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Implementation of Wind Energy Projects in the Autonomous Networks and their Coupling With Diesel Powered Generators: Barriers, Solutions and Elements for a Roadmap to Success

Expert report of

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Prepared for:
Regroupement des Organismes Environnementaux en Énergie (ROEÉ)

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I. INTRODUCTION AND QUALIFICATIONS

Q: Please state your name and provide details of your education and professional qualifications

A: My name is Tim Weis. I am a professional engineer, registered with the Association of Professional Engineers and Geoscientists of Alberta, and currently the Alberta Regional Director at the Canadian Wind Energy Association (CanWEA), where I work on public policy, research and advocacy activities for Alberta's wind energy industry.

I have worked for over a decade in renewable energy technical research and policy design and have written numerous publications on technical and policy issues facing renewable energy development in Canada at national, provincial and municipal levels. I have worked directly with over 20 communities at various stages of development of renewable energy projects and have also worked as a renewable energy consultant examining wind energy challenges in the Yukon and the Northwest Territories.

Prior to joining CanWEA, I worked for over 11 years with the Pembina Institute, a sustainable energy policy think-tank where my last position was as the Director the Renewable Energy and Energy Efficiency program.

I have a Ph.D. (Université du Québec à Rimouski) in environmental sciences (sciences de l'environnement), where my thesis was focused on wind energy development in remote communities, including technical and policy challenges. I also have an M.Sc. (University of Alberta) and a B.A.Sc. (University of Waterloo), both in mechanical engineering.

Q: Have you previously testified as an expert in matters before the Quebec Régie de l'énergie

A: Yes.

2005: http://www.regie-energie.qc.ca/audiences/3550-04/Memoires3550/RNCREQ_GaspeWindStudy_3550_25mai05.pdf

2006: http://www.regie-energie.qc.ca/audiences/3595-06/APLNQL3595/B-19-APNQL_RappExpert-Weis_3595_28aout06.pdf

2007: http://www.regie-energie.qc.ca/audiences/3648-07/MemoiresInterv3648/C-13-5-ROEE-RNCREQ_RapportExp_3648_28mar08.pdf

Q: Do you have other direct experience in Quebec?

A: My PhD is from the Université du Quebec à Rimouski. My doctoral research focused more broadly on remote communities across Canada and my thesis is titled: "Renewable North: Policy Considerations for Wind-Diesel Systems in Remote Canada". I have not worked directly on renewable energy projects with remote or off grid communities in Quebec.

II. TESTIMONY

Q: What is the purpose of the testimony?

A: The purpose of my testimony is to submit an independent expert opinion on the progress of wind energy projects in Quebec's isolated communities. This overview will provide context for what other jurisdictions are doing with respect to renewable energy in remote communities in order to assist the Board with the verification of the adequacy of Hydro-Quebec's work to date and will assist the Board in developing a roadmap for the implementation of these systems.

Q: Is this testimony on behalf of CanWEA?

A: No. I am now employed by CanWEA, but I was engaged to do this work before I moved from the Pembina Institute to CanWEA. My work for CanWEA focuses on utility-scale, grid-connected wind energy. This testimony is not made on behalf of CanWEA and does not present CanWEA's official position. This expert report and testimony was done on my own time as an independent researcher who has spent years looking at and working with remote communities on renewable energy options.

III. PRELIMINARY REMARKS

Q: Can you please provide the Régie with an overview of your findings with respect to approach and progress of Hydro-Québec in the implementation of wind-diesel?

A: Hydro-Quebec was an early leader and pioneer in examining wind-diesel research[1], and installed one of Canada's first wind-diesel pilot projects in Kuujjuaq in 1986.

However, Hydro-Quebec, like the rest of Canada, has subsequently fallen behind the global pace to develop wind-diesel (and other renewable-hybrid) systems in remote locations. As an example, Alaska has 25 wind-diesel projects operating, and an additional 11 projects under development/construction[2]. Wind-diesel systems are operating around the world from Antarctica[3], to Greece[4], to Australia[5] to the Carribean[6].

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[1] R. Gagnon, A. Nouaili, Y. Jean, P. Viarouge; «Mise à jour des outils de modélisation et de simulation du Jumelage Éolien-Diesel à Haute Pénétration Sans Stockage et rédaction du devis de fabrication de la charge de lissage», Rapport IREQ-97-124-C, 1997.

[2] Renewable Energy Alaska Project (REAP) http://alaskarenewableenergy.org/why-renewable-energy-is-important/alaskas-renewable-energy-projects/

[3] http://www.antarctica.gov.au/living-and-working/stations/mawson/living/electrical-energy

[4] http://renknownet2.iwes.fraunhofer.de/pages/wind_energy/data/2003Kassel_engler_ppc.pdf

[5] https://www.ergon.com.au/community--and--our-network/network-projects/renewable-energy-sources#content-id-4977

Recent efforts to develop wind-diesel systems in in Cap-Aux Meules and Kangiqsuallujjuaq are both positive steps towards developing projects, however these efforts are considerably behind the pace of other developed (and many developing) countries, as well as the original pace of development expected in Quebec. Wind-diesel projects were expected to be put in service in Nunavik for 2008[7].

Additionally, Hydro-Quebec has not updated its 2008 expert report on wind-diesel energy for the Nunavik and Îles-de-la-Madeleine, which was expected by November 1st, 2012[8]. While the progress on pilot projects has been slower than hoped, this should not be a barrier to further developing a strategic development plan or road map.

An important first step in such an effort should be to begin community engagement on potential project development. It has been found in Alaska that wind-diesel projects have tended to be more successful when the local community is engaged and supportive[9]. Although Hydro-Québec certainly refers to the value and necessity of close collaboration with Aboriginal communities, my review of the evidence in this case does not, in my view, reflect a significant degree of community engagement, particularly with respect to local ownership or development opportunities.

A strategic development plan or road map can also help to develop human capacity and expertise in the remote communities. This could help to reduce construction and maintenance costs associated with flying skilled labor in from southern Quebec. It will also maximize the local and regional economic benefits where the projects are developed.

Such a road map would be aided by the development of long-term energy sustainability targets for Quebec remote communities. Such targets and regional planning considerations would help inform development decisions beyond the narrow scope of short-term economic viability in any one community in particular. More concretely, in my view the pilot and individual site based approach taken to date by Hydro-Québec for the development of wind-diesel, apparently accepted to date by the Régie, can ultimately become an impediment to moving more broadly towards sustainable options. While developing demonstration projects is a useful step to work out development and technical challenges, pilot projects can, and often have become ends unto themselves in Canada's history of wind-diesel project development. What is required is the establishment of clear, broader energy sustainability targets to guide development of wind-diesel and metrics against which progressed can be measured, to ensure pilot projects do not become the end result.

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[6]http://www.mottmac.ie/sectors/power_generation_diesel_engine_combined_cycle_gas_turbine_open_cycle_gas_turbine_waste_to_energy_combined_heat_and_power/power_generation_diesel_engine_combined_cycle_gas_turbine_open_cycle_gas_turbine_waste_to_energy_combined_heat_and_power/dieselpower_generation/

[7] Decision D-2011-162, par. 354, file R-3748-2010

[8] D-2013-183 par 30

[9] Ginny Fay and Nataliya Udovyk (2011) Factors Influencing Success of Wind-Diesel Hybrid Systems in Remote Alaska Communities:Results of an Informal Survey, http://www.iser.uaa.alaska.edu/Publications/2011_10_05-3factorsuccesswindsystems_.pdf

A related issue is that focussing on economic and technical feasibility of one or two pilot projects is inherently a cautious or risk averse approach. The one-step-at-a-time method fails to capture the benefits of a more general and multi-community commitment to development of wind-diesel projects. Notably, mobilization of engineering, transportation, supply, equipment and construction and electrical system crews for several projects at once would in my view result in significant economies of scale and logistical benefits. Perhaps equally importantly, it would also capture the imagination and energies of the communities involved and of Hydro-Québec in a way which makes commitment and success much more likely.

There is also an inherent fallacy built in to the more cautious, pilot project to measure economic and technical feasibility approach. Specifically, it assumes that there are no economic, environmental, development and social costs and risks associated with the continued use (and further expansion) of diesel alone. This assumption is unlikely to be true and beyond a measure of avoided costs.

The Northwest Territories provides an example of a more broadly-conceived approach to wind project development going beyond only technical and economic factors. Four off grid communities in the Innuvialuit Settlement Region (in the Mackenzie Delta and on the shores of the Beaufort Sea) decided to pursue a demonstration project in Tuktoyaktuk, despite it having the poorest wind regime[10]. Tuktoyaktuk however was deemed to have the best human capacity to service the demonstration project, as well as the potential to service future projects in surrounding communities. While the Tuktoyaktuk project never materialized due to a lack of support from the federal government (note the Northwest Territories has a total population of just over 44,000 people, compared to over 8 million in Quebec, both have roughly the same number of remote communities), it is a model worth exploring.

Q: Can you please briefly indicate to the Régie your general views on the environmental and cost implications of the reduction of the use of diesel in the autonomous networks through development of wind-diesel systems?

Diesel generators are commonplace in remote communities across Canada (and around the world) as they are a well-known technology, can start and stop quickly to respond to load, and can operate across a wide range of service demands. In spite of these advantages, diesel systems present notable challenges for remote communities.

The challenges of relying in diesel for the long-term include limitations on community growth, air pollution, risks of fuel spills and soil remediation. These are typically not factored into the current prices of energy. Importing fuel also creates a long-term dependency on resources from outside of the communities.

n addition to the clear environmental benefits, wind-diesel systems are becoming increasingly attractive in economic terms. Alaska has been an early leader in developing wind-diesel systems to reduce diesel consumption in its remote

[10] Proceedings report, Remote Communities Wind Energy Conference, Tuktoyaktuk 2007. http://www.enr.gov.nt.ca/sites/default/files/reports/wind_energy_conference_proceedings_report_march_2008.pdf, page 19

communities. Experience in Alaska has shown that significant diesel fuel savings can be made by implementing wind-diesel systems, but also that cost reductions have improved as further projects are developed. In 2010, it was reported early demonstration projects cost as much as 50 c/kWh (installed in the late 1990s), while more recent wind-diesel projects have been installed at costs as low as 14 c/kWh[11].

Diesel savings can be substantial, with reductions reported ranging from 5-50 per cent of annual fuel consumption. Similar projects in remote Australian communities also have reported diesel savings on the order of 10-50 per cent.[12,13] The Alaska Energy Authority has reported that the net present value of the benefits of the systems supported though the State's Renewable Energy Fund are close to double the net present value of the costs[14].

Q: Can you please comment on the significance of emissions from diesel generators in autonomous networks as a justification for wind-diesel projects?

A: Beyond the fuel and costs savings, air emissions are of course reduced. Even taken collectively, the population of remote communities is relatively small. As such, the gross greenhouse gas emissions resulting from the use of diesel for electricity in these communities is only a small percentage of Quebec's overall greenhouse gas emissions – the same would be true for any 20,000 individuals in Quebec. However, global warming is inherently a cumulative environmental problem, and any subset of the population could easily make the argument that their gross emissions are small by comparison to the overall problem (the same argument is made by the oil sands in comparison to overall global emissions[15]).

On a per capita basis, the use of diesel fuel for electricity generation is roughly equivalent to using coal, or over 100 times worse than Quebec's average electricity intensity. There are numerous operating wind-diesel examples in Arctic villages that displace anywhere from 10-25% of annual diesel fuel consumption[16]. The addition of wind turbines in the community of Ramea, Newfoundland (Canada's longest operational wind-diesel system) reduces 750 tonnes/yr CO_2, 16 tonnes/yr NO_x, and 1 tonne/year SO_2,[17] in a community of just over 700 residents.

The gains from reduced transportation and combustion-related emissions from diesel generators are much more significant than the life-cycle greenhouse gas impacts of wind turbines (i.e. full accounting for manufacturing and construction-related emissions, etc.). The life-cycle greenhouse gas impact of wind turbines has been well studied. These life-cycle emissions for wind turbines would be slightly higher in the case of remote communities due to transportation distances. However, the greenhouse gas

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[11] http://www.iser.uaa.alaska.edu/Publications/researchsumm/wind-diesel_summary.pdf

[12] http://www.soe-townsville.org/strandwindproject/data/ER121.PDF

[13] http://www05.abb.com/global/scot/scot221.nsf/veritydisplay/33d7473dc0436cc7c1257afd004e3d8c/$file/Case%20study_Coral%20Bay_9AKK100580A2549_Dec2012_HR.pdf

[14] http://www.akenergyauthority.org/re-fund-6/4_Program_Update/FinalREFStatusReport2013.pdf?rev=true

[15] CAPP, Air Emissions in Canada's Oil Sands http://www.capp.ca/getdoc.aspx?DocId=193748, page 2

[16] http://www.pembina.org/docs/arctic/Wind-Diesel-1-Brett-Pingree.pdf

[17] http://newenergy.is/gogn/Radstefnur/28apr2008/8.wind_hydrogen_diesel_newfoundl.pdf

emissions from the annual transportation of diesel fuel would also be higher to remote communities. The result is that the somewhat higher life cycle greenhouse gas emissions for installed wind capacity in remote communities would be negligible in comparison to the overall benefits from reduced use of diesel fuel[18].

Q: Please comment on the expert report of Bernard Saulnier filed in the previous case.[19] Is this report still up to date?

A: The work submitted by Mr. Saulnier remains relatively current. While there have been, and continue to be incremental improvements in wind turbine technology, storage systems and integration software, the fundamental concepts and principles put forth by Mr. Saulnier have not changed.

While it was not the thrust of the evidence previously provided by M. Saulnier, a major change that has occurred in the past three years (since the report was filed) has been that the price of solar photovoltaics (PV) has declined in price by close to 50%. Insofar as the objective is to reduce recourse to high priced and environmentally damaging fossil fuels, consideration of renewable energy options need no longer be restricted to wind-diesel projects. Hydro-Québec and the Régie should consequently consider the place of solar PV as a potentially attractive option in remote communities.

The Northwest Territories have put together a solar PV program targeting solar in remote communities up to 20% of average load, and looking towards 75%[20]. Northern Quebec has similar solar potential to the NWT as seen in Figure 1, with perhaps the greater solar resource in the communities on the Hudson's Bay coast of Nunavik.

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[18] National Renewable Energy Laboratory http://www.nrel.gov/docs/fy13osti/57187.pdf

[19]Translation of Mr. Saulnier's expert report: R-3864-2013, C-ROEÉ-0033; Original version: R-3748-2010, C-RNCREQ-0015.

[20] http://www.nwtclimatechange.ca/sites/default/files/Solar_Energy_Strategy_2012-2017_0.pdf

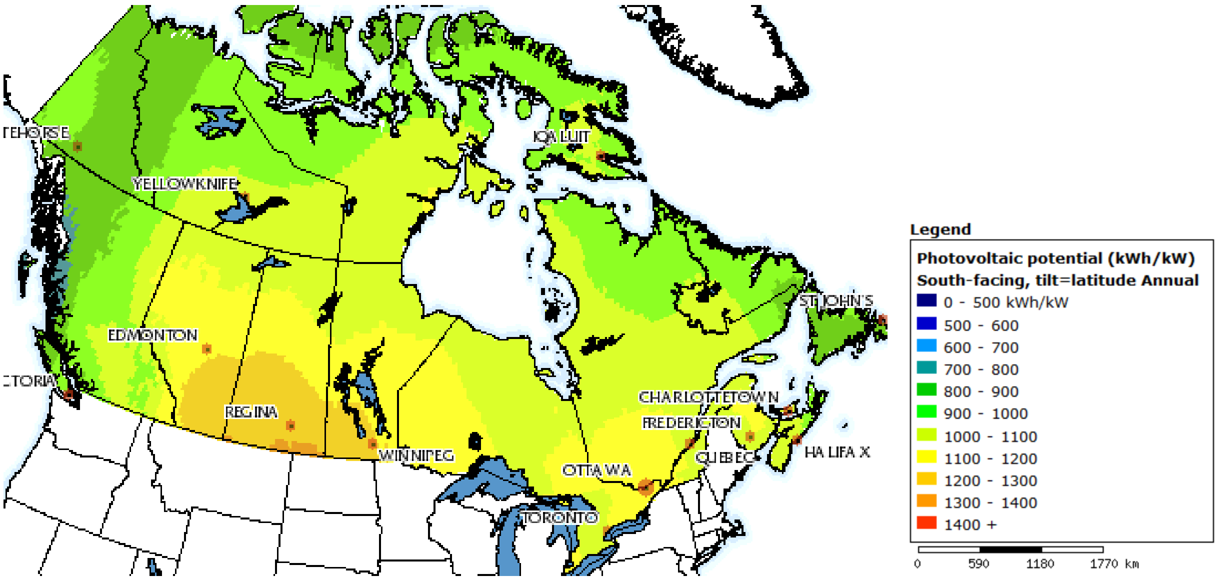

Figure 1: Solar PV potential and insolation map of Canada
Source: Natural Resources Canada[21]

There are similar integration issues with solar as with wind, although time scales and seasonal changes are notably different. There are limitations to solar in remote communities, notably those north of 60. Nonetheless solar PV can still tangibly reduce significant amounts of diesel. In addition, solar has the benefits of no moving components, and can be installed more rapidly than wind turbines . For Hydro-Québec's isolated communities, a solar PV program could be more broadly developed so as to engage more communities than the initially proposed wind-diesel projects. Such an effort could also provide valuable experience in the integration of variable output renewable generating capacity.

IV. ANALYSIS

Q: How does the state of development and operationalization of wind-diesel systems in the autonomous networks of Quebec compare to what has been achieved in other countries or jurisdictions?

A: Canada is trailing behind many other countries when it comes to the implementation of renewable energy systems, notably wind-diesel hybrid systems in remote communities. With respect to implementing wind-diesel systems, Quebec is arguably further ahead of most Canadian provinces and territories, having undertaken studies to deploy pilot projects in Cap-aux-Meules and Kangiqsualluijjuaq.

However, when compared to other developed nations with similar aboriginal community contexts, Canada, including Quebec, lags behind development notably in Alaska and

[21] http://pv.nrcan.gc.ca/pvmapper.php?LAYERS=2057,4240&SETS=1707,1708,1709,1710,1122&ViewRegion=-2508487%2C5404897%2C3080843%2C10464288&title_e=PV+potential+and+insolation&title_f=Potentiel+photovoltaïque%C3%AFque+et+ensoleillement&lang=e&lang=e

Australia. Since initial efforts began in 1997, Alaska, has 25 wind-diesel projects that are operational as can be seen in the figure below (Fire Island and Eva Creek are large-scale projects connected to the Alaska power grid). This development has largely been aided by the Alaska Renewable Energy Fund, which has allocated over $200 million to renewable energy projects (not just wind) across the state[22]. Additional support has come from the U.S. Federal government. This scale of funding has not been provided for through Hydro-Québec and has not been available in Quebec either from provincial or federal governments, and so it is not a surprise that Alaska has moved so much further ahead. Nonetheless, Alaska's successes in developing and continuing to operate and expand wind-diesel systems illustrate how institutional, social and technical barriers have been overcome and the economics of projects has continued to improve.

Figure 2: Alaska Wind Energy Map 2012

Q: What are typical project development timelines for remote wind-diesel in applications?

A: Remote wind-diesel projects tend to be more complicated to complete than on-grid counterparts. However, with proper planning, a four-year cycle from the start of studies to turbine commissioning is not uncommon.

Several case study examples include Kasigluk, and Kodiak, Alaska where "project planning began in 2002 and the turbines were on-line and producing electricity in 2006"

[22] Renewable energy and sustainable communities: Alaska's wind generator experience, http://www.ncbi.nlm.nih.gov/pmc/articles/PMC3749852/pdf/IJCH-72-21520.pdf

and “wind studies began in August 2005 and the project was completed in July 2009”, respectively.[23]

Canada’s long-operating wind-diesel project in Ramea, Newfoundland began operation in 2004 after initial project planning began in 2000.

Similar timelines applied for a demonstration project in Tuktoyaktuk, which began in 2008. Wind monitoring had been ongoing in all of the surrounding communities since 2006, including Tuktoyaktuk. A technical aspects report was completed in early 2008 outlining critical logistical steps[24]. Geotechnical, environmental impact and technical feasibility studies were completed by 2010 and an installation date was targeted for the summer of 2011 had anticipated funding materialized. This timeframe is consistent with a 4-5 year development period from initial studies to operational projects.

Hydro-Quebec’s pilot projects are not dependent on federal funding and so a four year timeframe is reasonable to expect from concept to installation. Using these metrics, Hydro-Quebec appears to be well behind schedule given that projects were targeted to be in service by 2008[25].

Q: Can you please comment on the economic challenges to the implementation of wind-diesel systems in the autonomous networks as stated by Hydro-Quebec in its answer to question 16.4 of the Board’s information request no. 1?

A: There are numerous technical and economic challenges with respect to implementing wind-diesel systems in remote communities. These challenges are well known and have been documented.[26,27,28,29,30]

Specific challenges to the pilot projects in Cap-aux-Meules and Kangiqsuallujjuaq are outlined by Hydro-Québec in this case as being:

- “the difficulty reconciling the need to select windy sites close to the power stations (so as to reduce costs) with the need to keep sites far enough away that they do not interfere with air transportation ;
- the high construction costs associated with working in an extremely remote, isolated area;

[23] http://alaskarenewableenergy.org/wp-content/uploads/2009/04/WindToolkit_For-web_FINALMarch24_20111.pdf page 27, 28
[24] https://nwtresearch.com/sites/default/files/technical-aspects-of-a-wind-project-for-tuktoyaktuk.pdf
[25] R-3748-2010, D-2011-162, par. 354.
[26] J. Maissan, "A Report on the State-of-the-art and Economic Viability of Wind Power Development in Arctic Communities," Aurora Research Institute, Canada, 2006.
[27] http://www.energy.gov.yk.ca/pdf/wind_energy_for_small_communities__april_2006.pdf
[28] https://nwtresearch.com/sites/default/files/technical-aspects-of-a-wind-project-for-tuktoyaktuk.pdf
[29] T.M. Weis, A. Ilinca, and J. Pinard, "Stakeholders’ perspectives on barriers to remote wind–diesel power plants in Canada," Energy Policy, vol. 36, no. 5, pp. 1611-1621, 2008.
[30] Alaska Energy Authority Renewable Energy Grant Recommendation Program Impact Evaluation www.akenergyauthority.org/re-fund-6/4_Program_update/AlaskaREFundImpactEvaluationReport_Volume2.pdf, page 59

- the highly limited resources available in the Arctic (e.g., heavy equipment, contractors, room and board, hardware, concrete);
- a small annual window for marine transport;
- the communities' desire for financial compensation or royalties;
- the need to adapt the equipment to the Arctic climate;
- the availability of wind turbines suited to the demand;
- the need to install additional equipment to provide for grid stability."[31]

While these are real challenges posed by remote community projects, none of these challenges are new or unique to northern and remote communities in Quebec.

On the other hand, Hydro-Québec's path to wind-diesel is free of some obstacles common elsewhere. For example, common challenges to remote community-driven projects are the need to negotiate a power purchase agreement (PPA) with the utility, the need to work with utility to interconnect and integrate with the diesel system, and the challenge of accessing financing. These can often be major barriers to community owned and developed projects, or developer-driven projects. None of these challenges exist for Hydro-Québec which owns and operates the diesel facilities in Quebec's remote communities, has access to the diesel operational data and has capital resources to finance what are small projects (relative to the size of the overall company).

Nonetheless, the challenges listed above by Hydro-Québec need to be considered carefully and planned for where possible. In addition, unexpected challenges and costs will invariably arise as projects move forward, some of which may be unique to any particular community, and others more broadly systematic. After careful analysis, there comes a time when there is a need to "break the study cycle"[32] particularly with demonstration and pilot projects, in order to uncover some of the unknown costs and challenges that are revealed in practice. At the end of the day, paractical experience shows that future projects should be expected to be more cost effective than initial demonstration projects, and future project decisions should not solely be based on the financials of a pilot program as can be seen in the figure below:

[31] R-3864-2013, HQD-4, document 1, (B-0022), answer to question 16.4 of the Régie's information request no. 1.
[32] Christina Ianniciello, BC Ministry of Energy and Mines, Remote Community Energy: Policies & Programs in BC, presented at Renewables in Remote Microgrids Conference Toronto, June 2013 http://www.bullfrogpower.com/remotemicrogrids/presentations/session_7_bc_ministry_of_energy_mines_and_natural_gas.pdf, slide 9.

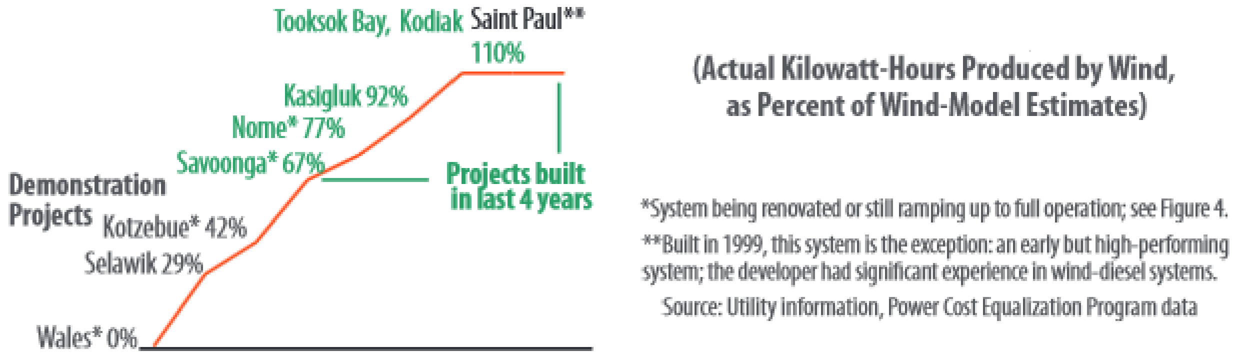

Figure 3: Evolving performance of wind-diesel systems in Alaska

Source: Adapted from Wind-diesel systems in Alaska: A Preliminary Analysis[33]

Q: Can you please comment on the role of social barriers to the implementation of wind diesel systems?

A: As discussed earlier, Alaska is an important jurisdiction to look to when developing wind-diesel projects in cold climates, not only because of the number of projects that are operational there, but also length of time that projects have been operational in the state, as well as the breadth of systems. Many of these systems have been studied both at individual and collective levels. While the development of wind-diesel projects is typically heavily weighted to the technical engineering and logistical aspects of the project, social and local human capacity can have an important bearing on the short and long-term success of wind-diesel projects.[34,35]

Fay and Udovyk[36] have compiled factors that have affected the success of wind-diesel projects in the state. They found that:

> …social factors such as "Community's commitment, participation and support of the project" and "Local work-force training" were cited as frequently as the highest ranking technical factors, indicating that technically inclined developers recognized the importance of community interests and factors being involved and addressed for successful project development and operation.

While "reliable, robust and cost efficiency equipment" was cited most frequently, "Community participation and support" was cited as often as "Adequate wind/proper siting" as potential success factors, by stakeholders engaged wind-diesel projects in Alaska. Furthermore, "Local workforce training" was the fourth most frequently cited potential success factor.

[33] http://www.iser.uaa.alaska.edu/Publications/researchsumm/wind-diesel_summary.pdf

[34] http://www.uaf.edu/files/acep/EPSCoR-FY11-12-Report_UAF_Update_9_4_2012_final.pdf page 16-18

[35] Rich Stromberg, Alaska Energy Authority (2012) Best Practices in Wind Energy Feasibility and Concept Design http://www.uaf.edu/files/acep/2013_REC_Best%20Practices%20in%20Wind%20Energy%20Feasibility%20and%20Concept%20Design_Rich%20Stromberg.pdf

[36] Ginny Fay and Nataliya Udovyk (2011) Factors Influencing Success of Wind-Diesel Hybrid Systems in Remote Alaska Communities: Results of an Informal Survey

> A number of respondents commented that a community's interest in the project is a significant factor without which the long-term success cannot be accomplished. Respondents stressed that developers should approach projects with thoughts on how to best serve and educate the community about the project, not simply constructing the project without community input because the financial resources are available.

Fostering community support can also help to expedite development as local project champions may have insight into local land use constraints, or have experience with local project development. Demonstration projects tend to be led by an engineering focus, and local community engagement is often a secondary consideration, particularly at a regional level.

Q: Can you please also comment on any institutional barriers to the implementation of wind diesel systems?

In the absence of strong community pull for renewable energy projects, it is not uncommon for utilities to move cautiously and slowly on developing alternatives to diesel supply, as evidenced by the slow pace of development of renewable energy all across Canada.

This is somewhat understandable as the utilities' mandate is to supply reliable energy at as low a cost as possible. John Maissan, a former senior engineer at Yukon Energy who lead the development of two wind turbine projects near Whitehorse, suggests that: "Utilities seek simplicity, and minimized 'bother' as well as reliability. This mindset is counter-productive to RE as complexity and additional attention required"[37]. Comfort levels with diesel generators, fuel supply and operations and maintenance lend themselves to structural resistance to change.

Hydro-Québec is a large utility with a broad clientele. It is able to absorb the full costs of servicing its remote communities into the broader rate base. This structure however does not creative an incentive for communities to develop or benefit financially from local renewable energy projects directly.

In fact, if renewable energy projects are solely owned by Hydro-Québec, communities may in fact be perversely affected if local fuel suppliers' market is reduced. While it would place an inequitable burden on residents of Quebec's remote communities to pay the full costs of diesel-generated electricity, there are potentially opportunities for communities to be able to access to value of fuel displacement costs through cost sharing on energy efficiency, local microgeneration or potentially even standing offer power purchase agreements for alternatives that displace diesel fuel[38].

Q: In conclusion, can you summarize your views regarding elements for the development of a road map for wind-diesel systems in Quebec?

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[37] http://www.bullfrogpower.com/remotemicrogrids/presentations/session_7_leading_edge_projects.pdf

[38] Northwest Territories Power Corporation (2008) Wind Generation in the Northwest Territories; Request for Proposals, RFP No. 20804, Hay River, Northwest Territories.

A: While it is important that economic considerations be paramount in the development wind-diesel systems, a narrow economic lens alone does not always capture the full benefits of renewable energy projects. The full benefits include reduced greenhouse gas emissions (this is a real gain even where there is no efficient emissions market and pricing), local air quality improvements, the diminished risk of fuel spills and ground contamination and mitigation against fuel price fluctuations and/or spikes.

The development of regional renewable energy targets (or emission reduction targets) is an important first step. This can help broaden the decision making scope from an individual community level to the broader regional level, and serve as a metric to measure progress to long-term community sustainability.

Regional targets also forecast a longer-term commitment, enabling individuals, development corporations and communities to invest in long-term training and infrastructure where required. In addition, longer-term targets enable economies of scale in equipment purchasing and with respect to human capacity development and training.

Renewable energy targets that extend beyond electricity also enable other opportunities such as fuel switching towards electric space and/or water heating using renewable electricity directly[39] or as dump loads[40].

Community consultation and engagement needs to be planned at the local as well as at a regional level. This ensures that communities understand why development is happening in one community before another, and can assist in strategic decision making including the development of relevant job skills and northern development and service corporations. This also should not preclude the potential for local community project development and ownership.

Capital stock replacement of diesel generators should consider generators and controllers that a suited for eventual integration with renewable energy systems. This may include selecting different sizes of gensets, low-load engines, as well as potentially the location of the diesel plant.

Q: Does this conclude your testimony?

A: Yes, thank you.

[39] Dennis Meiners, 2013, Removing Barriers to Renewables Based Remote Community Microgrids http://www.bullfrogpower.com/remotemicrogrids/presentations/intelligent_energy_systems.pdf, slides 9-12
[40] https://city.summerside.pe.ca/municipal-services/pages/2012/1/heat-for-less-now-program/