Public Perception of Hydroelectric Power and the Suitability of Small-Scale Generation as an Alternate Power Source in Newfoundland and Labrador

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1. Introduction

1.1 Background

Hydroelectricity started with the wooden waterwheel and various types of waterwheels have been used in Europe and China for approximately 2000 years (Paish, 2002). The technique to use water to generate electricity was nearly perfected during the Industrial Revolution with efficiencies approaching 70% in many thousands of waterwheels in use (Paish, 2002). Improved engineering skills in the 19th century led to the development of modern-day turbines. The first hydro-turbine was created in France in the 1820s and this led to many waterwheels being replaced by turbines, as many people were thinking of how to exploit hydropower for large-scale generation of electricity (Paish, 2002). The golden age of hydropower was during the first half of the 20th century before oil became the main source of energy for most of the modern world. The development of hydropower in the 20th century was usually associated with the building of large dams. These dams while providing a major reliable power source and flood control benefits, flooded large areas of fertile land and displaced many thousands of inhabitants in the surrounding areas (Paish, 2002).

1.2 Hydro as a Renewable Energy Source

At both the world summit on sustainable development in Johannesburg in 2002, and the third world water forum in Kyoto in 2003, representatives from more than 170 countries have reached a consensus by declaring all hydropower to be renewable and worthy of international support (Yüksel, 2010). Some benefits they noted were, but are not limited to the improvement of electric grid stability and reliability. Hydropower helps fight climate change, makes a significant contribution to development, and fosters energy security and price stability (Yüksel, 2010). The renewable energy sector has grown in the past few years, and the future growth of the energy sector is in renewable energy. Air and water pollution are major aspects of continued reliance on non-renewable energy sources and this is having negative impacts on quality of life for many people (Akella *et al.*, 2009). The economic benefit of focusing on renewable energy sources is job creation. Renewable energy has cost-effective applications, such as investors saving more money from reduced fuel or power bills than invested in plant capital. Renewable energy also diversifies the economy as more varied activity strengthens it and creates more ways to generate revenue (Akella *et al.*, 2009).

Hydroelectric resources are widely spread geographically, with most of the potential for electricity generation in developing countries (Bartle, 2002). Hydroelectric power generation is a well-advanced technology with more than a century of experience. Hydro turbines convert water pressure into mechanical shaft power, which can be used to drive an electricity generator or other machinery. The power of the turbine is proportional to the pressure head and volume flow rate, and the best turbines have efficiencies of approximately 80-90%, but this reduces with size (Paish, 2002).

When hydropower reaches its peak in a certain area, it means less reliance on less flexible electricity sources, such as oil and gas (Bartle, 2002). The initial investment of a large-scale hydropower facility can be high, but hydro has relatively low operating costs and long plant life compared to other large-scale generating options. Large hydroelectric dams can help to subsidize functions like irrigation, water supply, navigation, and recreation (Bartle, 2002).

Conventional energy sources such as oil, coal, and natural gas are damaging to the environment and human life (Akella *et al.*, 2009). As a result, the globe is facing pressure on environmental fronts, and the future use of coal for example, was a focus of the Kyoto Protocol. Renewable energy supplies 15-20% of the world's total energy demands, but this is dominated by biomass, as "new" renewable energy sources (solar, wind, geothermal, and small hydropower) only contribute two percent (Akella *et al.*, 2009).

1.3 Small-Scale Hydro

Hydro is traditionally thought of as the building of large dams, which creates large artificial lakes; floods fertile land, displaces people, and interferes with river flow (Paish, 2002). Small hydro doesn't usually require dams, barrages or the build-up of water. Small-scale hydroelectric power is one of the most cost-effective and environmentally benign energy technologies and is the main prospect for future hydro developments where large-scale opportunities have already been exploited (Paish, 2002). A megawatt is defined as one million watts or one thousand kilowatts (Newfoundland Labrador Hydro, n.d.). There is no international agreement to define "small hydro," but 2.5MW – 25MW is the general consensus for the standard range of power. It can be broken down further into mini hydro (<500kW) and micro hydro (<100kW) (Small Hydro, n.d.). On the other side, above 25MW is considered large-scale hydro production (Paish, 2002). In most parts of the world the limit is 10MW, but China has regulations that set the upper limit to 25MW (Paish, 2002).

Emission reductions are expected to be real, measurable, and long term when it comes to installing more small hydro facilities. A run-of-river hydro power plant with no dam and flooding area had virtually no environmental impact, but a small visual impact.

It contributes to job creation in rural and remote areas, increases revenue for residents, and distributes electricity to local inhabitants (Akella *et al.*, 2009).

2. Materials and Methods

2.1 Survey

A short survey was created to determine the knowledge and attitudes of the general public when it comes to hydroelectric energy in general. The survey consisted of nine questions and are as follows:

i. In your own words, describe what hydroelectricity is and how it works.
ii. Where would you be most likely to go to obtain information about hydroelectric power? Select all that apply.
iii. To your knowledge, does NL Hydro only deal with hydroelectricity?
iv. Select which areas of NL you think NL Hydro services. Select all that apply.
v. Attitudes towards hydroelectricity as a source of energy?
vi. How much of an impact do you think hydroelectricity has on aquatic life?
vii. In your own words, describe what you think could be some potential problems with hydroelectric power.
viii. Age group.
ix. Sex.

The participants were given an option to skip any question that they felt uncomfortable with or did not wish to answer. A more detailed version of this survey is available by request. This survey was distributed in the daily email Grenfell Campus distributes called Messenger that goes to everyone in the student body, as well as publicly through Facebook and contact through personal acquaintances. The survey was published in Messenger twice within the same week, and left up on Facebook until the two-week deadline for responses came to an end.

2.2 Suitability Analysis

Literature was obtained that contained information on what is considered small-scale hydroelectric power generation, initial startup costs, as well as estimated power generation and potential problems with hydro energy during the winter due to ice build-up. Also obtained from literature were the average household power consumption rates and the average number of people living in rural areas of Newfoundland where the diesel generating stations are positioned. This information can be used to determine whether or not small-scale hydro facilities generate enough power to provide homes with stable and reliable energy throughout the year.

Paying attention to fish passage through the small-scale hydro system is important so that no damage is done to the surrounding environment when the facility is implemented. The areas that NL Hydro services are outlined in Appendix A. The power generation of the diesel plants NL Hydro operates was determined by visiting the NL Hydro website and navigating to the Transmission and Rural Operations (TRO) page. This division of NL Hydro is responsible for the operation and maintenance of all NL Hydro transmission and distribution systems that include 25 diesel plants, as well as three gas turbines, one frequency converter, and one mini-hydro plant (Diesel, n.d.). Using the information on average household energy use, average power generation for small-scale facilities, and the total installed capacity of NL Hydro's diesel power plants, the minimum and maximum number of small-scale hydro plants need to fulfill the energy requirements of the communities can be determined.

3. Results

3.1 Survey Results

42 people participated in this survey. 83.3% of participants responded to the first question and described what they thought hydroelectricity was and how it worked. The majority of responses involved the idea that it is "electricity from water," while some

went into more detail mentioning that water was used to “power a turbine” to generate electricity, while a small percentage of people knew that the energy was produced by water but did not know how.

Referring to Figure 1.1, when answering question number two, 100% of the participants answered. It was found that when given a choice, 31% of people would go to NL Hydro to obtain information about hydroelectricity, while Natural Resources Canada comes in second with 21%, and third is National Geographic with 18%. If a participant chose the other category, they were asked to explain where else they would go to obtain this information. 2% of participants chose other, and all of the responses stated that they would either go to Google or to the Internet.

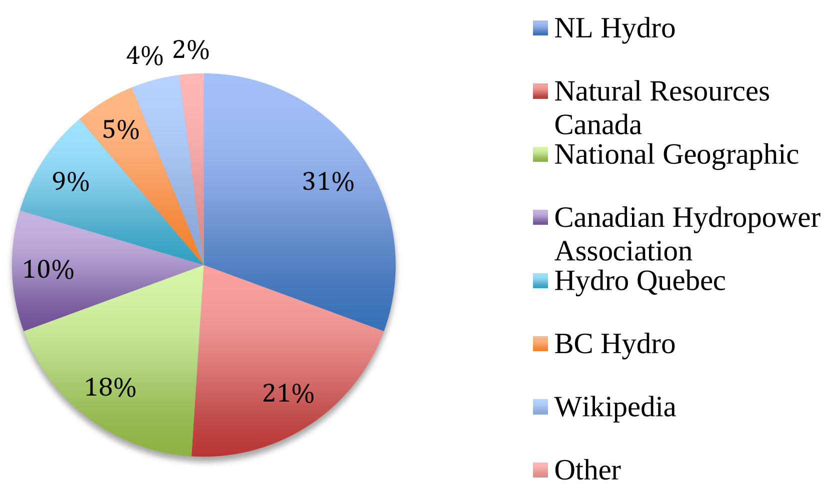

Figure 1 Percentage of respondents willing to obtain information on hydropower from different sources

The third question was answered by 100% of the participants and it was found that 50% of participants didn’t know whether or not NL Hydro only deals with hydroelectricity, 33.33% of participants said no, that NL Hydro does not only deal with hydroelectricity, and 16.67% of participants said yes, NL Hydro only deals with hydroelectricity. Within the question there was a chance for participants to explain what else NL Hydro used to generate power for the island. There were a total of six responses for this option, with all participants stating that they think NL Hydro uses coal and fossil fuels to generate some of their electricity. The fourth question was answered by 95.2% of participants and when asked which areas of Newfoundland they thought NL Hydro serviced, approximately 60% of participants, when given a choice, responded that NL Hydro serviced all of Newfoundland, while the West Coast, Central, and Northern Peninsula were the most popular if the whole island was not selected.

The fifth question was also answered by 95.2% of participants who were asked to rate their attitudes towards hydroelectricity from strongly disagree to strongly agree when given different scenarios. The percentages given are from the categories with the highest number of participant responses. 40% of participants both agree and strongly agree when asked if hydropower is a cleaner energy source, 45% agree that they would choose hydropower as a primary source of energy for their household, and 40% neither agree of disagree when asked if they were comfortable relying on hydropower throughout the year. 35.9% strongly agree that hydropower is a viable solution for our increasing energy demands, 48.72% agree that hydropower is cheaper long term, and 35.9% agree that hydropower should be considered a renewable resource.

When asked how much of an impact they think hydroelectricity has on aquatic life in question six, out of the 88.1% that answered, 43.24% of participants think that it has a negative impact when rated on a scale from extremely negative to extremely positive.

When asked to describe some problems that could arise with hydroelectric power, 69% of participants responded. The majority of the responses mentioned interference with migration routes of aquatic species, as well as habitat loss, flooding, the loss of water, and ice buildup. 92.9% and 90.5% of participants answered questions eight and nine respectively, with 41.03% of participants being between the ages 18 and 24, 28.21% age 46 and above, and 15.38% being between 25 and 35, as well as between 36 and 45 years of age. No participants were age 18 or below. When asked for their gender, 90.5% of participants responded with 73.7% being female and 26.3% being male.

3.2 Suitability Analysis Results

As mentioned previously, small-scale hydro is defined as anything that generates power between 2.5MW and 25MW of electricity (Paish, 2002). It is difficult to determine the initial startup cost of a small-scale hydro facility due to many contributing factors, and there is a positive correlation between the amount of power demanded and the cost of installation. The cost depends on the flow rate of the body of water it is positioned in, the type of turbine, the size of the turbine, and the cost of the generator and gearbox (Aggidis *et al.*, 2010).

Hydropower is an important energy source in cold climate countries such as those in Arctic regions like Norway. The Norwegian hydropower industry has a long tradition and is still one of the world's largest producers of hydropower, with it providing 99% of their energy demands (Gebre *et al.*, 2013). Ice forms on lakes, reservoirs, and rivers whenever the surface water cools to zero degrees Celsius or a fraction of a degree lower. In general, ice regimes in rivers and lakes can be defined by three main periods: (1) freeze-up and ice formation, (2) mid-winter and stable ice conditions, and (3) ice breakup in spring (Gebre *et al.*, 2013). Public safety, facility protection, and loss of energy are major considerations with respect to the operation of hydropower facilities during winter months. Ice problems are more prevalent during freeze-up (60%), then during the ice-covered period (25%), and during breakup (15%). It was found that Manitoba Hydro loses tens of millions of dollars every year due to ice effects (Gebre *et al.*, 2013). One of the most difficult problems facing river intakes in cold weather is the accumulation of frazil ice on the intake. The buildup of this ice on the intake may lead to the partial or complete blockage of it, and it could case problems downstream. These blockages can happen very fast, sometimes within minutes (Gebre *et al.*, 2013). Depending on the severity of the problem, expenses for clearing the ice may be large and shutdown can even occur if the problem gets too bad. It is recommended to design guidelines to ensure proper considerations are made to ice-related effects, operational procedures need to be devised that ensure ice problems are reduced, ice control structures should be put in place, and thermal measures should be taken such as heating of the intake gates (Gebre *et al.*, 2013).

The total number of people that are serviced by NL Hydro's diesel power generating stations is 17, 823 (Statistics Canada B, 2011). This number is calculated by searching the population of communities in Newfoundland and Labrador that are outlined by NL Hydro who are serviced by the diesel generating plants (Diesel, n.d.). Happy Valley-Goose Bay has the highest population with 7552 residents and Mud Lake has the lowest population with 54 residents. Each town/city that is serviced by NL Hydro's diesel plants and their populations are listed in Table 1.

The average household energy use, by household and dwelling characteristics is estimated to be 112 gigajoules per four-person household/year in Newfoundland and Labrador as of 2011 which is the number I will be using for my calculations. The accumulated average power consumption between a one, two, three, four, and five or more person household is estimated to be 111 gigajoules (GJ)/year (Statistics Canada A, 2011). To convert this to a number that can be easily worked with, gigajoules can be converted into gigawatt-hours (GWh) by dividing the number of gigajoules by 3600, as a gigawatt-hour is equal to 10^9 watt-hours or 3600 gigajoules. When calculated, 0.031111 GWh is the result. Since the power generation of a small-scale hydro facility is commonly in megawatts (MW), it is best to convert the 0.031111 GWh into megawatt-hours (MWh). This is done by multiplying by a factor of 100, and becomes 31.111 MWh per four-person home per year in Newfoundland and Labrador.

When looking at the literature, there are five upstream fish passage facilities that could possibly be put in place to protect them. The first is denil fish passes, which have two designs: (1) the ‘plane baffle’ or ‘standard’ with a slope of between 15 and 20%, and (2) the ‘super-active’ bottom-baffle fish pass in which herringbone-patterned steel baffles are placed on the bottom while the two sides of the channel are kept smooth. The second passage facilities are the pool fish passes, which are most frequently used at small-scale hydroelectric plants, have a slope range from seven to more than 25%, and when implemented properly can facilitate the passage of almost all fish species. The third is pre-barrages, which are often an efficient and inexpensive solution to enable fish to clear fairly low obstacles consisting of several walls or weirs downstream of the obstacle that create large pools which break up the drop to be cleared (Larinier, 2008). The fourth passage facility is natural bypass channels, the design of which is similar to those for pool fish passes but with a slope from two to five percent. Finally, there are fish locks and fish elevators that are only rarely used at small-scale hydro facilities, as they do not cater to a wide variety of species (Larinier, 2008).

Transmission and Rural Operations (TRO) is structured in three regions: TRO Labrador, TRO Northern, and TRO Central. In their Labrador and Northern Region, NL Hydro's diesel plant capacity equals 49.2 megawatts (MW). In their Central Region, diesel plant capacity equals 6.5MW, with a total installed capacity of 55.7MW of electricity through diesel throughout Newfoundland and Labrador (Diesel, n.d.).

As seen in Table 1, to power each community based on the 7.78MWh/y per person energy requirement, 6.332 small-scale hydro stations are required at a 2.5MW production capacity, 1.583 small-scale hydro stations are required at a 10MW production capacity, and 0.633 small-scale hydro stations are required at a 25MW production capacity to sustain the power needs of 17,823 people on a yearly basis. Most small communities need less than one small-scale hydroelectric facility to meet their needs for the entire year with just installing a 2.5MW facility, with the exception of Happy Valley-Goose Bay, St. Anthony, and Nain. These are also the areas with the highest populations and because of this, higher energy demands.

Table 1 Energy and facility requirements of each community NL Hydro services with diesel plants

	Population	Electricity Required in (MWh/yr)	# of Hydro Plants Required at 2.5MW Generation Capacity	# of Hydro Plants Required at 10MW Generation Capacity	# of Hydro Plants Required at 25MW Generation Capacity
Labrador					
Happy Valley-Goose Bay	7552	58754.56	2.683	0.671	0.268
Mud Lake	54	420.12	0.019	0.005	0.002
Black Tickle	168	1307.04	0.060	0.015	0.006
Cartwright	516	4014.48	0.183	0.046	0.018
Hopedale	556	4325.68	0.198	0.049	0.020
Makkovik	361	2808.58	0.128	0.032	0.013
Nain	1188	9242.64	0.422	0.106	0.042
Paradise River	349	2715.22	0.124	0.031	0.012
Postville	206	1602.68	0.073	0.018	0.007
Rigolet	306	2380.68	0.109	0.027	0.011
Northern					
Charlottetown	308	2396.24	0.109	0.027	0.011
L'Anse-au-Loup	550	4279.00	0.195	0.049	0.020
Mary's Harbour	383	2979.74	0.136	0.034	0.014
Norman Bay	720	5601.60	0.256	0.064	0.026
Port Hope Simpson	441	3430.98	0.157	0.039	0.016
St. Lewis	207	1610.46	0.074	0.018	0.007
Williams Harbour	349	2715.22	0.124	0.031	0.012
Hawke's Bay	338	2629.64	0.120	0.030	0.012
St. Anthony	2418	18812.04	0.859	0.215	0.086
Central					
Francois	114	886.92	0.040	0.010	0.004
Grey River	123	956.94	0.044	0.011	0.004
Little Bay Islands	97	754.66	0.034	0.009	0.003
McCallum	92	715.76	0.033	0.008	0.003
Ramea	280	2178.40	0.099	0.025	0.010
St. Brendan's	147	1143.66	0.052	0.013	0.005
Total	**17823**	**138662.94**	**6.332**	**1.583**	**0.633**

4. Discussion

4.1 Survey Discussion

Question one brought to light the limited knowledge of the general public when asked what hydroelectricity is and what it does. With most participants responding that hydroelectric power is “electricity from water” it is clear that they know the general premises of hydropower, but do not know the specifics on how the electricity is actually generated. Some people went beyond that to include that it involves a turbine, but most did not know how it worked at all. I believe this limited knowledge can be contributed to a lack of information surrounding hydroelectricity as a whole. Hydroelectricity needs to be a more prevalent topic in today’s world, especially with the growing concerns about climate change and global warming. More information on renewable energy technologies should be made available in schools and to the public to avoid confusion and misconceptions that are often associated with hydroelectricity.

Question two gave participants several options to choose from when asked where they would most likely obtain information on hydroelectric power. Although the majority of people chose NL Hydro as their main source as well as Natural Resources Canada, there were some people whom when given a choice would go to Google or just simply to the Internet. As we have entered the age of technology and easily accessible information, “Google It” has become a go-to response when a person asks a question they need answers for. The problem with this approach is that sometimes the Internet is not a very reliable source of information. When one Google’s something, the results that come up after hitting enter are not always the most credible, with Wikipedia being one of the first website links to show up when something is searched. Although only four percent of participants would go to Wikipedia directly for information on hydroelectricity, when the topic is searched on Google, more often than not that is the site they would click on for information.

As mentioned before, NL Hydro does not only deal with hydroelectricity but with diesel and gas as well. The third question brought to light were the misconceptions of the public on what NL Hydro actually does. Nalcor is the parent company of NL Hydro, but when people see the Newfoundland and Labrador Hydro logo, some immediately think they just deal with hydroelectricity, as Nalcor is not often thought to be associated with NL Hydro. This ties in with the misconceptions about the service areas of NL Hydro as the majority of participants think that they service the whole island, rather than the small portion of Newfoundland and all of Labrador that they actually service as displayed in Appendix A. the cause of this could be that people may associate NL Hydro with NL Power and think that they are the same company when they are not.

Public attitudes on hydroelectricity varied. As most participants agreed that hydropower is a cleaner energy source and that they would choose hydro as a primary source of energy for their household, they were not sure if they were comfortable relying on it throughout the entire year. What is shocking is that only a small percentage of participants think that hydroelectricity is a renewable resource. A high percentage of participants think that hydropower also has a negative impact on aquatic life in question six, and some mentioned that the disruption of migration routes and loss of water were some of the potential problems in question seven. While some had the right idea when identifying some of the problems, the thought that hydroelectricity uses up water was the most astonishing. These responses, similar to question one, can be contributed to a limited education on what hydropower actually is and how it works.

The age groups of the participants also reflected on education. As 28.21% of participants were above age 46, it is safe to assume that hydroelectric power was not taught or thought about during their school life, contributing to the misconceptions surrounding hydropower. Even though 41.03% of participants were between the ages of 18 and 24, the results showed that the majority of people that participated were not sure what to think about hydropower and its effects on the environment despite most being in post-secondary education. Gender did not seem to influence opinion, but these results can be interpreted as being skewed towards the female population as the majority of respondents were female.

4.2 Suitability Analysis Discussion

As determining the cost of a small-scale hydroelectric facility is difficult to do because of the variability, the best way to generate cost is to go out to a proposed site and evaluate it. Looking at the capacity of the facility, water flow, type of turbine, generator, and the type of materials used to build the area amongst other things, will have to be completed once the site is located and found suitable. Some types of turbines are best put in different areas depending on the scale of power generation and water and site suitability.

Proposing a small-scale hydroelectric facility in colder climates warrants more consideration than warmer climates due to the possibility of ice build-up on the system. As Norway is accustomed to dealing with hydroelectric stations and their complications, literature was reviewed to see if an example of how to deal with this problem could be of use in our climate. As said by Gebre *et al.* (2013), blockages can happen within minutes and can stop the entire system from running, so precautions need to be taken to make sure that this does not happen. Gates must be installed so that the ice cannot buildup and possibly damage the turbine, and the gate must be heated. Even if these precautions are considered more expensive, they need to be implemented so that the system does not fail and residents are not left without power. It is recommended that during winter months residents from the community be employed by the town to make sure that ice is cleared out of the way of the system as a preventative measure before it can do harm to the internal workings of the system. During the summer months, only a few residents need to be hired to maintain the system and do periodic checks to make sure everything is running smoothly.

The average household energy use and the number of people are important pieces of information to make sure that the installed small-scale facility is capable of supplying the residents of the area with enough electricity to sustain their day-to-day energy needs. With the number calculated for the energy requirements of a four-person household per year, it becomes easy to calculate the average energy requirement for one person. Using this number and the number of people in each community currently being serviced by NL Hydro's diesel plants, it becomes easy to calculate how many power stations are needed in order to power the homes in those communities safely and effectively as seen in Table 1.

Choosing a proper fish passage system is critical when installing a small-scale hydroelectric facility because it allows the fish to move as they usually would without disturbing the natural ecosystem too much. Out of the five fish passage systems identified above, the one that would most likely be implemented would be the pool fish passes, most often used in small-scale hydro applications that allow almost all fish species to pass through them. This is helpful because it can cover a wide range of aquatic species and can be put anywhere a small-scale facility is with no concerns to the individual fish species in the area, especially if multiple species inhabit the same river or area. A picture can be found in Appendix B of the general structure of these systems.

Through calculations, it can be known that small-scale hydroelectric facilities can be implemented in the same areas that NL Hydro services with their diesel operating plants while providing the residents in those areas with sufficient electricity to power their homes. The larger population centers such as Happy Valley-Goose Bay (HVGB), St. Anthony, and Nain need bigger capacity facilities, such as a 25MW station for HVGB, and a 10MW facility for both St. Anthony and Nain due to their population size. Communities like Mud Lake where the population is very low, a smaller size plant like 2.5MW would be enough to generate their electricity throughout the year with plenty of room for extra power usage if necessary.

In TROs Labrador division, which are communities listed in Table 1, a 25MW power station installation shared between the communities of Black Tickle, Cartwright, Hopedale, Makkovik, Paradise River, Postville, and Rigolet would generate sufficient electricity to meet the needs of the people living in those communities, and as they are all in TROs Labrador division, it can be assumed that the framework for delivering the electricity to each community is in place and would only need to be altered minimally with the exception of Nain which would have its own station as noted above. The same can be said about TROs Northern division, consisting of Charlottetown, L'Anse-au-Loup, Mary's Harbour, Norman Bay, Port Hope Simpson, St. Lewis, Williams Harbour, and Hawke's Bay with a 25MW generating station shared between them. St. Anthony is included in their Northern division, but due to their population size and location it is recommended that they have their own station as mentioned above. The Central division of TRO consisting of François, Grey River, Little Bay Islands, McCallum, Ramea, and St. Brendan's would be able to function properly with a 10MW generation facility shared between them, as the network can be assumed to be in place similar to TROs other divisions.

4.3 Small Hydro Organizations

The Small Hydro International Gateway under the Hydropower Implementing Agreement (HIA) is a working group of international energy agency member countries and others that have a common interest in advancing hydropower worldwide. It currently consists of Japan, the United States, and Norway. The member governments either participate themselves, or designate another organization in their country to represent them on the Executive Committee (Small Hydro, n.d.). In the past, Canada, China, Finland, France, Italy, and the United Kingdom were all member governments in this organization. This organization provides information on technology, policy, regulations, and planning, as well as conducting workshops called "Hydrovision" almost every year on small hydropower development.

Finding locally sourced turbines for the small-scale hydroelectric facilities would be beneficial to reducing the carbon footprint of installation of these facilities. There is a company in Canada named Canadian Hydro Components who have been manufacturing hydroelectric turbines for over 25 years. They have products that can generate a range of 100kW to 25MW of electricity, and are completely customizable depending on power output and customer requirements (Canadian Hydro Components, n.d.).

5. Conclusion

In conclusion, there seem to be many misconceptions about hydroelectric power as a whole, including how it works and what it actually is. It can also be assumed that the majority of people do not know where their power comes from, as it is the thought of the majority of people that NL Hydro services all of Newfoundland and Labrador. Public education is crucial to the future development of hydroelectric power in Newfoundland and Labrador. Educating school-aged children on renewable energy technologies as well as educating the general public through forums, programs, or workshops would help tremendously in the acceptance and understanding of renewable technologies, as well as dispel myths and misconceptions that people may have, like hydroelectric facilities “using up” or “consuming” the water that it uses to generate electricity.

Also, it was found that small-scale hydroelectric facilities could be proposed to help replace the diesel plants that NL Hydro operates in Newfoundland and Labrador. Even though there are the challenges of ice and expense of installation that cannot be accurately estimated, calculations show that the estimated power generation would be enough to cover the power needs of the populations in these rural communities, with excess power that makes sure during the winter months that the strain on the system is relatively light. This would be due to increased energy consumption for heating a house and various other appliances that are used daily. Also during the winter months, precautions need to be taken to ensure the integrity of the system is not compromised by ice build-up accumulating near the intake and potentially damaging the turbine by training and hiring residents from nearby communities to monitor the intake and free the intake from ice should the need arise. Norway is a good country to model our hydroelectric facilities after, as that is where they get almost 100% of their electricity. People also need to be hired year-round for regular maintenance to make sure that everything is running smoothly and there are no service interruptions. Using the existing network of power distribution would cut down on costs, as it would not have to be built from the ground up, along with causing minimal disruption to the service of the residents in the rural communities. Between the divisions of TRO, it was found that seven hydroelectric facilities of varying power are enough to meet the energy requirements and should be installed in rural Newfoundland and Labrador to replace the diesel power generating stations that are currently in place.

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Appendix A

Service area map between NL Power and NL Hydro for Newfoundland and Labrador

Note:
This map is intended to provide a general indication of the geographical areas presently served by Newfoundland and Labrador Hydro and Newfoundland Power. It is not intended to define the service area or rights of either utility.

Appendix B

A fish pool passage system used in most small-scale hydroelectric systems