Enabling a Clean Energy Future for Canada's Remote Communities

Introduction

Reliable, cost-effective and efficient energy supply for Canada's remote communities is a challenge gaining increased attention from global, federal and provincial leaders. Centralized electrical grids do not currently reach many remote communities in Canada. As a result, 257 of Canada's 292 remote off-grid communities are electrified by diesel generators[1], for which fuel is delivered by air, water and winter roads. Reliance on diesel and other fossil fuels for energy supply has economic, social and environmental impacts on the nearly 200,000 Canadian, Inuit, Innu, Metis and First Nation peoples who live in these communities.[2]

Rising and unpredictable fuel costs, increasing energy demand and environmental issues relating to greenhouse gas emissions and contamination, suggest that alternative energy provision solutions need to be implemented to reduce and replace diesel consumption, creating more sustainable energy systems for these communities. However, there are a number of complex and systemic barriers inhibiting clean energy solutions from being deployed across Canada. Using a series of industry consultations, the Advanced Energy Centre has identified a preliminary list of barriers to reducing diesel consumption in these communities, and outlined measures the Centre will take to address some of these challenges. We also invite your further feedback and insights on this challenge in 2016, through an online survey and interviews.

For the purposes of this document and the Advanced Energy Centre's ongoing research to better understand this challenge, we define a remote community as "any community not currently connected to the North-American electrical grid nor to the piped natural gas network; and is a permanent or long-term (5 years of more) settlement with at least 10 dwellings."[3]

WHAT IS THE ADVANCED ENERGY CENTRE?

The Advanced Energy Centre at MaRS Discovery District seeks to foster the adoption of innovative energy technologies in Canada, and to leverage those successes and experiences into international markets. Within the community energy program, the Centre aims to convene stakeholders (community, utilities, governments, and technology vendors) to examine barriers inhibiting deployment of renewable off-grid microgrid systems, and showcase pathways to future adoption. The Centre believes that collaboration in this sector will enable lower lifecycle energy costs, local economic development in off-grid communities, and project opportunities for Canadian technology vendors.

Launched in February 2014, the Centre is a private-public partnership between Capgemini, Siemens Canada, Ontario Power Generation (OPG), London Hydro, NRStor, Hydro Ottawa, the Independent Electricity System Operator (IESO) and the Ministry of Energy at the Government of Ontario. The Centre is also proud to collaborate with Sustainable Development Technology Canada (SDTC), Department of Foreign Affairs Trade and Development (DFATD) Canada and Export Development Canada (EDC) on fostering growth and export opportunities for Canada's clean energy sector.

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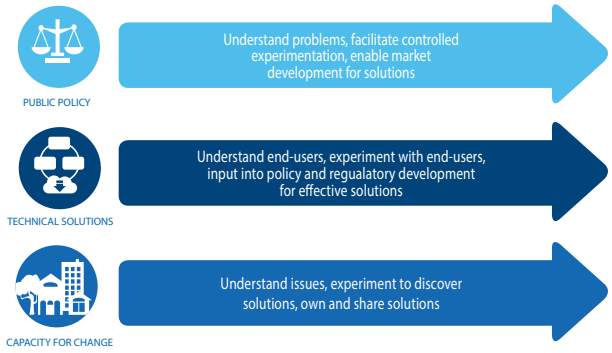
OUR APPROACH TO ENERGY SECTOR TRANSFORMATION



Prior to implementing innovative energy solutions, it is essential that project proponents consider the policy environment, state and cost of technology, and the market capacity (including community, businesses, governments). By convening stakeholders in a neutral third-party setting, the AEC strives to enable new conversations between government, industry, and local communities along these three dimensions: policy, technology, and local capacity.

Innovative energy projects that fail to consider all of these dimensions may produce poor results, risk perpetuating negative outcomes, and increase deployment complexities and timelines. Solely developing technical or policy solutions, without establishing capacity within communities and utilities, will not sustainably advance innovation within local energy systems. Vendors must consider key policy drivers and local implications of technology, while building capacity within the local utility and communities for further technology adoption.

Only in a favourable policy environment can key stakeholders understand innovative solutions, and be equipped to adopt technical solutions at scale within remote northern communities. Similarly, if technical solutions and local capacity are not available, favourable policies will be insufficient to advance local energy systems. It is essential to consider solutions along the three dimensions - policy, solutions and capacity - to sustainably address complex issues.

With this document, the Centre aims to convey preliminary feedback from stakeholder interviews and workshops, to describe the systemic barriers to the provision of low-cost, clean electricity in Canada's remote communities. The Centre will build on this research, engaging more stakeholders in action orientated discussions and further research, to support development and deployment of community-level solutions to overcome these challenges. The Centre will convene follow-up sessions focused on discussing and showcasing sustainable policy and technical solution models, to advance commercially viable deployment of renewable off-grid microgrids in Canada's remote communities.

Impacts of Diesel Consumption In Canada's Remote Communities

Economic Impacts

- High, increasing and fluctuating cost of diesel, including high delivery costs
- Cost burden of subsidized electricity in these communities
- Impact of maintenance costs and load capacity limitations on local economic growth potential

Diesel reliance has both long and short-term economic implications for remote off-grid communities. Perhaps the most prominent economic policy driver for decreased diesel generation, is the high and fluctuating cost of this fuel. Looking ahead, the US Energy Information Administration projects that diesel prices will steadily continue to increase until 2040, from $19.22 MMBtu USD ($13.8 MMBtu CAD) to $34.42 MMBtu USD ($24.6 MMBtu CAD), representing a 76% price hike.[4] Furthermore, prices will continue to fluctuate over time according to supply and demand, geopolitical and other risk factors.

Between 2004 and 2008, the cost of delivered fuel increased by 70% in Ontario.[5] The Government of Canada's *Status of Off-Grid Communities in Canada*[6] report emphasizes that that fuel prices are "highly dependent on the mode of transportation to the delivery site" and that "fuel sent by air can be up to twice the amount paid in communities accessible by barge/road." The report also predicted an increased reliance on air freight for fuel transport going forward, attributed to climate change effecting warmer winters and therefore shorter ice road seasons for road transport.

The provision of electricity in these communities is often highly subsidized, therefore local energy users are not paying the true cost for their usage. For example, in Ontario, the cost of producing off-grid electricity using diesel can be up to 10x higher (up to 94 cents/kWh) than electricity within the primary electricity grid[7]. The annual cost of funding diesel generation in Onatrio's remote communities is estimated at $90 million annually (fuel cost, operation and maintenance, capital expenditure), subsidized by the Government of Canada, Ontario ratepayers, residential and business utility customers and the Government of Ontario (see Fig. 1).[8]

As energy demands increase with growing populations and energy use, all costs of supplying and storing diesel fuel increase, especially when the existing system is at capacity, aging, underperforming or requires significant upgrades or replacements.[9] According to the Senate's report, Powering Canada's Territories, these capacity and performance related factors of existing diesel systems "strain public resources and limit economic growth and prosperity."[10] High maintenance costs coupled with existing capacity limitations can deter new business or existing businesses to expand, further limiting opportunities for economic growth. For example, in 2010 the off-grid diesel community of Kasabonika Lake First Nation in Ontario had been operating at load capacity for three years. The community estimated the total economic cost of this load impediment to be $9,666,400 over 4 years, taking into account reduced housing stock, job losses and inability to grow local businesses.[11]

Environmental Impacts

- Risk of diesel spills in-situ and in transit, causing contamination of soil and ground water
- Greenhouse gas emissions from diesel combustion and fuel transportation

Challenging fuel logistics and delivery of diesel in Canada's most isolated populations can have serious environmental implications. Lengthy distances significantly increase the risk of spills and leakages, and once delivered there is still a risk of inadequate storage, with leaks causing in-situ contamination of soil and groundwater. In 2006, a fuel line broke at Canadian Forces Station Alert and spilled 22,000 litres of diesel. The diesel concentration in the surrounding contaminated soil was over 2000 parts per million (ppm), which is 800% more than the 260 ppm accepted by federal guidelines.[12] Polycyclic Aromatic Hydrocarbons are a group of toxic compounds associated with diesel contamination, which are proven to cause cancer with prolonged exposure.[13] There are a number of cases whereby communities have reported illnesses within the surrounding population following diesel contamination incidences.[14/15]

In addition to the environmental risks associated with these spills, the remediation efforts are often expensive and can have social and health implications to the local population. For example, according to the Treasury Board Contaminated Sites Inventory, the cost of assessment and remediation of diesel contamination due to leakage at one site in the Sayisi Dene First Nation, Manitoba, was $110,473 and $3,629,871 respectively.[16/17]

As a fossil fuel, the use of diesel for electricity production inherently causes GHG emissions and localized air pollution, in addition to those transportation related emissions associated with delivering the fuel. The Government of Ontario notes; "a large, diesel-powered community produces more than 10,000 tonnes of carbon dioxide a year."[18] In diesel-based communities, the estimated consumption to generate electricity alone is 215 million litres/year (excluding transportation and heating), and per capita, has almost double the environmental footprint of the Canadian emission average[19].

Social Impacts

- Load limits of existing diesel system limiting growth and economic potential of communities, and other critical infrastructure development
- Noise and local air pollution emissions affect well-being of local population
- Effects of diesel contamination on local population's health and well-being

Across Canada, there are many communities underserved by exclusively diesel-powered microgrids. Upon reaching nameplate electrical capacity, grid operators are prevented from connecting new loads. This prevents the connection and construction of new housing stocks, and instead forces families to crowd into existing housing. This trend also limits development of new tourism, infrastructure investments and upgrades (schools, water treatment, health services etc.) and commercial operations in remote communities.

For example, the diesel electricity system in Sayisi Dene First Nation in Manitoba required upgrades, and had reached load capacity. As a result, school and nursing station expansions were placed on hold, as well as a new police detachment, a grocery store, a community service building, and a warehouse.[20] Situations like this represent an opportune time for communities, utilities and governments to consider the non-diesel fuel alternatives which can be implemented to meet these increased load requirements. In the community of Deer Lake in Northern Ontario, the construction of 152kW of solar on the rooftop of the school, by NCC Development and Canadian Solar, enabled the electrical connection of five brand new homes grid.[21]

According to Aboriginal Affairs and Northern Development Canada (AANDC)[22], other social implication of diesel systems include the operating noise pollution and local emissions – including nitrogen oxides, hydrocarbons and other air pollutants[23], which may have adverse health impacts for communities' residents.

In addition, diesel contamination of air, soil and water can have serious health implications for local residents. In Attawapiskat, students and community members were affected by a diesel fuel leak from pipes underneath an elementary school. Due to significant health and safety issues, the school was closed down and fenced. Despite its closure in 2008, a new school was not completed until 2014 and clean up is expected to be complete by 2016[24], during which community members experienced illnesses and students studied in poor conditions[25], illustrating additional adverse social impacts these spills can also induce.

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Systemic Barriers To Implementing Clean Energy Solutions

Despite the high cost of fossil-fuel generation in remote communities, negative environmental effects, and adverse socioeconomic outcomes, diesel remains the standard resource for electrical generation across Canada's remote off-grid communities. As such, the Centre has been working to identify key barriers to the adoption of diesel reduction strategies for remote communities, including renewable energy and storage solutions, in collaboration with Canadian private and public sector organizations. Over three sessions in Spring 2015, the Centre convened a preliminary group of energy sector stakeholders at MaRS, to examine these factors.

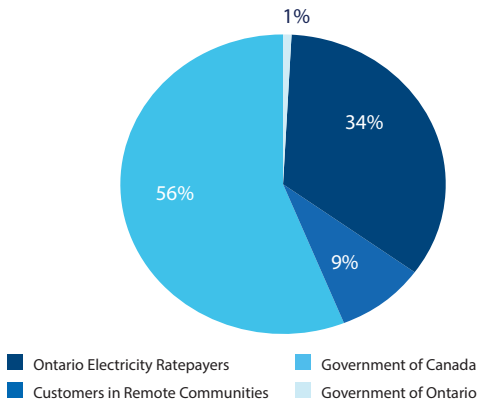
These sessions focused on improving understanding of the existing barriers to creating alternatives to diesel for the energy supply to Canada's remote off-grid communities. Below we have synthesized these discussions and workshops into key policy, solutions and capacity related barriers. The document proceeds to identify two practical initiatives the Centre will undertake, with the aim of inducing systems change in the provision of electricity to these communities, for increased deployment of alternative energy solutions.

Public Policy

- Complicated diesel procurement funding streams, leading to confusing incentive structure for clean energy alternatives
- Lack of viable contracting method, undermining business case for alternative systems
- No current mechanism to incorporate environmental and socio-economic benefits
- Lack of integration between upfront and operational funding across i) multiple jurisdictions and ii) consistent time frame

Workshop participants agreed that the streams of funding used to procure diesel fuel for electricity generation in remote communities are complicated, as shown in Figure 1 below, which leads to a confusing and ineffective incentive structure for alternatives. Given multiple funding streams, it is perfectly rational that no one organization can justify implementing alternative solutions, given that total benefits and avoided costs do not accrue to that same organization. This also increases the complexity and challenges associated with tracking performance metrics and measuring the impact of these alternatives.

Figure1: Share of Annual Cost of Diesel Generation in Ontario's Remote Communities by Funding Source[26]



Stakeholders stated that provinces and territories lack viable contracting structures (e.g. a standard formula for 'avoided cost of diesel' that leads to a power purchase agreement [PPA] rate) to incentivize a project proponent from partnering with the local community to construct these lower-cost alternatives to diesel generation. Therefore in many instances, the existing funding structures lack enough incentive to build a viable business case for these alternative systems. This has been a challenging issue to resolve, since provision of energy in remote communities is a multi-jurisdictional public policy issue, requiring collaboration between local and regional First Nations governments and councils, the Government of Canada, and provincial/territorial ministries.

In addition, participants highlighted is a burgeoning of federal and provincial grants and programs for the support of alternative energy development in these regions. For example, the community project at T'Sou-ke First Nation in BC, which consisted of a conservation program, solar hot water heaters and a 75kW solar PV received funding from a total of 16 different sources. Participants felt that the differing application processes, timelines and requirements for these federal funding programs make securing funding for these alternatives systems unreasonably time and resource heavy.[27]

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Stakeholders also discussed that when planning electricity systems investments under current funding structures, the environmental and socio-economic benefits of diesel alternatives were not adequately captured (e.g. construction and skilled job creation, new local energy system control, reduced environmental impacts, decreased reliance on social financial support, benefit of new equity partnerships for energy provision). In addition, they cited that opportunities for new revenue and job creation through operation and development of community alternative energy projects, have the potential to empower residents with a sense of pride and self-sufficiency. Current funding mechanisms aren't optimized to capture these additional benefits afforded by diesel alternatives.

Alternative renewable generators carry a larger upfront capital cost compared to traditional diesel alternatives, however their operation costs are proven to be much less over time, especially with the reducing cost of renewable and storage technologies. Those consulted felt the current funding system prioritised the upfront capital cost of delivering electricity to these remote communities, inadequately reflecting the long term economic gains implementing alternatives to diesel generation hold. It was agreed that capital and operational costs were not adequately captured to reflect the most efficient use of rate and tax payers money in funding electricity systems in Canada's remote communities. Because the current funding structures don't always allow for the implementation of a system with the lowest life cycle operating cost, this reduces the ability to leverage additional funds for other local priorities (e.g. education, community infrastructure, or health care).

Technical Solutions

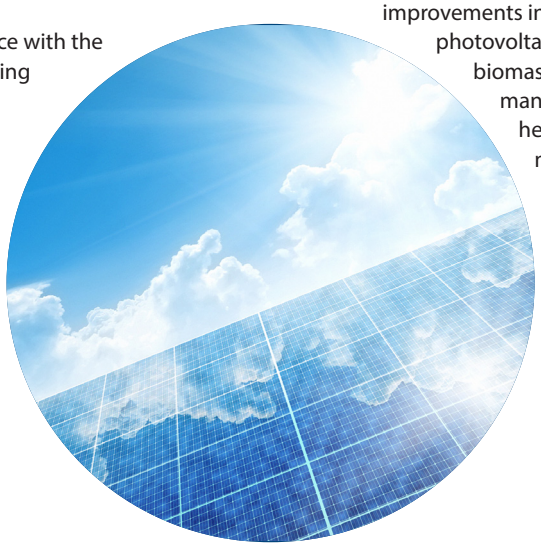
- Lack of understanding on technical feasibility of implementing renewables into remote off-grid systems
- Lack of understanding on the cost of these alternative system solutions
- Need for a more holistic viewpoint on energy, with other community infrastructure projects
- Technology reliability risk of alternative energy systems in these communities, when compared to conventional diesel generators

Participants felt that there is a lack of understanding around the technical feasibility of renewable microgrid solutions and a lack of clarity around cost estimates for reducing diesel consumption with renewable energy resources. For many important stakeholders, it is not clear what viable alternatives actually exist, and what the approximate costs would be for Canada's remote communities to embrace high-penetration of renewable energy systems. It was raised that program managers are grappling with the magnitude of capital versus operating expenditures for a renewable microgrid project, appropriate project discount rates, project timelines, contingencies, degree of customization required and more.

In addition, it was also felt that in accordance with the IESO's Aboriginal Community Energy Planning (ACEP) process, the current evaluation of community projects may not be holistic enough and does not adequately examine the interface with other local infrastructure, such as water purification plants or institutional facilities, to obtain system performance and economic efficiencies.

Stakeholders emphasized that deployment of alternative systems was made more difficult due to challenges associated with operating in remote northern regions, including snow, extreme cold, and the effects of remoteness. For all remote systems, including energy supply, reliability is always the primary concern and is of paramount importance for utilities operating in remote communities. There is a very low tolerance risk, and it is evident that any alternative systems must meet or exceed the performance results of the existing diesel systems.

Those sonsulted cited a perceived technology risk as a key barrier to the increased deployment of these alternative systems, as they are still view as 'new' and diesel is seen as a comparatively 'trusted' system in terms of reliability. Despite recent dramatic improvements in technologies, including solar photovoltaic, small-scale wind, innovative biomass systems, and diesel generator management systems, there is very strong hesitation to implement these solutions more widely.



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Capacity For Change

- Developers require more examples and data from successfully deployed systems, to instill confidence and strengthen business cases for future projects
- Shortage of knowledge and technical proficiency, inhibiting community engagement in planning, design, deployment and operation of clean energy systems
- Lack of training opportunities available to acquire skills and knowledge within communities
- Poor clarity on innovative collaboration models for new partnerships, focused on economic benefits for communities and developers alike

Participants felt there was a lack of knowledge of the successfully deployed projects displacing diesel and more sharing of best practice was required to give confidence to developers of these systems. They stated that quantifying and sharing the socio economic benefits of these projects was a key piece in strengthening the business case for alternative systems.

In some cases, poor communication, compounded by insufficient levels of decision making authority afforded to community leaders, resulted in projects being prevented from going forward. Many felt that some past projects have lacked meaningful collaboration with local residents, or have missed out on opportunities to include the community in critical decision-making processes, form economic partnerships, or create positive cultural spinoffs. Limited energy literacy amongst community members was also noted as a potential barrier to integrating the community into the planning process for energy system renewal.

Stakeholders noted that communities currently lack adequate opportunities to collaborate on an equal footing with public utilities and private developers, in terms of deploying, operating and maintaining these systems. They felt that a lack of knowledge and technical proficiency within the communities was a significant barrier to developing these more holistic collaboration models, compounded by a lack of training opportunities available to acquire the skills and knowledge needed within the community.

In addition, it was agreed that more clarity was needed to define the parameters of what these more holistic and equitable models for project collaboration would look like, and how they could be designed to deliver the most economic benefits for all stakeholders - governments, private developers, utilities and perhaps most importantly the community itself. Participants felt that these models need to also focus on local economic benefits, with equitable partnerships which position remote communities for long term economic and social prosperity.

NEXT STEPS:

Supporting a Clean Energy Future for Canada's Remote Communities

In the coming months the Centre will be working to take action on some of the challenges listed above, in collaboration with its public and private sector partners. We aim to address barriers preventing the increased adoption of alternative energy systems in Canada's Remote Communities, by addressing key knowledge gaps and presenting potential alternative funding models, to strengthen the business case for developing these projects. This will be executed through two further discussion papers, published by the Centre in spring 2016.

A. DEPLOYMENT COSTS OF REMOTE RENEWABLE MICROGRIDS

The Centre is soliciting industry input, with a 3rd-party request-for-information, on cost ranges and projections for advanced microgrid systems in off-grid communities, while protecting commercial data.

B. PRICING AND CONTRACTING MODELS FOR RENEWABLE ENERGY IN REMOTE MICROGRIDS

The Centre is using an online survey and interviews to crowdsource policy and program solutions focused on pricing and contracting models for clean energy in Canada's off-grid communities.

Connecting Projects With Export Opportunities

Around the world, remote villages and communities are beginning to transition from diesel generation to renewable energy and there is a demand for expertise, innovative products and integrated solutions. Globally the the remote microgrids market is currently worth an estimated $2.4 billion, and is expected to to increase to more than $10 billion annually by 2024, at a compound annual growth rate (CAGR) of 17.4%.[28] Many jurisdictions are seeking utility-proven microgrid solutions that can resolve high-cost diesel fuel, as well as alleviating concerns around weak grid connections or unreliable power supply. By developing globally best-in-class remote microgrid solutions, Canadian entrepreneurs will learn from innovative pilot projects and community-scale deployments here in Ontario. The AEC is focused on establishing linkages between Canadian projects and international opportunities.

In addition to enabling information sharing in our role as secretariat for the Canada Remote Microgrid Network alongside Natural Resources Canada and AANDC, the AEC is committed to establishing non-governmental relationships with the Sustainable Energy for All (SE4ALL) initiative and the Energy Access Practitioners Network hosted by the United Nations Foundation.

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The Advanced Energy Centre would like to acknowledge our partners at Ontario Power Generation, Siemens Canada, NRStor and Capgemini for their generous support and dedication to unlocking opportunities to cost-effectively deploy renewable energy resources in remote communities, and supporting Canada's cleantech entrepreneurs.

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