Power Generation

Position Paper

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Executive Summary

All forms of electricity generation have environmental impacts. These must be considered during the review and evaluation of electricity generation proposals and policies brought forward in Muskoka. This paper provides information on the current options, benefits and barriers associated with various methods of electricity generation and may assist in such reviews.

The discussion of benefits and barriers to generation options is, by necessity, generic in nature. Individual generation units, particularly small ones, are likely to be unique and may incorporate measures to avoid or mitigate some of the barriers identified. The material in this paper should be used only as a general guide and does not remove the need for site-specific investigation on the merits of an individual project.

Beyond the benefits and barriers discussed for each possible generation option, major benefits that apply to virtually all generation in Muskoka are that:

- local sources of generation lessen the demand on the grid to deliver electricity from remote generation sources, ultimately reducing or delaying the need for new transmission lines;
- there are lower losses from transmission, improving the efficiency of the system; and
- most construction, operation and maintenance costs (with the exception of fuel costs in the case of natural gas) stay within Muskoka.

The implementation of <u>full cost accounting</u> to the selection of new generation assets has the potential to identify which options truly represent the best choices. This is particularly true where the accounting is done on a full life cycle basis. Assessed in this way, generation from non-emitting renewable options can be seen to have very low environmental impacts.

Generation from non-emitting renewable sources such as hydro, wind and solar facilities also has the potential benefit of displacing fossil fuel-based generation elsewhere in the province, thus lowering overall emissions associated with the problems of climate change, acid rain, smog and air toxins.

Nuclear and/or coal-based generation are considered unlikely options for Muskoka, and so are not discussed in detail. The benefits and barriers for options considered more likely to be developed in Muskoka are summarized in the following table.

Option	Benefits Barriers		Mitigation Measures
Gas-fired generation - General	 lowest emissions of fossil options quick to build and low capital cost high availability to respond to demand flexible sizing small physical "footprint" 	 emissions contribute to climate change and smog operating cost depends on volatile gas prices non-renewable noise ground-level fog from cooling systems "upstream" issues re: gas supply (e.g. fracking) 	 siting and setbacks from residential areas noise abatement structures emissions can be decreased by design provisions for higher efficiency and low Nitrogen Oxides emissions
Gas-fired cogeneration	 highest efficiency (80%) and lowest emissions of gas-fired options 	 needs to be co-located with demand for thermal energy may be limited in ability to turn down when demand is low 	 same as above for "Gas-fired generation - General"
Gas-fired combined cycle generation	 moderately high efficiency (50%) and low emissions 	 higher capital cost than simple cycle (see below) 	 same as above for "Gas-fired generation General"
Gas-fired simple cycle generation	 lowest capital cost of gas-fired options 	 lowest efficiency and highest emissions of gas- fired options 	 same as above for "Gas-fired generation General"
Limited-storage hydro	 no direct emissions low operating costs low noise can store small amounts of energy (water) during low demand for use during high demand flood control 	 visual impairment due to infrastructure potential fish barrier and fish mortality due to turbines public access restrictions minor changes to river flow regime 	 siting and infrastructure design to minimize visual impairment use of existing flow control dams turbine design to minimize fish mortality control river flow in accordance with Management Plan
Run-of-river hydro	 no direct emissions low operating costs low noise no changes to river flow regime 	 visual impairment due to infrastructure potential fish mortality due to turbines no ability to store energy (water) for use during high demand 	 same as above for "Limited-storage hydro"
Wind turbines	 no direct emissions can be co-located with other land uses 	 not available to follow demand at all times few sites with good wind power potential in Muskoka potential visual impacts 	 use in conjunction with Limited-storage hydro or other storage options appropriate siting and setbacks will reduce visual impacts

Table i: Benefits and barriers for power generation options in Muskoka

Option	Benefits	Barriers	Mitigation Measures
		 uncertainties re: impacts on human health, birds, bats 	as well as potential impacts on humans, birds, bats
Solar photovoltaic	 no direct emissions efficiency increasing, costs decreasing no noise 	 not available to follow demand at all times potential visual impact potential large "footprint" may interfere with farming, heritage areas, habitat etc. 	 use in conjunction with Limited-storage hydro or other storage options siting to avoid visual and "footprint" issues
Biomass combustion	 renewable CO₂ emissions not counted as GHGs 	 needs large amounts of biomass with long-term secure supply transportation of biomass may be major cost and public concern power plant emissions may impact human health 	 co-location with biomass source emission control technologies available
Waste-to-energy	 reduce costs, visual impacts and land use associated with landfills reduce greenhouse gas emissions from landfills 	 financial arrangements may be onerous public acceptance has been mixed transportation of MSW may be public concern emissions may impact human health 	 siting to alleviate transportation issues emission control technologies available
Generation from landfill gas	 reduce greenhouse gas emissions from landfills 	 capital cost of gas collection system 	
Generation from (farm) biogas	 reduces potential water pollution from animal manure reduce potential for local odour problems 	 capital costs for system may be difficult to recover for small farm operations 	
Energy conservation & efficiency	 generally the least expensive form of "new" generation very large potential in Ontario for improvement no emissions, health, environmental, water, land use, habitat or visual impacts no new transmission lines 	 concern that reductions in electricity use may not be maintained over time 	

Recommendations

Muskoka Watershed Council (MWC) supports electricity generation options that are consistent with objectives that:

- Promote activities and best practices that support an environmentally sustainable economy and environmentally healthy communities; and
- Promote environmentally responsible behaviour by individuals, government, business and industry by demonstrating lifestyle and best management practices that enhance the economic, social and environmental well-being of watershed communities.

More specifically:

- 1. MWC strongly supports sustainable electricity generation, transmission and conservation initiatives. These need to balance the economic and social benefits for Muskoka (and Ontario) with environmental impacts. These goals could best be achieved by ensuring consistency of approach with the District's neighbours.
- MWC strongly supports demand-side electricity conservation and efficiency measures as the first priority in managing demand for electricity before the construction of new facilities.
- 3. MWC strongly supports local electricity initiatives that increase the efficiencies in existing facilities provided environmental impacts are carefully considered.
- 4. MWC supports the concept of community social enterprise, individual and municipal electricity generation projects because these enhance the economic, social and environmental well-being of watershed communities.
- 5. Where new power generation facilities are proposed in Muskoka, it is MWC's position that any new proposal be reviewed based on the following principles:
 - a) Small-scale decentralized power generation projects are preferred over largescale centralized power generation projects as they have a smaller environmental footprint and minimize the requirement for new transmission lines which can cause habitat fragmentation and other environmental impacts.
 - b) All new projects should minimize negative impacts on wetlands, fish habitat, shorelines and large natural areas. For example, hydro projects that use existing dam structures on altered sites are preferable to creating new dams, road and transmission infrastructure to access previously undisturbed natural sites.
 - c) New electricity projects should consider all the alternatives including the "No" alternative.
 - d) Renewable electricity generation options provide supply with the lowest overall environmental and health impacts.
 - e) Assessment of all new projects should be based on evaluation of the full life cycle environmental, health and social costs of alternative generating sources.

- 6. Opportunities for sustainable generation discussed in this report are evolving rapidly and continuing to receive significant financial incentives from the province. The impacts of climate change on electricity generation in Muskoka are likely to be better defined as studies are completed. In consideration of these factors, MWC recommends that opportunities for sustainable generation be reviewed on a more frequent basis (e.g. every two years).
- 7. Many of the components of poor air quality related to electricity generation come from activities outside of Muskoka and to a large extent outside of Ontario. MWC supports any efforts through provincial, federal and international initiatives to encourage other jurisdictions to develop air quality improvement strategies related to coal-powered electricity generation that impacts our air quality in Ontario and globally.

Introduction

The mission of Muskoka Watershed Council (MWC) is "to champion watershed health". Our goal is to sustain and enhance the water and terrestrial ecosystems of the watersheds of Muskoka for the environmental, health, economic, spiritual and intrinsic values they provide.

All forms of electricity generation have environmental impacts. These must be considered during the review and evaluation of electricity generation proposals and policies. On this basis, MWC extensively reviewed electricity generation options and the Power Generation Position Paper was published in February 2009.

Since that time, it has become clear that many jurisdictions are changing how they generate electricity and how they use it. The traditional reliance on large generating stations and transmitting the power over long distances has been supplemented by much smaller generators being connected directly to distribution systems. This has come about as a result of utilities around the world being faced with community opposition to large transmission lines [1] and also as a result of improved economics of many smaller scale generation options.

The interval since the last MWC Position Paper on Electricity Generation also saw advances in renewable energy technologies and declining equipment costs. On all these bases, a much broader uptake has been seen of smaller scale energy generation by private citizens, industry and municipalities.

Access to a reliable electrical supply is essential for people and the economy of Muskoka. This paper reviews the current options, benefits and barriers associated with the various methods of electricity generation in Muskoka and make a clear case for action to encourage sustainable electricity generation policies.

Recent Ontario Initiatives Affecting Electricity Generation

The Green Energy and Green Economy Act, Bill 150, (GEA)

In 1998, the provincial Government "deregulated" the electricity system, separating the generation and distribution functions and introducing a competitive market for electricity generation. This paved the way for expanded development of energy generation facilities, transmission and distribution systems by individuals, municipalities, community groups, independent generators and other organizations.

The GEA came into effect on May 14, 2009. The aims of the GEA are to decrease use of fossil fuels, expand renewable energy generation, encourage energy conservation and promote the creation of clean energy jobs.

The Feed-in Tariff (FIT) Program

The FIT program was launched to support the goals of the GEA. It provides energy purchase contracts for large, small and micro generators of electricity from renewable sources. The contracts include fixed prices that are intended to ensure generators recoup their costs and make a profit. The FIT program initially applied to energy generation projects over 10 kW and the microFIT program for those under 10 kW. These programs apply to solar PV, wind power, hydro-electricity and bioenergy (biomass, biogas on farm, biogas and landfill gas) generation. In 2014 the government replaced the FIT program for projects over 500 kw with a competitive procurement model (large renewables procurement).

Municipal Input to Electricity Generation Projects

Under the initial FIT 1.0 program, municipalities had little say regarding generation projects. But the newer FIT 2, 3 and 4 programs contain a number of provisions which provide municipalities with greater influence, including the ability for municipalities to selectively support the projects they feel fit best with local planning priorities and local character. [2]

All but microFIT solar and wind power projects are subject to environmental approvals under provincial regulations.

Provincial Policy Statement and Municipal Official Plans

The Ontario Provincial Policy Statement (PPS) contains provisions which are to be integrated into all municipal plans. Section 1.8.1 of the most recent PPS directs municipal planning authorities to: "support energy conservation and efficiency, improved air quality, reduced greenhouse emissions, and climate change adaptation through land use and development patterns."

Smart Meters

The future for electricity distribution will be computerized and data-driven. For this reason, Smart Meter use is included in the GEA and is now mandatory across Ontario. Smart Meters, in conjunction with other smart grid devices, tie individual electricity use information into programs which monitor usage across the grid allowing direct intervention if peak loads are being passed. These features will support electricity conservation measures (discussed later in this paper).

Ontario Long-Term Energy Plan

In December 2013, Ontario issued "Achieving Balance, Ontario's Long-Term Energy Plan". [3] This predicts future growth patterns and sets out methods to get there most efficiently. A key feature of the plan is that conservation will be preferred as the first choice before building new generation and transmission. The concept here is that conserving a given amount of electricity is equivalent to, but preferable in many ways to, getting the same amount of power from new generation. Following this concept, the plan forecasts that from 2013 to 2031, the role of conservation will increase from 5% to 16% of electricity production. During the same period, nuclear's share of electricity production will decrease from 56% to 39% (the Pickering nuclear plant will cease operation during this time), hydro-electricity and gas will remain constant at 22% and 10% respectively, wind will increase from 3% to 9%, solar photovoltaic will increase from 1% to 2%.

The Long-Term Energy Plan (LTEP) committed to the development, where needed, of regional energy plans for the province's 21 electricity regions. A plan for the South Georgian Bay/Muskoka Region is now under development as of June, 2015. [4] The LTEP is expected to be reviewed in 2016.

Current Electricity Generation Mix in Ontario

Ontario has a more diverse mix of electricity generation sources than most other provinces. For example, the provinces of Alberta, Saskatchewan and Nova Scotia rely primarily on thermal (coal and gas) generation, and British Columbia, Manitoba, Quebec and Newfoundland rely primarily on hydro generation. As indicated in Table 1, Ontario has substantial generation capacity from nuclear, hydro-electric and thermal sources. Such a diverse supply mix can enhance the reliability of the electricity system by making it less prone to potential problems with any one source.

Source	Installed Capacity (MW)	Fraction of Total Capacity (%)	Total Generation (MWh)	Fraction of Total Generation (%)
Nuclear	12,947	38.3	94,900,000	62
Hydro-electric	8,119	24.0	37,100,000	24
Gas/Oil	9,920	29.4	14,800,000	10
Coal *	0	0	100,000	<1
Wind	2,483	7.4	6,800,000	4
Biofuel	302	0.9	300,000	<1
Solar			18,500	<]
Imports			4,900,000	-
Total	33,771		154,000,000	

Table 1: Ontario Installed Generation Capacity (MW) and Total Generation (TWh) for 2014 [5]

* Last coal-fired generator phased-out April 2014

Table 1 indicates that a source's fraction of total capacity may be very different from its fraction of total generation. Sources for which the fraction of total generation is higher than the fraction of total capacity are normally operating close to their maximum rated capacity, i.e. at a capacity factor perhaps between 0.6 and 0.9 (see section on "Capacity Factor" below). Sources for which the fraction of total generation is lower than the fraction of total capacity are often not producing electricity at all or are operating at well below their maximum rated capacity, i.e. at a relatively low capacity factor perhaps between 0.1 and 0.4. This is due to a number of characteristics of each source, summarized in the following description of generation sources.

Capacity Factor

Capacity Factor is the amount of power a plant actually generates (MWh) divided by the amount of power it would generate (MWh) if run continuously at maximum rated capacity.

If a hypothetical power plant with a capacity of 1 MW were to operate at maximum capacity for a year (8,760 hours) it would generate $1 \times 8,760 = 8,760$ MWh of electricity.

However, plants virtually never run at all times at maximum rated capacity. The reasons for this include scheduled and unscheduled maintenance, lack of "fuel" (including water in a reservoir or wind), load-following (running only enough to match demand) or not being scheduled to run because other lower-cost generation is available.

If the hypothetical 1 MW plant actually produces 4,380 MWh of electricity over a year, then its capacity factor is 4,380/8,760 = 0.5. This is equivalent to the plant being run continuously at 50% of maximum rated capacity; however such continuous operation is almost never the case, and generation rates may vary widely over a given day.

MW and MWh

MW (Megawatt = 1 million watts) is a measure of the instantaneous rate of generation or consumption of electric power. (Analogy: the rate at which water flows out of a hose)

MWh (Megawatt-hour) is a measure of the total amount of electricity generated or consumed over a period of one hour. A generator with a capacity of 2 Megawatts operating at full capacity for 24 hours would generate 48 Megawatt-hours (MWh) of electricity. (Analogy: the amount of water in the tank after an hour of runnina the hose)

Sources of Electricity Generation

Thermal Power Generation (Nuclear, Coal, Oil, Gas, Biomass)

All thermal power generation plants use heat to produce electricity. Nuclear, coal, biomass and some oil-fired plants use the heat from a nuclear reaction or from the burning of a fuel to produce steam which powers a turbine which in turn powers the electricity generator. Some oil-fired plants and most gas-fired plants use fuel directly to power a combustion turbine which in turn powers the electricity generator. In all these plants, the cost of producing electricity is a combination of the "fixed" costs, primarily the amortized cost of building the plant, and the "variable" costs, which may be primarily the cost of fuel. Plants with higher variable costs are likely to be used only when needed to meet high electricity demand at certain times of the day. These are known as "peaking" plants.



Nuclear: Nuclear power is highly capital-intensive, but once the investment has been made and the nuclear plant has been commissioned, the cost of the nuclear fuel is low relative to the cost of fossil fuels. Also, nuclear plants cannot vary their output rapidly to respond to changing electrical demand. Therefore the operating strategy is normally to run the plant at or near its maximum capacity as much as possible. This mode of operation is known as "baseloaded", meaning that the plant's output is maximized and contributes to supplying the "base" amount of electricity that is needed even at times of lowest demand. Other types of plants may vary their output to supply the incremental electricity (above the "base" amount) needed to meet the demand that exists at any particular time.

The combination of the need to run at maximum output to recover "sunk" capital cost, the low cost of fuel, the relatively clean nature of the process, the need to maintain relatively constant output and the ability to re-fuel while operating results in CANDU nuclear plants potentially operating at a capacity factor of 0.8 or more.

Coal: Coal is low in cost relative to other fossil fuels, and in many provinces coal-fired power plants are located adjacent to coal mines, contributing to lowering of fuel costs and increasing security of supply. Such plants are generally base-loaded. However, Ontario has imported virtually all of its coal. Coal contains a very large number of compounds that, in addition to causing high emissions of air pollutants, create operational and maintenance problems for the plant. Maintenance requirements have resulted in a capacity factor of 0.6 being common for coal-fired plants in general.

Gas: Whereas natural gas can fuel a number of sources of electricity generation, almost all new natural gas-fired electricity generation is expected to be based on combustion turbine plants. These can be built as simple-cycle units or as more efficient but more costly combined-cycle units. Their most efficient use, however, is in cogeneration mode, where the units produce both electricity and useful thermal energy for use in industrial processes or space heating and cooling.

Simple-cycle units are relatively inexpensive to build and can be brought on-line quickly. However, the cost of natural gas makes their electricity relatively expensive. This has led to their use primarily as peaking units, operating at low capacity factors but able to respond quickly to changes in electricity demand.

Cogeneration units are most commonly used where there is an ongoing need for their thermal energy. Electricity is therefore produced as effectively base-load generation, operating at higher capacity factors than other gas-fired sources.

Biomass: Biomass-fired units are usually associated with the availability of waste biomass from some other enterprise. Therefore the fuel itself is relatively inexpensive although transportation costs may be substantial. Where costs for fuel, including transportation, are low and the supply of fuel is consistent, biomass plants can be run at a high capacity factor.

Hydro

In this type of power generation, the flow of water turns turbines which produce electricity. Hydro-electric plants are often the lowest-cost source of power available to a provincial electricity grid, and are therefore used as much as possible. The main limitation is the supply of water, which usually varies over the course of a year and between years according to climatic conditions. However, in the short term at least, the supply of water can be predicted and for some systems the supply can be managed such that generation can be matched to demand. Capacity factors may vary greatly among plants and over time.

Wind

Once the plants are built, the operating costs of electricity generation from wind are very low and therefore wind generation capacity is used as much as possible. However, electricity generation is very sensitive to wind velocity, being proportional to the cube function of velocity. When the wind velocity drops far below the desired operating range, generation decreases dramatically. For these reasons, wind generation generally has a very low capacity factor, generally not more than 0.3 [6], and for inland central Muskoka only about 0.1. The likely capacity factor is accounted for in the design and cost decisions for a given site.

Solar

Photovoltaic cells transform solar energy into direct electric current, which can then be changed into alternating current and fed into the electricity grid. Like wind, solar energy itself cannot be economically stored and cannot be depended upon to meet demand at a certain location and time. As is the case for wind power, solar-generated electricity can be used in conjunction with hydro-electric systems to conserve water for generation when solar energy is not available, and in the future with systems for storage of the electricity generated by solar photovoltaic cells.

Similar to wind power, the capacity factor for solar systems in Ontario is rather low (<0.15) requiring a correspondingly large multiple of the installed capacity to achieve the desired average output.

Environmental Impacts of Electricity Generation Options

The most common measure for the impact of alternate sources of generation is the so-called "carbon footprint" which is most commonly expressed in terms of "greenhouse gas equivalent" to take into account both carbon dioxide and other GHGs such as methane (from natural gas). Many studies have been undertaken on "carbon footprint" and this index is of primary importance when considering the impact of generation on climate change. In Figure 1 below, [7] reading the bar chart from left to right, the contribution of coal fired generation can be seen to exceed 1,000 Tonnes CO₂ equivalent/GWh (1,000 kilograms per kWh), while nuclear and

renewables are all below 100, less than 1/10th the value for coal. An important aspect of such studies is that they aim to take into account "upstream" and "downstream" sources of carbon such as emissions from construction, fuel transportation, decommissioning, etc., and not just that emitted directly in generation.



Figure 1: Greenhouse gas equivalent emissions of electricity generation options

Greenhouse gases, while very important, are only one measure of the impacts of electricity generation. Increasingly, studies look at the full range of environmental and social impacts of generation options. Figure 2 [8] is illustrative of such studies.

Though this study and others [9] have expressed environmental impacts in varying ways, the conclusions are consistent with this illustrative example and the GHG chart in Figure 1: renewables have very low overall environmental impacts.

Managing an electricity system according to the full environmental impacts of each generation option is relatively new and not fully implemented. As a result, renewable sources which may have very low environmental and health impacts are seen as being excessively expensive and "uncompetitive" compared to fossil fuel-based sources which do not account for their environmental and health costs (considered as "externalities" because they are not directly paid out). The Green Energy Act attempts to address this imbalance by paying premiums through the FIT program to encourage development of certain types of green energy which cannot as yet compete effectively in a competitive electricity market. Ultimately, however, the implementation of <u>full cost accounting</u> to the selection of new generation assets has the potential to identify which options truly represent the best choices. This is particularly true where the accounting is done on a full life cycle basis, such that the full economic, social and environmental costs of manufacturing the equipment, extracting, processing and transporting the fuel (if any), health impacts of emissions and effluents, environmental losses, and ultimate decommissioning of the plant are taken into account.

Figure 2: Relative environmental impacts for waste, water, land use, radioactivity, greenhouse gases and contaminant emissions (weighted) of electricity generation options (adapted from SENES and OPA)



Current Electricity Generation in Muskoka

Hydro-electricity is the only form of generation that has had a long-term and major presence within Muskoka. The Muskoka River system drops from a height of approximately 525 m near Algonquin Park, to a height of approximately 177 m at the outlet to Georgian Bay. This 348 m drop in height, coupled with the volume of water in the system, means that substantial amounts of hydro-electric generation are potentially achievable. These characteristics have led to the development, beginning in 1894, of hydro-electric generations on the system. [10] The 10 current stations, listed in Table 2, have a combined electricity generation capacity of approximately 35 MW.

River	Station Name	Capacity (MW)	Head (metres)	Owner	
	Bracebridge Falls	2.6	10	Bracebridge Generation	
N. Muskoka	High Falls	2.6	14.6	Bracebridge Generation	
	Wilson's Falls	2.9	13.1	Bracebridge Generation	
S. Muskoka	Hanna Chute	1.46	9.0	Ontario Power Generation	
	Matthias	2.45		Orillia Power Generation	
	South Falls	5.0	11	Ontario Power Generation	
	Tretheway	2.0	10.7	Ontario Power Generation	
	Little Burgess	0.32		KRIS Renewable Power	
Muskoka	Big Eddy	8.0		Ontario Power Generation	
	Ragged Rapids	8.0		Ontario Power Generation	
		Total = 35.33			

Table 2: Current hydro-electric generating stations in Muskoka

The plants in the above table represent approximately 0.1% of Ontario's generation capacity, and on average likely generate approximately the same proportion of Ontario's electricity. The output of electricity from these plants varies seasonally and daily in accordance with availability of water and, to some extent, in response to demand for electricity on the Ontario grid (plants of this size are not "dispatched" based on demand, but may vary their output in response to demand-related pricing). However, the amount of electricity generated in Muskoka will generally be less than the district demand, such that Muskoka will be a net importer of substantial amounts of electricity generated elsewhere in Ontario or imported from other jurisdictions.

Therefore, decisions made in Muskoka relating to new electricity generating options for the future, as well as measures to reduce demand for electricity, have implications beyond Muskoka. These include the release of air contaminants and greenhouse gases from fossil fuel-based generating plants, the accumulation of spent nuclear fuel, the diversion of rivers for hydro power and the construction of new transmission lines. Many of these implications have the potential to impact the environment and quality of life within Muskoka. Therefore a "not in my backyard" approach to power generation in Muskoka may not be in the long-term best interest of Muskoka.

The sites at which the existing plants are located are often locations of stirring natural beauty. They are emblematic of Muskoka's "green" identity and warrant our protection. In general, careful consideration of social and environmental impacts has gone into the recent expansion of small hydro-electric stations in Muskoka. See for example the Bracebridge Falls Environmental Impact Statement. [11]

Future Electricity Generation Options for Muskoka

Some electricity generation options have a very low probability of being developed in Muskoka in the foreseeable future. These options, and the reasons they are considered unlikely to be developed, are discussed briefly below followed by a more detailed review of the benefits and barriers to options that are more likely to be developed in Muskoka.

Options Unlikely to be Developed in Muskoka

NUClear: CANDU nuclear plants in Canada are developed from units of at least 700 MW in size which, for technical reasons, are best developed as a multi-unit plant. The large size of the plants means that they are best located in proximity to major load centers and existing or planned transmission corridors. Large nuclear plants require very large volumes of cooling water, and this is why all plants developed in Canada have been located adjacent to large waterbodies such as the Great Lakes. The limited amount of Georgian Bay shoreline available in Muskoka and the distance from major load centers and transmission corridors makes the development of large nuclear generating plants in Muskoka unlikely. Although future options for nuclear plants are likely to include those that are smaller and modular, [12] the licensing and infrastructure challenges posed for new nuclear sites also make nuclear a very unlikely option for Muskoka.



Coal: Like nuclear plants, coal plants are usually large in size and situated close to load centres and large cooling water sources such as the Great Lakes. Also, the burning of coal to produce electricity releases large quantities of emissions including sulphur dioxide, nitrogen oxides, respirable particulates, mercury and other heavy metals, and carbon dioxide. These are associated with serious health and environmental impacts including acid rain, smog, air toxins and climate change. These considerations and others have led to Ontario phasing out coal-fired electricity generation as of April 15, 2014. [13] Therefore, the development of coal-fired generation in Muskoka is unlikely.

Possible Electricity Generation Options for Muskoka

Environmental benefits and barriers must be assessed as well as societal needs in addressing power generation options.

The following discussion of benefits and barriers to generation options is, by necessity, generic in nature. Individual generation units, particularly small ones, are likely to be unique and may incorporate measures to avoid or mitigate some of the barriers identified. The following discussion should be used only as a general guide and does not remove the need for site-specific investigation on the merits of an individual project.

Beyond the benefits and barriers discussed in the following for each possible generation option, major benefits that apply to virtually all generation in Muskoka are that:

- local sources of generation lessen the demand on the grid to deliver electricity from remote generation sources, ultimately reducing or delaying the need for new transmission lines;
- there are lower losses from transmission, improving the efficiency of the system;
- most construction, operation and maintenance costs (with the exception of fuel costs in the case of natural gas) stay within Muskoka;

As well, municipally-owned generation is a source of revenue, offsetting tax-based revenue.

Generation from non-emitting renewable sources such as hydro, wind and solar facilities also has the potential benefit of displacing fossil fuel-based generation elsewhere in the province, thus lowering overall emissions associated with the problems of climate change, acid rain, smog and air toxins.

Climate change is destined to alter the Muskoka environment in a number of ways, and these will need to be taken into account as new generation facilities are installed. For example, reductions in water flow, especially in the summer and early fall, may reduce hydro-electric generation; higher flows in early spring might not be fully useable to generate additional power from existing hydro-electric plants if they exceed the installed capacity; a higher frequency of cloudy days may reduce the output of solar arrays; and wind patterns are likely to be different from those for which wind generation has been optimized.

Natural Gas-Fired Combustion Turbine Generation - Generic:

The following are benefits and barriers common to all natural gas-fired combustion turbine generation options. Specifics on these options follow the generic description.

Benefits: Natural gas is the cleanest-burning of the fossil fuels. Uncontrolled emissions of sulphur dioxide, particulates and heavy metals are virtually zero, and emissions of nitrogen oxides and carbon dioxide may be as low as 20% of those from coal-fired generation, depending on the efficiency of the unit.

Natural gas-fired combustion turbines can generate large amounts of power in relation to their "footprint", their output can respond quickly to changes in demand, and can they be made to blend in well within an urban environment. They do not require space for fuel storage, such as a coal pile or oil tank. They can be built quickly at relatively low capital cost and in a wide range of capacities.

Barriers: Natural gas is a non-renewable fossil fuel. In addition to the releases of nitrogen oxides and carbon dioxide during combustion at the generation site, the extraction, processing and transportation of natural gas is associated with substantial releases of methane, which is 25 times more potent a greenhouse gas than carbon dioxide. [14] However the full-cycle emissions are still the lowest of the fossil fuels if the gas is extracted by conventional means. But easily extracted supplies are nearing their end and new techniques of extraction requiring hydraulic fracturing have resulted in public concerns relating to groundwater contamination, inadvertent escape of methane gas, earthquake triggering, etc. There is also concern that here has not been a life cycle analysis done of the carbon used to obtain these deposits to show if there is an overall savings in emissions.

Experience in the Greater Toronto Area has recently shown that communities may not accept the presence of large gas-fired plants in their neighbourhoods. Such decisions are based, in part, on the fact that gas-fired combustion turbine generation uses a turbine similar to those used in jet aircraft, which will require the use of substantial sound insulation in locations where noise is an issue.

Depending on system design, combustion turbine-based units may use cooling systems, which can release large amounts of water vapour into the air. This can cause ground-level fog which may be a safety concern for traffic. Use of river and lake water for cooling in Muskoka would likely be undesirable given the smaller size of these water sources and the proportionately greater impacts of higher water temperatures on biota.

The cost of electricity from natural gas-fired generation is highly dependent on the price of gas. At gas prices of 2-4 \$/mmBtu prevalent in the period 2009-2012 electricity generation from gas is competitive relative to many other sources of generation. However, a return to prices in the range of 6-10 \$/mmBtu prevalent during the period 2005-2008 greatly reduces the competitiveness of gas unless cost is outweighed by factors such as the need for peaking power or the efficiency of the cogeneration option. Uncertainties in the future price for natural gas may make this option less attractive.

Natural Gas-Fired Combustion Turbine Generation - Options

Natural Gas-Fired Cogeneration:

Benefits: The cogeneration configuration (also known as combined heat and power) most commonly uses a gas turbine to power an electricity generator. The hot exhaust from the turbine is used to generate steam or hot water that can then be used for industrial processes or space heating. In this way, up to 80% of the energy in the natural gas is converted to useful energy, resulting in the highest efficiency and lowest emissions of any natural gas-fired generation system.

Cogeneration units can be made in a wide range of sizes to fit a range of applications, down to very small (micro) installations. Their high efficiencies can counterbalance, to some extent, potentially high costs for natural gas.

Barriers: Cogeneration must be linked to some on-going need for thermal energy. Examples are industrial processes, hospitals, government offices and educational institutions which need significant quantities of hot water for heating or process (e.g. laundry) needs. There are likely to be relatively few opportunities for these on a retrofit basis throughout Muskoka compared to more urban/industrial areas. Future construction of such facilities, as well as multi-family dwellings, such as condominiums, could incorporate hot water systems (heating and other) compatible with gas-fired cogeneration. This would provide a financial benefit to offset the significantly higher costs of natural gas to be experienced during the life of these facilities.

Combined-Cycle Natural Gas-Fired Generation

Benefits: Combined-cycle units typically use a gas turbine to power an electricity generator. The heat from the gas turbine exhaust is used to generate steam which is then used to generate additional electricity, resulting in overall efficiencies in the order of 50%. Combined-cycle units are therefore less efficient than cogeneration units but more efficient than simple cycle units. Emissions are in accordance with efficiency. Units can respond quickly to changes in demand and are therefore well suited for peaking service.

Barriers: Combined-cycle natural gas-fired units are usually built specifically to deal with peaking service requirements in areas of high and varying demand. They are therefore best located adjacent to these areas. Muskoka is not currently such a location.

Future cogeneration units may employ fuel cells, which are better sized for small commercial and industrial applications, and they can operate almost silently. Most fuel cells generate electricity from hydrogen which can be derived from natural gas. Those able to burn natural gas directly are at large-scale testing in Germany. [30] As these become commercially available over the next few years, they would enable businesses and institutions to benefit from a source of quiet and efficient distributed generation.

Simple-Cycle Natural Gas-Fired Generation

Benefits: These units are relatively inexpensive and can be brought on-line quickly.

Barriers: These are the least efficient of the gas-turbine based generation options, and emissions are accordingly higher. The lower efficiencies also lead to higher fuel costs.

Renewables:

Hydro-Electric Generation:

The existing hydro-electric stations in Table 2 account for less than half the drop in the Muskoka River system, suggesting that additional hydro potential exists within the system. The Ontario Ministry of Natural Resources and Forestry (MNRF) Renewable Energy Atlas [15] lists a number of sites in the system where the potential exists, at least in theory, to develop additional hydro-electricity. However, this source contains no information on the feasibility or cost of developing this potential at any given site. Subject to that caution, those sites that have a potential of greater than 100 kW are listed in Table 3. A number of sites with less than 100 kW of potential likely exist.

River	Location	Capacity (MW)	Head (metres)	Existing Dam?
N. Muskoka	Mary Lake Dam	0.43	2.4	Yes
	6.4 km below Mary Lake	0.46	2.4	No
	Duck Chute	0.67	3.4	No
	Fairy Lake Dam	0.41	2.4	Yes
S. Muskoka	Baysville Dam	0.52	3.0	Yes
	Slaters Chute	1.42	7.9	No
	Crozier Chute	2.4	12.19	No
Oxtongue	Marshs Falls	0.54	6.69	No
Muskoka	North Bala Falls	4.0	6.0	Yes
	Gray Rapids	5.34	8.10	No
	Go Home Lake Dam	6.48	9.5	Yes
Indian River	Port Carling Dam	0.23	2.09	Yes
Dee River	Windermere	0.15	7.9	No

Table 3: Potential hydro-electric generation sites with capacity >100 kW In Muskoka

Future Hydro-Electric Generation Options

Generally, hydro-electric generation is classed as either reservoir-based or "run-of the river". The former involves drawing water stored in a reservoir for release through one or more turbines for the generation of electricity. The rate at which water is drawn from the reservoir can be varied over a wide range to match generation to electricity demand on a daily and seasonal basis, subject to any water management plans that exist to regulate reservoir levels and river flows. The reservoirs generally store water from the wet seasons to provide for generation during drier periods. So called "run-of-the-river" generation uses only the river flow available at a given time. No stored water is available to deal with changes in electricity demand.

Under the Muskoka River Water Management Plan (MRWMP), all current hydro-electric generation facilities in Muskoka are classed as "run-of-the-river", but in fact they have some limited (less than 48 hours) water storage capacity and so can and do vary generation in response to demand on a daily basis. For the purposes of this paper, such plants will be referred to as the "limited storage" option.

The MRWMP sets out operational limits for each dam, and these collectively aim to support the diverse interests of fish and wildlife, navigation, power generation, recreation and flood control. This plan has its origins in the 1940 Hackner-Holden Agreement, amendment and associated plans. The dams, and associated management plans, have over time become an accepted and generally beneficial part of Muskoka as we know it. Against this background, it is very unlikely that a conventional reservoir-based hydro-electricity station could ever be built in Muskoka. Therefore the following discussion will not address conventional reservoir-based hydro-electric generation as an option in Muskoka. Such systems generally are associated with the most severe environmental impacts of all hydroelectricity options.

Limited-Storage Hydro-Electric Generation:

Benefits: By avoiding the creation of large reservoirs and the associated flooding of land, these systems avoid the most prominent environmental and social concerns commonly associated with reservoir-based systems. The ability to store limited amounts of water can enable them, to some extent, to match their output to electricity demand. In the same manner, they can, to some extent, complement other renewable generation systems by storing water when the sun is shining or the wind is blowing, then using the stored water to generate electricity when solar and wind power is not available. Experience in Muskoka over many years has shown that these systems can be integrated into the overall water management plan of a river system to deal with a range of interests such as of fish and wildlife, navigation, power generation, recreation and flood control.

Some of the existing generating facilities on the Muskoka River system have recently been upgraded to increase their generation capacity without impairing, and in some cases improving, their environmental impact (e.g. Bracebridge Falls, Wilson's Falls). Further such upgrades, or the addition of generation capacity to existing control dams, is a low environmental impact possibility for the future.

Barriers: New limited storage waterpower developments require the construction of infrastructure such as an intake structure, dam, penstocks, powerhouse and tailrace area. These can impair the scenic beauty of the site. For safety reasons, these facilities require exclusion areas. The imposition of exclusion areas can impact the public's enjoyment of the site for recreation and cultural heritage purposes. The new infrastructure can also impact fish migration and spawning, though there is some potential for these impacts to be positive.

Changes in electricity generation can result in frequent and rapid changes in flow velocity and water levels downstream of the plant. Unstable ice below dams can have a negative impact on economic development and tourism in areas that rely on snowmobiling, ice fishing and other winter ice activities, and throughout the summer months, increases in flow velocity could pose a public safety hazard to those swimming, fishing and boating on the river. However, such concerns will, to some extent, be



mitigated by provisions of the MRWMP and those of the Lakes and Rivers Improvement Act (LRIA) administered by the Ontario Ministry of Natural Resources and Forestry. Hydro-electric plant safety systems address these provisions.

Water flow and level fluctuations due to climate change may result in more extreme rain and drought conditions. Hydro-electric dams may not achieve optimal use if flow values do not match what is required to meet electricity demand at a given time.

Run-of-the-River Hydro-Electric Generation:

Benefits: These systems do not store water and therefore do not cause flooding of land or rapidly fluctuating water levels in reservoirs and downstream. Where a dam is already in place, there are designs on the market that rely on buried pipes with only an electrical box off from the side of the river which, when buffered with foliage, has very little visual impact.

Barriers: Run-of-river sites still require some infrastructure, which may include an intake, dam, penstocks, powerhouse and tailrace area. These can impair the scenic beauty of the area. In some cases new technologies can minimize the visual impact of infrastructure, but public opinion may oppose even low visual impact developments. Some new designs for submerged turbines that do not require a dam and associated infrastructure are only practical where very large flow volumes and/or velocities are available. Such flow volumes/velocities are not available in the Muskoka River watershed.

For safety reasons, run-of-the-river facilities may require exclusion areas. The imposition of exclusion areas can impact the public's enjoyment of the site for recreation and cultural heritage purposes.

Lacking the ability to store water for additional generation in periods of high demand, these systems do not complement wind and solar generation to the same extent that reservoir-based systems do.

Run-of-the-river facilities are also subject to changes in river flow changes due to climate change.

Wind:

Benefits: Wind turbines have no direct emissions or releases that affect human health or climate change and very low indirect (full cycle) emissions. Operations and maintenance activities also have minimal impacts. Wind turbines can be co-located with other land uses such as agriculture.

Barriers: Wind cannot be stored in a reservoir the way water can and there is no way to ensure that wind energy is available ("dispatchable") to meet demand at a certain location and time. This barrier can be mitigated to some extent by using wind power in conjunction with hydro-electricity systems that have some storage capacity and with other energy storage options (see discussion on storage on page 26). As wind

generation capacity becomes more widely distributed across Ontario, there is increased probability that at any given time, wind-generated electricity is being fed into the grid at some locations.

Compared to some other regions in Ontario, Muskoka does not have many sites with very good wind power potential. Exceptions to this include the shoreline of Georgian Bay. [16] Wind turbines need to be mounted on towers and in prominent locations so that they are exposed to unobstructed air flow. This increases the likelihood of visual impacts (increased built form) resulting in local tourism impacts.

Under FIT 2.0, wind turbines (even small ones) cannot be located on or adjacent to residential properties [17] which limits the incentive for their deployment.

Concerns expressed relating to high bird mortality have been largely discounted by studies showing that bird mortality at wind turbines is low both in absolute terms and in relation to radio towers and tall buildings. Danger to birds can be mitigated through appropriate siting. Bats, however, have been reported to have a high mortality related to wind turbines.

Some citizens living close to large wind turbine developments have expressed concerns for noise and related health effects. Some research does show health effects on small mammals but definitive human health impacts are as yet unproven. In May 2010, Ontario's Chief Medical Officer for Health, in response to public health concerns about wind turbines, released a report that examined an extensive body of international scientific literature, as well as information provided by individuals and organizations concerned with wind power. [18] The report concluded that the scientific evidence available to date does not demonstrate a direct causal link between wind turbine noise and adverse health effects.

On November 6, 2014, Health Canada released the results of a study on the relationship between wind turbine noise and health effects in people living near wind power developments in Ontario and Prince Edward Island. [19] The study found no evidence to support a link between exposure to wind turbine noise and any of the self-reported or measured health endpoints examined. However, the study did demonstrate a relationship between increasing levels of wind turbine noise and annoyance towards several features (including noise, vibrations, shadow flicker and the aircraft warning lights on top of the turbines) associated with turbines.

Solar Photovoltaic Generation:

The sun's energy as it meets the earth greatly exceeds (by more than 1,000 times) our need for energy in the form of electricity. The conversion efficiency of solar panels is increasing and the cost is decreasing as more use is made of the technology.

Benefits: Solar photovoltaic panels have no direct emissions or releases that affect human health or climate change and very low indirect (full cycle) emissions. Operations and maintenance activities also have minimal impacts. The panels emit no noise. Panels come in all sizes, with consequent pricing, making this option more widely accessible.

Barriers: Like wind, solar energy cannot be stored in a reservoir the way water can, and is not "dispatchable". As with wind, the barrier can be mitigated to some extent by using solar in conjunction with reservoir-based hydro-electricity and other energy storage options (see discussion on storage on page 27). Although costs are falling rapidly for solar cells, overall costs are still relatively high compared to other sources of generation, especially when the relatively low Capacity Factor achievable in Central Ontario is taken into account.

A 5 MW ground mounted solar array requires approximately 100 acre (40ha) of land. Large solar systems therefore have the potential to impact on natural heritage areas and the habitat these preserve. Current agricultural practices may end for this more lucrative use of land.

Visual impacts, such as increased built form, may result in local tourism impacts, particularly where systems are sited on the shoreline of waterbodies and other scenic landscapes. Smaller solar systems, including those mounted on roofs, are likely to have only minor visual impact. Furthermore, building-integration of solar panels can significantly reduce the overall cost per kW with the reduction in panel cost, as an ever increasing portion of the cost of solar is otherwise devoted to capital and installation of the panel supports.

Biomass Combustion:

Biomass is usually plant material that is a by-product from agricultural and forestry sources. It can be burned to create steam to drive a turbine or gasified for direct use to fuel a generation system.

Benefits: The carbon released from combustion of biomass is not considered as a contribution to greenhouse gases because it is part of the natural carbon cycle of plants; what is released can be taken up by other plant growth. The biomass is also considered a renewable fuel source because, once harvested, plants can be replanted.

Barriers: To be economically feasible, biomass generation requires a continuous supply of low-cost by-product material with long-term security of supply. Transportation of biomass over long distances is generally not economically feasible for biomass combustion projects.

Biomass combustion potentially releases large quantities of particulate matter and smaller amounts of nitrogen oxides and polyaromatic hydrocarbons (PAHs), all of which can have human health impacts. Control technologies for these pollutants must be included in the design, construction and operation of the plant.

Waste to Energy Generation:

Requiring 10-20 hectares of land, these facilities typically feed municipal solid waste (MSW) into a furnace where it is burned at very high temperatures. The heat is then used to create steam which runs a turbine. The waste is intended to have minimal

recycled material content and any residual metals are removed from the ash for recycling. The ash is usually shipped to landfill to be used as daily cover and/or reused in manufacturing construction materials.

Benefits: Waste to energy systems divert waste from landfills, thus reducing operations and maintenance costs for landfilling, reducing the problems associated with leachate from landfills, reducing emissions of the greenhouse gas methane from landfills, extending the life of existing landfills and delaying the need for new ones.

Where fossil fuels are a significant part of the electricity generation mix, as is currently the case in Ontario, energy from waste may displace fossil fuel-based generation and thus reduce emissions of greenhouse gases (the extent to which this occurs varies over time and requires complex data analysis).

Proven technology exists to control emissions of toxic air contaminants to extremely low levels, far below levels permitted under Ontario law. Regulatory agencies in Canada, the U.S. and Europe have conducted extensive emissions testing on waste to energy facilities and confirmed that emissions are, in fact, extremely low.

Barriers: The decision to build a waste to energy facility involves a commitment to maintaining a stream of MSW sufficient to keep the facility running at an economical level for an extended period of time. The waste generation level in Muskoka is not sufficient to support this type of plant.

The history of waste to energy proposals indicates that public acceptance is likely to be a significant barrier. There is usually a significant public lobby against it from local citizens concerned with costs, air emissions, truck traffic, noise etc.

Generation from Landfill Gas:

Using a series of pipes, landfill gas is extracted from landfill sites, processed and typically used to run an internal combustion electricity generator. Landfill gas is about 40-60% methane, with the remainder being mostly carbon dioxide. Landfill gas also contains other contaminants.

Benefits: Without a system in place for its capture, the methane in landfill gas ultimately escapes to the atmosphere and contributes to climate change. Collection and combustion converts the methane to carbon dioxide, a far less potent greenhouse gas. Other components of landfill gas emissions can have negative human health impacts. These can be removed in combustion or by treating exhaust gases. Emissions from the plant are subject to Ministry of Environment and Climate Change Guidelines.

Barriers: The technology for generation from landfill gas is well proven. The main potential barrier is the capital cost of the gas collection and combustion system and the lifetime of the supply of gas versus the return from sale of electricity. Costs are reduced by incorporation of gas collection into the landfill design, and deployment on large landfills, i.e. larger than those to be found in Muskoka.

Biogas (Farm):

Biogas is created on farms as a by-product of the decomposition of manure and other organic material. If these materials are routed through a "tank" known as a digester, gas containing methane can be extracted, processed and typically used to run an internal combustion electricity generator.

Benefits: The digestion of farm waste contributes to reducing the potential impact on waterbodies of runoff as the digestion kills most of the pathogens. Digestion also reduces odour impacts on neighboring properties. [20] Air emissions from the operation are subject to Ministry of Environment and Climate Change Guidelines.

Barriers: The main potential barrier is the capital cost of the digester system and the quantity of waste available versus the return from the sale of electricity. Farming operations in Muskoka may not be large enough to justify the capital cost, and trucking waste from other farms is likely to be aesthetically undesirable and economically prohibitive.

Adjuncts to Generation

Energy Storage

Electricity storage systems use surplus electricity generated during times of low demand to create a reservoir of energy in a form that can be used for generation in times of high demand. Historically, the most common option has been pumped storage, where electricity is used to drive pumps that pump water into reservoirs, where it can be held until needed to run a hydro-electric generator. Such systems are in use in Ontario, and opportunities to deploy small scale pumped storage may exist within the District, for example, involving disused quarries where their introduction may be considered as part of quarry rehabilitation. Other possible storage options include compressed air, battery systems and flywheel systems. [21] These options are currently being used on a demonstration basis in Ontario for high-value applications such as voltage control (IESO). Their general application for routine storage of surplus electricity in Ontario requires further development and demonstration at increasing scale to address the current issues of relatively high cost and low efficiencies. However, as for solar generation, cost and conversion efficiency is improving rapidly and these options can be expected to be commercially feasible within current planning horizons. [22] [23]

Electricity Conservation & Efficiency

Electricity conservation and efficiency are terms often used interchangeably, but they are not the same. Conservation refers to reducing the use of a service, for example, turning off a light that is not needed. Efficiency refers to using less energy for the same service, for example, changing to an energy efficient light bulb which provides the same light but uses less electricity. Both conservation and efficiency can reduce electricity use. Conservation and efficiency are often viewed as equivalent to and preferable to new generation. Negawatts is a term coined to describe the amount of new electricity generation avoided by conservation and efficiency measures. As noted previously, conservation is a key element of the Ontario Long-Term Energy Plan, and is considered as a "first choice" and major source of "new generation". As a source of "supply", it is targeted to increase from 5% in 2013 to 16% in 2032.

The District of Muskoka has carried out studies of its own energy usage and initiated projects based on renewable energy generation as part of its energy efficiency initiatives. [24]

Of particular interest from the District's study is the relatively large percentage (>70%) of electricity consumption associated with the water and sewer function. This would suggest particular attention could be paid to additional generation associated with these functions.

There is constant evolution involving research and development to provide advancements in efficiency and assistance in decreasing energy use. One example in the area of conservation of energy came from the David Suzuki Foundation, which published a detailed position paper on a program it calls Property Assessed Payment for Energy Retrofits (PAPER), in which municipalities cover the costs of retrofitting homes, based on expert audits, with payments made on municipal tax bills, and therefore transferable to new owners if a home is sold. This program has the potential to significantly decrease residential energy requirements. Work is currently underway to set up pilot projects in Ontario.

Benefits: Generally, the least expensive form of new generation is that part of an existing generator's capacity that is "freed up" by conservation and efficiency. Electricity conservation in Ontario is expected to cost 3-6 cents per kilowatt hour, far less than the cost of any form of new generation. [3]

Since Canada lags far behind other countries in electricity conservation and efficiency, there is a large potential for improvement. Ontario expects conservation to reduce demand by 30 terawatt-hours in 2032, representing a 16% reduction in forecast gross demand for electricity.

The B.C. government, in its Clean Energy Act, has set a target of meeting at least 66% of future electricity load growth via conservation and efficiency by 2020. [25]

Conservation does not require investment in new transmission facilities, imposes no new operations and maintenance requirements and no new emissions or water or habitat impacts.

Barriers: Conservation and efficiency programs have in the past been criticized for being unable to ensure that electricity demand reductions were sustained. For example, people given efficient light bulbs used their savings to purchase other energy consuming items (thus negating energy savings). [26] This may also be true of other savings experienced through conservation or added energy efficiency.

Conservation messages need to be "refreshed" and new ways of expressing the goals need to be found to avoid losing their impact over time. An example of a new and compelling message for sustainability can be found in the "Blue Dot" campaign. [27]

Transmission Lines

The Ministry of Energy's 2010 Long-Term Energy Plan identified five priority transmission investment projects (out of 20) for system reliability, increased energy flow and for incorporating renewable energy. Three are located in Southwestern Ontario in the Sarnia-London corridor, the fourth is an east-west tie in Northern Ontario and the fifth is a new transmission line from Nipigon to Pickle Lake to serve local communities and the "Ring of Fire" area. For increased southern Ontario load needs, two new north/south 500 kV dual circuit transmission lines are planned, one soon to be in service from the Bruce plant to Milton. Government policy states that existing corridors are to be used as much as possible, including series 400 highway and railway corridors. [28]

Benefits: Enhanced grid tie-in could increase the reliability of power distribution in Muskoka, however, new transmission corridors through Muskoka do not appear to be in the works. Distributed generation and storage involving renewable sources should reduce the need for additional transmission over time and further strengthen the local system.

Microgrids

Combining locally generated renewable energy with other sources such as small co-gen and storage introduces the possibility for "neighbourhood scale" generation and distribution. [29]

Benefits: This could be configured to work independent of the grid (stand-alone) in the event of interruption of grid power. Storage integral to these facilities can benefit the Grid by providing dispatchable power and contributing to voltage stabilization on long distribution lines. Such installations may be of interest to isolated groups in Muskoka, such as groups of cottagers living on an island or rural "crossroads communities" who might each provide power from one or more sources on a shared loop. Evolution of this concept will depend on both improvements to the hardware (especially storage) as well as new forms of agreement between the operators of "microgrids" and the main grid which pays the microgrid operator a fair price for its surplus power and compensates the main grid operator for the backup service it provides. While there are few examples of microgrids operating in Canada outside remote communities, over 1,000 MW of Microgrid capacity is in service in the US.

The combined use of electricity and natural gas for the three main consumption functions: water and Sewer, Long term care facilities and housing, represents almost 90% of the District's usage, suggesting that the District's own usage would be a good candidate for combined heat and power approaches (see the previous discussion of Cogeneration). As these evolve they might also take on the characteristics of a "microgrid".

Barriers: The main barrier to the increased use of Microgrids is the lack of well-established legal framework and procurement practice for storage. It is understood that the OEB is developing a contract framework to enable small-scale storage which will likely redress this within current planning timescales.



Excerpted from Tracking the Energy Revolution – Global 2014

Summary and Recommendations

Muskoka Watershed Council (MWC) supports electricity generation options that are consistent with objectives that:

- Promote activities and best practices that support an environmentally sustainable economy and environmentally healthy communities; and
- Promote environmentally responsible behaviour by individuals, government, business and industry by demonstrating lifestyle and best management practices that enhance the economic, social and environmental well-being of watershed communities.

More specifically:

- 1. MWC strongly supports sustainable electricity generation, transmission and conservation initiatives. These need to balance the economic and social benefits for Muskoka (and Ontario) with environmental impacts. These goals could best be achieved by ensuring consistency of approach with the District's neighbours.
- 2. MWC strongly supports demand-side electricity conservation and efficiency measures as the first priority in managing demand for electricity before the construction of new facilities.
- 3. MWC strongly supports local electricity initiatives that increase the efficiencies in existing facilities provided environmental impacts are carefully considered.

- 4. MWC supports the concept of community social enterprise, individual and municipal electricity generation projects because these enhance the economic, social and environmental well-being of watershed communities.
- 5. Where new power generation facilities are proposed in Muskoka, it is MWC's position that any new proposal be reviewed based on the following principles:
 - a. Small-scale decentralized power generation projects are preferred over largescale centralized power generation projects as they have a smaller environmental footprint and minimize the requirement for new transmission lines which can cause habitat fragmentation and other environmental impacts.
 - b. All new projects should minimize negative impacts on wetlands, fish habitat, shorelines and large natural areas. For example, hydro projects that use existing dam structures on altered sites are preferable to creating new dams, road and transmission infrastructure to access previously undisturbed natural sites.
 - c. New electricity projects should consider all the alternatives including the "No" alternative.
 - d. Renewable electricity generation options provide supply with the lowest overall environmental and health impacts.
 - e. Assessment of all new projects should be based on evaluation of the full life cycle environmental, health and social costs of alternative generating sources.
- 6. Opportunities for sustainable generation discussed in this report are evolving rapidly and continuing to receive significant financial incentives from the province. The impacts of climate change on electricity generation in Muskoka are likely to be better defined as studies are completed. In consideration of these factors, MWC recommends that opportunities for sustainable generation be reviewed on a more frequent basis (e.g. every two years).
- 7. Many of the components of poor air quality related to electricity generation come from activities outside of Muskoka and, to a large extent, outside of Ontario. MWC supports any efforts through provincial, federal and international initiatives to encourage other jurisdictions to develop air quality improvement strategies related to coal-powered electricity generation that impacts our air quality in Ontario and globally.

Bibliography

- [1] "http://www.energy.gov.on.ca/en/ldc-panel/," [Online].
- [2] "Ontario Independent Electricity System Operator FIT and microFIT Programs, http://fit.powerauthority.on.ca/".
- [3] "http://www.powerauthority.on.ca/power-planning/long-term-energy-plan-2013," [Online].
- [4] IESO, "South Georgian Bay/Muskoka Regional Planning, http://www.ieso.ca/Pages/Ontario%27s-Power-System/Regional-Planning/South-Georgian-Bay-Muskoka/default.aspx," [Online].
- [5] "http://www.ieso.ca/Pages/Power-Data/Supply.aspx," [Online].
- [6] "http://www.canwea.ca/," [Online].
- "http://www.worldnuclear.org/uploadedFiles/org/WNA/Publications/Working_Group_Reports/comparison_of_ lifecycle.pdf," [Online].
- [8] "SENES and OPA".
- [9] "http://ec.europa.eu/research/energy/pdf/externe_en.pdf," [Online].
- [10] "Muskoka River Water Management Plan, Final Plan Report, January 2006 www.muskokawaterweb.ca/water-101/water-quantity/mrwmp".
- [1]] "http://www.bracebridgegeneration.com/LinkClick.aspx?fileticket=9A1hRteWyNU%3D&tabid=114".
- [12] "http://www.iaea.org/NuclearPower/Downloadable/SMR/files/IAEA_SMR_Booklet_2014.pdf, "[Online].
- [13] "http://news.ontario.ca/mei/en/2014/04/creating-cleaner-air-in-ontario-1.html," [Online].
- [14] "http://www.epa.gov/climatechange/ghgemissions/gases/ch4.html," [Online].
- [15] "http://www.giscoeapp.lrc.gov.on.ca/web/MNR/Integration/Renewable/Viewer/Viewer.ht ml," [Online].
- [16] "Canadian Wind Energy Atlas http://www.windatlas.ca/en/maps.php," [Online].
- [17] "http://microfit.powerauthority.on.ca/microfit-program-resources/revised-faqs," [Online].
- [18] "Ontario CMOH, The Potential Health Effects of Wind Turbines, May 2010,

http://microfit.powerauthority.on.ca/microfit-program-resources/revised-faqs".

- [19] "Health Canada, Wind Turbine Noise and Health Study, Nov., 2014, http://www.hcsc.gc.ca/ewh-semt/noise-bruit/turbine-eoliennes/summary-resume-eng.php".
- [20] "http://www.huffingtonpost.ca/david-dodge/farming-for-biogas-closin_b_2759083.html," [Online].
- [21] "http://temporalpower.com/," [Online].
- [22] "PJD, Personal Communication, Robert Stasko, Director OSEA April 23, 2015".
- [23] "http://www.ontariosea.org/Storage/65/5644_Storage_working_Group_briefing_paper.pdf," [Online].
- [24] "https://muskoka.civicweb.net/document/24442/2014%20Energy%20Conservation%20and% 20Demand%20Management%20Plan.pdf?handle=8C6F5FD88DE94370B05ADF9F99CBE2B5,"
 [Online].
- [25] "http://www.bchydro.com/about/sustainability/conservation/electricity_conservation_efficiency_advisory_committee.html," [Online].
- [26] "http://www.masterresource.org/2010/10/energy-efficiency-saunders/," [Online].
- [27] "http://bluedot.ca/the-plan/]," [Online].
- [28] "http://www.osler.com/NewsResources/Details.aspx?id=2983," [Online].
- [29] "http://www.theglobeandmail.com/report-on-business/breakthrough/renewable-energymicro-grids-get-smart/article14868343/," [Online].
- [30] "http://www.fuelcelltoday.com/media/949136/av_11-04-13_fuel_cells_for_residential_heat_and_power_in_europe.pdf," [Online].