Northern Hydro Assessment Waterpower Potential in the Far North of Ontario

Commissioned by Ontario Waterpower Association, financial support from the Ontario Government

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Executive Summary

The Province of Ontario, Ontario Power Generation (the former Ontario Hydro), the Ontario Waterpower Association and the Ministry of Energy have all studied the undeveloped waterpower potential in Ontario at various points in time. Invariably, such studies have concluded that a large portion of this energy is contained in the Moose, Albany and Attawapiskat rivers flowing north towards James Bay and in the Severn and Winisk rivers flowing into Hudson's Bay. Estimates have consistently identified thousands of Megawatts of hydraulic potential and, in fact, some or much of that energy has been included in previous power system plans for the province (e.g. Demand Supply Plan (1990), and Integrated Power System Plan (2007)). To date, however, that recognized potential remains largely untapped.

In 2010, the Ministry of Energy's (ENERGY's) "Long Term Energy Plan" (LTEP) established an initial objective of 9,000 MW of waterpower to be in service by 2018. The LTEP also established a priority for new transmission in north western Ontario as well as the provision of service to diesel dependent communities. Ontario has well over 8000 MW of waterpower in service and enough projects contracted to meet the 2010 LTEP target. Consistent with the iterative nature of Power System Planning, the Ministry of the Ontario Power Authority (OPA) are leading a cyclical review of the long-term energy supply portfolio considerate of the current energy, economic and environmental drivers. Such a review necessarily requires a fresh evaluation and consideration of available waterpower potential in northern Ontario, with due consideration for the key policies and priorities that have emerged since the 2010 LTEP.

This study provides an objective evaluation of the costs and energy potential of Ontario's waterpower situated in the Far North both to help inform the next LTEP and to support key provincial socioeconomic priorities in the north. Actual potential will depend on site specific environmental factors and other considerations.

The study concluded the following:

1. The average costs and associated Levelized Unit Energy Cost (LUEC) for developing water power in Ontario's Far North and associated uncertainty, based on a review of available historical data, can be summarised as shown in Table ES-1.

Table ES-1 Reported Costs and Median LUEC for Waterpower Development in Ontario's Far North

Installed Capacity (MW)	Estimated Cost of Construction Based on Precedent Projects ($2013/kW)			Median LUEC (60% c.f.)	Annual Operating Costs In thousands ($2013/kW/y)	
	Median	Expected Max	Expected Min		Annual OPEX	Annual CAPEX
1 -10	7000	8500	5500	0.078	50 - 90	15 - 90
11- 50	6000	7500	4500	0.061	35 - 50	5 - 15
51 – 200	5300	6500	4000	0.053	25 - 35	2 to 5
201 – 1000	4600	5500	3800	0.046	20 - 25	1 – 2
>1000	4000	4500	3700	0.041	15 - 20	0.5 to 1

2. The estimated cost and duration for the performance of Environmental Assessments (EA) and permitting for Greenfield Waterpower Developments in Ontario's Far North are as summarised in Table ES-2.

Table ES-2 Cost and Schedule for Environmental Assessments and Permitting for Waterpower Facilities in Ontario's Far North

Capacity (MW)	Estimated Cost (2013 $M)	Estimated Duration (years)
<10	1.5 to 3	2 to 4
10 - 200	2 – 20	3 to 7
>200	>20	5 to10

3. The typical time needed to implement waterpower projects in Ontario's Far North are summarised in Table ES-3.

Table ES-3 Typical Schedule Requirements for Implementation of Waterpower Projects in Ontario's Far North

Installed Capacity (MW)	EA/Permitting Duration (Years)	Construction Duration (years)	Final Engineering * (months)	Total Duration (years)
<10	2 to 5	2 to 3	3 to 6	4 to 8
10 - 200	2 to 7	3 to 5	6 to 24	5 to 12
>200	5 to 10	5 to 8	24 to 36	10 to 20

4. The most cost effective waterpower opportunities in proximity to the six (6) First Nation Communities north of Red Lake are listed in Table ES-4. These facilities would meet local demand from remote communities, enhance local reliability of the grid, and in addition, any extra generation that is not used locally could be used elsewhere on the Ontario grid.

   The values in this table were determined in this study with the use of GIS-based hydroelectric potential screening model.

Table ES-4 Sites to Service the Red Lake Cluster

Site #	Community Name	GIS ID	River	Dist (km)	Size (MW)	Energy (GWh/y)	CF	Capital Cost[1] ($M)	LUEC ($/kWh)
1	Pikangikum	322	Berens	10	8.2	36.1	0.50	44	0.071
2	Poplar Hill	10012	Berens	3	11.8	57.8	0.56	65	0.064
3	Deer Lake	13312	Severn	6	5.4	23.8	0.50	32	0.080
4	North Spirit Lake	12514	Flanagan – Severn Tributary	13	2.6	9.9	0.44	16	0.104
5	Sandy Lake	8646	Severn	0	15.5	76.1	0.56	86	0.062
6	Kee-Way-Win	9562	Severn	26	24.1	119	0.56	140	0.063

5. The most cost effective waterpower opportunities in proximity to the fourteen (14) First Nation Communities north of Pickle Lake, as well as the Ring of Fire, are listed in Table ES-5. These facilities would meet local demand from remote communities, the demand within the Ring of Fire, and would enhance local reliability of the grid. In addition, any extra generation that is not used locally could be used elsewhere on the Ontario grid.

   The values in this table were determined in this study with the use of GIS-based hydroelectric potential screening model.

[1] Capital cost terminology is interchangeable with construction cost in this report

Table ES-5 Sites to Service the Pickle Lake Cluster plus the Ring of Fire

Site #	Community Name	GIS ID	River	Dist (km)	Size (MW)	Energy (GWh/y)	CF	Capital Cost ($M)	LUEC ($/kWh)
7	Eabametoong	514	Albany	11	26	129	0.56	141	0.059
8	Neskantaga	14040	Outlet of Windsor Lake – Attawapiskat Tributary	19	23	114	0.56	123	0.059
9	Webequie	3781	Outlet of Winisk Lake – Winisk Tributary	17	23	114	0.56	142	0.066
10	Nibinamik	078	Inlet of Wapikopa Lake – Winisk Tributary	13	17	85.3	0.56	96	0.062
11	North Caribou Lake	No feasible sites identified.							
12	Kingfisher Lake	10324	Asheweig – Winisk Tributary	28	2.4	13.9	0.44	16	0.108
13	Wawakepewin	12496	Asheweig – Winisk Tributary	9	4.3	18.9	0.50	37	0.109
14	Kasabonika Lake	11055	Asheweig – Winisk Tributary	7	6.9	30.4	0.50	50	0.091
15	Wapekeka	21801	Severn Tributary	11	6.0	26.3	0.50	54	0.109
16	Bearskin Lake	20471	Makoop – Severn Tributary	18	5.6	24.4	0.50	36	0.086
17	Kitchenuhmaykoosib Inninuwug	24767	Outlet of Big Trout Lake	19	5.5	24.1	0.50	43	0.099
18	Sachigo Lake	18077	Sachigo – Severn Tributary	16	5.3	23.4	0.50	36	0.089
19	Muskrat Dam	20887	Severn	25	38	185	0.56	196	0.056
20	Wunnumin Lake	5519	Pipestone	22	13.5	66.5	0.56	83	0.068
ROF	Ring of Fire	13814	Attawapiskat	20	31	152	0.56	172	0.060

6. The most cost effective waterpower opportunities in proximity to three (3) of the five (5) remote First Nation Communities in Ontario's Far North are listed in Table ES-6.

Table ES-6 Sites to Service off-Grid Remote Communities

Site #	Community Name	GIS ID		Size (MW)	Energy (GWh/y)	CF	Capital Cost ($M)	LUEC ($/kWh)
1	Fort Severn	n/a	n/a	n/a	n/a	n/a	n/a	n/a
2	Weenusk (Peawanuk)	471	Winisk	4.1	18.0	0.5	22.6	0.078
3	Whitesand (Armstrong)	n/a	n/a	n/a	n/a	n/a	n/a	n/a
4	Kiashke Zaaging Anishinaabek (Gull Bay)	414	Gull River – Inlet to Lake Nipigon	2.2	9.5	0.5	11.5	0.083
5	Marten Falls	50	Albany	4.3	19.0	0.5	24	0.078

The three projects listed have generating capacities of between 2 MW and 5 MW. Since these are isolated loads of around 1 MW, the projects should be downsized to yield a capacity of between 1 and 2 MW. The best method of downsizing should be determined in a subsequent more detailed study. It could be achieved by reducing the dam height, or by utilizing a portion of the available flow.

The review of the area around Whitesand did not yield any appropriate sites for development. At Fort Severn, the river is quite large, but the topography is quite flat, which is not ideal for traditional hydropower development. Here hydrokinetic options may make some sense, or other renewable generation such as wind generation.

7. A review was undertaken of previously identified large and medium waterpower sites, as summarized in Reference 10 (Hatch Acres, 2005) using the screening model developed for this study. In general, it was found that the results of the GIS screening tool were consistent with earlier studies.

   The following was concluded:

   - Drainage basin areas were accurately reported within 2% in most cases.
   - Mean annual flow estimates were energy estimates were accurately reported within 20% in most cases.
   - For large sites over 100 MW, the LUEC varies from $0.05 to $0.18 per kWh, For medium sites between 20 and 100 MW, the LUEC varies from $0.04 to $0.09 per kWh. The variation was largely determined by the capacity factor of the site. The lowest LUEC were associated with high capacity factor sites such as 60%.