

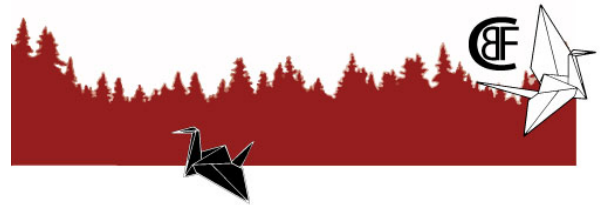
F & B Consulting | Resiliency & Antifragility

Florian Boulais & Katrine Frese

Box 31289 | Whitehorse, YT | Y1A 5P7

info@fb-consulting.ca | (867) 993-3831

fb-consulting.ca



Cover Letter

My name is Florian Boulais. I am the cofounder of F & B Consulting. Katrine Frese and myself are long time Yukoners. We both grew up in Europe and come from very varied backgrounds. Katrine has a Phd in Geology, worked in the field of re-insurance in Switzerland (insuring insurances) in risk assessment and management, worked as YESAB office manager and has developed and has been teaching Yukon U's Climate Change Policy Certificate. On my end, I have a background in engineering with specialisation in computers, electronics, laser technologies (including high power laser and fiber optics). I worked as a licenced jet engine mechanic. I have dedicated myself to a more resilient Yukon for the last 20 years through my investment in business and non-profits.

We have started F & B Consulting at the beginning of 2021 because we felt that there is much to be improved for the Yukon to become resilient and that we had useful insights to share on that subject.

Electricity has become the most fundamental need we have as modern citizen; without it, nothing else works. After approaching Yukon Energy directedly (Michael Brandt, vice president amongst others) and not being able to properly convey the depth of our thought regarding electric grid resiliency, we chose to engage with the utility board.

We hope that the Utility board will find the submission useful.

We remain at your disposition for questions.

Florian Boulais



Yukon Energy Corporation General Rate Application Submission

Yukon Energy, as a business at arm's length from the Yukon government, has the ethical responsibility to educate Yukon Energy's customers that rely on the grid about its qualities and shortcomings. *Yukon Energy's Mission is to enable Yukon's prosperity with sustainable, cost-effective and reliable electricity.* Reliability is the ability to avoid short term power interruptions. Yukon Energy's mission does not include resilience. Resilience is the ability to avoid long and potentially catastrophic power outages.

"Legally, a manufacturer has a duty to warn when it knows or should know of a product's hazards. Manufacturers that fail to meet this duty can be judged negligent. Thus, when considered from a legal perspective, manufacturers are held to a high standard - that of an expert in understanding and anticipating risks."

- *Handbook of Warnings*, Michael S. Wogalter, 2006, p.620.

The question we ask is: **"How much prosperity do Yukoners need before we think about resilience?"**

1 Purpose

For the purpose of this paper, F & B Consulting performed a high-level systems analysis of the reliability of Yukon's electric grid. Based on the results of this [systemic analysis](#), the paper will present how to enhance grid resilience and focus on resource allocation supported by potential rate raises.

(<https://embed.kumu.io/8ee45449fe7903f19a09d3d166788de0>)

Currently, Yukon's grid is faced with the following Top 3 issues contributing to its fragility:

- Increasing complexity of the grid
- Rapidly shifting demand and lack of capacity
- Reliance on global supply chains

2 Outline and objectives

The core of this submission is structured as follows:

- Context
 - Defining resilience in the context of electric energy production
 - Yukon context with regards to electric energy
- Results: Systemic analysis of why electric resiliency matters and why it is not given more attention
- Discussion of how the global systemic interactions affect the Yukon grid and population
- Recommendations
- Definitions and references

3 Outcomes

It is unequivocal that Yukon Energy needs to improve its resiliency.

After the Utility Board's consideration of the paper, a next step and outcome would be a conversation between the Board and Yukon Energy and other stakeholders, e.g. Atco, about increasing the cost of electricity and educating the public in order to:

- create paid positions at Yukon Energy and Atco with the purpose of increasing Yukon Energy's and Yukoners resiliency
- to inform the public that ultimately, Yukon Energy cannot guarantee that electric power will remain on. Yukon Energy has a responsibility to effectively convey this message to the public in order to activate individual agency and resilience

4 Context

4.1 Resilience in the context of electric energy production

"Reliability assumes blue skies. Resilience is the ability to take a punch," says Scott Aaronson of the Edison Electric Institute (The National Academies Press, *Communications, Cyber Resilience, and the Future of the U.S. Electric Power System: Proceedings of a Workshop*, (2020), p.4 <https://www.nap.edu/download/25782>)

Resiliency in the context of electric production is best understood when compared to reliability: reliability is the ability of the Yukon Energy/Atco to avoid frequent short interruptions of the electric supply. Resiliency is the ability of Yukon Energy/Atco to avoid an extended and catastrophic interruptions of the power supply.

4.2 Yukon context with regards to electric energy

- The Yukon grid is independent, with smaller sub grids which is good for its overall resilience
- With the introduction of governmental incentives to use electric heating and the increasing reliance on electrically controlled heating appliances, the great majority of houses require electricity in order to generate heat, cook and have access to water
- Difficulty to rapidly replace crucial staff as the Yukon does not attract enough technicians
- Ageing infrastructure
- Long stretches of extremely cold temperatures. An extended power interruption in winter will lead to major material damage and might lead to death of people
- Difficulty to predict the required load required due to rapid changes in population and industry needs
- Electric supply lines are extremely long making them more susceptible to natural and human generated geomagnetic variations

5 Results: Systemic analysis of why electric resiliency matters and why it is not given more attention

Click [here](#) in order to access the preliminary interactive systemic map. We're pleased to provide an opportunity to present this map and answer any questions you might have.

(<https://embed.kumu.io/8ee45449fe7903f19a09d3d166788de0>)

When using the map, select the item you would like to look at and the description will appear on the left pane.

5.1 Narrative

The map is made of 3 feedback loops:

- Illusion of safety loop
- Resilience loop
- "I don't believe you cluster"

The "Illusion of safety loop" shows how the relationship between the customers, politicians and Yukon Energy creates an electric utility whose main focus is efficiency and reliability. The customer measures his/her satisfaction about Yukon Energy in 2 ways: through the quality of the power they use and their bill. Their feedback goes back to Yukon Energy through political pressure to offer the most reliable and cost-effective product possible.

The "Resilience loop" is most interesting because of its current low influence. In the lay persons eye, reliability and resiliency are the same thing giving the customer the illusion of safety and therefore disabling his/her agency. When wanting to achieve more resilience, the standard cost benefit analysis does not function to address unpredictable Black Swan type events. With resilience, the return on investment is either delayed or not obvious in the case of an event that was avoided all together. As well, we observe that resilience is coming at the cost of lower efficiency and lower reliability making it unpopular with the customers e.g. using technologies that are less effective at managing the grid but more robust to deter cyber hacking

The "I don't believe you cluster" is made of all the systemic traps and cognitive biases that hinder resiliency in its ability to gain traction. Humans come with tremendous evolutionary baggage: Wikipedia suggests there is close to 200 cognitive biases that affects our ability to understand a situation correctly (https://en.wikipedia.org/wiki/List_of_cognitive_biases). Typically, a cognitive bias is a heuristic - rule of thumb - evolution has found to circumvent information overload. For example, Magnitude Overload describes the difficulty a leader has to take appropriate action when faced with a potentially devastating event. This can lead to 2 outcomes: inability to properly magnify their feelings of dread or empathy for disasters predicted to have massive loss or to completely abdicate which then leads to the ostrich effect and to ignoring the issue altogether. System traps

such as Agenda Inertia lead to inaction because of devotion to an established agenda in order to “get things done”.

5.2 Observations:

We found that in the current systems map - this document will be evolving - public education holds a key role. If Yukon Energy increases its rates, it will have resources available to increase its resiliency but ultimately, in order for the public to support higher rates, to have political support, and to activate peoples own agency to become more resilient, public education regarding the massive disruptions coming down the road needs to be effective. In this age of information overload, more than ever, change is triggered when an issue becomes the center of our collective attention. Effective communication of the urgency of the situation needs to be achieved for our highest collective good.

6 Discussion: How the global systemic interactions affect the Yukon grid and population

Our systems analysis identified 9 specific interactions between global systems and the Yukon grid. Each of these interactions merit further consideration. Should the board have issues with any of the subsequent items, we invite the board to dismiss it. That being said, it takes only one of those items to be true in order to convey the unprecedented nature of our time, globally, with its repercussions in the Yukon. The underlying dynamic of all those items are reinforcing feedback loops that are self-terminating by nature and are therefore going to create major disruptions in the near future.

One of the reasons we think the following items are important and lack consideration is because, again, they cannot be analyzed with the popular cost-benefit analysis. The following items focus on a synthesis of known dynamics, feedback loops and relationships rather than on the elements they are made up of.

1. Almost all the natural resources the global economic and industrial systems are using have reached their peak production (oil, steel, rare earth metals,...) and are now declining suggesting a drastic increase in production costs and decrease in supplies availability in the near future. This points towards increased maintenance and development costs. *Increased electricity costs would allow creating redundancy, optionality and replacement of old infrastructure in order to weather the effects of shortages and increase in cost in the future.*
2. The unprecedented increase of money in circulation in the global economy due to government backed quantitative easing (money printing) to overcome the economic repercussions of COVID we will see (and are already seeing) a substantial increase in resource costs. Canada with its massive financial support packages has increased its GDP to

- debt ratio by 80% - the biggest increase in the world. *It would not be healthy for Yukon Energy to be locked in a low rate that cannot accommodate for increased operational costs.*
3. As climate change and the repercussions of COVID and other coming disruptions break the promise of a future where every global citizen will have access to the fruit of the industrial age, polarization and geopolitical tensions will reach levels that have not been seen in a long time and for the first time in history, on a global scale. This will drastically increase the odds of disruptions of supply chains as well as an increase of cost of resources and goods. *Hardening, redundancy and optionality acquired will help accommodate for future disruptions.*
 4. Exponentially powerful technologies are increasingly available to state and non-state actors. A young rebel in the middle east can purchase software on the dark web and learn within 3 months how to break into a utility's OT(Operational Technology) with the purpose of extracting money¹. An angry university student is in a position to design a deadly virus in his basement using the now widely available gene drive CRISPR technology². One might weaponize a consumer drone to create massive damage to fuel tanks and surrounding infrastructure³. *Increased rates would help Yukon Energy mobilize necessary resources to prevent and inform the public of the possibility of such event to happen.*
 5. Computer power is increasing at a speed that is faster than we can make sense of. Algorithms have now independent agency to learn and develop. As the complexity of the electric grid increases its vulnerability to technological disruptions is increasing at an exponential rate⁴. The illusion of being sheltered in the Yukon further increases the risk cyber-hacking. The Internet opens users to global potential but as well, to global threats. As outlandish as such threats seem, every expert in the field agrees that there is not nearly enough done by utilities to prevent such events. *Yukon Energy should have a hacker expert whose sole purpose would be to try to hack his way into Yukon Energy's IT and OT (Operational Technology) since weak points will likely not be obvious to outsiders contracted to assess Yukon Energy's systems and staff behaviors. Weak points can then be fixed.*
 6. Climate change is a systemic issue - as long as the economic incentive structure favors harvesting trees or whales over having them as a part of a functioning ecosystem, we will keep destroying the thin green layer that protects life on earth from the incredible harshness of the cosmos with increasingly devastating consequences. A dynamic system inherently resists change. The change in the incentive structures (or economic system) required in order to address climate change is so profound that the current economic model will likely have to collapse before anything changes. This will likely happen in the next couple of decades with devastating consequences and again, disruptions to the global supply chains. Based on General System Theory when a system has become mature - like the global economy - it is highly efficient and interconnected. On the other hand, it has become rigid and unable to adapt (Rigidity Trap)⁵. The global economic system cannot adapt to climate change as it has become too rigid to adapt and unwilling to engage in creative destruction to make room for a new and more adapted economic system to emerge. From a systemic perspective, the next unavoidable event is an event that will trigger a chain reaction which will abruptly dissolve the current global economic system for a new, more adapted, system to emerge. This is always a difficult transition. The dissolution of the old system is typically quite fast and the new system very slow to emerge⁶. Redundancy and optionality will, again, help prevent the massive disruptions that an emerging new economic system will trigger. *Again, a rate increase and public education will help weather the effects of these disruptions down the road.*

7. US Nasa scientists have calculated a 10% chance in the next 10 years of a major solar event of the size of the Carrington event that occurred about 100 years ago. Electromagnetic disruptions of this kind can be weathered with a minimal investment allowing the hardening of the grid.⁷ *Raising rates would allow to take steps to have preventions systems in place that will help weather such an event would have devastating consequences if no preparation has been done.*
8. In Canada, with the 4-year election cycle, long term planning is difficult at best, as a lot of energy is wasted by the parties in ineffective conflict and trying to remain in power. China with its autocratic model is able to plan 30 years ahead. Autocracy is not a solution but neither is the current model with its 4-year election cycle as it cannot address the profound systemic issues that require long term planning and consistent effort. *Again, a rate increase and public education will help weather the effects of these disruptions.*
9. Perhaps the most challenging aspects of our current situation is that we find ourselves in perhaps the thickest fog we've ever collectively encountered. This is largely due to the acceleration of technological development and our increasing inability to individually and collectively make sense of our world. As Daniel Schmachtenberger puts it: "We are running in the forest increasingly fast, increasingly blind." *As a general response to this dynamic, increased self-reliance for Yukon Energy, the Yukon and its citizens is a must.*

7 Recommendations

The Opportunity of Increasing the Cost of Electricity

In light of the findings of our systems analysis, raising electricity cost to the customers is an opportunity to:

- build financial capacity to tackle the challenge of ongoing public education (e.g. have a flyer with the bill every month)
- hire experts for cyber security
- create redundant and optional infrastructure
- renew aging infrastructure faster
- expand infrastructure faster
- hire experts to harden the grid to electromagnetic disruptions
- help make sure customers are conscious of saving energy (Jevin's paradox (1965): more effective production and cheaper cost lead to higher demand)

Investing in Public Education

Ongoing public education about the increasing difficulty of providing reliable, resilient, green electricity would:

- create public and political support for resiliency
- create public and political support for increased electricity rates
- help start a conversation about climate change and repercussions and adaptations

- most importantly, being informed that Yukon Energy cannot guarantee that the power will always be on, will remove the illusion of safety and allow electric users to make alternate plans in case of a long power outage

8 Definitions

8.1 Systems Thinking

Systems Theory: Principles, models, and laws that apply to complex interrelationships and interdependencies of sets of linked components which form a functioning whole, a system. Any system may be composed of components which are systems in their own right (sub-systems), such as several organs within an individual organism. (Harvard Education - <https://connects.catalyst.harvard.edu/Profiles/display/Concept/Systems%20Theory>)

Systems thinking is the ability or skill to perform problem solving in [complex systems](#). In application it has been defined as both a skill and an awareness. A system is an entity with interrelated and interdependent parts; it is defined by its boundaries and is more than the sum of its parts (subsystem). Changing one part of the system affects other parts and the whole system, with predictable patterns of behavior. Furthermore, the individuals working as part of a system are components as well, therefore contributing to its outcome (Wikipedia - https://en.wikipedia.org/wiki/Systems_theory)

Systems map is the result of a group process to address complex and persistent issues in a complex system. By focusing on feedback loops and an integration of the collective understanding of the system's behaviour, a pragmatic systems map is created that will allow the discovery of unexpected levers that will change the behaviour of the system as a whole. *Using systems thinking in complex problem solving helps avoid the typical traps such as the assumption that a problem is linear, obvious and easy to fix. Complex issues are dynamic, interconnected and rarely obvious.*

8.2 Key terms related to systems map

Cassandra Syndrome: The Cassandra metaphor relates to a person whose valid warnings or concerns are disbelieved by others. The Cassandra Syndrome is triggered by predictable parameters related to human cognitive biases or systemic traps.

Systemic trap: Is a self-perpetuating feedback loop that affects the behavior of a system in an unhealthy way.

Complexity mismatch (systemic trap): Happens when a complex issue is explained by an expert to a leader and is not being conveyed effectively due to a lack of deep understanding and background of the leader.

Black Swan event: Unpredictable or very low probability events with high severity consequences. This term was coined by the mathematical statistician Nassim Nicholas Taleb and refers to statistical outliers. Traditional cost benefit analysis does not apply in the territory of Black Swan events as most of those events have never happened before or have not been seen in living memory. On the other hand, when

these events occur, the consequences are of such magnitude that crucial utilities need to build sizeable amounts redundancy and reserves in order to have the resiliency to weather such an event when it happens, and it always does. *In essence, it is not possible to calculate the likelihood of a Black Swan event. On the other hand, it is easy to measure the fragility of a system and what to do to remove it.*

Reliance on erroneous consensus (cognitive bias and systemic trap): Process by which one relies on consensus about a scientific subject to assess the validity of a claim: if everybody agrees, no reason to question a theory. Reliance on consensus science is a good heuristic but it is often forgotten that it only takes one occurrence to disprove a theory. As a consequence, emergent high impact events fall through the cracks of what is deemed worthy of attention as there is often little or no science to back up their existence. Sometimes the event has never been seen before, or at least not in the modern context or in the Yukon (Cyber threats, Carington type solar coronal mass ejection, supply chain breakdown,...)

Recency bias: A cognitive bias that favors recent events over historic ones. A memory bias, recency bias gives "greater importance to the most recent event", such as the final lawyer's closing argument a jury hears before being dismissed to deliberate. (Wikipedia)

Consumer self-agency: Ability of an individual to come up with their own solutions and applying them. In order for a person to activate their agency, they need to understand that there is a problem and a clear understanding of it. Within the frame of the systemic analysis, consumer self-agency is the key to societal resiliency. Top-down resilience is limited in its reach. On the other hand, when every person is informed and empowered, a much more effective form of resiliency occurs: emergent resiliency. Just like in the human body: every cell has a high degree of agency which makes the human body incredibly resilient.

8.3 References

- ¹ BNN Bloomberg, U.S. *Unveils Plan to Protect Power Grid from Foreign Hacker* (2021) <https://www.bnnbloomberg.ca/u-s-unveils-plan-to-protect-power-grid-from-foreign-hackers-1.1592737>
- ² Risk Bites, *What is a gene drive* (2015) <https://youtu.be/KgvhUPiDdq8>
- ³ Wired Magazine, *Why the US government is terrified by hobbyist drones* (2015) <https://www.wired.com/2015/02/white-house-drone/>
- ⁴ The National Academies Press, *Communications, Cyber Resilience, and the Future of the U.S. Electric Power System: Proceedings of a Workshop*, (2020), p.4 <https://www.nap.edu/download/25782>
- ⁵ Systems Innovation, *The adaptive cycle* (2019) <https://youtu.be/jkp5tNGPI6M>
- ⁶ Science Direct, *The adaptive cycle, more than a metaphor* (2019) <https://doi.org/10.1016/j.ecocom.2019.100767>
- ⁷ The National Academies Press, *Enhancing the Resilience of the Nation's Electricity System* (2017) <https://www.nap.edu/download/24836>

