Assessing the Potential Uptake for a Remote Community Wind Incentive Program in Canada

Final Report

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Assessing the Potential Uptake for a Remote Community Wind Incentive Program in Canada

A Report for the Canadian Wind Energy Association

By:

Tim Weis • John Maissan

December 2007

the PEMBINA institute

Sustainable Energy Solutions

Leading Edge Projects Inc.

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The Pembina Institute creates sustainable energy solutions through research, education, consulting and advocacy. It promotes environmental, social and economic sustainability in the public interest by developing practical solutions for communities, individuals, governments and businesses. The Pembina Institute provides policy research leadership and education on climate change, energy issues, green economics, energy efficiency and conservation, renewable energy, and environmental governance. More information about the Pembina Institute is available at www.pembina.org or by contacting info@pembina.org.

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Leading Edge provides consulting services with wind energy assessment, planning, and management, conducting studies and analyzing multi-disciplinary technical information sets to develop rational conclusions and write succinct reports, offering strong communication skills with a focus on detail. More information on Leading Edge can be found at www.leprojects.com.

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1 Introduction

1.1 Wind-diesel projects in Canada and Alaska

While Canada has some of the world's leading experts in wind-diesel technology as well as four manufacturers of medium-scale wind turbines that are appropriately sized for community-scale wind-diesel projects, few successful projects have been developed in Canada to date.

Using predominantly Canadian-built wind turbines the state of Alaska has successfully implemented wind-diesel systems in six communities, totaling close to 2 MW of wind power. This process began in 1997 with the community of Kotzebue, who now has 17 wind turbines and close to 1 MW in their community alone.

Kotzebue is aiming to install 2-4 MW to reach 'high-penetration' wind levels, i.e. enough wind capacity to be able to shut off the diesel generators for extended periods of time. In 1999, a high-penetration wind-diesel system was commissioned on St. Paul's Island using a single 225 kW turbine which also provides additional heating to the local school with the excess energy. By the year 2002 Wales, Alaska had installed two wind turbines totaling 100 kW of wind power also in a high-penetration configuration and in 2004, Selawik, Alaska installed 150 kW of wind energy capacity onto their remote grid. Toksook Bay and Kasigluk began installing 400 kW and 300 kW high penetration systems respectively[1].

The only operating wind-diesel system currently operating in Canada consists of six, 65 kW wind turbines that were installed in a medium penetration configuration in the remote fishing village of Ramea on the south shore of Newfoundland in 2003 and have been operational ever since. There are currently at least ten remote Canadian communities that are monitoring their wind resources with the hopes of developing wind energy projects. The community of Tuktoyaktuk, NWT hosted a conference in November 2007 in order to help foster development strategically in the North.

[1] Wind Power on Native American Lands: Opportunities, Challenges, and Status (Poster), Prepared for WINDPOWER 2007, 3-6 June 2007, Los Angeles, California <www.eere.energy.gov/windandhydro/windpoweringamerica/pdfs/wpa/ poster_2007_native_americans.pdf>

1.2 Opportunities in Canada

Wind-diesel systems present an opportunity for reducing fossil fuel use in many remote areas, to help shelter these communities from fuel price volatility as well as increasing local sustainability. However, limited access to strong winds, limited tower heights, increased transport costs and difficult operations and maintenance associated with remote sites result in very high costs. Without long-term government support to help develop the industry, wind-diesel systems have had difficulty competing with traditional diesel power plants in Canada even though their generation cost can be five to ten times that of conventional, grid-connected power plants.

Canada has many remote sites that require electricity including communities, mine sites, logging camps and remote communications systems. The number of sites is always in flux as new industrial sites are developed, while others close or are decommissioned, at the same time larger communities have been connected to provincial or territorial power grids, recent examples include Dawson City, YK, Kyuquot, BC and Fox Lake, AB.

There are two reports that are often cited with respect to the number of remote communities in Canada, the RETScreen™ Database – Canadian Remote Communities was compiled by Natural Resource Canada (NRCan) in 1999 and found that there were close to 300 remote communities with a population over 200,000 by using the criteria that the community is:

1. Not presently connected to the North-American electrical grid or piped natural gas network, and
2. Permanent or long term (5 years or more) settlements with at least 10 permanent residences.

In 2005, Indian and Northern Affairs Canada (INAC) compiled a narrower list of remote communities that feel under its mandate, which does not include industrial sites or non-Aboriginal fishing communities in Atlantic Canada. This list, compiled by Daniel VanVliet of INAC lists 160 communities, with a population close to 100,000. Maps of both studies are shown in Figure 1 below.

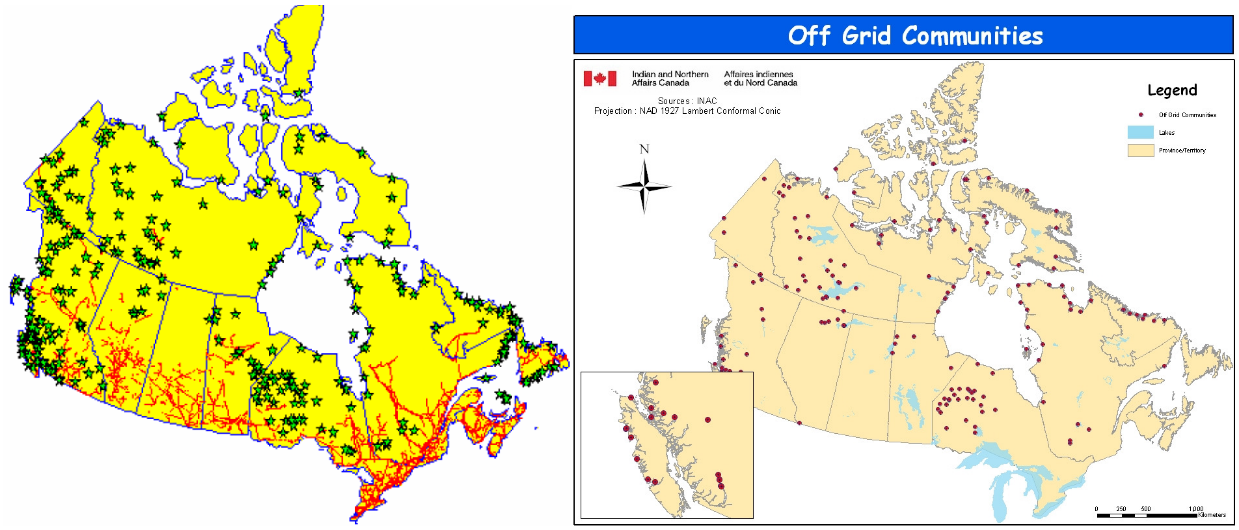


Figure 1: Remote community maps compiled by NRCan in 1999 (left) and INAC in 2005 (right)

The current study draws on both of these previous sets of work, to list which of these communities have realistic possibilities of installing wind-diesel hybrid systems if the necessary economic incentives were in place. The results are not restricted to INAC communities, but rather remote sites that would qualify for a proposed Remote Community Wind Incentive Program (ReCWIP). No formal guidelines exist for ReCWIP eligibility, but the authors recommend that the following criteria be used to define *remote*:

- A community or industrial site with a population no less than 20 permanent/continual residents that is not connected to the main North American electrical grid.

It is the view of the authors that the use of diesel generators should not a be requirement for eligibility, as communities such as Whitehorse or Yellowknife, for example, which are both supplied primarily from hydro-electricity may one day want to build additional wind capacity to reduce peaking diesel requirements. In addition some communities, notably in the NWT use natural gas for their electricity (Norman Wells and Inuvik), and this may increase should the Mackenzie Valley pipeline project be built.

Small telecommunications sites, as well as the distant early warning sites are not included in this study.

2 Uptake Potential

2.1 ReCWIP design

The Remote Community Wind Incentive Program (ReCWIP) designed by CanWEA's northern caucus distinguishes two categories for wind power development:

- **Category 1: Large communities and industrial facilities**. This category includes large communities (with an average electrical loads of 2 MW or higher) as well as industrial facilities in remote areas. Examples include Iqaluit, Yellowknife, Les Îles de la Madeleine, and the Diavik and Ekati diamond mines.
- **Category 2: Small remote communities**. This category includes all small remote communities that are accessible either seasonally or year-round by air, water, or road.

Category 1 sites are likely to use utility-scale wind turbines on order of magnitude of 500-2000 kW, while category 2 sites would likely use medium-sized wind turbines typically 50-300 kW.

2.2 Category 1 potential

The following table lists all of the known potential communities and industrial sites which could be considered for wind power systems that would be classified as category 1. It should be noted that new mine sites are currently begin developed, particularly in Nunavut, as the melting Artic ice makes the North more accessible, this list should therefore be considered a minimum[2]. Estimates are based on best available information for each site. Information was gathered from public records, and first hand information about specific projects which may be proprietary. The symbol ~ is used to denote where reasonably accurate information was available, (e)

[2] Globe and Mail, "Mineral exploration in Nunavut booming" by Bob Weber, Nov 1, 2007. www.theglobeandmail.com/servlet/story/LAC.20071101.NUNAVUT01/TPStory?cid=al_gam_globeedge

indicates an estimated value made by the authors. Low penetration systems are likely in mining applications as the mines also co-generate their heat from existing diesel plants and would therefore require minimum base loads as wind is less competitive against co-generated heat than it is against diesel generated electricity. In cases with extremely good wind resources, medium penetration systems are possible.

Table 1: Category 1 – Large communities and industrial facilities potential

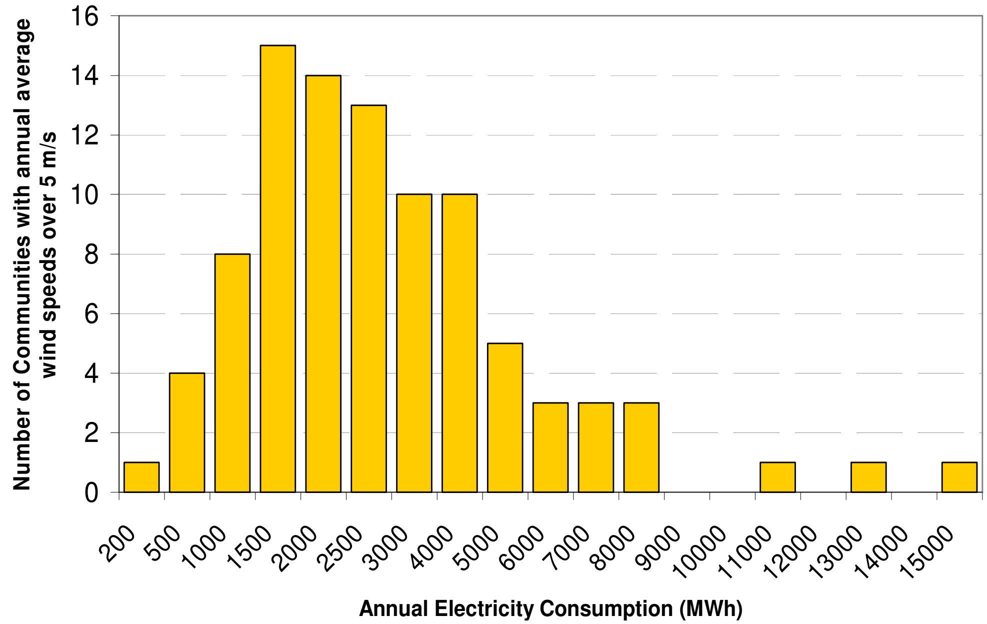
Site	Electrical Capacity	Remaining life	Wind resource	Comments	Estimated wind penetration level	Estimated potential wind capacity
Labrador						
1. Voisey's Bay	~10-15 MW	30 yrs	probably good	Nickel mine, with port on coast. Large operation with low mountains visible in photos. Guess at power load. Probably good wind regime on ridges. Good candidate for wind power, but fuel is lower in cost here because of proximity to coast.	Low-medium	3-8 MW
NWT						
2. Ekati	~13 MW	~15 yrs	~ 7 m/s	Ekati diamond mine has explored wind energy but the need for -40℃ equipment limited options. Possible future NTPC power line.	Low-medium	3-8 MW
3. Diavik	~10 MW	~15 yrs	~ 7 m/s	Diavik diamond mine has explored wind energy but with staff turnover is seems to have fallen off the table. Would need -40℃ equipment. Possible future NTPC power line.	Low-medium	2-6 MW
4. Snap Lake	~15 MW	~20 yrs	(e) 7 m/s	Diamond mine just getting into production. Some information on wind indicates a resource in the order of 7 m/s. Would need -40℃ equipment. Possible future NTPC power line.	Low-medium	4-8 MW
5. Cantung	~3-4 MW	Up to 15 yrs	unknown	North American Tungsten Corp. In rugged mountains, accessed from Yukon by road. Probably limited practicality for wind power, likely icing.	Unlikely	0 MW
6. Gahcho Kué	~8-10 MW	15-20 yrs	~6-7 m/s	DeBeers diamond project in feasibility and permitting stage. Relatively near DeBeers'	Low-medium	2-5 MW

				Snap Lake. Interested in wind but limited information – probably similar resource to other area diamond mines. Guess at power and mine life. Possibility of NTPC power line.		
7. Yellowknife	60+ MW	Indefinite	~5-6 m/s	There is an increasing demand on the Yellowknife power grid, and some discussions about location wind power on the territories largest grid as a	Very Low	0.2-1 MW
8. Norman Wells	14.5 MW	Indefinite	~6-7 m/s	Natural gas supply is declining. Wind monitoring equipment has been installed in the community.	Low	1-3 MW
N. Ontario						
9. Victor	~4-8 MW	17 yrs	(e) 5 m/s	DeBeers diamond project to be in production in 2008. 90 km W of Attawapiskat. Believe transmission line in the plans. Wind resource probably only moderate in any case.	Unlikely	0 MW
Nunavut						
10. Jericho	~3-4 MW	~9 yrs	(e) 6-7 m/s	Diamond mine, 160 km N of Ekati/Diavik opened in 2006. Significant exploration in the area. Life may be too short to consider wind. Power cost $0.197 @ $0.66 per litre. Would need -40℃ equipment.	Unlikely	0 MW
11.Meadowbank	~10 MW	8 yrs	(e) 5-6 m/s	Agnico-Eagle gold mine 70 km N of Baker Lake under construction. To be in production in 2010. Mine life may be a bit short for wind energy to be viable	Unlikely	0 MW
12. Iqaluit	15 MW	Indefinite	~6-6.5 m/s	A current RFP exists for a hydro system. Would not necessarily negate wind power. A good candidate for a technical hub for the eastern Arctic as it is the home of Quiliq power.	Very Low-Low	0.2-1 MW
Quebec						
13. Îles de la Madelaines	15+ MW	Indefinite	8.5 m/s	Excellent wind resource, with a long history of wind monitoring. Local community opposition to view is potential obstacle.	Low-Medium	2-8 MW
14. Raglan	(e) 4-8 MW	~30 yrs	(e) 7+ m/s	Nickel mine in N. Quebec processes 3,000 tonnes per day. They have expressed interest	Low-Medium	1-3 MW

				in wind power. Believe good candidate for wind power. Would need -40°C equipment.		
Yukon						
15. Mactung	~6-8 MW	20+ yrs	(e) 6-7 m/s	Well known deposit, feasibility study underway. Production could be as little as 4 years off. Owners are concerned about the volatile price of diesel power. Guess at power. High elevation fairly mountainous. Guess at wind.	Low	1 MW
16. Selwyn Project	25+MW	20++ yrs	(e) 6-7 m/s on ridges	Pacifica Resources, enormous and good grade lead and zinc deposits along 30 to 60 km formation in Howard's Pass. Would be a very large tonnage operation, but will take a long time to come to fruition 5+ yrs. High elevation probably reasonable wind.	Low-Medium	4-10 MW
16. Wolverine	~8 MW	~10 yrs	(e) 6-7 m/s	In financing stage – have permits. Long way from grid but possible. High ridges probably have reasonable wind and icing. Probably limited potential for a project.	Unlikely-Low	0-1 MW
17. Whitehorse	110 MW	Indefinite	~7 m/s	Unlikely in short term as there is a hydro surplus, however another mine (Carmacks Copper) that would have an electrical load of about 8 MW and would be grid connected is now in the permitting process. This would consume much of the hydro surplus now available and would result in significant winter diesel peaking load. Proven wind resource means a potential expansion of existing wind farm	Low	0-5 MW
National						
Unidentified and future sites	30-100 MW	n/a	n/a	These mines are likely to include uranium mines - for which there is presently a great deal of exploration, as well as current mine sites not identified on this list.	Low-Medium	6-18 MW
Total						29.4-85 MW

2.3 Category 2 potential

The following table lists all of the remote communities in Canada that currently use diesel power for their electricity supply and have a local wind resource of at least 5 m/s. Load data was collected for each community from various sources including RETScreen database, public utility data, recent energy baseline studies, studies completed for local utilities and the INAC study recently completed by Daniel VanVliet. HOMER micropower optimization model developed by NREL (www.nrel.gov/homer) was used to model remote community wind energy potential.



Community load data was simulated using the Alaska community load calculator also developed by NREL and was scaled to representative loads for the selected communities. Using the following assumptions optimum scenarios were constructed for wind-diesel systems without power storage for each community:

- 1.20 $/L average price of diesel 2008-2018
- 6,000 $/kW installed wind costs, declining to 5,000 $/kW for communities over 4,000 MWh/yr
- 0.10 $/kWh O&M costs, declining to $0.05 for communities over 4,000 MWh/year
- 0.15 $/kWh ReCWIP in place

The results of the HOMER model are illustrated below, where the green shaded area indicates the conditions where wind energy systems are preferred. Note that in this model, the diesel generators are modeled simply as a grid. While this is not the best technical model, if a fixed displaced cost of fuel rate is negotiated for an IPP, modeling the diesel power as a grid is perfectly accurate for an economic model.

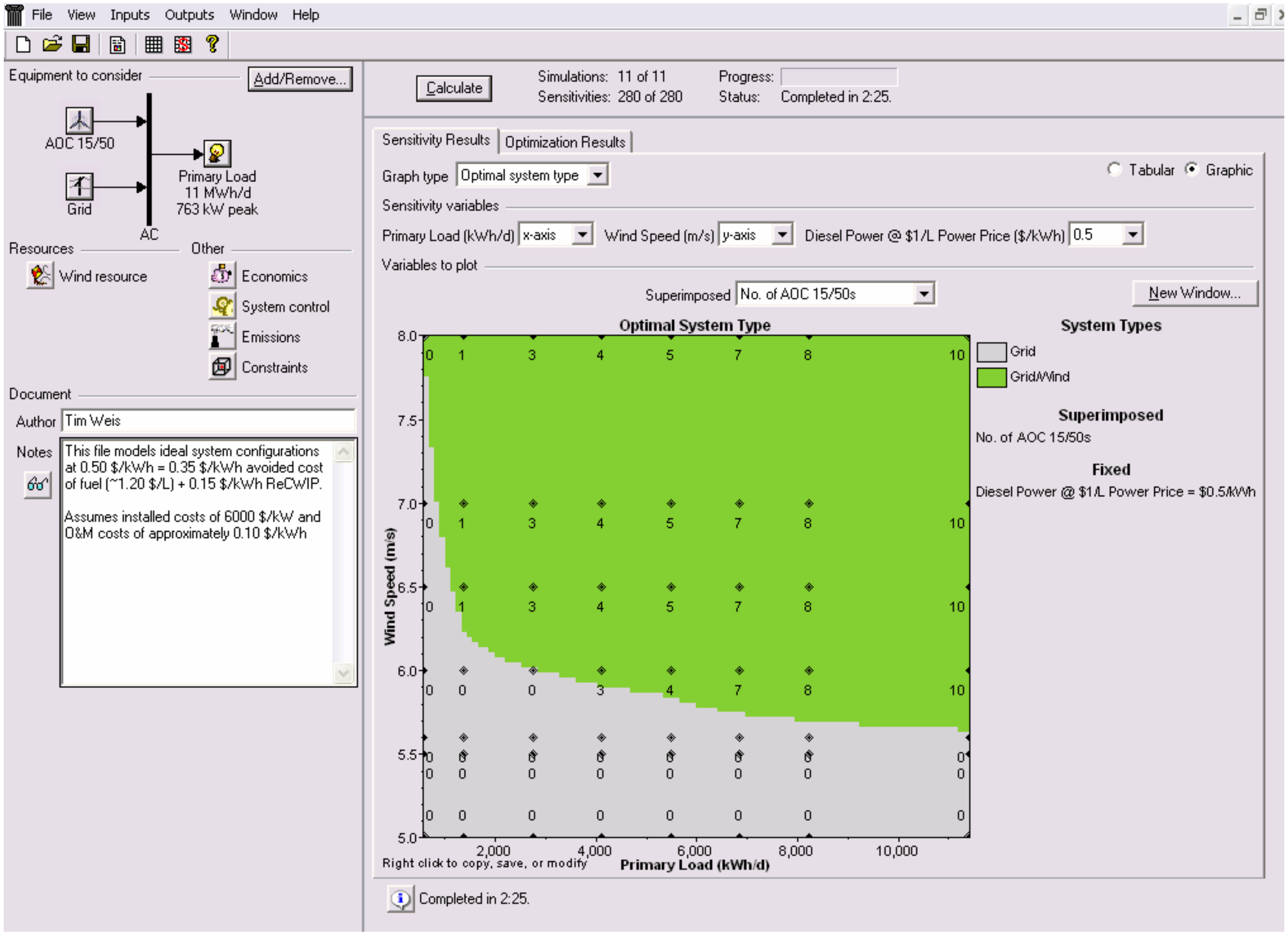


Figure 2: Optimal systems for small communities with ReCWIP – minimum wind speed approx 6.0 m/s

It is also worth noting, that when the 0.15 $/kWh subsidy is removed the minimum wind speed that is required to make systems economic changes from approximately 6.0 m/s to 7.0 m/s as shown below.

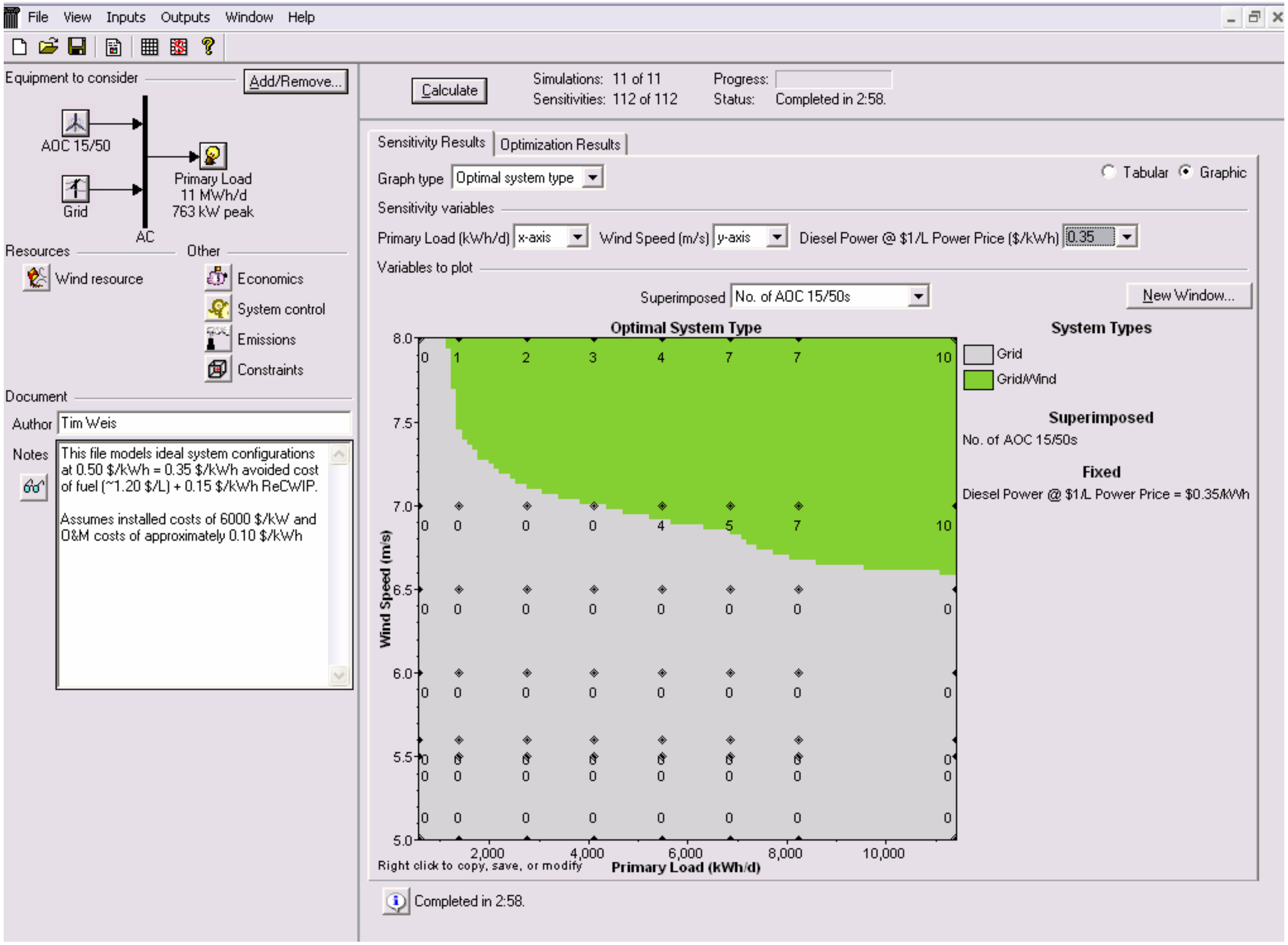
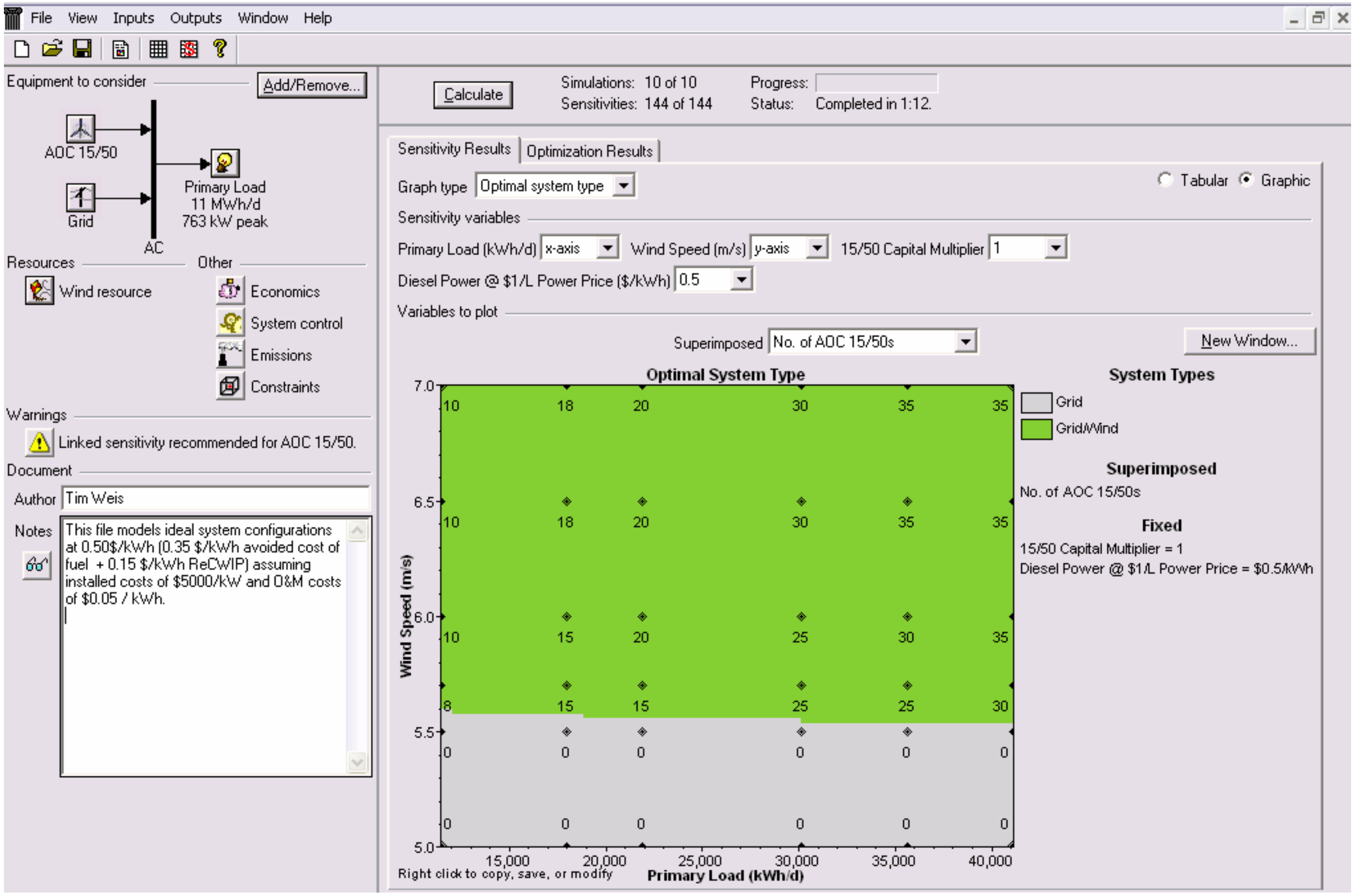


Figure 3: Optimal system sizes for small communities without ReCWIP – minimum wind speed typically 7.0 m/s

The results below are based on the same assumptions above and illustrates the larger community results.



The each community's optimum system was selected using the HOMER model results based on the community's annual electric load and the local wind speed. The overall results are listed in the table below.

Table 2: Category 2 Uptake Potential

	Site	Electrical Generation (MWh/yr)	Population (2007)	Ave. Wind Speed @ 30 m (m/s)	Wind Resource	HOMER model wind capacity (kW)	Estimated annual wind generation (MWh)
	Northwest Territories						
1	Aklavik	3,107	590	5.3	Fair	0	0
2	Colville Lake	419	80	6	Moderate	0	0
3	Deline	2,269	530	5.9	Moderate	325	486
4	Fort Good Hope	2,147	690	5.4	Fair	0	0
5	Ulukhaktok	2,060	400	6.5	Good	325	611
6	Lutsel K'e	1,396	330	5.2	Fair	0	0
7	Paulatuk	1,396	290	6	Moderate	195	304
8	Rae Lakes	1,068	290	6.1	Good	130	211
9	Sachs Harbour	1,388	120	7.5	Very Good	195	486
10	Trout Lake	590	80	5.5	Fair	0	0
11	Tulita	1,920	470	5.3	Fair	0	0
12	Tuktoyaktuk	4,585	870	5.6	Moderate	520	676
	Nunavut						
13	Arctic Bay	2,262	620	5.6	Moderate	0	0
14	Arviat	6,700	2,060	7.3	Very Good	1,170	2,776
15	Baker Lake	6,279	1,730	5.9	Moderate	975	1,459
16	Broughton Island	2,066	530	6.1	Good	325	528
17	Cambridge Bay	7,692	1,480	6.7	Very Good	1,300	2,607
18	Cape Dorset	5,061	1,240	6.3	Good	650	1,140
19	Chesterfield Inlet	1,766	360	7.5	Very Good	325	810
20	Clyde River	2,683	650	7.5	Very Good	455	1,134
21	Coral Harbour	2,736	660	5	Fair	0	0
22	Grise Fiord	828	150	5.6	Moderate	0	0
23	Hall Beach	2,303	600	5.3	Fair	0	0
23	Kimmirut	1,817	420	6	Moderate	325	507

24	Kugluktuk	4,490	1,300	6	Moderate	650	1,015
25	Pelly Bay	1,905	470	6.6	Very Good	325	631
26	Rankin Inlet	14,016	2,360	6.5	Good	1,950	3,667
27	Repulse Bay	2,450	560	6.2	Good	455	769
28	Resolute	3,872	200	6	Moderate	520	812
29	Taloyoak	2,460	810	5.7	Moderate	0	0
30	Whale Cove	1,574	270	7.7	Excellent	260	679
	Yukon						
31	Destruction Bay/Burwash Landing	794	135	6	Moderate	0	0
32	Old Crow	1,589	290	6.5	Good	260	489
	Québec						
33	Akulivik	2,050	430	8.5	Excellent	325	998
34	Aupaluk	1,025	310	7.5	Very Good	195	486
35	Inukjuak	7,288	1,210	8	Excellent	1,300	3,622
36	Ivujivik	1,480	300	7.5	Very Good	260	648
37	Kangiqsualujjuaq	3,189	610	8	Excellent	520	1,449
38	Kangiqsujuaq	2,278	470	9	Excellent	455	1,523
39	Kangirsuk	2,733	410	8	Excellent	455	1,268
40	Kuujjuaq	12,755	1,630	6.4	Good	1,625	2,970
41	Kuujjuarapik	7,744	700	7	Very Good	1,235	2,705
42	Puvirnituk	6,377	1,260	6.5	Good	1,105	2,078
43	Quaqtaq	1,480	280	6.5	Good	260	489
44	Salluit	4,555	950	7.5	Very Good	650	1,620
45	Tasiujaq	1,253	170	7.5	Very Good	195	486
46	Umijuaq	2,050	330	10	Excellent	325	1,259
	Newfoundland-Labrador						
47	Black Tickle	1,737	260	8.5	Excellent	325	998
48	Cartwright	3,371	700	8.5	Excellent	520	1,597
49	Charlottetown	1,407	330	7.5	Very Good	195	486
50	Davis Inlet	1,578	530	9	Excellent	260	870
51	Francois	1,248	240	7	Very Good	195	427
52	Grey River	1,185	270	6.5	Good	195	367

53	Harbour Deep	1,493	230	7	Very Good	260	570
54	Hopedale	3,064	590	8.5	Excellent	520	1,597
55	La Poile	925	10	6	Moderate	0	0
56	Little Bay Islands	3,064	300	8.5	Excellent	520	1,597
57	Makkovik	3,177	140	8.5	Excellent	520	1,597
58	Mary's Harbour	2,950	420	8.5	Excellent	520	1,597
59	McCallum	1,185	240	7	Very Good	195	427
60	Mud Lake	408	80	6.5	Good	0	0
61	Nain	5,142	1,100	6	Moderate	715	1,116
62	Paradise River	330	70	7.5	Very Good	65	162
63	Petites	862	120	6	Moderate	0	0
64	Port Hope Simpson	3,154	700	7.5	Very Good	585	1,458
65	Postville	1,543	260	7.5	Very Good	260	648
66	Ramea	4,680	660	7	Very Good	260*	570
67	Rencontre East	1,557	240	7	Very Good	260	570
68	Rigolet	1,679	380	8	Excellent	260	724
69	South East Bight	742	130	7	Very Good	130	285
	Manitoba						
70	Sayisi Dene	2,572	340	6.5	Good	325	611
71	Shamattawa	3,196	1,230	5.5	Fair	0	0
72	Lac Brochet	2,505	730	6	Moderate	325	507
	Ontario						
73	Fort Severn	2,653	500	7	Very Good	455	997
74	Bearskin Lake	2,735	730	6	Moderate	455	710
75	Kitchenumaykoosib Inninuwug	5,554	1,320	6.5	Good	195	367
76	Deer Lake	3,798	890	5.5	Fair	0	0
77	Keewaywin	2,364	320	5.5	Fair	0	0
78	Kingfisher	1,900	420	5	Fair	0	0
79	Gull Bay	1,088	900	6	Moderate	65	101
80	North Spirit Lake	1,743	430	5.5	Fair	0	0
81	Peawanuck	1,226	140	7	Very Good	195	427
82	Sachigo	2,862	650	5.5	Fair	0	0
83	Sandy Lake	10,773	1,890	5	Fair	0	0

84	Wapekeka	1,511	360	6.5	Good	0	0
85	Wawakapewin	220	60	5	Fair	0	0
86	Weagamow	4,224	830	5.5	Fair	0	0
87	Webequie	2,739	660	5.5	Fair	0	0
88	Wunnummin Lake	2,094	480	5.5	Fair	0	0
	BC						
89	Gilford Island	569	620	6	Moderate	0	0
90	Hesquiath	591	630	6.5	Good	65	122
	National						
	Unidentified sites and community growth			6.5		2,000	3,761
	Total					**31,380 kW**	**68,666 MWh/yr**

*In addition to existing wind turbines

It is worth noting that the numbers listed above should be considered as a floor of realistic near-term potential. If fuel costs escalate beyond $1.20 per litre and installation costs are reduced with increased volumes, additional community projects are likely to become viable. In addition, some communities may find improved local wind resources if a detailed monitoring program is completed. Some communities identified above may also have alternative options for renewable energy systems notably mini-hydro, however, there are also additional communities/locations yet unidentified that will qualify (notably Sable Island, or large DEW line sites).

3 Conclusions

3.1 Remote wind potential in Canada

This report outlines the potential for near-term remote wind energy potential for projects that could realistically be implemented within the 10-year time frame of the ReCWIP. The overall *technical potential* for remote wind power is significantly higher depending on changing economics and priorities in the future.

3.2 Category 1 uptake potential

The 2008 budget submission for ReCWIP recommended funding for 10 projects with an average size of 7.5 MW for a total of 75 MW for category 1 projects.

It is the view of the authors that the overall number of projects in category 1 is realistic, but the average size of projects should likely be reduced to reflect low to medium penetration projects. The current analysis found between 30-85 MW of near-term potential, and therefore a target of 40 MW for the ReCWIP program is very realistic.

Should phases still be pursued, a sub-total for phase 1 of 10 MW is realistic, and in phase 2 larger projects and project expansions are realistic, such that a sub-total of 30 MW is realistic. This would result in an overall uptake of 40 MW over 10 years, or about 45% of the near-term, medium-penetration potential.

3.3 Category 2 uptake potential

The 2008 budget submission for ReCWIP recommended funding for 24 projects with an average size of 0.5 MW for a total of 12.4 MW for category 2 projects.

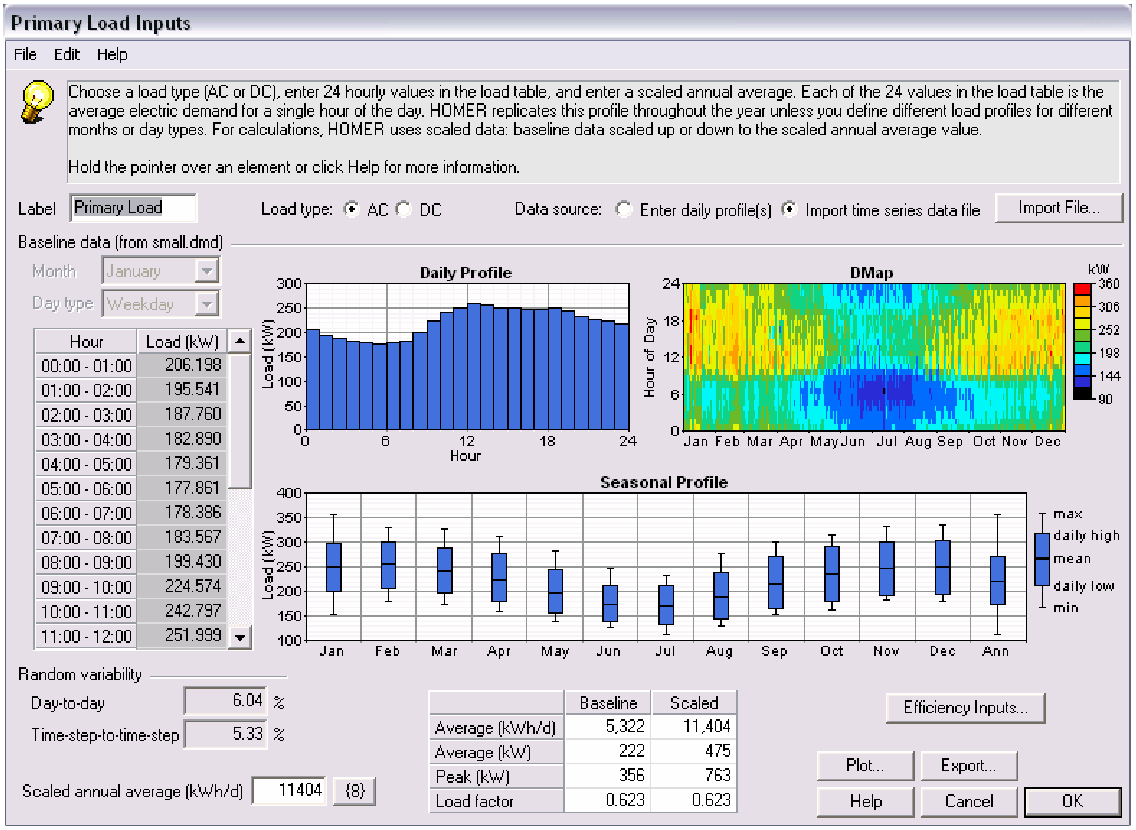
It is the view of the authors that this recommendation is realistic and if anything may be too small. The practical limit is about 5 projects per year, and 300 kW average capacity for a total of 15.0 MW over 10 years or about 40% of the near-term potential. This implementation rate will likely ramp up towards the end of the program (i.e. slower in phase I, vs. phase II).

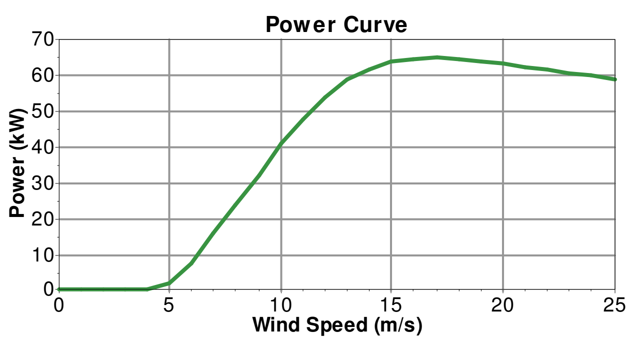
3.4 Final recommendation

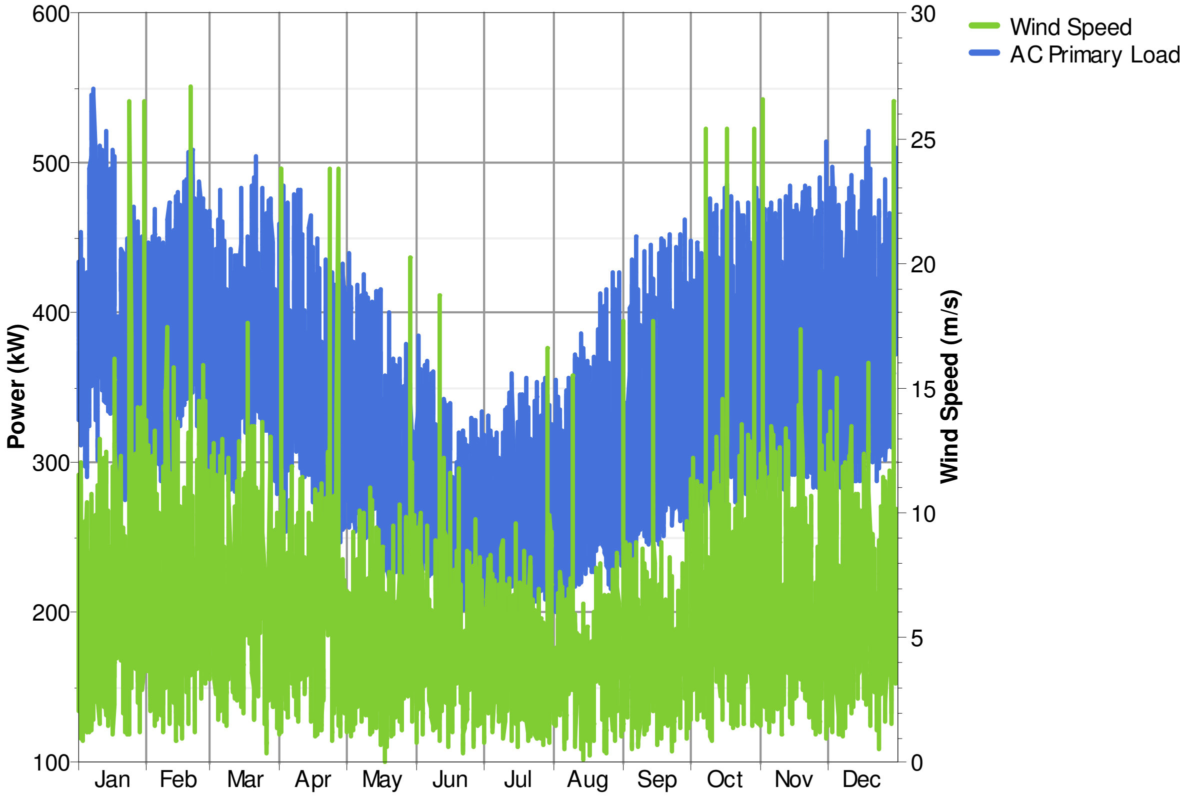
It is recommended that overall program projection be reduced to 55 MW from 87.4 MW, noting that it is very likely to be fully used, and more likely to be over- rather than under-subscribed.

Appendix A

HOMER Analysis






Wind Speed
AC Primary Load
Power (kW)
Wind Speed (m/s)
600
500
400
300
200
100
30
25
20
15
10
5
0
Jan
Feb
Mar
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Appendix B

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