SkyFarming Pty Ltd
developing community windfarms
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Economic Regulation Authority
ATTN:Mr Robert Pullella
Executive Director Competition, Markets and Electricity
Level 6, Governor Stirling Tower
197 St George's Terrace
Perth WA 6000

21/11/2007

Dear Mr Pullella

Improvements to Mid West Regional Network

SkyFarming Pty Ltd would like to offer some comment on the PB Power's Technical appraisal of the proposed 330kV line for the ERA.

On p17, there is a reference about the 1000MW of capacity suggested by Energy Visions and SkyFarming Pty Ltd.

For SkyFarming, this was never about supplying local load, this was about providing for large scale wind installation to supply Perth. An important part of this is allowing the wind plant to be geographically dispersed over a large area. An idea of how significant this distribution is, see attachement A - Wind WA, page 9.

It is highly likely that after this Saturday, Australia will have a new Federal Government under Mr Rudd who has proposed a 20% by 2020 target for renewables in Australia.

Wind is simply, the most cost effective, mature and practical (large scale) renewable technology available. (Under MRET, wind was the surprise winner of all the technologies eligible, see below[1].)

Fuel Type	Redding (GWh per annum)	Latest data (GWh per annum) (Carbon Markets Report)
Sugar Cogen	4864	1080
Wind	402	3470
Landfill Gas	836	600
Hydro	834	1940
SWH	1150	1623
Other Biomass	1500	439
Other	117	158
Total	9703	9310

Generation by fuel under MRET – original projections versus latest data.

The area between Geraldton and Perth is vast, coastal and mostly empty of people. It is good wind country with available power line being the only restriction.

[1] p25, Ecogeneration, July/August 2007

A comment about the term 'baseload';

Baseload is an economic (and to a degree, technical) requirement of large coal and nuclear power stations, where the high capital cost and low running cost of these plants mean strong incentives to produce as much as possible whenever possible. Wind is similar, with high capital costs and low running costs. It is NOT a requirement of the grid.

Gas and Wind Plant

While wind plant is expensive to install and cheap to run, gas plant is the opposite, cheap to install but expensive to run. As gas is tied to the international price of oil, it can only go up as the demand for oil goes up while supplies become more depleted and pressure for reducing carbon emissions increases. Agreements between gas plant and wind plant operators could see gas compliment, rather than compete with, wind plant during peak hours.

Islanding Option (11)

This is an interesting option but as the wind blows anytime, this option would restrict the amount of wind that could be installed on the island grid to around the minimum load. Maximum rated wind capacity in excess of this would have to spill excess output during high wind, low load times as there would be no way of exporting it.

How much spill is acceptable is dependant on the value of this electricity and how often it would occur. Time of day curves[2] for the load on the grid and wind generation on the coast suggest it would not be often.

Yours sincerely

Andrew Woodroffe

[2] See p12 of Attachment A

Attachment A

Wind WA

Wind WA

Supplying the bulk of electricity in WA by wind

by
Andrew Woodroffe
11/10/2007

SkyFarming Pty Ltd

Contents

Load versus Accumulated Hours a Year

Timestamp data for the South West Interconnected System (SWIS) as shown in Figure 1 was obtained from Western Power for one year, April 05 to March 06, to calculate the graph in Figure 2.

Date and Time	SWIS	Rounded MW
1/04/2005 0:00	1,262	1,300
1/04/2005 0:30	1,222	1,200
1/04/2005 1:00	1,193	1,200
1/04/2005 1:30	1,173	1,200
1/04/2005 2:00	1,167	1,200
1/04/2005 2:30	1,154	1,200
1/04/2005 3:00	1,163	1,200
1/04/2005 3:30	1,166	1,200
1/04/2005 4:00	1,193	1,200
1/04/2005 4:30	1,216	1,200
1/04/2005 5:00	1,282	1,300
1/04/2005 5:30	1,356	1,400
1/04/2005 6:00	1,514	1,500
1/04/2005 6:30	1,635	1,600
1/04/2005 7:00	1,792	1,800
1/04/2005 7:30	1,881	1,900
1/04/2005 8:00	1,917	1,900
1/04/2005 8:30	1,922	1,900
1/04/2005 9:00	1,937	1,900
1/04/2005 9:30	1,926	1,900
1/04/2005 10:00	1,920	1,900
1/04/2005 10:30	1,923	1,900
1/04/2005 11:00	1,927	1,900
1/04/2005 11:30	1,921	1,900
1/04/2005 12:00	1,916	1,900
1/04/2005 12:30	1,897	1,900

Figure 1, Timestamp data for the SWIS

The load in MW was graphed against accumulated hours a year for WA's electricity consumption on the SWIS – just under 15,000 GWh.

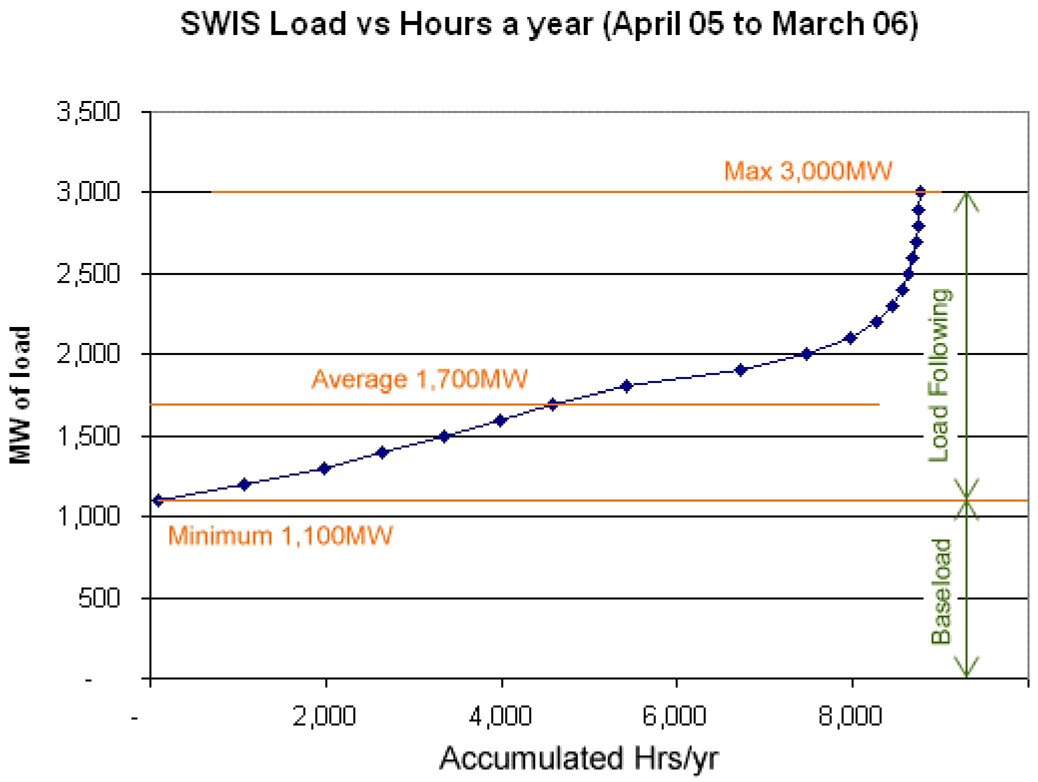

Figure 2, SWIS versus Accumulated Hrs/yr

From this graph, we can see that the baseload was just over a third the maximum load, and the average just over half the maximum. This means that the system already has load following capability of two thirds the Max load, ie just under 2000MW.

Windspeed Distribution and Power from Wind

Based on the 800kW Enercon E48 wind turbine, a typical powercurve – if somewhat smaller than most modern machines.

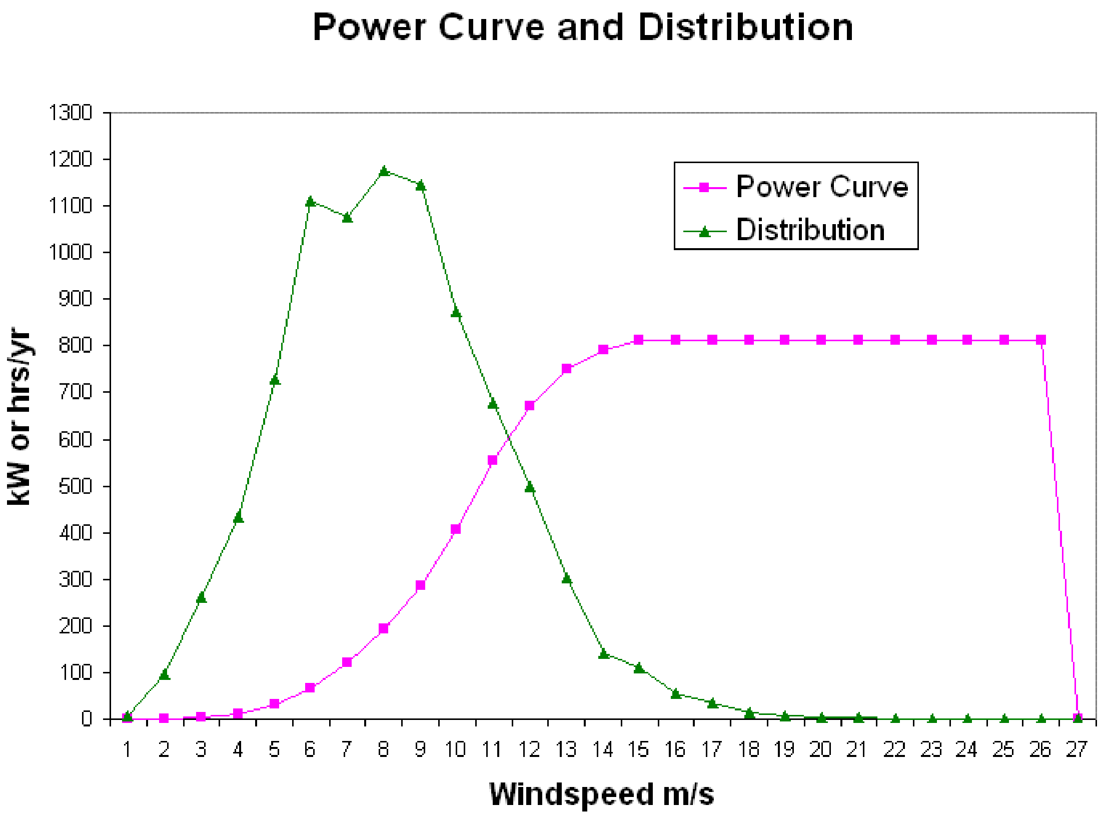

Figure 3, Windspeed versus Power Output and Distribution

Wind distribution is based on a year's worth of wind data from a mast on top of Mt Barker Hill, 70km north of Albany (and the coast) on the highway. The electricity generated by the wind turbine is the product of these two curves. The windspeeds have been doctored to give a modest Capacity Factor, CF, of 0.35 ~ around 2,300 MWh/y. Now, we can combine the two curves by recalculating the distribution curve as accumulating hours a year and graphing it against the corresponding power output for that windspeed. Ie at 6m/s, the distribution is 1075 hours a year, including the hours at windspeeds lower than 6m/s, we get 3716 accumulated hours, the output at 6m/s is 120kW.

At 12m/s, the accumulated hours are 8391 hours and the power output is 750kW.

Combining the distribution curve and the power curve provides a single curve for a single turbine ie output for one turbine will look something like this.
This is a single turbine supplying electricity to roughly 500 people.

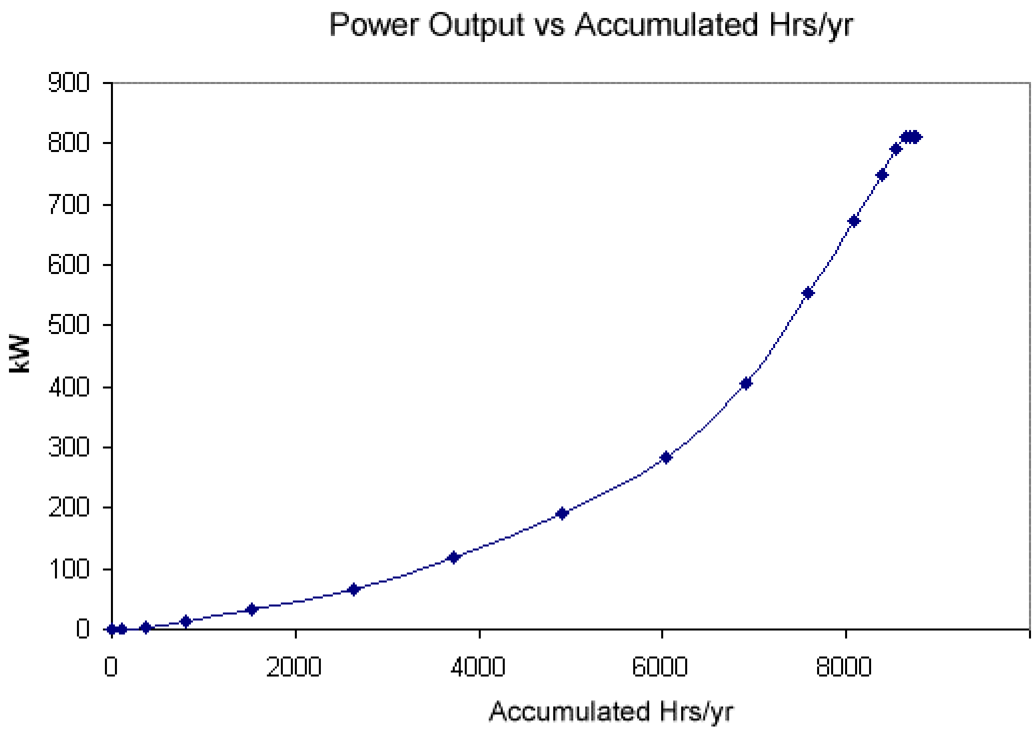

Figure 4, Power versus Accumulation Hrs/yr

Of course, more turbines, more windfarms more geographically spread will give a flatter curve, it will be rare that the wind will be strong or weak, everywhere.

Geographical Dispersion

An idea of how much flatter is given by looking at data from four different sites. In this case, 1 years worth of half hourly data at Bureau of Meteorology sites around the SWIS, speeds adjusted to give a capacity factor of 35% with an E48 power curve.

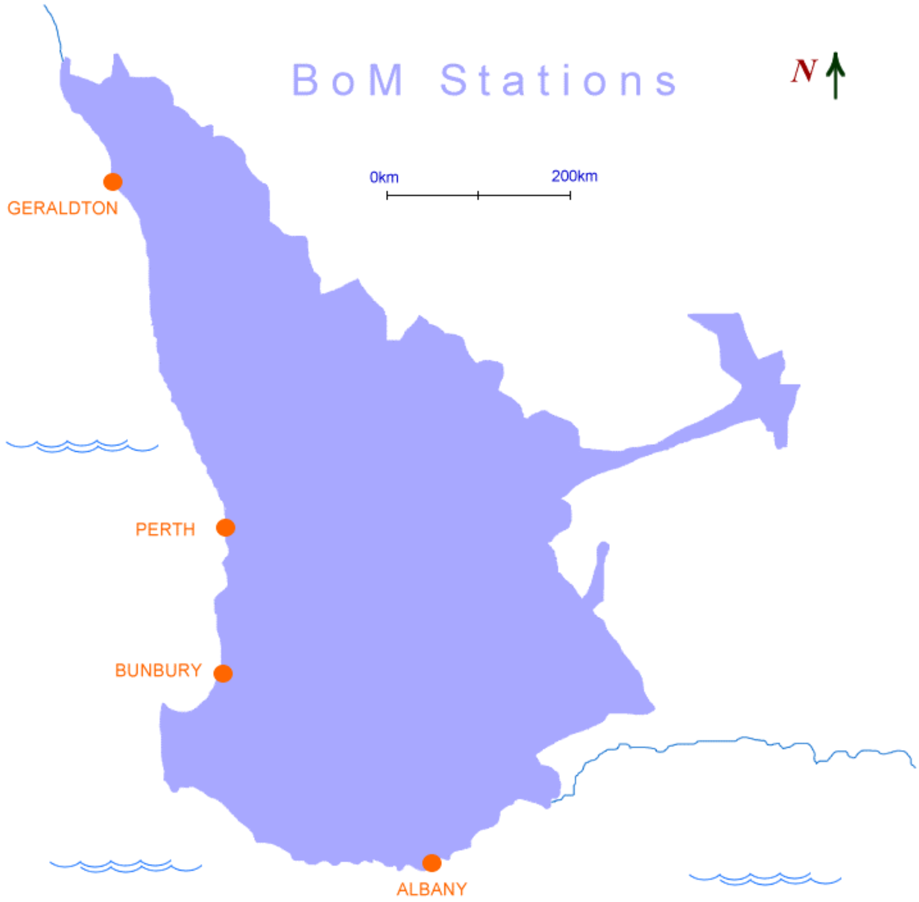

Figure 5, BoM Stations

Modifing the power output scale to be in % and assuming the size of windfarm and Capacity Factor (about 35%) is the same for all four sites, the curves look like this;

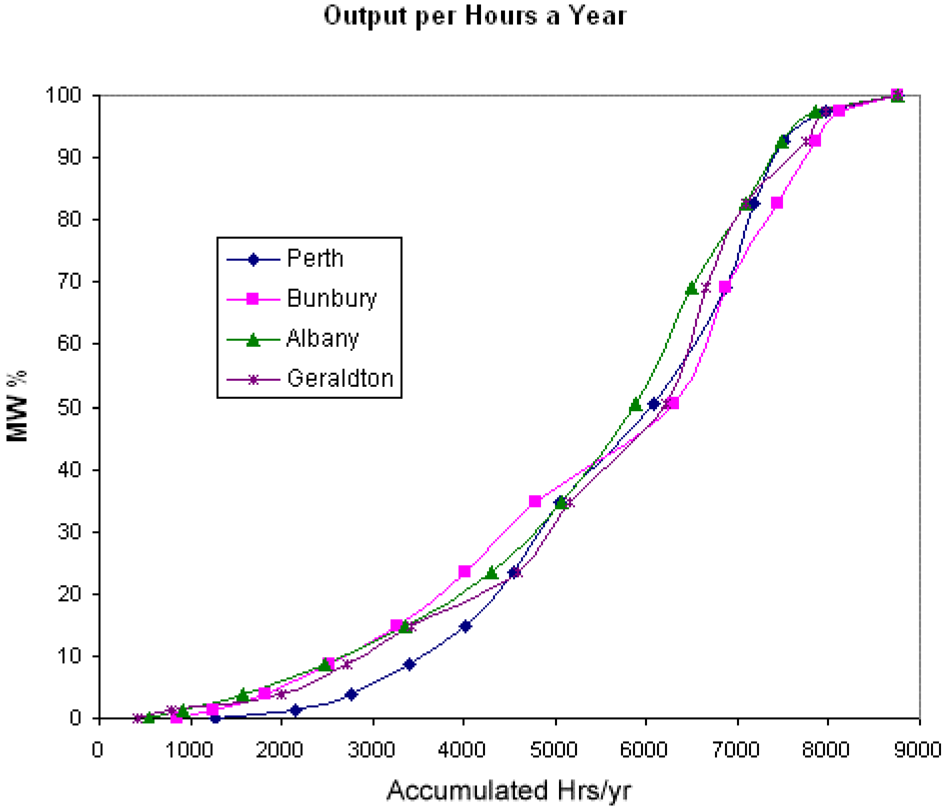

Figure 6, % Power versus Accumulated Hrs/yr

The average for all sites is shown below, however, we ought be looking not at the average, but at the average of all the wind farms every half an hour;

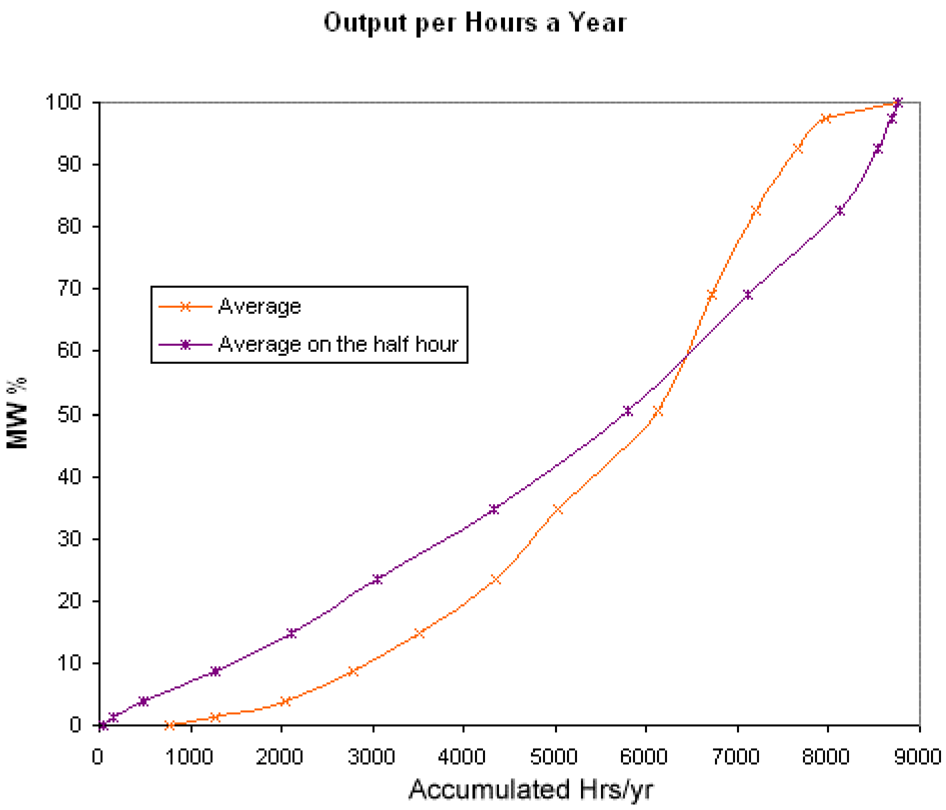

Figure 7, Average and Real Time Average

The resulting curve is somewhat different, and this illustrates what we mean be geographical dispersion.

Adding the production from windfarms at all four sites at the same time gives a flatter curve, as fronts pass through, one windfarm will be producing when the other is not, similarly, it will be also rare for both to be producing at full power or not at all.
What is really interesting are the very few hours above 80% of full output.

2000MW of wind plant

Back to the SWIS, from Figure 2 we see the system can cope with nearly 2000MW of variable load.
But 2000MW intermittant supply of energy by the wind?! 2000MW is greater than our minimum of 1100MW so there will be times of the year when the wind plant will need to be derated. How often and how much will the wind be excessive?

The difference between the load and the energy generated for each half hour for the year April 05 to March 06 is calculated.

Date and Time	SWIS Load	2000MW Wind Plant	Difference	Rounded
1/04/2005 0:00	1261.51	1160.49	101.02	100
1/04/2005 0:30	1222.40	1086.42	135.98	100
1/04/2005 1:00	1192.62	1086.42	106.20	100
1/04/2005 1:30	1173.16	1259.26	-86.10	-100
1/04/2005 2:00	1167.08	1185.19	-18.10	0
1/04/2005 2:30	1154.30	1135.80	18.49	0
1/04/2005 3:00	1162.71	1086.42	76.30	100
1/04/2005 3:30	1166.23	1135.80	30.43	0
1/04/2005 4:00	1192.64	1259.26	-66.62	-100
1/04/2005 4:30	1215.51	1407.41	-191.90	-200
1/04/2005 5:00	1282.29	1506.17	-223.89	-200
1/04/2005 5:30	1356.07	1358.02	-1.95	0
1/04/2005 6:00	1513.85	1358.02	155.82	200
1/04/2005 6:30	1635.21	740.74	894.46	900
1/04/2005 7:00	1791.79	1283.95	507.84	500
1/04/2005 7:30	1880.72	1012.35	868.38	900
1/04/2005 8:00	1916.83	1506.17	410.66	400
1/04/2005 8:30	1921.51	1629.63	291.88	300
1/04/2005 9:00	1937.27	1851.85	85.42	100
1/04/2005 9:30	1926.41	1259.26	667.15	700
1/04/2005 10:00	1920.16	1333.33	586.83	600
1/04/2005 10:30	1922.66	2000.00	-77.34	-100
1/04/2005 11:00	1927.15	2000.00	-72.85	-100
1/04/2005 11:30	1920.63	1407.41	513.22	500
1/04/2005 12:00	1916.30	1506.17	410.13	400
1/04/2005 12:30	1896.82	1506.17	390.65	400

Figure 8, SWIS Load vs 2000 MW of Wind Plant in 'Real Time'

Load vs Additional Generation required, 2000MW Windplant

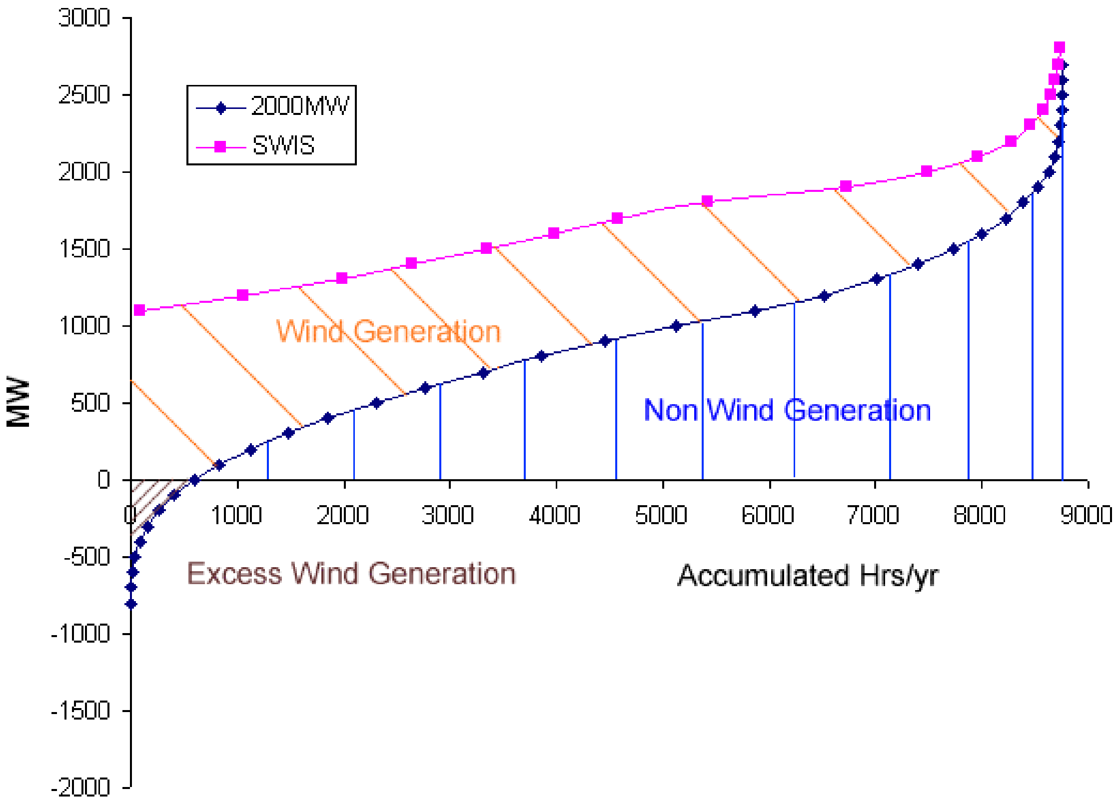

Figure 9, SWIS and 2000MW Wind Generation

From the above graph, the area between the two curves is the wind energy generated. This is about 41% penetration. The area above the blue curve and below the Accumulated Hrs/yr axis is excess wind energy which occurs when the load is less than the wind plant produces - this is around 1% of the overall wind generation. The remaining electricity generation required is under the rest of the blue curve.

	2000MW	Load
Electricity (GWh/yr)	6047	14,828
% of total Load	41%	100%
% excess	1%	na

Table 1, 2000MW of Wind vs Load

Why the tiny excess?

Why, other than geographical disperson, when the lowest load is almost half the 2000MW of wind plant, is only 1% of the electricity generated by the wind in excess?

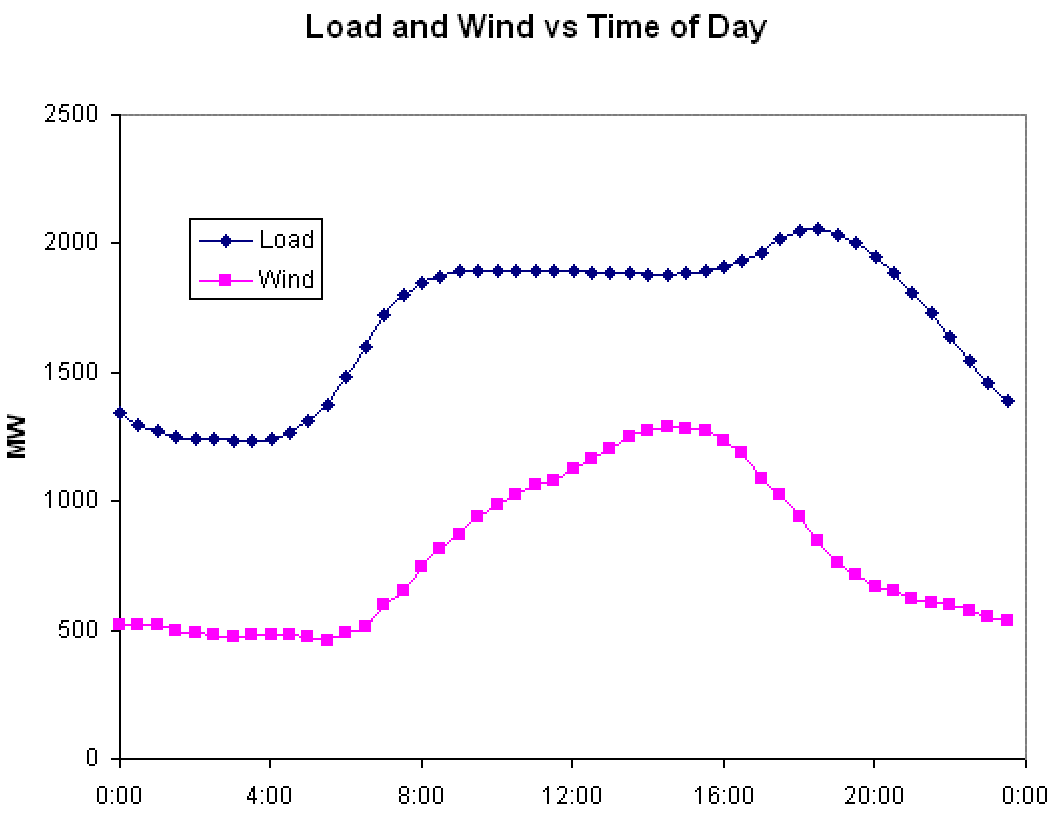

Figure 9, SWIS and 2000MW Wind Generation Time of Day

What does 2000MW look like?

•At 5MW/square kilometre, we need 400km^2
•SWIS covers 322,000km^2 (1 ½ size of Victoria)[1]
•400km^2 could be 2km x 200km which compares with a north south distance of the SWIS of some 1600km

Possible wind sites of 200MW

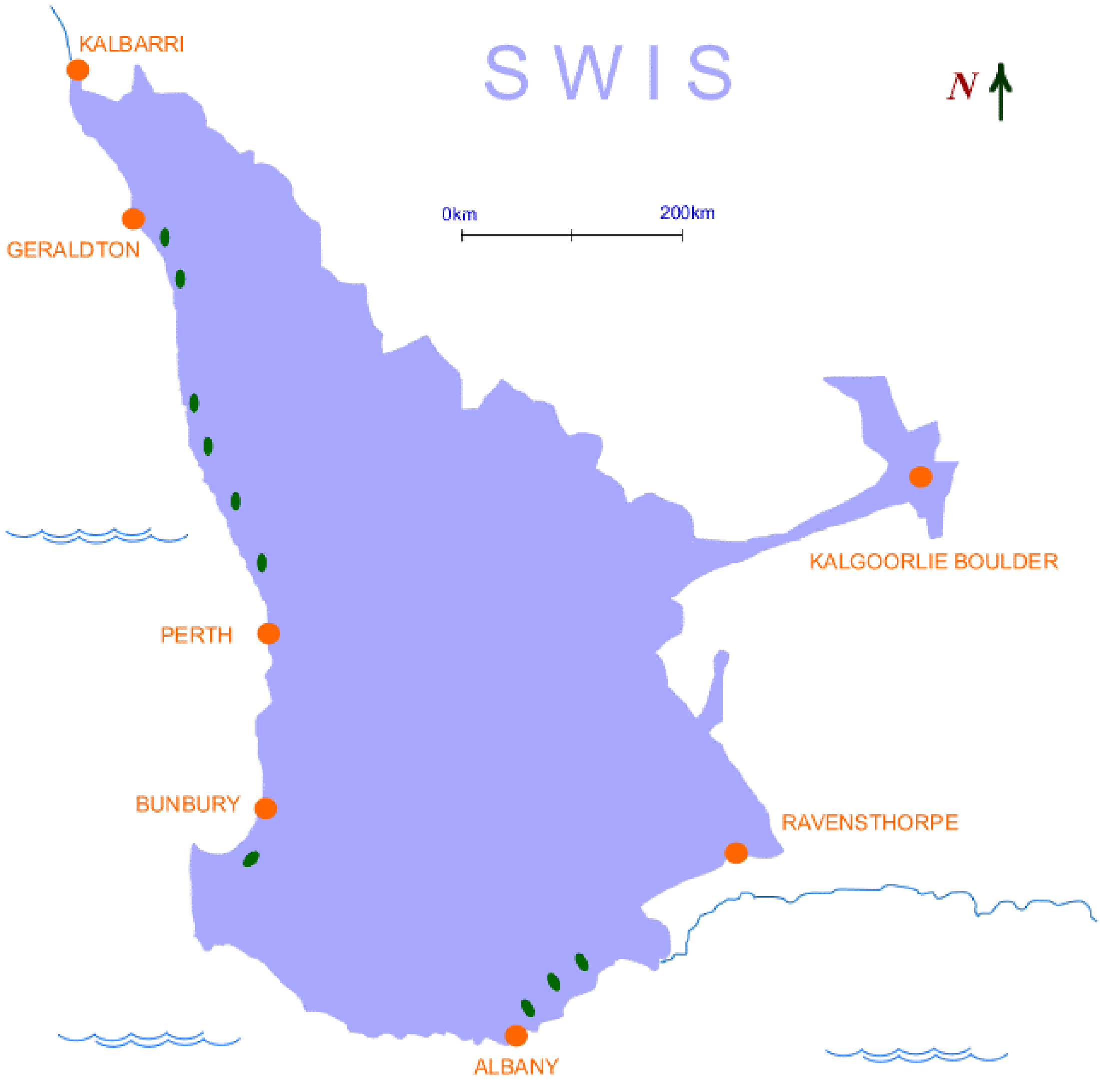

Figure 10, Possible Windfarm Locations

[1] http://www.wpcorp.com.au/subContent/aboutUs/ourNetwork/Network_Vital_Statistics.html

Other parameters

- Number of jobs in construction; 2,960 jobs for 5 years[2]
- Number of jobs in operation, 216 permanent jobs[3]
- Total job years = 16,160
- Equivalent to 733MW of coal (at 90% CF)

Based on 20 year life

[2] assumes 7.4 job years/MW if job 100% local, Dr Robert Passey , March 2003 Driving Investment, Generating Jobs Report, p17

[3] assumes 37 job years / TWh Dr Robert Passey , March 2003 Driving Investment, Generating Jobs Report, p17

Quick look at the Economics

Peak is 6am to 10pm, weekdays only. All other times are offpeak, including the weekend or during public holidays.
Using wholesale prices of $25/MWh for offpeak and $75/MWh for peak, we get . . .

	2000MW	Load
Offpeak ($m/yr)	67	181
Peak ($m/yr)	233	530
Total ($m/yr)	301	711
Excess ($m/yr)	2.7	na
Value of electrical energy ($/MWh)	50	48
Capital Cost* ($m)	3,600	na

Table 2, SWIS, 2000MW Economics

*Assuming $1.8/W

These figures do not include the value of the capacity of the plant to the SWIS. If it can be assumed that this wind plant is installed sooner rather later, it can also be assumed that much the existing generation, particularly gas powered load following and peaking plant, will still exist.

Nevertheless, it may be possible to use demand management and bio diesel fueled gensets to deal with the very few hours a year when the SWIS needs more that the peaking plant can offer ie during rare low wind everywhere and high demand conditions.

It may also be possible to utilise the storage potential of some solar thermal power plants.