water Heating (incremental)					
1	One-time Costs - Retrofit			2	Recurring Costs (\$/yr.)
	Capital/Device	\$100.00		Maintenance	\$10.00
	Installation	\$25.00		Support	\$0.00
	Other	\$0.00		Other	\$0.00
	Total	\$125.00		Total	\$10.00
3	Net present Value Cost (1)		\$198.79		
		Low		High	
4	Peak Reduction (kw/yr.)	0.245		0.273	
5	LIFECYCLE Peak reduction	2.45		2.73	
				11,326	count
6	Cost of Electric Peak Reduction (CEPR)			2.8	MW to
	(Rounded to \$)	\$81.00		\$73.00	3.1 MW
		Average		\$77.00	2.9 Avg MW
	(1) Discount Rate/yr.	7.5%			
	Device Lifetime (yr.s)	10			

LIFECYCLE COSTING WORKSHEET					
Electric Thermal Storage - Central Heating System					
1	<u>One-time Costs</u>			2	<u>Recurring Costs (\$/yr.)</u>
	Capital/Device	\$3,800.00		Maintenance	\$100.00
	Installation	\$500.00		Support	\$0.00
	Other (Meter)	\$150.00		Other	\$0.00
	Total	\$4,450.00		Total	\$100.00
3	<u>Net present Value Cost (1)</u>		\$5,399		
		<u>Low</u>		<u>High</u>	
4	<u>Peak Reduction (kw/yr.)</u>	3.555		3.640	(95% of Peak period 2)
5	<u>LIFECYCLE Peak reduction</u>	53.33		54.61	
				1,916	count
6	<u>Cost of Electric Peak Reduction (CEPR)</u>			6.81	MW to
	(Rounded to \$)	\$101		\$99	6.98 MW
		Average		\$100.00	6.90 Avg MW
	(1) Discount Rate/yr.	7.5%			
	Device Lifetime (yr.s)	15			

LIFECYCLE COSTING WORKSHEET					
Electric Thermal Storage - 1 Room Unit Supplemental Heating System					
1	<u>One-time Costs</u>			2	<u>Recurring Costs (\$/yr.)</u>
	Capital/Device	\$1,000.00		Maintenance	\$50.00
	Installation	\$150.00		Support	\$0.00
	Other (Meter)	\$0.00		Other	\$0.00
	Total	\$1,150.00		Total	\$50.00
3	<u>Net present Value Cost (1)</u>		\$1,624		
		<u>Low</u>		<u>High</u>	
4	<u>Peak Reduction (kw/yr.)</u>	1.244		1.274	(95% of Peak period 1,2)
5	<u>LIFECYCLE Peak reduction</u>	18.67		19.11	
				1,384	count
6	<u>Cost of Electric Peak Reduction (CEPR)</u>			1.72	MW to
	(Rounded to \$)	\$87		\$85	1.76 MW
		Average		\$86.00	1.74 Avg MW
	(1) Discount Rate/yr.	7.5%			
	Device Lifetime (yr.s)	15			

LIFECYCLE COSTING WORKSHEET					
One-Way Switch - Engine Block Heater					
1	<u>One-time Costs - Retrofit</u>		2	<u>Recurring Costs (\$/yr.)</u>	
	Capital/Device	\$50.00		Maintenance	\$5.00
	Installation	\$25.00		Support	\$0.00
	Other	\$0.00		Other	\$0.00
	Total	\$75.00		Total	\$5.00
3	<u>Net present Value Cost (1)</u>				
		Low		High	
4	<u>Peak Reduction (kw/yr.)</u>	0.173		0.216	
5	<u>LIFECYCLE Peak reduction</u>	1.73		2.16	
				10,172	count
6	<u>Cost of Electric Peak Reduction (CEPR)</u>			1.8	MW to
	(Rounded to \$)	\$65.00		\$52.00	2.2 MW
		Average		\$58.50	2.0 Avg MW
	(1) Discount Rate/yr.	7.5%			
	Device Lifetime (yr.s)	10			

LIFECYCLE COSTING WORKSHEET					
One-Way Switch - Engine Block Heater (incremental)					
1	<u>One-time Costs - Retrofit</u>		2	<u>Recurring Costs (\$/yr.)</u>	
	Capital/Device	\$50.00		Maintenance	\$5.00
	Installation	\$10.00		Support	\$0.00
	Other	\$0.00		Other	\$0.00
	Total	\$60.00		Total	\$5.00
3	<u>Net present Value Cost (1)</u>				
		Low		High	
4	<u>Peak Reduction (kw/yr.)</u>	0.173		0.216	
5	<u>LIFECYCLE Peak reduction</u>	1.73		2.16	
				10,172	count
6	<u>Cost of Electric Peak Reduction (CEPR)</u>			1.8	MW to
	(Rounded to \$)	\$56.00		\$45.00	2.2 MW
		Average		\$50.50	2.0 Avg MW
	(1) Discount Rate/yr.	7.5%			
	Device Lifetime (yr.s)	10			

LIFECYCLE COSTING WORKSHEET					
One-Way Switch - Lighting (stand-alone)					
1	<u>One-time Costs - Retrofit</u>			2	<u>Recurring Costs (\$/yr.)</u>
	Capital/Device	\$100.00		Maintenance	\$5.00
	Installation	\$50.00		Support	\$5.00
	Switches	\$10.00		Other	\$0.00
	Total	\$160.00		Total	\$10.00
3	<u>Net present Value Cost (1)</u>		\$233.79		
		<u>Low</u>		<u>High</u>	
4	<u>Peak Reduction (kw/yr.)</u>	0.082		0.091	
5	<u>LIFECYCLE Peak reduction</u>	0.82		0.91	
				14,622	count
6	<u>Cost of Electric Peak Reduction (CEPR)</u>			1.2	MW to
	(Rounded to \$)	\$285.00		\$256.00	1.3 MW
		Average		\$270.50	1.3 Avg MW
	(1) Discount Rate/yr.	7.5%			
	Device Lifetime (yr.s)	10			

LIFECYCLE COSTING WORKSHEET					
One-Way Switch - Lighting (incremental)					
1	<u>One-time Costs - Retrofit</u>			2	<u>Recurring Costs (\$/yr.)</u>
	Capital/Device	\$0.00		Maintenance	\$0.00
	Installation	\$20.00		Support	\$5.00
	Switches	\$10.00		Other	\$0.00
	Total	\$30.00		Total	\$5.00
3	<u>Net present Value Cost (1)</u>		\$66.89		
		<u>Low</u>		<u>High</u>	
4	<u>Peak Reduction (kw/yr.)</u>	0.082		0.091	
5	<u>LIFECYCLE Peak reduction</u>	0.82		0.91	
				14,622	count
6	<u>Cost of Electric Peak Reduction (CEPR)</u>			1.2	MW to
	(Rounded to \$)	\$81.00		\$73.00	1.3 MW
		Average		\$77.00	1.3 Avg MW
	(1) Discount Rate/yr.	7.5%			
	Device Lifetime (yr.s)	10			

LIFECYCLE COSTING WORKSHEET					
One-Way Switch - Plug Loads					
1	<u>One-time Costs - Retrofit</u>			2	<u>Recurring Costs (\$/yr.)</u>
	Capital/Device	\$100.00		Maintenance	\$2.50
	Installation	\$5.00		Support	\$0.00
	Switches	\$15.00		Other	\$0.00
	Total	\$120.00		Total	\$2.50
3	<u>Net present Value Cost (1)</u>		\$138.45		
		<u>Low</u>		<u>High</u>	
4	<u>Peak Reduction (kw/yr.)</u>	0.060		0.082	
5	<u>LIFECYCLE Peak reduction</u>	0.60		0.82	
				14,622	count
6	<u>Cost of Electric Peak Reduction (CEPR)</u>			0.9	MW to
	(Rounded to \$)	\$229.00		\$168.00	1.2 MW
		Average		\$198.50	1.0 Avg MW
	(1) Discount Rate/yr.	7.5%			
	Device Lifetime (yr.s)	10			

LIFECYCLE COSTING WORKSHEET					
One-Way Switch - Plug Loads (incremental)					
1	<u>One-time Costs - Retrofit</u>			2	<u>Recurring Costs (\$/yr.)</u>
	Capital/Device	\$0.00		Maintenance	\$2.50
	Installation	\$5.00		Support	\$0.00
	Switches	\$15.00		Other	\$0.00
	Total	\$20.00		Total	\$2.50
3	<u>Net present Value Cost (1)</u>		\$38.45		
		<u>Low</u>		<u>High</u>	
4	<u>Peak Reduction (kw/yr.)</u>	0.060		0.082	
5	<u>LIFECYCLE Peak reduction</u>	0.60		0.82	
				14,622	count
6	<u>Cost of Electric Peak Reduction (CEPR)</u>			0.9	MW to
	(Rounded to \$)	\$64.00		\$47.00	1.2 MW
		Average		\$55.50	1.0 Avg MW
	(1) Discount Rate/yr.	7.5%			
	Device Lifetime (yr.s)	10			

LIFECYCLE COSTING WORKSHEET						
One-Way Switch - Pools/Spas						
1	<u>One-time Costs - (stand-alone)</u>			2	<u>Recurring Costs (\$/yr.)</u>	
	Capital/Device	\$115.00			Maintenance	\$25.00
	Installation	\$150.00			Support	\$0.00
	Switches	\$0.00			Other *	\$0.00
	Total	\$265.00			Total	\$25.00
3	<u>Net present Value Cost (1)</u>		\$449.47		* Rate Discount or Incentive	
		Low			High	
4	<u>Peak Reduction (kw/yr.)</u>		0.587	0.624	(50% applicable)	
5	<u>LIFECYCLE Peak reduction</u>		5.87	6.24		
					1,120	count
6	<u>Cost of Electric Peak Reduction (CEPR)</u>				0.7	MW to
	(Rounded to \$)	\$77.00		\$72.00	0.7	MW
		Average		\$74.50	0.7	Avg MW
	(1) Discount Rate/yr.	7.5%				
	Device Lifetime (yr.s)	10				

LIFECYCLE COSTING WORKSHEET						
One-Way Switch - Pools/Spas						
1	<u>One-time Costs - incremental</u>			2	<u>Recurring Costs (\$/yr.)</u>	
	Capital/Device	\$75.00			Maintenance	\$12.00
	Installation	\$50.00			Support	\$0.00
	Switches	\$0.00			Other *	\$0.00
	Total	\$125.00			Total	\$12.00
3	<u>Net present Value Cost (1)</u>		\$213.55		* Rate Discount or Incentive	
		Low			High	
4	<u>Peak Reduction (kw/yr.)</u>		0.587	0.624	(50% applicable)	
5	<u>LIFECYCLE Peak reduction</u>		5.87	6.24		
					1,120	count
6	<u>Cost of Electric Peak Reduction (CEPR)</u>				0.7	MW to
	(Rounded to \$)	\$36.00		\$34.00	0.7	MW
		Average		\$35.00	0.7	Avg MW
	(1) Discount Rate/yr.	7.5%				
	Device Lifetime (yr.s)	10				

Worksheets For Calculating Counts By End Use For Per-Unit Cost Calculations And Supply Curve Development

One-Way Switch - Water Heating				
Sector	Dwelling Units	Unit Sat	Elec Sat	Elec Units
1980 & newer non-electrically heated single detached homes	4419	100%	79%	3,491
Pre-1980 non-electrically heated single detached homes	3741	100%	79%	2,955
1980 & newer electrically heated single detached homes	672	100%	100%	672
Pre-1980 electrically heated single detached homes	570	100%	100%	570
Total SDH				
1980 & newer non-electrically heated attached/row housing	586	100%	79%	463
Pre-1980 non-electrically heated attached/row housing	495	100%	79%	391
1980 & newer electrically heated attached/row housing	89	100%	100%	89
Pre-1980 electrically heated attached/row housing	76	100%	100%	76
Total Attached				
Non-electrically heated apartment units	1268	80%	100%	1,014
Non-electrically heated apartment common areas	72	20%	0%	0
Electrically heated apartment units	198	100%	100%	198
Electrically heated apartment common areas	11	0%	100%	0
Total Apartment				
Non-electrically heated mobile/other	884	100%	79%	698
Electrically heated mobile/other	129	100%	100%	129
Total Mobile				
Small diesel grid housing	266	100%	83%	221
Seasonal housing	862	50%	83%	358
Residential garages	284	0%	100%	0
Sentinel Lighting	947	0%	0%	0
	15,569			
Annual kWh		2,762		11,326
				72.7%

Electric Thermal Storage - Central Heating System									
Sector	Dwelling Units	Unit Sat	Elec Sat	Elec Units	Central Unit Applicability	Central Unit Count	Room Unit Applicability	Room Unit Count	
1980 & newer non-electrically heated single detached homes	4419	100%	5%	221	100%	221	100%	221	628
Pre-1980 non-electrically heated single detached homes	3741	100%	5%	187	100%	187	0%	0	879
1980 & newer electrically heated single detached homes	672	100%	89%	598	100%	598	0%	0	7401
Pre-1980 electrically heated single detached homes	570	100%	89%	507	100%	507	100%	507	9105
Total SDH									SDH avg
1980 & newer non-electrically heated attached/row housing	586	100%	5%	29	100%	29	100%	29	10,722
Pre-1980 non-electrically heated attached/row housing	495	100%	5%	25	100%	25	100%	25	
1980 & newer electrically heated attached/row housing	89	100%	89%	79	100%	79	100%	79	
Pre-1980 electrically heated attached/row housing	76	100%	89%	68	100%	68	100%	68	
Total Attached									
Non-electrically heated apartment units	1268	100%	5%	63	0%	0	100%	63	
Non-electrically heated apartment common areas	72	100%	5%	4	100%	4	100%	4	
Electrically heated apartment units	198	100%	95%	188	100%	188	100%	188	
Electrically heated apartment common areas	11	100%	95%	10	100%	10	100%	10	
Total Apartment									
Non-electrically heated mobile/other	884	100%	5%	44	0%	0	100%	44	
Electrically heated mobile/other	129	100%	89%	115	0%	0	100%	115	
Total Mobile									
Small diesel grid housing	266	100%	2%	5	0%	0	100%	5	
Seasonal housing	862	50%	5%	22	0%	0	50%	11	
Residential garages	284	100%	5%	14	0%	0	100%	14	
Sentinel Lighting	947	0%	0%	0	0%	0	0%	0	
	15,569								
Single Family for Central	Annual kWh	10,722		2,180	14.0%	1,916	12.3%	1,384	8.9%

One-Way Switch - Engine Block Heater					
Sector	Dwelling Units	Unit Sat	Elec Sat	Elec Units	
1980 & newer non-electrically heated single detached homes	4419	90%	100%	3,977	
Pre-1980 non-electrically heated single detached homes	3741	82%	100%	3,068	
1980 & newer electrically heated single detached homes	672	82%	100%	551	
Pre-1980 electrically heated single detached homes	570	75%	100%	428	
Total SDH					
1980 & newer non-electrically heated attached/row housing	586	86%	100%	504	
Pre-1980 non-electrically heated attached/row housing	495	76%	100%	376	
1980 & newer electrically heated attached/row housing	89	78%	100%	69	
Pre-1980 electrically heated attached/row housing	76	69%	100%	52	
Total Attached					
Non-electrically heated apartment units	1268	0%	100%	0	
Non-electrically heated apartment common areas	72	67%	100%	48	
Electrically heated apartment units	198	0%	100%	0	
Electrically heated apartment common areas	11	67%	100%	7	
Total Apartment					
Non-electrically heated mobile/other	884	67%	100%	592	
Electrically heated mobile/other	129	67%	100%	86	
Total Mobile					
Small diesel grid housing	266	75%	100%	200	
Seasonal housing	862	0%	100%	0	
Residential garages	284	75%	100%	213	
Sentinel Lighting	947	0%	100%	0	
	15,569				
	Annual kWh	258		10,172	65.3%
One-Way Switch - Lighting (stand-alone)					
Sector	Dwelling Units	Unit Sat	Elec Sat	Elec Units	
1980 & newer non-electrically heated single detached homes	4419	100%	100%	4,419	
Pre-1980 non-electrically heated single detached homes	3741	100%	100%	3,741	
1980 & newer electrically heated single detached homes	672	100%	100%	672	
Pre-1980 electrically heated single detached homes	570	100%	100%	570	
Total SDH					
1980 & newer non-electrically heated attached/row housing	586	100%	100%	586	
Pre-1980 non-electrically heated attached/row housing	495	100%	100%	495	
1980 & newer electrically heated attached/row housing	89	100%	100%	89	
Pre-1980 electrically heated attached/row housing	76	100%	100%	76	
Total Attached					
Non-electrically heated apartment units	1268	100%	100%	1,268	
Non-electrically heated apartment common areas	72	100%	100%	72	
Electrically heated apartment units	198	100%	100%	198	
Electrically heated apartment common areas	11	100%	100%	11	
Total Apartment					
Non-electrically heated mobile/other	884	100%	100%	884	
Electrically heated mobile/other	129	100%	100%	129	
Total Mobile					
Small diesel grid housing	266	100%	100%	266	
Seasonal housing	862	100%	100%	862	
Residential garages	284	100%	100%	284	
Sentinel Lighting	947	100%	0%	0	
	15,569				
	Annual kWh	1,029		14,622	93.9%

One-Way Switch - Plug Loads						
Sector	Dwelling Units	Unit Sat	Elec Sat	Elec Units		
1980 & newer non-electrically heated single detached homes	4419	100%	100%	4,419		
Pre-1980 non-electrically heated single detached homes	3741	100%	100%	3,741		
1980 & newer electrically heated single detached homes	672	100%	100%	672		
Pre-1980 electrically heated single detached homes	570	100%	100%	570		
Total SDH						
1980 & newer non-electrically heated attached/row housing	586	100%	100%	586		
Pre-1980 non-electrically heated attached/row housing	495	100%	100%	495		
1980 & newer electrically heated attached/row housing	89	100%	100%	89		
Pre-1980 electrically heated attached/row housing	76	100%	100%	76		
Total Attached						
Non-electrically heated apartment units	1268	100%	100%	1,268		
Non-electrically heated apartment common areas	72	100%	100%	72		
Electrically heated apartment units	198	100%	100%	198		
Electrically heated apartment common areas	11	100%	100%	11		
Total Apartment						
Non-electrically heated mobile/other	884	100%	100%	884		
Electrically heated mobile/other	129	100%	100%	129		
Total Mobile						
Small diesel grid housing	266	100%	100%	266		
Seasonal housing	862	100%	100%	862		
Residential garages	284	100%	100%	284		
Sentinel Lighting	947	100%	0%	0		
	15,569					
	Annual kWh	545		14,622	93.9%	
One-Way Switch - Pools/Spas						
Sector	Dwelling Units	Unit Sat	Elec Sat	Elec Units	kWh/DU	div by El Sat
1980 & newer non-electrically heated single detached homes	4419	11%	89%	433	791	888.764
Pre-1980 non-electrically heated single detached homes	3741	11%	89%	366	721	810.1124
1980 & newer electrically heated single detached homes	672	10%	100%	67	814	814
Pre-1980 electrically heated single detached homes	570	9%	100%	51	742	742
Total SDH						843.6796
1980 & newer non-electrically heated attached/row housing	586	10%	89%	52		
Pre-1980 non-electrically heated attached/row housing	495	9%	89%	40		
1980 & newer electrically heated attached/row housing	89	9%	100%	8		
Pre-1980 electrically heated attached/row housing	76	8%	100%	6		
Total Attached						
Non-electrically heated apartment units	1268	0%	100%	0		
Non-electrically heated apartment common areas	72	8%	89%	5		
Electrically heated apartment units	198	0%	100%	0		
Electrically heated apartment common areas	11	8%	100%	1		
Total Apartment						
Non-electrically heated mobile/other	884	4%	91%	32		
Electrically heated mobile/other	129	4%	100%	5		
Total Mobile						
Small diesel grid housing	266	9%	91%	22		
Seasonal housing	862	4%	91%	31		
Residential garages	284	0%	100%	0		
Sentinel Lighting	947	0%	0%	0		
	15,569					
	Annual kWh	8,164		1,120	7.2%	

Appendix H Background-Section 10: Achievable Workshop Action Profile Slides

Appendix I

Background-Section 10: Achievable Workshop Measure Worksheets