October 25, 2008

Comments by Paul Gipe[1]
on
"A Community Wind Energy Program for New Brunswick

A Preliminary Report by Yves Gagnon and Mathieu Landry"

It is with great reluctance that I comment on the preliminary report. The authors have made a significant contribution to defining what is and is not a community wind project in New Brunswick. However, there are serious technical errors, and errors of judgment in the report. There is also the appearance that my and others comments about the needs of community wind projects have fallen on deaf ears.

1. page 3. I would argue that there is no "policy gap" in New Brunswick. There is no renewable energy policy in New Brunswick and, therefore, there can be no policy gap between them. In no way can a net-metering policy for projects less than 2 MW can be considered a serious renewable energy policy in any jurisdiction. Net-metering is not a policy and not a policy mechanism. Nor can a program calling for tenders for projects greater than 20 MW be considered a serious policy for the successful development of renewable energy. In almost every jurisdiction, the use of RFPs for wind development has resulted in governments missing their renewable targets. Thus, New Brunswick has no policy for projects of any size that will likely lead to the province reaching its targets in a timely, cost-effective, and more importantly, equitable manner.

2. page 4. As I argued in my previous submission, apparently to no avail, community wind projects can be of any size. However, the authors continue to insist that community wind projects fall between 2 and 20 MW. This, again as stated before, relegates community wind to artificial constraints on project size and, hence, limits the choice that communities can make themselves about what is and is not the right size for them.

3. page 4. Feed-in tariffs (Standard Offer Contracts) have been shown time and time again that they are the ideal procurement mechanism for projects of all sizes. They are not only ideal for community wind projects but also for large, corporate projects as well as small projects developed by farmers and homeowners.

4. page 9. It is not clear that there is a good reason for limiting projects to 15 MW. If a community can afford a larger project or a larger project is more profitable it should have the right to do so. As stated previously, there is little justification for choosing 15 MW. It appears the authors had chosen 15 MW prior

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to the public consultation and have stubbornly stuck with this recommendation regardless of advice to the contrary.

5. page 10. The recommendation to have NB Power manage the contracts is unwise. Why does the province want to have the fox guarding the hen house. It is the province's responsibility to manage and implement the program and it should not delegate this responsibility to a private company.

6. page17. The authors need to revisit their economic calculations. Their conclusions are in error. No one in Canada who actually works with wind energy believes that a project can be built in 2010 for $0.09/kWh. While there may be companies that "bid" projects at that price, there are none that can "build" actual projects at that price.

There are a number of errors in the economic forecast that lead to this erroneous tariff. Most egregious is the use of a single number to represent the broad range of wind resources that will be encountered by community wind developers. Though New Brunswick has a well deserved reputation for being windy, it is apparent that the authors, by proposing a single number value for payment, have not given any serious thought to the near certainty that the wind resource will differ from one site to the next.

Moreover, the authors rely on a confusing and misleading metric for productivity: capacity factor. The use of "capacity factor" has caused more mistakes in wind energy development than any other single term. I suggest that the authors consult European industry practice as well as numerous textbooks on the subject for a thorough explanation.

Nevertheless, I have included here some extracts from Generator Ratings & Capacity Factors: Why You Should Avoid Them found on my web site.

Specific capacities are a function of how heavily the rotor is loaded. At high wind sites, it's possible to extract more energy from the rotor because of the strong winds. To do so the turbine is modified to extract more energy and this is reflected in a higher generator rating in kilowatts and a higher rotor loading in kW/m^2. Modern commercial wind turbines are available in specific capacities from 0.3 kW/m^2 to more than 0.4 kW/m^2. The Vestas V80 has a specific capacity of 0.36 kW/m^2, whereas the V82 has a specific capacity of 0.31 kW/m^2. The 3 MW Vestas V90 has a very high rotor loading of 0.47 kW/m^2 reflecting that it's designed for very energetic sites.

The capacity factor and specific generation per rated kilowatt are only of value when data on swept area is unavailable or uncertain in statistical summaries.

Annual Specific Yield or annual generation per area swept by the rotor in $kWh/m^2/yr$ is the ideal measure of reliability, efficiency, and a site's wind resource. Specific yield is solely a function of wind regime and wind turbine performance, and is independent of the turbine's rating in kilowatts.

Turbine rating has a direct effect on generation per unit, and an inverse effect on generation per kilowatt and capacity factor. Increasing a turbine's rated capacity may increase generation slightly by enabling the turbine to capture energy in higher winds, while at the same time lowering overall capacity factor.

As discussed previously, specific rated capacity is a function of wind turbine design. Once turbine design is known, capacity factors can be related to specific yields.

At exceptionally energetic sites, such as on the west coast of the Jutland peninsula or on Whitewater Hill in California, contemporary wind turbines can yield 1,000-1,250 kWh/m²/yr. San Gorgonio Farms, which operates 200 of the world's most productive wind turbines, consistently produces 1,100-1,200 kWh/m²/yr. There are also numerous coastal sites in Northern Europe where specific yields exceed 1,000 kWh/m²/yr.

Consequently, the preferred metric is Annual Average Specific Yield in kWh/m²/yr. This unit of measurement eliminates the “generator rating” in wind turbine nomenclature. For example, at a site with a yield of 1,000 kWh/m²/yr, a turbine will have a capacity factor from 0.20 to about 0.40. Conversely, a capacity factor of 0.36 will have a yield from 950 kWh/m²/yr to more than 1,500 kWh/m²/yr depending upon the rating of the turbine. See the table on Capacity Factor and Specific Yields below.

Equivalent Capacity Factor for Specific Rated Capacity

Specific Yield	Specific Capacity in kW/m²			
kWh/m2/yr	0.3	0.4	0.5	0.6
400	0.15	0.11	0.09	0.08
450	0.17	0.13	0.10	0.09
500	0.19	0.14	0.11	0.10
550	0.21	0.16	0.13	0.10
600	0.23	0.17	0.14	0.11
650	0.25	0.19	0.15	0.12
700	0.27	0.20	0.16	0.13
750	0.29	0.21	0.17	0.14
800	0.30	0.23	0.18	0.15
850	0.32	0.24	0.19	0.16
900	0.34	0.26	0.21	0.17
950	0.36	0.27	0.22	0.18
1,000	0.38	0.29	0.23	0.19
1,050	0.40	0.30	0.24	0.20
1,100	0.42	0.31	0.25	0.21
1,150	0.44	0.33	0.26	0.22
1,200	0.46	0.34	0.27	0.23
1,250	0.48	0.36	0.29	0.24
1,300	0.49	0.37	0.30	0.25
1,350	0.51	0.39	0.31	0.26
1,400	0.53	0.40	0.32	0.27
1,450	0.55	0.41	0.33	0.28
1,500	0.57	0.43	0.34	0.29

Why this is important is that, as explained below, there are only a few sites on earth with average yields approaching 1,500 kWh/m²/yr. (See the table of Tararua below.) Thus, it is extremely unlikely that all community power sites will be this productive. As a consequence any estimates of return on investments based on such yields are extremely unlikely.

Tararua Wind Plant New Zealand Specific Yields for Vestas V47						
		Diameter	Swept Area	Specific Yield		
	kWh/yr	m	m^2	$kWh/m^2/yr$		Capacity Factor
Low	1,457,901	47	1,735	840	800	0.25
Median	2,500,000	47	1,735	1,440	1,500	0.43
High	3,050,622	47	1,735	1,760	1,800	0.53
WindStats, Spring 2005, Vol. 18, No. 2, pg 13.						

Further, I would question reliance on data from NRCan for capacity factors. There is no complete citation to check the source, but it is likely that this is "data" proposed for the EcoEnergy subsidy reservation. As such, this is an inflated number to protect their reservation. Again, the average does not reflect the breadth of performance of real projects, those with higher and lower performance. And it is the lower values that will determine whether community projects go bankrupt. It is irresponsible not to present a range of values and propose a range of tariffs.

The study's installed costs are far from the mark as well. The study assumed $2,200 CAD/kW even though they cite the Helimax study showing $2,800 CAD/kW. Current costs have reached nearly $3,000 CAD/kW.

The study again errs by only examining costs in relation to rated capacity. As shown in the table below, an installed cost of $3,000/kW can result in specific costs of from $900/m² to $1,800/m², a difference of two times! And it is the cost relative to rotor swept area ($/m²) that is the true measure of a wind project's cost.

Specific Installed Cost ($/m2) in Terms of Rated Capacity				
Installed	Specific Capacity in kW/m^2			
$/kW	0.3	0.4	0.5	0.6
2,000	600	800	1,000	1,200
2,100	630	840	1,050	1,260
2,200	660	880	1,100	1,320
2,300	690	920	1,150	1,380
2,400	720	960	1,200	1,440
2,500	750	1,000	1,250	1,500
2,600	780	1,040	1,300	1,560
2,700	810	1,080	1,350	1,620
2,800	840	1,120	1,400	1,680
2,900	870	1,160	1,450	1,740
3,000	900	1,200	1,500	1,800

What does all this mean? It means that the authors need to revisit costs, yields, and their economic calculations to provide a range of tariffs that will produce reasonable profits with a variety of different wind resources.

Using the author's assumptions with the exception of more realistic installed cost and more realistic annual reoccurring costs, we can revisit the tariff calculation. The assumptions used are presented in the tale below.

Tariff Calculation Using Chabot Profitability Index Method for Generic Turbine in New Brunswick			
Adapted by Paul Gipe, pgipe@igc.org			
Enter Data in These Cells.			
Average Weighted Cost of Capital Before Tax			
Equity		20%	
Return on Equity	ROE	7.0%	
Debt		80%	
Interest on Debt		7.00%	
Nominal AWCC		7.0%	
Inflation		3.0%	
AWCC real	t	3.9%	
Rotor Diameter	80	5,027	m2
Rated Capacity		2,000	kW
Specific Installed Cost	Ius	$1,114	$/m2
Installed Cost	I	$5,600,000	
		$2,800	$/kW
Annual Expenses	Kom	4.0%	
Term	n	20	years
Discount Rate (AWCC)	t	3.9%	real
Specific Yield	Eas	700	kWh/m2/y
Capital Recovery Factor (n,t)	Kd	0.0728	
Profitability Index Target	PI	0	NPV/I
Cost of Energy	T1	$0.180	$/kWh
Simple Payback	SPBT	8.9	years
Note: Before tax, 100% Adjustment with Inflation.			

Rather than pay all projects $0.09/kWh, the tariffs should be based on resource intensity, that is, average yield. The average equivalent tariffs will range from a low of $0.011/kWh at very windy sites to a high of $0.18/kWh at less windy sites as shown below.

Calculation of Constant Equivalent Tariff (Teq) and Tariff T2					
Example Only					
Term of Fixed Price, T1			j	5.00	years
CRF During Fixed Price Period, j			CRF(t,j)	0.224	
			1/CRF	9.265	
			CRF(t,j)	0.108	
			Years 1-j		Years j-n
		Eas	T1	Teq	T2
		Yield			
		kWh/m2/y		$/kWh	$/kWh
Target	**0.00**	**700**	**$0.180**	**$0.180**	**$0.180**
	0.04	800	$0.180	$0.161	$0.153
	0.09	900	$0.180	$0.147	$0.132
	0.13	1000	$0.180	$0.136	$0.115
	0.17	1100	$0.180	$0.127	$0.102
	0.21	1200	$0.180	$0.119	$0.090
	0.26	1300	$0.180	$0.113	$0.081
	0.30	**1400**	**$0.180**	**$0.107**	**$0.072**

All projects should be paid $0.18/kWh for the first five years. In subsequent years the tariff (T2) will depend upon the productivity of the project. At windy sites with yields of 1,400 kWh/m²/yr the tariff will fall to $0.07/kWh for the next 15 years. At sites with only 700 kWh/m²/yr the tariff will remain $0.18/kWh for the next 15 years. This is the only fair and rational way to provide equitable tariffs to all New Brunswick communities for the profitable development of their wind resources.

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