Capacity Factor of Ontario Wind Energy Generating Facilities

Capacity Factor (Efficiency) Given as a Percentage of the Nameplate Power Output: July 2009 – May 2011

Month	Amaranth	Dillon	Gosfield	Kings-bridge	Port Alma I	Port Alma II	Port Burwell	Prince	Ripley	Talbot	Under-wood	Wolfe Island	Overall
Nameplate (MW)	**200**	**78**	**50**	**40**	**101**	**99**	**99**	**189**	**76**	**99**	**182**	**198**	
Jul-09, -10	16, 16			11, 13	18, 16		14, 12	15, 15	12, 14		14, 16	14, 17	14, 16
Aug-09, -10	18, 18			21, 17	21, 14		17, 13	19, 22	21, 19		21, 19	16, 20	19, 18
Sep-09, -10	16, 29		, 22	18, 34	21, 31		17, 26	16, 37	17, 33		16, 35	20, 32	18, 32
Oct-09, -10	25, 29			35, 35	39, 37		34, 32	29, 31	30, 29		33, 33	32, 32	31, 32
Nov-09, -10	23, 32		, 39	32, 42	35, 40	, 37	25, 33	34, 44	29, 40		28, 39	22, 33	27, 37
Dec-09, -10	31, 26		, 42	43, 51	41, 47	, 51	36, 39	29, 31	37, 53		39, 48	35, 34	35, 39
Jan-10, -11	27, 27		,38	39, 36	48, 38	, 43	36, 33	28, 25	39, 39	, 33	38, 36	27, 27	33, 33
Feb-10	24, 43	, 56	, 55	25, 45	31, 52	, 58	23, 47	21, 34	25, 50	, 51	24, 48	23, 42	24, 46
Mar-10	28, 27	, 40	, 34	27, 31	37, 38	, 41	26, 26	26, 28	28, 32	, 35	26, 29	37, 29	29, 31
Apr-10	34,38	, 40	, 49	38, 38	47, 49	, 52	30, 35	31, 31	36, 38	, 47	34, 38	29, 38	33, 40
May-10	24,(27)	,(32)	,(34)	24,(28)	37, (35)	,(38)	27,(22)	25,(27)	24,(28)	,(33)	22,(29)	20,(35)	25,(30)
June-10	19			18	27		18	19	18		18	17	19
Annual Average	**24, 28**			**28, 32**	**34, 35**		**25, 28**	**24, 29**	**26, 33**		**26, 32**	**24, 30**	**26, 31**

Note: The second set of numbers in the columns corresponds to July 2010 to May 2011. Along the bottom row, the second set of numbers are estimated annual averages for July 2010 to June 2011.

Comment:
The table shows the monthly capacity factor for the Ontario wind farms for the year July 2009 to June 2010, left-hand set, and for the part-year July 2010 to May 2011, right-hand set (NB the May figures are for the first half). The capacity factor is the actual power output divided by the nameplate power; it is given as a percentage. The nameplate for each wind farm is given in the second row. As an example, consider the July-09 entry for Amaranth: The average hourly output for that month was 32 MW. Dividing by the nameplate power of 200 MW, we get 16%. The row labeled **Annual Average** is the 12-month average for July 2009 to June 2010 (but see note above).

It is instructive to consider the variation of the annual average capacity factor of the Ontario wind generating plants from year to year. This can only be done for the complete years of operation of the plants. Amaranth was brought on line in 2006 and enlarged during the 2008 – 2009 year. The figures for 2010 – 2011 involve an extrapolation for the second half of May and the month of June.

Annual Average Capacity Factor (Efficiency) Given as a Percentage of the Nameplate Power Output.

Year July to June	Amaranth 1	Amaranth 1 and 2	Kingsbridge	Port Alma	Port Burwell	Prince	Ripley	Underwood	Wolfe Island
2006 – 2007	30		33		29				
2007 – 2008	29		35		27	29			
2008 – 2009			33		28	27	33		
2009 - 2010		24	28	34	25	24	26	26	24
2010 - 2011		28	32	35	28	29	33	32	30

It is clear from the capacity factors of plants operating back to 2006 that 2009 – 2010 was a poor year across Ontario. This is most likely a fluctuation involving the variation of wind speed over time. The wind speed does vary from year to year as is particularly obvious from the very windy past winter. Wind speed records going back 5 years were only available to me for Toronto. The annual average wind speeds (v) are given in the following table:

Year	2006-2007	2007-2008	2008-2009	2009-2010	2010-2011
v (km/h)	17.1	16.6	16.6	16.5	18.0
$(v/v_0)^3$	1.02	0.93	0.93	0.91	1.19

The power produced by a wind turbine varies as the third power (cube) of the wind speed. The third row of the table shows the cube of the ratio of the annual average to the 5-year average. Therefore we can expect that the annual power output would have been 10% below average in 2009-2010 and 20% above average in 2010-2011. There are many uncertainties in this analysis: Toronto is taken as the proxy for the province; some turbines will be down for maintenance; the cube law operates only over the middle range of wind speeds; and so on.

The bottom line is that for July 2009 to June 2010 the Ontario wind energy system produced an average power output of 280 MW, about one third of one coal plant. This was enough to power the needs of 200,000 homes. This output was less than 1% of the electrical energy capacity available to Ontario (31.5 GW on December 30th, 2009 at noon) and about 1.5% of the typical demand (19 GW on December 30th, 2009 at noon, including 2 GW for export). Currently, with a

nameplate 1411 MW up and running and above average wind speeds the average power output is about 440 MW, about one half of a coal plant.

For Wolfe Island, the average efficiency over its first year of full operation was 24%. This is comparable to the overall efficiency for all of the wind farms for the same period. This average power generation of 49 MW was enough to power 35,000 homes. This compares with 75,000 homes claimed by Canadian Hydro Developers, the Honorable John Gerretsen, Minister of the Environment, and on occasion by the Kingston Whig Standard. The 35,000 is based upon Hydro One's figures of 850 kWh per month for an Ontario home without electric heat and 1700 kWh for a home with electric heat. I have assumed an average of 1000 kWh per month for an average home. The long term average efficiency should be in the range 25 to 28%.

On the same date, December 30th 2009, that the above numbers for Ontario's power generating capacity and power demand were recorded, the fraction of the Ontario energy supply that was "green" (nuclear, hydroelectric and wind) was 80%. The European protestors at Copenhagen who awarded Canada the "fossil of the year" award can only dream about such a high fraction of "green" electrical energy in their home countries! Manitoba and Quebec have "green" electrical energy ratios similarly high because of their abundance of hydroelectricity.

John Harrison – May. 2011.