

Yukon Utilities Board
In the Matter of Yukon Electrical Company Limited
2013-2015 General Rate Application

RESPONSE TO UNDERTAKING #17

November 5, 2013
Transcript Volume 2

Undertaking: By Mr. Janigan to Mr. Redden

Page 284, Lines 14 - 19.

With response to the feasibility study referred to in UCG-YECL-37, to confirm with the participants of the study that YECL can produce the study and, if so, to produce same.

Yukon Electrical Response:

Please refer to Attachment 1 for a copy of the study referred to in UCG-YECL-37, "Burwash Landing and Destruction Bay Wind-Diesel Prefeasibility Study."

YUKON UTILITIES BOARD		
EXHIBIT <u>B-18</u>		
DAY	ENTERED BY	DATE
	<u>YECL</u>	<u>NOV 6, 2013</u>

Burwash Landing and Destruction Bay Wind-Diesel Prefeasibility Update

October 18, 2010

Prepared for the Yukon Electrical Company Limited

By

JP Pinard, P.Eng., PhD.

703 Wheeler St., Whitehorse, Yukon Y1A 2P6

Tel. (867) 393-2977; Email jpp@northwestel.net,

And

John Maissan, P.Eng., of Leading Edge Projects Inc.

219 Falcon Drive, Whitehorse, Yukon Y1A 0A2

Tel. (867) 668-3535; Fax (867) 668-3533; Email john@leprojects.com

Executive Summary

This study provides an update to the latest costs and site assessments to allow the Yukon Electrical Company Limited (YECL) make a decision on moving forward with a wind development in Destruction Bay.

Reports and measurements dating as far back as 1982 were reassessed and used to create a micro-scale wind map of the area. The wind map identified a number of locations within 200 m of the power line whose mean long term wind speed were 6.3 m/s or better.

Of the wind turbines available on the market for this scale of power need and with the necessary cold climate packages two were selected: the Northwind 100 kW Arctic; and, the Aeronautica 225 kW. An energy model using wind turbine and diesel generator specifications and load and wind data was used to determine the yearly energy production from different wind plant options.

Costs were determined for 1, 2, and 3 Northwind 100 kW Arctic wind turbines, and for one Aeronautica 225 kW wind turbine. The capital costs for a project with the Northwind turbines ranged from \$1 million for a low penetration 100kW plant, \$1.9 million for a 200 kW 2-turbine, to \$2.7 million for a high penetration 300 kW three turbine plant. A single Aeronautica 225 kW plant was assessed at \$1.6 million.

Of the four options proposed the Aeronautica 225 kW was found to have the lowest 20 year levelized cost of energy (LCOE) at \$0.409/kWh. This cost was based on the allowance of running the 150 kW generator at 30% load or 45 kW. The LCOE goes up to \$0.449/kWh under a 50% or 75 kW minimum load. Of three Northwind plant sizes the 2-turbine option was found to have the lowest LCOE at \$0.467/kWh. This goes up to \$0.503 if the minimum allowable load is 50% or 75 kW. At the present average cost of diesel fuel of \$0.85/litre and an assumed inflation rate of 2% the LCOE of diesel generation is \$0.293/kWh.

Because the Northwind has a proven track record in Alaska, it is the base case turbine for this study. Two Northwind 100 kW Arctic turbines are recommended as a medium penetration wind plant for the Destruction Bay – Burwash Landing power system.

Subsidies may available from both the Yukon Government and the Department of Indian and Northern Affairs Canada. There is also a new Northern wind funding proposal put forward by the CanWEA that may pass in next federal budget that would provide 30% of the project costs. If these subsidies become available it should be possible to make this project economically viable. Recommendations for next steps are given at the end of this report.

Introduction

There has been interest in wind in Burwash Landing and Destruction Bay since the early 1980's. The National Research Council (NRC) in 1982 to 1984 and the Yukon Government's Public Works Branch (PWB) in 1987-88 measured the winds at Destruction Bay. Although the PWB reported insufficient winds (tower was located at the Destruction Bay grader station), an NRC study (TES 1983¹) reported a mean wind speeds of 5.16 m/s for the year 1982. The tower in the NRC study was at 20 m height, the location is not described in the study, however, the authors believe it was at the same site as the station established by Yukon Energy.

Yukon Energy established a wind monitoring station over two one-year periods 1995-96 and 1997-98 and commissioned several reports. The site for the Yukon Energy wind monitoring was located near the shoreline about 4 km northwest of Destruction Bay. Results of this series of studies revealed that the annual mean wind speed was in excess of 6 m/s at 30 m above ground (AGL).

In 2008 the mean annual load on the local grid was 228 kW with a load range between 130 and 390 kW. The load has been met with three diesel generators of 150, 220, and 290 kW respectively. Some of these generators are expected to be replaced in the coming years. Of perhaps some significance to this study, the community of Burwash Landing has a small district heating system that feed a number of buildings but is intended to grow in the future to include 90% of the homes.

The purpose of this study is review the above studies, to gather and assess the existing wind data and to use numerical wind flow modelling techniques combined with the wind measurement to identify other sites that are closer to the powerline. Once sites have been identified and their wind speeds estimated, then the energy modelling tool, HOMER, is used to simulate the diesel displaced (hourly) by wind over a one-year period. The energy production estimates from the HOMER model are incorporated into a finance model which includes various capital cost items and operation and maintenance cost and financing costs to estimated the cost rate of wind into the diesel system. Recommendations are made on the next steps for the development of wind in Burwash Landing and Destruction Bay.

The Sites for the wind project

The two communities of Destruction Bay and Burwash Landing are located along the southwest shore of Kluane Lake in southwest Yukon (see Figure 1). The communities are about 16 km apart and are connected by a 25 kV powerline. The diesel plant is located in Destruction Bay. In order to keep costs down it is desirable to locate a wind plant as close to the powerline as possible and yet be able to capture the best wind regime in the area. Sites within 500 m of power line

The initial site of interest for this study is by the shooting range 4 km northwest of Destruction Bay where the Yukon Energy measurements were taken in the 1990's. Other sites however will be

¹ TES, 1983: Vertical Axis Wind Turbine and Wind Prospecting Site Technical Summary for 1982. Report written by T.E.S. Limited for the National Research Council of Canada. In Yukon EMR Library.

considered and wind flow modelling will be used to help identify these other sites. From an atmospheric fluid dynamics point of view the maximum mean wind speed is expected to be in the middle of the valley above Kluane Lake. On land typically sites with the best winds are located on hills closer to the shoreline of the lake. Of course the mountaintops have the best winds generally, but in this case these mountaintop sites are unrealistically difficult to access, and combined with icing and severe wind conditions, those mountaintop sites are likely to be commercial unviable.

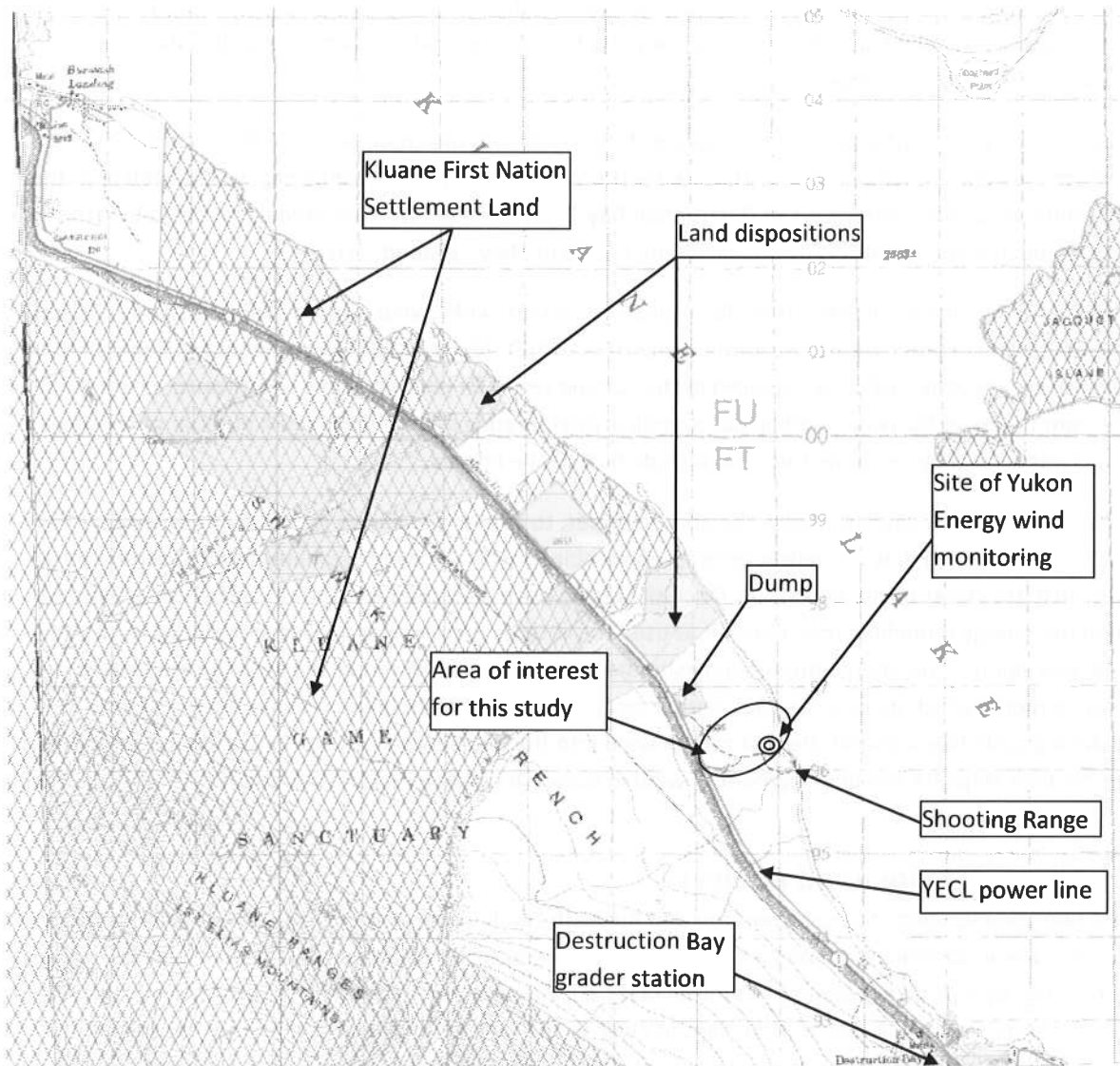


Figure 1: Map of the area between Destruction Bay and Burwash Landing. The power line follows on the northeast side of the Alaska Highway between the two communities. The site where the Yukon Energy, and the NRC, wind monitoring took place is shown. The grader station is where the Public Works Branch apparently put their wind monitoring station. The area of interest is where possible wind sites will be explored in this study. Other areas will also be explored through the wind flow modelling.

Analysing the Available Wind Data

Environment Canada provides online public access to hourly weather data and the Burwash Landing airport measurements are available dating back to 1966. For this study hourly measurements were extracted from 1990 to 2009 (twenty years). The Burwash Measurements however have been made during office hours and so, generally, no wind measurements were made outside of the typical work hours, which varied from time to time but typically were from 7am to 5pm.

Wind data was also extracted from the upper air measurements made at the Whitehorse weather station. The upper air, also known as weather balloon or radiosonde, data is a semi-daily data set that goes back to mid-1950. For long term comparison the upper portion of the upper air measurements are used for the comparison. During the 1990's the measurements in the lower portion (from the surface at 705 m ASL to about 1400 m ASL) were made sporadically so couldn't be used for this comparison. As shown in the graph of Figure 2 below there is little apparent correlation ($R=0.16$; a correlation of $R=1.0$ is a perfect correlation whereas $R=0$ means there is no correlation) between the Burwash A (airport) station and the upper air. They both show, however, that the long term trend are relatively stable. At Burwash the slight decline in the wind speed (about -0.06 m/s in twenty years) may have been caused by vegetation growth, new buildings, and other factors in the area. The upper air shows a 0.38 m/s increase in wind speed over the last twenty years.

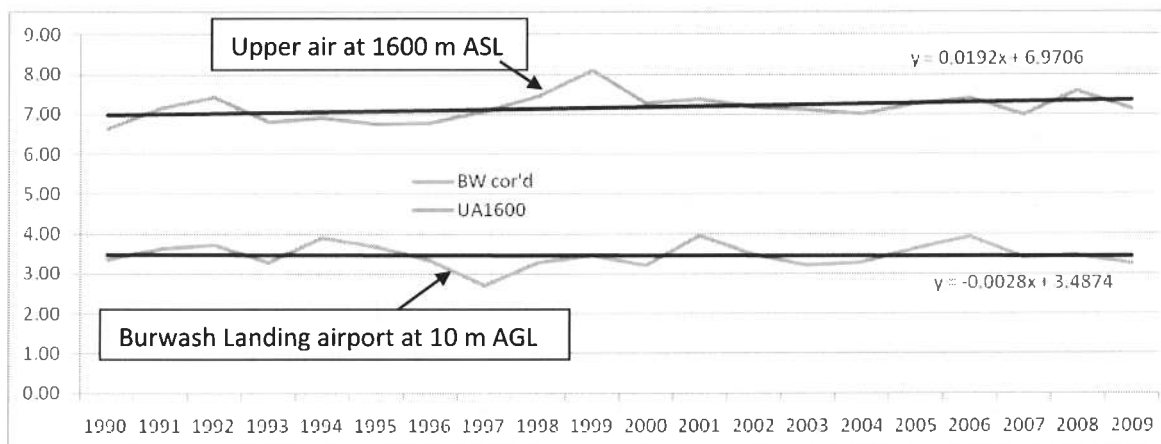


Figure 2: Mean annual wind speed at the Burwash A (airport) compared to the Whitehorse upper air. The straight black lines are the trend lines and are accompanied by their respective equations.

The NRC data is available in a table form of monthly mean wind speed in TES (1983) and, as stated earlier showed a mean wind speed of 5.16 m/s at 20 m AGL during the period from January to December 1982. The Yukon Energy wind monitoring data covered the periods from October 11, 1995 to November 5, 1996 and September 10, 1997 to September 9, 1998. The 1995-96 data is suspect, the measured wind speed are about 15% below the anticipated winds that were recorded in the NRC study measurements of 1982. The 1997-98 data recorded an average of 5.19 and 6.09 m/s at 20 and 30 m AGL respectively which are more closely matched with the NRC data.

For this study the Yukon Energy 1997-87 data is correlated to the Burwash A data so as to project the wind data to long term (20 years). But in order to properly compare the Yukon Energy to the Burwash A data set only the measurements made during the hours from 7am to 2pm were compared. The average wind speed during those hours in the 1997-98 period are 5.3 and 6.13 m/s at 20 and 30 m AGL respectively at the Yukon Energy site; and 3.54 m/s (10 m AGL) at Burwash A. The correlation during that truncated period is $R = 0.80$ which is considered to be an excellent correlation.

The short-term wind speed measured at the Destruction Bay site is adjusted to a twenty-year mean using the MCP method of measuring, correlating, and predicting the long-term mean winds. The formula is:

$$E_s = \mu_s + \frac{R \cdot \sigma_s}{\sigma_r} (E_r - \mu_r),$$

where E_s is the estimated long term wind speed at the site of the wind monitoring station, μ_s is the measured wind speed at the site, μ_r is the measure reference wind speed, and E_r is the measured long-term mean wind speed at the reference station. The other variables in the equation are the correlation coefficient R and the standard deviation for the reference station, σ_r , and the wind monitoring site, σ_s . These values are listed in Table 1. From the above formulae the twenty-year (1990-2009) projected mean of the Destruction Bay site is 6.02 m/s at 30 m AGL.

Table 1: Details of values in the evaluation of the long-term mean wind speed of the wind monitoring station at Destruction Bay using the MCP method.

Measure-Correlate-Predict	Values	units	Height AGL
Estimated Long-term mean at site $E_s =$	6.02	m/s	30 m
Estimated Long-term mean at reference $E_r =$	3.48	m/s	10 m
Measured site $u_s =$	6.09	m/s	30 m
Measured reference $u_r =$	3.54	m/s	10 m
Measured cross-correlation coefficient $R =$	0.80		
measured standard deviation at site $\theta_s =$	4.46	m/s	30 m
measured standard deviation at reference $\theta_r =$	2.91	m/s	10 m

Table 2 shows summary values of wind speeds for the Burwash and Destruction Bay sites. The Destruction Bay numbers include wind projected to higher levels above ground. These numbers were obtained by using log law formulation.

Turbulent air flow over rough surfaces tends to generate a vertical profile of horizontal winds that are fairly predictable. The wind speed profile near the ground is dependent on neutral well mixed air conditions and the roughness of the ground surface. This vertical profile can be defined by the natural log law equation:

$$u_2 = u_1 \frac{\ln(z_2/z_o)}{\ln(z_1/z_o)}$$

where u_1 is the known wind speed at z_1 (typically at 10 m AGL), and is projected to u_2 at the height z_2 . The surface roughness is defined by z_o which as a rule of thumb is 1/10 the height of the grass, brush, or ground undulations surrounding the site where the measurements are made. This equation is considered most accurate up to approximately 100 m above the surface. The surface roughness z_o can be categorised by the type and size of vegetation as well as the hilliness of the ground itself. If we know the wind speeds at two heights of say 10 and 30 m then we can also find the value of z_o , look the value up on a roughness chart and compare the land description to the actual ground surrounding the station. With the known z_o we can use the log equation to predict the wind speed at higher elevations.

Around the Destruction Bay wind monitoring site the land surface is typically forested with undulating terrain. The surface roughness based on the measurement is estimated to be $z_o = 1.92$ m, this would represent a surface roughness of a dense forest.

Table 2: Details of measurements and their projection to longer term and to higher elevations. Bold values indicate the estimated long-term (20-years, 1990-2009) mean wind speed at the Destruction Bay wind monitoring station.

Location and measurement period	Height	Wind speed	
Burwash A station, 10 Sept 97 to Sept 1998:	10 m AGL	3.54	m/s
Dbay site, 10 Sept 97 to Sept 1998:	20 m AGL	5.19	m/s
	30 m AGL	6.09	m/s
Mean(7to14h only):	20 m AGL	5.30	m/s
Mean(7to14h only):	30 m AGL	6.13	m/s
Burwash A station 20-year (1990-2009) mean:	10 m AGL	3.48	m/s
Ratio of 1997-98 to 20-year mean at A station:		0.98	
Dbay site projected to twenty years:	10 m AGL	3.61	m/s
	20 m AGL	5.13	m/s
	30 m AGL	6.02	m/s
	40 m AGL	6.65	m/s
	50 m AGL	7.14	m/s
	60 m AGL	7.53	m/s

At the site of the Yukon Energy wind monitoring the mean long term wind speed at 40 m AGL is estimated, according to the best fit of the log law curve, to be 6.65 m/s. For the wind flow and the energy models in the following sections the projected long-term mean wind of 6.02 m/s at 30 m AGL will be used and the model will project those to 40 m AGL.

The Wind Flow modelling

The wind model used to create the wind map for the area is OpenWind by AWS Truewind (www.awstruwind.com). OpenWind uses a mass-consistent wind flow model to project winds from one location to another. As input, the model uses surface elevation data, surface roughness, and a table of wind speed distribution by direction.

The elevation data is obtained from the Yukon Government's Geomatics Yukon website (<http://geomaticsyukon.ca/>). The elevation surface from the Geomatics data set was found to be inaccurate by ± 20 m especially around the wind site; for example, the valley just southeast of the site does not appear in the Geomatics surface data. To correct this error site visits were made using a GPS with a pressure sensor that was calibrated regularly to several local benchmarks whose elevations are known. The accuracy of this method improves the elevation accuracy to within ± 2 m. The surface was corrected around the site of the Destruction Bay wind monitoring and towards the southeast across the valley. A more extensive and accurate elevation map can be obtained from a local surveying firm (cost of order of \$4,000).

The surface roughness map was created from a satellite image where three types of surfaces were identified: forest $z_0 = 0.5$ m, grassy or sand $z_0 = 0.1$ m, and water $z_0 = 0.001$ m. The table of wind speed distribution is derived from the corrected one year set of wind speed data from the 1997-98 period.

The wind flow modeling portion of OpenWind creates a wind map for each wind flow direction and wind speed. The wind speeds in the wind maps are directly associated with the table of wind speed distributions. All of wind speed maps that are created are combined in one singular map that shows the average wind speed and it is shown in Figure 3 on the next page. On the page following Figure 3 are photographs showing the main study area (Figures 4) and the southeast-most area (Figure 5) which may merit further investigation.

Energy System

Wind Turbines Selected for Study

The main focus of this study has centered on the Northwind 100 (or NW 100), a 100kW wind turbine made by Northern Power Systems (NPS) of Vermont. This is a turbine of modern design (variable speed, direct drive, permanent magnet generator, large diameter rotor) which is available with a cold weather option package that allows operation down to -40°C . See Attachment 1 for a brochure and technical information on this turbine. The Northwind 100 is increasingly being used in Alaskan village wind-diesel systems and is establishing a positive track record in the north. Its main drawback is that it is fairly costly. It is available with a 37 meter tubular tower (also a 30m tower) and requires a crane for installation.

A second wind turbine is also presented as an option in this report. It is the Aeronautica 29-225 (or AW 225). This 225kW turbine is of a conventional older Danish design (Norwin) which was produced and sold commercially for a number of years (has a positive track record in warmer climates), and which is now being manufactured again in the USA by Aeronautica. It is available in a very cold weather option for operation down to -40°C . This turbine operates at fixed speed, has a 29 meter rotor (relatively smaller than the Northwind rotor for its capacity), a gearbox and an induction generator. It is available with a 40 meter tubular tower and would require a crane for its installation. We are told that the first installation in Alaska is anticipated in the near future. Attachment 2 contains information on this turbine.

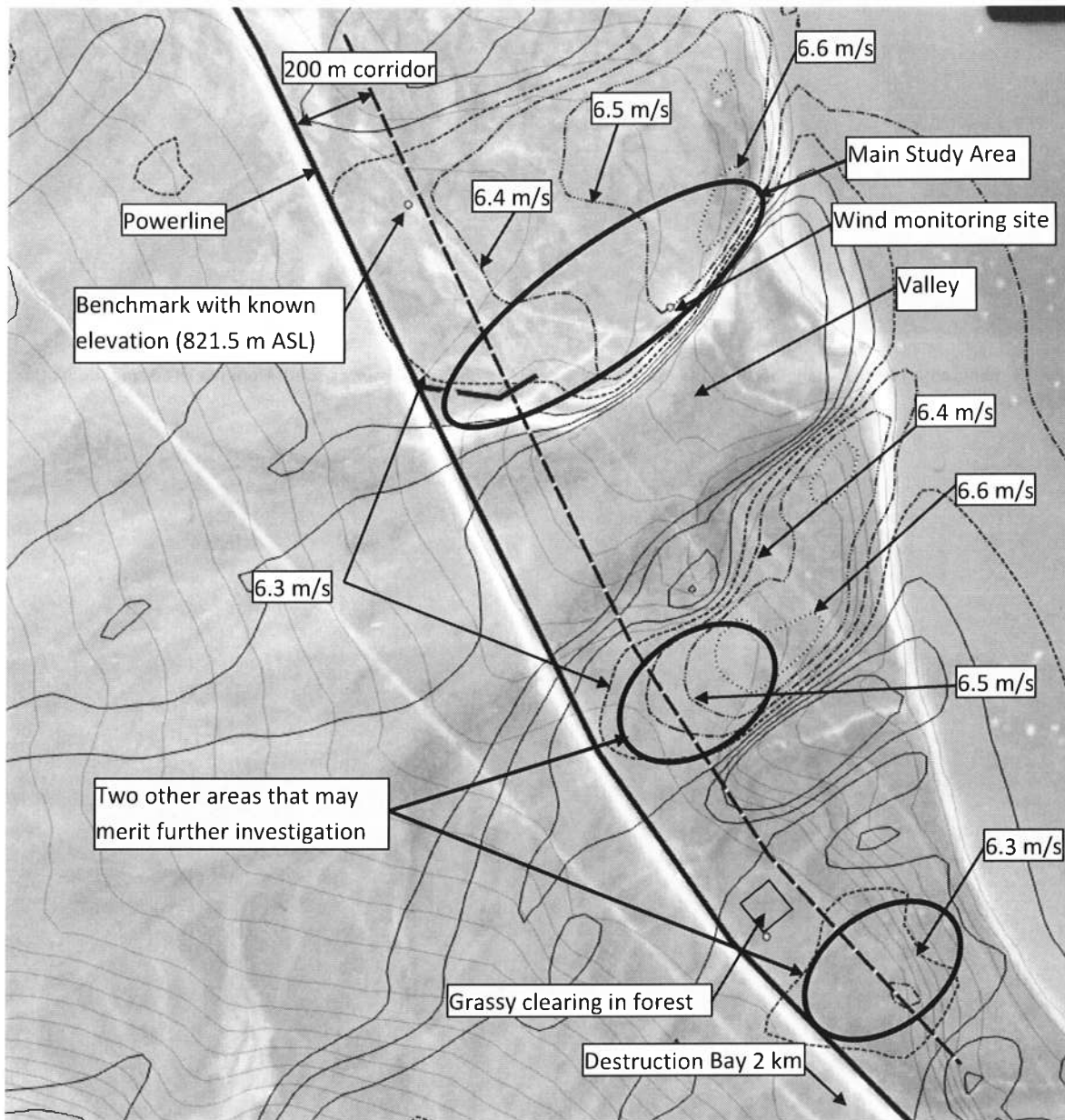


Figure 3: A satellite image of the study area overlain by contours of modelled wind speed at 40 m AGL. The wind speed contours are black and are at 0.1 m/s intervals. The gray elevation contours are at 5 m intervals, lake is at 781 m above sea level and the first contour on the shoreline is at 785 m ASL.

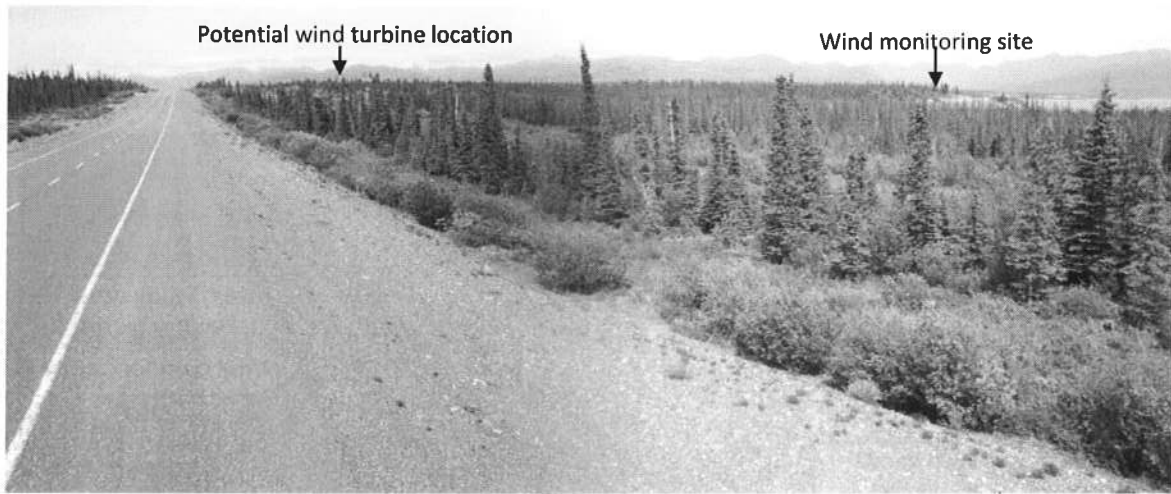


Figure 4: Panoramic photo looking north of the main study area taken about 800 metres south from the site along the Alaska Highway.

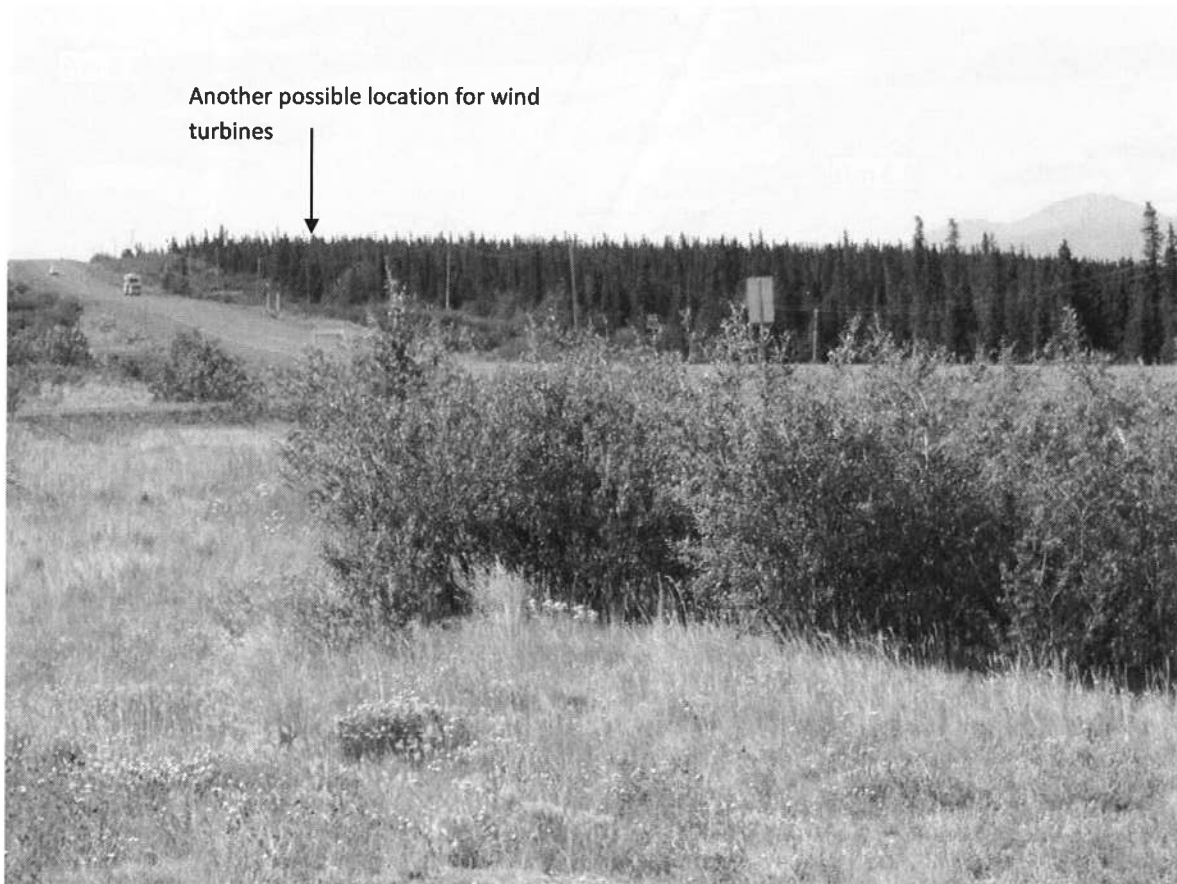


Figure 5: Photo looking north of the southeast-most area of interest shown in Figure 3. Photo was taken about 500 metres south from the site along the Alaska Highway. The photographer was standing in a rest area just northwest of Destruction Bay. Note that Kluane Lake is immediately to the right (east) of this photograph.

Capital Costs of Various Wind Projects Configurations

Four different project configurations were examined. These are projects of 1, 2, and 3 Northwind 100 (100kW) turbines, and a project of 1 Aeronautica 225kW wind turbine. The capital costs estimated for each of these four project configurations are summarized in Table 3 below and in presented detail (including notes) in Attachment 3.

Table 3: Summary of estimated project costs

Description	1 NW 100	2 NW 100	3 NW 100	1 AW 225
Turbine purchase	\$377,000	\$754,000	\$1,131,000	\$609,000
Geotechnical & foundations	\$100,000	\$165,000	\$230,000	\$110,000
Subtotal construction	\$847,000	\$1,564,000	\$2,206,000	\$1,309,000
ES&G and contingency	\$177,870	\$328,440	\$463,260	\$274,890
Construction total	\$1,024,870	\$1,892,440	\$2,669,260	\$1,309,000
Training	\$32,000	\$32,000	\$32,000	\$32,000
Total Project Cost	\$1,056,870	\$1,924,440	\$2,701,260	\$1,615,890
Total Project Cost per kW	\$10,569	\$9,622	\$9,004	\$7,182

A number of the capital cost components were developed in some detail, so the confidence level in these numbers can be considered better than normally found in prefeasibility studies. Supporting information on these cost components can be found in attachments as outlined below. For the project configurations involving 2 or 3 NW 100 turbines some judgment was used with respect to incremental component costs for the additional turbines. For example travel costs for company technicians would not be duplicated for the added turbines. For the Aeronautica 225 turbine, costs for several of the capital cost components were projected from the detailed calculations for the Northwind 100 turbine.

Northwind 100 turbine purchase:	Attachment 4
Aeronautica 225 purchase:	Attachment 5
Shipping costs:	Attachment 6
Import information	Attachment 7
Crane costs:	Attachment 8
Installation, commissioning, & travel:	Attachment 9
Training costs:	Attachment 10

Operating and Maintenance Costs

Operating and maintenance (O&M) cost estimates were based on fairly detailed information contained in the NPS Product Sales Agreement provided by the Northwind 100 manufacturer. This includes information on the first two years for which some of the servicing costs are included as part of the warranty in the turbine purchase price, as well as costs for an extended 5 year service plan. O&M costs for the Aeronautica 225 were based on the NW 100 costs. The authors estimated that the annual O&M cost for one turbine NW 100 would be about \$15,000 per year with additional turbines incurring an incremental O&M cost of \$10,000 per year. These figures do not include any allowances for major component failures during the 20 year design life of the turbines. More detailed information is found in Attachment 11.

Energy Production

The HOMER model was used to calculate the annual energy production from the turbines. HOMER was developed by the National Renewable Energy Laboratory (NREL) of the US Government and is now distributed and supported by HOMER Energy (www.homerenergy.com). HOMER is a power system analysis and optimization model. The energy model uses published wind turbine power curves, diesel plant production specifications, and a one-year time series measurements of both wind speed and community power load to model the energy output of various power generators. A graph of the wind speed and load data are shown in Figure 6 below.

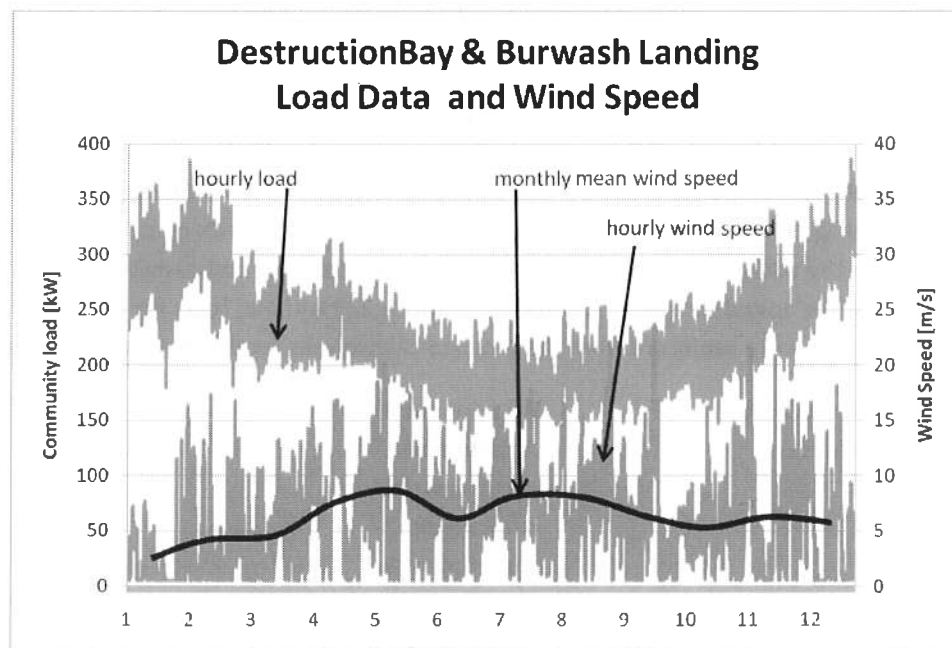


Figure 6: A one-year time series of hourly community load and wind speed. The wind speed is scaled to the right side of the graph, and the load data are scaled to the left side.

Using the wind speed and the electrical load data, and the specified minimum diesel plant loading this model also calculates the surplus wind energy that would not displace diesel generation. HOMER model does not, however include a facility for incorporating turbine availability and electrical and other losses into its calculations; the authors calculated those separately. The authors' calculations yielded net generation figures by applying corrections to the HOMER generation figures, and net surplus figures the same way. The result is a calculation of displaced diesel generation. A summary of these calculations is presented in Table 4 below and details can be found in Attachment 12.

The calculations described above were performed twice, once with the minimum diesel plant load set at 45kW or 30% of the smallest diesel generator (150kW), and a second time with the minimum diesel plant load set at 75kW or 50% of the smallest generator. As can be seen from Table 2 the amount of surplus wind energy from projects with more than one NW100 wind turbine increases rapidly when the minimum diesel plant load is increased from 45kW to 75kW. The same is true for the single Aeronautica 225 turbine project. A project involving a single NW 100 is not affected by this change because its energy production results in the diesel plant load almost never falling below the threshold 75kW. The calculations assumed a wind turbine availability of 95% (5% downtime) and losses (electrical and other) of 5%.

Table 4: Wind project energy production and diesel displacement

Min diesel & description	Project configuration			
Minimum diesel 45kW	1 NW 100	2 NW 100s	1 AW 225	3 NW 100s
HOMER generation kWh	257,346	514,692	539,021	772,036
HOMER surplus kWh	0	20,200	38,919	136,932
Calculated net gen kWh	231,611	463,223	485,119	694,832
Calculated net surplus kWh	0	4,759	34,278	103,477
Diesel displaced kWh	231,611	458,464	450,841	591,355
Minimum diesel 75kW				
HOMER generation kWh	257,346	514,692	539,021	772,036
HOMER surplus kWh	353	53,156	80,626	205,348
Calculated net gen kWh	231,611	463,223	485,119	694,832
Calculated net surplus kWh	0	37,715	73,900	171,893
Diesel displaced kWh	231,611	425,508	411,219	522,939

Economic Analyses

The capital project costs, the annual O&M costs, and the diesel energy displaced were inputs into Leading Edge Projects' (Leading Edge) 20 year utility style economic model to calculate the levelized cost of energy (LCOE) for each of the project configurations. Assumptions that were made to complete the model inputs were: a general inflation rate of 2% (applies to annual O&M costs), a cost of capital of 7.53% (YECL's GRA approved cost of capital), and a discount rate of 5.42% based on the inflation rate and the cost of capital. For the purposes of comparison the LCOE of diesel generated electrical energy based on fuel costs only were run. The economic model runs explored three starting prices of diesel fuel (\$0.85, \$1.00, and \$1.20 per litre) and three diesel fuel inflation rates (2%, 3%, and 4%). A plant fuel efficiency of 3.41 kWh per litre was assumed. Table 3 below summarizes the LCOEs of the different wind project configurations and the comparative diesel fuel cases. Copies of all model runs are presented in Attachment 13. The LCOEs of wind project configurations are also presented in Attachment 3 for ease of reference.

As can be seen from Table 5, the calculated LCOE of wind energy from all project configurations is higher than diesel energy at present diesel fuel prices. The single Aeronautica 225 project would provide the lowest cost wind energy at \$0.409 to \$0.449 per kWh due to the turbine's lower purchase cost and the installation economy of scale – one turbine compared to two NW 100 turbines. Yet at present fuel prices energy from the Aeronautica 225 would be up to \$0.12 per kWh higher than from diesel generation. Wind energy from the two NW 100s at \$0.467 and \$0.503 per kWh are the next most economical after the Aeronautica 225 project. The practical implication of the economic analyses is that any wind energy project in Destruction Bay / Burwash Landing would require subsidization to be competitive with diesel energy.

Table 5: LCOEs from wind projects and diesel generation

Wind projects	Project configuration			
Minimum diesel 45kW	1 NW 100	2 NW 100s	1 AW 225	3 NW 100s
LCOE \$ per kWh	\$0.514	\$0.467	\$0.409	\$0.508
Minimum diesel 75kW				
LCOE \$ per kWh	\$0.514	\$0.503	\$0.449	\$0.575
Diesel generation	Present cost & LCOE \$ / kWh at fuel inflation rate % per year			
	Present	2%	3%	4%
Fuel at \$0.85 per litre	\$0.250	\$0.293	\$0.319	\$0.348
Fuel at \$1.00 per litre	\$0.293	\$0.344	\$0.374	\$0.407
Fuel at \$1.20 per litre	\$0.352	\$0.413	\$0.449	\$0.489

An examination of the figures in Table 2 shows high levels of surplus wind energy with the three NW 100 project and a 45kW minimum diesel plant load, but more modest levels with two NW 100s or a single Aeronautica 225. Raising the minimum diesel plant load to 75kW increases the surplus wind energy significantly. While it may be possible to market the surplus wind energy, the likely value, being space heat energy, will be a fraction (perhaps a third) of the value of electricity, so efforts should be channelled toward minimizing the allowable minimum diesel plant load. This will maximize the utilization of wind energy from a somewhat larger wind project which can in turn benefit from some economies of scale.

The authors explored the effects of harvesting energy from a higher wind resource and capital subsidies in a simplified manner based on the 2 Northwind 100 project configuration. Since it appears that an improved wind resource of 6.5 m/s is available within 800 meters of the Alaska Highway (compared to the base case of 6.3 m/s 200 meters from the highway) this option was examined. This case involves a higher capital cost (roads and power line) and somewhat higher O&M costs (snow clearing & road maintenance) but also a higher energy production. The analyses showed that the LCOE would increase from \$0.467 per kWh to \$0.481 per kWh with a 45kW minimum diesel plant load and would increase from \$0.521 per kWh to \$0.503 per kWh with a 75kW minimum diesel plant load. Thus the trade-off is not economic for this project, but the optimization of available wind speed and distance from the highway in site selection will be beneficial.

The authors also explored the impact of capital subsidies on the 2 Northwind 100 project configuration with a 45kW minimum diesel plant load. A capital subsidy of \$500,000 was found to reduce the LCOE of wind energy from \$0.467 to \$0.362 per kWh. A capital subsidy such as that recently proposed by the Canadian Wind Energy Association's Northern and Remote Wind Incentive Program (NoRWIP) of 30% of project budget (\$577,332) plus an additional \$250,000 would reduce the LCOE of wind energy to \$0.294 per kWh essentially the same as the LCOE of diesel energy at \$0.293 per kWh with fuel at \$0.85 per litre. This case effectively defines the capital subsidy required – approximately 43% of the project cost – with a project of 2 Northwind 100s to have it match the cost of diesel energy. The economic analyses spreadsheets for these two cases are included in Attachment 13.

In none of any of the analyses described above have the authors assumed any benefits or revenues other than the cost of displaced diesel fuel.

Greenhouse Gas Reductions

Leading Edge has completed Greenhouse Gas (GHG) generation calculations for the combustion of diesel fuel based on information from Environment Canada. The main GHG components of CO₂, CH₄, and N₂O were considered and converted to CO₂ equivalent (CO₂ eq). The production of GHG in CO₂ eq was calculated to be 2.7898 kg per litre of diesel fuel consumed. With the diesel plant heat rate of 3.41kWh per litre the GHG production is 0.8181 kg of CO₂ eq per kWh. Using this figure the GHG reductions that would result from each of the wind project configurations are calculated and presented in Table 6. Detailed calculations are presented in Attachment 14. Indirect GHG production from manufacturing, processing, transportation, and other operational activities were not considered.

Table 6: GHG reductions from wind projects

Wind projects	Project configuration			
Minimum diesel 45kW	1 NW 100	2 NW 100s	1 AW 225	3 NW 100s
Annual GHG reduction kg	189,481	375,069	368,833	483,788
Minimum diesel 75kW				
Annual GHG reduction kg	189,481	348,108	336,418	427,816

Funding sources

There are a number of funding sources that could be accessed to help make this project economically viable. The Department of Indian and Northern Affairs Canada (INAC) has for many years offered the ecoENERGY program for aboriginal and northern communities, which is aimed at supporting climate change impacts, the costs of energy and the costs of reducing greenhouse gas emissions. The eligible projects are focused on proven energy technologies and include renewable energies such as small or micro hydro facilities, wind turbines, solar PV and biomass. The program also supports energy efficiency through improved diesel generation efficiency (in off-grid communities), district heating applications, solar thermal, geothermal and improved energy/heating systems in community buildings. For large energy projects such as this case there is up to \$250,000 available for capital and soft costs. The eligible organizations are Aboriginal and northern communities; Aboriginal community groups (volunteer groups, community associations and institutions); territorial governments and northern organizations; and, Aboriginal businesses and Aboriginal industries.

The Yukon Government through the Yukon Economic Development Corporation has a program called the Strategic Industries Development Fund (SIDF). This fund will support such costs as business and financial planning, feasible studies, and project management. There is up to \$500,000 that could be available for these types of cost. This fund would not support purchase of capital assets or costs associated with construction.

Another program that is being proposed by the Canadian Wind Energy Association's (CanWEA) for funding under the 2011 Federal Budget is the Northern and Remote Wind Incentive Program (NoRWIP). This program is designed to spur development of wind-diesel systems in Canada's northern industrial facilities and remote communities. The program proposes a contribution of \$250,000 on completion of a feasibility study to specified standards and a capital contribution of up to \$4,000 per kW or 30% of project budget, whichever is less.

More information on these fund opportunities are found in Attachment 15.

Conclusions

A number of sites within 200 m of the power line whose mean annual winds were in excess of 6.3 m/s (at 40 m AGL) were identified. In the energy and financial analysis the Aeronatica yielded the lowest costs with a LCOE of \$0.409/kWh. It however, does not have the track record that the Northwind has enjoyed in neighbouring Alaska and so there may be issues that come up in an electrical engineering feasible study on this matter. The best scenario with two Northwind 100s to make a 200 kW wind plant is estimated to have a LCOE of \$0.467/kWh. This is still \$0.17/kWh more expensive than the LCOE of diesel, however, and so will require a combination of subsidies, tight management, and creative engineering to bring down these costs.

Subsidies are available to support more feasibility work that would reduce the project design and assessment costs. The ecoENERGY fund could be used for capital purchases. It would be necessary to wait for a funding program such as the NoRWIP to provide the most significant portion of the funding necessary for this project.

Recommendations/Next Steps

There is enough information now available for YECL to consider the possibility of a wind power project in Destruction Bay / Burwash Landing. If YECL wishes to pursue the possibility of a project the next step would be to initiate a discussion with the Kluane First Nation (KFN) (who have just elected a new Chief and Council) about such a project.

Should these discussions proceed positively, the next project steps could involve the following:

1. Lobby for NoRWIP
2. Identify and apply for subsidies for feasibility work
3. With KFN identify preferred development site
4. Identifying components of and budget for feasibility work which may include:
 - a. Permitting & environmental work
 - b. Commission a more accurate elevation model
 - c. Wind monitoring at selected site
 - d. Geotechnical study & foundation design for towers
 - e. Electrical engineering (turbine/technology options, wind diesel integration etc.)
 - f. Exploring market for surplus wind energy (KFN district heating system logical)
 - g. Identifying subsidies required to make project economic
 - h. Develop formal agreements with KFN

As part of this evaluation, explore the possibility of marketing the surplus wind energy. There could be a market particularly in Burwash where a district heating system already exists that could take advantage the surplus electricity.

**Index of Attachments accompanying the report on
Burwash Landing and Destruction Bay Wind-Diesel Prefeasibility Update**

- Attachment 1 – Northwind Related Material
 - 1 2010-07-28 Northwind 100 wind turbine purchase cost
 - 2 Email correspondence with Northern Power Systems
 - 3 Northwind 100 Arctic Brochure
 - 4 specsheet-northwind-arctic
 - 5 SmartView RTU Application Requirements
 - 6 A00298 Northwind 100 Application Requirements
 - 7 Northwind 100 Logistics Installation Guidelines
 - 8 NPS PRODUCT SALES AGREEMENT_COMPLETE
- Attachment 2 – Aeronautica Related Material
 - 1 Email correspondence with Aeronautica
 - 2 Spec_Sheet_Norwin225
 - 3 Spec_Sheet_Norwin225 2
 - 4 N29_Controller2001
 - 5 225_one_line
 - 6 225kWTrans-sheet_AW_40
 - 7 N29-40-FoundLoads-01
 - 8 N29-225kW-Foundation-analysis-data-02
 - 9 N29-225kW-Noise-Meas-Svallerup(DK)
- Attachment 3 – Destruction Bay wind project options and Cost Assumptions
- Attachment 4 – Northwind 100 wind turbine purchase cost
- Attachment 5 – Aeronautica 225 purchase cost
- Attachment 6 – Shipping costs
- Attachment 7 – Import information
- Attachment 8 – Crane costs
- Attachment 9 – Installation, commissioning, & travel
- Attachment 10 – Training costs
- Attachment 11 – Northwind 100 wind turbine O&M costs
- Attachment 12 – Calculation of diesel displaced 45kW and 75 kW min diesel
- Attachment 13 – LE Projects LCOE Economic models
- Attachment 14 – Wind project GHG reductions
- Attachment 15 – Funding source material

Attachment 1

1 2010-07-28 Northwind 100 wind turbine purchase cost.xls

Destruction Bay Wind Study		
Norhtwind® 100 Arctic wind turbine purchase cost		
Component description	Cost \$US	Cost \$CDN
Norhtwind® 100 Arctic wind turbine, 21 meter rotor	\$347,500	\$364,875
37 meter tubular tower, included in price		
FAA Light L810 Obstruction lighting kit	\$2,500	\$2,625
Anchor bolt template ring	\$3,900	\$4,095
Anchor bolt Embment ring	\$4,900	\$5,145
Total cost	\$358,800	\$376,740
Assumed exchange rate \$CDN = \$US X 1.05		

John Maissan

From: Narwid, David [dnarwid@northernpower.com]
Sent: Monday, July 26, 2010 2:22 PM
To: John Maissan
Subject: RE: NorthWind 100 Arctic

Importance: High

John,

Hope you had a nice weekend.

I am following up from our call last week and to provide you with the information that you will need to prepare a pre-feasibility for the project mentioned.

See below my answers or comments.

From: John Maissan [mailto:john@leprojects.com]
Sent: Friday, July 23, 2010 1:16 PM
To: Narwid, David
Subject: NorthWind 100 Arctic

Hi David,

Thanks for the helpful telephone conversation a short while ago. Dr. JP Pinard PhD, P.Eng., a consulting engineer, and I have been retained by The Yukon Electrical Company Ltd. (a regulated power utility in Yukon) which provides diesel power generation and distribution services to isolated communities in Yukon to prepare a pre-feasibility study for a wind project in an isolated community in Yukon. There has been a 2 year wind resource assessment completed (late 1990s) and several related studies on a possible wind-diesel project have been completed so we are starting from a strong information base. The community is Destruction Bay / Burwash Landing on the Alaska Highway – or Alcan Highway – about 265km or 164 miles NW of Whitehorse and has an average load of about 200kW (range from 150 to 250kW). My responsibilities in this project are updating the capital and operating cost estimates for four project options (ranging from low to high penetration) which could involve from 1 up to 4 turbines.

As per our conversation below is a list of the information that I am looking for regarding the four different options that we are examining:

1. Budget purchase prices for 1, 2, 3, or 4 NorthWind 100 Arctic turbines with 37 meter towers (also black ice-phobic coated blades, operation to -40°C, heated cabinets, and heated wind control instruments); See attached Purchase and Sales Agreement (PSA) for pricing information. Use the NW100 Arctic pricing in Exhibit A.
2. Budget price for most cost effective transport option (truck or train-truck?) for each of the four options;
It is difficult to get pricing for transportation as the pricing will fluctuate depending on demand for services, time of year it is to be shipped and method of transportation. Generally our development partners handle this arrangement in very remote areas such as AK. Here is a link to a document that lists the shipping sizes and weights of the turbine where you can independently get quotes for shipping:

https://na5.salesforce.com/sfc/p/700000009Whdfc9f1W_RHfSM2oNdYWvvpZ_kxAl=

3. **Budget price for 5 year service contract for each of the four project configurations;** See attached PSA for pricing information. An estimate is \$16,800 per turbine plus travel expenses.
4. **Budget prices for Installation, installation supervision, and commissioning for each of the four options;** Very difficult to provide as there are too many variables for this type of project plus Northern Power does not install turbine, but rather our partners do. The installation supervision and commissioning fees are in the PSA that is attached. A turnkey installation in the lower 48 runs \$500-600K and our experience with AK installations can run \$800K to 1million for a total installed cost.
5. **Design parameters for foundations and if possible a conceptual concrete foundation design for the 37 meter tower (assuming no bedrock and no permafrost);** We do not have a common design for a foundation as they are all derived once a geotech analysis has been completed. I am including a link to an application requirements document that you can use to help figure out a foundation, but it really is designed specific to the project. The document does include the loads.

https://na5.salesforce.com/sfc/p/700000009WhdM_VvqGuq54DSXDTEwr7O5iyj8IkA=

6. **Minimum crane lift requirements (minimum hook height, and likely radius for heaviest lift);** See document referenced in item 2
7. **Smart View options and budget costs (and installation costs?);** See attached PSA for pricing
8. **Training options and costs were obtained from your website;** Completed
9. **Comprehensive lists of NPS supplied services included in above pricing and owner responsibilities;** and Northern Power only provides the equipment, commissioning services and installation support (on the first two installations after you have gone through installation training at Northern Power) Your organization will be responsible for the engineering and the installation.
10. **Any other options or recommendations for products or services that may be required and are not listed above.** The Applications Requirements document shows all the requirements for the electrical, structural and communication aspects of the installation. For example- there would need to be a dedicated transformer for each turbine.

One additional document you may find useful is the Smartview RTU Application Requirements:

<https://na5.salesforce.com/sfc/p/700000009Whdny1yLir4J6.3PcqDt4FfxYk9LOY=>

We can refer you to our installation partners who you can hire out for assistance if needed.

Let me know if you have any questions.

Regards,

David

Thank you for your assistance David, it is much appreciated.

Regards,

John Maissan

John F. Maissan, P.Eng.
Leading Edge Projects Inc.
219 Falcon Drive
Whitehorse, Yukon
Y1A 0A2 Canada
P: +1 (867) 668-3535
F: +1 (867) 668-3533
E: john@leprojects.com

John Maissan

From: Axworthy, Alan [aaxworthy@northernpower.com]
Sent: Tuesday, July 27, 2010 2:27 PM
To: john@leprojects.com
Cc: David Narwid
Subject: Re: Northwind 100

Hi, John. Our controllers are not absolutely required for any situation. There are a number of ways of dealing with excess wind production; dispatch control and secondary loads are a couple. Regardless of the approach you choose, you'll need to have someone design the overall system to behave gracefully in all loading scenarios. The low-, medium-, and high-penetration labels don't really do much beyond convey how much attention you need to pay to excess production from the wind turbine. In general, low penetration doesn't require anything special beyond what the turbine & diesel plant controllers normally do. Medium requires something to use to absorb a bit of excess wind energy. High generally requires significant energy storage.

I hope this helps. Good luck with your project development efforts.

Alan
-H-

On Jul 27, 2010, at 1:46 PM, "Narwid, David" <dnarwid@northernpower.com> wrote:

John,

I will refer your question on the load controllers to Alan Axworthy, one of our application engineers whom I have cc'd on this message. Alan is traveling and it may take him a day or two to respond

As for your other questions.

CONUS= Continental US
OCONUS= Outside Continental US.

Regards,

David

From: John Maissan [mailto:john@leprojects.com]
Sent: Tuesday, July 27, 2010 11:42 AM
To: Narwid, David
Subject: Northwind 100

Hi David,

Thanks for the Sales Agreement. I have been going through all the documents that you have provided and have a couple of preliminary questions.

Could you explain under what circumstances in wind-diesel systems a dispatch load controller would be used and under what circumstances a secondary load controller would be used? In particular I am wondering whether the dispatch load controller would be required in a low penetration application whether it is only required in medium penetration applications. Am I correct in thinking that the secondary load dispatch controller would be used only in high penetration situations?

What are "CONUS" and "OCONUS"?

Thanks!

John

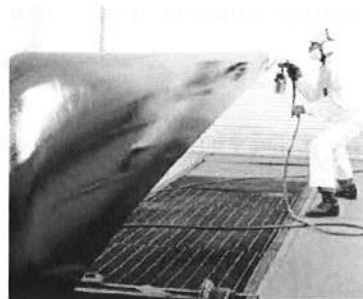
John F. Maissan, P.Eng.

Leading Edge Projects Inc.

P: +1 (867) 668-3535

F: +1 (867) 668-3533

E: johnm@leprojects.com



Northwind[®] 100 ARCTIC

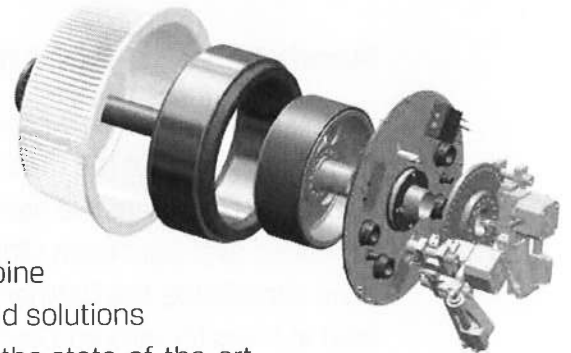
Community Scale Wind Turbine for Cold Climates



Direct.

To Cold Climates Everywhere.

Wind power has been in use around the world for decades. Even so, the mainstream technology used in most wind turbines today is not always the best fit for specialized environments. Arctic conditions where temperatures reach below -20°C (-4°F) and ice buildup is common, can negatively impact wind turbine operations. Demanding environments require specialized solutions and that is why Northern Power Systems has designed the state-of-the-art Northwind 100 Arctic Turbine.



Public Schools • Small Businesses • Farms & Dairies • Municipal Buildings

Not all turbines operate well in extreme environments.

The **Northwind** 100 Arctic is designed for them.



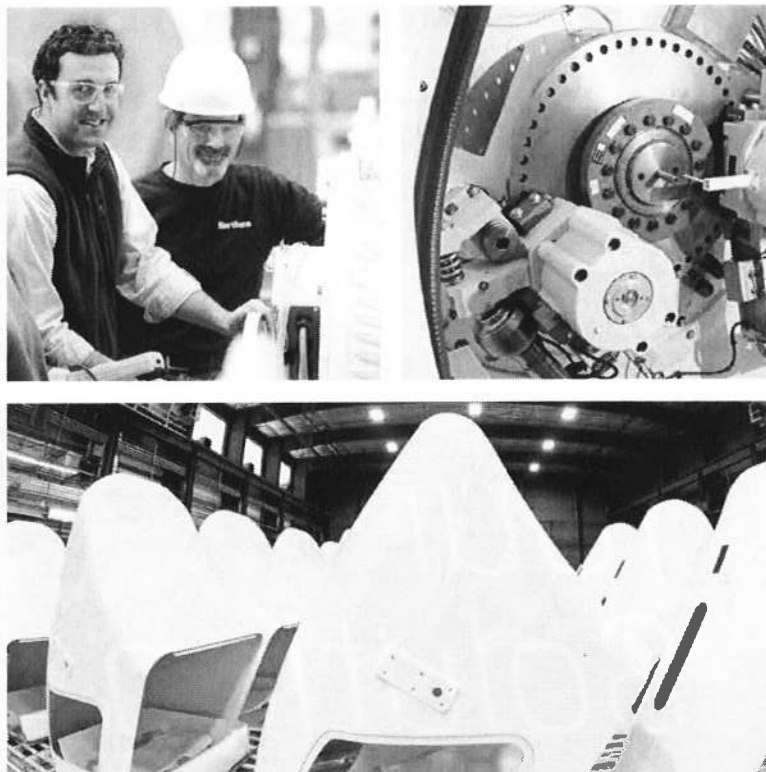
Superior by design—Proven through experience

Northern Power Systems knows extreme environments. Our early HR3 turbine model has survived 198 mph winds and -60° C temperatures in Antarctica and still continues to operate. We have shipped more than 20 turbines into Alaska and have produced over 3.8 million kilowatt hours to date. Based on over 30 years of proven wind experience, the Northern team has created an arctic turbine model that is truly best in class for cold and icy environments.

The Northwind 100 Arctic turbine shares a number of the advanced design elements that make Northern's standard Northwind 100 the ideal turbine choice in mainstream markets. Additional features and design enhancements in this specialized model ensure optimum performance for your wind project no matter the frigid conditions—so that you can achieve your renewable energy goals whether you are located in the tundra or the Alps.

Greenhouses • Universities • Corporations • Hotels & Resorts • Libraries

Our Design



The right technology: Permanent Magnet Direct Drive (PMDD)

Northern's PMDD technology is designed for superior performance in all environments, but it also forms the basis of our superior performance in Arctic conditions.

>> **Low maintenance:** Our PMDD technology and simple design architecture are why the Northwind 100 Arctic requires only minimal preventative maintenance—once per year. In this way you can set your maintenance schedule to avoid particularly harsh seasons. Additionally, the gearless technology bypasses much of the long-term maintenance issues that are associated with the more conventionally designed gearbox turbines.

>> **Better energy capture:** All turbines can make more power in cold environments, but Northern has developed an advanced design and control system that takes advantage of the high air densities associated with very cold temperatures.

The Right Options

Aside from the obvious benefits of choosing a turbine that has been optimized to operate specifically for your cold weather region, we also offer remote monitoring and wind diesel options.

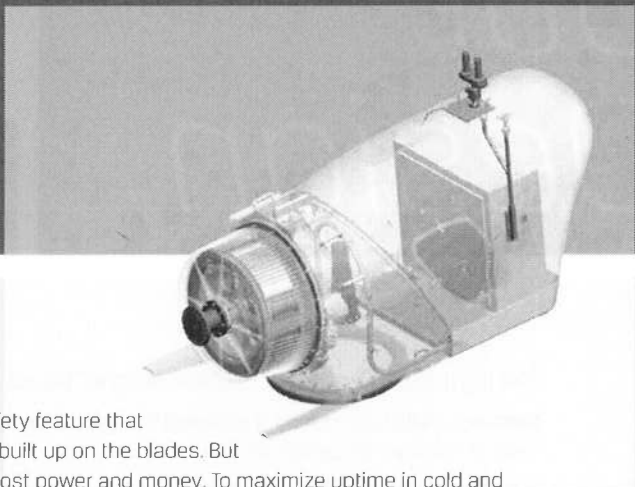
>> **SmartView Products:** our web based monitoring and reporting platform supports a range of options—from reporting, supervisory controls, and turbine monitoring from your PC to remote diagnostics services from Northern Power Systems—to ensure optimum turbine performance and avoiding unnecessary service calls.

>> **Wind Diesel:** our state-of-the-art turbine combined with our advanced control systems and years of expertise allow for the seamless integration into your diesel grid, enabling utilities to save fuel, cut emissions, and reduce diesel maintenance.

Malls • Island Communities • Ski Resorts • Churches • Town Offices • Rural Utilities



Your Solution



Customized blades for icy conditions

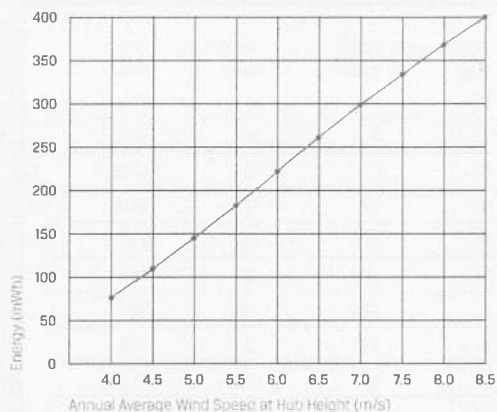
Like most other turbines, the Northwind 100 Arctic has a safety feature that automatically shuts the turbine off when too much ice has built up on the blades. But each moment that turbines are not operating translates to lost power and money. To maximize uptime in cold and icy environments, our blades come with a specially formulated **hydro phobic polymer coating** ensuring a **smooth surface** so ice cannot easily build up on the blades. If ice does form, our **black blades** absorb the sun's heat and allow for ice to be shed easily.

Advanced turbine design for arctic conditions: Ensuring reliability and accessibility

- » **Blades:** Fiberglass reinforced and unique aerodynamic design
- » **Controls:** Air density compensation enables maximum energy capture in cold environments
- » **Materials:** Low temperature castings ensure safe operation of the turbine to -40° C
- » **Tubular Tower & Enclosed Heated Nacelle:** Maintenance and service personnel are protected from uncomfortable and often dangerous conditions
- » **Heating:** Power converter and controls cabinet are heated to maximize operation, expanding possible operating temperatures

Manufacturing Facilities • Remote Villages • Hospitals • Sports Facilities

Annual Energy Production: 21-Meter Rotor Standard Air Density, Rayleigh Wind Speed Distribution



Specifications

Model	Northwind 100 ARCTIC
Design Class	Class S (air density 1.34 kg/m ³ , average annual wind below 8.3 m/s, 50-yr peak gust below 56 m/s)
Design Life	20 years
Hub Height	37 m (121 ft)
Rotor Diameter	21 m (69 ft)
Rated Electrical Power	100 kW, 3 Phase, 480 VAC, 60 Hz
Cut-In Wind Speed	3.5 m/s (7.8 mph)
Gearbox Type	No gearbox (direct drive)
Generator Type	Permanent magnet, passively cooled
Apparent Noise Level	55 dBA at 85m (278 ft)

For more detailed information, see the Northwind 100 ARCTIC Specifications Sheet.
All specifications subject to change without notice.



Northern POWER SYSTEMS

29 Pitman Road, Barre, VT 05641
1 877 90 NORTH +01 802 461 2955

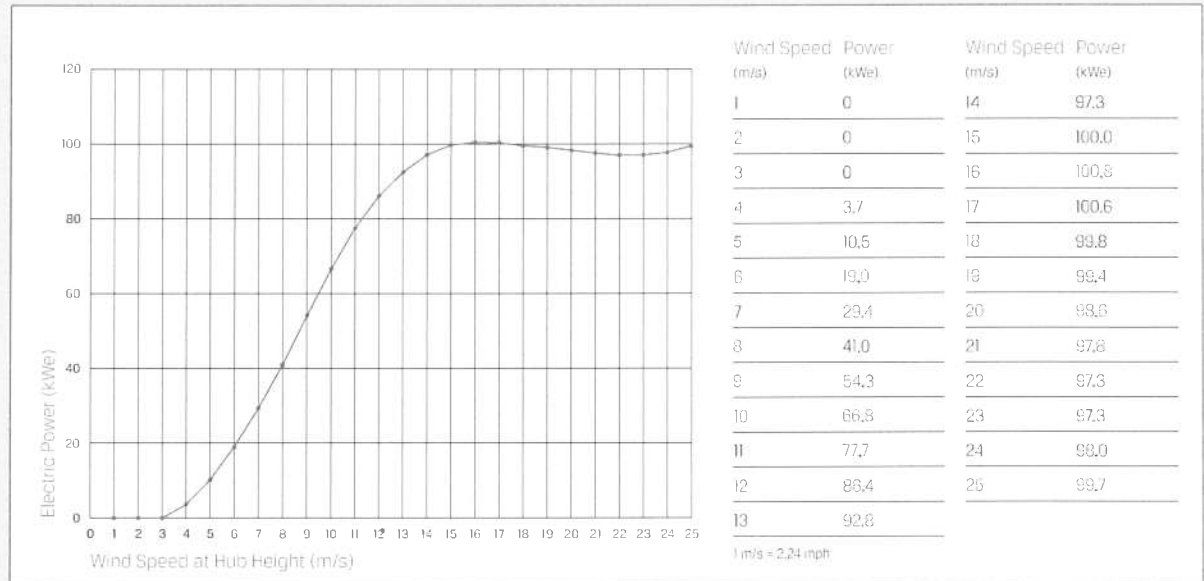
WWW.NORTHERNPOWER.COM

Northern Power Systems has over 30 years of experience in developing advanced, innovative wind turbines. The company's next generation wind turbine technology is based on a vastly simplified architecture that utilizes a unique combination of permanent magnet generators and direct-drive design. This revolutionary new approach delivers higher energy capture, eliminates drive-train noise, and significantly reduces maintenance and downtime costs. Northern Power Systems is a fully integrated company that designs, manufactures, and sells wind turbines into the global marketplace from its headquarters in Vermont, USA.

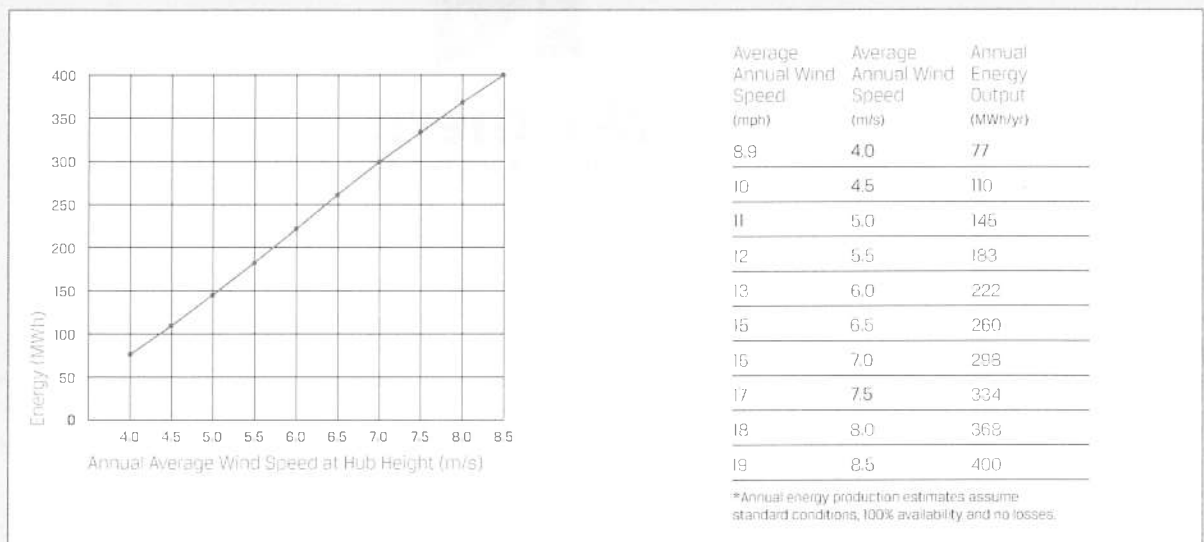
Specifications

Northwind[®] 100 ARCTIC

Power Curve: 21-Meter Rotor Standard Air Density (1.225 kg/m³)



Annual Energy Production*: 21-Meter Rotor Standard Air Density, Rayleigh Wind Speed Distribution



Specifications

GENERAL CONFIGURATION	DESCRIPTION
Model	Northwind 100 ARCTIC
Design Class	Class S (air density 1.34 kg/m ³ , average annual wind below 8.3 m/s, 50-yr peak gust below 56 m/s)
Design Life	20 years
Hub Height	37 m (121 ft) / 30 m (98 ft)
Tower Type	Tubular steel monopole
Orientation	Upwind
Rotor Diameter	21 m (69 ft)
Power Regulation	Variable speed, stall control
PERFORMANCE	DESCRIPTION (based on annual average air density of 1.34 kg/m ³ , equivalent to -10°C (14°F) at sea level)
Rated Electrical Power	100 kW, 3 Phase, 480 VAC, 60 Hz
Rated Wind Speed	14.5 m/s (32.4 mph)
Maximum Rotation Speed	59 rpm
Cut-In Wind Speed	3.5 m/s (7.8 mph)
Cut-Out Wind Speed	25 m/s (56 mph)
Extreme Wind Speed	56 m/s (125 mph)
WEIGHT	DESCRIPTION
Rotor (21-meter)	1,400 kg (3,100 lbs)
Nacelle (standard)	5,800 kg (13,000 lbs)
Tower (37-meter)	13,800 kg (30,000 lbs)
DRIVE TRAIN	DESCRIPTION
Gearbox Type	No gearbox (direct drive)
Generator Type	Permanent magnet, passively cooled
BRAKING SYSTEM	DESCRIPTION
Service Brake Type	Two motor-controlled calipers
Normal Shutdown Brake	Generator dynamic brake and two motor-controlled calipers
Emergency Shutdown Brake	Generator dynamic brake and two spring-applied calipers
YAW SYSTEM	DESCRIPTION
Controls	Active, electromechanically driven with wind direction/speed sensors and automatic cable unwind
CONTROL/ELECTRICAL SYSTEM	DESCRIPTION
Controller Type	DSP-based multiprocessor embedded platform
Converter Type	Pulse-width modulated IGBT frequency converter
Monitoring System	SmartView Remote Monitoring System, ModBus TCP over Ethernet
Power Factor	Set point adjustable between 0.9 lagging and 0.9 leading
Reactive Power	+/- 45 kVAR
NOISE	DESCRIPTION
Apparent Noise Level	Less than 55 dBA at the base of the tower
ENVIRONMENTAL SPECIFICATIONS	DESCRIPTION
Temperature Range: Operational	-40°C to 50°C (-40°F to 122°F)
Temperature Range: Storage	-40°C to 55°C (-40°F to 131°F)
IP Class: Generator/Nacelle	IP55/IP54
Lightning Protection	Receptors in blades, nacelle lightning rod and electrical surge protection
Icing Protection	Turbine designed in accordance with Germanischer Lloyd Wind Guidelines Edition 2003
Blades	Treated with black hydrophobic polymer coating to minimize icing

All Specifications subject to change without notice.

SS-090901-02





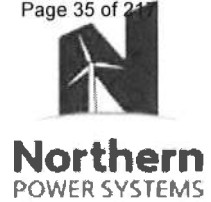
Northern
POWER SYSTEMS

SmartView RTU Application Requirements

A01131 A

Northern Power
29 Pitman Road
Barre, VT 05641 USA
1-877-90-NORTH

www.northernpower.com



Approved Use

Public	
NDA Required	X
Internal Use Only	

Revision History

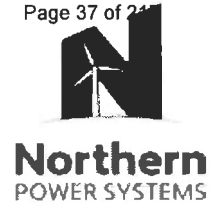
Revision	Release State	Date	Description of Change
A	For Customer Use	2009-09-03	Document created, based partially on H00181 SmartView Network and Internet Options.



Northern
POWER SYSTEMS

Contents

1	Introduction.....	4
2	Definitions	4
3	Environment.....	4
4	Networking	5
4.1	Local Area Network Options	5
4.1.1	Fiber Optic	5
4.1.2	100BASE-TX.....	6
4.2	Internet Options.....	6
4.2.1	Existing LAN with Internet Access	7
4.2.2	DSL or Cable	7
4.2.3	Cellular Wireless	8
4.2.4	Satellite	8
4.3	Networking Questionnaire.....	8
5	Administration & Configuration.....	9



1 Introduction

The purpose of this document is to provide an overview of how to provide a functional environment for a SmartView RTU at a Northwind site.

This document contains recommendations and assumes the reader has sufficient experience to properly interpret and implement them. Please refer to industry best practices when planning an installation.

Please refer to Northern document R01129 SmartView RTU Specifications.

Please refer to all relevant standards.

2 Definitions

RTU	Remote Terminal Unit: A computer that resides at the site, acquires data from the turbine, buffers it, and transmits it to Northern Power. Also permits Northern technicians to remotely administrate turbine.
SCB	System Control Board: The brain of the turbine. Responsible for all control and some safety functions.
SmartView	A monitoring system consisting of the RTU, the SmartView web server at Northern Power, and the HMI.
HMI	Human Machine Interface: An application that permits a human to monitor and control a machine, in this case a wind turbine.
100BASE-TX	The most common type of 100Mbps Ethernet. Uses twisted pair copper cable, shielded or unshielded, of category 5 or higher quality. Uses 8P8C (aka RJ-45) connectors.

3 Environment

The RTU is a consumer grade PC. It must be installed in a protected, controlled environment. In hot climates this typically means an air conditioned enclosure, and in a cold climate a heated enclosure. Please refer to the RTU specifications for exact environmental limits.

The RTU also acts as a user interface to the turbine. It should usually be installed in a location that is convenient for technicians and operators who may need to monitor or control turbine operation.

4 Networking

4.1 Local Area Network Options

In order for SmartView® Monitoring System to monitor a Northwind® turbine, both the turbine and the SmartView RTU (computer) must be connected to an Ethernet network. Both the turbine and RTU feature 100BASE-TX Ethernet interfaces. Although theoretically any network which can carry TCP/IP packets may be used to connect them, it's strongly recommended to use Ethernet; it's ubiquitous and reliable.

When planning a site network, it's important to consider are how many turbines are being installed, what are the distances between the turbines and the network to which they are connecting, and is it practical to run cable either below ground or on poles.

Northern recommends customers use a qualified computer network engineer to plan and oversee the installation of their site network. A qualified network engineer should at a minimum be familiar with Ethernet, both over fiber and copper cable, TCP/IP, and associated technologies. They should be able to design the network and troubleshoot issues during commissioning.

4.1.1 Fiber Optic

Optical fiber is the preferred option. It is reliable and provides inherent electrical isolation. It is resistant to electromagnetic pulses and power surges from lightning and other causes. It is also resistant to electromagnetic interference (noise). The turbine has spare 100BASE-TX jacks, but no spare fiber jacks. To use fiber cable, the customer must install a media converter in the down-tower junction box connected to the existing 100BASE-TX switch using a short patch cable. The RTU also does not feature a fiber optic port, and so a media converter must also be installed near the RTU. Ethernet switches with internal media converters may also be used.

Northern recommends using a standard form of Ethernet over optical fiber, such as 100BASE-FX, 100BASE-SX, or 100BASE-BX. Specification limitations on length and other factors must be observed.

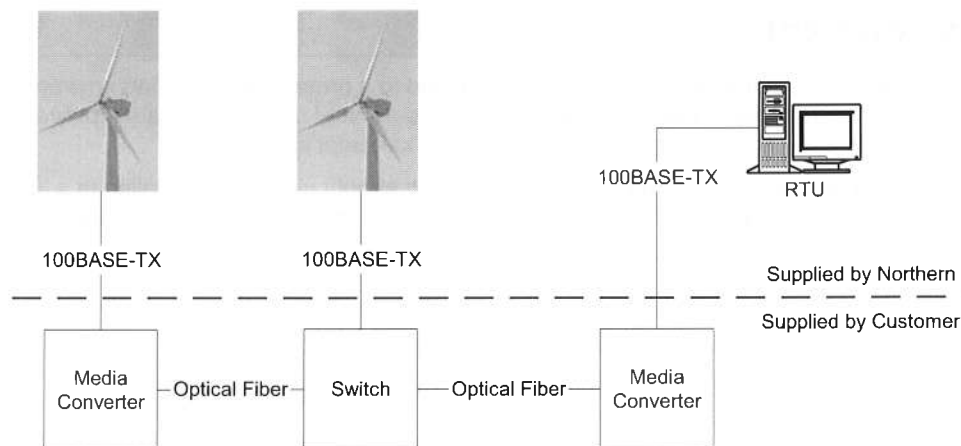


Figure 4-1 Fiber network

4.1.2 100BASE-TX

Twisted pair copper cable meeting the 100BASE-TX specification may be used. Northern recommends shielded Category 5e or better. It is appropriate for a site with a single turbine located within 100 meters of the nearest network switch. This is usually the option with the lowest initial cost.

The turbine comes with a 100BASE-TX switch with at least one spare port in the junction box at base of turbine.

Note: This option is **not** recommended for sites which experience frequent lightning strikes.

Warning: Ethernet rated surge suppressors must be fitted in-line with the cable at both the tower and building entrance. Surge suppressors must be connected to a good earth ground, e.g. a ground rod or the grounding bar inside the tower.

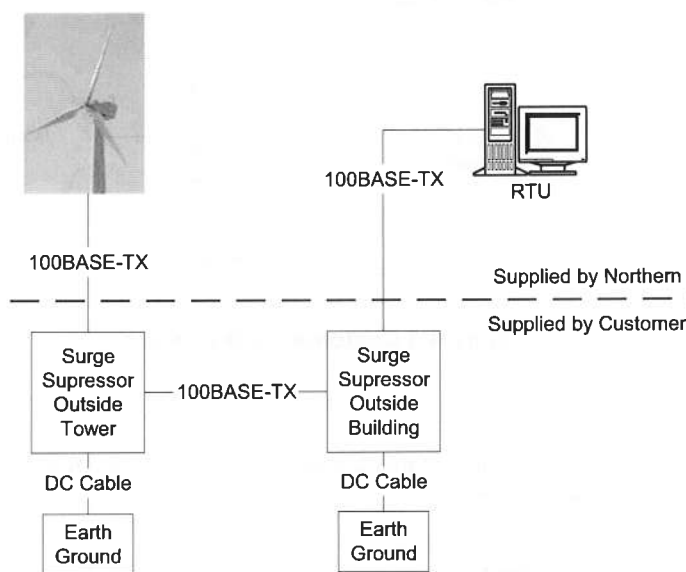


Figure 4-2 Copper network

4.2 Internet Options

As a part of the Northwind warranty terms, Northern requires the ability to remotely monitor the turbine over the Internet via SmartView. The RTU must have internet access for this reason.

Northern requires the RTU to be accessible from the Internet via a static public IP address or host name. If necessary, Northern can use a service such as DynDNS to establish a static host name for a dynamic IP address.

Northern requires the ability to make inbound connections on port 3307 to the RTU. This may require a port forwarding rule to be configured in the customer's router or firewall.

Northern requires that the RTU be unrestricted in its ability to make outgoing connections to other Internet hosts.

Northern recommends that the customer place both the RTU and the turbine behind a firewall. The turbine should be completely blocked from the outside. The RTU should be blocked except for TCP port 3307.

In general terms the RTU requires broadband Internet.

Internet access is provided by the customer. There are several options.

4.2.1 Existing LAN with Internet Access

If the customer already has a network with Internet service, the most effective option is to connect the RTU to the existing network. The customer should coordinate attachment of the turbine and RTU to the LAN with the customer's IT department.

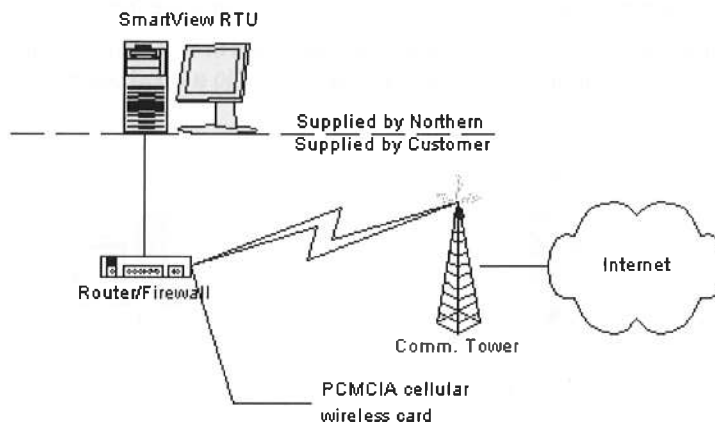


Figure 4-3 Customer LAN Internet

4.2.2 DSL or Cable

Cable modem and DSL type Internet access are widely available and inexpensive. This is a good option for sites without an existing network.

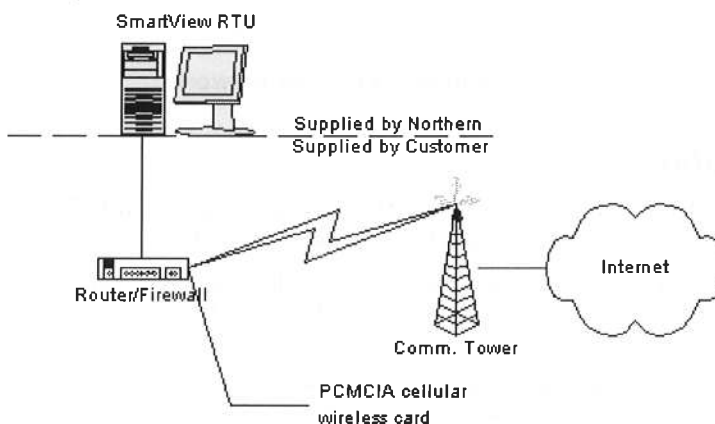


Figure 4-4 DSL or Cable Internet

4.2.3 Cellular Wireless

Broadband cellular wireless is widely available in most locations at reasonable prices and can avoid the expense of long distance cable runs. It usually features data transfer restrictions.

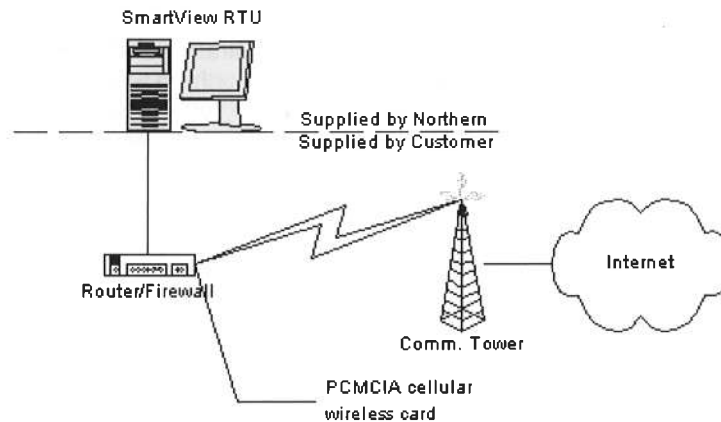


Figure 4-5 Cellular wireless Internet

4.2.4 Satellite

Satellite is Northern's least preferred option. It has higher cost, higher latency, and lower bandwidth. However it is the only option available in some areas. Satellite usually requires a clear view of the southern sky. In high latitudes, a larger dish may be required to achieve the necessary signal strength. There may be data bandwidth or transfer caps with different levels of service.

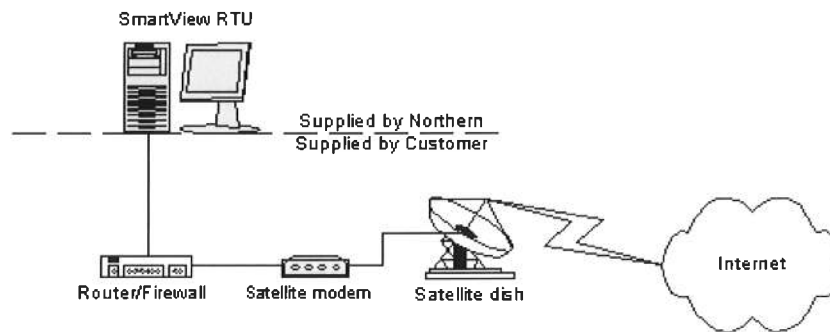


Figure 4-6 Satellite Internet

4.3 Networking Questionnaire

All customers are required to submit to Northern Power a written site network plan, describing how data will move from the SCB to the RTU, and from the RTU over the internet to the SmartView server. Please refer to H01171 SmartView RTU Network Questionnaire for details.

**Northern**
POWER SYSTEMS

5 Administration & Configuration

The RTU is a special purpose appliance, not a general purpose PC. Northern Power Systems maintains ultimate authority over RTU administration for as long as it is providing remote monitoring services.

The customer is not to install any software on the RTU or change RTU configuration in any way without receiving authorization from Northern (e.g. changing the time zone from UTC to local time).

Northern Power uses a remote desktop system to administrate the RTU. Please do not be surprised to find a Northern technician remotely controlling the RTU. Northern typically uses the LogMeIn.com service which tunnels a VNC connection over a reverse proxy to a LogMeIn bastion host. This usually enables Northern to connect to the PC without requiring the customer to make any changes to their firewall.



Northern
POWER SYSTEMS

Northwind® 100 Wind Turbine 21 Meter Rotor, 37 Meter Tower Application Requirements

Document A00298

December 2009

Revision History

Revision	Date	Description of Change
A	1/13/09	Release for customer use
B	6/18/2009	Release for customer use, electrical section revisions
C	12/30/09	Release for customer use, certification revisions, ECR-080



Contents

1	Introduction.....	3
2	Reference Documents	3
3	Environmental Requirements	3
4	Electrical Specifications and Requirements	4
4.1	Section Overview	4
4.2	Electrical Requirements	4
4.2.1	Grid Requirements.....	4
4.2.2	Transformer Requirements.....	4
4.2.3	Transformer Impedance Requirements.....	5
4.2.4	Transformer Winding Requirements.....	5
4.2.5	Interconnect Feeder.....	5
4.2.6	Disconnect Requirements.....	6
4.2.7	Grounding Requirements.....	6
4.2.8	Conduit Requirements	8
5	Control and Monitoring Requirements	9
5.1	Section Overview	9
5.2	Control Interface.....	9
5.2.1	Monitoring System.....	9
5.2.2	Turbine Network Interface Specifications	10
5.2.3	Network Time Service.....	10
6	Foundation Specifications and Requirements.....	11
6.1	Section Overview	11
6.2	Foundation Types.....	11
6.3	Structural Design Requirements	11
6.3.1	Foundation Design Loads.....	11
6.3.2	Stiffness/Frequency	12
6.3.3	Anchor Bolts.....	12
6.3.4	Seismic Considerations	14
6.4	Construction Requirements.....	14
6.4.1	Requirements for All Foundations	14
6.4.2	Requirements Associated with Long (Deep) Anchor Bolts.....	15
A	Appendix: System Design Parameters, Northwind 100/21/37	17
A.1	Turbine Configuration.....	17
A.2	Site Wind Speed Range	17
A.3	Extreme Foundation Loads	17
A.4	Anchor Bolts	17
A.5	Foundation Stiffness.....	18
A.6	Design References.....	18
B	Appendix: Electrical Specifications Examples	19



1 Introduction

This document presents key application requirements for the installation of a Northwind 100 wind turbine. These requirements include (or reference) site environmental parameters, foundation requirements, remote data connection and electrical interconnect requirements.

The customer shall utilize a qualified engineer to design the installation for their turbine(s) according to site-specific data which meets the requirements provided herein. The installation shall be designed and constructed in accordance with any and all applicable codes and regulations.

This document is applicable for the Northwind 100 wind turbine with 50 or 60 Hz power output, 21 meter rotor and 37 meter tower. Specifications for this turbine are listed in the document A01465, Northwind 100 General Specification.

2 Reference Documents

A01465, General Specifications

1001441, Layout, Conduit, 37m Tower Base

1000152, Bolt Ring, Base, 37m Tower (tower base section flange detail)

A00293 Protective Relay Specifications (Protective Relay Option Equipped Only)

J00295 Protective Relay Overview Schematic (Protective Relay Option Equipped Only)

A01131 SmartView RTU Application Requirements

3 Environmental Requirements

Environment specifications and requirements for the Northwind 100 turbine are published in the Northwind100 General Specification document A01465. Installation at a noncompliant site may result in reduced turbine performance and / or lifetime. It is the customer's responsibility to assure that the intended installation site meets turbine specifications and requirements.



4 Electrical Specifications and Requirements

4.1 Section Overview

This section defines the electrical design requirements for the Northwind 100 wind turbine installation. The customer shall design and install the electrical system using qualified engineers, and in accordance with this requirements document, Northwind100 General Specifications document A01465, site conditions, and all codes and regulations applicable to the site.

The Northwind 100 wind turbine scope of supply includes turbine electrical equipment to and including the fused disconnect and junction box located at the bottom of the tower.

4.2 Electrical Requirements

Permitting and determination of locally applicable installation codes and standards shall be determined by the customer. A Northwind 100 installation has specific requirements for grid, transformer, grounding, and conduit.

4.2.1 Grid Requirements

The Northwind 100 must be connected to a three-phase 60 or 50 HZ grid that is regulated to within +/- 5% voltage and not more than 3% voltage imbalance.

Note that there is no specification for grid voltage because a separate interconnection transformer is specified to provide the proper voltage for connection to the fused disconnect at the tower base.

Northwind 100 turbines are typically connected in two basic configurations:

- To utility medium voltage (MV) distribution feeders, typically at over 1000 volts.
- To the distribution system of a new or existing low voltage facility, typically under 600 volts.

At all times there shall be an isolation transformer. The interconnection must be reviewed by the customer to determine that the grid or facility has the capacity to receive the full power output of the turbine.

4.2.2 Transformer Requirements

Each Northwind 100 must have a dedicated interconnect/isolation transformer with the following specifications. This transformer is required for the turbine to meet IEEE519 and UL1741 standards. This transformer is required even if connecting to a distribution system matching its 480V output voltage. The transformer must have isolated primary and secondary windings. An autotransformer is not acceptable.

Table 1 Interconnection Transformer Requirements

Apparent Power Rating	112.5 kVA
Low-Voltage Winding	480 VAC, Grounded Wye
High-Voltage Winding	(Determined by customer)
Impedance	See 4.2.3



Efficiency	NEMA TP-1 or greater
Voltage Adjustment Taps	+2 -2 each individual tap, approximately 2.5%

4.2.3 Transformer Impedance Requirements

The Northwind 100 operates over a wide range of interconnect impedances (the interconnect impedance being the impedance between the Northwind 100 output contactor and the grid source). In order for the power electronics to function properly, the acceptable range is:

Minimum Impedance = $0.025 + j0.075$ ohms

Maximum Impedance = $0.15 + j0.38$ ohms

In a medium voltage utility distribution (infinite primary model), the interconnect impedance is dominated by the isolation transformer. If utility grid impedance is neglected, an isolation transformer of 3.5% at 112.5KVA is required to satisfy minimum impedance requirements. In the case of a low voltage interconnect (i.e. high interconnect impedance) one should select an isolation transformer with less than 4% Z (impedance). It is the responsibility of the customer's electrical system designer to verify the interconnect impedance and to specify the appropriate transformer

4.2.4 Transformer Winding Requirements

The turbine-side connection of the isolation transformer is required to be grounded wye. The grid-side connection can be either wye or delta. This grid-side connection is usually determined by utility requirements or facility requirements based on consideration for ground fault protection, potential ferro-resonance, etc.

The Northwind 100 wind turbine only provides balanced three-phase output current, so the transformer does not need to accommodate current imbalance. This means there is no need to run a neutral conductor. The neutral of the grounded Wye should be bonded to ground within the transformer.

4.2.5 Interconnect Feeder

In Northwind 100 applications which connect to substantial medium-voltage utility distribution, line losses and voltage drop considerations are minimal. Typically the step-up transformer is mounted as close to the turbine as possible (< 5 meters) to keep losses in the 480V connection to a minimum.

Northwind 100 applications connecting to low voltage facility distribution systems require more planning to minimize kW losses and voltage rise. Depending upon interconnect feeder distance, a cost comparison is typically made between running larger conductors at 480V or stepping up to a higher voltage and running smaller wire, but incurring the cost of an additional step-down transformer to connect to the facility. Northern recommends a total line loss in the feeder of less than 1%.

A voltage drop across the entire circuit causes voltage at the output terminals of the turbine to rise as the turbine pushes power into the interconnection. Most utilities require the turbine to trip at 110% voltage (at the utility tie point), so there is a limit to how much voltage rise can be tolerated (typically less than 5% between turbine terminals and the regulated utility source). A voltage rise calculation should be performed at full output and minimal facility consumption to verify that over-voltage tripping will not occur.

Energy (kWh) losses can add up significantly over the lifetime of the installation. The owner of the turbine should make an informed decision on installation cost vs. lifetime cost of the interconnection cables and transformer(s). See Appendix B, Example 1.



4.2.6 Disconnect Requirements

A means of disconnecting all power from the turbine and its control circuits is required between the turbine's last down-tower electrical box and the isolation transformer. This disconnecting means must be:

- Readily accessible from the turbine base
- Externally operable
- Lockable
- Service rated, NEMA/IP rating to match environment in which it is installed.
- Where installed, be compliant with all code regulations.

4.2.7 Grounding Requirements

The turbine installation requires an earth-ground electrode system. An earth-ground electrode system typically is comprised of driven ground rods and buried copper wire in the surrounding soil and/or connection to foundation concrete and steel.

The customer is responsible for the design, installation and connection of/to the earth-ground electrode system in compliance with codes mandated by the local authority having jurisdiction and the following Northern requirements:

- The earth-ground electrode system shall have a resistance value of 5 ohms or less.
- In addition to the grounding requirements of a separately derived system for the isolation transformer, it shall be bonded to the tower earth-ground electrode system using #1/0 AWG copper wire minimum. Exothermic weld is the only acceptable means to accomplish this.
- Ground conductors of ancillary structures shall be bonded to the tower earth-ground electrode system with #1/0 AWG copper wire minimum.
- Tower foundation bolts shall not be used as terminations for ground conductors
- The foundation reinforcing steel and foundation piles (if used) shall be electrically bonded together to serve as or supplement the foundation electrode.
- Two conductors shall be attached using an exothermic welding process to the electrically interconnected reinforcing steel in two separate locations that are on opposite sides of the turbine tower. Each conductor shall be connected to the turbine tower bonding bus. Refer to Figure 1 for connection detail.
- The turbine bonding bus is pre-drilled to accept ground conductors with crimp type or compression lugs and is located at the turbine tower base. Anti-oxidation compound shall be used on these connections.
- Ground conductors used for attachment to the earth-ground electrode system shall be protected with a plastic sleeve, conduit, or insulation to provide corrosion/physical protection where conductors enter or exit the concrete floor of the tower interior. All conduit ends above grade shall be terminated with a bushing.
- If ground conductors are to be routed through metallic conduit, the conductors shall be electrically bonded to the conduit at both ends.



Northern
POWER SYSTEMS

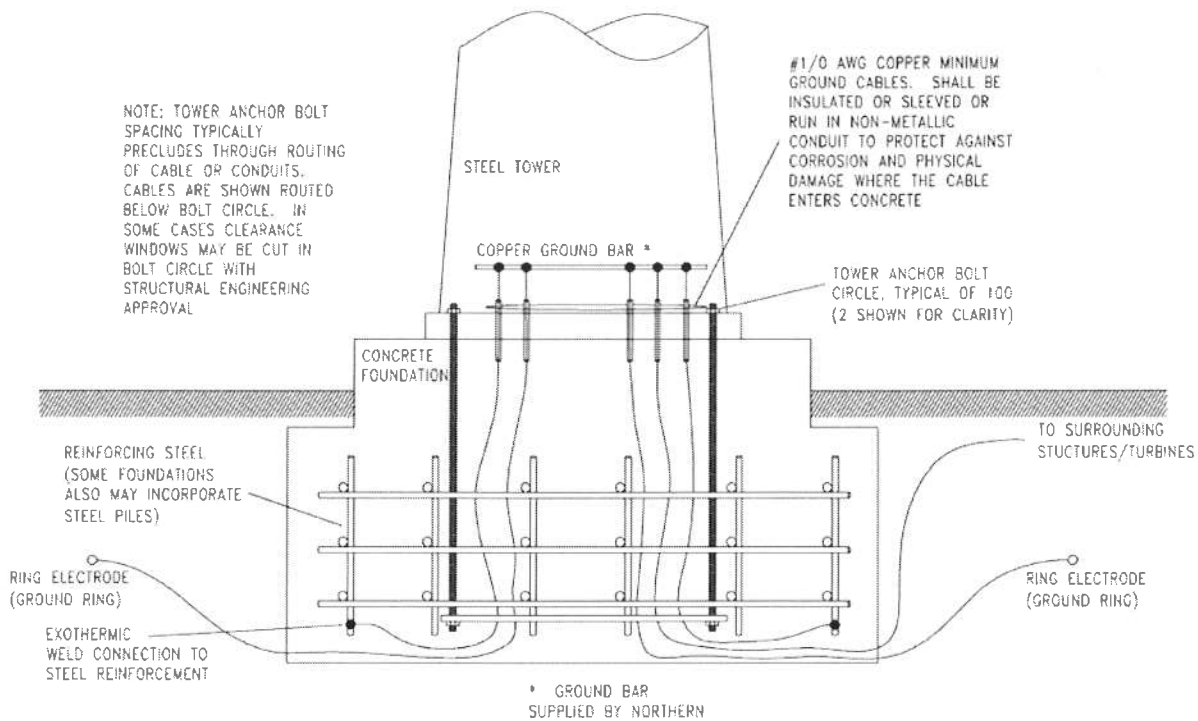


Figure 1 Grounding Detail Example

For low-impedance earth electrode systems, Northern recommends:

- A ring earth electrode encircling the foundation, in addition to the electrode system formed by foundation reinforcing steel.

When designing and installing the earth electrode system, Northern recommends the following references:

- IEC 62305 (Protection Against Lightning)
- Germanischer Lloyd Guideline for the Certification of Wind Turbines
- MIL-HDBK 419, Grounding, Bonding and Shielding for Electronic Equipment and Facilities
- IEEE 141-1993 (Red Book)
- IEEE 142-2007 (Green Book)
- NFPA 780 art 3 (Standard for Installation of Lightning Protection Systems)
- NFPA 70 art 250 (Grounding and Bonding)
- Motorola R-56, "Standards and Guidelines for Communications Sites"



4.2.8 Conduit Requirements

Conduit recommendations are summarized in Table 3. When interpreting the location references, note that the tower door is located at 6 o'clock, and the turbine grounding bus is located at 10:30 o'clock (as viewed from above). Locate conduits at least 100mm (4") away from the tower flange to provide clearance for grout and bonding bus. Customer is responsible for all final decisions regarding conduit size, quantity and layout. Refer to drawing 1001441 specific requirements..

Table 2 Recommended Conduit Schedule

Conduit Trade Size	Quantity	Location	Usage
4"	See 1001441	See 1001441 Drawing	Power cables
2"	See 1001441	See 1001441 Drawing	Communications
Customer Spec	Customer Spec	opposite sides	Ground wire protection



5 Control and Monitoring Requirements

5.1 Section Overview

This section defines the control and remote data interconnect requirements for the Northwind 100 wind turbine.

5.2 Control Interface

The Northwind 100 includes a fully automatic control system that safely operates the turbine to maximize energy capture in all operating conditions. The controller is housed in the power controller cabinet in the nacelle, with a communication interface in the junction box at the base of the tower. The customer permissive input requires a customer-supplied dry contact closure for the turbine to operate.

Table 3: Controller Specification

Network Interface	Internal static IP address required* External access shall be blocked by customer firewall
Customer Permissive equivalent circuit	24 Vdc relay coil with 2A fused 24 Vdc power

* A static IP address for the turbine needs to be established as soon after purchase as possible.

5.2.1 Monitoring System

The Northwind 100 comes equipped with Northern's SmartView Monitoring System, which provides a data logging and diagnostic interface required to provide remote support for the Northwind 100. It also provides a web-based human-machine interface (HMI) that can be accessed by any authorized person from anywhere in the Internet. The SmartView Monitoring System includes a computer to be installed at or near the site of the turbine, referred to as the Remote Terminal Unit (RTU).

The customer is responsible for providing a protected environment for the RTU, and for providing an Ethernet communication network. The customer is also responsible for providing Internet access to the RTU throughout the warranty period.

One SmartView Monitoring System will be provided for each site. If a site contains multiple Northwind 100 turbines, only one monitoring system will be provided that will monitor all turbines.

Table 4: Desktop Remote Terminal Unit Specifications

Model	Desktop computer, including LCD monitor, keyboard and mouse
Typical Case Dimensions (H x W x D)	44.7cm x 17.1cm x 46.8cm (17.6" x 6.8" x 18.4")
Typical Weight	17.7 kg (39 lbs)
Typical Input Power	120/22/ Vac, 250 Watts, 50 or 60 Hz
Network Interface	100baseT, Ethernet, TCP/IP



	Internal static IP address required External access shall be blocked by firewall except access to RTU port 3307 via static IP address or host name required
Required Environment	Indoor environment, 0°C to 40°C (32°F to 104°F)

Please refer to A01131 SmartView RTU Application Requirements and R01129 SmartView RTU Specifications for details regarding the RTU.

5.2.2 Turbine Network Interface Specifications

The Northwind 100 wind turbine includes as standard an Ethernet network switch in the tower base. Its specifications are provided below in Table 5.

Table 5: RJ45 Copper Port Specifications

Port Type	IEEE 802.3 Compliant
Speed & Duplex	10/100 auto-detecting for speed & duplex (full or half)
MDI/MDIX	Auto-mdi/mdix-crossover automatically supports either straight or crossed cables
Polarity	Auto-polarity for automatic correction of crossed TXD and RXD pairs

Northern recommends:

- Fiber optic connection to turbines. For sites with the following conditions, fiber optic connections are strongly recommended:
 - Frequent lightning activity
 - Multiple turbine installations
 - Long distances between turbine and RTU
- Wireless modems or bridges may be used but the following conditions apply:
 - Antenna cables must not require perforating the tower or grout in any way. All cables exiting the turbine should be run in conduit through the foundation.
 - High level security from unauthorized network access is required.
- If Category 5 or 6 cables must be used (not recommended), place surge suppressors on both ends of all cables that leave the tower.

The number and type of connections and the specifications for the different ports are listed in the SmartView RTU Application Requirements document A01131.

5.2.3 Network Time Service

The turbine requires access to the Internet on UDP port 123 so it can reach a network time server and set it's internal clock using the Simple Network Time Protocol.



6 Foundation Specifications and Requirements

6.1 Section Overview

This section defines the foundation design requirements for the Northwind 100 wind turbine. The customer shall design a foundation for their turbine(s) using qualified engineers according to site-specific geotechnical data and the structural requirements in the Appendix which achieve the requirements provided herein. The use of site-specific geotechnical data ensures that the foundation design is optimized for the site's soil conditions. The foundation shall be designed and constructed in accordance with all applicable codes and regulations.

6.2 Foundation Types

There are several types of wind turbine foundations. They include, but are not limited to:

- Concrete spread footing
- Pile footing with concrete pile cap
- Deep concrete/steel mono-pile
- Deep steel freeze-pile

The selection of the right type of foundation for a given site requires knowledge of both soil conditions and the availability of local resources. Concrete spread footings or deep monopiles are typically appropriate and most economical for the majority of sites. Documentation suitable for the purpose of estimating typical spread footings has been assembled in the document W00188 Northwind 100 Logistics and Installation Guidelines.

While not suitable for construction, reference to the Logistics and Installation Guidelines during planning stages should provide the basis for an accurate foundation budget. Final foundation sizes and details shall be derived from the information provided or referenced herein and from geotechnical studies of the project site.

6.3 Structural Design Requirements

In all types of foundations, the base of the tower must be tightly fastened to the top of the foundation. The anchor bolts make this critical connection. The anchor bolts transmit the tower loads into the foundation, and the foundation transmits the loads into the surrounding soil. The foundation must provide adequate resistance to the overturning moment resulting from the lateral loads on the turbine, and in order to prevent settling and subsequent loosening of the foundation, the loads imposed upon the soil by the tower and foundation must not exceed the bearing strength (maximum allowable bearing pressure) of the soil.

The structural design criteria of the foundation are dependent on turbine configuration (e.g. rotor diameter, hub height, tower top mass) and site data (e.g. wind speed, air density). Structural design criteria for available turbine configurations and IEC standard site conditions are provided in Appendix A.

6.3.1 Foundation Design Loads

The foundation loads for the tower may be found in Appendix A. Unless otherwise specified, the loads provided DO NOT include safety factors or load factors. They are the characteristic extreme loads at the base of the tower as calculated during tower design. Appropriate load and/or safety factors are



jurisdiction-dependent and shall be applied to the loads by the foundation engineer. The foundation design loads shall be no less than those resulting from the use of the following partial load factors:

- The partial load factor for loads derived from wind and aerodynamics (F_{xy} , M_{xy} , M_z) shall not be less than 1.35.
- The partial load factor for favorable loads (e.g. dead loads, which are favorable because they increase the overturning resistance) shall not be greater than 0.9.

The foundation engineer shall submit a design summary to Northern Power in which the foundation design safety and/or load factors are explicitly identified.

Where permitted by applicable codes, the provided loads may be scaled down if more accurate site data (e.g. from site studies or code-based wind maps) regarding extreme wind speed (3 second gust; 50 year return) and air density is available. Scaling in this manner may reduce foundation cost. If scaling of the provided loads for site-specific data results in foundation loads greater than those provided (e.g. as could happen at a site with high air density and high wind speed), the site conditions may exceed turbine design limits, and Northern Power must be contacted to re-evaluate the suitability of the turbine configuration for the site.

6.3.2 Stiffness/Frequency

In order to prevent resonance of the tower structure, the foundation must be designed to achieve a turbine system fundamental frequency that is sufficiently distant from the operating speed of the turbine. The corresponding requirements for the minimum lateral (horizontal) stiffness K_{xy} and rotational (overturning) stiffness $K_{\theta,xy}$ of the foundation may be found in Appendix A. There is no maximum stiffness requirement. The lateral stiffness and rotational stiffness shall be calculated by the structural and/or geotechnical engineer and shall be noted on the foundation drawings.

6.3.3 Anchor Bolts

The anchor bolts are to be specified by the foundation engineer. The anchor bolts must be capable of bearing loads greater than or equal to those assumed during tower design. This is achieved through an appropriate combination of fastener size and strength (i.e. grade or class). The fasteners and fastener preload assumed during tower design may be found in the appendices.

The anchor bolts and associated hardware shall be stamped by the manufacturer to demonstrate accordance with the governing standard(s) and shall be accompanied by lot traceability records.

6.3.3.1 Anchor Bolt Pattern

The anchor bolt pattern in the foundation must match the bolt pattern in the flange at the base of the tower. The bolt pattern at the base of the tower may be found in the document identified in the appropriate appendix; note that the tower base flange is an internal flange (bolts inside the tower).

6.3.3.2 Anchor Bolt Selection: Required Size & Length; Implications for Stiffness

The bolts must be sized such that adequate clearance is present between the bolts and the holes of the tower base flange to account for tolerance stack-up and bolt misalignment. Northern Power assumed standard (coarse thread) metric sizes (e.g. M24x3.0, M27x3.0) during tower design. In the United States, where imperial specifications are prevalent, inch-specification fasteners of approximately the same size (e.g. M24→1", M27→1 1/8") may be substituted, when approved by the foundation engineer (considering clearance and fastener strength).

The length of the anchor bolt shall be determined by the foundation engineer. The effective grip length of the anchor bolt must be sufficient to result in a bolt aspect ratio (L/d) greater than or equal to that assumed during tower design. The minimum bolt L/d ratio is provided in Appendix A.



In addition to the bolt-specific requirements, the bolted joint at the foundation-tower interface shall be designed to ensure a sufficiently high ratio of joint axial stiffness to bolt axial stiffness. This is required in order to ensure that the bolt preload assumptions and resultant bolt strength calculations performed during tower design remain valid. The minimum joint/bolt stiffness ratio is provided in Appendix A.

6.3.3.3 Anchor Bolt Selection: Strength (Class/Grade) & Corrosion Resistance

High strength structural/construction fasteners shall be used according to the relevant DIN or ASTM specification. Heavy-hex nuts of the corresponding specification shall be used. Washers shall be structural flat or plate washers with a minimum hardness of 30 HRC (~350 HV). The foundation engineer shall specify an appropriate coating on the fasteners to ensure adequate corrosion resistance; mechanical zinc-plating or hot-dip galvanizing is typical. Examples of acceptable fastener standards are summarized as follows:

DIN Standards

- High Strength Threaded Rod & Studs: DIN 975
- Heavy Hex Structural Bolts: DIN 6914 (EN 14399)
- Heavy Hex Nuts: DIN 6915 (EN 14399)
- Structural Washers: DIN 6916 (EN 14399)¹, DIN 7349

ASTM Standards

- High Strength Threaded Rod & Studs: ASTM A449, ASTM F1554, ASTM A193; ASTM A615 (e.g. Williams-type anchors)
- Heavy Hex Structural Bolts: ASTM A325, ASTM A490
- Heavy Hex Nuts: ASTM A563, ASTM A194
- Structural Washers: ASTM F436

Fastener specifications for low-temperature applications may be substituted as required by the foundation engineer and/or applicable codes.

6.3.3.4 Anchor Bolt Selection: Preload

An appropriate combination of fastener size and strength shall be selected such that the required bolt preload is 75% ($\pm 5\%$) of the minimum yield strength of the fastener, such that fasteners do not exceed their proof load during bolt tightening.

Regardless of the fastener specification, the bolt preload shall fall within the preload range assumed during tower design (see Appendix A for specific limits). The effects of bolt preload shall be given due consideration during design of other details; see Section 5.4.

6.3.3.5 Anchor Bolt Tightening: Direct Tension Indicator (DTI) Method

Due to the inaccuracy ($\pm 25\%$) inherent to using torque as a means of controlling bolt tension, the use of load-indicating washers—also known as direct tension indicators, or DTIs—is preferred to the use of conventional methods (such as torque-tightening, turn-of-nut, or nut runners) when tightening the foundation anchor bolts. DTIs are inexpensive, easy to use, and offer a positive go/no-go indication of adequate bolt preload.

¹ The oversized holes in the tower base flange necessitate the use of (2) DIN 6916 structural washers beneath the bolt head or nut. For the other washer specifications (DIN & ASTM) listed here, only (1) washer is required.



If DTIs are used, the load rating of the DTI shall match the required bolt preload, and all DTI calibration and installation instructions shall be followed. Oversized washers may be required for use beneath the DTI.

6.3.3.6 Anchor Bolt Tightening: Torque Control Method

If torque control methods are used for bolt tightening, the target tightening torque shall be determined assuming a nut factor (k) of 0.15 unless more accurate data regarding friction coefficients is available. Lubricant (e.g. nickel-based anti-seize paste) shall be applied to external threads and mating fastener faces (i.e. bottom face of nut and top face of washer) to ensure a relatively consistent coefficient of friction among the fasteners. A calibrated torque wrench shall be used.

6.3.3.7 Anchor Bolt Tightening: Preparation & Tightening Sequence

All fasteners shall be clean, and the threads free from damage or deformation. Previously used bolts, nuts, washers or studs may not be used as anchor bolts or bolt-hardware. The mating surfaces of the flanges are typically galvanized only, and should be free of dirt, paint, rust, or other contaminants. Use a wire brush to clean the surfaces as required.

The foundation engineer shall specify the tightening sequence for the anchor bolts. Numbering of bolts is recommended to facilitate the tightening process. All bolts shall be snug (i.e. tightened to at least 20% of target with a large ratchet or impact wrench) prior to beginning the tightening sequence to achieve full preload (or target torque). Upon completion of the tightening sequence, the sequence shall be repeated to check for appropriate preload (or torque) in the first several bolts tightened in the pattern, as they typically loosen as the adjacent bolts are brought to full preload. Bolts should continue to be checked until the target preload (or torque) is consistently demonstrated.

6.3.4 Seismic Considerations

Seismic loading, though typically non-governing, shall be considered as required by applicable codes and/or the geotechnical report. If seismic load cases govern foundation design, Northern Power shall be contacted to evaluate the suitability of the turbine configuration for the site.

6.4 Construction Requirements

6.4.1 Requirements for All Foundations

All foundation designs must incorporate the following details:

- A means for leveling the foundation prior to tower installation (e.g. use of screw jacks at the base of a steel frame foundation) and/or a means for leveling or plumbing the bottom tower section after installation (e.g. use of leveling nuts on three or more anchor bolts to elevate and level/plumb the bottom tower section, then in-filling the gap with an appropriate grout). This procedure is described in the installation manual, but may also be provided on the foundation drawing. If the procedure is described on the drawing, the foundation drawing shall supersede the installation manual. The bottom tower section must be plumb/level $\pm 0.2^\circ$ (0.4" in 10'). If grout is to be used:
 - (i) Grouts shall meet ASTM C1107 and Army Corps of Engineers CRD-C-621.
 - (ii) The grout shall have a one-day strength of at least 45 MPa (6500 psi) so as to allow tightening of the bolts soon after installing the tower base section². Weaker grouts may be used, but cure time may need to be longer in order to develop adequate strength. Adequacy of grout strength shall be confirmed by the foundation engineer, because the

² Northern assumes a bolt preload of 249 kN in deriving required grout strength



requirements are dependent on the bolt preload. The area used for the stress calculation shall be the net area of the tower base flange (annular area minus area of holes).

- (iii) The grout shall be sufficiently thick so as to effectively distribute the compression load (from the bolts) into the concrete. The compressive stress at the grout/concrete interface shall not exceed the concrete strength. Grout is typically formed at a 45° angle relative to the concrete and flange surfaces. Adequacy of the grout thickness, grout cross-section, and concrete strength shall be confirmed by the foundation engineer because these requirements are affected by the bolt preload.
- (iv) The anchor bolts shall be sleeved (e.g. with PVC or foam pipe insulation) to prevent the grout from adhering to the anchor bolts.
- A means for ensuring that the anchor bolt pattern is properly aligned and positioned at the top surface of the foundation. Northern Power offers an anchor bolt template ring as an option.
- A means for liquid water to drain to the outside of the foundation from inside the tower. The foundation shall be designed to prevent the accumulation of water around the base of the tower to minimize corrosion. This drain may be governed by local plumbing codes. It is the responsibility of the foundation engineer to see that the design complies with all applicable codes and standards.
- A means for preventing rotation of the anchor bolts during tightening. If the anchor bolts extend deep into the foundation, anti-rotation is typically accomplished by the use of two nuts at the bottom (lower) end of the anchor bolt. If the bottom end of the anchor bolt is accessible such that a wrench can be placed upon it while the nut at the upper end of the bolt is tightened (e.g. if the entire anchor bolt is above the top surface of the foundation), means for anti-rotation are not required.
- If a pad-mounted transformer is planned, the foundation design should include the transformer's pad located as per Section 4.2.2.
- A grounding system that meets the specifications contained within Section 4, Electrical Specifications and Requirements.
- Power and control conduits as per Section 4.2.8.

6.4.2 Requirements Associated with Long (Deep) Anchor Bolts

In typical non-steel foundations, the anchor bolts extend to approximately the full depth of the foundation. In such cases, the following provisions must be made:

- A means for effectively distributing the bolt loads at the bottom of the foundation. In concrete foundation designs, this is typically accomplished by the use of a thick steel "embedment ring" which is cast into the concrete near the bottom of the foundation. The bolt pattern in the embedment ring must have tolerances sufficiently tight to ensure proper alignment of the anchor bolts. The foundation engineer may design the embedment ring or use Northern Power's embedment ring³ which is available as an option. In either case, the foundation engineer must approve the ring sizing as adequate. The foundation engineer must perform calculations to verify:
 - (i) The compressive stress in the concrete directly above the embedment ring (as a result of the tension from all bolts) is acceptable. This stress is dependent on the bolt preload, concrete strength, and the surface area of the embedment ring. The surface area used for the calculation shall be the ring area minus the area of the holes and the nuts.

³ Northern assumes 5000 psi (34 MPa) concrete and a bolt preload of 249 kN for its embedment ring design. The foundation engineer must confirm the ring designed by Northern Power is adequate for the concrete strength and bolt preload to be used.



- (ii) The embedment ring has adequate thickness so as to produce acceptable bending stresses in the ring.
- (iii) The embedment ring has an adequate pullout capacity (ultimate limit state; assume loss of clamping force at foundation/tower interface). The pullout capacity is dependent on the projected concrete failure area (a factor of embedment depth, proximity to edges, etc) and the concrete strength.
- A means for developing tension (preload) throughout the entire length of the anchor bolt, and which prevents purchase of the anchor bolts within the foundation except at the intended point of connection at the bottom of the foundation. In concrete foundation designs, this is typically accomplished by the use of sleeves (PVC pipe or similar) through which the anchor bolts are passed, preventing the bolts from being cast into the concrete.
- The engineer must specify a concrete mix that will allow the coarse aggregate to fit within the available space between the anchor bolt sleeves.
- The engineer must specify a concrete mix with an adequate range of slump that will ensure adequate fresh concrete flow through the anchor bolt sleeves.
- For very deep foundations and long anchor bolt lengths, the engineer must consider providing access for electrical and control conduits and the drain pipe through the long anchor bolts.



A Appendix: System Design Parameters, Northwind 100/21/37

A.1 Turbine Configuration

Please refer to Northwind100 General Specification document A01465.

A.2 Site Wind Speed Range

Please refer to Northwind100 General Specification document A01465

A.3 Extreme Foundation Loads

50-Year Extreme Load	Magnitude
F_{xy} (Shear)	124.4 kN (28.0 kip)
F_z (Weight)	-194.1 kN (-43.6 kip)
M_{xy} (Overturning Moment)	3352.8 kN-m (2471.0 ft-kip)
M_z (Torsional Moment)	31.5 kN-m (23.2 ft-kip)

- Coordinate system is defined with X and Y as orthogonal axes within the plane of the tower/foundation interface. The positive Z axis points upward; i.e. from the foundation toward the tower top.
- Loads DO NOT include safety factors. Appropriate safety factors for foundation design are jurisdiction-dependent and shall be selected by the foundation engineer. See Section 5.3.1.

A.4 Anchor Bolts

Fastener Specifications	DIN 975 (Stud), DIN 6915 (Nut), 2X DIN 6916 (Washer)
Nominal Fastener Size	M24x3.0
Fastener Strength Class	Class 10.9 (Stud), Class 10 (Nut)
Fastener Preload	185 kN (41.6 kip) MIN, 310 kN (69.7 kip) MAX
Bolt Ratio (L/d)	3.3 MIN
Axial Stiffness Ratio (Joint/Bolt)	9.5 MIN



A.5 Foundation Stiffness

Lateral Foundation Stiffness K_{xy}	5×10^7 N/m MIN
Rotational Foundation Stiffness $K_{\theta,xy}$	2.5×10^9 Nm/rad MIN

- K_{xy} is the stiffness of the foundation in any lateral (horizontal direction); $K_{\theta,xy}$ is the stiffness about any horizontal axis passing through the origin of the previously defined coordinate system.
- These requirements correspond to a minimum fundamental frequency of 0.7 Hz for the turbine-tower-foundation system. The maximum fundamental frequency for the system is 0.8 Hz, corresponding to the case where the foundation is of infinite stiffness (i.e. base of tower is "fixed"). The foundation cannot be too stiff; thus, no maximum stiffness requirements are given.

A.6 Design References

- 1000152 Bolt Ring, Base, 37m Tower
- 1001441 Layout, Conduit, 37m Tower Base



B Appendix: Electrical Specifications Examples

Example 1 - section 4.2.5:

Voltage drop can be translated to power lost: the current heats the wire it is being transmitted on. Power lost as heat is essentially kWh's lost as energy.

If a turbine creates 200,000 kWh/year, and loses 1%, that's 2,000 kWh. Over 20 years that's 40,000 kWh's.

If a turbine creates 200,000 kWh/year, and loses 3%, that's 6,000 kWh. Over 20 years that's 120,000 kWh's.

Using time-averaged cost of electricity at \$0.15 over 20 years, that is \$6,000 lost for 1% drop and \$18,000 lost for 3% drop. This is a significant amount of lost revenue, which could easily be avoided by utilizing proper design.

Northwind® 100 Wind Turbine Logistics & Installation Guidelines

W00188 REV C MAY 2009

CONTENTS

1	INTRODUCTION	3
2	TRANSPORT (BY OTHERS)	3
2.1	COMPONENTS FOR TRANSPORT	3
2.2	TOWERS FOR TRANSPORT	3
2.2.1	30M TOWER, 3 NESTED SECTIONS	3
2.2.2	37M TOWER, 3 NESTED SECTIONS	4
3	FOUNDATION (BY OTHERS)	4
3.1	PURPOSE	4
3.2	SUMMARY OF FOOTING PARAMETERS	4
4	INSTALLATION (BY OTHERS)	5
4.1	CRANE LIFTS	5
4.1.1	30M TOWER	5
4.1.2	37M TOWER	5
5	ELECTRICAL INTERCONNECT (BY OTHERS)	6
6	COMMISSIONING (BY NORTHERN)	6
7	REFERENCE DOCUMENTS	6

1 INTRODUCTION

This document describes the work associated with installation of the Northwind 100 wind turbine. It is meant to serve as a guide for estimating and planning purposes.

2 TRANSPORT

2.1 Components for transport

Component	Crate Mass (kg)	Crate Mass (lb)	Crate Exterior Dimensions LxWxH (m)	Crate Exterior Dimensions LxWxH (in)
Nacelle (<i>includes power cable and shipping skid</i>)	6000	13200	4.2 x 1.9 x 2.1	165 x 75 x 83
10m Blade (3)	1800	3960	10.4 x 1.14 x 1.10	409 x 45 x 43
Rotor Hub	290	640	0.61 x 0.91 x 0.91	24 x 36 x 36
Misc. Parts	150	325	1.22 x 0.61 x 0.91	48 x 24 x 36
<i>All of the above in a 40' ISO Shipping Container (gross; includes container)</i>	12100	26600		

2.2 Tower for transport

2.2.1 30m Tower, 3 nested sections

Tower Section	Mass		Length		OD-large		OD – small	
	Kg	Lb	M	ft	m	in	m	In
Lower	6500	14300	11.7	38.4	2.235	88.0	1.820	71.7
Middle	4400	9680	10.0	32.8	1.820	71.7	1.470	57.9
Upper	2900	6380	7.3	24.0	1.470	57.9	1.220	48.0
<i>Nested 30m Tower</i>	13800	30360	11.8	38.7	2.235	88.0	1.820	71.7

2.2.2 37m Tower, 3 nested sections

Tower Section	Mass		Length		OD - large		OD – small	
	kg	Lb	m	ft	m	in	m	in
Lower	6200	13640	11.9	39.0	2.000	78.7	1.740	68.5
Middle	4200	9240	11.9	39.0	1.740	68.5	1.480	58.3
Upper	3600	7920	11.9	39.0	1.480	58.3	1.220	48.0
Nested 37m Tower	14000	30800	12.0	39.4	2.000	78.7	1.740	68.5

3 FOUNDATION (BY OTHERS)

3.1 Purpose

The foundation shall be designed according to the requirements defined in A00298, Northwind 100 Application Requirements. It is expected that a traditional concrete spread footing foundation design will be appropriate for the majority of sites. Additional information regarding spread footing foundation design is provided below for use by contractors and engineers for estimating purposes. This information is not intended to replace the need for a site-specific geotechnical investigation or footing design, which are required per local building codes. It is rather intended to provide enough information to support a rational cost estimate with little effort. A design for the specific site conditions is virtually guaranteed to produce a lower-cost foundation design.

3.2 Summary of Footing Parameters

The following table shows dimensions and quantities for octagonal concrete spread footings sized for soil of five different bearing pressures from 1,500 psf to over 4,000 psf.

Allowable Soil Pressure (lb/ft ²)	Side (ft)	Area (ft ²)	Depth (ft)	Volume (yd ³)	Resteel (lb)
1,500	14	946	3	105	20,000
2,500	12	695	3	77	16,000
3,000	12	695	3	77	16,000
4,000	12	695	3	77	16,000
4,000+	11	584	3	65	14,000

4 INSTALLATION (BY OTHERS)

Installation takes approximately five working days for an equipment erection crew consisting of a crane, a foreman, an operating engineer, and two riggers. Refer to W00308, Northwind 100 Installation Instructions for the complete procedure and for a list of tools and other equipment required for installation.

1. Tower: Un-nest three tower sections. Install ladder and platform into each tower section.
2. Grout: Place bottom tower section onto foundation bolts. Level and grout tower base flange.
3. Rotor: Assemble three blades and hub on ground. Pitch each blade to required setting.
4. Nacelle: Minor preparations made on ground. Install met-mast.
5. Erection: Consists of lifts described below, with bolted connections made during each.

4.1 Crane Lifts

4.1.1 30m Tower

Lifts	Lift Weight		Hook Height	
	Kg	lb	m	Ft
30m Tower - Lower Section	6500	14300	15	49
30m Tower - Middle Section	4400	9680	25	82
30m Tower - Upper Section	2900	6380	32	105
Nacelle <i>(includes power cable)</i>	5800	12760	33	108
21m Rotor Assembly	1400	3080	33	108

4.1.2 37m Tower

Lifts	Lift Capacity		Hook Height	
	Kg	lb	m	Ft
37m Tower - Lower Section	6200	13640	15	49
37m Tower - Middle Section	4200	9240	27	89
37m Tower - Upper Section	3600	7920	39	128
Nacelle <i>(includes power cable)</i>	5800	12760	40	131
21m Rotor Assembly	1400	3080	40	131

5 ELECTRICAL INTERCONNECT (BY OTHERS)

Refer to A00298, Northwind 100 Application Requirements. Installer shall terminate the cables from the transformer to the junction box located inside the tower base.

6 COMMISSIONING (BY NORTHERN)

Commissioning will be completed by a Northern Power technician in 2-3 days (procedure is weather-dependent), according to the Northwind 100 Commissioning Test Procedure. The turbine will be ready for standalone operation at the completion of commissioning, at which time a Commissioning Certificate will be issued.

NOTE: The local utility will typically require a witness test prior to full-time operation of the wind turbine. This test must be performed by the utility and/or a designated third-party test engineer. This will have to be scheduled carefully. The Northern Power technician will need to be allowed to operate the turbine on a limited basis prior to the witness test. The Northern Power technician need not be present during the witness test.

7 REFERENCE DOCUMENTS

A00281, Northwind 100 General Specification

A00298, Northwind 100 Application Requirements

W00308, Northwind 100 Installation Instructions



PRODUCT SALES AGREEMENT

This Product Sales Agreement ("Agreement") is made as of the XX day of Month, 20 , by and between Northern Power Systems, Inc., a Delaware corporation having its principal place of business at 29 Pitman Road, Barre, Vermont, 05641 USA ("Northern"), and Company name , a State/Country [corporation] having its principal place of business at location ("Buyer"). Northern and Buyer are, together, referred to herein as the "Parties."

Whereas, Northern designs, manufactures and distributes energy related products including but not limited to electrical power systems, power electronics and wind turbine systems;

Whereas, Buyer desires to purchase products and/or services from Northern;

Whereas, Buyer is purchasing such products and/or services either (i) for re-sale to a designated customer or end-user (an "End-User"), who following the commissioning of the Turbine, is owner; or (ii) for its own use in which case Buyer becomes End User;

Whereas, Buyer or authorized development partner (a "Development Partner") will be responsible for installing and/or commissioning the products;

Whereas, Buyer or authorized service partner (a "Service Partner") will be responsible for scheduled and/or unscheduled maintenance on the Turbine in compliance with the operating and maintenance materials provided by Northern; and

Now, therefore, in consideration of the mutual agreements and covenants set forth herein, Northern and Buyer hereby agree as follows:

1. SALE OF GOODS. Northern shall sell to Buyer, and Buyer shall purchase from Northern, the products ("Products") and services ("Services") described in Exhibit A attached hereto and incorporated herein by this reference, upon the terms and conditions of this Agreement (including, without limitation, strict compliance with the payment terms set forth in Exhibit B attached hereto and incorporated herein by this reference).

2. SHIPPING AND DELIVERY; TITLE AND RISK OF LOSS.

2.1 Northern shall deliver the Products to Buyer in accordance with the "Guaranteed Shipping Date" set forth on Exhibit A, subject to the Buyer's strict compliance with the terms and conditions of this Agreement, including, without limitation, the payment terms set forth in Exhibit B. Buyer acknowledges that Northern shall have no obligation to deliver the Products to Buyer if Buyer is not in compliance with the terms of Exhibit B.

2.2 Northern will deliver all Products F.O.B. or EX WORKS, at the point of manufacture, per Exhibit A. Northern's transfer of Products to the carrier at the point of manufacture ("Shipping") shall constitute delivery to Buyer. Title to and risk of loss to the Products shall pass to Buyer upon Shipping. Buyers will be responsible for choosing their own freight-forwarders/suppliers. The Buyer may elect to participate in Northern's Preferred Freight Program. Within this program, Northern will provide a list of preferred freight-forwarders/suppliers that the buyers can call to schedule pick-up and

FM220 RevH

Initial & Date – Northern: _____

Release Date 11-16-09

Printed Copies are Uncontrolled

Initial & Date – Buyer: _____



delivery logistics in order to be invoiced directly for payment. Buyer shall be responsible for any insurance, freight, duty, handling, taxes (if applicable) and other charges and expenses relating thereto, including but not limited to those expenses estimated on Exhibit A. Northern's project management teams will work closely with both the Buyer and the freight-forwarders/suppliers on all logistical shipping events. Furthermore, if the customer does not have Cargo insurance Northern can also provide the contact information of an insurance broker that the buyer can call to purchase coverage. Otherwise the Buyer may elect to purchase Cargo Insurance through Northern Power's Master Cargo policy as listed on Exhibit A. In no event shall Northern be deemed to have assumed any liability in connection with any shipment of Products.

3. PAYMENT.

3.1 The period of price quote validity for Products and Services is set forth in Exhibit A.

3.2 All prices in Exhibit A are in U.S. dollars. Prices do not include any taxes (sales and use, VAT or other), tariffs, import or export duties, shipping, delivery, set fees, which are all payable by the Buyer unless specifically listed otherwise. Buyer shall pay any and all taxes and charges or provide Northern with acceptable exemption certificates before execution of Product Sales Agreement and payment of initial non refundable deposit per exhibit B.

3.3 Buyer shall make payments to Northern in accordance with the terms of Exhibit B.

3.4 Buyer shall make all payments, in U.S. (dollars) currency, either:

a) By mailing a check to:

Northern Power Systems, Inc.
Accounts Receivable
29 Pitman Road
Barre, VT 05641

b) By wire transfer to Northern's designated bank pursuant to the wire instructions set forth in Exhibit B (which may be changed by Northern upon written notice to Buyer).

3.4 Buyer hereby grants to Northern a purchase money security interest in all Products sold to Buyer as security for the due and punctual performance by Buyer of its obligations under this Agreement. At Northern's request, Buyer shall execute and deliver any instruments (including Uniform Commercial Code Financing Statements) which Northern deems necessary to protect its security interest in the goods. Buyer shall not encumber or otherwise permit any lien to exist on the Products unless and until Northern has been paid in full hereunder.

3.5 Buyer represents and warrants that it has the financial ability to fully perform its obligations under this Agreement. Buyer has obtained any commitments, consents or approvals from third parties necessary for Buyer to perform hereunder, and such commitments, consents or approvals are binding and non-discretionary. Buyer's performance of its obligations hereunder will not violate any agreement or instrument to which Buyer is a party or by which its properties are bound.

3.6 Buyer shall make all payments due to Northern hereunder without deduction, set-off or counterclaim.

FM220 RevH

Initial & Date – Northern _____

Release Date 11-16-09

Printed Copies are Uncontrolled

Initial & Date – Buyer: _____



4. SPECIFICATIONS; LIMITED WARRANTY.

4.1 The specifications for the Northwind® 100 Wind Turbine (the "Turbine") are set forth in Exhibit C attached hereto and incorporated herein by this reference (the "Specifications"). Buyer acknowledges receipt of, and has reviewed, the Specifications.

4.2 The limited warranty for the Turbine and the Services is set forth in Exhibit D attached hereto and incorporated herein by this reference (the "Limited Warranty"). **THE LIMITED WARRANTY PROVIDED HEREUNDER AND THE RIGHTS AND REMEDIES OF THE BUYER HEREUNDER ARE IN LIEU OF, AND BUYER EXPRESSLY WAIVES, ALL OTHER WARRANTIES, GUARANTEES, OBLIGATIONS, LIABILITIES, OR REMEDIES, UNLESS OTHERWISE EXPRESSED, ARISING BY LAW OR OTHERWISE, INCLUDING WITHOUT LIMITATION IMPLIED WARRANTIES OF MERCHANTABILITY AND NON-INFRINGEMENT, IMPLIED WARRANTIES ARISING FROM THE COURSE OF DEALING OR USAGE OF TRADE AND IMPLIED WARRANTIES OF SUITABILITY OR FITNESS FOR A PARTICULAR PURPOSE.**

4.3 Northern makes no representations or warranties whatsoever with regard to any Product other than the Turbine. Northern will transfer and assign to Buyer the warranties, if any, received by Northern from third party manufacturers of Products other than the Turbine, to the extent such warranties are transferable by their terms. Buyer expressly acknowledges that the Limited Warranty contained in Exhibit D does not apply or relate to Products other than the Turbine.

4.4 Extreme Wind Risk: Northern Power Systems wind turbines are designed to withstand wind loading to certain levels during extreme weather events. These extreme weather events present certain risks which are outside of the control of Northern. Buyer expressly acknowledges these risks as described in Exhibit D.

5. MODIFICATIONS/CHANGES. Any modification to the standard terms and conditions of this Agreement are set forth in Exhibit E (the "Supplemental Terms and Conditions"). Except for the Supplemental Terms and Conditions set forth in Exhibit E, if any, the stating of additional or different terms of sale by the Buyer or the furnishing by Buyer of additional documents, written or electronic (including any purchase order), shall not modify this Agreement, nor be binding upon Northern.

6. TITLE TO TURBINE. Northern represents and warrants to Buyer that, at the time of shipping the Turbine to Buyer, Northern will have good and marketable title to the Turbine, free and clear of all liens and encumbrances.

7. FORCE MAJEURE. Northern shall not be liable for any delay in performance, nonperformance, or any other deviation in performance of Northern's obligations, nor for any loss or damage to the goods supplied hereunder, when occasioned directly or indirectly by any cause beyond the reasonable control of Northern, its subcontractors or suppliers, including, but not limited to, acts of God, acts of criminals or public enemy, war, terrorism, riot, official or unofficial acts, orders, regulations or restrictions of any foreign or domestic government or agency thereof, acts of Buyer or its employees or representatives; strikes or labor difficulties involving employees of Northern or any other party; failure, shortage or delay in Northern's usual sources of labor, products or material supply, Northern shall have a reasonable extension of the time for performance when delayed by any such cause, which extension may result in a delay of the "Guaranteed Shipping Dates" set forth on Exhibit A.

8. DELAY BY BUYER/AVAILABILITY OF PRODUCT UPON BUYER'S READINESS.

FM220 RevH

Initial & Date – Northern _____

Release Date 11-16-09

Printed Copies are Uncontrolled

Initial & Date – Buyer: _____



Prior to thirty (30) days before the Guaranteed Shipping Date(s) of the Nacelle for each Turbine set forth in Exhibit A, Buyer may request, in writing, that Northern delay the delivery of Products to Buyer. If Northern grants such request, Northern shall apprise Buyer of any resulting adjustments to the Guaranteed Shipping Dates for the Products, which adjustments shall be in Northern's sole discretion.

If Northern deems it cannot reasonably reschedule the Guaranteed Shipping Date(s) of the Nacelle for each Turbine or Buyer's request for delay is received less than thirty (30) days prior to the Guaranteed Shipping Date set forth in Exhibit A, and Buyer is not prepared to receive Products at Buyer's designated site(s), Northern shall make delivery and Shipping of Products (including Turbine, blades and tower) as per Section 2 above to one or more storage facilities as part of Northern's "Turbine on Demand" (TOD) program. The TOD program provides for storage of Products at pre-selected locations by Northern's approved logistics partners on behalf of the Buyer and at Buyer's expense until Buyer is ready to receive Products at Buyer's designated site(s). Upon payment to Northern of any invoice relating thereto, Buyer may draw such Products from storage and arrange for shipment to Buyer designated site(s). Buyer shall be responsible for any insurance, freight, duty, handling, taxes (if applicable) and other charges and expenses relating thereto.

9. TERMINATION.

9.1 If Buyer fails to perform or observe any material term or condition of this Agreement within ten (10) days after receipt of written notice from Northern of such failure, including without limitation making payment when due in accordance with Exhibit B hereto, Buyer shall be in default and Northern may terminate this Agreement. In the event of any such termination, Buyer shall pay to Northern (i) all amounts due and payable hereunder for any completed Products delivered by Northern as of the termination date; (ii) the greater of (a) ten percent (10%) of the total product value set forth in Exhibit A if Northern has not yet commenced production and/or ordered supplies or (b) fifty percent (50%) of the total product value set forth in Exhibit A once Northern has commenced production and/or ordered or purchased supplies with regard to any Products not yet completed by Northern as of the termination date, and (iii) all costs incurred and legally committed to by Northern through the effective date of termination and all costs associated with terminating subcontracts, less credit, if any is granted at Northern's discretion, for returned purchases.

9.2 In the event Northern is unable to perform or observe any material term or condition of this Agreement by the Guaranteed Shipping Date(s) set forth in Exhibit A other than for reasons of force majeure (Section 7), Buyer's sole remedy shall be the prompt return of any payment made pursuant to this Agreement.

10. INSPECTION; ACCEPTANCE. Buyer shall inspect the Products including partial deliveries thereof within a reasonable period following arrival at Buyer's premises or the delivery site(s) but in any event within twenty (20) days of such arrival, and shall immediately notify Northern in writing of any failure of the Products to conform to the requirements of this Agreement. If Buyer fails to provide such notice within such time period, the Products, including partial deliveries of Products, shall be deemed to have been accepted by Buyer.

11. INSURANCE. In connection with Buyer's performance of its obligations under this Agreement, Buyer will procure and maintain, at Buyer's sole cost and expense, the following types and minimum amounts of insurance:

a. Commercial General Liability Insurance including Products Liability, Completed Operations and Contractual Liability coverage for losses including but not limited to bodily injury, death or property damage, with limits of not less than \$1,000,000 per occurrence and \$3,000,000 in the aggregate;

FM220 RevH

Initial & Date – Northern _____

Release Date 11-16-09

Printed Copies are Uncontrolled

Initial & Date – Buyer: _____



b. Automobile Liability Insurance coverage for all vehicles owned, non-owned, leased, hired or otherwise used by Buyer with limits of not less than \$1,000,000 combined single limit; and

c. Worker's Compensation Insurance coverage with Part A Statutory limits and Part B Employers' Liability limits not less than \$1,000,000 including waiver of subrogation in favor of Northern, its subsidiaries and affiliates.

d. From commencement of work or services hereunder through completion of the work to site the Products at Buyer's location (or the location of the End-User, if applicable), the Buyer or its subcontractor shall obtain and thereafter at all times during performance of the work maintain builder's risk insurance, on an "all-risk basis" on a completed value form including but not limited to the perils of earthquake, flood, collapse, rigging, sinkhole and subsidence and providing: (i) coverage for the project and the project site, insuring any buildings, structures, machinery, equipment, facilities, fixtures and other properties that constitute a part of the project in a minimum aggregate amount not less than full replacement value of the project, (ii) Northern, Buyer, and subcontractors of any tier shall be included as additional insureds under the builder's risk policy; and (iii) a certificate of insurance shall be provided prior to commencement of work as evidence of builder's risk coverage.

In addition, Northern requires Buyer to provide proof of Insurance coverage through a copy of a valid certificate of Insurance (COI) within 30 days of execution of this agreement or risk breach

12. CONFIDENTIALITY AND INTELLECTUAL PROPERTY.

12.1 Buyer expressly recognizes that (i) the software and/or firmware associated with the SmartView remote monitoring system and related user manuals (the "SmartView Software"), (ii) the software and/or firmware associated with the direct drive generator and the power converter and related user manuals (the "Turbine Control" and "Power Electronics Software") used with or included in the Turbine, and (iii) the design of Turbine, including the direct drive generator and the power converter, embody and constitute confidential and proprietary information of Northern ("Confidential Information"). Such direct drive generator and power converter, excluding the Turbine Control and Power Electronics Software, are collectively referred to herein as the "Power System." Buyer shall not tamper with, disassemble, modify, or reverse engineer any part of the Power System, either supplied by Northern as part of a system or as a separate item, nor shall Buyer disassemble, reverse compile or reverse engineer any SmartView Software or Turbine Control and Power Electronics Software. Buyer acknowledges that the disclosure by Buyer of Confidential Information may cause irreparable injury to Northern and damages that may be difficult to ascertain. **IN THE EVENT OF THE ACTUAL OR THREATENED DISCLOSURE OF CONFIDENTIAL INFORMATION, NORTHERN SHALL, IN ADDITION TO ANY OTHER RIGHTS OR REMEDIES AND NOTWITHSTANDING SECTION 17 OF THIS AGREEMENT, BE ENTITLED TO INJUNCTIVE RELIEF FROM A COURT OF COMPETENT JURISDICTION TO PROTECT AND RECOVER THE CONFIDENTIAL INFORMATION; NORTHERN RESERVES ALL RIGHTS TO PURSUE AND OBTAIN APPROPRIATE LEGAL AND EQUITABLE REMEDIES FOR ANY VIOLATION OF THIS SECTION 12.** Buyer shall not object to the entry of an injunction or other equitable relief against Buyer on the basis of an adequate remedy at law, lack of irreparable harm or any other reason.

12.2 Subject to the terms of this Agreement, Northern hereby grants Buyer a non-exclusive, personal, non-transferable right and license under its intellectual property to use the Turbine Control and Power Electronics Software solely for Buyer's internal business purposes and in connection with the operation of the Turbine. The cost of this license is included within the price of the Turbine. Northern shall not be required to provide Buyer with maintenance, support or updates regarding the

FM220 RevH

Initial & Date – Northern _____

Release Date 11-16-09

Printed Copies are Uncontrolled

Initial & Date – Buyer: _____



Power System and Turbine Control and Power Electronics Software. Such services may be offered under separate agreements.

12.3 Subject to the terms of this Agreement, Northern hereby grants Buyer a non-exclusive, personal, non-transferable, right and license under its intellectual property to use the SmartView Software, solely for Buyer's internal business purposes and in connection with the operation of the Turbine. The cost of a single-seat license is included within the price of the Turbine. Northern shall not be required to provide Buyer with maintenance, support or updates regarding the SmartView Software. Buyer acknowledges that the SmartView Software is not intended to be used as billing software or to otherwise calculate charges or credits for electricity generated by the Turbine. Buyer acknowledges that Northern has an absolute and unconditional right to monitor the performance of any Turbine, including via SmartView monitoring, and expressly and irrevocably confirms here its permission for Northern to do so. End user acknowledges connectivity to the internet must be maintained at its expense to i) hold in effect the Limited Warranty (exhibit D) and ii) for any and all monitoring services during the life of the warranty. Maintaining Internet connectivity is exclusive of temporary power outages beyond the control of the buyer or end user.

12.4 Buyer shall be responsible for providing and maintaining adequate computer hardware and software and connectivity, including timely site preparation prior to commissioning to support the operation of the Turbine, the Turbine Control and Power Electronics Software and the SmartView Software.

12.5 Upon any termination of this Agreement for any reason, (i) the licenses granted hereunder shall terminate, (ii) Buyer shall cease using the Turbine Control and Power Electronics Software and the SmartView Software, and (iii) Buyer shall return all documentation provided by Northern in relation to the Turbine Control and Power Electronics Software and the SmartView Software.

12.6 Except as otherwise provided in this Section 12, this Agreement does not grant to Buyer any right, title, or interest in or to Northern's intellectual property, other proprietary rights or other information, including, but not limited to, Northern's name, trade marks, trade names, trade dress, trade symbols, copyrights, patents, patent applications, inventions, trade secrets, customer lists, product names or designations, processes, designs, or formulas.

12.7 This Section 12 shall survive the termination of this Agreement.

13. ON-SITE ACTIVITY. If Exhibit A calls for any on-site Services by Northern, including but not limited to inspection, start-up, technical representation, or other services the following conditions shall apply:

13.1 Buyer shall provide such assistance as Northern may reasonably require to facilitate timely performance of this Agreement. If Buyer is not the End-User, Buyer is responsible for support and facilitation by End-User of Northern's performance of this Agreement. If Northern is unable to perform through no fault of its own or as a result of Buyer's failure to cooperate or provide assistance, Northern shall be excused from performance. In such event, Northern may, at its option, terminate this Agreement or continue to perform to the extent possible, and shall be entitled to an equitable adjustment in purchase price and/or schedule. Buyer assistance shall be free of charge to Northern and shall include but not be limited to:

- (a) Buyer shall provide reasonable security and protection for all persons, property and equipment employed or used by Northern.

FM220 RevH

Initial & Date – Northern _____

Release Date 11-16-09

Printed Copies are Uncontrolled

Initial & Date – Buyer: _____



- (b) Buyer shall make available to Northern the use of any required utilities, including electrical power, transport and water.
- (c) Buyer shall assist Northern to obtain access to all necessary roads, railways, pumping stations, power lines, pipelines, canals, and the like.
- (d) Buyer shall obtain any permits, licenses, or authorizations necessary to perform this Agreement and Buyer shall be responsible for obtaining all environmental permits including without limitation, air permits, permits to construct and/or operate, and any land use permits.

13.2 If Northern, in the course of performing this Agreement discovers (i) subsurface or latent physical conditions at the site differing materially from those indicated in Exhibit C herein, or (ii) unknown physical conditions at the site, differing materially from those ordinarily encountered in the work as provided for in this Agreement, then Northern shall inform Buyer and Buyer shall promptly investigate the conditions. If the conditions do so differ and cause an increase in Northern's cost of or time for performance of any part of the work, whether or not changed as a result of such conditions, the parties shall make an equitable adjustment in the purchase price and/or schedule.

14. RESPONSIBILITY FOR SITING, ENGINEERING AND CONSTRUCTION.

14.1 Buyer acknowledges that it has received and reviewed Exhibit C hereto relating to Product Specifications; and Buyer understands it is solely and exclusively responsible for determining where to site the Turbine at the Buyer's location (or at the location of End User, as applicable). Buyer confirms the conformance of the site selected to the specifications indicated in Exhibit C hereto, as well as compliance with all state, local and municipal rules and regulations, including without limitation zoning and land use. Buyer further acknowledges that it has relied, or will be relying, solely upon its own independent investigation, review and analysis in reaching such determination and understands that Northern makes no representation or warranty regarding the suitability of the location chosen by Buyer. To the fullest extent permitted by law, neither Northern nor its affiliates, nor any of their respective directors, officers, employees, agents, advisors or representatives, shall have any liability or responsibility whatsoever to Buyer based upon the suitability, or lack thereof, of the location of the Turbine.

14.2 Buyer recognizes that the responsibility for the engineering analysis to ensure the proper construction and safe operation of the Turbine resides with Buyer and that Northern assumes no liability for such activities. Northern reserves the right to reject any product warranty claims where Buyer cannot demonstrate to Northern the adequacy of the Turbine installation per as-built drawings, geotechnical investigations, engineering calculations, and written representations for Buyer and its contractors.

14.3 Buyer acknowledges, that prior to finalizing Turbine siting and initiation of site construction, it is responsible for verifying the suitability of the site for electrical interconnection, as well as completing a geotechnical, wind data and financial analysis to support its purchasing and siting decisions.

15. LIMITATION OF LIABILITY.

FM220 RevH

Initial & Date – Northern _____

Release Date 11-16-09

Printed Copies are Uncontrolled

Initial & Date – Buyer: _____



15.1 NORTHERN SHALL NOT BE LIABLE TO BUYER FOR ANY INCIDENTAL, CONSEQUENTIAL, SPECIAL, PUNITIVE, INDIRECT OR EXEMPLARY DAMAGES ARISING OUT OF THIS AGREEMENT OR THE LIMITED WARRANTY, INCLUDING BUT NOT LIMITED TO LOST PROFITS OR COSTS OF COVER, LOSS OF REVENUE, LOSS OF PRODUCTION, LOSS OF USE OR BUSINESS INTERRUPTION OR THE LIKE, REGARDLESS OF WHETHER NORTHERN WAS ADVISED OR AWARE OF THE POSSIBILITY OF SUCH DAMAGES.

15.2 IN NO EVENT WILL THE TOTAL LIABILITY OF NORTHERN ARISING OUT OF THIS AGREEMENT OR THE LIMITED WARRANTY EXCEED THE AMOUNT PAID OR PAYABLE TO NORTHERN UNDER THIS AGREEMENT WITH REGARD TO THE NORTHWIND® 100 WIND TURBINE(S) DESCRIBED IN SECTION 1 OF EXHIBIT A OF THE AGREEMENT. THIS LIMITATION OF THE TOTAL LIABILITY OF NORTHERN SHALL APPLY REGARDLESS OF THE FORM OF ACTION, WHETHER IN CONTRACT, TORT, NEGLIGENCE, STRICT LIABILITY, CONTRIBUTION OR OTHERWISE. THIS IS NOT A LIMITATION OF THE TOTAL POTENTIAL LIABILITY OF BUYER OR END-USER FOR ANY VIOLATION OF SECTION 12 OF THIS AGREEMENT "CONFIDENTIALITY; INTELLECTUAL PROPERTY", ANY OF SUCH LIABILITY MAY EXCEED THE AMOUNT PAID OR PAYABLE TO NORTHERN UNDER THIS AGREEMENT.

16. SAFETY; COMPLIANCE WITH APPLICABLE LAW.

16.1 BUYER ACKNOWLEDGES THAT, AS WITH ANY SOPHISTICATED INDUSTRIAL MACHINERY, THE PRODUCT MAY BE UNSAFE OR EVEN DANGEROUS IF NOT OPERATED WITH DUE CARE AND CONSISTENT WITH THE OPERATIONS AND MAINTENANCE MANUAL PROVIDED BY NORTHERN. UNSAFE OPERATION OF THE PRODUCT – INCLUDING BY PROVIDING ACCESS THERETO TO PERSONS OTHER THAN QUALIFIED REPAIR AND MAINTENANCE PROFESSIONALS – MAY CREATE CIRCUMSTANCES THAT COULD CAUSE SERIOUS INJURY, DEATH, OR PROPERTY DAMAGE. OPERATION OF THE PRODUCT OTHERWISE THAN IN STRICT AND FULL COMPLIANCE WITH OPERATIONS AND MAINTENANCE MATERIALS PROVIDED BY NORTHERN WILL LIMIT OR ELIMINATE THE OPERABILITY OF THE TURBINE AND SHALL VOID THE LIMITED WARRANTY. BUYER (AND/OR END USER) ACKNOWLEDGES THAT IT IS BUYER (AND/OR END USER'S) SOLE RESPONSIBILITY TO ENSURE SAFE OPERATION OF THE PRODUCTS.

16.2 Buyer shall comply with all applicable laws and regulations related to the purchase of the goods and services under this Agreement including but not limited to, environmental regulations, technical standards and export controls. Goods shall not be exported or transshipped contrary to U.S. law. If Products are for to be shipped to a destination outside of the United States, Buyer is the exporter of record and solely responsible to acquire any required export license. Northern will assist in supply of information required in the application process.

16.3 Buyer's use of the Products shall comply with (i) all applicable health and safety laws and regulations, and (ii) Northern's Operations and Maintenance Manuals.

17. DISPUTE RESOLUTION.

17.1 Any controversy, dispute or claim between the Parties not settled by mutual agreement (a "Dispute") shall first be submitted to non-binding mediation. The Buyer further agree to include a similar mediation provision in all agreements with independent contractors and consultants retained for the Project and to require all independent contractors and consultants also to include a similar mediation provision in all agreements with their subcontractors, sub-consultants, suppliers and

FM220 RevH

Initial & Date – Northern _____

Release Date 11-16-09

Printed Copies are Uncontrolled

Initial & Date – Buyer: _____



fabricators, thereby providing for mediation as the primary method for Dispute resolution among the parties to all those agreements. In the event the Dispute is not resolved through non-binding mediation it will be resolved by final and binding arbitration. Any controversy, Dispute or claim between the Parties not settled by mutual agreement will be resolved by final and binding arbitration in Burlington, Vermont, USA: in accordance with the Commercial Arbitration Rules of the American Arbitration Association ("AAA"), and governed by the substantive laws of the State of Vermont, without regard to conflicts-of-laws rules, and by the Federal Arbitration Act (Title 9, U.S. Code).

THE PARTIES KNOWINGLY AND VOLUNTARILY WAIVE THEIR RIGHTS TO HAVE ANY DISPUTE TRIED AND ADJUDICATED BY A JUDGE OR A JURY.

18. END USER ACKNOWLEDGEMENT. This Agreement is made for the sole benefit of Northern and Buyer, and no other person shall have any right or remedy or other legal interest of any kind, as a third party beneficiary or otherwise, under or by reason of this Agreement, except and unless (i) an End-User is designated by Buyer on Exhibit D attached hereto and (ii) such End User has executed and delivered to Northern the End-User Acknowledgment in the form of Exhibit F attached hereto and incorporated herein by reference. For the avoidance of doubt, the Parties agree that Buyer is prohibited from transferring or assigning the Limited Warranty to End-User unless End-User has executed and delivered to Northern the End-User Acknowledgment.

19. MISCELLANEOUS.

19.1 Buyer may not assign its rights and obligations hereunder without the prior written consent of Northern, which will be in Northern's sole discretion. Northern's sole discretion could include, but not limited to: (i) Re-purchase of turbine(s) at original purchase price per exhibit A, (ii) Buyer meeting specific pre-conditions or requirements, (iii) Not allowing Buyer to remain in Northern's Preferred Partner Program. Northern may freely assign its rights hereunder. The rights and obligations under this Agreement will inure to the benefit of, and be binding upon, the parties hereto and their respective heirs, administrators, executors, personal representatives, successors and permitted assigns.

19.2 No action, failure of action or delay by either party will constitute a waiver of any of its rights or remedies under this Agreement. The waiver of a breach of any provision does not constitute a waiver of a subsequent breach of the same or different provision.

19.3 Northern is an independent contractor. Buyer and Northern are not, and will not be, joint venturers, partners, agents, servants, or employees or fiduciaries of the other, and do not have the power to bind or obligate the other.

19.4 The rights and liabilities of the parties under this Agreement are governed in all respects by the laws of the State of Vermont, without reference to or application of its conflicts of law provisions.

19.5 The parties hereto agree to cooperate in good faith to mutually pre-approve any press release, press or other media coverage relating to the installation and operation of the Turbine.

19.6 This Agreement, together with all Exhibits hereto, represents the entire understanding of the parties with respect to the subject matter herein and supercede all prior negotiations, representations or agreements, written or oral. This Agreement replaces and supersedes all previous agreements, term sheets, proposals, or letters of intent, whether written or oral, between the Parties relating to the supply of the Products from Northern to the Buyer. The stating of additional or different terms of sale

FM220 RevH

Initial & Date – Northern _____

Release Date 11-16-09

Printed Copies are Uncontrolled

Initial & Date – Buyer: _____



by the Buyer or the furnishing by Buyer of additional documents, written or electronic (including any purchase order), shall not modify this Agreement, nor be binding upon Northern.

19.7 This Agreement may not be amended, modified or altered except in writing signed by both Parties.

19.8 Any notice provided pursuant to this Agreement shall be in writing and shall be deemed given: (i) if by hand delivery, upon receipt thereof; (ii) if mailed, three (3) days after deposit in the U.S. mails, postage prepaid, certified mail return receipt requested, (iii) if sent via overnight courier by a nationally recognized service, upon receipt; or (iv) if sent via facsimile, upon confirmed receipt. All notices to Northern shall be addressed to it at the addresses indicated below and notices to Buyer shall be addressed to it at the address on the signature page hereof (or to such other address as either party may provide written notice of to the other in the manner provided for herein

If to Northern:

Northern Power Systems, Inc.
29 Pitman Road
Barre, Vermont 05641 U.S.A.
Fax: 802-461-2998
Attention: Services Department
Phone: (802) 461-2955
Fax: (802) 461-2995

19.8 This Agreement may be executed by the Parties in counterparts, including counterparts executed and delivered via facsimile, each of which shall be deemed an original and all of which together shall constitute one and the same instrument

FM220 RevH

Initial & Date – Northern _____

Release Date 11-16-09

Printed Copies are Uncontrolled

Initial & Date – Buyer: _____



IN WITNESS WHEREOF, the Parties have caused this Product Sales Agreement to be executed by their duly authorized representatives as of the date first written above.

Northern Power Systems, Inc.

[Insert Buyer Name]

By: _____
Signature

By: _____
Signature

Name _____
Print/Type

Name _____
Print/Type

Title _____
Print/Type

Title _____
Print/Type

Buyer Address for Notices:

[Buyer Name]
[Street]
[City, State, Zip Code]
Attention: [Buyer officer]
Phone: (---) -----
Fax: (---) -----

List of Exhibits:

- Exhibit A --- Products and Services
- Exhibit B --- Payment Terms
- Exhibit C --- Product Specifications
- Exhibit D --- Limited Warranty
- Exhibit E --- Supplemental Terms and Conditions
- Exhibit F --- End-User Acknowledgment
- Exhibit G --- Service Agreement

FM220 RevH

Initial & Date – Northern _____

Release Date 11-16-09

Printed Copies are Uncontrolled

Initial & Date – Buyer: _____

Exhibit A: Products and Services**Summary**

Validity

Pricing quote is valid until _____.

Product Total \$ -

Total Product Value \$ - (TPV)

Services Total \$ - Estimate

Total Contract Value \$ -

Guaranteed Shipping Date _____

Estimated Transit Time _____ days

1. Products

Item #	Product Description	Status	Quantity	Unit Price (US\$)	Total Price (US\$)
1	Northwind® 100 wind turbine (the "Turbine"), Class II, Includes: nacelle, rotor, tower, and 2 year Limited Warranty from date of Commissioning. Nacelle price is EX WORKS Northern's factory, Barre, VT.			\$ 328,500	\$ -
2	Northwind® 100 Arctic wind turbine (the "Turbine"), Class S, includes: nacelle, rotor using black hydrophobic polymer blade coating, tower, and 2 year Limited Warranty from date of Commissioning. Nacelle price is EX WORKS Northern's factory, Barre, VT.			\$ 347,500	\$ -
Electrical Output Options					
3	60Hz, 480V, 3-phase. UL & CSA Compliant			included in the "Turbine" price	\$ -
4	50Hz, 480V, 3-phase. CE Certified			included in the "Turbine" price	\$ -
Rotor Options					
5	Class II, 21m blade set, includes 3 blades. Price is EX WORKS, Third-party Point of Manufacturer, National City, CA.			included in the "Turbine" price	\$ -
Tower Options					
6	37m tower Price is F.O.B. USA - Storage Facility, Tacoma, WA			included in the "Turbine" price	\$ -
7	30m tower Price is F.O.B. USA - Storage Facility, Tacoma, WA	Pre-Order; 16-week lead time		included in the "Turbine" price	\$ -
Miscellaneous Options					
8	FAA Light: L810 Obstruction Lighting Kit			\$ 2,500	\$ -
9	Anchor Bolt Template Ring			\$ 3,900	\$ -
10	Anchor Bolt Embedment Ring			\$ 4,900	\$ -
11	Annual Maintenance Kit			\$ 500	\$ -
12	Wind for Schools Package - for 5 yrs; includes PublicView and StudentView			\$ 6,000	\$ -
13	Public View - 5 yrs - Contract provides Web Hosting			\$ 4,000	\$ -
14	Admin View - LIFETIME LICENSE			INCLUDED	\$ -
15	Admin View - Annual License fee - Per Additional User			\$ 600	\$ -
16	Brake Pad Replacement Kit			\$ 2,225	\$ -
17	Dispatch Load Controller for Wind-Diesel Applications	Pre-Order; 6 Month lead time		\$ 25,000	\$ -
18	Secondary Load Controller for Wind-Diesel Applications	Pre-Order; 6 Month lead time		\$ 147,500	\$ -

- The preceding prices do not include taxes (sales and use, VAT or other), tariffs, import or export duties, shipping, delivery, set fees or any materials, which are all payable by the Buyer, unless specifically listed otherwise above. Buyer shall pay any and all taxes and charges or provide Northern with acceptable exemption certificates before execution of Product Sales Agreement and payment of initial non refundable deposit per Exhibit B.
- All items identified as Pre-Order are subject to change in terms of availability, price or final specification. Should Northern make any such modifications the item will be cancelable at the discretion of the customer and the individual item will be subject to full refund.
- Wind for Schools Package - for 5 yrs; includes PublicView and StudentView (up to 50 seats using lite version of AdminView)

2. Shipping; Product Delivery

Northern's Shipping of Products at the point of manufacture or EX WORKS location shall constitute delivery to Buyer in strict accordance with Section 2 of the Product Sales Agreement. Buyer may request delay in delivery pursuant to Section 8 of the Product Sales Agreement; if delay is requested, Northern may make delivery by shipping Products to one or more storage facilities at expense of Buyer. Upon payment to Northern of any unpaid invoice relating thereto, Buyer may draw such Products from storage and arrange with a carrier for shipment to the site Buyer designates.

Guaranteed Shipping Dates and Estimated Transit Time		
Unit 1	Equipment	Estimated Transit Time
Destination Address*:	Nacelle Date: _____	Continental US: (1- 8 days) - New England 1-3 days - Midwest 2-5 days - West Coast 5-8 days Alaska/Hawaii: 14 days Europe: 14 days
	Tower Date: _____	Continental US: (14-21 days) - New England 18-21 days - Midwest 16-19 days - West Coast 14 days Alaska/Hawaii: 10-14 days Europe: 21 days
	Blades Date: _____	Continental US: (1- 8 days) - New England 5-8 days - Midwest 2-5 days - West Coast 1-4 days Alaska/Hawaii: 7-14 days Europe: 14-21 days

Insert/Complete one Table per Turbine for Unit XX		
Address:	Equipment	Estimated Transit Time
	Nacelle Date: _____	As per Unit 1 above
	Tower Date: _____	As per Unit 1 above
	Blades Date: _____	As per Unit 1 above

* Shipping destinations can be modified up to 5 days prior to Shipping upon mutual consent.
For All International exports - The following product percentage (%) splits will be used for purposes of representing value of Individual shipments on Commercial Shipping Invoices to satisfy local custom requirements. These percentages should be applied to the per unit pricing stated above:
Nacelle - 80%
Tower - 10%
Blades - 10%

3. Services

Item #	Service Description	Quantity	Unit Price (US\$)	Total Price (US\$)
Training Services				
19	Installation Training (3 Days) in Barre, VT		\$ 3,500	\$ -
20	O&M Level1 Technician Training in Barre, VT		\$ 500	\$ -
21	O&M Level 2 Advanced Technician Training in Barre, VT		\$ 1,050	\$ -
22	ON SITE - O&M Level1 Technician Training (Travel and Lodging Expenses Additional)		\$ 4,000	\$ -
Installation Support & Commissioning Services (Per Turbine)				
23	Field Service Installation support, CONUS	ESTIMATE ONLY	\$ 7,000	\$ -
24	Field Service Installation support, OCONUS/Int'l	ESTIMATE ONLY	\$ 10,500	\$ -
25	Field Service Commissioning, CONUS - MANDATORY	ESTIMATE ONLY	\$ 7,000	\$ -
26	Field Service Commissioning, OCONUS/Int'l - MANDATORY	ESTIMATE ONLY	\$ 10,500	\$ -
27	Field Service Commissioning, CONUS - Dispatch Load Controller for Wind-Diesel Applications Only	ESTIMATE ONLY	\$ 8,750	\$ -
28	Field Service Commissioning, OCONUS/Int'l - Dispatch Load Controller for Wind-Diesel Applications Only	ESTIMATE ONLY	\$ 11,750	\$ -
29	Field Service Commissioning, CONUS - Secondary Load Controller for Wind-Diesel Applications Only	ESTIMATE ONLY	\$ 14,000	\$ -
30	Field Service Commissioning, OCONUS/Int'l - Secondary Load Controller for Wind-Diesel Applications Only	ESTIMATE ONLY	\$ 18,800	\$ -
	Note: CONUS = Continental US; OCONUS = Outside Continental US			
Services Agreements (See Exhibit G)				
31	Two-year Limited Parts Warranty (years 1 & 2)*		INCLUDED	\$ -
32	Two-year 24 X 7 Monitoring (years 1 & 2)		INCLUDED	\$ -
33	Two-year Preventative Maintenance Provided by Northern (years 1 & 2) **	ESTIMATE ONLY	\$ 4,200	\$ -
34	24 X 7 Monitoring (\$1,200/year)		\$ 1,200	\$ -
35	Preventative Maintenance Provided by Northern - \$4,200/year	ESTIMATE ONLY	\$ 4,200	\$ -
36	Extended Limited Parts Warranty (Years 3 - 5)*** - \$3,200/year		\$ 9,600	\$ -
37	24 X 7 Monitoring (years 3 - 5) MANDATORY if Extended Limited Parts Warranty is purchased - (\$1,200/year)		\$ 3,600	\$ -
38	Brake Pad Maintenance, (Approx Year 5) ****		\$ 3,200	\$ -
Travel & Expenses Budgets				
39	Travel & expenses, CONUS	ESTIMATE ONLY	\$ 2,000	\$ -
40	Travel & expenses, OCONUS/Int'l	ESTIMATE ONLY	\$ 4,000	\$ -
Freight & Cargo Insurance				
41	CONUS Cargo Insurance Option		\$ 250	\$ -
42	OCONUS Cargo Insurance option		\$ 400	\$ -
43	Supply Chain Delivery Program - BLADES Option; Direct to Barre, VT		\$ 1,700	\$ -
44	Supply Chain Delivery Program - TOWER Option; Direct to Barre, VT		\$ 3,000	\$ -

- * Two (2) year Limited Parts Warranty is only available if commissioning is provided by Northern and a Preventative Maintenance Contract with an Authorized Service Partner is in effect.
- ** Two (2) year Preventative Maintenance Provided By Northern at the end of year 1- includes: One (1) Trip which includes Labor and CONUS Travel as well as consumables.
- *** The Extended Limited Parts Warranty (Years 3-5) is only available if a Preventative Maintenance Contract with an Authorized Service Partner is in effect and Smartview 24 X 7 Monitoring has been purchased. Extended Limited Parts Warranty is also exclusive of Freight Charges -Please refer to Exhibit D for detail.
- **** 5th yr Brake Pad Maintenance includes Consumables and Labor. Travel expenses billed separately if not performed during Annual Preventative Maintenance

- All items identified as ESTIMATE ONLY will be invoiced based on actual days (labor) and/or cost (expenses), in accordance with Northern's prevailing Commercial Rate Schedule.
- "Field Service Installation Support" shall consist of oversight of the following activities: unloading; tower unpacking; grout installation; tower and nacelle rigging and hoisting; tower section placement and bolt tensioning; rotor blade pitching; rotor rigging, hoisting, placement and bolt tensioning; down-tower electrical cabling & connections.
- "Field Service Commissioning" shall consist of the following activities: verifying installation completion, electrical connections, & bolt tensioning; performing all startup activities; completing commissioning checklist; obtaining commissioning checklist signoff by Buyer or End-user as appropriate; issuing Commissioning Certificate.

4. Buyer Requirements

This Agreement is based on the Buyer complying with the following material requirements, at the Buyer's expense and before Northern field installation support personnel arrive on site.

- The Turbine site will have the foundation completed and transformer installed and tied into the grid.
- Others shall install fiber communication lines and fiber terminations or wireless transceivers for communication between Turbine and location of SmartView server. Northern shall have terminated connections available to hook up to the Turbine controllers.
- Others shall provide Internet connectivity to each Turbine. Internet connection shall comply with specification in published Northern documentation, including A00298 Northwind 100 Application Requirements.

5. Specific Exclusions

This Agreement specifically excludes the following items, which shall be the responsibility of Buyer:

- Foundation and mounting hardware for the tower-to-foundation connection.
- Foundation materials and foundation parts.
- Interconnection transformer.
- Installation and erection labor, material, and equipment.
- Internet Connectivity



Exhibit B: Payment Terms

1. All payments shall be in U.S. dollars. Past-due invoices shall be subject to interest charges at the rate of 1.5% per month.

2. The **Product** payment milestones are as follows:

- (i) 10% of the Total Product Value ("TPV") is due from Buyer upon execution of this Agreement, at which time the Agreement shall become effective. This 10% payment is nonrefundable and nontransferable.
- (ii) 15% of TPV is due from Buyer upon the earlier of (i) thirty (30) days after execution of this Agreement or (ii) five (5) days prior to Guaranteed Shipping Date of the Nacelle as agreed in Exhibit A, pro-rated per unit.
- (iii) 25% of TPV is due from Buyer upon the earlier of (i) ninety (90) days after execution of this Agreement or (ii) five (5) days prior to Guaranteed Shipping Date of the Nacelle as agreed in Exhibit A, pro-rated per unit.
- (iv) 40% of TPV is due from Buyer upon Shipping of the Product, net 10 days from receipt of invoice, pro-rated per unit.
- (v) 10% of TPV is due from Buyer, net 10 days from receipt of invoice issued on the earlier of (i) commissioning date of the Product or (ii) 180 days following Shipping of the Product, pro-rated per unit.

In the event payment is not made when due in accordance with these milestones, and such payment default is not cured within ten (10) days, Northern shall have the right to declare this Product Sales Agreement in breach and to pursue all remedies provided in connection therewith.

3. **Service** payment terms are as follows:

- (i) All Services shall be paid by Buyer, net 30 days from receipt of invoice.
- (ii) In the event that, at the time the Product is ready for commissioning, Buyer has failed to pay the 90% of TPV in accordance with section 2 above, Northern shall not be required to commission the Product or otherwise make it available to Buyer for use.
- (iii) Buyer shall make all Service payments due to Northern hereunder without deduction, set-off or counterclaim.

4. Buyer shall be liable for all costs of collection incurred by Northern, including reasonable attorneys' fees.

5. A failure by Buyer to pay any amount due under this Exhibit B shall be deemed a material breach of this Agreement.

6. As of the execution date of this Agreement, Northern's designated bank for wire transfers, together with wire instructions, is as follows:

TD Bank
P.O. Box 329
Waitsfield, VT 05673-0329
Wire Transfer Routing:
ABA Number: 011600033
Account Number: 5241594367
Credit: Northern Power Systems, Inc.



Exhibit D: Limited Warranty Northwind® 100 Wind Turbine

1. LIMITED WARRANTY. Northern hereby warrants that on and subject to the terms and conditions hereof (i) the Turbine listed in Exhibit A shall be substantially free from defects in material and workmanship, (ii) the Turbine listed on Exhibit A shall substantially conform to the Specifications listed in Exhibit C, and (iii) the Services purchased by Buyer as indicated in Exhibit A will be performed by a Northern certified technician, or an authorized Development Partner or authorized Service Partner, using reasonable skill and care (collectively, the "Limited Warranty").

2. THIRD PARTY PRODUCTS. Northern makes no representations or warranties whatsoever with regard to (i) any Product listed on Exhibit A other than the Turbine, or (ii) any third party products that are add-ons, attachments or enhancements to the Turbine (such as a transformer). Northern will transfer and assign to Buyer the warranties, if any, received by Northern from third party manufacturers of Products other than the Turbine, to the extent such warranties are transferable by their terms. Buyer expressly acknowledges that the Limited Warranty contained in Section 1 does not apply or relate to Products other than the Turbine.

3. LIMITED WARRANTY ITEMS COVERED.

(a) The Limited Warranty covers all Turbine parts and Installation and Commissioning Services for Ninety (90) days from completion of Installation and Commissioning Services.

(b) Providing that commissioning services are performed by a Northern-certified commissioning service provider, and a Preventative Maintenance Contract with an Authorized Service Partner is in effect and SmartView 24 X 7 Monitoring is maintained the Limited Warranty on all Turbine parts shall extend for twenty-four (24) months from the date of commissioning or thirty (30) months from date of Shipping, whichever occurs first.

(c) Repair or replacement parts for Turbine: The Limited Warranty shall extend for Ninety (90) days from delivery of replacement parts or the remainder of the original Limited Warranty period, whichever is greater.

4. EXTENDED LIMITED WARRANTY. Northern may, at its sole discretion, offer up to an additional three (3) years of extended Limited Warranty for the Turbine covered under Article 3(a) of this Limited Warranty. The extended warranty will only be offered at the time of the original sale and is effective only if listed in Section 3 of Exhibit A and paid for by Buyer. The extended warranty hereunder, if any, shall not apply to Services.

5. REPAIR OR REPLACEMENT PARTS. All right, title and interest in any repair or replacement parts returned to Northern under this Limited Warranty vest in Northern upon receipt. Northern reserves the right to use refurbished, repaired or reclaimed parts in its performance under this Limited Warranty.

6. EXCLUDED FROM THIS LIMITED WARRANTY. The following shall be excluded from the Limited Warranty:

(a) All labor costs, including costs associated with travel, travel expenses, and other miscellaneous costs for field services, shall be on the account of the Buyer.

(b) Parts and items considered consumable in normal operations, including those parts and items supplied with the Turbine for maintenance, as well as maintenance services covered in Section 7 below.



- c) Any Turbine and its parts that are not installed, operated, and maintained in accordance with the unit's Operation & Maintenance Manuals.
- (d) All site preparation activities.
- (e) All foundation labor, parts, and materials, including mounting hardware for the tower-to-foundation connection.
- (f) All electrical interconnection labor, material and equipment, including the interconnection transformer.
- (g) All installation or erection labor, material, and equipment.
- (h) Damages due to accident, abuse, acts of God, acts of terrorism, misuse or negligence, or which result, in whole or in part, from improper or unauthorized use or repair of the System, third-party fabricated items (including but not limited to foundations), external electrical disturbances by equipment or goods not produced by Northern (including but not limited to electrical networks) or use of the Turbine in a manner for which it was not designed, or by other causes external to the Turbine.
- (i) Damages due to operation of the Turbine outside the specified range of environmental operational conditions.
- (j) Damages due to ordinary wear and tear.

7. MAINTENANCE. Northern's obligations under this Limited Warranty are contingent upon:

- (a) **Preventative Maintenance:** All preventative maintenance will be performed by a Northern-employee, a Northern-certified technician, or an Authorized Service Partner. Regular and scheduled maintenance actions, in accordance with procedures outlined in Northern's Operation and Maintenance Manuals will be performed on the Turbine and its associated equipment,
- (b) **Unscheduled Maintenance:** All unscheduled maintenance and repairs will be performed by a Northern-employee, a Northern-certified technician, or an Authorized Service Partner.
- (c) **Connectivity:** Buyer will provide Northern Internet access to the Turbine continually for the duration of any Limited Warranty term at the Buyer's expense.

8. REMEDY. Buyer's sole and exclusive remedy for a breach of this Limited Warranty shall be the adjustment, repair, or replacement of the defective item or part with a similar item or part free of defect. Such adjustments, repairs, or replacements will be made at Northern's Barre, Vermont, plant or at the site of the Turbine, if Northern so elects. All costs for shipping equipment or parts shall be responsibility of the Buyer EX WORKS (Incoterms 2000). All labor costs, including costs associated with travel, travel expenses, and subsistence costs for field services, as well as for services provided at Northern's Barre, Vermont, plant, shall be on the account of the Buyer per Exhibit G Service Agreement. This Limited Warranty shall only apply if Buyer gives Northern written notice of the alleged breach of the Limited Warranty within ten (10) days following the date upon which the breach is discovered by Buyer.

9. VOIDING OF THE LIMITED WARRANTY. This Limited Warranty is immediately void upon:

- (a) THE DISASSEMBLY OF THE WIND TURBINE PRODUCT, OR
- (b) THE DISASSEMBLY OF THE WIND TURBINE POWER SYSTEM, OR



(c) BUYER'S FAILURE TO COMPLY WITH ANY APPLICABLE HEALTH AND SAFETY LAWS OR REGULATIONS, OR

(d) THE SALE, ASSIGNMENT OR ANY OTHER TRANSFER OF TITLE BY BUYER OF THE ITEMS OR PARTS OTHERWISE COVERED UNDER THIS LIMITED WARRANTY, WITH THE EXCEPTION OF A TRANSFER OF TITLE FROM BUYER TO AN END-USER, IF ANY, IDENTIFIED IN SECTION 13 OF THIS EXHIBIT D.

(e) Exposure to Extreme Winds Described Below:

ANY GEOGRAPHIC LOCATION COULD AT SOME TIME BE EXPOSED TO EXTREME WIND GUSTS DUE TO SEVERE WEATHER SITUATIONS SUCH AS STORMS, HURRICANES, TORNADOS OR MICROBURSTS. NORTHERN POWER SYSTEMS WIND TURBINES ARE DESIGNED TO WITHSTAND WIND LOADING TO CERTAIN LEVELS DURING EXTREME WEATHER EVENTS. THOSE LIMITING WIND LOADS ARE DESCRIBED IN THE INTERNATIONAL DESIGN AND SAFETY STANDARD FOR WIND TURBINES (IEC-61400-1), WHICH DEFINES THE MAXIMUM GUST WITH AN EXPECTED RECURRENCE PERIOD OF 50 YEARS. THE TERMS AND VALUES IN THE PARAGRAPH BELOW ARE DESCRIBED IN EXHIBIT C (GENERAL SPECIFICATIONS – DOCUMENT # A01465) – TABLE 4 IEC WTGS CONDITIONS. METEOROLOGICAL MODELS OF STORM CONDITIONS ARE NOT ABLE TO ADEQUATELY PREDICT EXTREME WIND FORCES; THEREFORE SPECIFIC TURBINE FAILURE MODES CANNOT BE GENERALIZED. POSSIBLE FAILURE MODES INCLUDE TOWER BUCKLING, OVERTURNING, BLADE BUCKLING AND REDUCTION OF TURBINE COMPONENT LIFETIME; NOTWITHSTANDING SUBSEQUENT DAMAGE CREATED IN STORMS BY FLYING DEBRIS OF ALL TYPES. DAMAGE EXPECTED FROM EXTREME WINDS IS DESCRIBED BY THE NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION. COMPLETE INFORMATION CAN BE FOUND AT THE NOAA WEBSITE WWW.NHC.NOAA.GOV.

10. WAIVER OF ALL OTHER WARRANTIES. THE LIMITED WARRANTY PROVIDED HEREUNDER AND THE RIGHTS AND REMEDIES OF THE BUYER HEREUNDER ARE IN LIEU OF, AND BUYER EXPRESSLY WAIVES, ALL OTHER WARRANTIES, GUARANTEES, OBLIGATIONS, LIABILITIES, OR REMEDIES, EXPRESSED OR IMPLIED, ARISING BY LAW OR OTHERWISE, INCLUDING WITHOUT LIMITATION IMPLIED WARRANTIES OF MERCHANTABILITY AND NON-INFRINGEMENT, IMPLIED WARRANTIES ARISING FROM THE COURSE OF DEALING OR USAGE OF TRADE AND IMPLIED WARRANTIES OF SUITABILITY OR FITNESS FOR A PARTICULAR PURPOSE.

11. LIMITATION OF LIABILITY.

(a) NORTHERN SHALL NOT BE LIABLE TO BUYER FOR ANY INCIDENTAL, CONSEQUENTIAL, SPECIAL, PUNITIVE, INDIRECT OR EXEMPLARY DAMAGES ARISING OUT OF THIS AGREEMENT OR THE LIMITED WARRANTY, INCLUDING BUT NOT LIMITED TO LOST PROFITS OR COSTS OF COVER, LOSS OF REVENUE, LOSS OF PRODUCTION, LOSS OF USE OR BUSINESS INTERRUPTION OR THE LIKE, REGARDLESS OF WHETHER NORTHERN WAS ADVISED OR AWARE OF THE POSSIBILITY OF SUCH DAMAGES.

(b) IN NO EVENT WILL THE TOTAL LIABILITY OF NORTHERN ARISING OUT OF THIS AGREEMENT OR THIS LIMITED WARRANTY EXCEED THE AMOUNT PAID OR PAYABLE TO NORTHERN UNDER THIS AGREEMENT WITH REGARD TO THE NORTHWIND® 100 WIND TURBINE(S) DESCRIBED IN SECTION 1 OF EXHIBIT A OF THE AGREEMENT. THIS LIMITATION SHALL APPLY REGARDLESS OF THE FORM OF ACTION, WHETHER IN CONTRACT, TORT, NEGLIGENCE, STRICT LIABILITY, CONTRIBUTION OR OTHERWISE.



12. SUBCONTRACTORS. Northern may, at its discretion, subcontract such obligations under this Limited Warranty as it deems advisable, subject to Buyer's right to object to any particular subcontractor for cause.

13. ASSIGNMENT. This Limited Warranty is not assignable by the Buyer without the express written consent of Northern. Any attempt or purported assignment of this Limited Warranty shall be void ab initio. Northern hereby expressly consents to the assignment of this Limited Warranty from Buyer to the End-User designated below, provided, that, (i) Northern's obligations to End-User shall be exclusively limited to the terms and conditions of this Limited Warranty, (ii) End-User may not further assign this Limited Warranty without the express written consent of Northern, (iii) End-User shall strictly adhere to all of the terms and conditions imposed upon Buyer in this Limited Warranty as if End-User was substituted for "Buyer" hereunder, (iv) the Limited Warranty shall be ineffective and without force or effect unless and until Buyer has fully paid for the Products and Services, (v) in making such assignment, Buyer shall not increase, expand or otherwise amend or modify the terms and conditions of this Limited Warranty, (vi) End-User shall make all claims under this Limited Warranty directly to Northern, (vii) Buyer shall provide End-User with a copy of this Limited Warranty, and (viii) End-User has executed and delivered to Northern the End-User Acknowledgment in the form of Exhibit F.

The following entity or individual is designated by Buyer, and accepted by Northern, as the End-User for purposes of this Limited Warranty (if there is no End-User under this Agreement, please insert "none" in the blank

[Insert name of End-User, with contact information, or state "none"]



Page F1

Exhibit F: Northwind® 100 End-User Acknowledgment
(To Be Executed Upon Commissioning)

THIS END USER ACKNOWLEDGMENT ("End-User Acknowledgment") is made and entered into as of this _____ day of _____, 20____, by _____, a _____ [form of business entity and jurisdiction of organization], having its principal place of business at [_____] ("End-User"), in favor of NORTHERN POWER SYSTEMS, INC., a Delaware corporation, having its principal place of business at 29 Pitman Road, Barre, Vermont, 05641 USA ("Northern").

WHEREAS, End-User or _____ (the "Buyer") entered into a Product Sales Agreement dated as of _____, 2009 (the "PSA"), pursuant to which Buyer agreed to purchase from Northern certain Products and/or Services, a copy of which together with relevant Exhibits thereto has been provided to, and reviewed by End-User, and is attached hereto for ease of reference;

WHEREAS, the PSA relates to the wind turbine(s) bearing serial number(s) _____, which pursuant to the PSA has/have the benefit of a Limited Warranty for a period of _____ years ending _____;

WHEREAS, End-User is familiar with the terms of the PSA, and has had the opportunity to review and discuss with Northern any questions it may have in connection with the PSA;

WHEREAS, capitalized terms used herein but not defined shall have the meanings ascribed to them in the PSA;

WHEREAS, the PSA contemplates that Buyer may re-sell or transfer the Products and/or Services subject to the PSA to a designated customer or end user, provided that to have the benefit of the Limited Warranty, any resale or transfer of the Products and/or Services may only be made in strict compliance with the terms and conditions of the PSA, including without limitation, Section 18 End-User Acknowledgement and Exhibit D Limited Warranty of the PSA;

WHEREAS, End-User has received the Operations and Maintenance Manuals provided by Northern in connection with the sales of the Turbine;

WHEREAS, End-User now wishes to execute this End-User Acknowledgment in order to (i) receive the benefit of the Limited Warranty (Exhibit D to the PSA) and (ii) acknowledge certain other terms and conditions of the PSA, for the purpose of having the benefit thereof and being bound thereby; Northern wishes expressly to accept this End-User Acknowledgement; and Buyer wishes to confirm by its execution hereof that it has fulfilled its obligations under the PSA;

NOW, THEREFORE, IN CONSIDERATION OF THE FOREGOING, EACH OF THE UNDERSIGNED HEREBY AGREES AND ACKNOWLEDGES:

1. Terms of Limited Warranty. In accordance with Exhibit D of the PSA, End-User hereby acknowledges that: (i) Northern's obligations to End-User shall be exclusively limited to the terms and conditions of the Limited Warranty, (ii) End-User may not further assign the Limited Warranty without the express written consent of Northern, (iii) End-User shall strictly adhere to all of the terms and conditions imposed upon Buyer in the Limited Warranty as if End-User was substituted for "Buyer" thereunder, (iv) the Limited Warranty shall be ineffective and without force or effect unless and until Buyer has fully paid for the Products and Services, (v) in assigning the Limited Warranty to End-User, Buyer has not increased, expanded or otherwise amended or modified the terms and conditions of the Limited Warranty, (vi) End-



User shall make all claims under the Limited Warranty directly to Northern, (vi) Buyer has provided End-User with a copy of the Limited Warranty and the Specifications.

2. End-User acknowledges that they have a valid service agreement with Northern or an Authorized Service Partner or certified technician and the Buyer has properly transferred all rights and responsibilities to the End-User in fulfillment of the limited warranty (exhibit D).

3. CONFIDENTIALITY AND INTELLECTUAL PROPERTY.

3.1 End-User expressly recognizes that (i) the software and/or firmware associated with the SmartView remote monitoring system and related user manuals (the "SmartView Software"), (ii) the software and/or firmware associated with the direct drive generator and the power converter and related user manuals (the "Turbine Control" and "Power Electronics Software") used with or included in the Turbine, and (iii) the design of Turbine, including the direct drive generator and the power converter, embody and constitute confidential and proprietary information of Northern ("Confidential Information"). Such direct drive generator and power converter, excluding the Turbine Control and Power Electronics Software, are collectively referred to herein as the "Power System." End-User shall not tamper with, disassemble, modify, or reverse engineer any part of the Power System, either supplied by Northern as part of a system or as a separate item, nor shall End-User disassemble, reverse compile or reverse engineer any SmartView Software, or Turbine Control and Power Electronics Software. End User acknowledges that the disclosure by End-User of Confidential Information may cause irreparable injury to Northern and damages that may be difficult to ascertain. **IN THE EVENT OF THE ACTUAL OR THREATENED DISCLOSURE OF CONFIDENTIAL INFORMATION, NORTHERN SHALL, IN ADDITION TO ANY OTHER RIGHTS OR REMEDIES AND NOTWITHSTANDING SECTION 17 OF THIS AGREEMENT, BE ENTITLED TO INJUNCTIVE RELIEF FROM A COURT OF COMPETENT JURISDICTION TO PROTECT AND RECOVER THE CONFIDENTIAL INFORMATION; NORTHERN RESERVES ALL RIGHTS TO PURSUE AND OBTAIN APPROPRIATE LEGAL AND EQUITABLE REMEDIES FOR ANY VIOLATION OF THIS SECTION 12,** End-User shall not object to the entry of an injunction or other equitable relief against End-User on the basis of an adequate remedy at law, lack of irreparable harm or any other reason.

3.2 Subject to the terms of this Agreement, Northern hereby grants End-User a non-exclusive, personal, non-transferable right and license under its intellectual property to use the Turbine Control and Power Electronics Software solely for End-User's internal business purposes and in connection with the operation of the Turbine. The cost of this license is included within the price of the Turbine. Northern shall not be required to provide End-User with maintenance, support or updates regarding the Power System and the Turbine Control and Power Electronics Software.

3.3 Subject to the terms of this Agreement, Northern hereby grants End-User a non-exclusive, personal, non-transferable, right and license under its intellectual property to use the SmartView Software, solely for End-User's internal business purposes and in connection with the operation of the Turbine. The cost of a single-seat license is included within the price of the Turbine. Northern shall not be required to provide End-User with maintenance, support or updates regarding the SmartView Software. End-User acknowledges that the SmartView Software is not intended to be used as billing software or to otherwise calculate charges or credits for electricity generated by the Turbine. End-User acknowledges that Northern has an absolute and unconditional right to monitor the performance of any Turbine, including via SmartView monitoring, and expressly and irrevocably confirms here its permission for Northern to do so. End user acknowledges connectivity to the internet must be maintained at its expense to i) hold in effect warranty (exhibit D) ii) for any and all monitoring services during the life of the warranty. Maintaining Internet connectivity is exclusive of temporary power outages beyond the control of the buyer or end user.

3.4 End-User shall be responsible for providing and maintaining adequate computer hardware and software and connectivity, including timely site preparation prior to commissioning to support the



operation of the Turbine, the Turbine Control and Power Electronics Software and the SmartView Software.

3.5 Upon any termination of this Agreement for any reason, (i) the licenses granted hereunder shall terminate, (ii) End-User shall cease using the Turbine Control and Power Electronics Software and the SmartView Software, and (iii) End-User shall return all documentation provided by Northern in relation to the Turbine Control and Power Electronics Software and the SmartView Software.

3.6 Except as otherwise provided in this Section 3, this Agreement does not grant to Buyer or End-User any right, title, or interest in or to Northern's intellectual property, other proprietary rights or other information, including, but not limited to, Northern's name, trade marks, trade names, trade dress, trade symbols, copyrights, patents, patent applications, inventions, trade secrets, customer lists, product names or designations, processes, designs, or formulas.

3.7 This Section 3 shall survive the termination of this Agreement.

4. LIMITATION OF LIABILITY.

4.1 NORTHERN SHALL NOT BE LIABLE TO BUYER OR END-USER FOR ANY INCIDENTAL, CONSEQUENTIAL, SPECIAL, PUNITIVE, INDIRECT OR EXEMPLARY DAMAGES ARISING OUT OF THIS AGREEMENT OR THE LIMITED WARRANTY, INCLUDING BUT NOT LIMITED TO LOST PROFITS OR COSTS OF COVER, LOSS OF REVENUE, LOSS OF PRODUCTION, LOSS OF USE OR BUSINESS INTERRUPTION OR THE LIKE, REGARDLESS OF WHETHER NORTHERN WAS ADVISED OR AWARE OF THE POSSIBILITY OF SUCH DAMAGES.

4.2 IN NO EVENT WILL THE TOTAL LIABILITY OF NORTHERN ARISING OUT OF THIS AGREEMENT OR THE LIMITED WARRANTY EXCEED THE AMOUNT PAID OR PAYABLE TO NORTHERN UNDER THIS AGREEMENT WITH REGARD TO THE NORTHWIND® 100 WIND TURBINE(S) DESCRIBED IN SECTION 1 OF EXHIBIT A OF THE AGREEMENT. THIS LIMITATION OF THE TOTAL LIABILITY OF NORTHERN SHALL APPLY REGARDLESS OF THE FORM OF ACTION, WHETHER IN CONTRACT, TORT, NEGLIGENCE, STRICT LIABILITY, CONTRIBUTION OR OTHERWISE. THIS IS NOT A LIMITATION OF THE TOTAL POTENTIAL LIABILITY OF BUYER OR END-USER FOR ANY VIOLATION OF SECTION 12 OF THIS AGREEMENT "CONFIDENTIALITY; INTELLECTUAL PROPERTY", ANY OF SUCH LIABILITY MAY EXCEED THE AMOUNT PAID OR PAYABLE TO NORTHERN UNDER THIS AGREEMENT.

5. SAFETY; COMPLIANCE WITH APPLICABLE LAW.

5.1 END-USER ACKNOWLEDGES THAT, AS WITH ANY SOPHISTICATED INDUSTRIAL MACHINERY, THE PRODUCT MAY BE UNSAFE OR EVEN DANGEROUS IF NOT OPERATED WITH DUE CARE AND CONSISTENT WITH THE OPERATIONS AND MAINTENANCE MANUAL PROVIDED BY NORTHERN. UNSAFE OPERATION OF THE PRODUCT – INCLUDING BY PROVIDING ACCESS THERETO TO PERSONS OTHER THAN QUALIFIED REPAIR AND MAINTENANCE PROFESSIONALS -- MAY CREATE CIRCUMSTANCES THAT COULD CAUSE SERIOUS INJURY, DEATH, OR PROPERTY DAMAGE. OPERATION OF THE PRODUCT OTHERWISE THAN IN STRICT AND FULL COMPLIANCE WITH OPERATIONS AND MAINTENANCE MATERIALS PROVIDED BY NORTHERN WILL LIMIT OR ELIMINATE THE OPERABILITY OF THE TURBINE AND SHALL VOID THE LIMITED WARRANTY. END-USER ACKNOWLEDGES THAT IT IS END-USER SOLE RESPONSIBILITY TO ENSURE SAFE OPERATION OF THE PRODUCTS.



5.2 End-User shall comply with all applicable laws and regulations related to the purchase of the goods and services under this Agreement including but not limited to, environmental regulations, technical standards and export controls. Goods shall not be exported or transshipped contrary to U.S. law. If Products are to be shipped to a destination outside of the United States, End-User is the exporter of record and solely responsible to acquire any required export license. Northern will assist in supply of information required in the application process.

5.3 End-User's use of the Products shall comply with (i) all applicable health and safety laws and regulations, and (ii) Northern's Operations and Maintenance Manuals.

The undersigned End-User hereby executes this End-User Acknowledgment as of the date above indicated for the purpose of (i) accepting from Buyer the assignment of the Limited Warranty contained in the PSA upon the terms and conditions contained herein and in the PSA, and (ii) having the benefit of, and being bound by, certain other provisions of the PSA, as set forth herein.



End-User

By: _____
Signature

Name _____
Print/Type

Title _____
Print/Type

Northern

Northern hereby executes this End-User Acknowledgement as of the date above indicated to confirm its acceptance hereof.

NORTHERN POWER SYSTEMS, INC.

By: _____

Name/Title: _____

BUYER hereby executes this End-User Acknowledgment as of the date above indicated to confirm it has fulfilled its obligations under the PSA.

Buyer

By: _____

Name:

Title: _____

Attachment 1: Copy of extended service agreement between End-User and Northern, End-User and an Authorized Service Partner or designation of Northern-Certified Technicians responsible for maintenance of the Turbine(s).

Attachment 2: Copy SmartView documentation form.



Exhibit G: Service Agreement
Northwind® 100 Wind Turbine

This Service Agreement is made as of _____, 20____, by and between _____, the owner ("End-User") of a Northwind 100 Wind Turbine ("Turbine") and Northern Power Systems, Inc. ("Northern") with respect to maintenance and repair of the Turbine(s) indicated on **the attached Service Agreement Rate Sheet**. The term of this Service Agreement shall be for _____ (x) years commencing on: _____.

1. Covered Services

End-User hereby engages Northern to provide, and Northern hereby agrees to provide the services as detailed in the Service Agreement Rate Sheet, Maintenance Schedule, and consistent with Section 8 of the Operations & Maintenance Manual ("Services").

Additional Services

End-User may purchase additional services under this Agreement by making such a request to the Northern Service Department detailing the nature and type of services required, the dates for the services to be delivered, and the primary End-User contact. Northern will provide the End-User with a Service Order in a timely fashion that details the scope of services, the scheduled services dates, and the fee and expenses for such services. Northern will only provide such services once the Service Order has been prepared and approved by the End-User.

2. Provision of Services

In the provision of these services, End-User and Northern agree on the following terms and conditions:

Northern will provide the services in accordance with the Maintenance Schedule which may be revised in the normal course of business based on the turbine's maintenance standards and fleet maintenance history.

End-User shall at all times observe the guidance provided in the Operations & Maintenance Manual and updates, thereto provided by Northern, including without limitation the Safety and intellectual property protection terms of the Northwind 100 End User Acknowledgement.

End-User recognizes that Northern may make Turbine control system and software modifications as part of providing Services. Northern also agrees to use commercially reasonable efforts to provide the End-User notice of software upgrades, through email notification, which the End-User may choose to purchase.

End-User agrees to provide Northern prompt unencumbered access to site power and facilities where the Turbine is located for purposes of providing the Services; including arranging all necessary permissions, permits and/or approvals required on a timely basis to facilitate site visits.

End-User agrees to provide a contact person and relevant contact information to Northern for purposes of maintaining updated product and service information as well as for coordinating services hereunder; End-User agrees to keep such information current and up to date.



Page G2

This Service Agreement shall remain valid pending normal operation of the Turbine on a continuous basis in accordance with the guidelines as defined in the Operations & Maintenance Manual.

End-User recognizes that for safety reasons the Turbine will need to be shut off during service. Maintenance will occur during normal business hours Monday through Friday. Other service times are subject to published rates per Northern's Prevailing Commercial Rate Sheet.

Services will be provided only if Northern determines that the Turbine is safe to service and that the End-User represents that to their knowledge there are no prevailing safety issues that would prevent the Turbine from being serviced by Northern or its designee.

End-User will acknowledge its compliance with the Operations & Maintenance Manual and Northern or its designee may ask End-User for a Safety Declaration prior to the performance of the services. If such declaration is not furnished, Northern will investigate the performance history of the turbine and make a judgment on the "serviceability" of the turbine. Northern will promptly notify the End-User of the issues that need to be addressed and reach agreement on a plan to proceed.

3.) Safety. END-USER ACKNOWLEDGES THAT, AS WITH ANY SOPHISTICATED INDUSTRIAL MACHINERY, THE TURBINE MAY BE UNSAFE OR EVEN DANGEROUS IF NOT OPERATED WITH DUE CARE AND CONSISTENT WITH THE OPERATIONS AND MAINTENANCE MANUAL PROVIDED BY NORTHERN. UNSAFE OPERATION OF THE TURBINE – INCLUDING BY PROVIDING ACCESS THERETO TO PERSONS OTHER THAN QUALIFIED SERVICE AND MAINTENANCE PROFESSIONALS -- MAY CREATE CIRCUMSTANCES THAT COULD CAUSE SERIOUS INJURY, DEATH, OR PROPERTY DAMAGE. OPERATION OF THE TURBINE OTHER THAN IN STRICT AND FULL COMPLIANCE WITH OPERATIONS AND MAINTENANCE MATERIALS PROVIDED BY NORTHERN WILL LIMIT OR ELIMINATE THE OPERABILITY OF THE TURBINE AND SHALL VOID THE LIMITED WARRANTY. END-USER ACKNOWLEDGES THAT IT IS END-USER'S SOLE RESPONSIBILITY TO ENSURE SAFE OPERATION OF THE TURBINE.

4.) Fleet or Turbine Monitoring.

End-User grants Northern unconditional access to all information relating to the operation of the Turbine, including electronic access via SmartView to enable Northern to provide continuous monitoring of Turbine operation and performance and access to SmartView hardware at the site where the Turbine is located.

End-User agrees to provide real time Internet access only to Northern or Northern's designated agent. Northern agrees to provide monitoring of the operation and performance of End-User's Turbine through its Network Operations Center, using SmartView or other software data collection and analysis.

5.) Payments:

Payments are to be made by End-User to Northern by check or wire to Northern upon execution of Service Agreement.

Unscheduled maintenance: To be paid within 30 days of service.



Northern
POWER SYSTEMS

Page G3

6.) Contract Renewal:

The Service Agreement will automatically be extended for one (1) year in accordance with prevailing Service Agreement Rate Sheet and Commercial Rate Sheet unless End-User notifies Northern six (6) months prior to end date of this Agreement. Prices as published in the prevailing Service Agreement Rate Sheet and Prevailing Commercial Rate Schedule are subject to adjustment per CPI inflation index. Subsequent year payments shall be made upon the anniversary date of the execution of the Service Agreement.

7.) General Provisions. Any amendment to this Service Agreement shall be in writing signed by both parties. Any controversy, dispute or claim between the Parties not settled by mutual agreement (a "Dispute") will be resolved by final and binding arbitration in Burlington, Vermont, USA: in accordance with the Commercial Arbitration Rules of the American Arbitration Association ("AAA"), and governed by the substantive laws of the State of Vermont, without regard to conflicts-of-laws rules, and by the Federal Arbitration Act (Title 9, U.S. Code). THE PARTIES KNOWINGLY AND VOLUNTARILY WAIVE THEIR RIGHTS TO HAVE ANY DISPUTE TRIED AND ADJUDICATED BY A JUDGE OR A JURY. NEITHER PARTY WILL BE LIABLE TO THE OTHER FOR INDIRECT, CONSEQUENTIAL, SPECIAL, INCIDENTAL or PUNITIVE DAMAGES or LOST PROFITS. Any preprinted terms and conditions contained in any Service Order or other similar document shall be null and void and have no force in modifying the terms of this Service Agreement. This Service Agreement shall be interpreted in accordance with the laws of the State of Vermont. The parties agree to cooperate in mutual good faith to achieve the objective of this Service Agreement, and to negotiate in good faith the resolution of any disagreement arising in connection herewith; in the event good faith negotiations are unable to resolve any disagreement hereunder, the parties agree to submit any disagreement to binding arbitration to be conducted in accordance with the rules of the American Arbitration Association in a proceeding to be conducted in Burlington, Vermont. Any correspondence relating hereto shall be directed to the address indicated for the respective parties below.

The parties hereto, intending to be bound hereby, have caused this Service Agreement to be duly executed by an authorized representative as of the date above indicated.

END-USER:

NORTHERN POWER SYSTEMS, INC.

By: _____

By: _____

Name: _____

Name: _____

Title: _____

Title: _____

Address: _____

Address: _____

Service Department
29 Pitman Road
Barre, Vermont 05641
Tel: 802-461-2955
Fax: 802-461-2998

End-User's Designated Contact Person and contact information:

Name: _____

Title: _____

Phone: _____

Other Contact Information: _____



Service Agreement Rate Sheet:

Turbine Serial Number(s): _____

Warranty & Maintenance Services (Per Turbine)	Units	PRICE	Total
YEARS 1-2			
Two-year Limited Parts Warranty (years 1 - 2)*		INCLUDED	INCLUDED
Two-year SmartView 24 X 7- Monitoring (years 1- 2)		INCLUDED	INCLUDED
Two-year Preventative Maintenance Provided by Northern (years 1 -2) ** (estimated \$4,200/Year)		Time and Materials Per Prevailing Commercial Rate Schedule	
YEARS 3-5			
Extended Limited Parts Warranty***		\$ 3,200/year	
SmartView 24 X 7 Monitoring - MANDATORY if Extended Limited Parts Warranty is purchased		\$ 1,200/year	
Brake Pad Maintenance (Approx Year 5)****		\$ 3,200	
ANNUAL			
SmartView 24 X 7 Monitoring (Annually)		\$ 1,200/year	
Preventative Maintenance Provided by Northern (Annually)		Time and Materials Per Prevailing Commercial Rate Schedule	

Additional Services	
Unplanned Maintenance: - Labor rate for unplanned maintenance and warranty as detailed in Prevailing Commercial Rate Sheet. - Travel expenses to be reimbursed at actual cost + 15%. - Freight or other delivery charges to be reimbursed at actual cost + 15%.	\$125 per hour
Unplanned Maintenance provided outside the coverage of this contract or after its expiration.	Prevailing Commercial Rate Schedule

*Two (2) year Limited Parts Warranty is only available if commissioning is provided by Northern and a Preventative Maintenance Contract with an Authorized Service Partner is in effect

**Two (2) year Preventative Maintenance Provided By Northern at the end of year 1- includes: One (1) Trip which includes Labor and CONUS Travel as well as consumables

***The Extended Limited Parts Warranty (Years 3-5) is only available if a Preventative Maintenance Contract with an Authorized Service Partner is in effect and Smartview 24 X 7 Monitoring has been purchased. Extended Limited Parts Warranty is also exclusive of Freight Charges -Please refer to Exhibit D for detail.

**** 5th yr Brake Pad Maintenance includes Consumables and Labor. Travel expenses billed separately if not performed during Annual Preventative Maintenance

Maintenance Schedule



Page G5

Maintenance Schedule	Service Interval
Preventative Maintenance (includes all consumables, labor and continental US travel)	12 months
SmartView 24/7 monitoring and support	Continuous monitoring for the duration of Agreement
Brake Pad Maintenance (approximately year 5)	Not later than 60 months of continuous operations

Cost Items Specifically Excluded from the Maintenance Schedule:

- Utilities to support operation of the Turbine
- Telephone/DSL or internet access services
- End-User requested maintenance
- Parts and services related to non maintenance service and or repairs will be billed per the approved Service Order

Other vendors, contractors or providers of services (such as cranes or lifts) necessary to complete unplanned maintenance and repairs will be at the End-User's expense. It is understood that Northern is providing service technician(s), diagnostic equipment and hand tools only.

Basic Maintenance Kit & Basic Spare Parts Kit Includes:

Base Maintenance Kit - Part Number 100337, which includes such items as Grease Cartridges, Yaw Brake Pads, Yaw Oil, Yaw Bearing grease and Tower Door Filter.

Basic Spare Parts Kit - Part Number 100335, which includes miscellaneous parts subject to normal wear and tear. Turbine Limited Warranty provides coverage for period specified in End-User's purchase documentation. Beyond the Warranty period, parts are to be supplied at prices indicated in Northern's Northwind 100 Parts List, as updated from time to time. Spare parts will be furnished based on prevailing Commercial Rate Schedule that delineates price and availability.

Attachment 2

John Maissan

From: Erin McLarnon [erin@winddieselpower.com]
Sent: Wednesday, August 04, 2010 6:29 PM
To: 'John Maissan'
Cc: 'Gavin L. Bates'; 'Shaun W. Lockett'
Subject: Aeronautica Wind Turbines
Attachments: Spec_Sheet_Norwin225.pdf; Spec_Sheet_Norwin750.pdf; Comparing the Aeronautica 47-750kW and 54-750kW Power Curves.pdf

John –

Yes, the turbines VLT (very low temperature package) includes reengineered steel for the tower, nacelle and hub, heating for the gearbox, oil system, blades and generator, and insulation for the nacelle that allows the turbine to operate at -40.

Shaun, please let me know if I am missing anything.

Below is the most recent pricing (in US dollars) and what it includes:

Includes:

- One set of three LM Glass Fiber 13.4P blades (or equivalent)
- Nacelle and generator
- Tubular steel tower painted white, including safety ladder, lights, sockets and safety signs
- ADSL control system w/Internet interface
- Complete Documentation (Installation, Operations and Maintenance)
- **Standard four-year parts warranty** (an add'l year warranty can be purchased for \$12,000)
- One week on-site commissioning support and training from factory trained representatives
- Packaging for Transport

29-225 turbine (29m rotor dia)

On a 40m tower and VLT package - \$580,000
If wanted on a 30m tower, subtract \$7,000

47-750 (47m rotor dia)

On a 65m tower and VLT package - \$1,344,800
If wanted on a 55m tower, subtract \$7,000

54-750 (54m rotor dia)

On a 65m tower and VLT package - \$1,456,800
If wanted on a 55m tower, subtract \$7,000

My company, Wind Diesel North America, supplies the servicing of these turbines in Alaska and we could expand that service into Canada. Currently, a five-year service agreement in Alaska runs approx. \$55,000 with travel and parts extra. The current lead time for these turbines is approx. 8.5 months.

John, let me know what else you need.

Thanks,
Erin

From: John Maissan [mailto:john@leprojects.com]
Sent: Wednesday, August 04, 2010 12:56 PM
To: 'Erin McLarnon'
Cc: 'Gavin L. Bates'; 'Shaun W. Lockett'
Subject: RE: Low Load Diesels

Erin,

Thanks for the prompt response and I am glad to know that you are their agent. Does the cold weather package allow operation to -40 for operation in our part of the country? This is what I sent to Aeronautica:

I have been looking with interest at your two "new" wind turbines coming to market later this year. As these turbine sizes would suit some of our smaller northern locations very well I would be interested to know whether there is a cold weather package available for them that would allow them to operate to -30°C or - 40°C. If such options are available I would very much like to get from you the present pricing schedule for the turbines, the various towers, and the other options available – including service packages.

So yes, I would be interested in the 750 pricing, the pricing for the tower options for both turbines (I noticed they both had options) etc. This would allow me to do some serious comparisons to other (smaller) turbines.

Cheers!

John

John F. Maissan, P.Eng.
Leading Edge Projects Inc.
P: +1 (867) 668-3535
F: +1 (867) 668-3533
E: john@leprojects.com

From: Erin McLarnon [mailto:erin@winddieselpower.com]
Sent: Wednesday, August 04, 2010 1:27 PM
To: John Maissan
Cc: Gavin L. Bates; Shaun W. Lockett
Subject: Re: Low Load Diesels

Yes, I am their agent. The turbine is the Danwin/Norwin turbine out of Denmark, now being manufactured in the US under the Aeronautica name.

For a 225 with a cold weather package, you are looking at approx. \$580K US FOB New Hampshire.

I have the 750 pricing back in my office, if you are interested.

Let me know what add'l info I can send you. I have also cc'd Shaun Lockett, Aeronautica's National Sales Manager on this email too.

Sent from Erin McLarnon's iPhone

On Aug 4, 2010, at 11:58 AM, "John Maissan" <john@leprojects.com> wrote:

Thanks Erin,

I was not familiar with Aeronautica. I have sent them an email asking about pricing and cold weather options. Are you familiar with their equipment and have you any direct experience with them?

John

John F. Maissan, P.Eng.

Leading Edge Projects Inc.

P: +1 (867) 668-3535

F: +1 (867) 668-3533

E: john@leprojects.com

From: Erin McLarnon [mailto:erin@winddieselpower.com]

Sent: Friday, July 23, 2010 11:16 PM

To: John Maissan

Cc: Gavin L. Bates

Subject: Re: Low Load Diesels

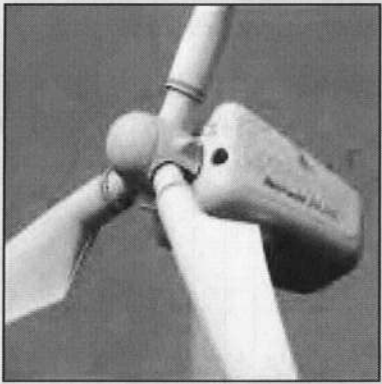
John-

Are you familiar with the Aeronautica/Norwin wind turbine?

www.aeronauticawind.com

Sent from Erin McLarnon's iPhone

On Jul 23, 2010, at 12:24 PM, "John Maissan" <john@leprojects.com> wrote:



AERONAUTICA

Norwin 29-225



225 Kilowatts of Power - Filling the Mid-Scale Gap

For too long the industry has been waiting for a turbine like this to fill the needs of commercial and industrial facilities, schools, office complexes, etc. The wait is over.

- ◆ 225kW Induction Generator design
- ◆ Low profile: only 180' tall on a 40m tower
- ◆ Stall-Regulated Simplicity
- ◆ Erection and Transport via common equipment

For too long the wind industry has been looking for a turbine that produces much more than 100 kilowatts of power, without having to go to the size or expense of a 600 or 700 kilowatt machine. The Aeronautica 29-225 fills that need.

The origin of this turbine goes 25 years back, with the first prototype installed in 1984, and with no less that 365 turbines installed in Denmark, the USA, Germany and Sweden.

At less than 190' tall on a 40m monopole tower, the 29-225 is a great stall-regulated wind turbine that will fit on many suburban and urban properties. It's simplicity of design has created both a robust and very cost effective turbine for commercial, industrial or municipal needs.

With its low profile, and efficient output, the 29-225 is a great match for many distributed generation applications. And Aeronautica wind turbines are *all manufactured in the United States*, reducing shipping costs and delivery times.

Fast Facts:

Orientation: <i>Upwind</i>	Rotor Diameter: <i>29m</i>
Rotor Speed: <i>37.9RPM</i> at load	Stall Regulated
Hub Height: <i>40m std, 50m opt.</i>	Blades: <i>Fiber Reinf. Polyester</i>

**Made in
America**

American Energy from America's Hometown

AERONAUTICA
Windpower

Plymouth, MA 1-800-360-0132 www.AeronauticaWind.com

29-225 kW System Specifications:

Blades

3 blades, upwind orientation
Fiberglass reinforced polyester

Rotor

Power regulation: Stall Regulated
Rotor size: 29m diameter (95')
Rotor speed: 37.9 rpm at load
Swept area: 664 m² (7,145 ft²)
Tilt angle: 5°
Coning angle: 0°
Blades make: LM 13.4
Pitch angle: Approx. -2.3° (Adj. during run-in)
Air brake, normal: Turnable Blade Tips
Mechanical Brake: Fail-safe disc brake on high speed shaft
Brake torque: 2x of nominal torque (1x by normal braking sequence)
RPM max. value: 1920 (60 Hz), 1600 (50 Hz), on the high-speed shaft

Generator

Nom. Electric Power: 225 kW
Generator: 4-pole, single wound, induction, IP54
Generator speed: 1800 (60 Hz) or 1500 (50 Hz) rpm synchronous.
Loss in generator: approx. 3 % at full load
Generator cut-in: Thyristor controlled gradual cut-in.
Grid connection: 60 Hz - 480V or 50 Hz - 480V

Operational:

Yaw motors: 2 pcs. active drives, electrical
Yaw brakes: 3 pcs. active hydraulic brakes
Yaw bearing: Slide bearing
Cut-in wind speed: 4 m/s (9 mph)
Cut-out wind speed: 25 m/s (60mph) based on 5 min avg.
Survival Speed: 67 m/s (150 mph)
Controller: CC-Electronic / NORWIN A/S
(Orbital controller
Noise: 98 dBA Sound Power (at Nacelle)

Monopole Tower

Conical Steel, White, 40m and 50m available
Nacelle access: interior tower ladder through locked door

Weights:

Rotor w/blades: Approx. 10,600 lbs (4,818 kg)
Nacelle (excl. Rotor): Approx. 15,260 lbs (6,936 kg)
Nacelle total: Approx. 25,860 lbs (11,754 kg)

Safety Issues

Induction generator has inherent anti-islanding
Fail-safe hydraulic disk brake
Grid monitoring for shutdown and operational performance

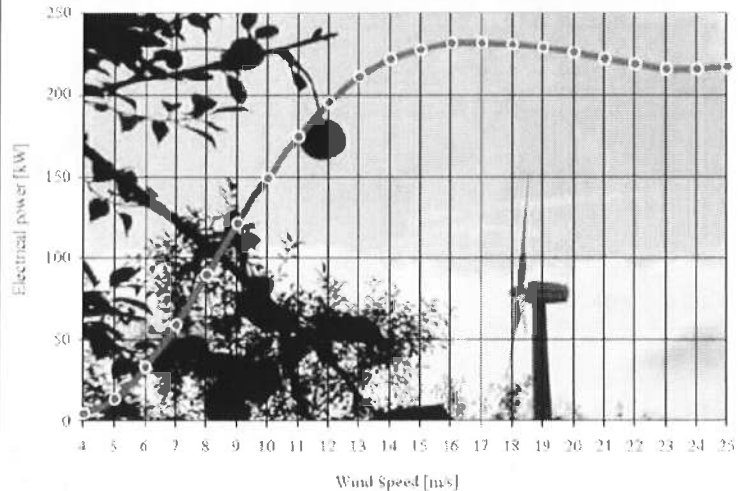
Shipping: All Prices are FOB Plymouth, MA, USA

Warranty: Standard warranty is for one year on the drive train and all on all major parts. Extended warranties are available.

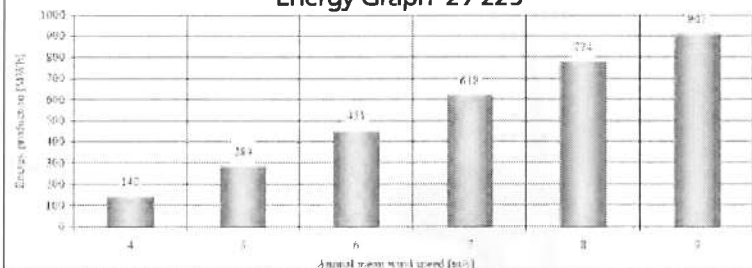
Installation: Aeronautica Windpower, LLC is only a supplier of equipment. We can, however, refer you to local installers or dealers for a complete installation.

Service Agreements: Annual Service Contracts are strongly advised and are available from local dealers and installers.

Power Curve 29-225

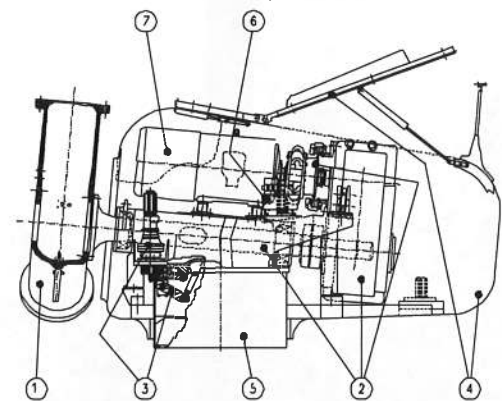


Energy Graph 29-225



Wind speed [m/s]	Elect. power [kW]
4	1
5	10
6	29
7	55
8	86
9	117
10	145
11	171
12	191
13	207
14	218
15	224
16	228
17	228
18	227
19	225
20	222
21	218
22	215
23	212
24	212
25	213

The Power Curve shown is for a 225kW turbine, with a 29m rotor. In the stall range, at wind speeds > 16.5m/s, the power curve may deviate somewhat from above. The power curve is valid for 1.225kg/m³ air density, clean blades and undisturbed horizontal air flow. For the Energy Graph, a Rayleigh wind speed distribution and 100% availability is assumed.



1. Rotor System
2. Mechanical Transmission
3. Yaw System
4. Nacelle Cover
5. Tower
6. Hydraulic Station
7. Generator

AERONAUTICA
Windpower

New!
FOUR YEAR
Warranty!

AERONAUTICA

29-225

225 Kilowatts of Power - Filling the Mid-Scale Gap

The industry has been waiting for a turbine like this to fill the needs of commercial and industrial facilities, schools, office complexes, etc. The wait is now over.

- ◆ 225kW Induction Generator design
- ◆ Low profile: only 180' tall on a 40m tower
- ◆ Stall-Regulated Simplicity
- ◆ Erection and Transport via common equipment

For too long the wind industry has been looking for a turbine that produces much more than 100 kilowatts of power, without having to go to the size or expense of a 600 or 700 kilowatt machine. The Aeronautica 29-225 fills that need.

The origin of this turbine goes 25 years back, with the first machines of this class installed in 1984 and over 360 turbines installed across Denmark, the USA, Germany and Sweden.

At less than 180' tall on a 40m monopole tower, the 29-225 is a great stall-regulated wind turbine that will fit on many suburban and urban properties. It's simplicity of design has created both a robust and very cost effective turbine for commercial, industrial or municipal needs.

With its low profile, and efficient output the 29-225 is a great match for many distributed generation applications. And Aeronautica wind turbines are *all manufactured in the United States*, reducing shipping costs and delivery times.

Fast Facts:

Orientation: <i>Upwind</i>	Rotor Diameter: <i>29m</i>
Rotor Speed: <i>37.9RPM at load</i>	Stall Regulated
Hub Height: <i>40m std, 50m opt.</i>	Blades: <i>Fiber Reinf. Polyester</i>

**Made in
America**

McEvoy Ranch, Petaluma, CA

American Energy from America's Hometown

AERONAUTICA
Windpower

Plymouth, MA 1-800-360-0132 www.AeronauticaWind.com

29-225 kW System Specifications:

Blades

3 blades, upwind orientation
Fiberglass reinforced polyester

Rotor

Power regulation: Stall Regulated
Rotor size: 29m diameter (95')
Rotor speed: 37.9 rpm at load
Swept area: 664 m² (7,145 ft²)
Tilt angle: 5°
Coning angle: 0°
Blades make: LM 13.4
Pitch angle: Approx. -2.3° (Adj. during run-in)
Air brake, normal: Turnable Blade Tips
Mechanical Brake: Fail-safe disc brake on high speed shaft
Brake torque: 2x of nominal torque (1x by normal braking sequence)
RPM max. value: 1920 (60 Hz), 1600 (50 Hz), on the high-speed shaft.

Generator

Nom. Electric Power: 225 kW
Generator: 4-pole, single wound, induction, IP54
Generator speed: 1800 (60 Hz) or 1500 (50 Hz) rpm asynchronous.
Loss in generator: approx. 3 % at full load
Generator cut-in: Thyristor controlled gradual cut-in.
Grid connection: 60 Hz - 480V or 50 Hz - 480V

Operational:

Yaw motors: 2 pcs. active drives, electrical
Yaw brakes: 3 pcs. active hydraulic brakes
Yaw bearing: Slide bearing
Cut-in wind speed: 4 m/s (9 mph)
Cut-out wind speed: 25 m/s (60mph) based on 5 min avg.
Survival Speed: 67 m/s (150 mph)
Controller: CC-Electronic / (Orbital controller
Noise: 98 dBA Sound Power (at Nacelle)

Monopole Tower

Conical Steel, White, 40m standard, 30 and 50m available
Nacelle access: interior tower ladder through locked door

Weights:

Rotor w/blades: Approx. 10,600 lbs (4,818 kg)
Nacelle (excl. Rotor): Approx. 15,260 lbs (6,936 kg)
Nacelle total: Approx. 25,860 lbs (11,754 kg)

Safety Issues

Induction generator has inherent anti-islanding
Fail-safe hydraulic disk brake
Grid monitoring for shutdown and operational performance

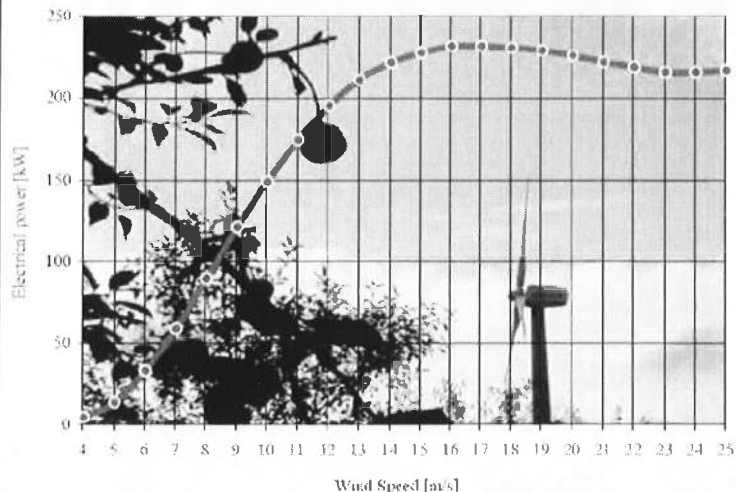
Shipping: All Prices are FOB Plymouth, MA, USA

Warranty: Standard warranty is for four years (parts). Extended warranties are available.

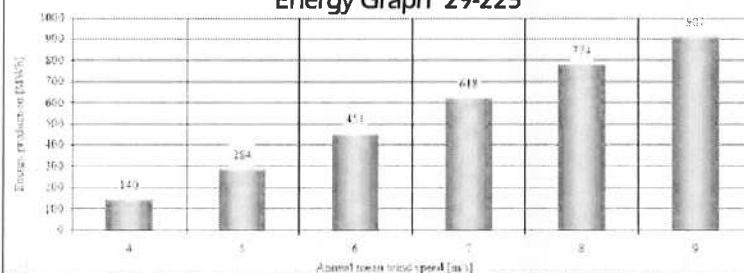
Installation: Aeronautica Windpower, LLC is only a supplier of equipment. We can, however, refer you to local installers or dealers for a complete installation.

Service Agreements: Annual Service Contracts are strongly advised and are available from local dealers and installers.

Power Curve 29-225

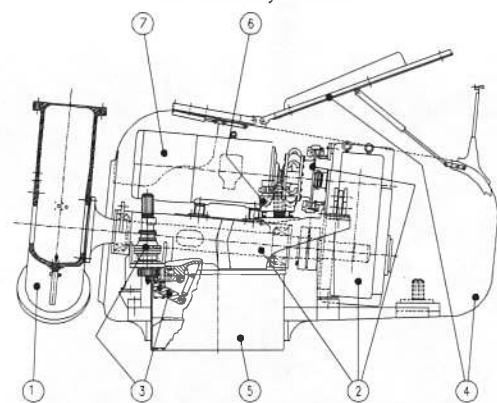


Energy Graph 29-225



Wind speed [m/s]	Elect power [kW]
4	1
5	10
6	29
7	55
8	86
9	117
10	145
11	171
12	191
13	207
14	218
15	224
16	228
17	228
18	227
19	225
20	222
21	218
22	215
23	212
24	212
25	213

The Power Curve shown is for a 225kW turbine, with a 29m rotor. In the stall range, at wind speeds > 16.5m/s, the power curve may deviate somewhat from above. The power curve is valid for 1.225kg/m³ air density, clean blades and undisturbed horizontal air flow. For the Energy Graph, a Rayleigh wind speed distribution and 100% availability is assumed.



1. Rotor System 2. Mechanical Transmission 3. Yaw System 4. Nacelle Cover 5. Tower 6. Hydraulic Station 7. Generator

AERONAUTICA
Windpower



Technical note

N29-Stall: Controller and monitoring

1. Alarm signals and display

The main control panel is placed at the bottom of the tower. From the control panel on line data and data stored in the controller can be accessed. Stored data needed is typically error messages and alarm signals.

With the possibility of adjusting selected parameters, authorized personnel can change operational limits of the turbine directly on the front panel.

A stationary or portable additional control panel can be mounted/connected to the top box in the nacelle for manual control of the turbine, when servicing.

A battery back up system supplies the emergency light.

Safety surveillance will monitor possible faults in the turbine and, if necessary, bring the turbine to a standstill.

Should the turbine come to a standstill due to some unacceptable conditions, it will start up automatically when proper conditions have been restored, e.g., after grid failure. When faults require service, the turbine will not be able to start up again until the fault has been corrected.

One of the special features of the turbine is that it has a number of back-up functions built in, and that the controller utilizes the possibility to operate the turbine even if a secondary system has broken down. This system increases the availability and makes it easier to schedule service of the turbine. If such an error appears a message will appear on the screen and eventually on a remote monitoring device.

The turbine is equipped with an external emergency system, working independently from the electronic control system supervising speed of rotor, nacelle vibrations and manual emergency push buttons.

A circuit breaker is installed in the power section, disconnecting the turbine from the grid in case of overload current or short circuit current.

The WTG communicates with the surrounding world via modems, either via the normal telephone lines or via mobile phones or other wireless remote systems. The best solution is been chosen for the given turbine project (NORWIN or their representative will check to turbine during the warranty period).

The system is normally set up in a manner so that the turbine in case of a fault will call up one or more given telephone numbers, typically addressed at the turbine service company. The first approach from the service team normally then is to access the turbine from the monitoring system in the office to get an overview of the situation, and eventually start up the turbine via monitoring program if the error is non critical or caused by external disturbances that has passed.

The monitoring system/program and the data that can be accessed in the turbine is described in the document 'N-MonitorPr.pdf', a clarification of the output possibilities are further outlined below in 2.



The turbine will only in principle only monitor the faults in the turbine itself. If the grid or the transformer causes the fault, the turbine will only react on it with some delay and after the limits of certain parameters has been exceeded.

Important examples of faults that will make the turbine shut down (400 Volt 50 Hz system):

Voltage low: If the voltage decreases below 360 V (-10%) for more than 0.5 seconds.

Voltage high: If the voltage exceeds 440 V (+10%) for more than 60 seconds

Voltage very high: If the voltage exceeds 460 V (+15%) for more than 0.5 seconds

Frequency low: If the frequency decreases below 47 Hz (-6%) for more than 0.5 seconds.

Frequency high: If the frequency exceeds 51 Hz (+2%) for more than 0.5 seconds.

The values can be adjusted if more narrow limits are desired.

In case of power loss, the turbine controller will store all data up to that point, and be ready to start up again when power is back. The controller UPS system will further make it possible to call up the turbine doing a grid loss, etc.

Important notes:

If grid loss occurs frequently i.e. due to lack of power where the utility shuts down portions of the grid, it would be a very big advantage if it could be possible to get a warning a few seconds before, because it will make it possible to shut down the turbine in a controlled manner. Grid loss is a highly undesired situation for the turbine because it creates a high loading on the system during the event. Frequent grid losses will definitely decrease the lifetime of the turbine, especially the transmission system. The normal amount of grid losses considered in a turbine design is 2-3 per year.

The transformer shall be equipped with a circuit breaker in addition to the controller's circuit breaker. This will normally be an automatic breaker. Fuses could in principal be used, but is not advisable because we would like all three phases to be cut off if one of the phases triggers the event.

2. Measure output clarification

Measurements made by the turbine can be accessed either through the controller panel or from the monitoring system. From the monitoring system printout of various items can be made.

The following primary items are measured and shown:

- Wind speed
- Voltage 3 phases
- Amps 3 phases
- Cos fi
- Frequency
- Power output
- Rotor / generator rpm
- Nacelle wind speed
- Nacelle direction
- Temperature: Gearbox, generator, main bearing, ambient, controller, etc.
- System pressures in hydraulic system and gear lubrication
- Brake position
- Generator cut in
- Brake opened or closed.



- kWh produced
- Error code
- Turbine state (procedure)
- Warning code (warns of potential error)

Production figures are calculated for each day and shown for a month back, and for each year.

Availability is specified in details i.e.:

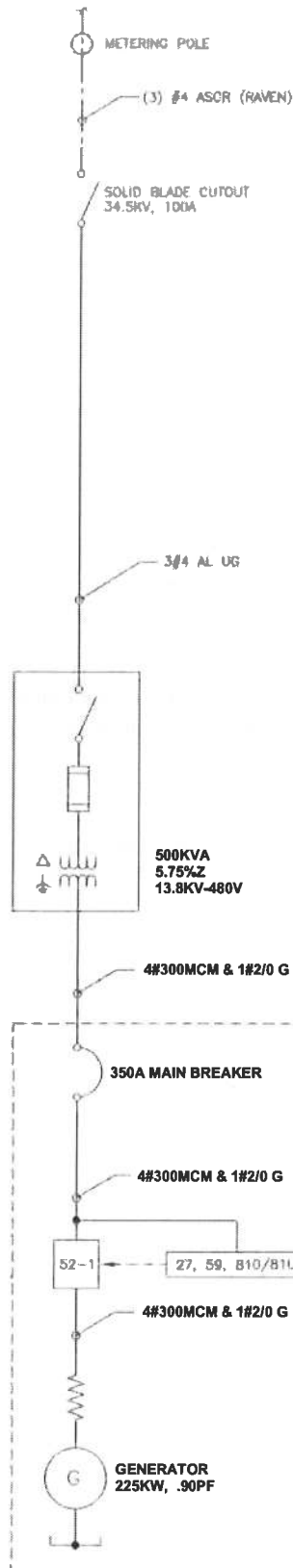
- Hours OK
- Hours not OK
- Hours in service
- Production hours
- Total hours
- OK % (availability)
- Not OK %
- Service %
- Production time %
- Stop's during operation
- Other statistics.

Error codes can be tracked up to a certain number back, so that it is possible to track an error event. This function makes it easier to find eventual faults, and to see how a fault initiated. The number of the different fault types is further counted and recorded.

The turbine power curve, measured with the nacelle anemometer is recorded and can be shown either as a graphical curve or as values. It is further possible to show the wind distribution as a graphical curve.

If a secondary surveillance system needs to be hooked onto the turbine, it will need to be done via communication with the PLC controller. Hooking up directly to measuring points is not acceptable because it can introduce spikes into the system and cause malfunction of the WTG.

To Power Company Grid Overhead Wiring



One-Line Drawing for Norwin 225 kW Turbine

Wind Turbine



One-Line Drawing for Norwin 225 kW Turbine

Technical Document AW-NW-225-091405

Dimensions and Weights



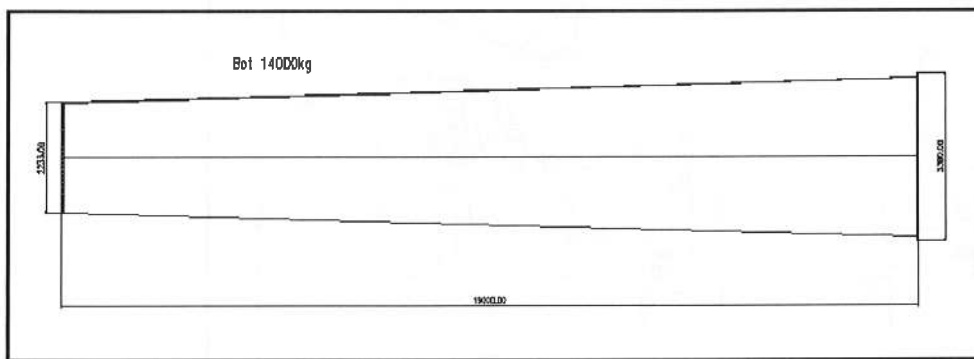
Turbine type: N29-225kW

Tower type: 40 meter6/2/2009 NH40/T 5 004 Rev. 002

The tower is in two sections, so each section is defined as Bot. Sec and Top sec.

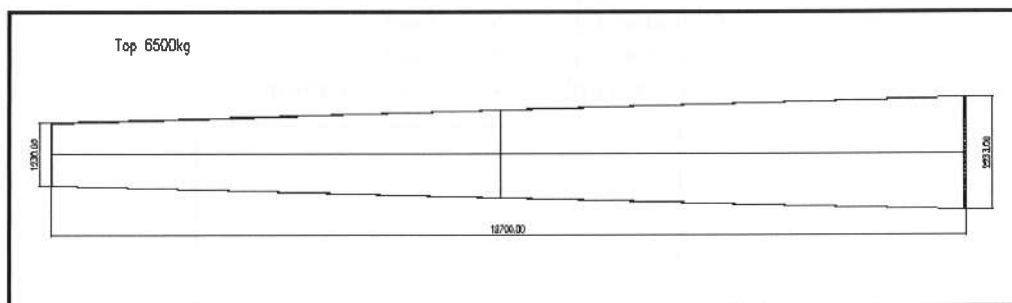
Bottom Section see fig. 1

Bottom flange:	Ø	3390 mm	133.46 Inches (")	11.12	Feet
Mid flange:	Ø	2233 mm	87.91 Inches (")	7.33	Feet
Length of sec.:		19000 mm	748.03 Inches (")	62.34	Feet
Weight of sec.:		14000 kg	30864.71 Pound (lb)	15.43	Ton (US short)



Top Section see fig. 2

Mid flange:	Ø	2233 mm	87.91 Inches (")	7.33	Feet
Top. flange:	Ø	1230 mm	48.43 Inches (")	4.04	Feet
Length of sec.:		19700 mm	775.59 Inches (")	64.63	Feet
Weight of sec.:		6500 kg	14330.05 Pound (lb)	7.17	Ton (US short)

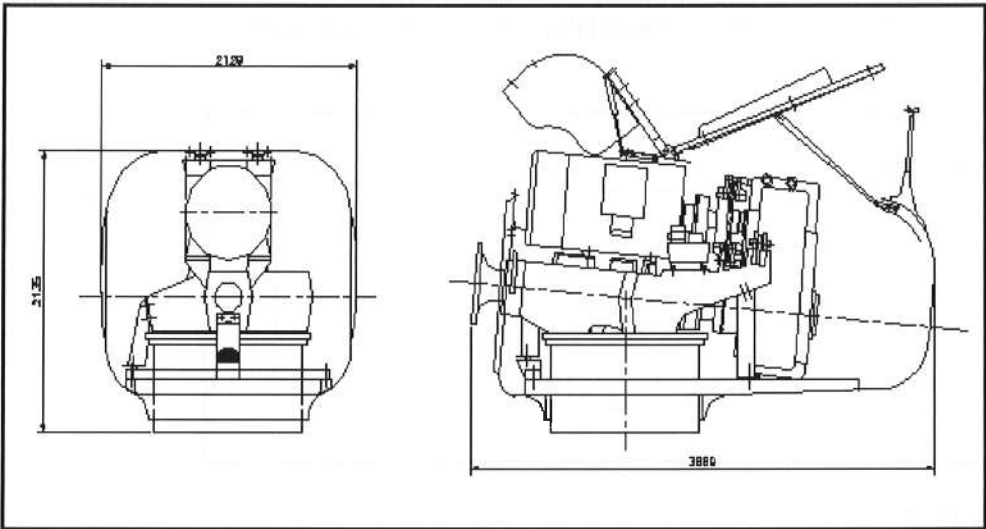


Nacelle:

The nacelle is mounted with main frame, main axle, gearbox, generator, top unit, yaw drive and various small parts.

Dimensions on nacelle:

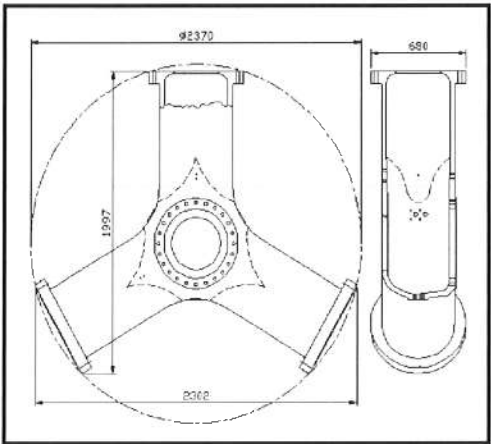
Width:	2129 mm	83.82 Inches (")	6.98	Feet
Height:	2135 mm	84.06 Inches (")	7.00	Feet
Length:	3869 mm	152.32 Inches (")	12.69	Feet
Weight:	6500 kg	14330.05 Pound (lb)	7.17	Ton (US short)



Hub:

Dimensions on hub:

Diameter:	ø	2370 mm	93.31 Inches (")	7.78	Feet
Height:		1997 mm	78.62 Inches (")	6.55	Feet
Width:		2302 mm	90.63 Inches (")	7.55	Feet
Depth:		680 mm	26.77 Inches (")	2.23	Feet
Weight:	ca.	1320 kg	2910.102 Pound (lb)	1.46	Ton (US short)



Blades:

Blade type: LM13,4 HHT

The blades are transported as set, which means 3 pieces

Dimensions on blades:

Diameter on root:	Ø	675 mm	26.57 Inches (")	2.21	Feet
Length:		13400 mm	527.56 Inches (")	43.96	Feet
Weight:		760 kg	1675.513 Pound (lb)	0.84	Ton (US short)

Controller cupboard:

Dimension on cupboard:

Depth:		500 mm	19.69 Inches (")	1.64	Feet
Height:		2100 mm	82.68 Inches (")	6.89	Feet
Width:		1300 mm	51.18 Inches (")	4.27	Feet
Weight:		200 kg	440.9245 Pound (lb)	0.22	Ton (US short)

NORWIN 29-Stall-225 kW		Foundation loads
40 m hub hight.	Extreme wind speed:	64 m/s
	Mean wind speed:	9.3 m/s

Extreme loads on foundation (bottom flange of tower):

Notice!

All extreme loads are **including** a load safety factor of: 1.35

Except for vertical load from tower and nacelle mass including a safety factor of: 0.90

Vertical load	kN :	274
Shear force	kN :	370
Bending moment	kNm :	11392
Torsion	kNm :	407

Equivalent fatigue loads on foundation (bottom flange of tower):

Calculated for the load number: 1.0 x 10E7

Equivalent fatigue loads for different S/N curve slopes:

S/N:	Shear force: kN	Bending moment: kNm
3	39.1	1833
4	31.4	1460
6	27.8	1284
8	27.9	1288
10	29.0	1332
12	30.1	1384

Mean loads on foundation (bottom flange of tower):

Shear force	kN :	27
Bending moment	kNm :	1248

Data for foundation structure analysis

This document provides lines of directions for:

- Extreme and fatigue loads on foundation unit
- Dimensions for the bottom of the tower
- Lines of directions for necessary soil investigation
- Foundation design assistance

1. Extreme and fatigue load data

Dependent on tower height and the acceptable wind condition, the foundation loads will be different. It should be noticed that the survival wind speed is normally determining the extreme bending moment on the foundation unit and thus determining the foundation design.

In the following the main design parameters for the acceptable wind classes are outlined:

Tower height	Maximum acceptable peak wind speed	Maximum acceptable mean wind speed (Rayleigh distribution)
[m]	[m/s]	[m/s]
40	64	9.3
30	59	9.3
30 (USA)	67.1	9.3

The following documents are the applicable foundation load documents for the different tower heights:

40 m tower height: N29-40-FoundLoads-01.pdf

30 m tower height: N29-30-FoundLoads-01.pdf

30 m tower height (USA): N29-30-USA-FoundLoads-02.pdf

2. Tower bottom dimensions

The tower bottom is available in one option: A double-sided bottom flange. The following contains a description of the general dimensions for the two towers and some notes on the foundation design.

Option 1: A double side flange.

The foundation is either made with a cast in steel section or with long cast in bolts (threaded bars) with an anchor ring in the bottom.

If the type of foundation with long cast in bolts is used the tower has to be mounted in to stages separated by the curing time of the under cast material. Stage 1: The tower bottom section is placed on nuts screwed onto 3 of the cast in bolts. The tower section is then leveled out and secured with upper nuts and under cast is made except in the 3 places with nuts. After curing the nuts are removed and

under cast is made in these 3 places. Stage 2: All the nuts can now be tightened and the upper section(s) of the tower can be mounted.

The dimensions for the tower bottom flange for this option are given below. In figure 1, an example of a tower bottom is shown for reference.

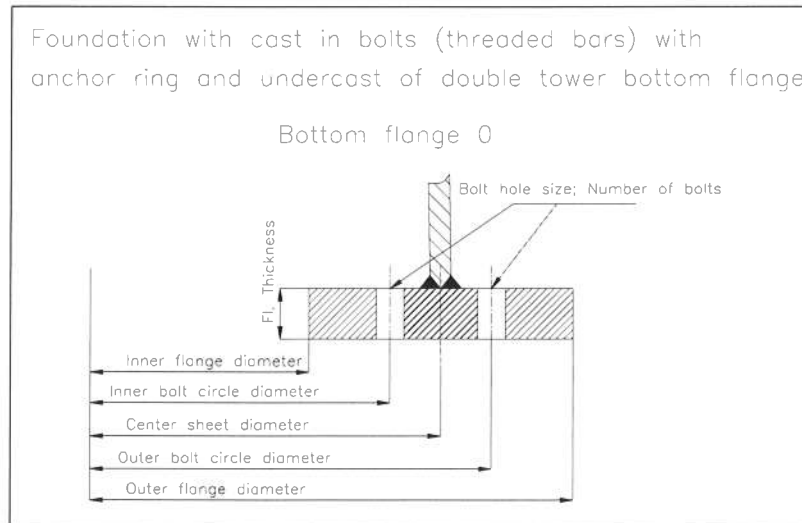


Figure 1. Example of bottom flange showing the double-sided bottom flange

Norwin 29 – 40 m tower; double flange bottom dimensions:	
Inner flange diameter:	2990 mm
Inner bolt circle diameter:	3090 mm
Center sheet diameter:	3190 mm
Outer bolt circle diameter:	3290 mm
Outer flange diameter:	3390 mm
Flange thickness:	45 mm
Number of bolts:	2 x 60 = 120
Bolt hole size:	Ø 33 mm
Flange steel type:	ISO-S275J2G4 / ASTM A-36
Bolt type:	M30-xxx-8.8-HDG (Hot Dip Galvanized)

Norwin 29 – 30 m tower; double flange bottom dimensions:	
Inner flange diameter:	1970 mm
Inner bolt circle diameter:	2090 mm
Center sheet diameter:	2190 mm
Outer bolt circle diameter:	2290 mm
Outer flange diameter:	2410 mm
Flange thickness:	40 mm
Number of bolts:	2 x 48 = 96
Bolt hole size:	Ø 33 mm
Flange steel type:	ISO-S275J2G4 / ASTM A-36
Bolt type:	M30-xxx-8.8-HDG (Hot Dip Galvanized)

Norwin 29 – 30 m tower (USA version); double flange bottom dimensions:	
Inner flange diameter:	1970 mm
Inner bolt circle diameter:	2090 mm
Center sheet diameter:	2190 mm
Outer bolt circle diameter:	2290 mm
Outer flange diameter:	2410 mm
Flange thickness:	40 mm
Number of bolts:	2 x 60 = 120
Bolt hole size:	Ø 33 mm
Flange steel type:	A709 GR50
Bolt type:	M30-xxx-8.8-HDG (Hot Dip Galvanized)

Lubrication of bolts before tightening: Molycote

Tightening torque for class 8.8 bolts with above lubrication: 1000 Nm

3. Lines of directions for necessary soil investigation

The normal information needed for the foundation design regarding soil conditions is described in the following list. It must however be emphasized that a geotechnical expert with knowledge on the local conditions always must be involved to evaluate if special things should be taken into consideration.

1. Drilling to 6-7 m (20-23 feet) dept to clarify the soil layers.
2. Bearing capacity of the different soil layers:
 Sand - Friction angle ϕ (deg)
 Clay - Cohesion measured by an un-drained shear strength C_u (kN/m²)
 or the bearing capacity directly if other methods are used.
3. Effective weight density of the different soil layers (kN/m³)
4. Effective weight density of filling soil if excavated soil cannot be used as backfilling
5. Ground water level - assumed maximum is essential
6. Drainable capacity of the ground after installation of the foundation.
7. If the soil is weak and a pile foundation is necessary, the assumed pile length and bearing capacity for pressure and tension is needed

4. Foundation design assistance

Norwin can in many cases (not USA) through our specialized consultant assist with dimensioning and design layout of foundation if all necessary information is available, and if it is within the normal range of foundation types. In figure 2 a design example for a foundation is shown.

The estimated price for this work is 8000 EURO per foundation design to be paid in advance.

In case of seismic activities in the area of erection, it is always necessary to have a local expert involved in the design, or to have a company with knowledge in the local conditions making the foundation design.

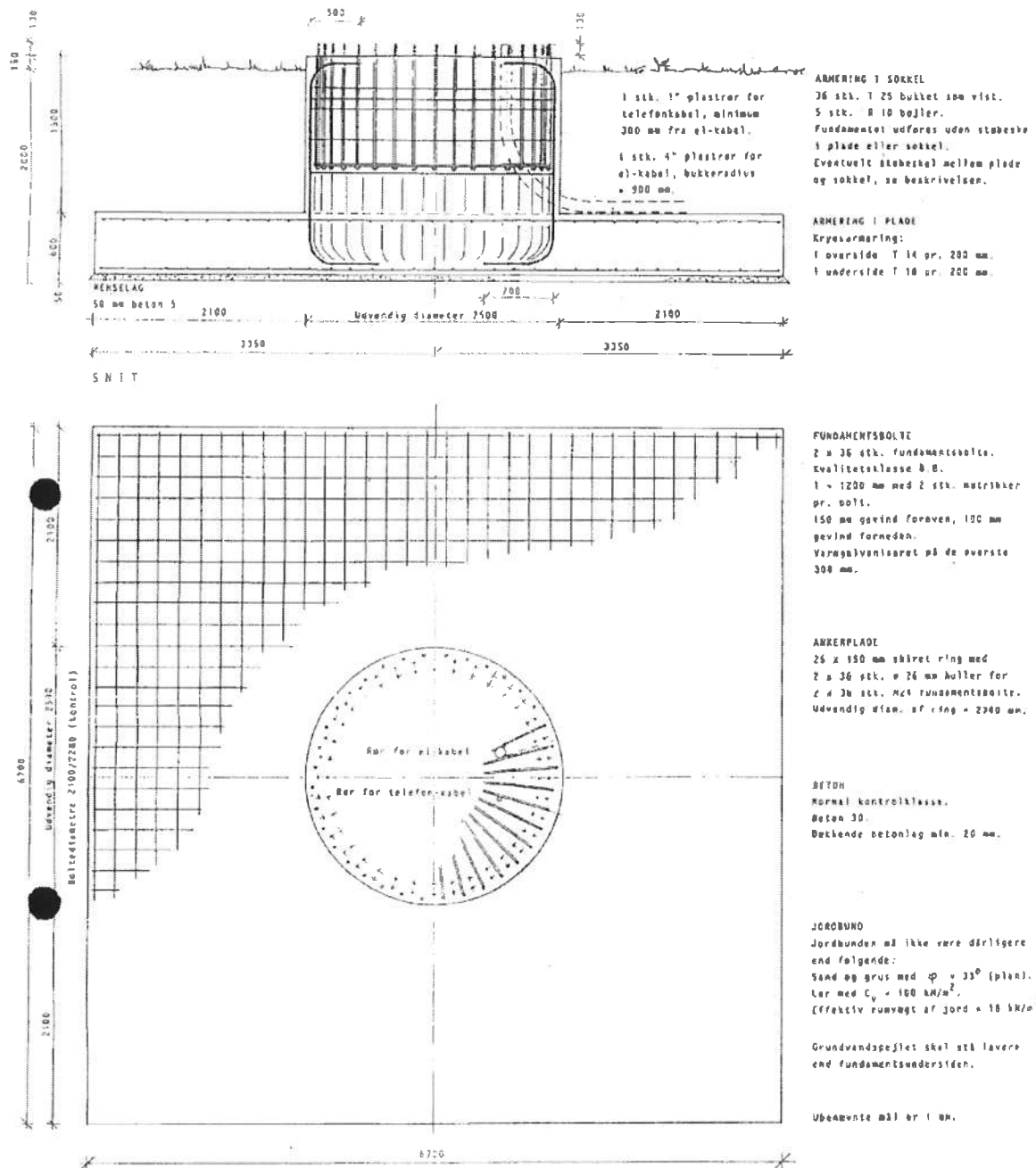


Figure 2. Example of foundation design

PRØVNINGSRAPPORT

Response to Undertaking #17

Attachment

Page 117 of 217



DANAK

Reg. nr. 134

Vindmølle Rebelshøj. Kalundborg

Antal sider: 12

Rapport nr.: P2.009.99

Glostrup, den 18. februar 1999

Sag: 35.1494.01 JBJ/ALJ/JBJ

Klient:

DAN service ApS
Industriledet 13. Svogerslev
4000 Roskilde

Rekvirent:

Ib Nørregaard

Udført af:

Jørgen Bjerger Nielsen

Teknisk ansvarlig:

Allan Jensen

Resumé:

Støjbelastningen fra en Norwin 29/225 kW vindmølle er bestemt i henhold til Miljøministeriets bekendtgørelse nr. 304 af 14. maj 1991 samt relevante dele af Miljøstyrelsens vejledning nr. 5 og nr. 6/1984 og brev fra Miljøstyrelsens Referencelaboratorium af 29. august 1995 vedr. korrektion for baggrundsstøj.

Der er følgende resultater:

Referencydeffekt ved vindhastigheden 8 m/s :

 $L_{WA,ref} = 97,0 \text{ dB re } 10^{-12} \text{ W}$

Støjbelastningen ved vindhastigheden 8 m/s :

Nærmeste nabo, Gåsetoftevej 74: $L_r = 38 \text{ dB} \pm 2 \text{ dB re } 20 \mu\text{Pa}$

Møllen giver ikke anledning til tydeligt hørbare toner eller impulser.

Efter aftale mellem Rebelshøj Vindmøllelaug I/S og DAN service Aps skal møllen overholde støjgrænsen 40 dB(A) ved nærmeste nabo, 300 m mod øst. Denne grænseværdi er ikke overskredet.

I denne prøvningsrapport kan tekst være skrevet med *kursiv*. Sådanne tekstafsnit, resultater m.v. ligger uden for den akkrediterede tekniske prøvning.

Rapporten må ikke gengives, undtagen i sin helhed, uden laboratoriets skriftlige godkendelse. Prøvningsresultaterne gælder alene for de prøvede emner.

Acoustica · Carl Bro as

Akustik · Støj · Vibrationer - F.R.I



AS reg. nr.: 46 103
Glostrup
Granskoven 8
2800 Glostrup
Tlf.: 4348 6011
Fax: 4348 6543

Kolding
Esbjergvej 20
6000 Kolding
Tlf.: 7550 8644
Fax: 7550 5343

Odense
Vermehrensvej 14
5230 Odense
Tlf.: 6591 6311
Fax: 6614 7140

Viborg
Vævervej 7
8800 Viborg
Tlf.: 8862 8722
Fax: 8725 6111

Aalborg
Schngårdholmsvej 2
9000 Aalborg
Tlf.: 9811 3011
Fax: 9811 7374

Århus
Nordlandsvej 60
8240 Risskov
Tlf.: 8932 6611
Fax: 8932 6682



Carl Bro

35.1544.01
Vindmølle Rebelshøj

Side 2 af 12 sider
Rapport nr. P2.009.99

INDHOLDSFORTEGNELSE

1. INDLEDNING	3
2. DE BERØRTE PARTER	3
3. DEFINITIONER	3
4. BESKRIVELSE AF MÅLEOBJEKT	4
5. MÅLEMETODE	4
6. ANVENDT MÅLEUDSTYR	4
7. MÅLEPOSITIONER	5
8. BAGGRUNDSSTØJ	5
9. METEOROLOGISKE FORHOLD	5
10. MÅLERESULTATER	5
11. STØJENS KAKAKTER	6
12. KORREKTIONER	6
13. GRÆNSEVÆRDIER	6
14. BEREGNING AF STØJBELASTNING VED BOLIG	7
15. UBESTEMTHED	7
16. KONKLUSION	8

BILAG

Bilag 1	Kortbilag med placering af mølle og naboer	side 9
Bilag 2	Anvendt måleudstyr	side 10
Bilag 3	Måleresultater	side 11
Bilag 4	Objektiv toneanalyse	side 12

Tekst skrevet med kursiv ligger uden for den akkrediterede tekniske prøvning

rap1

Acoustica - Carl Bro as



Carl Bro

35.1544.01
Vindmølle Rebelshøj

Side 3 af 12 sider
Rapport nr. P2.009.99

1. INDLEDNING

Efter rekvisition af Ib Nørregaard fra DANservice ApS er der foretaget målinger af støjen fra en Norwin 29/225 kW vindmølle, placeret øst for Lerchenfeld ved Kalundborg.

Støjmålingerne er udført tirsdag den 5. januar og lørdag den 6. februar 1999.

Formålet med målingerne er at bestemme møllens lydeffekt samt beregne støjbelastningen ved nærmeste nabo, beliggende på adressen Gåsetoftevej 74, i afstanden 300 m fra møllen.

Målingerne er udført efter anmodning fra Rebelshøj Vindmøllelaug I/S, som har ønsket dokumenteret, at møllen ikke overskrider grænseværdien 40 dB(A) ved nærmeste fremmede nabo.

2. DE BERØRTE PARTER

De berørte parter er leverandøren DANservice Viby Sjælland ApS, ejeren Rebelshøj Vindmøllelaug I/S, og nærmeste nabo.

3. DEFINITIONER

I denne rapport anvendes følgende symboler for lydtekniske begreber:

L_{pA}	:	Det A-vægtede lydtrykniveau i dB med referenceværdien 20 μ Pa
$L_{Aeq,ref}$	:	Det energiekvivalente, A-vægtede lydtrykniveau i dB med referenceværdien 20 μ Pa ved referencevindhastigheden 8 m/s.
L_r	:	Støjbelastningen, det energiekvivalente, korrigerede A-vægtede lydtrykniveau i dB med referenceværdien 20 μ Pa. Fremkommer ved korrektion af L_{Aeq} med 5 dB for forekomst af tydeligt hørbare impulser eller toner i støjen.
$L_{WA, ref}$	:	Det A-vægtede referencelydeffektniveau i dB med referenceværdien 10-12 W ved 8 m/s.



Carl Bro

35.1544.01
Vindmølle Rebelshøj

Side 4 af 12 sider
Rapport nr. P2.009.99

4. BESKRIVELSE AF MÅLEOBJEKT

Vindmøllen er af fabrikat Norwin.

Det er en 225 kW, 3-bladet, horisontalakset, stallreguleret og nettilsluttet propelvindmølle.

Den er opbygget med et rørtårn, hvor navhøjden er 30,8 m. Rotordiameteren er 29 m.

Rørtårnets fundament er placeret på en bakketop med en højde af 10-15 m over omliggende terræn mod vest og en højde af 3- 6 m over terrænet mod øst.

5. MÅLEMETODE

Den anvendte målemetode er beskrevet i Miljøstyrelsens bekendtgørelse nr. 304 af 14. maj 1991 og i brev fra Miljøstyrelsens Referencelaboratorium af 29. august 1995. Endvidere er anvendt dele af Miljøstyrelsens vejledning nr. 5/1984 og nr. 6/1984.

Målingen er gennemført som en +6 dB måling, dvs. med mikrofonen placeret på en hård plade, der ligger direkte på jorden. Vindhastigheden blev målt 10 m over terræn i en afstand af ca. 40 m fra møllen.

Der er udført målinger både med møllen i drift (totalstøj) og med møllen stoppet (baggrundsstøj).

Støjen og vindhastigheden blev registreret på stedet, og optaget på en båndoptager. I laboratoriet er optagelsen analyseret, og der er fundet sammenhørende værdier af et-minuts perioder af støjniveauet L_{Aeq} og middelvindhastigheden.

Ved lineær regressionsanalyse er referenceværdien fundet for middelvindhastigheden 8 m/s.

Det bemærkes, at målinger af totalstøj er korrigeret for baggrundsstøjens indflydelse i henhold til retningslinierne i brev fra Miljøstyrelsens Referencelaboratorium af 29. august 1995.

Endvidere er der foretaget en smalbåndsanalyse af den optagede møllestøj ved nærmeste nabo, med henblik på at vurdere om støjen indeholder tydeligt hørbare toner.

6. ANVENDT MÅLEUDSTYR

En oversigt over anvendt måle- og analyseudstyr findes i bilag 2.

Det anvendte udstyr er registreret i Acousticas instrumentdatabase og kan spores til udførte målinger i denne sag.

Tekst skrevet med kursiv ligger uden for den akkrediterede tekniske prøvning

rap1

Acoustica - Carl Bro as



35.1544.01
Vindmølle Rebelshøj

Side 5 af 12 sider
Rapport nr. P2.009.99

7. MÅLEPOSITIONER

Støjen blev målt i østsiden (læsidens) af møllen i 50 m's afstand fra midten af tårnet. Måleafstanden svarer til ca. 1,6 gange navhøjden.

Vindhastigheden blev målt 10 m over terræn og ca. 40 m fra møllen.

Terrænet omkring møllen er åbent og dyrket land.

På bilag 1 ses møllens placering og nærmeste naboer.

8. BAGGRUNDSSTØJ

De væsentligste kilder til baggrundsstøjen var trafik på offentlige veje samt enkelt overflyvninger. Måleperioder med væsentlig baggrundsstøj er ikke anvendt i måleresultatet.

9. METEOROLOGISKE FORHOLD

Tirsdag den 5. januar.

Det var overskyet og temperaturen var 5-8 ° C.

Middelvindretningen var SV, og middelhastigheden var ca. 7 m pr. sek. bestemt i 10 m's højde.

Lørdag den 6. februar.

Det var klart vejr og temperaturen var 2-4 ° C.

Middelvindretningen var NV, og middelhastigheden var ca. 8 m pr. sek. bestemt i 10 m's højde.

10. MÅLERESULTATER

Der er fundet sammenhørende værdier af støjniveauet og vindhastigheden i 70 et-minuts perioder for støjen med møllen i drift (totalstøjen) og i 50 et-minuts perioder med møllen stoppet (baggrundsstøj).

I bilag 3 er de sammenhørende værdier af det A-vægtede støjniveau og middelvindhastigheden indtegnet i et diagram. De beregnede regressionslinier er indtegnet.

Ved lineære regressionsanalyse er bestemt de værdier for støjen, der kan forventes ved vindhastigheden 8 m/s.



Carl Bro

35.1544.01
Vindmølle Rebelshøj

Side 6 af 12 sider
Rapport nr. P2.009.99

Baggrundsstøj, L_{Aeq}	:	39,9 dB
$L_{Aeq,ref}$	:	56,6 dB

Referencelydtrykket [$L_{Aeq,ref}$] for møllen er beregnet ved at korrigere niveauet for totalstøjen med niveauet for baggrundsstøjen, jævnfør afsnit 5.

11. STØJENS KARAKTER

I forbindelse med målingens gennemførelse er støjen observeret ved nærmeste nabo, beliggende 300 m øst for møllen. Ved en subjektiv vurdering er det konstateret, at der ikke forekommer tydeligt hørbare toner i støjen. Dette er verificeret ved en objektiv analyse, jf. bilag 4.

Det er ved en subjektiv vurdering endvidere konstateret, at støjen fra møllen ikke indeholder tydeligt hørbare impulser.

Vurdering og undersøgelse af støjens karakter er gennemført i henhold til Miljøstyrelsens vejledning nr. 5/1984 afsnit 9.8 og vejledning 6/1984 afsnit 7.2.

12. KORREKTIONER

Referencelydtrykniveauet [$L_{Aeq,ref}$] ved vindhastigheden 8 m/s kan omregnes til et referencelydeffektniveau [$L_{WA,ref}$] efter formelen:

$$L_{WA,ref} = L_{Aeq,ref} + 10 \times \log(4\pi \times (d^2 + h^2)) - 6 \text{ dB}$$

hvor

d = afstanden fra møllens fod til mikrofonen
 h = møllens navhøjde

Indsættes de aktuelle værdier for møllen ($d = 50$ m og $h = 30,8$ m) bliver

$$L_{WA,ref} = 56,6 + 40,4 \text{ dB} = 97,0 \text{ dB re } 10^{-12} \text{ W}$$

13. GRÆNSEVÆRDIER

Efter aftale mellem ejeren Rebelshøj vindmøllelaug I/S og fabrikanten DANservice Aps må støjbelastningen fra vindmøllen ikke overstige 40 dB(A) ved nærmeste fremmede nabo, beliggende 300 m mod øst.

35.1544.01
Vindmølle Rebelshøj

Side 7 af 12 sider
Rapport nr. P2.009.99

Støjgrænsen betragtes som overskredet, hvis måleværdien minus ubestemtheden er større end støjgrænsen. Den sande værdi af møllens bidrag til støjbelastningen er da med 95 % sandsynlighed større end støjgrænsen.

14. BEREGNING AF STØJBELASTNING VED BOLIG

Med udgangspunkt i referencydeffektniveauet $L_{WA,ref}$ kan det forventede A-vægtede lydtrykniveau 1,5 m over terræn og i afstanden "l" m fra møllefoden og ved vindhastigheden 8 m/s beregnes ved hjælp af formlen:

$$L_{pA} = L_{WA,ref} - 10 \times \log(l^2 + h^2) - 8 - \Delta L_a$$

hvor

- l = afstanden fra møllens fod til beregningpunktet
- h = møllens navhøjde
- L_a = er luftabsorptionen, 0,005 dB/m

Afstanden til udendørs opholdsarealer ved nærmeste ejendom på Gåsetoftevej 74 er bestemt til 300 m.

Støjbelastningen ved 8 m/s kan derfor beregnes til:

$$L_r = 37,9 \text{ dB re } 20 \mu\text{Pa}$$

15. UBESTEMTHED

Miljøministeriets bekendtgørelse nr. 304 anfører, at der en ubestemthed på måling af støj fra vindmøller på 2 dB.

35.1544.01
Vindmølle Rebelshøj

Side 8 af 12 sider
Rapport nr. P2.009.99

16. KONKLUSION

Støjbelastningen fra en Norwin 29/225 kW vindmølle er bestemt i henhold til Miljøministeriets bekendtgørelse nr. 304 af 14. maj 1991 samt relevante dele af Miljøstyrelsens vejledning nr. 5 og nr. 6/1984 og brev fra Miljøstyrelsens Referencelaboratorium af 29. august 1995 vedr. korrektion for baggrundsstøj.

Der er følgende resultater:

Referencydeffekt ved vindhastigheden 8 m/s :

$L_{WA,ref} = 97,0 \text{ dB re. } 10^{-12} \text{ W}$.

Støjbelastningen ved vindhastigheden 8 m/s :

Nærmeste nabo, Gåsetoftevej 74: $L_r = 38 \text{ dB} \pm 2 \text{ dB re } 20 \mu\text{Pa}$

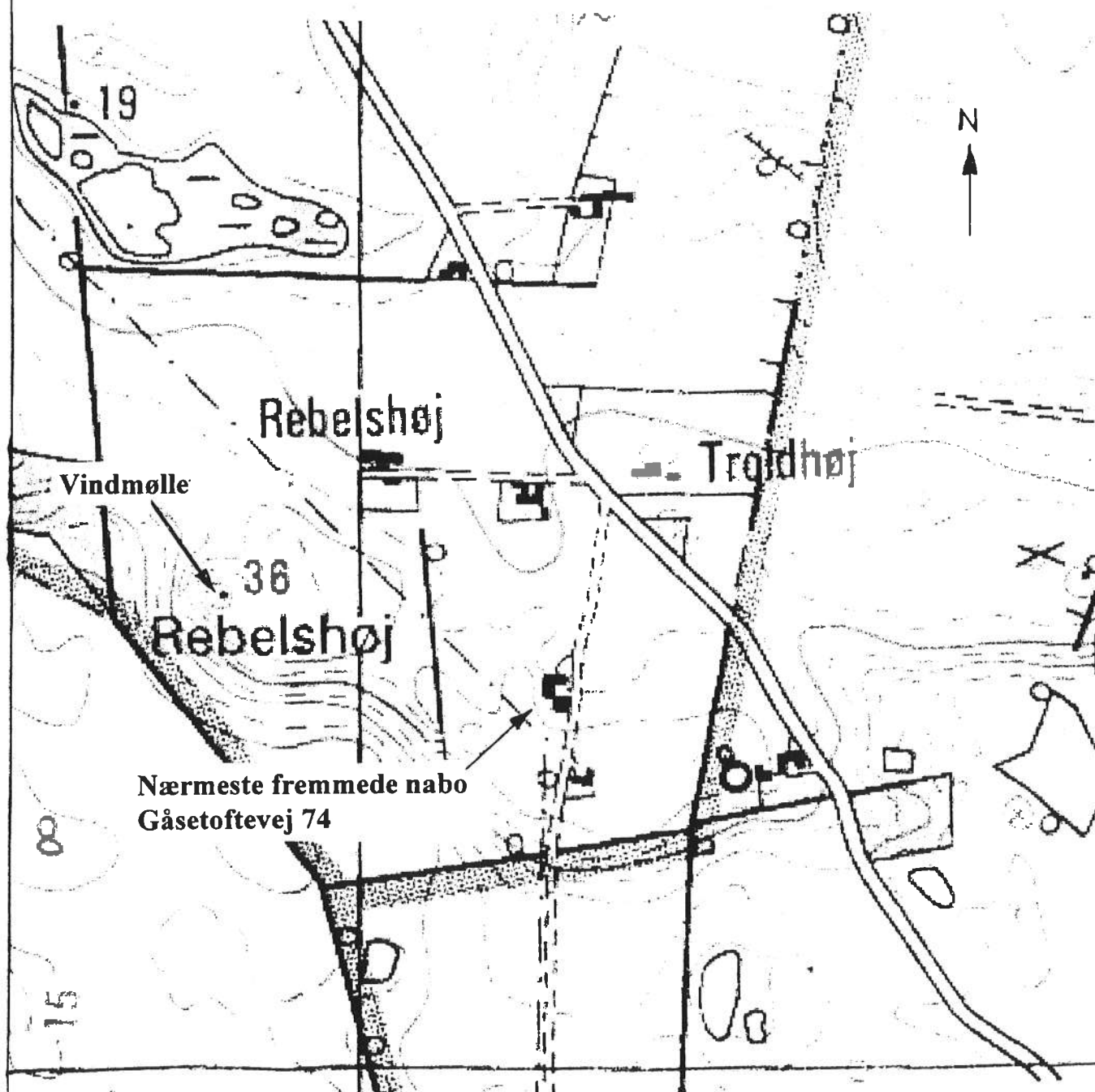
Møllen giver ikke anledning til tydeligt hørbare toner eller impulser.

Efter aftale mellem Rebelshøj Vindmøllelaug I/S og DAN service ApS skal møllen overholde støjgrænsen 40 dB(A) ved nærmeste nabo, 300 m mod øst. Denne grænseværdi er ikke overskredet.

35.1544.01
Vindmølle Rebelshøj

Side 9 af 12 sider
Rapport nr. P2.009.99

BILAG 1 Kortbilag med placering af mølle og naboer, mål 1:500



Tekst skrevet med kursiv ligger uden for den akkrediterede tekniske prøvning

rap1

Acoustica - Carl Bro as

35.1544.01
 Vindmølle Rebelshøj

Side 10 af 12 sider
 Rapport nr. P2.009.99

BILAG 2 Anvendt måleudstyr

Betegnelse	Fabrikat	Type	ACA nr.	Seneste kontrol	Næste kontrol
Lydtryk-måler	Brüel & Kjær	2231	515	09.10.1997	09.10.1999
Mikrofon	Brüel & Kjær	4165	556	15.04.1998	15.04.1999
Kalibrator	Brüel & Kjær	4230	377	28.07.1998	28.01.1999
Kalibrator	Brüel & Kjær	4230	378	20.11.1998	20.05.1999
Analysator	Nortronic	830	499	23.06.1997	23.06.1999
Båndoptag.	Sony	TCD-D7	612	13.03.1998	13.03.1999
Vindmåler	Schiltknect	221	MK II	02.07.1998	02.07.2000

Tekst skrevet med kursiv ligger uden for den akkrediterede tekniske prøvning

rap1

Acoustica - Carl Bro as

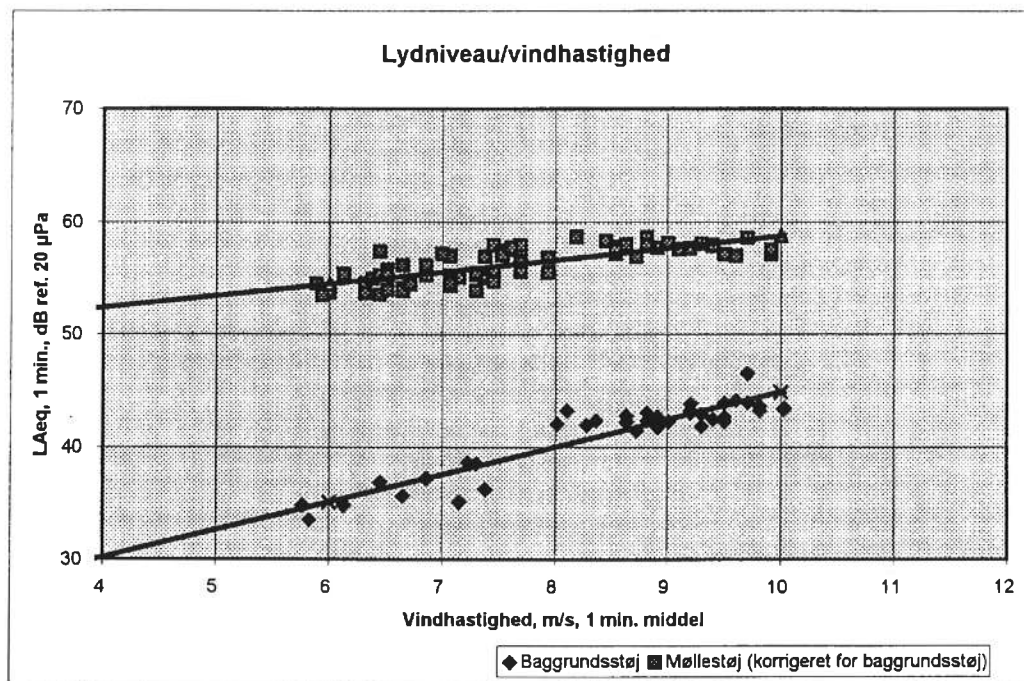


35.1544.01
Vindmølle Rebelshøj

Side 11 af 12 sider
Rapport nr. P2.009.99

BILAG 3 Måleresultater

Måling af ekstern støj fra vindmølle Norwin 29/225 kW



Vindmølle	Norwin 29/225 kW
Sag	Rebelshøj Vindmøllelaug I/S
Sag nr.	35.1544.01
Måledato	5. januar og 6. februar 1999
Udført af	Jørgen Bjerger Nielsen

Møllens referencydeffekt er målt på plade i henhold til Miljøministeriets bekendtgørelse nr. 304 af 14. maj 1991 samt brev fra Referencelaboratoriet af 29. august 1995.

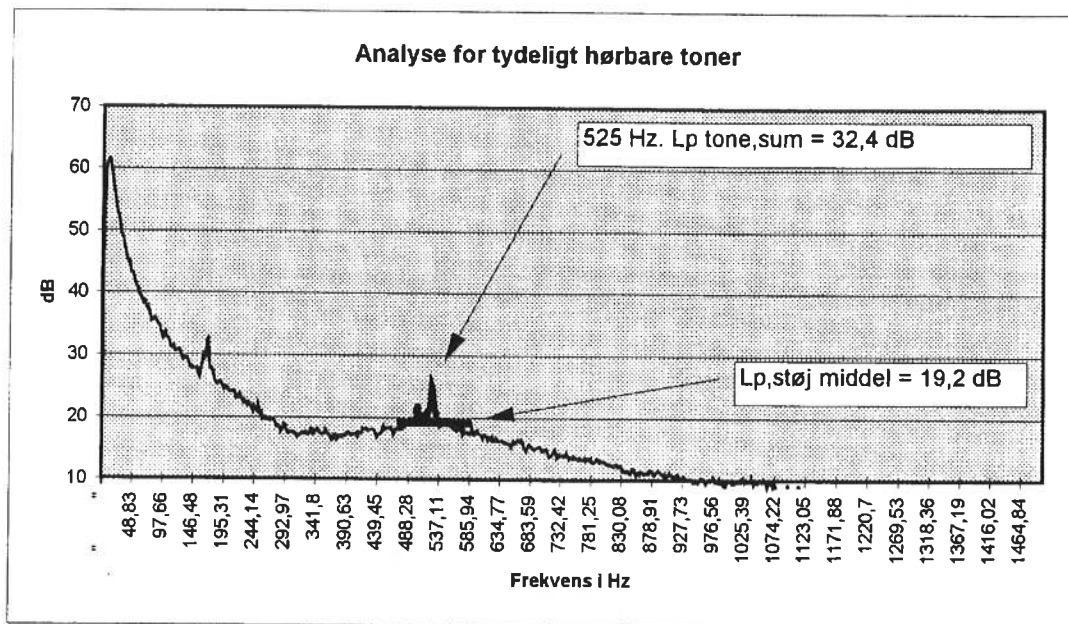
Referencevindhastighed	8 meter
Navnhøjde	30,8 meter
Måleafstand	50,0 meter
Baggrundsstøj $L_{Aeq, baggrundsstøj}$	39,9 dB ref. 20 µPa
Referencelydtryk $L_{Aeq, ref}$	56,6 dB ref. 20 µPa
Referencydeffekt $L_{WA, ref}$	97,0 dB ref. 10^{-12} W



35.1544.01
Vindmølle Rebelshøj

Side 12 af 12 sider
Rapport nr. P2.009.99

BILAG 4 Objektiv toneanalyse



Måleobjekt Norwin 29/225 kW
Måleposition Ved nabo, 300 m mod øst

Analyseparametre

Antal spektre:	235
Tidsvægtning	Hanning
Midling	Lin
Filtrets øvre analysefrekvens	1500 Hz
Effektiv analysebåndbredde	2,93 Hz
Frekvensvægtning	Lin
Reference for lydniveau	dB re 20µPa

Beregning af kriterieværdi delta L(ts)

Tone frekvens	525,4 Hz	og	Hz
Tone niveau, sum			32,4 dB
Kritisk bånd	476,5 Hz	til	582,3 Hz
Lp, støj middel			19,2 dB
Lp, kritisk bånd			34,7 dB
Kriterieværdi			-2,4
Kriteriekurve			4,1

Konklusion Kriterieværdi er under kriteriekurven, derfor intet tillæg

Attachment 3

2010-08-23 Destruction Bay wind project options Northwind & Aeronautica.xls

Destruction Bay Project Capital, O&M, and Energy Cost Summary				
Site close to power line				
Cost category	low penetration 1 NPS NW 100kW turbine	medium penetration 2 NPS NW 100kW turbines	medium+ penetration 3 NPS NW 100kW turbines	medium penetration 1 Aeronautica 225kW turbine
Environmental Assessment & Permitting				
environmental assessment & permitting	\$15,000	\$20,000	\$25,000	\$20,000
Site Preparation				
road construction (\$50,000 per km) 200m + 100/t	\$10,000	\$15,000	\$20,000	\$15,000
site & crane pad construction \$10,000 per turbine	\$10,000	\$20,000	\$30,000	\$20,000
powerline construction (\$150,000 per km), 200m + 100/t	\$30,000	\$45,000	\$60,000	\$30,000
Wind Equipment Purchase				
wind turbines including towers & SCADA	\$377,000	\$754,000	\$1,131,000	\$609,000
shipping	\$50,000	\$90,000	\$130,000	\$90,000
transformers	\$25,000	\$50,000	\$75,000	\$50,000
wind dispatch or secondary load controller	\$0	\$30,000	\$30,000	\$30,000
Installation				
geotechnical & design	\$40,000	\$45,000	\$50,000	\$50,000
foundations	\$60,000	\$120,000	\$180,000	\$60,000
equipment rental	\$50,000	\$80,000	\$105,000	\$75,000
control buildings	\$10,000	\$10,000	\$10,000	\$10,000
utility interconnection	\$45,000	\$45,000	\$45,000	\$45,000
labour - assembly & supervision	\$30,000	\$60,000	\$85,000	\$50,000
commissioning (simple, dispatch, & sec load)	\$20,000	\$45,000	\$65,000	\$20,000
travel and accommodation	\$15,000	\$20,000	\$25,000	\$20,000
Diesel Plant Modifications				
radio / high speed communications	\$10,000	\$30,000	\$30,000	\$30,000
PLC modifications	\$10,000	\$10,000	\$10,000	\$10,000
other plant modifications	\$20,000	\$40,000	\$60,000	\$40,000
Other				
initial spare parts	\$5,000	\$10,000	\$10,000	\$10,000
insurance	\$15,000	\$25,000	\$30,000	\$25,000
Subtotal construction	\$847,000	\$1,564,000	\$2,206,000	\$1,309,000
Design and management (ES&G) 10%	\$84,700	\$156,400	\$220,600	\$130,900
Subtotal construction plus ES&G	\$931,700	\$1,720,400	\$2,426,600	\$1,439,900
Contingency 10%	\$93,170	\$172,040	\$242,660	\$143,990
TOTAL CONSTRUCTION	\$1,024,870	\$1,892,440	\$2,669,260	\$1,583,890
Owners Costs				
staff training	\$32,000	\$32,000	\$32,000	\$32,000
Subtotal owners costs	\$32,000	\$32,000	\$32,000	\$32,000
TOTAL PROJECT COST	\$1,056,870	\$1,924,440	\$2,701,260	\$1,615,890
Installed capacity kW	100	200	300	225
Installed cost per kW	\$10,569	\$9,622	\$9,004	\$7,182
Annual O&M costs (\$15,000 + \$10,000/ additional t)	\$15,000	\$25,000	\$35,000	\$25,000
Total annual costs	\$15,000	\$25,000	\$35,000	\$25,000
Annual total wind energy kWh @6.3m/s	257,346	514,692	772,036	539,021
Annual diesel kWh displaced, 45kW min diesel	231,611	458,464	591,355	450,841
Levelized cost of energy (LCOE) 20 year life	\$0.514	\$0.467	\$0.508	\$0.409
Annual diesel kWh displaced, 75kW min diesel	231,611	425,508	522,939	411,219
Levelized cost of energy (LCOE) 20 year life	\$0.514	\$0.503	\$0.575	\$0.449

Destruction Bay Wind Project Prefeasibility Study

Cost Assumptions

The following are the more significant assumptions made in the assembly of various cost components for a possible wind project in Destruction Bay that may not be obvious from the cost summary spreadsheet. Most of the costs are fairly firm, they are based on budget numbers provided by various suppliers and in several categories no economies of multiple turbine installations are assumed while in others only modest reductions are assumed. The author believes that the costs are, overall, realistic rather than optimistic.

1. Environmental assessment and permitting: The assumed cost of \$15,000 for 1 Northwind turbine and \$20,000 for one Aeronautica 225kW wind turbine is based on YECL's experience for going through YESAA with simple projects. Additional costs of \$5,000 per turbine for multiple projects were assumed. Costs for permitting could go up by a factor of two or three if permitting requirements become extensive – in particular if bird and or other wildlife studies are required.
2. Power line construction: For the purpose of capital cost estimation it was assumed that a turbine project would be 200 meters from the existing power line and that overhead power lines would be used. Following the completion of this report in draft form it was brought to the author's attention that the low voltage (480 V) cabling from the turbine to the overhead power line would need to be installed underground at substantially higher unit costs than the overhead power line. Depending on project layout this could increase the costs by \$20,000 per turbine. Since this increase in costs would not change the overall conclusions of this report it was decided not to recalculate all the cost and economic spreadsheets at this time.
3. Wind turbines: Northwind 100 Arctic wind turbines complete with towers and the options considered appropriate would cost \$US358,800 or about \$CDN377,000 at an exchange rate of \$CDN1.05 = \$US1.00. No savings on the purchase of more than one turbine was assumed – probably a conservative assumption. The Aeronautica (Norwin) 225kW wind turbine on a 40m tower and with a very low temperature option package was listed at \$US580,000 or \$CDN609,000
4. Shipping: the transportation of each turbine from Vermont to Destruction Bay was estimated to cost \$28,000. The transport of the blades and tower to Vermont is estimated to be \$US4,700 or about \$CDN5,000 and the brokerage cost for shipping the turbine across the border was estimated to be less than \$400. About \$8,000 in savings can be realized by shipping the tower directly from Tacoma Washington. It is not known whether any savings could be realized by shipping the turbine blades directly from the manufacturing plant in California. The overall shipping costs were rounded up to \$50,000 for the first turbine and additional turbines were assumed to cost \$40,000 each. The Aeronautica turbine would need to be shipped from New Hampshire, only slightly farther than Vermont and in ratio to the Northwind a cost of \$90,000 was estimated.
5. Transformers: a transformer (large enough for two Northwind turbines or 1 Aeronautica turbine) will need to be specifically ordered for this application at a cost of about \$25,000

as the voltages are non-standard. With the purchase of a second turbine (or an Aeronautica turbine) a spare transformer is assumed to be purchased.

6. Geotechnical and design: it was assumed that the geotechnical work would be in the order of \$15,000, and that the design work for the Northwind turbines would be in the order of \$25,000 and the design work for the Aeronautica in the order of \$35,000. The design would be applicable to all turbines but an additional \$5,000 per turbine is added for geotechnical work for additional turbines.
7. Foundations: it was assumed that an octagonal or square concrete spread footing would be used for the turbines and that ground pressures of 2,500 pounds per square foot or more are allowable. Based on the manufacturer's information these footings would require 77 cubic yards (60 cubic meters) of concrete with 16,000 lbs of reinforcing steel. It was assumed that the in-place cost would be \$1,000 per cubic meter or \$60,000 per footing. The Aeronautica conceptual design requires only about 35 cubic meters but is set deeper into the ground so the same cost as for the Northwind was assumed.
8. Equipment rental: this is mostly for the crane. A crane that can install a Northwind turbine on a 37 meter tower will cost about \$30,000 in mobilization and demobilization costs plus about \$6,000 per day in operating costs – about \$40,000 for one turbine (with proper planning). With other equipment the total is expected to be about \$50,000 for the first turbine. Subsequent turbines were expected to experience reductions of \$20,000 to \$25,000 due to the reduced mobilization and demobilization costs. It was assumed that the Aeronautica turbine could be installed with a similar size crane.
9. Control building: a simple modified shipping container or similar was assumed. This would house the SmartView RTU for the Northwind (or equivalent for the Aeronautica) as well as the dispatch controller or secondary load controllers as appropriate.
10. Radio / high speed communications: it was assumed that besides the internet connection required for SmartView, a radio link would be maintained to the diesel plant for communications with the installation of a single turbine. For two or more turbines a high speed communications (telephone or fiber optic line) to the diesel plant would be required. Higher speed communications to the diesel plant were also assumed for the Aeronautica
11. Other diesel plant modifications: this is an allowance for other as yet unspecified but necessary changes to be made to the diesel plant. These will increase in complexity and cost as the wind penetration level increases, and in particular with high penetration diesel-off configuration.
12. GST: GST payable on goods and services has not been added to the project. It was assumed that these costs would be offset from GST collected from customers and thus would not be a net cost to the project.

October 15, 2010

John Maissan

From: Phil Borgel@atco.com
Sent: Wednesday, July 28, 2010 3:07 PM
To: john@leprojects.com
Subject: RE: d bay wind estimating

We're both in sync. We thought about that and the largest tx I have that is 14.4kv delta connectable is 50kva so I'd need a bank of transformers for each turbine. We're starting to look at a lot of transformers to plug in a few turbines.

The other option is to convert Burwash to 25kv but this was even more. It would entail 48 reconnection of transformers, 4 reconnections of 3 phase banks, changing the step up bank from 2400V delta to 25kv delta. a neutral would need to be run through out all of Burwash; and ideally back to the step up bank in D-bay.

Phil Borgel P.Eng
Supervising Engineer
Yukon Electrical Co. Ltd. & Northland Utilities Enterprises Ltd
100-1100-1 Ave. Whitehorse YT Y1A 3T4
Ph 867-633-7069 fax 633-5797

From: John Maissan [mailto:john@leprojects.com]
Sent: Wednesday, July 28, 2010 2:42 PM
To: Borgel, Phil
Subject: RE: d-bay wind estimating

Phil,

Just had a further thought – would it make any sense to consider two transformers, one nonstandard to bring the 480V up to a voltage so that you could use a stock / standard transformer to get up to your 14.4kV? Perhaps the non standard one could then be single phase units to reduce the cost of spares. Is this possible or realistic? Just thinking about costs and trying to keep them as low as reasonably possible.

John

From: Phil.Borgel@atco.com [mailto:Phil.Borgel@atco.com]
Sent: Wednesday, July 28, 2010 1:58 PM
To: john@leprojects.com
Subject: d-bay wind estimating

To help with estimates we came up with:

PLC parts 5-10k

Radios 5-10k (we went with radio link due to lack of ability to put fiber on our poles. Dedicated phone line is likely an option but an expensive one on a monthly basis. I'll try to get a price for unshielded –self supporting fiber that could be put right up tight to our power wires if we owned it.

16k plc logic and labour

SEL 547 protection relay

Sync check

480 V Breaker

Total 15k in parts

Labour and design (over and above ES&G) 30k

I will price out the nonstandard transformer and a spare (since there is not one in stock) at \$25k each for a total of \$50k for transformers to serve one or two turbines. Add \$25k for the 3 or 4 turbine option.

I'll price out the secondary to the transformers.

Are some of your considerations for plant mods like dump load going to be a battery bank that can feed power until we get another diesel running (when the wind supply drops out)?

Phil Borgel P.Eng

Supervising Engineer

Yukon Electrical Co. Ltd. & Northland Utilities Enterprises Ltd

100-1100-1 Ave. Whitehorse YT Y1A 3T4

Ph 867-633-7069 fax 633-5797

The information transmitted is intended only for the addressee and may contain confidential, proprietary and/or privileged material. Any unauthorized review, distribution or other use of or the taking of any action in reliance upon this information is prohibited. If you receive this in error, please contact the sender and delete or destroy this message and any copies.

John Maissan

From: Phil.Borgel@atco.com
Sent: Tuesday, August 31, 2010 4:08 PM
To: john@leprojects.com
Subject: RE: Draft Wind-Diesel Pre-feasibility report for Burwash Landing and Destruction Bay

The \$150 you used for power line is likely for overhead power line. The estimate I sent today was for underground secondary from a transformer to the turbine. I assume we'd have a transformer between two turbines and secondary going from the transformer to each turbine. My 100m of secondary could be long but I don't know what the conceptual design looks like.

Phil Borgel P.Eng
Supervising Engineer
Yukon Electrical Co. Ltd. & Northland Utilities Enterprises Ltd
100-1100-1 Ave. Whitehorse YT Y1A 3T4
Ph 867-633-7069 fax 633-5797

From: John Maissan [mailto:john@leprojects.com]
Sent: Tuesday, August 31, 2010 2:43 PM
To: Borgel, Phil; jpp@northwestel.net; Babyn, Jerome; Steinbach, Craig; Massie, Jay
Subject: RE: Draft Wind-Diesel Pre-feasibility report for Burwash Landing and Destruction Bay

Phil,

The power line connection cost was estimated at \$150,000 per km from the power line right to the turbine. This is \$15,000 per 100m. If this is not adequate we will need to add the difference of \$21,000. We should probably then talk about how you would like to see multiple turbines connected – all with daisy chain 480V cabling or separate runs or split the difference and go to overhead to a location between them.

The creative engineering comment is meant to capture the concept of thinking "outside the box" creatively for innovative solutions (e.g. on foundation design) to keep capital costs as low as possible while still doing a sound engineering job.

John

John F. Maissan, P.Eng.
Leading Edge Projects Inc.
P: +1 (867) 668-3535
F: +1 (867) 668-3533
E: john@leprojects.com

From: Phil.Borgel@atco.com [mailto:Phil.Borgel@atco.com]
Sent: Tuesday, August 31, 2010 1:07 PM
To: jpp@northwestel.net; Jerome.Babyn@atco.com; Craig.Steinbach@atco.com; Jay.Massie@atco.com
Cc: john@leprojects.com
Subject: RE: Draft Wind-Diesel Pre-feasibility report for Burwash Landing and Destruction Bay

I don't know if the estimated 100m of 480V wiring was included; I know I meant to send that to you. If it is not included I was guess-ta-mating that to be about \$36k. this assumes only wire, duct and trench. I assumed no junction box/pedestals... to interface between the transformer or turbine.

Aside from that the only other concern was the "creative engineering" comment in the conclusion.

Phil Borgel P.Eng
Supervising Engineer
Yukon Electrical Co. Ltd. & Northland Utilities Enterprises Ltd
100-1100-1 Ave. Whitehorse YT Y1A 3T4
Ph 867-633-7069 fax 633-5797

From: Jean-Paul Pinard [mailto:jpp@northwestel.net]
Sent: Friday, August 27, 2010 3:22 PM
To: Babyn, Jerome; Borgel, Phil; Steinbach, Craig; Massie, Jay
Cc: John Maissan
Subject: Draft Wind-Diesel Pre-feasibility report for Burwash Landing and Destruction Bay

Hi Jerome,

Please find attached the draft pre-feasibility report on the Burwash Landing and Destruction Bay Wind-Diesel project.

If you have comments and questions please let me know. We can also arrange a meeting to further discuss the results of this study. I will be away to Fort St John next week and will back in the office Sept 7 and on.

Thank you for your business and have a great weekend.

jp



JP Pinard, PEng, PhD
703 Wheeler Street, Whitehorse, Yukon, Y1A 2P6, 867-393-2977

The information transmitted is intended only for the addressee and may contain confidential, proprietary and/or privileged material. Any unauthorized review, distribution or other use of or the taking of any action in reliance upon this information is prohibited. If you receive this in error, please contact the sender and delete or destroy this message and any copies.

Attachment 4

1 2010-07-28 Northwind 100 wind turbine purchase cost.xls

Destruction Bay Wind Study		
Norhtwind® 100 Arctic wind turbine purchase cost		
Component description	Cost \$US	Cost \$CDN
Norhtwind® 100 Arctic wind turbine, 21 meter rotor	\$347,500	\$364,875
37 meter tubular tower, included in price		
FAA Light L810 Obstruction lighting kit	\$2,500	\$2,625
Anchor bolt template ring	\$3,900	\$4,095
Anchor bolt Embment ring	\$4,900	\$5,145
Total cost	\$358,800	\$376,740
Assumed exchange rate \$CDN = \$US X 1.05		

Attachment 5

John Maissan

From: Erin McLarnon [erin@winddieselpower.com]
Sent: Wednesday, August 04, 2010 6:29 PM
To: 'John Maissan'
Cc: 'Gavin L. Bates'; 'Shaun W. Lockett'
Subject: Aeronautica Wind Turbines
Attachments: Spec_Sheet_Norwin225.pdf; Spec_Sheet_Norwin750.pdf; Comparing the Aeronautica 47-750kW and 54-750kW Power Curves.pdf

John –

Yes, the turbines VLT (very low temperature package) includes reengineered steel for the tower, nacelle and hub, heating for the gearbox, oil system, blades and generator, and insulation for the nacelle that allows the turbine to operate at -40.

Shaun, please let me know if I am missing anything.

Below is the most recent pricing (in US dollars) and what it includes:

Includes:

- One set of three LM Glass Fiber 13.4P blades (or equivalent)
- Nacelle and generator
- Tubular steel tower painted white, including safety ladder, lights, sockets and safety signs
- ADSL control system w/Internet interface
- Complete Documentation (Installation, Operations and Maintenance)
- **Standard four-year parts warranty** (an add'l year warranty can be purchased for \$12,000)
- One week on-site commissioning support and training from factory trained representatives
- Packaging for Transport

29-225 turbine (29m rotor dia)

On a 40m tower and VLT package - \$580,000

If wanted on a 30m tower, subtract \$7,000

47-750 (47m rotor dia)

On a 65m tower and VLT package - \$1,344,800

If wanted on a 55m tower, subtract \$7,000

54-750 (54m rotor dia)

On a 65m tower and VLT package - \$1,456,800

If wanted on a 55m tower, subtract \$7,000

My company, Wind Diesel North America, supplies the servicing of these turbines in Alaska and we could expand that service into Canada. Currently, a five-year service agreement in Alaska runs approx. \$55,000 with travel and parts extra. The current lead time for these turbines is approx. 8.5 months.

John, let me know what else you need.

Thanks,
Erin

From: John Maissan [mailto:john@leprojects.com]
Sent: Wednesday, August 04, 2010 12:56 PM
To: 'Erin McLarnon'
Cc: 'Gavin L. Bates'; 'Shaun W. Lockett'
Subject: RE: Low Load Diesels

Erin,

Thanks for the prompt response and I am glad to know that you are their agent. Does the cold weather package allow operation to -40 for operation in our part of the country? This is what I sent to Aeronautica:

I have been looking with interest at your two "new" wind turbines coming to market later this year. As these turbine sizes would suit some of our smaller northern locations very well I would be interested to know whether there is a cold weather package available for them that would allow them to operate to -30°C or - 40°C. If such options are available I would very much like to get from you the present pricing schedule for the turbines, the various towers, and the other options available – including service packages.

So yes, I would be interested in the 750 pricing, the pricing for the tower options for both turbines (I noticed they both had options) etc. This would allow me to do some serious comparisons to other (smaller) turbines.

Cheers!

John

John F. Maissan, P.Eng.
Leading Edge Projects Inc.
P: +1 (867) 668-3535
F: +1 (867) 668-3533
E: john@leprojects.com

From: Erin McLarnon [mailto:erin@winddieselpower.com]
Sent: Wednesday, August 04, 2010 1:27 PM
To: John Maissan
Cc: Gavin L. Bates; Shaun W. Lockett
Subject: Re: Low Load Diesels

Yes, I am their agent. The turbine is the Danwin/Norwin turbine out of Denmark, now being manufactured in the US under the Aeronautica name.

For a 225 with a cold weather package, you are looking at approx. \$580K US FOB New Hampshire.

I have the 750 pricing back in my office, if you are interested.

Let me know what add'l info I can send you. I have also cc'd Shaun Lockett, Aeronautica's National Sales Manager on this email too.

Sent from Erin McLarnon's iPhone

On Aug 4, 2010, at 11:58 AM, "John Maissan" <john@leprojects.com> wrote:

Thanks Erin,

I was not familiar with Aeronautica. I have sent them an email asking about pricing and cold weather options. Are you familiar with their equipment and have you any direct experience with them?

John

John F. Maissan, P.Eng.

Leading Edge Projects Inc.

P: +1 (867) 668-3535

F: +1 (867) 668-3533

E: john@leprojects.com

From: Erin McLarnon [<mailto:erin@winddieselpower.com>]

Sent: Friday, July 23, 2010 11:16 PM

To: John Maissan

Cc: Gavin L. Bates

Subject: Re: Low Load Diesels

John-

Are you familiar with the Aeronautica/Norwin wind turbine?

www.aeronauticawind.com

Sent from Erin McLarnon's iPhone

On Jul 23, 2010, at 12:24 PM, "John Maissan" <john@leprojects.com> wrote:

Attachment 6

John Maissan

From: Barry Hnatchuk [BHnatchuk@manitoulintransport.com]
Sent: Wednesday, July 28, 2010 8:12 AM
To: john@leprojects.com
Subject: Rate Quote - Destruction Bay, YT

Hello John,

Our rates would be as follows:

40' standard containers 26600 lbs Barre, VT to Destruction Bay, YT
\$13985 per container

3 tubes bundled together at 40' x 6' 6" diameter 30800 lbs Tacoma, WA to
Destruction Bay, YT \$9900 per truck (3 tubes should fit on 1 truck)

For customs, please call Near North at 1-888-739-4002.

- * Rates includes fuel.
- * Rates are in CDN dollars.
- * Based on availability of equipment.
- * Customer to give 48 hours notice prior to pick up.
- * For pick ups, please call 1-800-407-5245.
- * Rates are based on 2 hours free load/offload time, after which waiting time is charged at \$85.00 per hour.
- * Quote is valid for 30 days.

Thanks,

Barry Hnatchuk
Manitoulin Logistics-Calgary
Manitoulin Group of Companies
(403) 299-0700
1-800-407-5245
(403) 299-0710 Fax
bhnatchuk@manitoulintransport.com

9500 Venture Avenue SE
Calgary, AB T3S 0A1

John Maissan

From: Narwid, David [dnarwid@northernpower.com]
Sent: Monday, August 09, 2010 2:20 PM
To: John Maissan
Cc: Axworthy, Alan
Subject: RE: Northwind 100 tower and blades

John,

Sorry for the delay in responding.

The tower and blades can be shipped from west coast to you. There is no reason they have to come here first.

Hope that helps.

Regards,

David

From: John Maissan [mailto:john@leprojects.com]
Sent: Sunday, August 08, 2010 8:59 PM
To: Narwid, David
Cc: Axworthy, Alan
Subject: Northwind 100 tower and blades

Hi David,

Could help me with one outstanding question on the Northwind 100 transport? The tower and blades are made on the west coast and it would be cheaper to transport them straight up here rather than to Vermont and up here from there. Can this be done or do they have to go back to Vermont for further additions / inspections etc?

Thanks,

John

John F. Maissan, P.Eng.
Leading Edge Projects Inc.
P: +1 (867) 668-3535
F: +1 (867) 668-3533
E: john@leprojects.com

Attachment 7

John Maissan

From: Adele Bradley [abradley@nearnorthcustoms.com]
Sent: Thursday, July 29, 2010 10:12 AM
To: john@leprojects.com
Subject: Fw: Import information--Near North Customs Brokers Inc.
Attachments: CGAA-POA.pdf; SAMPLE POA.pdf; New Client Profile and Payment Options.pdf; CREDIT APP 2010 pdf; GST DIRECT pdf; GST Program.doc

John;

I have just had confirmation that the turbines do entry duty free.

Thanks,
Adele Bradley CCS
Manager- Client Services
Near North Customs Brokers Inc.
20 Elliott Ave.
Barrie ON L4N 4V7
ph# (705) 739-0024 EXT 84125
fx# (705) 739 -0268
TOLL FREE FAX (888)-739-0023

----- Forwarded by Adele Bradley/Near North Customs on 29/07/2010 01:11 PM

Adele
Bradley/Near
North Customs

29/07/2010 01:06
PM

john@leprojects.com

To

cc

Subject

Import information--Near North
Customs Brokers Inc.

Good Morning John;

Thank you for taking the time to discuss your importing needs with me yesterday. Further to our conversation, I have attached the documents required to open the import account with Near North.

Pricing below is based on participation in the GST Direct program. An explanation of the GST Direct Program is below.

Brokerage \$150.00

Account registration \$45.00 (One time only fee) Plus any applicable duties and 5% GST on the Canadian dollar value of the shipment(s).

HST on service fees.

Other charges which may apply:

Outport fee \$35.00 (If for some reason the shipment has to clear inland instead of at the border) Handling \$35.00 --this would apply only to air or ocean shipments and does not apply to ground shipments.

I believe these wind turbines enter duty free, however, I have asked our Compliance expert to confirm and will let you know asap.

The GST Direct Program allows for payment of the GST and any duties directly to the Receiver General by the importer on a monthly basis. The statement for GST goes out in the third week of the month so payment can be sent for the end of the month deadline to Near North. We will then submit the cheque on behalf of the importer. Participation in this program allows us to offer a more competitive brokerage rate on higher value shipments as we do not have the outlay of the GST on behalf of the importer.

If you have any questions at all, please contact me.

Thanks,

Adele Bradley CCS

Manager- Client Services

Near North Customs Brokers Inc.

20 Elliott Ave.

Barrie ON L4N 4V7

ph# (705) 739-0024 EXT 84125

fx# (705) 739 -0268

TOLL FREE FAX (888)-739-0023

(See attached file: CGAA-POA.pdf)(See attached file: SAMPLE POA.pdf)

(See attached file: New Client Profile and Payment Options.pdf)

(See attached file: CREDIT APP 2010.pdf) (See attached file: GST DIRECT.pdf)(See attached file: GST Program.doc)

NEAR NORTH CUSTOMS BROKERS

GST DIRECT PROGRAM

Dear Client:

Effective January 1, 2005, clients importing regular HVS (high value shipments = \$1601. +) are required to be enrolled in the GST Direct Program.

Currently, when a shipment crosses customs, we pay the applicable GST to Revenue Canada at month end on your behalf then bill it out to you. This procedure can often result in potential shipment delays and additional charges. Once on the program, we will not pay the GST on your behalf nor will we bill it out to you on a per-shipment basis. How the GST program works is, if a shipment is cleared before or around the 18th of any given month, GST on the Canadian value of the goods is payable to the Receiver General on the last business day of that month. The GST on shipments cleared after (or around) the 18th of any month is not payable to the Receiver General until the last business day of the **following** month. Prior to month end, we will fax you a complete summary of shipments cleared in the current billing period that will highlight the GST amount due. You will then cut a cheque for that amount, made payable to the Receiver General and forward that to us before the last business day of each month. We will then hand deliver it on your behalf to Canada Customs on the due date.

The advantages of this program allow for a review of your brokerage rates; up to 45-day terms with Rev Can depending on the clearance date, and a consolidated report from us for your records at no cost.

Over all, the amount you pay in GST is absolutely no more or no less on this program. Revenue Canada and the Receiver General simply want to receive the funds directly from the business owners via cheque.

Please complete the attached letter **on your business letterhead** and return to our office ASAP. This process takes approximately 6-8 weeks to be approved by Canada Customs and must be in place before year-end. If you have any questions, please contact our Accounting Manager and GST expert, Rosemary Dumond.

Sincerely,

Adele Bradley

Customer Service Manager

Please sign below to confirm that any changes to the legal structure, name or nature of your business will be reported to Near North immediately so we may update this letter. Failure to do so renders the agreement void and all liability for any late remitted amounts will become the responsibility of the importer.

SIGNATURE OF AUTHORIZED OFFICER OF THE COMPANY

Name of Officer of the Company_____

DATE:_____

[your letterhead here]

GST AGREEMENT LETTER

To: Near North Customs Brokers Inc.
20 Elliott Ave.
Barrie, ON
L4N 4V7

This is to confirm our arrangement with respect to the payment of the taxes levied under the Excise Tax Act (GST) on imported goods, which you will clear through Canada Customs Border Services on our behalf using your release prior to payment privileges.

We agree to provide to you with separate payment by cheque for the full amount of the GST owing on these goods. The cheque will be made payable to **The Receiver General for Canada** and will be available for remittance to Canada Customs Border Services, through you, by the last business day of the month to which the billing period applies.

This will acknowledge that under this agreement, failure to provide such payment by the due date will result in the assessment of interest on the outstanding amount. We accept full responsibility and liability for the payment of interest assessed in this way.

We further acknowledge that non-payment of any and all amounts may result in the loss of this option for the release of future importations on our behalf, whether prior to the payment of duties and taxes or otherwise, until all debts including interest charges have been paid in full to Canada Customs Border Services.

In the event that payment is not provided within the required time limits, the Canada Customs Border Services may contact: _____ (contact person) at _____ (telephone number), or by fax at _____.

Our Business Number is _____ RM- _____. Our average monthly GST payable is _____.

Signature of Authorized Officer of the Company

Title of Officer

Name of Officer of the Company (please print here)

Date

NEW CLIENT PROFILE AND PAYMENT OPTIONS

ALL NEW ACCOUNTS MUST BE ACCOMPANIED BY A COMPLETED BUSINESS PROFILE

Near North Customs Brokers Inc. 20 Elliot Ave. Barrie, Ont. L4N 4V7 <u>Business Profile</u>		
Legal Company Name (as listed on your GST registration papers):		
Full Company Address		
Phone Number		Fax Number
		Postal Code:
		Website and/or Email
Structure of Business ☐ Sole Proprietor ☐ Partnership ☐ Corporation If yes, Corporation # _____		
President _____ VP _____		
Controller:		
How did you hear about us?	Referred by Whom?	GST Number BN- _____ RM- _____
Nature of Business		Date Business Started
☐ Resident Importer ☐ Non-Resident Importer (please note – a bond may be required)		
Other Information Pertinent to Ownership Details: The company is owned by (please select one) ☐ Private individual(s) If Private Individual, please provide Name _____ ☐ Publicly traded ☐ A parent company (please provide parent company details)		
Parent Company Details:		
<u>Payment Options</u>		
Please check one box below:		
☐ Credit Card (has additional 3% fee) ☐ On-Line Banking ☐ Deposit On Account	☐ Bank Transfer ☐ Certified Cheque ☐ Cash	
To discuss any payment options please call or email: finance@nearnorthcustoms.com or please call 705-739-0024 and ask for the Finance Manager.		
I understand that if this account goes beyond the financial terms of Near North Customs Brokers, shipments may be held up or delayed at the border		
		Initial Here:
The undersigned hereby authorizes Near North Customs Brokers to conduct an investigation for the purposes of obtaining credit. Such investigation may include checking supplier references and obtaining a credit report. Please note: Terms are 21 days. 2% monthly interest (24% per annum) on over due balances.		
Signed: _____	Title: _____	Date: _____

Amount of Credit:
Requested:

CLIENT CREDIT APPLICATION & AGREEMENT FORM

Legal Name of Business:		Trade Name (If different):	
☐ Corporation ☐ Partnership ☐ Proprietorship		Date registered or incorporated:	
Business Address:		City/Town	Province/State
		Postal Code:	How Long:
Business Phone: ()	Fax Number: ()	E-mail:	Web Site:
# of locations or branches:	# of employees:	Nature of Business:	Annual Sales: \$
Name of Principal Shareholder / Owner of Business:		Name of President if Incorporated:	
Accounts Payable Contact:	Telephone Number: Ext:	Fax Number:	Email:

YOUR BANKING INSTITUTION

Bank:	Full Address:		
Account Number (Mandatory):	Account Manager:	Telephone Number:	How long at this Bank? :

YOUR SUPPLIERS

Name & Address:	Name & Address:	Name & Address:
Name of Contact:	Name of Contact:	Name of Contact:
Telephone Number: ()	Telephone Number: ()	Telephone Number: ()
Name & Address:	Name & Address:	Name & Address:
Name of Contact:	Name of Contact:	Name of Contact:
Telephone Number: ()	Telephone Number: ()	Telephone Number: ()

PERSONAL DATA ON PRINCIPAL/OWNER OF BUSINESS

Last Name of Principal/Owner/Operator:	First Name:	Date of Birth: MM DD YYYY	Social Insurance Number:
Residential Address:	City/Town	Province:	Postal Code:
Home Telephone: ()	Rent ☐ Own ☐	Former Address	

Please fill out the form completely and fax it back to: 705-726-0321, Attention: FINANCE MANAGER,
or e-mail to: finance@nearnorthcustoms.com

PLEASE PRINT CLEARLY

IMPORTANT: Incomplete information will delay processing of your credit application.

BY SIGNING BELOW, I AUTHORIZE NEAR NORTH CUSTOMS BROKERS INC. AND OR ITS AGENTS, Canadian Credit Corporation, TO CONTACT ANY Credit REFERENCES GIVEN, INCLUDING BANKS, Financial Institutes TO RELEASE AND EXCHANGE SUCH CREDIT, BANKING AND FINANCIAL INFORMATION AS MAY BE NECESSARY TO DETERMINE CREDIT STANDING. I ALSO GRANT PERMISSION TO THE TRADE AND BANK REFERENCES LISTED ABOVE TO IMPART FINANCIAL INFORMATION REQUESTED BY NEAR NORTH CUSTOMS BROKERS INC. OR THEIR AGENTS, Canadian Credit Corporation, IN THE COURSE OF REGULAR CREDIT INVESTIGATIONS. AS THE PRINCIPAL/OWNER/OPERATOR REFERRED TO HEREIN I TAKE NOTICE THAT REPORTS WILL BE SOUGHT CONTAINING PERSONAL INFORMATION, FINANCIAL INFORMATION AND CREDIT INFORMATION AND I CONSENT TO THE RECEIPT, DISCLOSURE AND EXCHANGE OF SUCH INFORMATION TO OTHER BUSINESS RELATED PARTIES, AGENTS AND CONSUMER REPORTING AGENCIES. AS THE UNDERSIGNED I HEREBY AGREE THAT SUBSEQUENT CREDIT INFORMATION MAY BE OBTAINED THROUGHOUT THE DURATION OF THE BUSINESS RELATIONSHIP AND CONSENT TO THE RELEASE OF SAID INFORMATION. I CERTIFY THAT THE ABOVE INFORMATION IS TRUE AND CORRECT. I ALSO CERTIFY THAT I AM AUTHORIZED TO BIND THE COMPANY AND AGREE TO PAY INVOICES IN FULL 21 DAYS FROM DATE OF INVOICE. IN ADDITION I (WE) ACCEPT THAT THERE IS AN INTEREST CHARGE OF 2% PER MONTH OR 24% PER ANNUM ON ANY BALANCE OUTSTANDING OVER 21 DAYS.

AGREEMENT

I HAVE READ AND UNDERSTAND THE TERMS & CONDITIONS. I ALSO UNDERSTAND THAT NEAR NORTH CUSTOMS BROKERS INC. CAN CHANGE ITS POLICY AND CAN CANCEL CREDIT SUPPORT SERVICE AT ANY TIME.

Authorized Signature for Applicant:		
Print Name of Person who signed this application:		
Title/Position:	Telephone:	Date Signed:

CANADIAN SOCIETY OF CUSTOMS BROKERS

CONTINUOUS GENERAL AGENCY AGREEMENT AND POWER OF ATTORNEY
WITH POWER TO APPOINT A SUB-AGENT

KNOW ALL MEN BY THESE PRESENTS that

I/We (Name of Client and Business Number) _____ of
(Address) _____ do hereby constitute and appoint
(Name of Customs Broker and Business Number) _____, a Customs Broker
licensed under the Customs Act, of (Address) _____ my true and lawful attorney to
transact business on my behalf in all matters relating to the import and export of goods, including but not restricted to:

i) the release of and accounting for goods, document and data preparation, payment of, and refund of, all government duties, taxes and
levies in respect of imported and exported goods released or to be released, and

ii) the transportation, warehousing and distribution of such goods.

And I do hereby engage the customs broker to perform such services.

AND IN CONNECTION THEREWITH:

(a) to obtain, sign, seal, endorse and deliver for me all bonds, entries, permits, bills of lading, bills of exchange, declarations, claims of
any nature, or other means of payment or collateral security which comes into his possession and to use same, including drawbacks
and claims of any nature for reimbursement of duties, taxes, levies and the like;

(b) to receive all such payments and sums of money as are now due or may hereafter become due and payable to me relative to the
foregoing; and to endorse on my behalf and as my attorney and to deposit to and for his own account all such payments.

To facilitate the carrying out of such services on our behalf, I hereby authorize the customs broker to obtain and review from the Canada
Border Services Agency our Canada Border Service Agency importer profile.

I confirm that this Agency Agreement and Power of Attorney shall be deemed to constitute all notices and authorizations required by the
Minister of Foreign Affairs and the Export and Imports Controls Bureau in the Department of Foreign Affairs and International Trade with
respect to all matters relating but not limited to softwood lumber export issues and apparel tariff preference issues. Further I also confirm
that this Agency Agreement and Power of Attorney is intended to apply and does apply to allow the customs broker to act on our behalf
with respect to documentary compliance with all Federal Government programs involving the import or export of goods.

I acknowledge that any duties, charges or other amounts paid on my behalf or to my account by my attorney or sub-agent shall be a debt
due by me to my attorney or sub-agent and any refund, rebate or remission of such duties, charges or other amounts shall be the property
of my attorney or sub-agent and I direct and authorize any governmental agencies collecting same to deliver such rebate, refund or
remission to my attorney or sub-agent.

I hereby certify that, to the best of my knowledge, all documents and/or information that will be provided to my aforesaid attorney by myself
or on my behalf, in connection with this mandate, will be true, accurate and complete.

I further grant my attorney full power and authority to appoint any other person to whom a license to transact business as a Customs
Broker has been issued under the Customs Act as a sub-agent to transact the aforesaid business on my behalf and to revoke any such
appointment and to appoint any other person who holds such a license as a sub-agent in the place of any sub-agent whose appointment
has been revoked, as he, my attorney, shall from time to time think fit.

I hereby agree that this Agency Agreement and Power of Attorney and all transactions hereunder shall be governed by the Standard
Trading Conditions of the Canadian Society of Customs Brokers which are on the reverse side hereof and which have been read by the
undersigned.

I hereby ratify and confirm and agree to ratify and confirm all that my said attorney may do by virtue hereof.

This Agency Agreement and Power of Attorney shall be and remain in full force and effect, until due notice of its revocation shall have been
given to my aforesaid attorney, in writing and subject to article 8 of the Standard Trading Conditions

In witness whereof (Corporate Name) _____ has caused these presents to be sealed
with its corporate seal, attested to by the signature of its duly authorized officials at (Name of Municipality)
_____ in
(Name of Province/State and Country) _____, this _____ day of _____, 20____.

Corporate Name

Name of Customs Broker

By: _____
Name - Office Held

Accepted By: _____
Name - Office Held

By: _____ c/s
Name - Office Held

Date: _____

The following guidelines have been prepared by the CSCB to assist corporate members and their employees when they meet with clients to sign the general agency agreement and standard trading conditions.

GUIDELINES FOR THE COMPLETION OF THE GENERAL AGENCY AGREEMENT AND STANDARD TRADING CONDITIONS

It is important to remember that the General Agency Agreement (GAA) and Standard Trading Conditions (STC) are legally binding contracts. Clients should be encouraged to read these documents before signing them. It is recommended that all signatories initial each page of the GAA and STC.

Following are some additional considerations:

1. Who can sign the GAA/STC on behalf of the client when that client is an incorporated company?

If possible, obtain two signatures from individuals authorized to sign on behalf of an Incorporated company. Their titles should also be indicated. If possible, have the corporate seal affixed and ensure that the name of the client company corresponds exactly with the name on the corporate seal. In many jurisdictions a corporate seal is no longer required. In that case, it is important to verify that the persons signing the agreement have the authority to do so. In instances where the signatory is not an officer but has authority to sign, attach a copy of the corporate resolution granting this authority.

2. Who can sign the GAA/STC on behalf of the client when that client is not an incorporated company?

Unincorporated companies, associations, partnerships or sole proprietorships require the signature of at least one and preferably two duly authorized signing officers, partners or owners. Always insert the title or position of the person, i.e. president, partner. These signatures must be witnessed by another individual of "lawful age".

3. How do we proceed if amendments are made to the GAA and STC?

All signatories should initial any changes to the agreements.

4. Do the documents need to be originals or can we retain photocopies for our records?

It is always preferable to have a signed original in your possession. It is recommended that you take a minimum of two copies of the documents to your client for signing. One original can be left with the client and the other can then be returned for safekeeping in your own office.

CANADIAN SOCIETY OF CUSTOMS BROKERS

CONTINUOUS GENERAL AGENCY AGREEMENT AND POWER OF ATTORNEY
WITH POWER TO APPOINT A SUB-AGENT

KNOW ALL MEN BY THESE PRESENTS that

I/We (Name of Client and Business Number) Your legal operating name here (your GST number if you have one) of
(Address) Your full company address here do hereby constitute and appoint
(Name of Customs Broker and Business Number) NEAR NORTH CUSTOMS BROKERS INC 113418812RMX02, a Customs Broker
licensed under the Customs Act, of (Address) 20 ELLIOTT AVE, BARRIE, ONTARIO L3N 4V7 my true and lawful attorney to
transact business on my behalf in all matters relating to the import and export of goods, including but not restricted to:

i) the release of and accounting for goods, document and data preparation, payment of, and refund of, all government duties, taxes and
levies in respect of imported and exported goods released or to be released, and

ii) the transportation, warehousing and distribution of such goods.

And I do hereby engage the customs broker to perform such services.

AND IN CONNECTION THEREWITH:

(a) to obtain, sign, seal, endorse and deliver for me all bonds, entries, permits, bills of lading, bills of exchange, declarations, claims of
any nature, or other means of payment or collateral security which comes into his possession and to use same, including drawbacks
and claims of any nature for reimbursement of duties, taxes, levies and the like;

(b) to receive all such payments and sums of money as are now due or may hereafter become due and payable to me relative to the
foregoing; and to endorse on my behalf and as my attorney and to deposit to and for his own account all such payments.

To facilitate the carrying out of such services on our behalf, I hereby authorize the customs broker to obtain and review from the Canada
Border Services Agency our Canada Border Service Agency importer profile.

I confirm that this Agency Agreement and Power of Attorney shall be deemed to constitute all notices and authorizations required by the
Minister of Foreign Affairs and the Export and Imports Controls Bureau in the Department of Foreign Affairs and International Trade with
respect to all matters relating but not limited to softwood lumber export issues and apparel tariff preference issues. Further I also confirm
that this Agency Agreement and Power of Attorney is intended to apply and does apply to allow the customs broker to act on our behalf
with respect to documentary compliance with all Federal Government programs involving the import or export of goods.

I acknowledge that any duties, charges or other amounts paid on my behalf or to my account by my attorney or sub-agent shall be a debt
due by me to my attorney or sub-agent and any refund, rebate or remission of such duties, charges or other amounts shall be the property
of my attorney or sub-agent and I direct and authorize any governmental agencies collecting same to deliver such rebate, refund or
remission to my attorney or sub-agent.

I hereby certify that, to the best of my knowledge, all documents and/or information that will be provided to my aforesaid attorney by myself
or on my behalf, in connection with this mandate, will be true, accurate and complete.

I further grant my attorney full power and authority to appoint any other person to whom a license to transact business as a Customs
Broker has been issued under the Customs Act as a sub-agent to transact the aforesaid business on my behalf and to revoke any such
appointment and to appoint any other person who holds such a license as a sub-agent in the place of any sub-agent whose appointment
has been revoked, as he, my attorney, shall from time to time think fit.

I hereby agree that this Agency Agreement and Power of Attorney and all transactions hereunder shall be governed by the Standard
Trading Conditions of the Canadian Society of Customs Brokers which are on the reverse side hereof and which have been read by the
undersigned.

I hereby ratify and confirm and agree to ratify and confirm all that my said attorney may do by virtue hereof.

This Agency Agreement and Power of Attorney shall be and remain in full force and effect, until due notice of its revocation shall have been
given to my aforesaid attorney, in writing and subject to article 8 of the Standard Trading Conditions

In witness whereof (Corporate Name) Your legal operating name here (No seal is required) has caused these presents to be sealed
with its corporate seal, attested to by the signature of its duly authorized officials at (Name of Municipality)
Your city in Your state or province, country
(Name of Province/State and Country) this day of 20

Your legal operating name here (No seal is required)

Corporate Name

By Printed full name & title of signing party

Name - Office Held

By Signature of signing party c/s

Name - Office Held

Near North Customs Brokers Inc.

Name of Customs Broker

Accepted By: _____

Name - Office Held

Date: _____

The following guidelines have been prepared by the CSCB to assist corporate members and their employees when they meet with clients to sign the general agency agreement and standard trading conditions.

GUIDELINES FOR THE COMPLETION OF THE GENERAL AGENCY AGREEMENT AND STANDARD TRADING CONDITIONS

It is important to remember that the General Agency Agreement (GAA) and Standard Trading Conditions (STC) are legally binding contracts. Clients should be encouraged to read these documents before signing them. It is recommended that all signatories initial each page of the GAA and STC.

Following are some additional considerations:

1. Who can sign the GAA/STC on behalf of the client when that client is an incorporated company?

If possible, obtain two signatures from individuals authorized to sign on behalf of an Incorporated company. Their titles should also be indicated. If possible, have the corporate seal affixed and ensure that the name of the client company corresponds exactly with the name on the corporate seal. In many jurisdictions a corporate seal is no longer required. In that case, it is important to verify that the persons signing the agreement have the authority to do so. In instances where the signatory is not an officer but has authority to sign, attach a copy of the corporate resolution granting this authority.

2. Who can sign the GAA/STC on behalf of the client when that client is not an incorporated company?

Unincorporated companies, associations, partnerships or sole proprietorships require the signature of at least one and preferably two duly authorized signing officers, partners or owners. Always insert the title or position of the person, i.e. president, partner. These signatures must be witnessed by another individual of "lawful age".

3. How do we proceed if amendments are made to the GAA and STC?

All signatories should initial any changes to the agreements.

4. Do the documents need to be originals or can we retain photocopies for our records?

It is always preferable to have a signed original in your possession. It is recommended that you take a minimum of two copies of the documents to your client for signing. One original can be left with the client and the other can then be returned for safekeeping in your own office.

Attachment 8

Whitehorse based Crane options for NorthWind 100 wind turbine

RC Crane of Whitehorse has two cranes in Whitehorse the larger of which could handle the installation of a NorthWind 100 wind turbine on a 37 meter tower and the smaller of which could probably handle the installation of the turbine on a 30 meter tower but may not be able to handle the installation of a turbine on a 37 meter tower.

Smaller crane:

Link Belt 65 ton (60 tonne) HTC-8665 (2009); 115 foot (35 meter) main boom plus a 32 foot (9.7 meter) "jib". RC crane did not have the lifting charts for the jib available. Charts could not be found on line, but the newest comparable models are a 60 ton (50 tonne) crane and a 75 ton (70 tonne) according to the company website. The boom capacity limit on the slightly smaller crane with its 110 foot (33.5 meter) main boom is 19,500 lbs and the maximum jib capacity appears to be 9,400 lbs (vs. 13,000 lbs nacelle weight). The slightly larger crane main 127 foot (38.7 meter) boom capacity is 22,600 lbs and the maximum jib capacity appears to be 16,200 lbs.

It is not known whether the nacelle could be hoisted in two lifts but that will be explored with Northern Power Systems. This crane could probably install the turbine with a 30 meter tower but it would likely be at its very limits with the 37 meter tower.

Costs for this crane are \$5,000 for mobilization and de-mobilization, plus \$400 per hour (minimum 8 hours per day), plus room and board for the operator.

The installation time per turbine is likely to be in the 2 day range thus about \$7,000 per turbine variable cost (plus the fixed \$5,000 mobilization and demobilization cost).

Larger Crane:

The larger crane is a P&H 8115 125 ton lattice boom crane with a 150 foot (45.7 meter) boom. This one should easily handle the installation of the turbine.

Mobilization and de-mobilization for this crane are \$30,000 (disassembly and re-assembly required), and hourly costs are \$500 (minimum 10 hours per day), plus room and board for the crane operator. If installation time can be limited to one day the installation cost per turbine would be \$6,000 – in addition to the fixed \$30,000 mobilization and de-mobilization cost.



Arctic

CRANE SERVICES LTD.

P.O. BOX 3011 CLAIRMONT ALBERTA, T0H 0W0.
OFFICE: 780-814-6990 EDSON: 780-723-3373
FAX 780-567-3609 EMAIL: info@arcticcrane.com

July 28, 2010

QUOTE:

RE: DESTRUCTION BAY, YUKON PROJECT

ATTN: JOHN

Email: john@leprojects.com

Mob from Fort Nelson, BC to Destruction Bay, Yukon
24 Hours @ \$500.00 per hour = \$12,000.00

De Mob from Destruction Bay, Yukon to Fort Nelson, BC
24 Hours @ \$500.00 per hour = \$12,000.00

Pick Up & Rigger to haul fuel for crane from Fort Nelson, BC to Destruction Bay, Yukon
24 Hours @ \$100.00 per hour = \$2400.00

Pick Up & Rigger return to Fort Nelson, BC to Destruction Bay, Yukon
24 Hours @ \$100.00 per hour = \$2400.00

Subsistence per man per day @ \$200.00

Hoisting on location cost is \$565.00 per hour including rigger

Permit costs for Yukon to be applied
Permit costs for BC to be applied

Thank you for the opportunity to bid this project.

Blake Armstrong

Arctic Crane Service Ltd.
Ph: 780-814-6990 Email: blake@arcticcrane.com

Attachment 9

2010-07-28 Northwind 100 wind turbine installation cost.xls

Destruction Bay Wind Study		
Northwind® 100 Arctic wind turbine installation cost ESTIMATES, partly from NPS Sales Agreement		
Component description	Cost \$US	Cost \$CDN
Installation		
Northern Power Systems installation support	\$10,500	\$11,025
Installation labour 4 staff for 5 days		\$15,000
Total installation cost	\$10,500	\$26,025
Commissioning		
Northern Power Systems commissioning (simple)	\$10,500	\$11,025
YECL support witnessing 2 staff for 5 days		\$7,000
Total commissioning cost - one turbine	\$10,500	\$18,025
For dispatch controller add	\$1,250	\$1,313
YECL support witnessing staff 1 staff 1 day		\$1,000
For secondary load controller add	\$8,300	\$8,715
YECL support witnessing staff 1 staff 5 days		\$4,000
Travel and Accommodation		
Installation	\$4,000	\$4,200
Commissioning	\$4,000	\$4,200
Installation crew & YECL staff		\$6,000
Total travel and accommodation cost	\$8,000	\$14,400
Assumed exchange rate \$CDN = \$US X 1.05		

John Maissan

From: Erin McLarnon [erin@winddieselpower.com]
Sent: Tuesday, August 24, 2010 8:16 AM
To: 'John Maissan'
Subject: Foundations

John -

Hello! Sorry it has taken me so long to get back to you. I talked to the installer last week and he said proportionately the turbines take the same amount of concrete, but there are several factors that can change that such as the geo-tech, type of foundation and who engineered, tower height and stiffness, weight of nacelle.

So, in a nutshell there could be times when the NW 100 proportionately takes more concrete than the AW 225 and vice versa.

Let me know if I can do anything else for you.

Thanks,
Erin

Sincerely,

Erin McLarnon
Owner Manager
Wind Diesel North America, LLC
Physical: 9417 Rappe Drive
Mailing: P.O. Box 1158
Willow, AK 99688
PH: (907) 250-5890
FAX: 866-207-7731
www.winddieselpower.com

THIS EMAIL IS NOT RECOGNIZED AS OFFICIAL CORRESPONDENCE.

Opinions, inclusions and other information expressed on this message are not given or endorsed by WIND-DIESEL NORTH AMERICA, LLC unless otherwise indicated. The information contained in this message and any attachments is confidential and intended solely for the attention and use of the addressee(s).

Attachment 10

Training costs for wind project						
Northern Power Systems training - only required for the first project						
Training level	Fee PP	Travel PP	Accom PP	Salary PP	Cost PP	Total cost
Installer training	\$3,675.00	\$2,000.00	\$1,250.00	\$2,000.00	\$8,925.00	2 \$17,850.00
O&M tech levels 1 & 2	1627.5	\$2,000.00	\$1,250.00	\$2,000.00	\$6,877.50	2 \$13,755.00
Total training costs						\$31,605.00

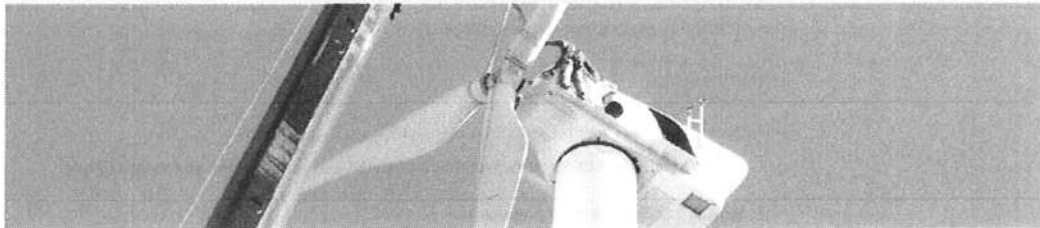


AROUND THE GLOBE | GET STARTED NOW

Wind Power Products Technology & Design News & Events About Us



2010 FACTORY TRAINING AND CERTIFICATION PROGRAM



Contact Us

- Site Map
- Privacy Policy

Northwind 100 Factory Training and Certification Program

Thank you for your interest in the Northwind 100 Factory Training and Certification Training Program.

Factory Training for the Installer

The Northwind 100 Installation Training Course (ITC) core objective is to prepare construction project managers, lead installers and site superintendents to effectively manage the installation of a Northwind 100 on time and budget. This course is required for any organization prior to an initial Northwind 100 install.

Cost for Installation Training is \$3500 per participant.

- [Click here to download the Installer Training Course Outline](#)

Earning Installer Certification

Successful completion of the Installation Training Course is only the first step towards Installer Certification. At the completion of the ITC the participant will be will issued a certificate documenting they are Factory Trained Installers.

After two successful installations, participants may earn their Installer Certification.

- [Click here to download the Installer Certification Application](#)

Factory Training and Certification for the Technician

New for 2010, we will be offering Operations and Maintenance Factory Training and Certification. The classes are for technicians who will be servicing and maintaining the NW 100. Each participant will complete an open book exam at the end of each class.

Upon successful completion of the class and passing the open book exam - the participant will receive either their Level 1 Technician or Level 2 Advanced Technician Certification.

- [Click here to download the Operations & Maintenance Level 1 Technician Course Outline](#)
- [Click here to download the Operations & Maintenance Level 2 Advanced Technician Course Outline](#)

Cost for the O&M Level 1 Technician Class is \$500 per participant.

Cost for the O&M Level 2 Advanced Technician Class is \$1050 per participant.

****Take advantage of the Level 2 Advanced Technician Class roll-out discount!****
If you attend this class in June, July, August or September you can deduct 20% off!
That is a \$210 per participant savings!

June - September 2010 Training Schedule

MONTH	CLASS	DATES
June	Installer Training Course	15,16,17
	Operations & Maintenance Technician Level 1	*18
	Operations & Maintenance Advanced Technician Level 2	23,24
July	Operations & Maintenance Technician Level 1	7
	Operations & Maintenance Advanced Technician Level 2	8,9
August	Installer Training Course	17,18,19
	Operations & Maintenance Technician Level 1	25
	Operations & Maintenance Advanced Technician Level 2	26,27

September	Installer Training Course	14,15,16
	Operations & Maintenance Technician Level 1	*17
	Operations & Maintenance Advanced Technician Level 2	22,23

***Please note: In June and September the Operations & Maintenance Technician Level 1 will be held the same week as the Installer Training Course.**

We cannot hold slots or confirm registration until payment has been received. Please remit payment directly to the contact person listed in the registration form. Once payment has been received we will send confirmation of registration.

For your convenience there are driving directions to Northern Power Systems as well as a list of local lodging options within the vicinity of our facility. For travel arrangement purposes, you can expect classes to wrap up around 4:00pm on the last day of your course.

Please feel free to get in touch with any questions.

Northern Power Systems
 1-877-90-NORTH
 1-802-461-2955

Downloadable Documents Needed for Training Course Registration:

- **2010 Northwind 100 Factory Training and Certification Overview and Registration Form**
- **Mutual Confidentiality Agreement**
- **Liability Waiver**
- **Driving Directions to Northern Power**
- **Lodging nearby to Northern Power**



Learn the art and science of blade pitching at the Installer Training Course!

The course content and design has been developed for those who are skilled at running construction projects and doing the hands on work.



29 Pitman Road, Barre, Vermont 05041 USA :: TOLL FREE 877 90 NORTH :: TEL 802 461 2955 :: FAX 802 461 2906

INSTALLER TRAINING COURSE OUTLINE

Target Participant

The objective of the Northwind ® 100 Installer Training Course is to prepare construction / project managers, lead installers and site superintendents to effectively manage the installation of a Northwind 100 on time and on budget. This course is required for any partner or service team prior to an initial Northwind 100 install.

Our field service technicians frequently report that there is a measurable difference with installations that are done by Installer Training Course graduates. The course content and design has been developed for those who are skilled at running construction projects and doing the hands-on work.

Earning Installer Certification

- Successful completion of the course is only the first step towards Installer Certification. At the completion of the course the participant will be will issued a certificate documenting they are factory trained.
- After two successful installations, participants may earn their Installer Certification.

Course Objectives

- The class is designed to walk participants through the critical installation activities of the Northwind 100 wind turbine
- To learn all the preparation and installation steps so participants can successfully manage and execute the Northwind 100 project from the permitting process to installing the turbine to the utility interconnect

Participant Prerequisite Skills include but are not limited to

- Installing wind turbines or similar machines
- Demonstrated ability to climb towers and perform manual tasks, such as bolt torques
- Demonstrated knowledge of AC electricity generation and distribution, specifically relative to 480 Volt systems
- Construction – Project Management

Course Prerequisites

- None, however, participants will be asked to sign a confidentiality and liability waiver with Northern Power Systems, Inc. as a requirement of participation.

Course Duration and Location

- Three days and takes place at Northern's headquarters in Barre, VT



Northern
POWER SYSTEMS

25 Pitman Road, Barre, Vermont 05641 USA :: TOLL FREE 877 90 NORTH :: TEL 802 461 2955 :: FAX 802 461 2996

At the end of the course the installer will

- Be able to plan an installation project schedule, including equipment and labor resources
- Identify the elements of an effective foundation design
- Know how to appropriately execute the installation from foundation to tower stacking through internet connectivity
- Know at least two best practices for each phase of the installation process and the specific steps to be taken to implement each recommendation
- Know the factors that comprise and impact an installation budget
- Be able to identify and mitigate potential problems that could surface during a real installation

Direct.



29 Pitman Road, Barre, Vermont 05641 USA :: TOLL FREE 877 90 NORTH :: TEL 802 461 2955 :: FAX 802 461 2996

OPERATIONS AND MAINTENANCE LEVEL1 TECHNICIAN COURSE OUTLINE

Target Participant

The local operator who will perform routine maintenance and complete Northwind 100 annual maintenance. The local operator will also serve as the on-the-ground first responder should there be a need to inspect the turbine before a fault reset.

Participant Prerequisite Skills

Prior to attending the Level1 class, it is expected that the Technician will have these demonstrated skills and abilities

- Demonstrated knowledge of AC electricity generation and distribution specifically relative to 480 Volt systems
- Demonstrated ability to climb tower, perform bolt inspections, and re-torque bolts to meet specifications
- Change grease cartridges, receptacles, air filters, etc
- Perform limited troubleshooting and diagnosis
- Trained in industrial climbing and safety procedures

Course Prerequisites

- Successful completion of Installation Training Course, Northwind 100 Installation or equivalent

Course Duration and Location

- One day and takes place at the Northern's headquarters in Barre, VT or on site during the Northwind 100 commissioning process
- An open-book exam will be given at the conclusion. The areas that will be covered will include basic operations, safety, yearly maintenance, and basic troubleshooting

Course Objectives

Upon completion of this training the technician will be able to:

- Follow all safety procedures required for tower climbing and lock out tag out procedures
- Operate the Base Junction Box Interface and the Up-Tower Controls Cabinet Interface
- Utilize E-Stop – at the appropriate times
- Perform routine maintenance functions
- Complete all tasks as required by the Northern Annual Maintenance Checklist
- Perform electrical systems inspections
- Perform annual Bolt Torque Check
- Perform basic troubleshooting
- Utilize a basic operational understanding of faults and alarms
- Perform visual inspections
- Serve as the eyes and ears for the Northwind 100 Technical Support Team
- Submit all required Northern paperwork for warranty compliance



Northern
POWER SYSTEMS

29 Pitman Road, Barre, Vermont 05641 USA :: TOLL FREE 877 90 NORTH :: TEL 802 461 2955 :: FAX 802 461 2996

OPERATIONS AND MAINTENANCE: LEVEL 2 ADVANCED TECHNICIAN COURSE OUTLINE

Target Participant:

The Operations and Maintenance Level 2 Advanced Technician will serve as the regional support resource for Northwind 100(s). This individual is capable of performing simple to complex service and maintenance functions.

In addition, the Advanced Technician will obtain the training to assist with deeper troubleshooting and diagnosis of the NW 100.

The technician will also serve as the on the ground first responder should there be the need to inspect the turbine, perform fault resets, perform component replacement, or complete technical service bulletins.

Demonstrated skills Include:

Prior to attending the Level2 class, it is expected that the Advanced Technician will have these demonstrated skills and abilities:

- Demonstrated ability to configure and utilize remote monitoring software.
- Ability to perform detailed wind turbine troubleshooting and diagnosis
- Ability to perform simple to complex wind turbine service
- Ability to perform simple to complex wind turbine component replacement

Course Prerequisites:

- ✓ Certified O&M Level1 Technician
- ✓ Competently perform all tasks provided by the Operations and Maintenance Level1 Technician.
- ✓ Demonstrated knowledge of AC electricity generation and distribution specifically relative to 480 Volt systems.
- ✓ Familiar with electrical static discharge procedures
- ✓ Trained in industrial climbing and safety procedures

Course Duration and Location

- Two days and takes place at Northern's headquarters in Barre, VT

Direct.



Northern
POWER SYSTEMS

29 Pitman Road, Barre, Vermont 05641 USA :: TOLL FREE 877 90 NORTH :: TEL 802 461 2955 :: FAX 802 461 2996

Course Objectives:

At the end of the course the Advanced Technician will be able to:

- Utilize Smartview to:
 - Diagnose faults and alarms
 - Perform trend analysis
- Follow all safety procedures required for tower climbing and lock out tag out procedures.
- Operate the Base Junction Box Interface the Uptower Controls Cabinet Interface.
 - Put the NW 100 into and out of Service State
 - Utilize manual controls to operate NW 100
- Complete simple to complex NW 100 component replacement
- Complete simple to complex NW 100 technical service bulletins

An open-book exam will be given at the end of class

Attachment 11

2010-07-28 Northwind 100 wind turbine O&M costs.xls

Destruction Bay Wind Study		
Northwind® 100 Arctic wind turbine O&M costs (from NPS Sales Agreement)		
Component description	Cost \$US	Cost \$CDN
Years 1&2		
Annual maintenance kit	\$500	\$525
Admin view additional license	\$600	\$630
Northern Power Systems monitoring (24-7)	\$0	\$0
Brake pads (\$3,200 / 5)	\$640	\$672
Preventive maintenance ESTIMATE	\$4,200	\$4,410
Travel and Expenses ESTIMATE	\$4,000	\$4,200
Total estimated annual cost years 1&2	\$9,940	\$10,437
Years 3 to 5		
Annual maintenance kit	\$500	\$525
Admin view additional license	\$600	\$630
Northern Power Systems monitoring (24-7)	\$1,200	\$1,260
Brake pads (\$3,200 / 5)	\$640	\$672
Extended parts warranty	\$3,200	\$3,360
Preventive maintenance ESTIMATE	\$4,200	\$4,410
Travel and Expenses ESTIMATE	\$4,000	\$4,200
Total estimated annual cost years 3 to 5	\$14,340	\$15,057
Years 6 and on		
Assume average costs will be \$15,000 / year + inflation from year 1 on		\$15,000+
Estimated annual costs from year 6 and on		\$15,000+
Assumed exchange rate \$CDN = \$US X 1.05		

Attachment 12

Destruction Bay wind project calculation of net diesel displaced from HOMER model output									
Minimum diesel plant load 45kW (30% of 150kW smallest generator)									
Project configuration	HOMER generation kWh	Losses from generation		Net generation	HOMER surplus energy kWh	Reductions in surplus		Net Surplus	Diesel displaced kWh
		Availability 95%	Electrical & other 5%			Availability	Electrical & other losses		
1 Northwind 100	257,346	12,867	12,867	231,611	0	0	0	0	231,611
2 Northwind 100s	514,692	25,735	25,735	463,223	20,200	12,867	2,573	4,759	458,464
1 Aeronautica 225	539,021	26,951	26,951	485,119	38,919	1,946	2,695	34,278	450,841
3 Northwind 100s	772,036	38,602	38,602	694,832	136,932	25,735	7,720	103,477	591,355
Assumptions in reductions of surplus:									
For 1 Northwind 100	1	The very small amount of surplus energy would be consumed by electrical & other losses							
For 2 Northwind 100s	1	One half of downtime is non-coincident making remaining generation all diesel displacing							
	2	One tenth of losses are systematic like electrical that occur during high output reducing surplus differentially							
For Aeronautica	1	Availability reduces losses in porportion to downtime - not preferentially							
	2	One tenth of losses are systematic like electrical that occur during high output reducing surplus differentially							
For 3 Northwind 100s	1	Non-coincident downtime makes 3/3 of availability losses diesel displacing							
	2	One fifth of losses are systematic like electrical that occur during high output reducing surplus differentially							

Destruction Bay wind project calculation of net diesel displaced from HOMER model output									
Minimum diesel plant load 75kW (50% of 150kW smallest generator)									
Project configuration	HOMER generation kWh	Losses from generation		Net generation	HOMER surplus energy kWh	Reductions in surplus		Net surplus	Diesel displaced kWh
		Availability 95%	Electrical & other 5%			Availability	Electrical & other losses		
1 Northwind 100	257,346	12,867	12,867	231,611	353	0	353	0	231,611
2 Northwind 100s	514,692	25,735	25,735	463,223	53,156	12,867	2,573	37,715	425,508
1 Aeronautica 225	539,021	26,951	26,951	485,119	80,626	4,031	2,695	73,900	411,219
3 Northwind 100s	772,036	38,602	38,602	694,832	205,348	25,735	7,720	171,893	522,939
Assumptions in reductions of surplus									
For 1 Northwind 100	1	The very small amount of surplus energy would be consumed by electrical & other losses							
For 2 Northwind 100s	1	One half of downtime is non-coincident making remaining generation all diesel displacing							
	2	One tenth of losses are systematic like electrical that occur during high output reducing surplus differentially							
For Aeronautica	1	Availability reduces losses in porportion to downtime - not preferentially							
	2	One tenth of losses are systematic like electrical that occur during high output reducing surplus differentially							
For 3 Northwind 100s	1	Non-coincident downtime makes 3/3 of availability losses diesel displacing							
	2	One fifth of losses are systematic like electrical that occur during high output reducing surplus differentially							

Attachment 13

1 2010-08-12 DBay 1 Northwind 100 45kW diesel LE Projects LCOE Economic model 20.xls

Leading Edge Projects Generation LCOE Economic Model													
Project: Destruction Bay 1 NorthWind 100 wind turbine - low penetration; wind speed 6.3 m/s, 45kW min diesel load													
Capital cost	\$1,056,870	Capacity		100 kW	Fixed O&M		\$15,000 per year		Discount rate		5.42%		
Cost of capital	7.53% Debt & equity	Annual Energy		231,611 kWh	Variable O&M		\$0.00 per kWh						
Inflation	2.00% per year	Project life		20 Years									
Year	Capital	Cost of Cap	Depreciation	Fixed O&M	Variable O&M	Total Ann cost	Ann energy	Cost per kWh	Discounted cost	Discounted energy	Discounted cost per kWh		
1	\$1,056,870	\$79,582	\$52,844	\$15,000	\$0	\$147,426	231,611	\$0.637	\$147,426	231,611	\$0.637		\$0.637
2	\$1,004,027	\$75,603	\$52,844	\$15,300	\$0	\$143,747	231,611	\$0.621	\$136,354	219,700	\$0.621		\$0.621
3	\$951,183	\$71,624	\$52,844	\$15,606	\$0	\$140,074	231,611	\$0.605	\$126,037	208,401	\$0.605		\$0.605
4	\$898,340	\$67,645	\$52,844	\$15,918	\$0	\$136,407	231,611	\$0.589	\$116,425	197,684	\$0.589		\$0.589
5	\$845,496	\$63,666	\$52,844	\$16,236	\$0	\$132,746	231,611	\$0.573	\$107,474	187,517	\$0.573		\$0.573
6	\$792,653	\$59,687	\$52,844	\$16,561	\$0	\$129,091	231,611	\$0.557	\$99,140	177,874	\$0.557		\$0.557
7	\$739,809	\$55,708	\$52,844	\$16,892	\$0	\$125,444	231,611	\$0.542	\$91,384	168,726	\$0.542		\$0.542
8	\$686,966	\$51,729	\$52,844	\$17,230	\$0	\$121,802	231,611	\$0.526	\$84,168	160,049	\$0.526		\$0.526
9	\$634,122	\$47,749	\$52,844	\$17,575	\$0	\$118,168	231,611	\$0.510	\$77,457	151,818	\$0.510		\$0.510
10	\$581,279	\$43,770	\$52,844	\$17,926	\$0	\$114,540	231,611	\$0.495	\$71,218	144,010	\$0.495		\$0.495
11	\$528,435	\$39,791	\$52,844	\$18,285	\$0	\$110,920	231,611	\$0.479	\$65,420	136,604	\$0.479		\$0.479
12	\$475,592	\$35,812	\$52,844	\$18,651	\$0	\$107,306	231,611	\$0.463	\$60,034	129,579	\$0.463		\$0.463
13	\$422,748	\$31,833	\$52,844	\$19,024	\$0	\$103,700	231,611	\$0.448	\$55,033	122,915	\$0.448		\$0.448
14	\$369,905	\$27,854	\$52,844	\$19,404	\$0	\$100,101	231,611	\$0.432	\$50,391	116,594	\$0.432		\$0.432
15	\$317,061	\$23,875	\$52,844	\$19,792	\$0	\$96,510	231,611	\$0.417	\$46,085	110,598	\$0.417		\$0.417
16	\$264,218	\$19,896	\$52,844	\$20,188	\$0	\$92,927	231,611	\$0.401	\$42,092	104,910	\$0.401		\$0.401
17	\$211,374	\$15,916	\$52,844	\$20,592	\$0	\$89,352	231,611	\$0.386	\$38,391	99,515	\$0.386		\$0.386
18	\$158,531	\$11,937	\$52,844	\$21,004	\$0	\$85,784	231,611	\$0.370	\$34,963	94,397	\$0.370		\$0.370
19	\$105,687	\$7,958	\$52,844	\$21,424	\$0	\$82,225	231,611	\$0.355	\$31,789	89,542	\$0.355		\$0.355
20	\$52,844	\$3,979	\$52,844	\$21,852	\$0	\$78,675	231,611	\$0.340	\$28,852	84,937	\$0.340		\$0.340
Real leveled cost of energy					\$0.514				\$1,510,137	2,936,982	\$0.514		

2 2010-08-12 DBay 2 Northwind 100s 45kW diesel LE Projects LCOE Economic model 20.xls

Leading Edge Projects Generation LCOE Economic Model													
Project: Destruction Bay 2 NorthWind 100 wind turbines - medium penetration; wind speed 6.3 m/s, 45 kW min diesel load													
Capital cost	\$1,924,440	Capacity	200 kW	Fixed O&M	\$25,000 per year	Discount rate	5.42%						
Cost of capital	7.53%	Annual Energy	458,464 kWh	Variable O&M	\$0.00 per kWh								
Inflation	2.00%	Project life	20 Years	Capacity factor									
Year	Capital	Cost of Cap	Depreciation	Fixed O&M	Variable O&M	Total Ann cost	Ann energy	Cost per kWh	Discounted cost	Discounted energy	Discounted cost per kWh		
1	\$1,924,440	\$144,910	\$96,222	\$25,000	\$0	\$266,132	458,464	\$0.580	\$266,132	458,464	\$0.580		
2	\$1,828,218	\$137,665	\$96,222	\$25,500	\$0	\$259,387	458,464	\$0.566	\$246,047	434,886	\$0.566		
3	\$1,731,996	\$130,419	\$96,222	\$26,010	\$0	\$252,651	458,464	\$0.551	\$227,333	412,521	\$0.551		
4	\$1,635,774	\$123,174	\$96,222	\$26,530	\$0	\$245,926	458,464	\$0.536	\$209,902	391,306	\$0.536		
5	\$1,539,552	\$115,928	\$96,222	\$27,061	\$0	\$239,211	458,464	\$0.522	\$193,670	371,182	\$0.522		
6	\$1,443,330	\$108,683	\$96,222	\$27,602	\$0	\$232,507	458,464	\$0.507	\$178,562	352,093	\$0.507		
7	\$1,347,108	\$101,437	\$96,222	\$28,154	\$0	\$225,813	458,464	\$0.493	\$164,503	333,986	\$0.493		
8	\$1,250,886	\$94,192	\$96,222	\$28,717	\$0	\$219,131	458,464	\$0.478	\$151,425	316,810	\$0.478		
9	\$1,154,664	\$86,946	\$96,222	\$29,291	\$0	\$212,460	458,464	\$0.463	\$139,265	300,517	\$0.463		
10	\$1,058,442	\$79,701	\$96,222	\$29,877	\$0	\$205,800	458,464	\$0.449	\$127,962	285,062	\$0.449		
11	\$962,220	\$72,455	\$96,222	\$30,475	\$0	\$199,152	458,464	\$0.434	\$117,460	270,402	\$0.434		
12	\$865,998	\$65,210	\$96,222	\$31,084	\$0	\$192,516	458,464	\$0.420	\$107,707	256,496	\$0.420		
13	\$769,776	\$57,964	\$96,222	\$31,706	\$0	\$185,892	458,464	\$0.405	\$98,652	243,305	\$0.405		
14	\$673,554	\$50,719	\$96,222	\$32,340	\$0	\$179,281	458,464	\$0.391	\$90,251	230,793	\$0.391		
15	\$577,332	\$43,473	\$96,222	\$32,987	\$0	\$172,682	458,464	\$0.377	\$82,458	218,924	\$0.377		
16	\$481,110	\$36,228	\$96,222	\$33,647	\$0	\$166,096	458,464	\$0.362	\$75,235	207,665	\$0.362		
17	\$384,888	\$28,982	\$96,222	\$34,320	\$0	\$159,524	458,464	\$0.348	\$68,542	196,985	\$0.348		
18	\$288,666	\$21,737	\$96,222	\$35,006	\$0	\$152,965	458,464	\$0.334	\$62,343	186,855	\$0.334		
19	\$192,444	\$14,491	\$96,222	\$35,706	\$0	\$146,419	458,464	\$0.319	\$56,607	177,245	\$0.319		
20	\$96,222	\$7,246	\$96,222	\$36,420	\$0	\$139,888	458,464	\$0.305	\$51,300	168,130	\$0.305		
Real levelized cost of energy					\$0.467				\$2,715,355	5,813,630	\$0.467		

3 2010-08-12 DBay 1 Aeronautica 225kW 45kW diesel LE Projects LCOE Economic model 20.xls

Leading Edge Projects Generation LCOE Economic Model													
Project: Destruction Bay 1 Aeronautica wind turbine - medium penetration; wind speed 6.3 m/s, 45kW min diesel load													
Capital cost	\$1,615,890	7.53% Debt & equity per year	Capacity Annual Energy	225 kW 450,841 kWh	Fixed O&M Variable O&M	\$25,000 per year \$0.00 per kWh	Discount rate	5.42%					
Cost of capital													
Inflation			Project life	20 Years	Capacity factor								
Year	Capital	Cost of Cap	Depreciation	Fixed O&M	Variable O&M	Total Ann cost	Ann energy	Cost per kWh	Discounted cost	Discounted energy	Discounted cost per kWh		
1	\$1,615,890	\$121,677	\$80,795	\$25,000	\$0	\$227,471	450,841	\$0.505	\$227,471	450,841	\$0.505		
2	\$1,535,096	\$115,593	\$80,795	\$25,500	\$0	\$221,887	450,841	\$0.492	\$210,476	427,655	\$0.492		
3	\$1,454,301	\$109,509	\$80,795	\$26,010	\$0	\$216,313	450,841	\$0.480	\$194,637	405,662	\$0.480		
4	\$1,373,507	\$103,425	\$80,795	\$26,530	\$0	\$210,750	450,841	\$0.467	\$179,878	384,800	\$0.467		
5	\$1,292,712	\$97,341	\$80,795	\$27,061	\$0	\$205,197	450,841	\$0.455	\$166,132	365,011	\$0.455		
6	\$1,211,918	\$91,257	\$80,795	\$27,602	\$0	\$199,654	450,841	\$0.443	\$153,331	346,239	\$0.443		
7	\$1,131,123	\$85,174	\$80,795	\$28,154	\$0	\$194,122	450,841	\$0.431	\$141,416	328,433	\$0.431		
8	\$1,050,329	\$79,090	\$80,795	\$28,717	\$0	\$188,601	450,841	\$0.418	\$130,328	311,542	\$0.418		
9	\$969,534	\$73,006	\$80,795	\$29,291	\$0	\$183,092	450,841	\$0.406	\$120,014	295,520	\$0.406		
10	\$888,740	\$66,922	\$80,795	\$29,877	\$0	\$177,594	450,841	\$0.394	\$110,424	280,323	\$0.394		
11	\$807,945	\$60,838	\$80,795	\$30,475	\$0	\$172,108	450,841	\$0.382	\$101,509	265,906	\$0.382		
12	\$727,151	\$54,754	\$80,795	\$31,084	\$0	\$166,633	450,841	\$0.370	\$93,226	252,231	\$0.370		
13	\$646,356	\$48,671	\$80,795	\$31,706	\$0	\$161,171	450,841	\$0.357	\$85,533	239,260	\$0.357		
14	\$565,562	\$42,587	\$80,795	\$32,340	\$0	\$155,721	450,841	\$0.345	\$78,391	226,955	\$0.345		
15	\$484,767	\$36,503	\$80,795	\$32,987	\$0	\$150,284	450,841	\$0.333	\$71,763	215,284	\$0.333		
16	\$403,973	\$30,419	\$80,795	\$33,647	\$0	\$144,860	450,841	\$0.321	\$65,616	204,212	\$0.321		
17	\$323,178	\$24,335	\$80,795	\$34,320	\$0	\$139,449	450,841	\$0.309	\$59,916	193,710	\$0.309		
18	\$242,384	\$18,251	\$80,795	\$35,006	\$0	\$134,052	450,841	\$0.297	\$54,635	183,748	\$0.297		
19	\$161,589	\$12,168	\$80,795	\$35,706	\$0	\$128,668	450,841	\$0.285	\$49,744	174,298	\$0.285		
20	\$80,795	\$6,084	\$80,795	\$36,420	\$0	\$123,299	450,841	\$0.273	\$45,217	165,334	\$0.273		
Real levelized cost of energy					\$0.409				\$2,339,657	5,716,965	\$0.409		

4 2010-08-12 DBay 3 Northwind 100s 45kW diesel LE Projects LCOE Economic model 20.xls

Leading Edge Projects Generation LCOE Economic Model												
Project: Destruction Bay 3 NorthWind 100 wind turbines - medium plus penetration; wind speed 6.3 m/s, 45kW min diesel load												
Capital cost	\$2,701,260	Capacity		300 kW	Fixed O&M		\$35,000 per year		Discount rate		5.42%	
Cost of capital	7.53%	Annual Energy		591,355 kWh	Variable O&M		\$0.00 per kWh					
Inflation	2.00%	Project life		20 Years	Capacity factor							
Year	Capital	Cost of Cap		Depreciation	Fixed O&M		Variable O&M		Total Ann cost		Ann energy	
1	\$2,701,260	\$203,405	\$135,063	\$135,063	\$35,000	\$35,000	\$0	\$0	\$373,468	\$373,468	\$0.632	\$0.632
2	\$2,566,197	\$193,235	\$135,063	\$135,063	\$35,000	\$35,000	\$0	\$0	\$363,998	\$363,998	\$0.616	\$0.616
3	\$2,431,134	\$183,064	\$135,063	\$135,063	\$36,414	\$36,414	\$0	\$0	\$354,541	\$354,541	\$0.600	\$0.600
4	\$2,296,071	\$172,894	\$135,063	\$135,063	\$37,142	\$37,142	\$0	\$0	\$345,099	\$345,099	\$0.584	\$0.584
5	\$2,161,008	\$162,724	\$135,063	\$135,063	\$37,885	\$37,885	\$0	\$0	\$335,672	\$335,672	\$0.568	\$0.568
6	\$2,025,945	\$152,554	\$135,063	\$135,063	\$38,643	\$38,643	\$0	\$0	\$326,259	\$326,259	\$0.552	\$0.552
7	\$1,890,882	\$142,383	\$135,063	\$135,063	\$39,416	\$39,416	\$0	\$0	\$316,862	\$316,862	\$0.536	\$0.536
8	\$1,755,819	\$132,213	\$135,063	\$135,063	\$40,204	\$40,204	\$0	\$0	\$307,480	\$307,480	\$0.520	\$0.520
9	\$1,620,756	\$122,043	\$135,063	\$135,063	\$41,008	\$41,008	\$0	\$0	\$298,114	\$298,114	\$0.504	\$0.504
10	\$1,485,693	\$111,873	\$135,063	\$135,063	\$41,828	\$41,828	\$0	\$0	\$288,764	\$288,764	\$0.488	\$0.488
11	\$1,350,630	\$101,702	\$135,063	\$135,063	\$42,665	\$42,665	\$0	\$0	\$279,430	\$279,430	\$0.473	\$0.473
12	\$1,215,567	\$91,532	\$135,063	\$135,063	\$43,518	\$43,518	\$0	\$0	\$270,113	\$270,113	\$0.457	\$0.457
13	\$1,080,504	\$81,362	\$135,063	\$135,063	\$44,388	\$44,388	\$0	\$0	\$260,813	\$260,813	\$0.441	\$0.441
14	\$945,441	\$71,192	\$135,063	\$135,063	\$45,276	\$45,276	\$0	\$0	\$251,531	\$251,531	\$0.425	\$0.425
15	\$810,378	\$61,021	\$135,063	\$135,063	\$46,182	\$46,182	\$0	\$0	\$242,266	\$242,266	\$0.410	\$0.410
16	\$675,315	\$50,851	\$135,063	\$135,063	\$47,105	\$47,105	\$0	\$0	\$233,020	\$233,020	\$0.394	\$0.394
17	\$540,252	\$40,681	\$135,063	\$135,063	\$48,047	\$48,047	\$0	\$0	\$223,791	\$223,791	\$0.378	\$0.378
18	\$405,189	\$30,511	\$135,063	\$135,063	\$49,008	\$49,008	\$0	\$0	\$214,582	\$214,582	\$0.363	\$0.363
19	\$270,126	\$20,340	\$135,063	\$135,063	\$49,989	\$49,989	\$0	\$0	\$205,392	\$205,392	\$0.347	\$0.347
20	\$135,063	\$10,170	\$135,063	\$135,063	\$50,988	\$50,988	\$0	\$0	\$196,222	\$196,222	\$0.332	\$0.332
Real levelized cost of energy								\$0.508				
										\$3,810,073	7,498,777	\$0.508

5 2010-08-23 DBay 1 Northwind 100 75kW diesel LE Projects LCOE Economic model 20.xls

Leading Edge Projects Generation LCOE Economic Model													
Project: Destruction Bay 1 NorthWind 100 wind turbine - low penetration; wind speed 6.3 m/s, 75kW min diesel load													
Capital cost	\$1,056,870	7.53%	Debt & equity	Capacity	100 kW	Fixed O&M	\$15,000	per year	Discount rate	5.42%			
Cost of capital				Annual Energy	231,611 kWh	Variable O&M		\$0.00	per kWh				
Inflation		2.00%	per year	Project life	20 Years								
Year	Capital	Cost of Cap	Depreciation	Fixed O&M	Variable O&M	Total Ann cost	Ann energy	Cost per kWh	Discounted cost	Discounted energy	Discounted cost per kWh		
1	\$1,056,870	\$79,582	\$52,844	\$15,000	\$0	\$147,426	231,611	\$0.637	\$147,426	231,611	\$0.637		
2	\$1,004,027	\$75,603	\$52,844	\$15,300	\$0	\$143,747	231,611	\$0.621	\$136,354	219,700	\$0.621		
3	\$951,183	\$71,624	\$52,844	\$15,606	\$0	\$140,074	231,611	\$0.605	\$126,037	208,401	\$0.605		
4	\$898,340	\$67,645	\$52,844	\$15,918	\$0	\$136,407	231,611	\$0.589	\$116,425	197,684	\$0.589		
5	\$845,496	\$63,666	\$52,844	\$16,236	\$0	\$132,746	231,611	\$0.573	\$107,474	187,517	\$0.573		
6	\$792,653	\$59,687	\$52,844	\$16,561	\$0	\$129,091	231,611	\$0.557	\$99,140	177,874	\$0.557		
7	\$739,809	\$55,708	\$52,844	\$16,892	\$0	\$125,444	231,611	\$0.542	\$91,384	168,726	\$0.542		
8	\$686,966	\$51,729	\$52,844	\$17,230	\$0	\$121,802	231,611	\$0.526	\$84,168	160,049	\$0.526		
9	\$634,122	\$47,749	\$52,844	\$17,575	\$0	\$118,168	231,611	\$0.510	\$77,457	151,818	\$0.510		
10	\$581,279	\$43,770	\$52,844	\$17,926	\$0	\$114,540	231,611	\$0.495	\$71,218	144,010	\$0.495		
11	\$528,435	\$39,791	\$52,844	\$18,285	\$0	\$110,920	231,611	\$0.479	\$65,420	136,604	\$0.479		
12	\$475,592	\$35,812	\$52,844	\$18,651	\$0	\$107,306	231,611	\$0.463	\$60,034	129,579	\$0.463		
13	\$422,748	\$31,833	\$52,844	\$19,024	\$0	\$103,700	231,611	\$0.448	\$55,033	122,915	\$0.448		
14	\$369,905	\$27,854	\$52,844	\$19,404	\$0	\$100,101	231,611	\$0.432	\$50,391	116,594	\$0.432		
15	\$317,061	\$23,875	\$52,844	\$19,792	\$0	\$96,510	231,611	\$0.417	\$46,085	110,598	\$0.417		
16	\$264,218	\$19,896	\$52,844	\$20,188	\$0	\$92,927	231,611	\$0.401	\$42,092	104,910	\$0.401		
17	\$211,374	\$15,916	\$52,844	\$20,592	\$0	\$89,352	231,611	\$0.386	\$38,391	99,515	\$0.386		
18	\$158,531	\$11,937	\$52,844	\$21,004	\$0	\$85,784	231,611	\$0.370	\$34,963	94,397	\$0.370		
19	\$105,687	\$7,958	\$52,844	\$21,424	\$0	\$82,225	231,611	\$0.355	\$31,789	89,542	\$0.355		
20	\$52,844	\$3,979	\$52,844	\$21,852	\$0	\$78,675	231,611	\$0.340	\$28,852	84,937	\$0.340		
Real levelized cost of energy						\$0.514			\$1,510,137	2,936,982	\$0.514		

6 2010-08-23 DBay 2 Northwind 100s 75kW diesel LE Projects LCOE Economic model 20.xls

Leading Edge Projects Generation LCOE Economic Model												
Project: Destruction Bay 2 NorthWind 100 wind turbines - medium penetration; wind speed 6.3 m/s, 75 kW min diesel load												
Capital cost	\$1,924,440	Capacity	200 kW	Fixed O&M	\$25,000 per year	Discount rate	5.42%					
Cost of capital	7.53%	Annual Energy	425,508 kWh	Variable O&M	\$0.00 per kWh							
Inflation	2.00%	Project life	20 Years	Capacity factor								
Year	Capital	Cost of Cap	Depreciation	Fixed O&M	Variable O&M	Total Ann cost	Ann energy	Cost per kWh	Discounted cost	Discounted energy	Discounted cost per kWh	
1	\$1,924,440	\$144,910	\$96,222	\$25,000	\$0	\$266,132	425,508	\$0.625	\$266,132	425,508	\$0.625	
2	\$1,828,218	\$137,665	\$96,222	\$25,500	\$0	\$259,387	425,508	\$0.610	\$246,047	403,625	\$0.610	
3	\$1,731,996	\$130,419	\$96,222	\$26,010	\$0	\$252,651	425,508	\$0.594	\$227,333	382,868	\$0.594	
4	\$1,635,774	\$123,174	\$96,222	\$26,530	\$0	\$245,926	425,508	\$0.578	\$209,902	363,178	\$0.578	
5	\$1,539,552	\$115,928	\$96,222	\$27,061	\$0	\$239,211	425,508	\$0.562	\$193,670	344,500	\$0.562	
6	\$1,443,330	\$108,683	\$96,222	\$27,602	\$0	\$232,507	425,508	\$0.546	\$178,562	326,784	\$0.546	
7	\$1,347,108	\$101,437	\$96,222	\$28,154	\$0	\$225,813	425,508	\$0.531	\$164,503	309,978	\$0.531	
8	\$1,250,886	\$94,192	\$96,222	\$28,717	\$0	\$219,131	425,508	\$0.515	\$151,425	294,037	\$0.515	
9	\$1,154,664	\$86,946	\$96,222	\$29,291	\$0	\$212,460	425,508	\$0.499	\$139,265	278,915	\$0.499	
10	\$1,058,442	\$79,701	\$96,222	\$29,877	\$0	\$205,800	425,508	\$0.484	\$127,962	264,571	\$0.484	
11	\$962,220	\$72,455	\$96,222	\$30,475	\$0	\$199,152	425,508	\$0.468	\$117,460	250,965	\$0.468	
12	\$865,998	\$65,210	\$96,222	\$31,084	\$0	\$192,516	425,508	\$0.452	\$107,707	238,058	\$0.452	
13	\$769,776	\$57,964	\$96,222	\$31,706	\$0	\$185,892	425,508	\$0.437	\$98,652	225,816	\$0.437	
14	\$673,554	\$50,719	\$96,222	\$32,340	\$0	\$179,281	425,508	\$0.421	\$90,251	214,203	\$0.421	
15	\$577,332	\$43,473	\$96,222	\$32,987	\$0	\$172,682	425,508	\$0.406	\$82,458	203,187	\$0.406	
16	\$481,110	\$36,228	\$96,222	\$33,647	\$0	\$166,096	425,508	\$0.390	\$75,235	192,737	\$0.390	
17	\$384,888	\$28,982	\$96,222	\$34,320	\$0	\$159,524	425,508	\$0.375	\$68,542	182,825	\$0.375	
18	\$288,666	\$21,737	\$96,222	\$35,006	\$0	\$152,965	425,508	\$0.359	\$62,343	173,423	\$0.359	
19	\$192,444	\$14,491	\$96,222	\$35,706	\$0	\$146,419	425,508	\$0.344	\$56,607	164,504	\$0.344	
20	\$96,222	\$7,246	\$96,222	\$36,420	\$0	\$139,888	425,508	\$0.329	\$51,300	156,044	\$0.329	
Real levelized cost of energy					\$0.503				\$2,715,355	5,395,726	\$0.503	

7 2010-08-23 DBay 1 Aeronautica 275kW 75kW diesel LE Projects LCOE Economic model 20.xls

Leading Edge Projects Generation LCOE Economic Model												
Project: Destruction Bay 1 Aeronautica wind turbine - medium penetration; wind speed 6.3 m/s, 75kW min diesel load												
Capital cost	\$1,615,890	7.53% Debt & equity 2.00% per year	Capacity	225 kW	Fixed O&M		\$25,000 per year		Discount rate		5.42%	
Cost of capital			Annual Energy	411,219 kWh	Variable O&M		\$0.00 per kWh					
Inflation			Project life	20 Years	Capacity factor							
Year	Capital	Cost of Cap	Depreciation	Fixed O&M	Variable O&M	Total Ann cost	Ann energy	Cost per kWh	Discounted cost	Discounted energy	Discounted cost per kWh	
1	\$1,615,890	\$121,677	\$80,795	\$25,000	\$0	\$227,471	411,219	\$0.553	\$227,471	411,219	\$0.553	
2	\$1,535,096	\$115,593	\$80,795	\$25,500	\$0	\$221,887	411,219	\$0.540	\$210,476	390,071	\$0.540	
3	\$1,454,301	\$109,509	\$80,795	\$26,010	\$0	\$216,313	411,219	\$0.526	\$194,637	370,011	\$0.526	
4	\$1,373,507	\$103,425	\$80,795	\$26,530	\$0	\$210,750	411,219	\$0.513	\$179,878	350,982	\$0.513	
5	\$1,292,712	\$97,341	\$80,795	\$27,061	\$0	\$205,197	411,219	\$0.499	\$166,132	332,932	\$0.499	
6	\$1,211,918	\$91,257	\$80,795	\$27,602	\$0	\$199,654	411,219	\$0.486	\$153,331	315,810	\$0.486	
7	\$1,131,123	\$85,174	\$80,795	\$28,154	\$0	\$194,122	411,219	\$0.472	\$141,416	299,569	\$0.472	
8	\$1,050,329	\$79,090	\$80,795	\$28,717	\$0	\$188,601	411,219	\$0.459	\$130,328	284,163	\$0.459	
9	\$969,534	\$73,006	\$80,795	\$29,291	\$0	\$183,092	411,219	\$0.445	\$120,014	269,549	\$0.445	
10	\$888,740	\$66,922	\$80,795	\$29,877	\$0	\$177,594	411,219	\$0.432	\$110,424	255,687	\$0.432	
11	\$807,945	\$60,838	\$80,795	\$30,475	\$0	\$172,108	411,219	\$0.419	\$101,509	242,537	\$0.419	
12	\$727,151	\$54,754	\$80,795	\$31,084	\$0	\$166,633	411,219	\$0.405	\$93,226	230,064	\$0.405	
13	\$646,356	\$48,671	\$80,795	\$31,706	\$0	\$161,171	411,219	\$0.392	\$85,533	218,233	\$0.392	
14	\$565,562	\$42,587	\$80,795	\$32,340	\$0	\$155,721	411,219	\$0.379	\$78,391	207,009	\$0.379	
15	\$484,767	\$36,503	\$80,795	\$32,987	\$0	\$150,284	411,219	\$0.365	\$71,763	196,363	\$0.365	
16	\$403,973	\$30,419	\$80,795	\$33,647	\$0	\$144,860	411,219	\$0.352	\$65,616	186,265	\$0.352	
17	\$323,178	\$24,335	\$80,795	\$34,320	\$0	\$139,449	411,219	\$0.339	\$59,916	176,686	\$0.339	
18	\$242,384	\$18,251	\$80,795	\$35,006	\$0	\$134,052	411,219	\$0.326	\$54,635	167,599	\$0.326	
19	\$161,589	\$12,168	\$80,795	\$35,706	\$0	\$128,668	411,219	\$0.313	\$49,744	158,980	\$0.313	
20	\$80,795	\$6,084	\$80,795	\$36,420	\$0	\$123,299	411,219	\$0.300	\$45,217	150,804	\$0.300	
Real leveled cost of energy					\$0.449				\$2,339,657	5,214,532	\$0.449	

8 2010-08-23 DBay 3 Northwind 100s 75kW diesel LE Projects LCOE Economic model 20.xls

Leading Edge Projects Generation LCOE Economic Model													
Project: Destruction Bay 3 NorthWind 100 wind turbines - medium plus penetration; wind speed 6.3 m/s, 75kW min diesel load													
Capital cost	\$2,701,260	Capacity		300 kW	Fixed O&M		\$35,000 per year		Discount rate		5.42%		
Cost of capital	7.53% Debt & equity	Annual Energy		522,939 kWh	Variable O&M		\$0.00 per kWh						
Inflation	2.00% per year	Project life		20 Years									
Year	Capital	Cost of Cap	Depreciation	Fixed O&M	Variable O&M	Total Ann cost	Ann energy	Cost per kWh	Discounted cost	Discounted energy	Discounted cost per kWh		
1	\$2,701,260	\$203,405	\$135,063	\$35,000	\$0	\$373,468	522,939	\$0.714	\$373,468	522,939	\$0.714		
2	\$2,566,197	\$193,235	\$135,063	\$35,700	\$0	\$363,998	522,939	\$0.696	\$345,278	496,046	\$0.696		
3	\$2,431,134	\$183,064	\$135,063	\$36,414	\$0	\$354,541	522,939	\$0.678	\$319,013	470,535	\$0.678		
4	\$2,296,071	\$172,894	\$135,063	\$37,142	\$0	\$345,099	522,939	\$0.660	\$294,548	446,337	\$0.660		
5	\$2,161,008	\$162,724	\$135,063	\$37,885	\$0	\$335,672	522,939	\$0.642	\$271,767	423,383	\$0.642		
6	\$2,025,945	\$152,554	\$135,063	\$38,643	\$0	\$326,259	522,939	\$0.624	\$250,562	401,609	\$0.624		
7	\$1,890,882	\$142,383	\$135,063	\$39,416	\$0	\$316,862	522,939	\$0.606	\$230,831	380,955	\$0.606		
8	\$1,755,819	\$132,213	\$135,063	\$40,204	\$0	\$307,480	522,939	\$0.588	\$212,476	361,364	\$0.588		
9	\$1,620,756	\$122,043	\$135,063	\$41,008	\$0	\$298,114	522,939	\$0.570	\$195,410	342,780	\$0.570		
10	\$1,485,693	\$111,873	\$135,063	\$41,828	\$0	\$288,764	522,939	\$0.552	\$179,547	325,152	\$0.552		
11	\$1,350,630	\$101,702	\$135,063	\$42,665	\$0	\$279,430	522,939	\$0.534	\$164,808	308,430	\$0.534		
12	\$1,215,567	\$91,532	\$135,063	\$43,518	\$0	\$270,113	522,939	\$0.517	\$151,120	292,568	\$0.517		
13	\$1,080,504	\$81,362	\$135,063	\$44,388	\$0	\$260,813	522,939	\$0.499	\$138,413	277,522	\$0.499		
14	\$945,441	\$71,192	\$135,063	\$45,276	\$0	\$251,531	522,939	\$0.481	\$126,622	263,250	\$0.481		
15	\$810,378	\$61,021	\$135,063	\$46,182	\$0	\$242,266	522,939	\$0.463	\$115,686	249,711	\$0.463		
16	\$675,315	\$50,851	\$135,063	\$47,105	\$0	\$233,020	522,939	\$0.446	\$105,548	236,869	\$0.446		
17	\$540,252	\$40,681	\$135,063	\$48,047	\$0	\$223,791	522,939	\$0.428	\$96,155	224,688	\$0.428		
18	\$405,189	\$30,511	\$135,063	\$49,008	\$0	\$214,582	522,939	\$0.410	\$87,457	213,133	\$0.410		
19	\$270,126	\$20,340	\$135,063	\$49,989	\$0	\$205,392	522,939	\$0.393	\$79,406	202,172	\$0.393		
20	\$135,063	\$10,170	\$135,063	\$50,988	\$0	\$196,222	522,939	\$0.375	\$71,959	191,775	\$0.375		
Real levelized cost of energy					\$0.575				\$3,810,073	6,631,216	\$0.575		

9 2010-08-12 DBay diesel gen \$0.85 per litre 2% LE Projects LCOE Economic model 20.xls

Leading Edge Projects Generation LCOE Economic Model													
Project: Destruction Bay diesel generation, fuel at \$0.85 per litre or \$0.25 per kWh at 3.41 kWh / litre, fuel inflation 2%													
Capital cost	\$0			Capacity	75 kW			Fixed O&M			\$0 per year	Discount rate	5.42%
Cost of capital	7.53%	Debt & equity		Annual Energy	500,000 kWh	Variable O&M		Capacity factor			\$0.25 per kWh	Fuel inflation	2.00% per year
Inflation	2.00%	per year		Project life	20 Years								
Year	Capital	Cost of Cap	Depreciation	Fixed O&M	Variable O&M	Total Ann cost	Ann energy	Cost per kWh	Discounted cost	Discounted energy	Discounted cost per kWh		
1	\$0	\$0	\$0	\$0	\$125,000	\$125,000	500,000	\$0.250	\$125,000	500,000	\$0.250		
2	\$0	\$0	\$0	\$0	\$127,500	\$127,500	500,000	\$0.255	\$120,943	474,286	\$0.255		
3	\$0	\$0	\$0	\$0	\$130,050	\$130,050	500,000	\$0.260	\$117,018	449,895	\$0.260		
4	\$0	\$0	\$0	\$0	\$132,651	\$132,651	500,000	\$0.265	\$113,220	426,758	\$0.265		
5	\$0	\$0	\$0	\$0	\$135,304	\$135,304	500,000	\$0.271	\$109,545	404,811	\$0.271		
6	\$0	\$0	\$0	\$0	\$138,010	\$138,010	500,000	\$0.276	\$105,990	383,992	\$0.276		
7	\$0	\$0	\$0	\$0	\$140,770	\$140,770	500,000	\$0.282	\$102,550	364,245	\$0.282		
8	\$0	\$0	\$0	\$0	\$143,586	\$143,586	500,000	\$0.287	\$99,221	345,512	\$0.287		
9	\$0	\$0	\$0	\$0	\$146,457	\$146,457	500,000	\$0.293	\$96,001	327,744	\$0.293		
10	\$0	\$0	\$0	\$0	\$149,387	\$149,387	500,000	\$0.299	\$92,885	310,889	\$0.299		
11	\$0	\$0	\$0	\$0	\$152,374	\$152,374	500,000	\$0.305	\$89,870	294,900	\$0.305		
12	\$0	\$0	\$0	\$0	\$155,422	\$155,422	500,000	\$0.311	\$86,954	279,734	\$0.311		
13	\$0	\$0	\$0	\$0	\$158,530	\$158,530	500,000	\$0.317	\$84,131	265,348	\$0.317		
14	\$0	\$0	\$0	\$0	\$161,701	\$161,701	500,000	\$0.323	\$81,401	251,702	\$0.323		
15	\$0	\$0	\$0	\$0	\$164,935	\$164,935	500,000	\$0.330	\$78,759	238,758	\$0.330		
16	\$0	\$0	\$0	\$0	\$168,234	\$168,234	500,000	\$0.336	\$76,203	226,479	\$0.336		
17	\$0	\$0	\$0	\$0	\$171,598	\$171,598	500,000	\$0.343	\$73,729	214,832	\$0.343		
18	\$0	\$0	\$0	\$0	\$175,030	\$175,030	500,000	\$0.350	\$71,337	203,783	\$0.350		
19	\$0	\$0	\$0	\$0	\$178,531	\$178,531	500,000	\$0.357	\$69,021	193,303	\$0.357		
20	\$0	\$0	\$0	\$0	\$182,101	\$182,101	500,000	\$0.364	\$66,781	183,362	\$0.364		
Real leveled cost of energy										\$1,860,558	6,340,334		

10 2010-08-12 DBay diesel gen \$0.85 per litre 3% LE Projects LCOE Economic model 20.xls

Leading Edge Projects Generation LCOE Economic Model													
Project: Destruction Bay diesel generation, fuel at \$0.85 per litre or \$0.25 per kWh at 3.41 kWh / litre, fuel inflation 3%													
Capital cost	\$0	7.53% Debt & equity	Capacity	75 kW	Fixed O&M	Variable O&M	\$0 per year	Discount rate	5.42%				
Cost of capital	Inflation	2.00% per year	Annual Energy	500,000 kWh	Project life	20 Years	\$0.25 per kWh	Fuel inflation	3.00% per year				
Year	Capital	Cost of Cap	Depreciation	Fixed O&M	Variable O&M	Total Ann cost	Ann energy	Cost per kWh	Discounted cost	Discounted energy	Discounted cost per kWh		
1	\$0	\$0	\$0	\$0	\$125,000	\$125,000	500,000	\$0.250	\$125,000	500,000	\$0.250	\$0.250	\$0.250
2	\$0	\$0	\$0	\$0	\$128,750	\$128,750	500,000	\$0.258	\$122,129	474,286	\$0.258	\$0.258	\$0.258
3	\$0	\$0	\$0	\$0	\$132,613	\$132,613	500,000	\$0.265	\$119,323	449,895	\$0.265	\$0.265	\$0.265
4	\$0	\$0	\$0	\$0	\$136,591	\$136,591	500,000	\$0.273	\$116,582	426,758	\$0.273	\$0.273	\$0.273
5	\$0	\$0	\$0	\$0	\$140,689	\$140,689	500,000	\$0.281	\$113,905	404,811	\$0.281	\$0.281	\$0.281
6	\$0	\$0	\$0	\$0	\$144,909	\$144,909	500,000	\$0.290	\$111,288	383,952	\$0.290	\$0.290	\$0.290
7	\$0	\$0	\$0	\$0	\$149,257	\$149,257	500,000	\$0.299	\$108,732	364,245	\$0.299	\$0.299	\$0.299
8	\$0	\$0	\$0	\$0	\$153,734	\$153,734	500,000	\$0.307	\$106,234	345,512	\$0.307	\$0.307	\$0.307
9	\$0	\$0	\$0	\$0	\$158,346	\$158,346	500,000	\$0.317	\$103,794	327,744	\$0.317	\$0.317	\$0.317
10	\$0	\$0	\$0	\$0	\$163,097	\$163,097	500,000	\$0.326	\$101,410	310,889	\$0.326	\$0.326	\$0.326
11	\$0	\$0	\$0	\$0	\$167,990	\$167,990	500,000	\$0.336	\$99,080	294,900	\$0.336	\$0.336	\$0.336
12	\$0	\$0	\$0	\$0	\$173,029	\$173,029	500,000	\$0.346	\$96,804	279,734	\$0.346	\$0.346	\$0.346
13	\$0	\$0	\$0	\$0	\$178,220	\$178,220	500,000	\$0.356	\$94,581	265,348	\$0.356	\$0.356	\$0.356
14	\$0	\$0	\$0	\$0	\$183,567	\$183,567	500,000	\$0.367	\$92,408	251,702	\$0.367	\$0.367	\$0.367
15	\$0	\$0	\$0	\$0	\$189,074	\$189,074	500,000	\$0.378	\$90,286	238,758	\$0.378	\$0.378	\$0.378
16	\$0	\$0	\$0	\$0	\$194,746	\$194,746	500,000	\$0.389	\$88,212	226,479	\$0.389	\$0.389	\$0.389
17	\$0	\$0	\$0	\$0	\$200,588	\$200,588	500,000	\$0.401	\$86,185	214,832	\$0.401	\$0.401	\$0.401
18	\$0	\$0	\$0	\$0	\$206,606	\$206,606	500,000	\$0.413	\$84,206	203,783	\$0.413	\$0.413	\$0.413
19	\$0	\$0	\$0	\$0	\$212,804	\$212,804	500,000	\$0.426	\$82,272	193,303	\$0.426	\$0.426	\$0.426
20	\$0	\$0	\$0	\$0	\$219,188	\$219,188	500,000	\$0.438	\$80,382	183,362	\$0.438	\$0.438	\$0.438
Real levelized cost of energy										\$2,022,812	6,340,334	\$0.319	\$0.319

11 2010-08-12 DBay diesel gen \$0.85 per litre 4% LE Projects LCOE Economic model 20.xls

Leading Edge Projects Generation LCOE Economic Model													
Project: Destruction Bay diesel generation, fuel at \$0.85 per litre or \$0.25 per kWh at 3.41 kWh / litre, fuel inflation 4%													
Capital cost	\$0	75 kW		Capacity	Annual Energy	75 kW	Fixed O&M	Variable O&M	Ann energy	Cost per kWh	Discounted cost	Discounted energy	Discounted cost per kWh
Cost of capital	7.53% Debt & equity	500,000 kWh		Project life	20 Years	20 Years	Capacity factor						
Inflation	2.00% per year												per year
Year	Capital	Cost of Cap	Depreciation	Fixed O&M	Variable O&M	Total Ann cost	Ann energy	Cost per kWh	Discounted cost	Discounted energy	Discounted cost per kWh		
1	\$0	\$0	\$0	\$0	\$0	\$125,000	500,000	\$0.250	\$125,000	500,000	\$0.250	\$0.42%	\$0.250
2	\$0	\$0	\$0	\$0	\$0	\$130,000	500,000	\$0.260	\$123,314	474,286	\$0.260		\$0.260
3	\$0	\$0	\$0	\$0	\$0	\$135,200	500,000	\$0.270	\$121,652	449,895	\$0.270		\$0.270
4	\$0	\$0	\$0	\$0	\$0	\$140,608	500,000	\$0.281	\$120,011	426,758	\$0.281		\$0.281
5	\$0	\$0	\$0	\$0	\$0	\$146,232	500,000	\$0.292	\$118,393	404,811	\$0.292		\$0.292
6	\$0	\$0	\$0	\$0	\$0	\$152,082	500,000	\$0.304	\$116,796	383,992	\$0.304		\$0.304
7	\$0	\$0	\$0	\$0	\$0	\$158,165	500,000	\$0.316	\$115,221	364,245	\$0.316		\$0.316
8	\$0	\$0	\$0	\$0	\$0	\$164,491	500,000	\$0.329	\$113,668	345,512	\$0.329		\$0.329
9	\$0	\$0	\$0	\$0	\$0	\$171,071	500,000	\$0.342	\$112,135	327,744	\$0.342		\$0.342
10	\$0	\$0	\$0	\$0	\$0	\$177,914	500,000	\$0.356	\$110,623	310,889	\$0.356		\$0.356
11	\$0	\$0	\$0	\$0	\$0	\$185,031	500,000	\$0.370	\$109,131	294,900	\$0.370		\$0.370
12	\$0	\$0	\$0	\$0	\$0	\$192,432	500,000	\$0.385	\$107,660	279,734	\$0.385		\$0.385
13	\$0	\$0	\$0	\$0	\$0	\$200,129	500,000	\$0.400	\$106,208	265,348	\$0.400		\$0.400
14	\$0	\$0	\$0	\$0	\$0	\$208,134	500,000	\$0.416	\$104,776	251,702	\$0.416		\$0.416
15	\$0	\$0	\$0	\$0	\$0	\$216,460	500,000	\$0.433	\$103,363	238,758	\$0.433		\$0.433
16	\$0	\$0	\$0	\$0	\$0	\$225,118	500,000	\$0.450	\$101,969	226,479	\$0.450		\$0.450
17	\$0	\$0	\$0	\$0	\$0	\$234,123	500,000	\$0.468	\$100,594	214,832	\$0.468		\$0.468
18	\$0	\$0	\$0	\$0	\$0	\$243,488	500,000	\$0.487	\$99,237	203,783	\$0.487		\$0.487
19	\$0	\$0	\$0	\$0	\$0	\$253,227	500,000	\$0.506	\$97,899	193,303	\$0.506		\$0.506
20	\$0	\$0	\$0	\$0	\$0	\$263,356	500,000	\$0.527	\$96,579	183,362	\$0.527		\$0.527
Real levelized cost of energy										\$2,204,229	6,340,334		\$0.348

12 2010-08-12 DBay diesel gen \$1.00 per litre 2% LE Projects LCOE Economic model 20.xls

Leading Edge Projects Generation LCOE Economic Model													
Project: Destruction Bay diesel generation, fuel at \$1.00 per litre or \$0.25 per kWh at 3.41 kWh / litre, fuel inflation 2%													
Capital cost	\$0	7.53% Debt & equity		Capacity	75 kW	Fixed O&M		\$0 per year		Discount rate	5.42%		
Cost of capital	Inflation	2.00% per year		Annual Energy	500,000 kWh	Variable O&M		0.293 per kWh		Fuel inflation	2.00%	per year	
				Project life	20 Years	Capacity factor							
Year	Capital	Cost of Cap		Depreciation	Fixed O&M	Variable O&M	Total Ann cost		Ann energy	Cost per kWh		Discounted energy	Discounted cost per kWh
1	\$0	\$0	\$0	\$0	\$0	\$146,500	\$146,500		500,000	\$0.293	\$146,500	500,000	\$0.293
2	\$0	\$0	\$0	\$0	\$0	\$149,430	\$149,430		500,000	\$0.299	\$141,745	474,286	\$0.299
3	\$0	\$0	\$0	\$0	\$0	\$152,419	\$152,419		500,000	\$0.305	\$137,145	449,895	\$0.305
4	\$0	\$0	\$0	\$0	\$0	\$155,467	\$155,467		500,000	\$0.311	\$132,694	426,758	\$0.311
5	\$0	\$0	\$0	\$0	\$0	\$158,576	\$158,576		500,000	\$0.317	\$128,387	404,811	\$0.317
6	\$0	\$0	\$0	\$0	\$0	\$161,748	\$161,748		500,000	\$0.323	\$124,220	383,992	\$0.323
7	\$0	\$0	\$0	\$0	\$0	\$164,983	\$164,983		500,000	\$0.330	\$120,188	364,245	\$0.330
8	\$0	\$0	\$0	\$0	\$0	\$168,282	\$168,282		500,000	\$0.337	\$116,287	345,512	\$0.337
9	\$0	\$0	\$0	\$0	\$0	\$171,648	\$171,648		500,000	\$0.343	\$112,513	327,744	\$0.343
10	\$0	\$0	\$0	\$0	\$0	\$175,081	\$175,081		500,000	\$0.350	\$108,861	310,889	\$0.350
11	\$0	\$0	\$0	\$0	\$0	\$178,583	\$178,583		500,000	\$0.357	\$105,328	294,900	\$0.357
12	\$0	\$0	\$0	\$0	\$0	\$182,154	\$182,154		500,000	\$0.364	\$101,910	279,734	\$0.364
13	\$0	\$0	\$0	\$0	\$0	\$185,797	\$185,797		500,000	\$0.372	\$98,602	265,348	\$0.372
14	\$0	\$0	\$0	\$0	\$0	\$189,513	\$189,513		500,000	\$0.379	\$95,402	251,702	\$0.379
15	\$0	\$0	\$0	\$0	\$0	\$193,304	\$193,304		500,000	\$0.387	\$92,305	238,758	\$0.387
16	\$0	\$0	\$0	\$0	\$0	\$197,170	\$197,170		500,000	\$0.394	\$89,310	226,479	\$0.394
17	\$0	\$0	\$0	\$0	\$0	\$201,113	\$201,113		500,000	\$0.402	\$86,411	214,832	\$0.402
18	\$0	\$0	\$0	\$0	\$0	\$205,135	\$205,135		500,000	\$0.410	\$83,606	203,783	\$0.410
19	\$0	\$0	\$0	\$0	\$0	\$209,238	\$209,238		500,000	\$0.418	\$80,893	193,303	\$0.418
20	\$0	\$0	\$0	\$0	\$0	\$213,423	\$213,423		500,000	\$0.427	\$78,267	183,362	\$0.427
Real levelized cost of energy						\$0.344				\$2,180,575		6,340,334	\$0.344

13 2010-08-12 DBay diesel gen \$1.00 per litre 3% LE Projects LCOE Economic model 20.xls

Leading Edge Projects Generation LCOE Economic Model													
Project: Destruction Bay diesel generation, fuel at \$1.00 per litre or \$0.25 per kWh at 3.41 kWh / litre, fuel inflation 3%													
Capital cost	\$0	7.53%	Debt & equity	Capacity	75 kW	Fixed O&M	Ann energy	Cost per kWh	Discounted cost	Discounted energy	5.42%	Discounted cost	per kWh
Cost of capital	7.53%	2.00%	per year	Annual Energy	500,000 kWh	Variable O&M	Capacity factor	\$0 per year	Discounted rate	Fuel inflation	3.00%	per year	
Inflation				Project life	20 Years								
Year	Capital	Cost of Cap	Depreciation	Fixed O&M	Variable O&M	Total Ann cost	Ann energy	Cost per kWh	Discounted cost	Discounted energy		Discounted cost	per kWh
1	\$0	\$0	\$0	\$0	\$0	\$146,500	500,000	\$0.293	\$146,500	500,000		\$0.293	\$0.293
2	\$0	\$0	\$0	\$0	\$0	\$150,895	500,000	\$0.302	\$143,135	474,286		\$0.302	\$0.302
3	\$0	\$0	\$0	\$0	\$0	\$155,422	500,000	\$0.311	\$139,847	449,895		\$0.311	\$0.311
4	\$0	\$0	\$0	\$0	\$0	\$160,085	500,000	\$0.320	\$136,635	426,758		\$0.320	\$0.320
5	\$0	\$0	\$0	\$0	\$0	\$164,887	500,000	\$0.330	\$133,496	404,811		\$0.330	\$0.330
6	\$0	\$0	\$0	\$0	\$0	\$169,834	500,000	\$0.340	\$130,430	383,992		\$0.340	\$0.340
7	\$0	\$0	\$0	\$0	\$0	\$174,929	500,000	\$0.350	\$127,434	364,245		\$0.350	\$0.350
8	\$0	\$0	\$0	\$0	\$0	\$180,177	500,000	\$0.360	\$124,506	345,512		\$0.360	\$0.360
9	\$0	\$0	\$0	\$0	\$0	\$185,582	500,000	\$0.371	\$121,647	327,744		\$0.371	\$0.371
10	\$0	\$0	\$0	\$0	\$0	\$191,149	500,000	\$0.382	\$118,852	310,889		\$0.382	\$0.382
11	\$0	\$0	\$0	\$0	\$0	\$196,884	500,000	\$0.394	\$116,122	294,900		\$0.394	\$0.394
12	\$0	\$0	\$0	\$0	\$0	\$202,790	500,000	\$0.406	\$113,455	279,734		\$0.406	\$0.406
13	\$0	\$0	\$0	\$0	\$0	\$208,874	500,000	\$0.418	\$110,849	265,348		\$0.418	\$0.418
14	\$0	\$0	\$0	\$0	\$0	\$215,140	500,000	\$0.430	\$108,302	251,702		\$0.430	\$0.430
15	\$0	\$0	\$0	\$0	\$0	\$221,594	500,000	\$0.443	\$105,815	238,758		\$0.443	\$0.443
16	\$0	\$0	\$0	\$0	\$0	\$228,242	500,000	\$0.456	\$103,384	226,479		\$0.456	\$0.456
17	\$0	\$0	\$0	\$0	\$0	\$235,089	500,000	\$0.470	\$101,009	214,832		\$0.470	\$0.470
18	\$0	\$0	\$0	\$0	\$0	\$242,142	500,000	\$0.484	\$98,689	203,783		\$0.484	\$0.484
19	\$0	\$0	\$0	\$0	\$0	\$249,406	500,000	\$0.499	\$96,422	193,303		\$0.499	\$0.499
20	\$0	\$0	\$0	\$0	\$0	\$256,889	500,000	\$0.514	\$94,207	183,362		\$0.514	\$0.514
Real levelized cost of energy										\$2,370,736		6,340,334	\$0.374

14 2010-08-12 DBay diesel gen \$1.00 per litre 4% LE Projects LCOE Economic model 20.xls

Leading Edge Projects Generation LCOE Economic Model													
Project: Destruction Bay diesel generation, fuel at \$1.00 per litre or \$0.25 per kWh at 3.41 kWh / litre, fuel inflation 4%													
Capital cost	\$0	7.53% Debt & equity 2.00% per year	Capacity Annual Energy Project life	75 kW 500,000 kWh 20 Years	Fixed O&M Variable O&M Capacity factor	\$0 per year 0.293 per kWh	Discount rate	5.42%					
Cost of capital Inflation							Fuel inflation	4.00% per year					
Year	Capital	Cost of Cap	Depreciation	Fixed O&M	Variable O&M	Total Ann cost	Ann energy	Cost per kWh	Discounted cost energy	Discounted cost per kWh			
1	\$0	\$0	\$0	\$0	\$146,500	\$146,500	500,000	\$0.293	\$146,500	500,000	\$0.293	\$0.293	\$0.293
2	\$0	\$0	\$0	\$0	\$152,360	\$152,360	500,000	\$0.305	\$144,525	474,286	\$0.305	\$0.305	\$0.305
3	\$0	\$0	\$0	\$0	\$158,454	\$158,454	500,000	\$0.317	\$142,576	449,895	\$0.317	\$0.317	\$0.317
4	\$0	\$0	\$0	\$0	\$164,793	\$164,793	500,000	\$0.330	\$140,653	426,758	\$0.330	\$0.330	\$0.330
5	\$0	\$0	\$0	\$0	\$171,384	\$171,384	500,000	\$0.343	\$138,756	404,811	\$0.343	\$0.343	\$0.343
6	\$0	\$0	\$0	\$0	\$178,240	\$178,240	500,000	\$0.356	\$136,885	383,992	\$0.356	\$0.356	\$0.356
7	\$0	\$0	\$0	\$0	\$185,369	\$185,369	500,000	\$0.371	\$135,039	364,245	\$0.371	\$0.371	\$0.371
8	\$0	\$0	\$0	\$0	\$192,784	\$192,784	500,000	\$0.386	\$133,219	345,512	\$0.386	\$0.386	\$0.386
9	\$0	\$0	\$0	\$0	\$200,495	\$200,495	500,000	\$0.401	\$131,422	327,744	\$0.401	\$0.401	\$0.401
10	\$0	\$0	\$0	\$0	\$208,515	\$208,515	500,000	\$0.417	\$129,650	310,889	\$0.417	\$0.417	\$0.417
11	\$0	\$0	\$0	\$0	\$216,856	\$216,856	500,000	\$0.434	\$127,902	294,900	\$0.434	\$0.434	\$0.434
12	\$0	\$0	\$0	\$0	\$225,530	\$225,530	500,000	\$0.451	\$126,177	279,734	\$0.451	\$0.451	\$0.451
13	\$0	\$0	\$0	\$0	\$234,551	\$234,551	500,000	\$0.469	\$124,476	265,348	\$0.469	\$0.469	\$0.469
14	\$0	\$0	\$0	\$0	\$243,933	\$243,933	500,000	\$0.488	\$122,797	251,702	\$0.488	\$0.488	\$0.488
15	\$0	\$0	\$0	\$0	\$253,691	\$253,691	500,000	\$0.507	\$121,141	238,758	\$0.507	\$0.507	\$0.507
16	\$0	\$0	\$0	\$0	\$263,838	\$263,838	500,000	\$0.528	\$119,508	226,479	\$0.528	\$0.528	\$0.528
17	\$0	\$0	\$0	\$0	\$274,392	\$274,392	500,000	\$0.549	\$117,896	214,832	\$0.549	\$0.549	\$0.549
18	\$0	\$0	\$0	\$0	\$285,367	\$285,367	500,000	\$0.571	\$116,306	203,783	\$0.571	\$0.571	\$0.571
19	\$0	\$0	\$0	\$0	\$296,782	\$296,782	500,000	\$0.594	\$114,738	193,303	\$0.594	\$0.594	\$0.594
20	\$0	\$0	\$0	\$0	\$308,653	\$308,653	500,000	\$0.617	\$113,191	183,362	\$0.617	\$0.617	\$0.617
Real levelized cost of energy									\$2,583,356	6,340,334		\$0.407	\$0.407

15 2010-08-12 DBay diesel gen \$1.20 per litre 2% LE Projects LCOE Economic model 20.xls

Leading Edge Projects Generation LCOE Economic Model															
Project: Destruction Bay diesel generation, fuel at \$1.20 per litre or \$0.352 per kWh at 3.41 kWh / litre, fuel inflation 2%															
Capital cost	\$0	7.53% Debt & equity			Capacity	75 kW	Fixed O&M	Ann energy		\$0 per year	Discount rate	5.42%			
Cost of capital		2.00% per year			Annual Energy	500,000 kWh	Variable O&M	0.352 per kWh							
Inflation					Project life	20 Years	Capacity factor				Fuel inflation	2.00% per year			
Year	Capital	Cost of Cap		Depreciation	Fixed O&M	Variable O&M	Total Ann cost		Ann energy	Cost per kWh		Discounted cost	Discounted cost per kWh		
1		\$0	\$0	\$0	\$0	\$176,000	\$176,000		500,000	\$0.352		\$176,000	\$0.352		
2		\$0	\$0	\$0	\$0	\$179,520	\$179,520		500,000	\$0.359		\$170,288	\$0.359		
3		\$0	\$0	\$0	\$0	\$183,110	\$183,110		500,000	\$0.366		\$164,761	\$0.366		
4		\$0	\$0	\$0	\$0	\$186,773	\$186,773		500,000	\$0.374		\$159,413	\$0.374		
5		\$0	\$0	\$0	\$0	\$190,508	\$190,508		500,000	\$0.381		\$154,239	\$0.381		
6		\$0	\$0	\$0	\$0	\$194,318	\$194,318		500,000	\$0.389		\$149,233	\$0.389		
7		\$0	\$0	\$0	\$0	\$198,205	\$198,205		500,000	\$0.396		\$144,390	\$0.396		
8		\$0	\$0	\$0	\$0	\$202,169	\$202,169		500,000	\$0.404		\$139,704	\$0.404		
9		\$0	\$0	\$0	\$0	\$206,212	\$206,212		500,000	\$0.412		\$135,169	\$0.412		
10		\$0	\$0	\$0	\$0	\$210,336	\$210,336		500,000	\$0.421		\$130,782	\$0.421		
11		\$0	\$0	\$0	\$0	\$214,543	\$214,543		500,000	\$0.429		\$126,538	\$0.429		
12		\$0	\$0	\$0	\$0	\$218,834	\$218,834		500,000	\$0.438		\$122,431	\$0.438		
13		\$0	\$0	\$0	\$0	\$223,211	\$223,211		500,000	\$0.446		\$118,457	\$0.446		
14		\$0	\$0	\$0	\$0	\$227,675	\$227,675		500,000	\$0.455		\$114,612	\$0.455		
15		\$0	\$0	\$0	\$0	\$232,228	\$232,228		500,000	\$0.464		\$110,893	\$0.464		
16		\$0	\$0	\$0	\$0	\$236,873	\$236,873		500,000	\$0.474		\$107,293	\$0.474		
17		\$0	\$0	\$0	\$0	\$241,610	\$241,610		500,000	\$0.483		\$103,811	\$0.483		
18		\$0	\$0	\$0	\$0	\$246,442	\$246,442		500,000	\$0.493		\$100,442	\$0.493		
19		\$0	\$0	\$0	\$0	\$251,371	\$251,371		500,000	\$0.503		\$97,182	\$0.503		
20		\$0	\$0	\$0	\$0	\$256,399	\$256,399		500,000	\$0.513		\$94,028	\$0.513		
Real levelized cost of energy													\$2,619,666	6,340,334	\$0.413

16 2010-08-12 DBay diesel gen \$1.20 per litre 3% LE Projects LCOE Economic model 20.xls

Leading Edge Projects Generation LCOE Economic Model													
Project: Destruction Bay diesel generation, fuel at \$1.20 per litre or \$0.352 per kWh at 3.41 kWh / litre, fuel inflation 3%													
Capital cost	\$0	Capacity	75 kW	Fixed O&M	Ann energy	Cost per kWh	Discounted cost	Discounted energy	Discounted cost per kWh				
Cost of capital	7.53% Debt & equity	Annual Energy	500,000 kWh	Variable O&M	500,000	\$0 per year	Discount rate						
Inflation	2.00% per year	Project life	20 Years	Capacity factor		0.352 per kWh	Fuel inflation						
Year	Capital	Cost of Cap	Depreciation	Fixed O&M	Variable O&M	Total Ann cost	Ann energy	Cost per kWh	Discounted cost	Discounted energy	Discounted cost per kWh		
1	\$0	\$0	\$0	\$0	\$176,000	\$176,000	500,000	\$0.352	\$176,000	500,000	\$0.352		
2	\$0	\$0	\$0	\$0	\$181,280	\$181,280	500,000	\$0.363	\$171,957	474,286	\$0.363		
3	\$0	\$0	\$0	\$0	\$186,718	\$186,718	500,000	\$0.373	\$168,007	449,895	\$0.373		
4	\$0	\$0	\$0	\$0	\$192,320	\$192,320	500,000	\$0.385	\$164,148	426,758	\$0.385		
5	\$0	\$0	\$0	\$0	\$198,090	\$198,090	500,000	\$0.396	\$160,378	404,811	\$0.396		
6	\$0	\$0	\$0	\$0	\$204,032	\$204,032	500,000	\$0.408	\$156,694	383,992	\$0.408		
7	\$0	\$0	\$0	\$0	\$210,153	\$210,153	500,000	\$0.420	\$153,094	364,245	\$0.420		
8	\$0	\$0	\$0	\$0	\$216,458	\$216,458	500,000	\$0.433	\$149,578	345,512	\$0.433		
9	\$0	\$0	\$0	\$0	\$222,952	\$222,952	500,000	\$0.446	\$146,142	327,744	\$0.446		
10	\$0	\$0	\$0	\$0	\$229,640	\$229,640	500,000	\$0.459	\$142,785	310,889	\$0.459		
11	\$0	\$0	\$0	\$0	\$236,529	\$236,529	500,000	\$0.473	\$139,505	294,900	\$0.473		
12	\$0	\$0	\$0	\$0	\$243,625	\$243,625	500,000	\$0.487	\$136,301	279,734	\$0.487		
13	\$0	\$0	\$0	\$0	\$250,934	\$250,934	500,000	\$0.502	\$133,170	265,348	\$0.502		
14	\$0	\$0	\$0	\$0	\$258,462	\$258,462	500,000	\$0.517	\$130,111	251,702	\$0.517		
15	\$0	\$0	\$0	\$0	\$266,216	\$266,216	500,000	\$0.532	\$127,122	238,758	\$0.532		
16	\$0	\$0	\$0	\$0	\$274,202	\$274,202	500,000	\$0.548	\$124,202	226,479	\$0.548		
17	\$0	\$0	\$0	\$0	\$282,428	\$282,428	500,000	\$0.565	\$121,349	214,832	\$0.565		
18	\$0	\$0	\$0	\$0	\$290,901	\$290,901	500,000	\$0.582	\$118,562	203,783	\$0.582		
19	\$0	\$0	\$0	\$0	\$299,628	\$299,628	500,000	\$0.599	\$115,838	193,303	\$0.599		
20	\$0	\$0	\$0	\$0	\$308,617	\$308,617	500,000	\$0.617	\$113,177	183,362	\$0.617		
Real levelized cost of energy							\$0.449		\$2,848,120	6,340,334			

17 2010-08-12 DBay diesel gen \$1.20 per litre 4% LE Projects LCOE Economic model 20.xls

Leading Edge Projects Generation LCOE Economic Model													
Project: Destruction Bay diesel generation, fuel at \$1.20 per litre or \$0.352 per kWh at 3.41 kWh / litre, fuel inflation 4%													
Capital cost	\$0												
Cost of capital	7.53%	Debt & equity											
Inflation	2.00%	per year											
Year	Capital	Cost of Cap	Depreciation	Fixed O&M	Variable O&M	Total Ann cost	Ann energy	Cost per kWh	Discounted cost	Discounted energy	Discounted cost per kWh		
1	\$0	\$0	\$0	\$0	\$176,000	\$176,000	500,000	\$0.352	\$176,000	500,000	\$0.352		
2	\$0	\$0	\$0	\$0	\$183,040	\$183,040	500,000	\$0.366	\$173,627	474,286	\$0.366		
3	\$0	\$0	\$0	\$0	\$190,362	\$190,362	500,000	\$0.381	\$171,285	449,895	\$0.381		
4	\$0	\$0	\$0	\$0	\$197,976	\$197,976	500,000	\$0.396	\$168,976	426,758	\$0.396		
5	\$0	\$0	\$0	\$0	\$205,895	\$205,895	500,000	\$0.412	\$166,697	404,811	\$0.412		
6	\$0	\$0	\$0	\$0	\$214,131	\$214,131	500,000	\$0.428	\$164,449	383,992	\$0.428		
7	\$0	\$0	\$0	\$0	\$222,696	\$222,696	500,000	\$0.445	\$162,232	364,245	\$0.445		
8	\$0	\$0	\$0	\$0	\$231,604	\$231,604	500,000	\$0.463	\$160,044	345,512	\$0.463		
9	\$0	\$0	\$0	\$0	\$240,868	\$240,868	500,000	\$0.482	\$157,886	327,744	\$0.482		
10	\$0	\$0	\$0	\$0	\$250,503	\$250,503	500,000	\$0.501	\$155,757	310,889	\$0.501		
11	\$0	\$0	\$0	\$0	\$260,523	\$260,523	500,000	\$0.521	\$153,657	294,900	\$0.521		
12	\$0	\$0	\$0	\$0	\$270,944	\$270,944	500,000	\$0.542	\$151,585	279,734	\$0.542		
13	\$0	\$0	\$0	\$0	\$281,782	\$281,782	500,000	\$0.564	\$149,541	265,348	\$0.564		
14	\$0	\$0	\$0	\$0	\$293,053	\$293,053	500,000	\$0.586	\$147,524	251,702	\$0.586		
15	\$0	\$0	\$0	\$0	\$304,775	\$304,775	500,000	\$0.610	\$145,535	238,758	\$0.610		
16	\$0	\$0	\$0	\$0	\$316,966	\$316,966	500,000	\$0.634	\$143,572	226,479	\$0.634		
17	\$0	\$0	\$0	\$0	\$329,645	\$329,645	500,000	\$0.659	\$141,636	214,832	\$0.659		
18	\$0	\$0	\$0	\$0	\$342,830	\$342,830	500,000	\$0.686	\$139,726	203,783	\$0.686		
19	\$0	\$0	\$0	\$0	\$356,544	\$356,544	500,000	\$0.713	\$137,842	193,303	\$0.713		
20	\$0	\$0	\$0	\$0	\$370,805	\$370,805	500,000	\$0.742	\$135,983	183,362	\$0.742		
Real levelized cost of energy										\$3,103,554	6,340,334		\$0.489

18 2010-08-24 DBay 2 Northwind 100s 45kW \$500k subsidy LE LCOE Ec model 20.xls

Leading Edge Projects Generation LCOE Economic Model												
Project: Destruction Bay 2 NorthWind 100 wind turbines - medium penetration; wind speed 6.3 m/s, 45 kW min diesel, \$500k cap subsidy												
Capital cost	\$1,424,440	Capacity	200 kW	Fixed O&M	\$25,000 per year	Discount rate	5.42%					
Cost of capital	7.53%	Annual Energy	458,464 kWh	Variable O&M	\$0.00 per kWh							
Inflation	2.00%	Project life	20 Years	Capacity factor								
Year	Capital	Cost of Cap	Depreciation	Fixed O&M	Variable O&M	Total Ann cost	Ann energy	Cost per kWh	Discounted cost	Discounted energy	Discounted cost per kWh	
1	\$1,424,440	\$107,260	\$71,222	\$25,000	\$0	\$203,482	458,464	\$0.444	\$203,482	458,464	\$0.444	\$0.444
2	\$1,353,218	\$101,897	\$71,222	\$25,500	\$0	\$198,619	458,464	\$0.433	\$188,405	434,886	\$0.433	\$0.433
3	\$1,281,996	\$96,534	\$71,222	\$26,010	\$0	\$193,766	458,464	\$0.423	\$174,349	412,521	\$0.423	\$0.423
4	\$1,210,774	\$91,171	\$71,222	\$26,530	\$0	\$188,923	458,464	\$0.412	\$161,249	391,306	\$0.412	\$0.412
5	\$1,139,552	\$85,808	\$71,222	\$27,061	\$0	\$184,091	458,464	\$0.402	\$149,044	371,182	\$0.402	\$0.402
6	\$1,068,330	\$80,445	\$71,222	\$27,602	\$0	\$179,269	458,464	\$0.391	\$137,676	352,093	\$0.391	\$0.391
7	\$997,108	\$75,082	\$71,222	\$28,154	\$0	\$174,458	458,464	\$0.381	\$127,091	333,986	\$0.381	\$0.381
8	\$925,886	\$69,719	\$71,222	\$28,717	\$0	\$169,658	458,464	\$0.370	\$117,238	316,810	\$0.370	\$0.370
9	\$854,664	\$64,356	\$71,222	\$29,291	\$0	\$164,870	458,464	\$0.360	\$108,070	300,517	\$0.360	\$0.360
10	\$783,442	\$58,993	\$71,222	\$29,877	\$0	\$160,092	458,464	\$0.349	\$99,542	285,062	\$0.349	\$0.349
11	\$712,220	\$53,630	\$71,222	\$30,475	\$0	\$155,327	458,464	\$0.339	\$91,612	270,402	\$0.339	\$0.339
12	\$640,998	\$48,267	\$71,222	\$31,084	\$0	\$150,574	458,464	\$0.328	\$84,241	256,496	\$0.328	\$0.328
13	\$569,776	\$42,904	\$71,222	\$31,706	\$0	\$145,832	458,464	\$0.318	\$77,393	243,305	\$0.318	\$0.318
14	\$498,554	\$37,541	\$71,222	\$32,340	\$0	\$141,103	458,464	\$0.308	\$71,032	230,793	\$0.308	\$0.308
15	\$427,332	\$32,178	\$71,222	\$32,987	\$0	\$136,387	458,464	\$0.297	\$65,127	218,924	\$0.297	\$0.297
16	\$356,110	\$26,815	\$71,222	\$33,647	\$0	\$131,684	458,464	\$0.287	\$59,647	207,665	\$0.287	\$0.287
17	\$284,888	\$21,452	\$71,222	\$34,320	\$0	\$126,994	458,464	\$0.277	\$54,565	196,985	\$0.277	\$0.277
18	\$213,666	\$16,089	\$71,222	\$35,006	\$0	\$122,317	458,464	\$0.267	\$49,852	186,855	\$0.267	\$0.267
19	\$142,444	\$10,726	\$71,222	\$35,706	\$0	\$117,654	458,464	\$0.257	\$45,486	177,245	\$0.257	\$0.257
20	\$71,222	\$5,363	\$71,222	\$36,420	\$0	\$113,005	458,464	\$0.246	\$41,442	168,130	\$0.246	\$0.246
Real levelized cost of energy					\$0.362				\$2,106,543	5,813,630		\$0.362

19 2010-08-24 DBay 2 Northwind 100s 45kW NorWIP & \$250k subsidy LE LCOE Ec model 20.xls

Leading Edge Projects Generation LCOE Economic Model													
Project: Destruction Bay 2 NorthWind 100 wind turbines - medium penetration; wind speed 6.3 m/s, 45 kW min diesel, \$500k cap subsidy													
Capital cost	\$1,097,108												
Cost of capital	7.53%	Debt & equity											
Inflation	2.00%	per year											
			Capacity	200 kW	Fixed O&M	\$25,000	per year	Discount rate	5.42%				
			Annual Energy	458,464 kWh	Variable O&M	\$0.00	per kWh						
			Project life	20 Years	Capacity factor								
Year	Capital	Cost of Cap	Depreciation	Fixed O&M	Variable O&M	Total Ann cost	Ann energy	Cost per kWh	Discounted cost	Discounted energy	Discounted cost per kWh		
1	\$1,097,108	\$82,612	\$54,855	\$25,000	\$0	\$162,468	458,464	\$0.354	\$162,468	458,464	\$0.354		
2	\$1,042,253	\$78,482	\$54,855	\$25,500	\$0	\$158,837	458,464	\$0.346	\$150,668	434,886	\$0.346		
3	\$987,357	\$74,351	\$54,855	\$26,010	\$0	\$155,216	458,464	\$0.339	\$139,662	412,521	\$0.339		
4	\$932,542	\$70,220	\$54,855	\$26,530	\$0	\$151,606	458,464	\$0.331	\$129,398	391,306	\$0.331		
5	\$877,686	\$66,090	\$54,855	\$27,061	\$0	\$148,006	458,464	\$0.323	\$119,829	371,182	\$0.323		
6	\$822,831	\$61,959	\$54,855	\$27,602	\$0	\$144,417	458,464	\$0.315	\$110,910	352,093	\$0.315		
7	\$767,976	\$57,829	\$54,855	\$28,154	\$0	\$140,838	458,464	\$0.307	\$102,599	333,986	\$0.307		
8	\$713,120	\$53,698	\$54,855	\$28,717	\$0	\$137,270	458,464	\$0.299	\$94,857	316,810	\$0.299		
9	\$658,265	\$49,567	\$54,855	\$29,291	\$0	\$133,714	458,464	\$0.292	\$87,648	300,517	\$0.292		
10	\$603,409	\$45,437	\$54,855	\$29,877	\$0	\$130,169	458,464	\$0.284	\$80,936	285,062	\$0.284		
11	\$548,554	\$41,306	\$54,855	\$30,475	\$0	\$126,636	458,464	\$0.276	\$74,690	270,402	\$0.276		
12	\$493,699	\$37,176	\$54,855	\$31,084	\$0	\$123,115	458,464	\$0.269	\$68,879	256,496	\$0.269		
13	\$438,843	\$33,045	\$54,855	\$31,706	\$0	\$119,606	458,464	\$0.261	\$63,475	243,305	\$0.261		
14	\$383,988	\$28,914	\$54,855	\$32,340	\$0	\$116,110	458,464	\$0.253	\$58,450	230,793	\$0.253		
15	\$329,132	\$24,784	\$54,855	\$32,987	\$0	\$112,626	458,464	\$0.246	\$53,781	218,924	\$0.246		
16	\$274,277	\$20,653	\$54,855	\$33,647	\$0	\$109,155	458,464	\$0.238	\$49,443	207,665	\$0.238		
17	\$219,422	\$16,522	\$54,855	\$34,320	\$0	\$105,697	458,464	\$0.231	\$45,414	196,985	\$0.231		
18	\$164,566	\$12,392	\$54,855	\$35,006	\$0	\$102,253	458,464	\$0.223	\$41,675	186,855	\$0.223		
19	\$109,711	\$8,261	\$54,855	\$35,706	\$0	\$98,823	458,464	\$0.216	\$38,206	177,245	\$0.216		
20	\$54,855	\$4,131	\$54,855	\$36,420	\$0	\$95,406	458,464	\$0.208	\$34,988	168,130	\$0.208		
									\$1,707,976	5,813,630			
Real leveled cost of energy					\$0.294								

Attachment 14

2010-08-24 Wind project GHG reductions.xls

Destruction Bay Wind Project Annual GHG Reductions				
GHG reduction is 0.8181 in kg CO ₂ eq per kWh (2.7898 kg per litre)				
Description	Project configuration			
	1 NW 100	2 NW 100s	1 AW 225	3 NW 100s
Minimum diesel 45kW				
kWh of diesel energy displaced	231,611	458,464	450,841	591,355
GHG reduction in kg CO ₂ eq / yr	189,481	375,069	368,833	483,788
Minimum diesel 75kW				
kWh of diesel energy displaced	231,611	425,508	411,219	522,939
GHG reduction in kg CO ₂ eq / yr	189,481	348,108	336,418	427,816

Attachment 15



[INAC](#) > [Environment & Natural Resources](#) > [Climate Change](#)

Large Energy Projects

**We are currently accepting energy project funding applications
for fiscal year 2010-2011.**

**The deadline for submitting applications is
Friday, October 1, 2010.**

Project Funding Criteria

1. Large Energy Projects must facilitate the engagement of Aboriginal peoples and northerners in energy-related activities, and facilitate community driven strategies for addressing the use and provision of energy. Specifically, projects must target Aboriginal and northern communities, peoples and organizations.
2. Large Energy Projects must implement renewable energy technologies for local energy generation and/or energy efficiency technologies for energy savings.
3. Proposals that include key partners (such as provincial/territorial governments, Aboriginal governments, educational institutions, professional or industrial associations, non-governmental organizations or the private sector) whose contributions are monetary or in kind will be given greater consideration for funding than proposals that do not have other identified partners.
4. Only direct costs for projects with greenhouse gas (GHG) and criteria air contaminant (CAC) emission reductions will be funded (i.e. project design, assessment, installation, etc.). Workshops, conferences and information meetings will not be funded.

Program Implementation

The *ecoENERGY for Aboriginal and Northern Communities Program* will support energy efficiency and renewable energy projects with active Aboriginal and northern community involvement that lead to concrete, quantifiable and verifiable GHG and CAC emission reductions.

Specifically, Large Energy Projects are designated as projects that have substantial GHG emissions reductions (above 4,000 tonnes over the project life cycle) and represent complex endeavours that require a range of partnerships and arrangements to implement. Some examples of projects that may be suitable for funding under the Large Energy Projects stream include: the design and installation of a heat recovery system on a diesel generating plant; technical feasibility studies for a micro-hydro project; and, negotiation of partnership agreement(s) or business planning for a new wind energy farm.

The maximum life cycle considered for GHG and CAC emission reduction calculations for Large Energy Projects is 20 years.

The maximum level of funding considered for projects is \$250,000.

Eligible Recipients

Eligible recipients for program funding are:

- Aboriginal and northern communities
- Band Councils
- Tribal Councils
- National Aboriginal organizations and other Aboriginal organizations, including professional organizations
- Aboriginal community groups (volunteer groups, community associations and institutions)

- Territorial governments and northern organizations
- Aboriginal businesses and Aboriginal industries

In most cases, funds for approved projects will be flowed through a financial transfer from the INAC national office to the INAC regional office. A regional office will then make its own arrangements to transfer funding to the funding recipient. In all cases, funding recipients will be required to complete a final report on their project.

Reporting Requirements and Conditions on Approved Projects

While specific reporting requirements may depend upon project variables such as duration and complexity, and will be outlined to funding recipients in writing once a funding arrangement is in place, requirements are generally as follows:

1. The funding recipient will report on the project's progress at least twice in the fiscal year following approval of the funds at 6 month intervals and / or upon request.
2. Prior to receiving funding, the funding recipient will estimate variables such as current (i.e., in the absence of the renewable energy or energy efficiency project) energy consumption or fuel use as well as corresponding GHG emissions and costs. As the project proceeds to implementation, variables such as power performance, energy and cost savings and actual greenhouse gas reductions resulting from the project must be estimated. All estimates must normally be accompanied by a RETScreen analysis, or demonstrated with some other suitable tool.
3. The funding recipient will recognize the contribution made by the *ecoENERGY for Aboriginal and Northern Communities Program* in communications and promotional literature associated with the project and its activities in general, where feasible.
4. A standard final report (template will be provided to all recipients) will be completed, and where feasible, recipients will supply copies of documents and reports created through the course of the project to ecoENERGY.
5. Recipients will provide either audited financial statements detailing the expenditure of ecoENERGY funds in as much detail as provided in the approved project proposal or financial report(s) with back-up documentation (e.g., receipts and invoices).

Proposal Review Process

Applicants will receive an email or telephone confirmation when their application has been received.

Large Energy Project applications will undergo a systematic review by the *Large Energy Projects Working Group*. This review process includes analyses of the technical aspects of the project, the project budget and partnerships, the economic, social and environmental benefits of the project and the likelihood that the project will succeed to implementation. Applicants may be asked follow-up questions about the application, beyond what is asked for in the proposal template, before a final decision is made whether or not to fund the project.

Applicants will be notified by email or telephone whether their project has been approved for funding or not.

Minimum Criteria for Funding

The critical accountability of the *ecoENERGY for Aboriginal and Northern Affairs Program* to the Government of Canada is the reduction of GHG and CAC emissions in Aboriginal and northern communities.

In addition, through reducing GHG and CAC emissions, the *ecoENERGY for Aboriginal and Northern Affairs Program* is focused on enhancing the sustainable development of Aboriginal and northern communities through improvements in environmental quality, economic development and social well-being.

Only projects that contain the following **minimum** criteria will be considered for funding by the *Large Energy Projects Working Group*.

1. Clear impact on the reduction of GHG and CAC emissions: A project's clear impact on GHG and CAC

emission reductions must be demonstrated through the use of the RETScreen tool the proponent.

2. Cost per tonne of GHG reductions: Projects will be evaluated in part based on their cost per tonne of GHG emission reductions. Projects will be considered if the cost per tonne is less than \$15, over the lifecycle of the project.
3. Community proponent and benefit: Agreement from the local band or community that it is supportive of the project is essential. Local community participation in the project is also required. In addition, project benefits must accrue to the community as a whole and not solely to an individual or a sub-group of the community.
4. Community champions: There must be key people in the community who demonstrate the commitment to promote, develop and implement the project, potentially in partnership with external organizations / companies.
5. Likelihood of proceeding to implementation: Projects should represent a high likelihood of proceeding to implementation.
6. Proven project approach: The project will utilize an approach that has been proven before or has a high likelihood of being effective.
7. Renewable resource availability: The resource that will be used (wind, water, solar) must be available in large enough quantities to make the project viable and sustainable.
8. Availability of technical infrastructure: Technical infrastructure must be available to the community or be included in the project design (e.g. proximity of transmission lines).
9. Awareness of permitting process: The applicant must have some awareness of environmental and other permitting processes.
10. Projects that leverage resources: Projects that have support or funding commitments from other partners (including other INAC programs, other federal departments, provincial and territorial governments, utilities, bands, local communities and / or the private sector), will be considered favourably for funding compared to those that do not.
11. Fully complete project submission template: The project proponent must fully complete the *ecoENERGY for Aboriginal and Northern Communities Program Large Energy Project Submission Template* (funding application). This template includes a description of the project, quantitative information showing the current energy situation in the community, a description of the energy technology to be employed, identification of the impact of the proposed technology, identification of the amount of GHG and CAC emission reduction impacts of the project and documentation of other social, economic and community benefits arising from the project.

Project Funding Terms

The following terms apply to Large Energy Projects:

1. Maximum percentage of project funding: The *ecoENERGY for Aboriginal and Northern Communities Program* will fund no more than 30% of the project development costs and capital costs in on-grid communities. Off-grid communities may receive up to a maximum of 50% of project costs. Ideally, projects will require less than this maximum percentage from INAC to make the project viable.
2. Maximum funding amount: Total *ecoENERGY for Aboriginal and Northern Community Program* funding for a project will not exceed \$250,000.
3. Use of *ecoENERGY for Aboriginal and Northern Communities Program* funding: Contributions can be allocated to one or more of the following types of project activities:
 - Community climate change capacity development (directly related to the project)
 - GHG emissions estimates and verification of reductions

- Project management components
 - Pre-feasibility/feasibility studies, environmental assessments, and resource analyses
 - Capital costs
 - Project implementation costs
4. Community benefits: Where funding leads to revenue, it is highly desirable that a proportion of this revenue remain in the local community.
 5. Other contributions and funding: Funding may be combined with other federal contributions as long as the total percentage of the federal contribution to the project does not exceed the requirements stipulated by other funding programs.
 6. Nature of *ecoENERGY for Aboriginal and Northern Communities Program* funding: All funding provided will be in a form of a contribution to the local community towards the total cost of the project. The precise scheduling of payments to the community will be based on the achievement of project milestones. The recipient of the funds will be required to submit verification (e.g. a receipts, invoices, etc.) showing that the funds have been properly allocated and may be subject to audit.

For more information about our large energy project funding, please contact ecoENERGIE-ecoENERGY@ainc-inac.gc.ca.

Date Modified: 2010-08-18

ecoEnergy for Aboriginal and Northern Communities

Large Energy Projects

Submission Template for Request for Contribution to Energy Efficiency and Renewable Energy Project

Project Name: (Name that is Commonly Agreed to)

Primary Proponent: (Organization/Community Submitting the Request)

Community: (Name of Community)

Region: (Province/Territory of Canada)

Project Focus: (Type of Energy Efficiency and/or Renewable Energy Focus)

Key Contact: (Name of the Person/s)

Title/Affiliation: (Title/Organization of the Key Contact)

Contact Coordinates: (Address, Phone, Fax, Email of Key Contact)

Community Head: (Name & Coordinates of Head Elected Community Leader)

References: (Local/Regional References, with Coordinates, Who are Familiar with the Project and Can Provide Background: Community Leaders/Elders, Local Utility, Community Partners, INAC Regional Office Contact)

Project Description:

- Concise Summary of the Project
- Basis for the Energy Efficiency/Renewable Energy Opportunity
- Name/Affiliation of Partners/Proponents
- Sustainable Development Benefits/Outcomes (environment, social, economic)
- Project Impact on GHG and CAC Reductions

Estimated Length: 1 Page

Project Partnership:

- Description of Primary Project Partner/Proponent
- Aboriginal or Northern Community/Communities Involved
- Nature of Partnership (alliance, joint venture, new company, etc.)

Estimated Length: ½ Page

Explanation of Current Energy Generation & Consumption Patterns:

- Profile of Energy System, Inputs/Outputs
- Quantitative (Actual or Estimated) Energy Baseline

Estimated Length: ½ Page

Planned Energy Efficiency/Renewable Energy Approach:

- Identification of Specific Generation/Consumption Opportunity to be Targeted
- Explanation of How Energy Will be Generated/Consumed More Efficiently
- Reference to Where The Approach Has Been Used Successfully Before (with contacts)

Estimated Length: ½ Page

Summary of Energy Efficiency & Renewable Technologies to be Used

- Explanation of Specific Technologies/Process/Practices to be Applied
- Explanation of How the Intervention Will Make Energy Generation/Consumption More Efficient

Estimated Length: ½ Page

Estimate of Greenhouse Gas Reductions Achieved Directly Through the Project:

- Energy & GHG Emission Assumptions
- Basic GHG Emissions Baseline (Using On-Line Tools: ie. RETScreen)
- Risks that May Jeopardize the GHG Reductions Being Achieved

Estimated Length: 1 Page

Project Budget

- Overall Budget for Proposed Project
- Budget Breakdown
- Identification of Use of Potential *INAC Clean Energy Initiative, Large Energy Projects* Contribution
- Assumptions of Budget Estimates
- Budget Rationale

Use the Budget Tables 1 and 2 found in appendix a).
Estimated Length: 1 Page

Documentation of Other Project Benefits:

- Explanation of Other Benefits (Social, Economic, Community)
- Risks that May Jeopardize Realization of these Benefits

Estimated Length: ½ Page

Submitter Comments:

- Comment, Information, and Input from the Submitter

Estimated Length: <1 Page

*Note: All submissions will be kept confidential

appendix a

Budget Table 1

**Detailed Budget Information for INAC's Clean Energy Initiative Project
Funding**

Class of Expenditures* (fill in classes as applicable)	Previous Year 2006-2007 (if applicable)	Current Year 2007-2008
1. Salaries and Wages		
2. Equipment and Facilities		
3. Travel		
4. Professional Fees (i.e. contracts)		
5. Operating Costs (i.e. supplies, publications, phone, fax, mail, administration fee)		
6. Other Costs (must specify)		
TOTAL COSTS		

NOTE: One form must be completed for each proposal submitted.

* See the attachment "Description of Each Class of Expenditure" for more detailed information.

Budget Table 2

Detailed Budget Project Information

Class of Expenditures* (fill in classes as applicable)	Previous Year 2006-2007 (if applicable)	Current Year 2007-2008
1. Recipient Support (including in-kind)		
a) Salaries		
b) Equipment and Facilities		
c) Operating Funds (in-house resources)		
2. Other Project Funding Sources (Specify as much detail as possible)		
a) Financing		
b) Investors/Partners		
c) Other		
Total Estimated Costs for Recipient Support And Other Project Funding Sources (#1 and #2 above)		
Total <i>INAC Clean Energy Initiative</i> Funding Requested (from Table 1)		
GRAND TOTAL PROJECT COSTS		

NOTE: One form must be completed for each proposal submitted.

* See the attachment "Description of Each Class of Expenditure" for more detailed information.

Description of Each Class of Expenditure

Proposals submitted to *INAC's Clean Energy Initiative* funding should include the following level of budget detail and indicate multi-year funding as applicable:

TABLE 1

1. Salaries and Wages

- This category should not include the salaries of full-time continuous or term federal employees participating in the proposed project. These salaries are A-base and are covered by the particular department whether the personnel are participating in an *INAC Clean Energy Initiative* project or in other work. Such salaries should be reported as Associated Support (Table 2).
- Legitimate entries under this category are the wages of people hired specifically for the project (i.e. non-federal employees including students and native and/or local employment). Caution should also be exercised that double counting of contracted employees does not occur.

2. Equipment and Facilities

- Equipment costs (purchase, lease, maintenance): specify the type of equipment and the extent to which it will be applied to *INAC Clean Energy Initiative* projects.
- Only equipment that is specifically purchased, leased, or developed for the particular project should be reported in this category.
- The maintenance cost of equipment already owned by the federal government and used as part of the project should be reported as Associated Support (Table 2).

3. Travel

- Includes all travel, accommodation and meals

4. Professional Fees

- Contracts: please indicate the total estimated value of each contract to be let under the project, the contractor name (if known), and purpose.

5. Operating Costs

- Includes miscellaneous operating costs (office supplies and operating expenses, phone, printing, computer time, fax, postage)
- Supplies
- Publication costs (specify name and anticipated date of issue)
- Administration fees of no greater than 15% (if applicable)

- If an “administrative fee” is levied on money coming into a department for the purpose of cost recovery for light, heat, office and laboratory supplies, communications, and administrative support, then these costs should be reported in this category. Otherwise, such costs are considered Associated Support and should be reported in Table 2.

6. Other Costs

- If any budget items do not clearly fit in any of the above classes of expenditure, please identify them here.

TABLE 2

Recipient Support

- Indicate associated contributions by the recipient (staff salaries, services, facilities and operating funds)

Other Project Funding Sources

- Indicate the estimated value, status and source of other known or potential contributions to the project - e.g. investors, partners, financing, other government departments, in-kind etc.

STRATEGIC INDUSTRIES DEVELOPMENT FUND

YUKON ECONOMIC DEVELOPMENT | INVESTYUKON.COM



The Strategic Industries Development Fund (SIDF) is designed to help support strategic development projects and the growth of Yukon's key industries.


YUKON
LARGER THAN LIFE

SIDF OBJECTIVES

The objectives of the SIDF are to:

- Identify, pursue and facilitate the development of strategic industries, projects and economic infrastructure.
- Facilitate the maximization of secondary benefits from strategic projects.
- Increase awareness of and investment in strategic industries and strategic projects.

EXPECTED PROJECT OUTCOMES INCLUDE

- Increased economic activities.
- Successful business arrangements that provide positive community economic impacts.
- Positive long-term impacts on employment and wealth creation.
- Increased private sector employment.
- More diversified economy between and within sectors.

Projects must have start and end dates that result in an outcome with broad-based economic benefits for Yukon. There are two broad categories of development projects:

STRATEGIC INDUSTRY DEVELOPMENT PROJECTS

Projects that support industry development as a whole.

For example: research that identifies and addresses barriers to industry development or identification and feasibility of needed economic infrastructure.

STRATEGIC BUSINESS DEVELOPMENT PROJECTS

Projects that have the potential to generate significant wealth and contribute to the growth of a strategic industry in Yukon.

For example: a business development which results in new products that meet market demand.

STRATEGIC PROJECT PHASES

By their nature, projects develop in stages or phases from initiation to closure. Depending on these phases, various activities will take place and can be supported over the life of the project by the SIDF. Listed below are examples of eligible and ineligible activities under the SIDF:

INITIATION – PRELIMINARY STAGE

- Research to identify emerging opportunities.
- Concept development and scoping of project.
- Pre-feasibility studies.
- Business planning.
- Economic impact analysis.
- Business scanning for secondary benefits.

DEVELOPMENT STAGE

- Marketing plans.
- Feasibility studies.
- Investment attraction.
- Financial planning.
- Development planning and project management.

IMPLEMENTATION STAGE

- Project management and implementation support.
- Operational plans.
- Organizational development.
- Updating of business plans and financial projections.
- Product testing.
- Project analysis.

CLOSURE STAGE

- Post-project analysis and support.

INELIGIBLE ACTIVITIES/COSTS MAY INCLUDE

- Activities/costs normally associated with construction.
- Purchase of capital assets.
- Leasehold improvements.
- Ongoing operation and maintenance.
- Activities/costs that are related to the owner/promoter or his/her immediate family.
- Certain administration costs.

ACCESSING THE SIDF

All proposals to the SIDF are evaluated on a merit basis. A proponent should first meet with a Business Development Advisor to review project criteria and assessment guidelines. Based on the outcome of this initial assessment, proponents may be asked to submit a more detailed proposal for further assessment.

FUNDING AMOUNTS AVAILABLE

Funding may be available for up to 50% (in certain cases up to 75%) of total project cost. Funding from the SIDF over the life of a project is up to the maximum following amounts and is subject to appropriation of funds:

- Tier I – up to \$100,000.
- Tier II – up to \$500,000.

PROPOSAL ASSESSMENT

The following is used to assess proposals for funding. More detailed information on proposal assessment is available from the Business Development Advisor.

1. Description of the project including financial commitment, partnerships and industry impact.
2. Explanation on how the project achieves one or more of the SIDF objectives.
3. Reasonableness of the funding request.
4. Likelihood of the project resulting in new employment and wealth creation.
5. Applicant is in good financial standing with the Government of Yukon.

CONTACT

Strategic Industries
Box 2703 Whitehorse, Yukon Y1A 2C6

Phone: (867) 456-3920
Fax: (867) 393-6228





August 13, 2010

Jean-François Pagé, Clerk
Standing Committee on Finance
6-14 131 Queen Street, House of Commons
Ottawa, Ontario K1A 0A6

Re: CanWEA submission for Federal 2011 Pre-Budget Consultations

Dear Mr. Pagé,

It is our pleasure to provide you with the Canadian Wind Energy Association's (CanWEA) proposal for funding under the 2011 Federal Budget. Our proposal consists of two key elements:

- Support for a \$25 million, five-year "Wind Energy Capacity Development Initiative" (WECDI) to support implementation of the government-supported, industry-led Wind Technology Roadmap.
- Support for a \$63 million, 5 year "Northern and Remote Wind Incentive Program" (NoRWIP) that spurs development of wind-diesel systems in Canada's northern industrial facilities and remote communities.

Details on these proposals are below. Please note that this submission does not include CanWEA's standing request for federal funding of a "Pan-Canadian Wind Integration Study". It is hoped that the required \$3 to \$4 million in funding for this priority initiative will be identified prior to release of the 2011 Federal Budget.

1 SUPPORT FOR A "WIND ENERGY CAPACITY DEVELOPMENT INITIATIVE" TO DRIVE RESEARCH AND CREATE JOBS IN THE CANADIAN SUPPLY & VALUE CHAIN

In 2009, the federal government released the Wind Technology Roadmap, the result of a year's work by over 100 subject experts representing government, industry and academia. The objective of the government-supported, industry-led WindTRM was "to identify key investments and actions so as to increase Canadian innovation and social and economic outcomes." The result, supported by all parties, identified opportunities in six key areas and established a path forward for Canada to fully benefit from its tremendous wind potential. The federal government has not yet identified specific funding to move the recommendations forward. **CanWEA is recommending that the federal government establish a \$25 million, 5 year "Wind Energy Capacity Development Initiative" (WECDI) to support implementation of key WindTRM recommendations. This initiative would focus on maximizing Canadian job creation and knowledge**

development for every MW of installed wind in Canada. It would do this by encouraging capacity building both in Canadian industries through supply and value chain development, and through Canadian university and college research and development initiatives.

1.1 Program Focus

WECDI would focus on the areas of the WindTRM that involve wind technology innovation and Canadian wind industry development support. Both are critical to efforts aimed at job creation and capacity-building, and both represent areas that are currently under-funded relative to other energy technologies and to other countries' wind development programs. The specific priorities identified in the WindTRM are to:

- **Drive Supply Chain Development.** The WindTRM identified a need to facilitate partnerships and encourage Canadian sourcing of materials, components and services. In this area, WECDI will work with industrial partners on initiatives to develop their capacity and increase their competitiveness, both in Canada and in international markets.
- **Create Centres of Excellence.** The WindTRM identified the opportunity to create Centres of Excellence in three key areas: Wind Resource and Energy Yield Assessment, Advanced Operation and Transmission Planning Methodologies, and Ancillary Services: Wind Integration and Wind Firming Technology. These Centres of Excellence would build on the excellent academia-industry foundation established by the Wind Energy Strategic Network (WESNet) which will see its funding lapse in 2013.
- **Accelerate Development of Small Wind Technology.** The WindTRM identified a tremendous opportunity for Canada to take a leadership role in the still-emerging field of small wind, with a particular focus on mid-sized turbines and remote applications. Actions under this area would serve to improve system performance and reliability and to reduce life cycle costs. This would build on work being undertaken by both the Wind Energy Institute of Canada (WEICan) and TechnoCentre éolien.

Note that the WindTRM also identified a need for funding of demonstration projects that showcase technologies targeted in the areas described above. It is expected that funding for such projects would be allocated in subsequent years once the three areas above have been initiated and are ready to field demonstration projects.

1.2 Funding

CanWEA is recommending that the federal government establish WECDI through a fund of \$25 million per year spread over a five-year period. This would increase the federal government's average annual expenditures on wind R&D from \$2.5 million per year to \$7.5 million per year¹. This would bring Canadian wind R&D expenditures up to an equivalent

¹ Current annual wind-specific federal funding includes \$500K for the Program for Energy Research and Development, \$1 million for ecoEnergy Technology Initiative and \$1 million for the Wind Energy Strategic Network (provided through NSERC)

per capita spending level as the United States, where expenditures on wind R&D amount to \$US 79 million per year.²

The recommended allocation is as follows (in \$CAD million, undiscounted):

	2011	2012	2013	2014	2015	Total
Drive Supply Chain Development	2.0	2.0	2.0	2.0	-	8.0
Create Centres of Excellence						
<i>Wind Resource and Energy Yield Assessment</i>	0.6	0.6	0.6	0.6	0.6	3.0
<i>Advanced Operation and Tx Planning Methodologies</i>	0.6	0.6	0.6	0.6	0.6	3.0
<i>Ancillary Services: Wind Integration and Wind Firming Technology</i>	0.6	0.6	0.6	0.6	0.6	3.0
Accelerate Development of Small Wind Technology	1.0	2.0	2.0	2.0	1.0	8.0
Total (\$ millions)	4.8	5.8	5.8	5.8	2.8	25.0

1.3 Benefits

The following benefits would be realized through implementation of WECDI:

- **Job creation in the Canadian supply and value chain.** WECDI would help to ensure that a larger proportion of jobs stay in Canada as a result of wind energy development. If Canada reaches 12,000 MW of installed capacity by 2015, at least 8,000 new jobs would be added, spurred in large part by WECDI.
- **Knowledge development in academia and industry.** The WESNet program has shown how federal funding can increase wind R&D and drive associated capacity development within both universities and their industry partners. In this area, it is expected that WECDI would significantly increase the number of individuals specializing in wind each year, in both universities and academia.
- **Increased investment in Canadian wind industry.** It is expected that WECDI would help to drive up the proportion of investment in Canadian wind farms that stays in Canada (currently estimated at an average of 30%). This would provide a strong signal of the federal government's intention to drive investment in Canada for both existing domestic supply chain industries and new entrants.

2 SUPPORTING WIND ENERGY DEPLOYMENT IN NORTHERN INDUSTRIES AND REMOTE COMMUNITIES

Canada has many northern industrial facilities and roughly 300 northern and remote communities, including aboriginal communities with a total population of about 200,000 people. These areas are isolated from the national grid and typically draw their electricity from diesel generator sets that are expensive, cause a great deal of pollution (local air contaminants and greenhouse gases), and bring few economic or capacity-development benefits to the community. **Medium-sized wind turbines and wind-diesel hybrids are proven, cost-effective alternatives in many of these situations. CanWEA is proposing**

² Fiscal Year 2010 Wind Power Program Budget, <http://www1.eere.energy.gov/windandhydro/budget.html>

that the federal government provide \$63 million for capital grants that would support the deployment of 6 wind projects in northern industrial facilities and 20 wind projects in remote communities. These projects would have a total capacity of 47 MW and would meet roughly 8% of all electricity demand in northern mines and remote communities, thereby eliminating the need for over 500 million litres of expensive imported diesel fuel over the life of these projects. This investment would sufficiently cover the “cost gap” between wind and incumbent diesel generation, thereby driving northern utilities and industrial facility operators to make the significant investments necessary to move to wind and wind-diesel systems.³ Wind development in the north would also provide significant economic benefits to Canada’s mid-size wind turbine manufacturers who supply the technology best-suited to these applications (Canada is home to more than half of the world’s manufacturers building turbines in the 30 to 100 kW range). While these manufacturers still maintain a significant market share in this range, a lack of a domestic market has started to erode their dominance.

2.1 Program Focus

The **Northern and Remote Wind Incentive Program (NoRWIP)** would focus on two categories for wind power development:

Category 1: Large northern industrial facilities and communities. This category includes large communities with an average electrical load of 2 MW or higher (such as Iqaluit and Yellowknife) as well as northern industrial facilities (such as the Diavik and Ekati diamond mines). For this category NoRWIP would provide

- A contribution of \$250,000 on completion of feasibility studies to specified standards;
- A capital contribution of up to \$1,000 per kW or 20% of project budget, whichever is less. This contribution should be made in two portions: the first payment would be 50% of the amount specified above at the time a firm order for wind turbines is placed; the second payment would be made on commissioning of the project and 90% or more of the actual project costs confirmed.

Category 2: Small remote communities. This category includes all small remote communities that are accessible either seasonally or year-round by air, water, or road but are not connected to larger provincial or territorial power grids. For this category NoRWIP would provide:

- Contribution of \$250,000 on completion of a feasibility study to specified standards.
- Capital contribution of up to \$4,000 per kW or 30% of project budget, whichever is less. This contribution will be made in two portions: the first payment will be 50% of the amount specified above at the time a firm order for wind turbines is placed; the second payment would be made on commissioning of the project and 90% or more of the actual project costs confirmed.

³ In many cases, utilities and industrial facility operators with already-amortized diesel generation assets are only willing to pay the cost of avoided diesel consumption when considering new generation technologies. This presents a challenge for any technology that requires new investment. The proposed NoRWIP funding levels are intended to overcome this gap between wind and incumbent diesel systems.

2.2 Funding

The overall proposed budget for NoRWIP is \$63 million, including \$36 million for large communities and industrial facilities, and \$27 million for small remote communities. The table below provides an overview of the proposed funding schedule over five years for NoRWIP (including both feasibility studies and capital grants):

	Category 1 Projects			Category 2 Projects			Totals
Year	Projects started	MW capacity	Amount	Projects started	MW capacity	Amount	Amount
1	1	5	\$250,000	4	1.4	\$1,000,000	\$1,250,000
2	2	15	\$2,500,000	6	2.1	\$3,230,000	\$5,730,000
3	3	20	\$9,250,000	10	3.5	\$7,825,000	\$17,075,000
4	0		\$15,000,000	0	0	\$8,420,000	\$23,420,000
5	0		\$9,000,000	0	0	\$6,825,000	\$15,825,000
Program totals	6	40	\$36,000,000	20	7	\$27,300,000	\$63,300,000

Assumes that there are 2 projects of 10 MW each, 4 projects of 5 MW each (Category 1) and 20 projects of 300 kW average size (Category 2)

2.3 Benefits

A Northern and Remote Wind Incentive Program would provide the following benefits:

- 26 new wind energy projects (47 MW of capacity) in northern mining, remote and Aboriginal communities;
- \$500 million dollars in total diesel fuel savings in participating communities and industrial facilities over the life of these projects;
- 80 kilotonnes of CO₂e emission reductions per year, equivalent to taking more than 26,000 cars off the road;
- Building and strengthening Canada's competitive advantage in mid-range wind turbine technologies and development of wind-diesel hybrid systems;
- Capacity building on wind and wind-diesel technologies, particularly in northern industrial facilities and Aboriginal communities.

Please do not hesitate to contact me if you have any questions regarding this submission.

Sincerely,



Sean Whittaker
Vice President, Policy

