University of Alberta Future Energy Systems

Newfoundland and Labrador Energy Market Profile

Measuring the Costs and Benefits of Energy Transitions

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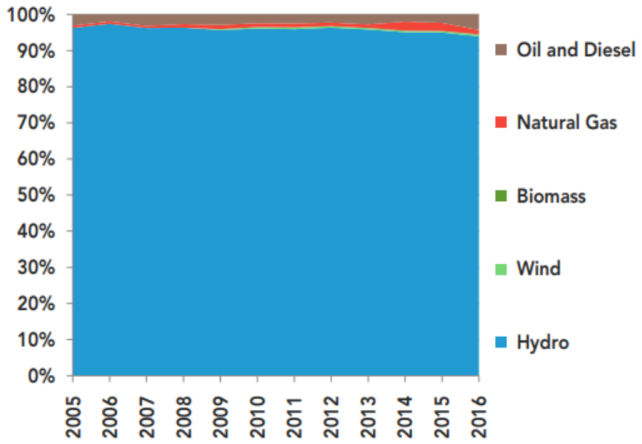
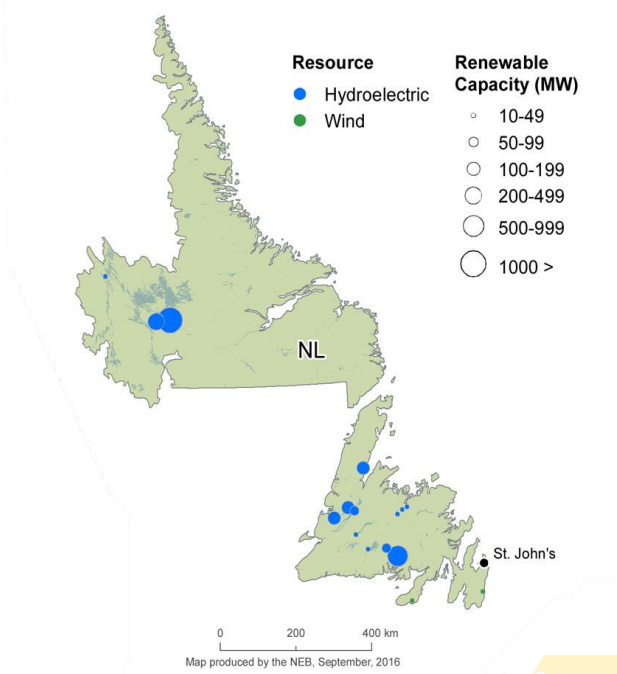
Context

In 2016, Newfoundland and Labrador generated 94.3% of its electricity from renewable sources, approximately 6,848 MW or ~39,700 kWh (NEB, 2018a). Hydroelectricity dominates the renewable sector, at 93.9% of total electricity generation, thanks to the massive 5,428 MW Churchill Falls generating station (NEB, 2018a). A small share of wind and biomass capacity also exists, but are nearly negligible at 54 MW and 15 MW, respectively (NEB, 2018a).

While generation is mostly provincially owned via Newfoundland & Labrador Hydro (Hydro) and its subsidiaries, distribution is managed mostly privately by Newfoundland Power (NP), a subsidiary of Fortis that supplements generation with just over 20 small hydro facilities (Government of Newfoundland and Labrador, 2018). Electricity is delivered to customers through the Island Interconnected System, which is isolated from North America, and the Labrador Interconnected System, which is connected to Quebec. With the development of the new Muskrat Falls hydroelectric project (824 MW), these two systems will be connected to each other through the Labrador-Island Link, and the rest of North America through the Maritime Link, opening access to greater trade in energy (NEB, 2018b). Two private wind power producers have secured purchase agreements with Hydro, along with a handful of other hydro and biomass generation facilities (Government of Newfoundland and Labrador, 2018).



Electricity Generation by Source in Newfoundland and Labrador
Source: NEB, 2018a



Renewable Resources and Capacity in Newfoundland & Labrador
Source: NEB, 2018b

Demographics

2016 Census Profile (Statistics Canada, 2017)

- **Population:** 519,716
- **Average age:** 43.7 years
- **Working age distribution:** 66.2%
- **Private dwellings:** 265,739
- **Private dwellings occupied by usual residents:** 218, 673

Consumption & Trade

Average electricity consumption in Newfoundland and Labrador was 16.9 MWh/capita in 2015, the fourth highest rate in Canada (NEB, 2018c). Residential was the highest consuming sector, followed by industrial and commercial, with a 5% decrease in total electricity demand since 2005 (NEB 2018c). Newfoundland and Labrador are electricity exporters, with 2015 net exports in the range of 29 TWh or 69% of total generation, due in large part to a long-term contract (expires 2041) exporting electricity from the Churchill Falls plant to HydroQuebec. The agreement is not without criticism and has faced several Supreme Court challenges from Newfoundland and Labrador, as the price paid by HydroQuebec falls significantly below market value and is claimed to hamper economic development in the region (Martin, 2006).

With the development of new transmission infrastructure that links Newfoundland to Labrador (Labrador Link), and the two to Nova Scotia (Maritime Link), the province will finally be able to sell electricity to North American markets including the USA, one of the rationales behind the construction of the Muskrat Falls and Gull Island projects (Government of Newfoundland and Labrador, 2018).

Energy Generation Regulations

Newfoundland and Labrador began developing a Net Metering Program in 2007 that launched eight years later, in 2015. The program allows residential and commercial customers to develop their own small scale electricity production, up to 100 kW, with credit or cash paid for any excess generation, and province wide participation capped at 5 MW (Government of Newfoundland and Labrador, 2018). Participants are responsible for all costs associated with their generation project beyond those of a standard utility connection and may face fees to upgrade infrastructure, in addition to purchasing equipment, installation, maintenance, permits and inspections (Newfoundland Labrador Hydro, n.d.). In the provinces Net Metering Framework policy, it states the intention behind a net metering program was not to increase the mix of renewable energy in the grid but to allow customers the option of offsetting their own energy usage (Government of Newfoundland and Labrador, 2015).

While the province owns most large generation, Power Purchase Agreements do exist for two operational wind projects in the towns of St. Lawrence and Fermeuse, and a Biogas Electricity Generation Pilot Project was launched in 2014/15, with a 2 MW individual project cap and again a 5 MW province wide participation cap (Government of Newfoundland and Labrador, 2018). No biogas projects appear to be operational at the time of writing.

Policy, Legislation, & Targets

Electricity in Newfoundland and Labrador is regulated by the Board of Commissioners of Public Utilities (PUB) through the *Electrical Power Control Act* 1994, a document which empowers the PUB to oversee both Newfoundland Power and the crown corporation Newfoundland and Labrador Hydro, and set rates for each provider and customer class, based on cost of service (Government of Newfoundland and Labrador, 2018).

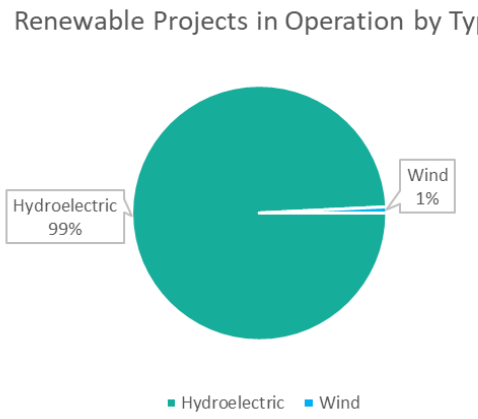
Provincial goals and energy policy are based on the document 2007 Energy Plan: Focusing Our Energy. The document relies heavily on aspirational, rather than quantifiable targets, such as:

- Environmental Leadership
- Energy Security
- Sustainable Economic Development
- Maximizing Electricity Export Value
- Maximizing Long-Term Value of Oil and Gas
- Effective Governance

Specific policy actions regarding electricity include developing the Lower Churchill hydroelectric project and associated transmission links, preparing for the Upper Churchill/Churchill Falls contract to expire in 2041, maintaining control of renewable electricity resources and approving private projects with discretion, replacing Holyrood heavy oil fuel power plant with renewables, investigating renewable energy in remote diesel-based communities, investigating 'other' renewable energy generation methods for suitability, and continuing least cost rate setting (Government of Newfoundland, 2007).

Renewable Projects Overview & Dataset

A dataset of 38 operational or in development renewable energy projects has been compiled for Newfoundland and Labrador from two primary sources: Government of Canada - Renewable Energy Powerplants, 1MW or more, and Atlas of Canada - Clean Energy Resources Projects. Of the 7,029.5 MW of operation projects, 99% (6,960.2 MW) are hydroelectric projects, 0.8% (54 MW) are wind projects, and the remaining 0.2% (15.3 MW) are bioenergy projects. No solar energy projects were identified at the commercial level, however, this list does not include Net Metering participants.



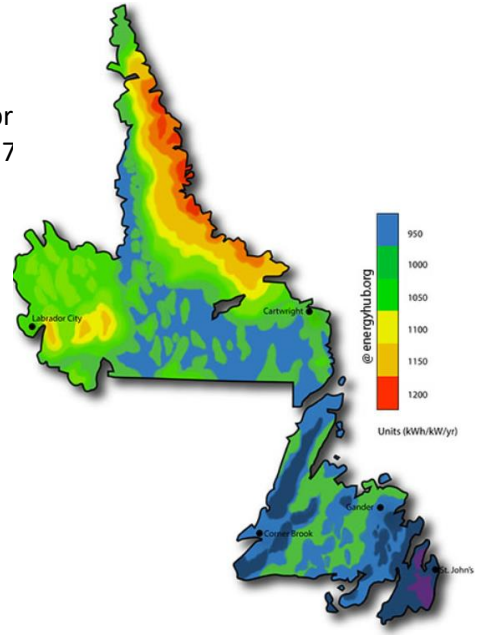
One major renewable energy project is currently under development in Newfoundland and Labrador; the Lower Churchill project is a multi-billion dollar undertaking that includes Muskrat Falls (824 MW) and Gull Island (~2,250 MW) generating stations and two transmission links spanning over 1,600 KM. Muskrat Falls is currently in development, but Gull Island has yet to start construction. See https://muskratfalls.nalcorenergy.com/project-overview/.

Renewable Energy Potential

The island of Newfoundland is separated from Labrador and mainland Canada by the strait of Belle Isle, both located on the eastern coast. The geography of the two land masses both feature mountain ranges, the Long Range (an extension of the Appalachian) in Newfoundland and the Tourngat in Labrador, and numerous lakes and rivers. Labrador borders Quebec, is the most eastern part of the Canadian Shield, and features tundra in its far north (World Atlas, 2018). These lake and river networks make for an excellent and well-developed hydroelectric potential, while numerous bays and fjords, along with coastal winds, suggest other untapped energy potential. Unfortunately, little research has been done to quantify and develop investment in these resources by either the province or outside agencies.

Solar

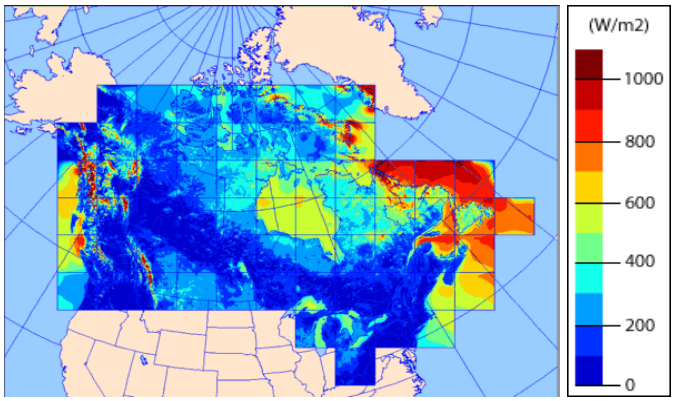
In terms of raw solar resource potential, Newfoundland and Labr received an F rating, with a 5 kW system able to produce only 4,7 kWh per year due to fog and cloud issues (Solar Panel Power Canada, 2018). However, the province does have a good net metering policy, which offers credits and market value cash rebates for excess energy sold to the grid, although systems are limited to 100 kW or less with a cap of 5 MW for province-wide participation.



Average Annual Solar Energy Production per kW installed
Source: https://solarpanelpower.ca/solar-power-maps-canada/

Wind

While quantitative assessments are difficult to find, Newfoundland and Labrador have been characterized by Environment Canada as having excellent wind energy potential, with estimates ranging from 440 MW to "117 times its 2006 energy demand" (Fisher, Iqbal & Fisher, 2008; Mercer, Sabau, & Klinke, 2017). Regions of note include the Northeast coast, the Burin Peninsula, the Northern Peninsula and parts of central Newfoundland (Fisher, Iqbal & Fisher, 2008). With only two wind projects in operation totalling ~54 MW, there is certainly undeveloped potential in the province.



Annual Mean Wind Energy at 50m Height.
Source: http://www.windatlas.ca/maps-en.php

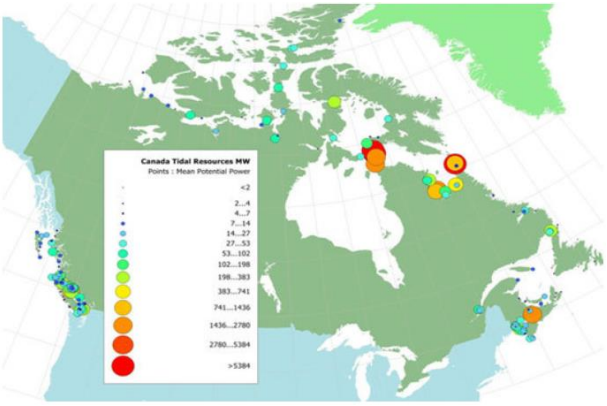
In a 2015 national study by Barrington-Leigh & Ouliaris, wind potentials across the nation were measured to determine the feasible generation. Using GIS, high wind potentials were identified using wind speeds of 7 m/s at a height of 80 m. The study excluded protected lands, inland water bodies, First Nations land, and a 5 km buffer around population centres. The remaining lands were then amended to only include lands near transmission lines (Barrington-Leigh & Ouliaris, 2015). Assuming that 25% of the remaining high potential areas are utilised, which accounts for competing land uses, Newfoundland and Labrador could generate 530 TWh per year. Of Newfoundland and Labrador's total 2015 energy demand of 32 TWh per year, onshore wind energy could account for 1622% of Newfoundland and Labrador's

total energy generation, leaving ample ability to export energy to meet demand in the neighbouring provinces connected by transmission lines (Barrington-Leigh & Ouliaris, 2015).

Newfoundland and Labrador also has some potential for offshore wind energy as well. Barrington-Leigh & Ouliaris (2015) evaluated the potential for offshore wind across the nation. Offshore wind benefits from higher wind speeds, but is challenged by higher construction costs, higher maintenance costs due to seawater corrosion, and higher transmission costs (Barrington-Leigh & Ouliaris, 2015). Most commercial offshore wind occurs at shallow depths. When examining feasible lands for offshore wind, areas near the shore and water bodies near population centres or transmission lands were considered feasible. Areas with high potential were off the coast of British Columbia, on the Great Lakes, on the Gulf of St. Lawrence, and Bay of Fundy. High potential sites do not account for shipping lanes and environmentally sensitive areas. Assuming a 50% utilization of high potential areas, it was determined that offshore wind farms in Newfoundland and Labrador could produce 13 TWh per year, meeting 42% of the total energy demand in Newfoundland and Labrador of 32 TWh per year (Barrington-Leigh & Ouliaris, 2015). Although, Newfoundland and Labrador have significant capacity to develop wind energy, only two small wind projects have been developed. Newfoundland and Labrador can capitalise on wind power to produce enough energy to support much of the eastern seaboard.

Ocean

While Newfoundland and Labrador do have ocean proximity, according to a report commissioned by the Government of Newfoundland and Labrador, the resource potential for wave and tidal are considered less than those on the west coast of Canada (e4Tech, Orion Innovations, Wade Locke Economic Consulting, 2010).



Tidal Resources across Canada
Source: https://www.nrcan.gc.ca/energy/renewable-electricity/marine-energy/7371

Tidal energy is still in its infancy, and technology is still in the process of being developed. As such, it is hard to have a realistic estimate of how much energy can be feasibly generated from tidal sources. Barrington-Leigh & Ouliaris (2015) assumed 15% of the tidal potential on the shores of Newfoundland and Labrador can be realistically captured. Under this parameter, Newfoundland and Labrador could generate 0.56 TWh per year, or 1.71% of the total energy demand of 32 TWh per year.

Wave energy is another growing technology and is also difficult to determine the true potential of wave power. Waves are faster further from the shore, but floating wave converters have high transmission and maintenance costs. In an attempt to estimate the wave energy potential of Nova Scotia, Barrington-Leigh & Ouliaris (2015) assumed wave power facilities would have to locate near the coast. Using the 500 km of coastline on the Atlantic Ocean divided amongst the four provinces with Atlantic coasts and assuming a 10% efficiency of conversion between theoretical potential and electricity generated, it was

determined that Newfoundland and Labrador could generate 5 TWh per year, or 11% of the total 49 TWh per year Newfoundland and Labrador energy demand (Barrington-Leigh & Ouliaris, 2015).

Geothermal

While geothermal heating does exist in Newfoundland and Labrador, high temperature geothermal for electricity generation is not considered to be easily accessible and is not included in the province's list of other energies to explore and develop, but once again few hard numbers exist to quantify resource potential (e4Tech, Orion Innovations, Wade Locke Economic Consulting, 2010).

Biomass

A 2010 survey of potential other energies estimates annual forest biomass feedstocks from the entire island at ~300,000 m^3 (enough for one 12 MW plant) and organic waste at ~60,000 tonnes annually for use in waste to energy projects (e4Tech, Orion Innovations, Wade Locke Economic Consulting, 2010). However, only one biomass project exists in the province, and that is a privately owned biomass generator associated with a mill. While developing potential biomass feedstocks aligns with the provinces waste and GHG management policies, there may be little feasible development at present.

Hydroelectric

While Newfoundland and Labrador are known for having large and relatively well-developed hydroelectric resources, due in part to both geography and precipitation, potential remains for smaller, run-of-river developments. With the moratorium on private energy development in 1998, these small hydro projects have remained mostly undeveloped in favour of large investments, like Muskrat Falls and the future Gull Island. A 1986 inventory of small hydro resources suggests ~850 MW of potential energy reserves over 160 sites, while a more recent reassessment puts the feasible potential at 940 MW over 190 sites (Fisher, Iqbal, & Fisher, 2008).

Barrington-Leigh & Ouliaris (2015) used the technical feasibility of hydroelectric resources and assumed a 60% capacity to generation ratio and 60% of feasible sites are developed to determine the feasibility of energy generation from hydroelectric sources. Newfoundland and Labrador could produce 61 TWh per year, which could meet 187% of the total 32 TWh per year demand.

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