Recent Developments in Renewable Energy in Remote Aboriginal Communities, Newfoundland and Labrador, Canada

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An energy transition is being proposed for Labrador's remote aboriginal communities that are currently serviced by diesel fueled electricity generators. The Nunatsiavut Regional Government (NRG) is concerned about electricity price increases, power outages and shortages that affect economic development in communities. The high cost of connecting the communities to the Labrador or Newfoundland interconnected grids restricts access to clean and affordable hydroelectricity provided by large projects in southwestern Labrador. Instead, the NRG proposed local renewable sources of electricity as the means to improve community wellbeing. This paper reviews the electrical systems, past renewable electricity projects, as well as available renewable resources for electricity generation in Labrador's isolated communities. A transition from diesel generated electricity to less carbon intensive generation is promoted through utility scale run-of-river projects in five of the 16 communities and wind and solar pilot projects to be developed by the Nunatsiavut Regional Government. A net metering policy encourages community participation in small scale wind and solar applications to reduce their greenhouse gas emissions, high electricity expenses and increase development capacity.

Keywords: Newfoundland and Labrador, remote aboriginal communities, indigenous communities, renewable electricity, community ownership, wind, solar

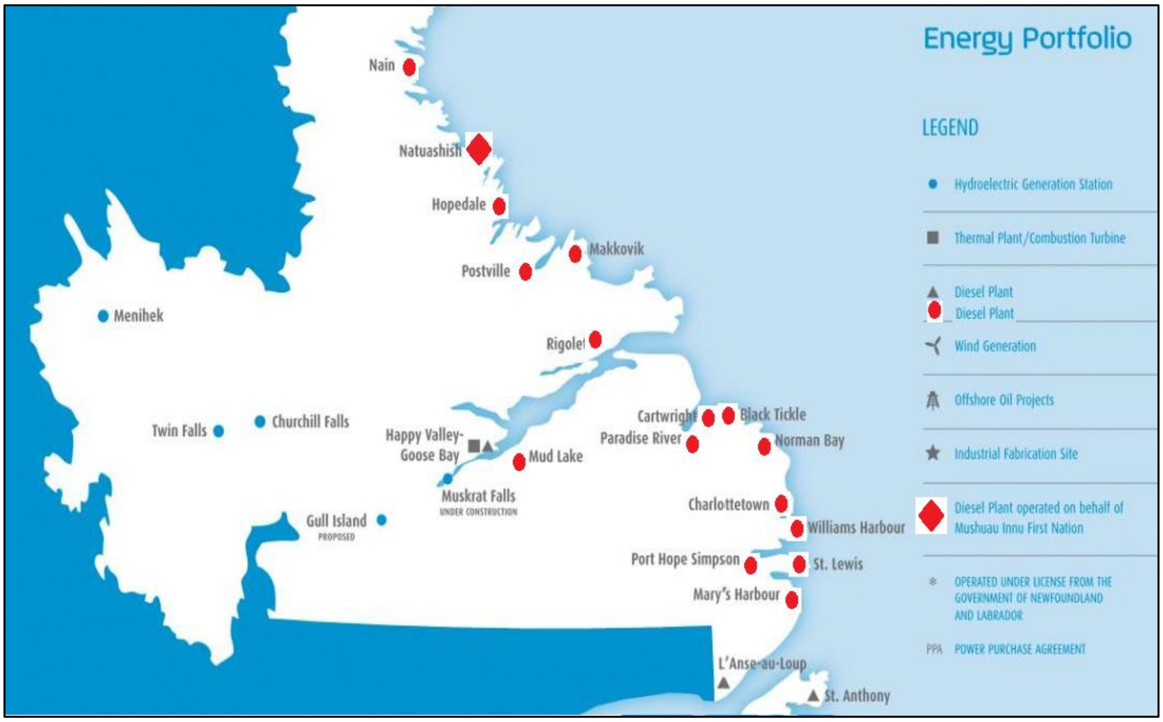
Introduction

The remote aboriginal[1] communities in Labrador are serviced by diesel fueled electricity generator systems operated by Newfoundland and Labrador Hydro, with the exception of one community that independently runs its diesel electric system. Despite the substantial operating costs of these diesel systems, the cost of connecting the communities to the Labrador or Newfoundland interconnected grids is prohibitively high, therefore limiting access to the renewable electricity provided by large hydroelectric projects in southwestern Labrador (GNFL, 2007). Recently, the Government of Newfoundland and Labrador, in cooperation with Newfoundland and Labrador Hydro and Nunatsiavut's Regional Government, have begun to examine the potential of integrating hydroelectricity, wind and solar into communities' systems to reduce diesel consumption and greenhouse gas emissions (GNFL, 2015a). The next sections provide an overview of the population served in Labrador's 16 remote aboriginal communities, the capacity and type of current electricity generation systems, electricity price and rate

[1]The term aboriginal community is used in this paper. It is recognized that some communities prefer the term indigenous community while others prefer aboriginal community and that both are used in the literature.

structures, future demand expectations, renewable resource availability, as well as provincial plans to support communities' participation in renewable electricity generation.

Figure 1: The 16 remote aboriginal communities in Newfoundland and Labrador



Source: Nalcor Energy (2014, p.64), modified.

Population

There are 28 remote communities in Newfoundland and Labrador with a total population of 9,500 in 2011. Eleven remote communities are non-aboriginal communities, while 16 out of the 17 communities in Labrador are aboriginal communities with a population of approximately 5,700 (AANDC and NRCan, 2011; Statistics Canada, 2012) (Figure 1).

Fifteen of the aboriginal remote communities are serviced by Newfoundland and Labrador Hydro (NLH) and one community, the Natuashish-Mushuau Innu First Nation, runs its own electricity system as an Independent Power Authority (IPA). Four communities (Mud Lake, Norman Bay, Paradise River, and Williams Harbour) have a population below 100. The challenges faced by these small communities are illustrated by Williams Harbour where the residents voted to be relocated to other areas[2], while Black Tickle[3] is experiencing a steep decline in community services (Table 1). Eight communities have a population between 100 and 500, two communities have approximately 550 people, and two communities, the Natuashish-Mushuau Innu First Nation and Nain, have population of approximately 1,000.

[2] http://www.cbc.ca/news/canada/newfoundland-labrador/williams-harbour-votes-96-in-favour-of-relocation-only-1-no-vote-1.3213147
[3] http://www.cbc.ca/news/canada/newfoundland-labrador/why-black-tickle-s-residents-are-so-leery-about-moving-1.3207617

Table 1: Remote Aboriginal communities, Newfoundland and Labrador

Nr	Community name	Population 2011	Diesel plant capacity (2011)[4] kW	Annual electricity demand (2011) MWh[5]	Serviced by
1	Black Tickle	138[6]	765	1,080	
2	Cartwright	516	1,485	3,933	
3	Charlottetown	308	620	1,496	
4	Hopedale	556	1,840	2,673	NLH Hydro
5	Makkovik	361	1,300	2,422	
6	Mary's Harbour	383	1,300	3,110	
7	Mud Lake	60 Ɨ	180	221	
8	Natuashish-Mushuau Innu FN	931	695	No data	IPA
9	Nain	1188	2,920	5,142	
10	Norman Bay	45[7]	No data	No data	
11	Paradise River	14[8]	145	186	
12	Port Hope Simpson	441	1,390	2,186	NLH Hydro
13	Postville	206	735	1,293	
14	Rigolet	306	870	2,064	
15	St. Lewis	207	695	1,923	
16	Williams Harbour	59 Ɨ	325	419	
	TOTAL	**5,719**	**15,625**	**28,148**	

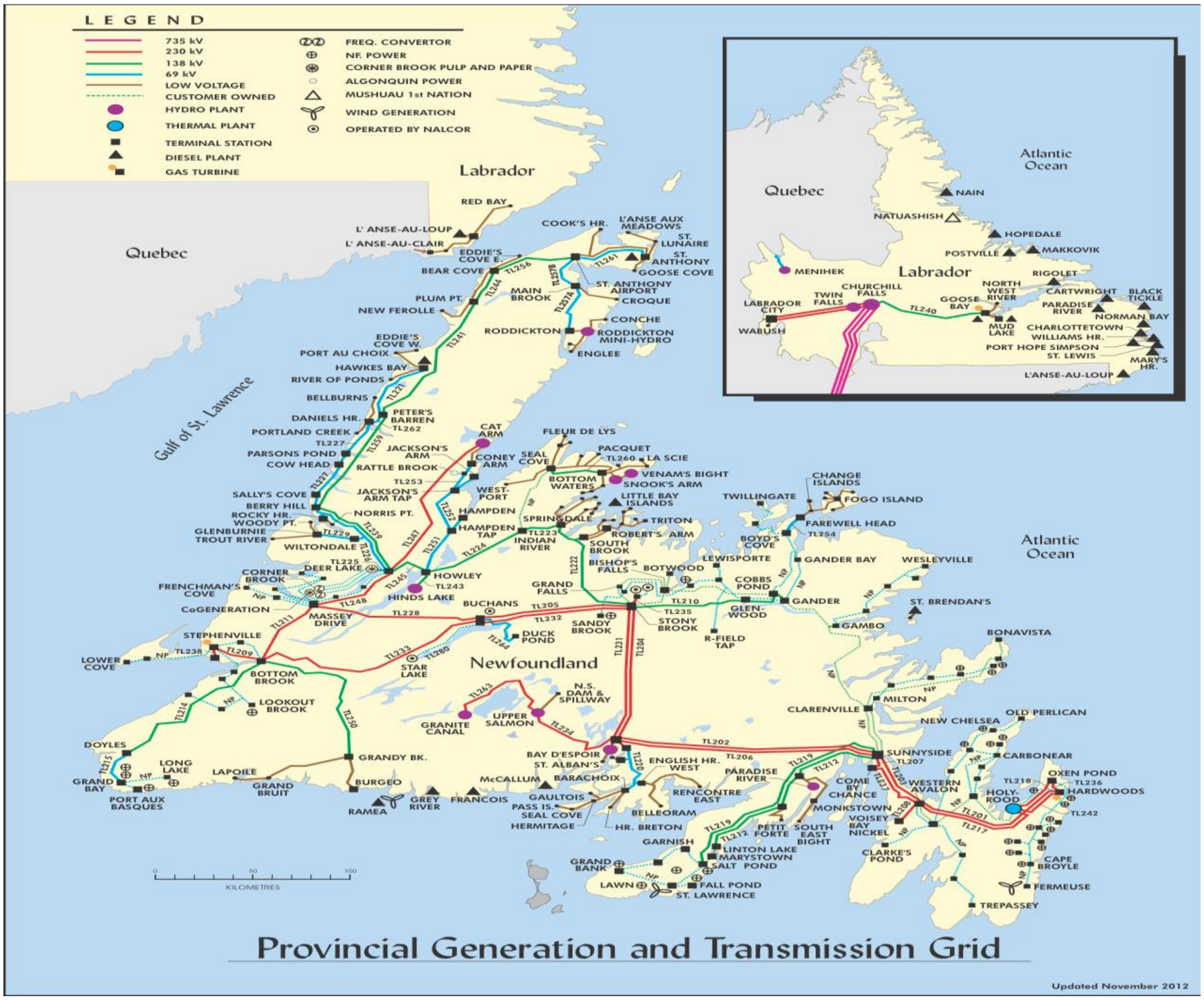
Ɨ Population according to AANDC and NRCan (2011).
Source: Statistics Canada (2012); NLH (2016).

Electricity system

Electricity generation and distribution in Newfoundland and Labrador is provided through Newfoundland Power and Newfoundland and Labrador Hydro (NLH), a subsidiary of the Crown Corporation Nalcor Energy since 2007 (GNFL, 2016). NLH was established as Newfoundland Power Commission (NPC) in 1954 with the goal to extend electrification within the province to rural areas. NPC provided electricity, built transmission lines, and installed diesel plants between 1958 and 1964, and in 1975 was incorporated into Newfoundland and Labrador Hydro (NLH) (Baker , 1990). Currently, NLH provides electricity to approximately 290,000 customers through hydroelectric, residual oil-fired, wind, biomass and diesel generation plants. Customers are connected to the Island Interconnected System (IIS), the Labrador Interconnected System (LIS), and the various isolated diesel systems (PA-Hatch , 2015). NLH operates 25 thermal plants province-wide, with a total capacity of 35.8 MW (PA-Hatch , 2015, p. 39; NLH, 2016). 16 diesel plants are in Labrador's remote communities and serve approximately 3,300 customers, consuming approximately 15 million litres of diesel annually (NLH, 2009; Nalcor Energy, 2014b) (Figure 2).

Figure 2: Newfoundland and Labrador Hydro generation and transmission system

[4] According to AANDC and NRCan (2011), unless otherwise noticed.
[5] According to AANDC and NRCan (2011), unless otherwise noticed.
[6] http://www.cbc.ca/news/canada/newfoundland-labrador/why-black-tickle-s-residents-are-so-leery-about-moving-1.3207617
[7] http://www.southernlabrador.ca/home/norman_bay.htm
[8] http://www.southernlabrador.ca/home/paradise_river.htm



Source: PA-Hatch (2015, p.33).

Electricity rates

Each of the five electricity systems in Newfoundland and Labrador (Island Interconnected, Labrador Interconnected, Island Isolated, Labrador Isolated, and the L'Anse de Loup system) has different electricity rates based on the different costs of electricity generation. Residential customers on the isolated diesel systems receive the same rates as the customers in the interconnected systems. The 2015 electricity rates in diesel serviced areas for residential consumers were 10.573 c/kWh for the first block of kWh per month and 11.933 c/kWh for the second block (see Table 2). All kWh in excess of 1,000 kWh monthly were charged with 16.261 c/kWh. However, the application of the Northern Strategic Plan (NSP) subsidy in residential consumers decreases the rates to as low as 3.38 c/kWh for the first block of electricity consumption (Cherniak, Dufresne, Keyte, Mallett, & Scott, 2015). The general service rates were 16.82 c/kWh and rates for governmental residential and governmental general service accounts were 83.567 c/kWh and 75.468 c/kWh respectively (NLH, 2015).

Table 2: Residential rates for Newfoundland and Labrador communities in diesel serviced areas

	Rates c/kWh	Electricity consumption blocks, in kWh Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sept.	Oct.	Nov.	Dec.
First Block	10.573	1000	1000	900	900	800	800	700	700	700	800	900	1000
Second Block	11.933	0	0	100	100	200	200	300	300	300	200	100	0

Source: NLH (2015, p. 47).

The cost for electricity generation in the isolated diesel powered communities is considerably higher, and approximately 75% of the cost is subsidized through the contributions of other ratepayers in the interconnected systems (GNFL, 2007; PA-Hatch , 2015). The provincial government provides additional subsidies (approximately $ 1.6 million for 2012) through the Northern Strategic Plan (NSP), established in 2007, for reducing electricity costs for residential customers in Labrador's and Labrador Straits' coastal aboriginal and non-aboriginal communities (NFL-AA, n.d.; Nalcor Energy, 2012).

Future power requirements and plans

Electricity demand in the Island Interconnected system is projected to increase at an annual rate of 0.9% for the 2015 to 2032 period with the system peak increasing by approximately 0.8% annually for the same period (PA-Hatch , 2015). The annual electricity demand for the Labrador Interconnected system has decreased since 2009 due to reduced demand from mining and energy industries but is expected to recover to its previous levels by 2022. With the anticipated connection of the Labrador and Island grids, the new interconnected system is expected to have modest annual energy and peak growth requirements from 2017 to 2022 (PA-Hatch , 2015). Finally electricity requirements in the isolated diesel systems have increased since 2007 at an annual rate of 3.4%, due to new connections and an increase in residential consumption (PA-Hatch , 2015).

The future requirements of Newfoundland and Labrador's electricity system are related to increased exploration and development of mining and energy resources, and development of clean renewable electricity for domestic use and exports (Nalcor Energy, 2014a). Government plans also include targets for greenhouse emission reductions through the introduction of renewables, and the promotion of energy efficiency through the Residential Energy Efficiency Program (REEP), promoted by Newfoundland and Labrador Housing Corporation (NFL, 2011; GNFL, 2015a). One primary goal is the elimination of approximately 1.3 million tonnes of carbon emissions from the Holyrood thermal plant through the building of the Lower Churchill project and the development of the Labrador-Island Transmission link. Government targets in relation to Labrador's remote aboriginal communities include the participation of aboriginal groups in natural resources projects, cooperation in areas where wind developments are subject to aboriginal treaties or land claims, and collaboration with aboriginal governments for the displacement of diesel fuel in community electricity systems (Nalcor Energy, 2014a; GNFL, 2015a).

Availability of renewable energy sources in NFL's remote communities

Renewable supply options for Newfoundland and Labrador's future electricity demand include the development of the provinces hydroelectricity and wind resources. The Lower Churchill project, consisting of the 825 MW Muskrat Falls and the 2,250 MW Gull Island site developed downstream of the 5,428 MW Churchill Falls project, and the 1,100 km Labrador-Island link transmission are the main providers of clean, affordable hydroelectricity for the coverage of provinces' residential, industrial and interprovincial trade needs (GNFL, 2015a). Additionally, Nalcor is examining the potential for the integration of large scale wind projects, and currently has two Power Purchase Agreements for two 27 MW wind projects on Newfoundland to reduce demand (and greenhouse gas emissions) from the Holyrood thermal plant (GNFL, 2015a).

Renewable energy policies and promotion in NFL remote communities

The 16 aboriginal communities in Labrador are powered by diesel generators operated by NLH, except for the community of Natuashish-Mushuau Innu First Nation, which runs its own diesel powered electricity system. There are approximately 16 MW of installed diesel capacity, which generated approximately 28,000 MWh in 2011, consumed approximately 7,800,000 litres/year of diesel fuel, and contributed 22,400 tonnes $CO_{2,eq}$/year in carbon emissions[9] (Table 1). Only the community of Mary's Harbour was involved in renewable electricity generation through a 175 kW hydroelectric project developed in 1987 (Table 3), but which has been inactive for the last seven years (Roberts, 2016).

Table 3: Renewable electricity projects, Newfoundland and Labrador

	Community	Hydro MW	Wind kW	Solar kW	Year	Source
Existing projects						
1	Black Tickle					
2	Cartwright					

[9] Based on the assumption of an average efficiency of 3.6 kWh/lit diesel and emissions of 2.88 kg CO_2/lit diesel.

3	Charlottetown			
4	Hopedale			
5	Makkovik			
6	Mary's Harbour	0.175	1987	Ah-You & Leng (1999)
7	Mud Lake			
8	Natuashish-Mushuau Innu FN			
9	Nain			
10	Norman Bay			
11	Paradise River			
12	Port Hope Simpson			
13	Postville			
14	Rigolet			
15	St. Lewis			
16	Williams Harbour			
	Total	**0.175**		

The main priority of the Government of Newfoundland and Labrador remains the development of large scale hydroelectricity and wind projects in cooperation with Nalcor Energy (GNFL, 2015a).

Support for small scale wind, solar power and micro-hydro as alternative technologies able to contribute to the province's electricity supply was initiated with the "2007 Energy Plan" and a "net metering" policy to support small renewable generation developers (GNFL, 2007). Government support was provided for the introduction of renewable electricity into remote community systems by financing the development of the Ramea wind-diesel project (GNFL, 2015a). The Ramea[10] project was initiated as a medium penetration system with the connection of three 65 kW wind turbines to the community's grid in 2004 (Oprisan, 2007). To increase system efficiency three 100 kW wind turbines and a hydrogen energy storage system were added in 2010. The project has produced approximately 615,000 kWh of renewable electricity since 2010 and is used as a model for wind-hydrogen-diesel applications in the environment of Canadian remote communities (GNFL, 2015a).

Additionally, since 2008 the provincial government has invested more than $3.5 million for the installation of equipment and data analysis of communities' wind and hydroelectric potential (GNFL, 2015a). The potential for integration of solar, wind and small scale hydroelectric facilities into communities' diesel systems was assessed through an NFL Hydro study of Labrador's larger communities (with annual load of more than 200 kW and generation in excess of 3,000 MWh) conducted in 2009 (NLH, 2009). According to the study, the communities of Hopedale, Makkovik, Charlottetown, Port Hope Simpson, and Mary's Harbour have sites for hydroelectricity generation that could lead to electricity costs lower than the current diesel generation cost, and interconnection points to connect hydroelectric facilities capable of powering two or three of the communities (NLH, 2009). The potential for wind power applications is limited for Cartwright, Charlottetown, Mary's Harbour, and Port Hope Simpson,

[10] Ramea is a non-aboriginal remote community located in Newfoundland.

while savings between 30-43% in diesel consumption can be realized for the communities of Hopedale, Makkovik, and Nain due to strong wind resources. The study also identifies a low solar potential for all communities due to limited insolation during the summer months. Additional support for small scale renewable deployment is examined through a “net metering” policy that will assist residential and general service customers to offset their own electricity usage through individual renewable generation systems that will not exceed a maximum limit of 100 kW, while additional limits on total generation apply in the isolated diesel systems (GNFL, 2015b).

Finally, the Nunatsiavut Regional Government (NRG), expressing its concerns over electricity price increases and power outages and shortages that affect economic development in communities (Cherniak, Dufresne, Keyte, Mallett, & Scott, 2015), developed an energy strategy and plan to address energy security issues in remote aboriginal communities and improve the communities’ socioeconomic conditions (NG, 2016). The plan identified the installation of pilot projects, such as efficient heating stoves and district heating systems, the installation of new diesel generators that reduce diesel consumption and community expenses, the installation of a demonstration solar photovoltaic project on the Illusuak Cultural Centre in Nain, the installation of a small-scale wind-diesel system in Hopedale, and feasibility studies for small hydro projects in Makkovik, Nain and Hopedale. The Nunatsiavut Regional Government aims to develop and implement these projects through the financial support of the Government of Newfoundland and Labrador, as well as industry contributions (NG, 2016).

Conclusion

The 16 remote aboriginal communities in Labrador rely on diesel fueled generators for their electricity needs while the high cost of connection to the main grid limits community access to a reliable and clean hydroelectricity supply from the Labrador Interconnected grid. The transition from diesel generated electricity to renewable resources is promoted through utility scale run-of-river projects in five of the 16 communities supported by the Government of Newfoundland and Labrador and Newfoundland and Labrador Hydro, and wind and solar pilot projects to be developed by the Nunatsiavut Regional Government with government and industry financial support. The “net metering” policy could encourage the successful deployment of small scale wind and solar applications by local governments as the cost of the technology decreases and positive experience is gained in other northern jurisdictions. This could enable communities to reduce high electricity costs, service interruptions and greenhouse gas emissions while improving socio-economic conditions as desired by the Nunatsiavut Regional Government.

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