MINUTES OF MEETING

SAPPHIRE WIND FARM
COMMUNITY CONSULTATIVE COMMITTEE (CCC)

1 pm, Tuesday 1 October 2013
Kings Plains Castle

Attendees:

Lisa Andrews (LA)	Independent Chair
Ed Mounsey (EM)	Wind Prospect CWP (WPCWP)
Adrian Maddocks (AM)	Wind Prospect CWP
Richard Ennis (RE)	Community Representative
Neil Eigeland (NE)	Community Representative
Helen Hewens (HH)	Community Representative
Don Hollingworth (DH)	Landowner
Merlene O'Brien (MO)	Country Women's Association
Chris Voll (CV)	Church Communities Australia
Norann Voll	Church Communities Australia (Observer)
Cheryl Rudd (CR)	Wellingrove Progress Association
Anthony Alliston (AA)	Manager Development Services - Inverell Shire Council

Apologies:

Carol Newberry	Community Representative
Colin Price	Mayor – Glen Innes Severn Council

ITEM	ACTIONS
1.0 Welcome and Introductions Meeting opened at 1.05pm by Lisa Andrews. All present invited to introduce themselves and explain their role on the CCC.	
2.0 Apologies As above.	
3.0 Confirmation of Previous Minutes Nil – First Meeting.	
4.0 Declaration of Interests LA declared her interest that she has been engaged by WPCWP to chair the CCC. LA went on to explain the Role of the Committee, in that it is an advisory CCC initiated by the proponent WPCWP as an information sharing forum.	
5.0 Business Arising	

Nil – First Meeting.	
6.0 Correspondence tabled Out: AM via email - Meeting Information/Agenda	
5.0 Reports Adrian Maddocks presented an overview of the company and project to the CCC: • Wind Prospect CWP • Project Justification • Project Description • Project Update • Pre-construction Activities • Photo Gallery with an opportunity at the end for open discussion, questions and responses. (Refer to presentation – copy attached.) Questions & Responses: *RE -Have you got permission to put power into the grid?* AM –We have submitted a Connection Enquiry and are currently negotiating with Transgrid over the 330 or 132 kV connection options. *CV -Where will the access road be?* AM - Main access will be via Gwydir Highway, Polhill Rd & Waterloo Rd. Components will likely be delivered to the Port of Brisbane and then transported down the coast, then along the Gwydir Highway. *CV – Has there been an amended layout?* AM - There have been slight changes to the layout, as shown in the Response to Submissions document which was submitted to the Department of Planning in May 2012. We will send out the most up to date map with the minutes. *NE – What are the amendments?* AM – Minor modifications made to internal access tracks and the location of some construction facilities. All information is available on the Department of Planning & Infrastructure website on the Major Projects page, just look for Sapphire Wind Farm. I will send you the link: http://majorprojects.planning.nsw.gov.au/index.pl?action=view_job&job_id=3245 *AA – You can also get the link for the project from the Inverell Shire Council website.* *CR – Looking at the map projected, can you explain the difference between the purple dots and the blue dots.* AM – There are two possible layouts – 1 = 159 turbines and 2 = 125 turbines - depending on the size of the turbines selected (yet to be determined). The size of	Copy of presentation by AM to be distributed electronically to CCC. AM confirmed map shown in Presentation was correct. Link to website to be sent to CCC members.

the turbines determines the spacing on the machines. *CV – Will they be the same manufacturer?* AM – Yes. We can mix and match turbine sizes by the same manufacturer, as long as we don't exceed the maximum capacity (319 MW). We also can't exceed 159 turbines. *CR – Access across Polhill Road – will you be required to maintain?* AM – Yes, we will undertake an assessment of all the impacted roads and bridges to see what is required. We may not use the existing bridges, however, and will work with Inverell Shire Council and Glen Innes Severn Council regarding the upgrading works required. Dilapidation reports will be prepared to determine the existing condition of the roads and bridges, this is an important safety aspect for the construction phase, wear and tear, etc. Once built, the roads will be restored back to an appropriate condition as agreed with Council. *CR – With regard to the Wellingrove cluster – how long will it take you to do?* AM – This will depend on where we start construction within the project; which has not been determined yet. We typically build in clusters with the time frame for each cluster being 6-12 months. *CR – How long for the total build?* AM – 18 months to 2 years for the entire project to be constructed. *RE – Isn't this just a feel good project as you can't store power?* AM – This is a viable project which provides electricity into the grid. It has to be viable in order for us to want to build it. *RE – But there is no guarantee of what you may produce?* AM – The amount of power generated is dependent on the wind. Masts have been installed at Sapphire for at least 3 years and on-site data is correlated with long-term data from the Bureau of Meterology. *RE – What will be lost from carbon emissions? Will they close anything?* ED – Very difficult to answer as it depends on demand. Coal fired power stations are unlikely to close down, but may be used less. *RE – Coal power will have to kick in when the wind isn't blowing?* ED – There will need to be a balance – whether it is hydro/solar/coal/wind, etc. *RE – I would be happy with the project, if they could store the energy. You can't store wind or solar energy. I don't want it just to make the people in Sydney feel better.* AM – Coal fired power stations don't store power. *RE – but it's not a clean energy.* *CV – Can relate to questions RE raises, but recognises the committee exists to work for best outcomes given the project's current realities* ED – there are many papers on the nature of renewable energy supply, I will provide these details to LA for distribution to the CCC. AM – provided information on the Community Fund and explained that the funds are based on the number of turbines. It will be up to the Councils to determine how the funds are spent.	ED to provide information for distribution to CCC.

RE – Will the turbines interfere with mobile phone reception? AM – No. *CV – Can the turbines host a telecommunications facility?* AM – It could be feasible to use the community funds for this aspect, however, this is a broader decision. *CR – who makes this decision?* AM – the community. We would sit on the committee, but we don't have a say on how the money is distributed; it will be up to the people nominated onto the committee to decide how best to spend the funds. *CR – what are other committees doing?* ED – Varies, but includes new fire trucks, improvements to village facilities, etc - funds are only available, once the project is operational.	
6.0 General Business *AA –Terms of reference from the draft guidelines – are these meetings being recorded?* LA – responded – no. Must have approval from the CCC to record. *DH – In terms of the Community Fund – who are the community?* AM – People living in Inverell and Glen Innes council areas in proximity to the project. *DH – What distance from the Wind Farms are included?* AD – Where do you draw a line in the sand? Usually its people in the immediate vicinity of the project – up to 10 kms away for example. Probably local to this area as shown on the project map on the screen. The community funds are used to benefit the community and it will be up to the Committee decide where that money is spent, or how close to the project site. *CV – is the project fully capitalised? What happens if WPCWP go belly up?* ED – the project is fully capitalised before it commences. *RE – will you sell the project off?* ED – if it was sold, we would remain as project managers; as our asset, but not owned by us. Like the Boco Rock Wind Farm in Nimmitabel where the project is run by our people, but it is not owned by us. *CR – how does it work with host landowners?* AM – They receive an annual lease payment for the life of the wind farm, which is usually 25 years x 3 = up to 75 years *RE – have you got a guaranteed fund to clean up the site when you are finished?* AM – a decommissioning fund will be built up over the 25 years to clean-up and decommission the site. *RE – do you have to have guaranteed funds or does it fall back to the Shire Council?* AM – the worst case scenario, if the company where to go bankrupt, the machinery left standing could be sold / recycled and the steel would pay for the cost of the rehabilitation. *HH – you are waiting on the Federal Government's approval, 3-4 weeks, but there*	Chris & Noranne Voll left the meeting at this time (1.50pm) and invited the CCC to hold the next meeting at Danthonia.

is also a 6 month window? AM – there is a process of uncertainty because of the recent change in government. The new federal government have said they will undertake another review the Renewable Energy Target (RET), which helps fund wind farm developments, so at the moment there is a bit of a lull until we know what is happening with the RET.	
7.0 Meeting Schedule Tuesday 8 April at 1:00pm at the Bruderhof Community, "Danthonia", Inverell. (Chris & Noranne Voll have kindly invited all CCC members to join in their communal lunch at Danthonia, which commences promptly at 12 noon.) The CCC members agreed that they were happy for their contact details to be placed on the project website. The community can also be directed to the Councils should they require more information. All media enquiries are to be referred to Adrian Maddocks @ WPCWP. At least one month's notice will be given if this date is to change. Please email LA with any issues or agenda items. Meeting closed at 2.05 pm	

Sapphire WIND FARM

Sapphire Wind Farm

Community Consultation Committee

Meeting #1 – 1st October 2013

www.sapphirewindfarm.com.au

Sapphire WIND FARM

Presentation Overview

- Wind Prospect CWP
- Project Justification
- Project Description
- Project Update
- Pre-construction Activities
- Photo Gallery
- Discussion / Q&A

Sapphire WIND FARM

CWP

Wind Prospect CWP

- Joint venture between Wind Prospect Group (WPG) and Continental Wind Partners (CWP)

Wind Prospect Group

- Over 18 years – 2,500 MW – over 50 wind farms around the world (UK, Australia, Europe, South Africa)
- Newcastle Office – NSW portfolio of wind farm developments (Boco Rock, Sapphire, Crudine Ridge, Bango and Uungula)

Continental Wind Partners

- CWP is a full-service developer focused on large-scale projects in Europe and Australia
- Recently finished managing the construction of the second largest onshore wind farm in Europe, the 600 MW (240 WTG) Fantanele project in Romania

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Sapphire WIND FARM

CWP

Project Justification

- International, National and State wide commitments support the development of clean and sustainable energy projects
- Renewable Energy Target – 20% renewable by 2020 – supported by NSW government
  - Market based incentive designed to lead to lowest cost clean energy (*review pending Q1 2014*)
- Ongoing need for new power generation in NSW
  - Clean energy technologies target Climate Change
- Wind Power is suitable and well supported by Australians
  - 85 % of residents supported wind farms being built in NSW with 80 % supporting wind farms in their local region (DECCW survey)
- Sustainable regional investment and employment

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Sapphire WIND FARM

CWP

Project Justification (Continued)

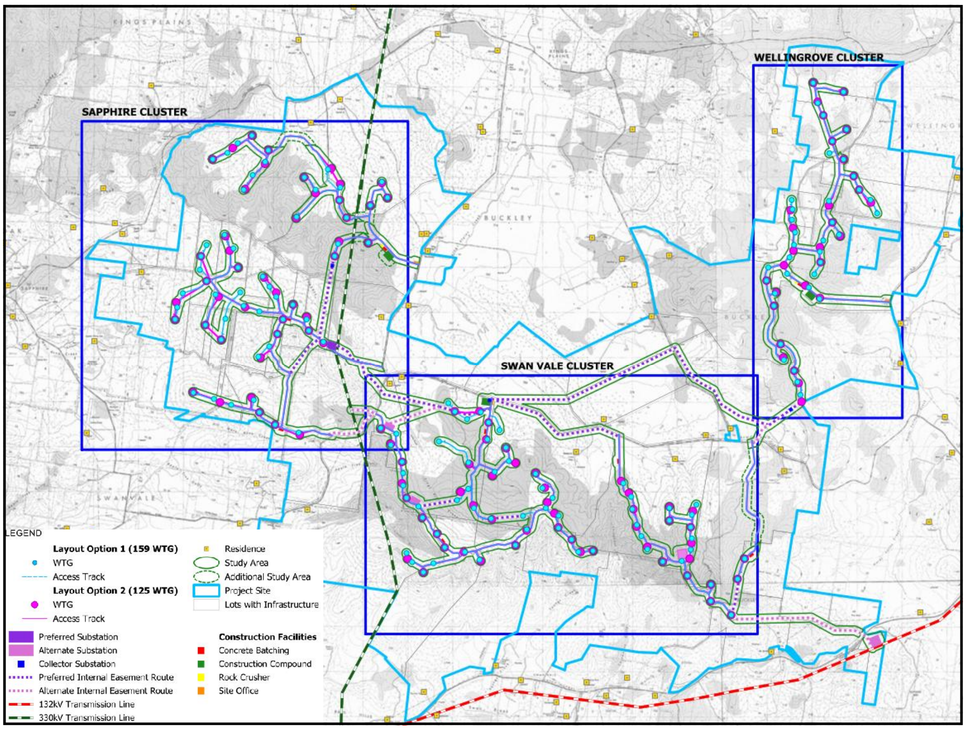
- Economic Benefits (50 MW of wind farm capacity)
  - Generates:
    - Direct employment of up to 48 construction jobs
      - *Approximately $25,000 per person spending in the local area (shops, restaurants, hotels and other services). That totals up to $1.2 million*
    - Direct employment of around five staff
      - *$125,000 per annum influx of personal expenditure locally*
  - Results in:
    - Indirect employment during construction, approximately:
      - *160 people locally*
      - *504 State jobs*
      - *795 Nation-wide jobs*
  - Provides:
    - Approximately $250,000 for farmers in land rental per annum
    - Over $60,000 on Community Projects each year

Sapphire WIND FARM

CWP

Project Description

- Location – 28 km east of Inverell, 18 km west of Glen Innes:
  - Roads around Sapphire WF include Gwydir Highway, Polhill Road, Kings Plains Road, Waterloo Road, Eastern / Western Feeder Roads.
- Site Design – Up to 159 wind turbines, two planning layouts, WTG 1.5 – 3 MW, maximum 319 MW
- Ancillary Infrastructure including:
  - Collector and Switching Substations
  - Site Compounds (Temporary and Permanent)
  - Underground / overhead electrical transmission lines
  - Wind monitoring masts
- Potential power connection points:
  - 330 kV running through the Sapphire Cluster
  - 132 kV transmission line to the south of the Gwydir Highway



Sapphire WIND FARM

Project Update – Current & Ongoing Activities

- Planning Assessment:
  - Submitted Environmental Assessment in November 2011
  - State Consent granted 26th June 2013 (19 months)
  - Federal Consent (EPBC Act) pending confirmation of further offsets
- Implementation of the Community Consultation Committee
- Ongoing consultation with neighbours, Councils, landowners and stakeholders as appropriate
- Exploring further environmental offsets and BioBanking opportunities
- Community Fund development:
  - CCC may play a role in reviewing / managing funds
  - Public amenities, conservation and transport / infrastructure needs analysis could be undertaken by the CCC
  - Money to be paid annually by Sapphire Wind Farm into the fund once operational

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Pre-Construction Activities

Health, safety and environment
- CDM coordinator for design phase
- Designer assessment & review
- Tender information pack
- Environmental management plan

Turbine specification
- Power curve noise warranty
- Siting & certification
- Grid code compliance
- Transport & erection

Electrical engineering
- Electrical systems design
- Electrical studies
- System specification
- Grid offer assessment & review

Civil engineering
- Geotechnical specification & investigation
- Infrastructure design
- Turbine foundation design
- Access studies
- Highway approvals
- Environmental

Procurement & contracts
- Turbine supply
- Civil works
- Electrical works
- Balance of plant
- Contestable works
- Operation & maintenance
- Power purchase agreement

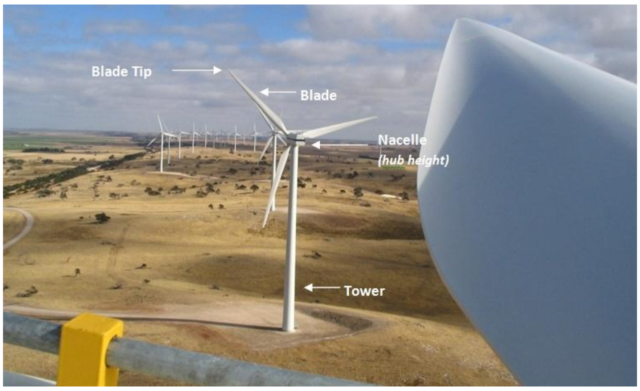
Planning and environmental
- Satisfying planning conditions
- Ecology assessments and inspection
- Construction method statements
- Environmental management plans
- Legal agreements
- Consultation with statutory bodies
- Amendments and applications

Legal agreements
- Leases & easements
- Third party agreements

There's a lot to do!

Sapphire WIND FARM

Photo Gallery – Wind Turbine Generators (WTG)



Wind Farm and Wind Turbine components

Sapphire WIND FARM

CWP

Photo Gallery - Construction


Temporary on-site concrete batching plant and rock crusher

Sapphire WIND FARM

CWP

Photo Gallery - Construction

Typical hardstand area adjacent to a rock anchor footing

Sapphire WIND FARM

CWP

Photo Gallery - Construction

Tower construction and blade storage prior to completion

Sapphire WIND FARM

CWP

Photo Gallery – Turbine Erection

A range of typical turbine erection photographs

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CWP

Photo Gallery - Construction

Laying underground electrical cable within and outside road network

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Sapphire WIND FARM

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Photo Gallery - Construction

Installation of overhead transmission lines

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CWP

Photo Gallery - Construction

Transformer foundation (foreground) and electrical substation and switchgear infrastructure (background)

Aerial photograph of Brown Hill (Hallett 1) Wind Farm, SA shortly after construction

Sapphire WIND FARM

WIND PROSPECT CWP

Discussion / Q&A

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The Base-Load Fallacy

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Abstract

It is claimed by some that a large-scale electricity generation system cannot be based upon renewable sources of energy, because the latter are alleged to be 'intermittent' sources that cannot provide base-load (24-hour) power. This paper shows that there is actually a wide variety of renewable energy sources with different types of time variability. Some of these have similar variability to coal (e.g. bio-electricity, hot rock geothermal, solar thermal electricity with thermal storage) and are therefore base-load. Although large-scale wind power has a different variability, it can substitute for some base-load coal with the assistance of a small amount of peak-load power plant (e.g. gas turbine). Together, a mix different types of renewable energy sources can replace a conventional generating system and can be just as reliable.

Introduction

Opponents of renewable energy, from the coal and nuclear industries and from NIMBY (Not In My Backyard) groups, are disseminating the fallacy that renewable energy cannot provide base-load power to substitute for coal-fired electricity. Even Government Ministers and some ABC journalists are propagating this conventional 'wisdom', although it is incorrect. The political implications are that, if the fallacy becomes widely believed to be true, renewable energy would always have to remain a niche market, rather than achieve its true potential of becoming a set of mainstream energy supply technologies.

The refutation of the fallacy has the following key logical steps:

- With or without renewable energy, there is no such thing as a perfectly reliable power station or electricity generating system.
- Electricity grids are already designed to handle variability in both demand and supply. To do this, they have different types of power station (base-load, intermediate-load and peak-load) and reserve power stations.
- Some renewable electricity sources (e.g. bioenergy, solar thermal electricity and geothermal) have identical variability to coal-fired power stations and so they are base-load. They can be integrated into electricity grids without any additional back-up, as can efficient energy use.
- Other renewable electricity sources (e.g. wind, solar without storage, and run-of-river hydro) have different kinds of variability from coal-fired power stations and so have to be considered separately.
- Wind power provides a third source of variability to be integrated into a system that already has to balance a variable conventional supply against a variable demand.

- The variability of small amounts of wind power in a grid is indistinguishable from variations in demand. Therefore, existing peak-load plant and reserve plant can handle small amounts of wind power at negligible extra cost.
- For large amounts of wind power connected to the grid from several geographically dispersed wind farms, total wind power generally varies smoothly and therefore cannot be described accurately as 'intermittent'. Thus, the variability of large-scale dispersed wind power is unlike that of a single wind turbine. Nevertheless, it may require some additional back-up.
- As the penetration of wind power increases substantially, so do the additional costs of reserve plant and fuel used for balancing wind power variations. However, when wind power supplies up to 20% of electricity generation, these additional costs are still relatively small.

These steps are now discussed in more detail. First it is necessary to define 'base-load'.

Base-load power stations

A base-load power station is one that is in theory available 24 hours a day, seven days a week, and operates most of the time at full power. In practice, this is an ideal. In reality, even base-load power stations break down from time to time and, as a result, can be out of action for weeks. In mainland Australia, base-load power stations are mostly coal-fired – a few are gas-fired. Coal-fired power stations are by far the most polluting of all power stations, both in terms of greenhouse gas emissions and local air pollution.

Overseas, some base-load power stations are nuclear. They produce little pollution during normal operation, but much pollution (including carbon dioxide emissions) from mining, enrichment, plant construction and decommissioning, reprocessing and waste management. They also increase the risks of proliferation of nuclear weapons and have the capacity for rare but catastrophic accidents.

Renewable energy can provide several different clean, safe, base-load technologies to substitute for coal (Diesendorf 2007a):

- bioenergy, based on the combustion of crops and crop residues, or their gasification followed by combustion of the gas;
- hot rock geothermal power, which is being developed in South Australia and Queensland;
- solar thermal electricity, with overnight heat storage in water or rocks or a thermochemical store; and
- large-scale, distributed wind power, with a small amount of occasional back-up from peakload plant.

It is obvious that the first three of these types of renewable power station are indeed base-load. Efficient energy use, the natural companion of renewable energy, can also substitute directly for base-load coal. However, the inclusion of large-scale wind power in the above list may be a surprise to some people, because wind power is often described as an 'intermittent' source, one that switches on and off frequently. Before discussing the variability of wind power, we introduce the concept of 'optimal mix'.

Optimal mix of base-load and peak-load

An electricity supply system cannot be built out of base-load power stations alone. These stations are inflexible to operate. They take all day to start up from cold and in general their output cannot be changed up or down quickly enough to handle the peaks and other variations in demand. Base-load stations used as reserve cannot be started up quickly from cold. Base-load power stations, especially coal-fired and nuclear, are generally cheap to operate, but their capital costs are high. So they cannot be used just to handle peaks in demand. To pay back their high capital costs, base-load power stations must be operated as continuously as possible. A faster, cheaper, more flexible type of power station is needed to complement base-load and handle the peaks.

Peak-load power stations are designed to be run for short periods of time each day to supply the peaks in demand and to handle unpredictable fluctuations in demand on timescales ranging from a few minutes to an hour or so. They can be started rapidly from cold and their output can be changed rapidly. Some peak-load stations are gas turbines, similar to jumbo jet engines, fuelled by gas or (rarely) by oil. They have low capital costs but high operating costs (mostly fuel costs). Hydro-electricity with dams is also used to provide peak-load power. Because the amount of water available is limited to that stored in the dam, the ‘fuel’ of a hydro power station is a scarce resource and therefore a valuable fuel that is best used when its value is highest, that is, during the peaks.

A third type of power station, intermediate-load, runs during the daytime, filling the gap in supply between base- and peak-load power (see Figure 1). Its output is more readily changed than base-load, but less than peak-load. Its operating cost lies between those of base- and peak-load. Sometimes intermediate load is supplied by gas-fired power stations and sometimes by older, smaller, black coal-fired stations.

Clearly, if an electricity generating system has too much peak-load plant, it will become very expensive to operate, but if it has too much base-load plant, it will be very expensive to buy. For a particular pattern of demand there is a mix of base-load, intermediate-load and peak-load plant that gives the minimum annual cost. This is known as the *optimal mix* of generating plant. Figure 1 sketches how a mix of base-load, intermediate-load and peak-load generation combines to meet the daily variations in demand in Summer and Winter.

Reliability of generating systems

Even an optimal mix of fossil-fuelled power stations is not 100% reliable. To achieve this would require an infinite amount of back-up and hence an infinite cost. In practice, a generating system has a limited amount of back-up and a specified reliability. This can be measured in terms of (a) the average number of hours per year that supply fails to meet demand or (b) by the frequency and duration of failures to meet demand.

Consider an electricity generating system comprising N thermal power generation units with rated capacities c_i, where $i = 1, ..., N$, with total rated capacity

$$C = \sum c_i$$

where the sum is over all values of i from 1 to N.

At a given time, the available capacity (i.e. that which is not undergoing planned or forced outage) of unit i is a random variable a_i and the total available capacity at a given time is

$$A = \sum a_i$$

The load or demand at a given time is the random variable L. Measure (a) of the reliability of the generating system (mentioned above) is the Loss of Load probability (LOLP), denoted by p_0, which is the average value of the fraction of time that the load L is greater than the total available power A:

$$p_0 = Average\ [Pr\ (A<L)] \qquad (1)$$

where Pr denotes 'probability'. The value of p_0 is determined by the electricity utility's choice of c_i, N and hence C. Ultimately the choice is political: how many hours per year of blackouts can a government tolerate?

The economic optimal mix of thermal generating units, for a given value of p_0, is the configuration of base-load, intermediate-load and peak-load power stations that minimises the cost function

$$F = \sum c_i y_i + e_i z_i \qquad (2)$$

where the sum is again over all values of i. Here y_i is the annualised capital cost per megawatt of rated capacity c_i; e_i is the annual energy generated by unit i; and z_i is the total operation, maintenance and fuel cost per unit of energy generated. The cost function Equation *(2)* is evaluated numerically under the constraint given by Equation *(1),* as shown by Martin and Diesendorf (1982). The calculation is a non-trivial, since A and L are random variables (i.e. described by probability distributions which are obtained from empirical data).

Wind power as base-load

To replace the electricity generated by a 1000 megawatt (MW) coal-fired power station, with annual average power output of about 850 MW, a group of wind farms with capacity (rated power) of about 2600 MW, located in windy sites, is required. The higher wind capacity allows for the variations in wind power and is taken into account in the economics of wind power.

Although this substitution involves a large number of wind turbines (for example, 1300 turbines, each rated at 2 MW), the area of land actually occupied by the wind turbines and access roads is only 5–19 square km, depending upon wind speed. Farming continues between the wind turbines. For comparison, the coal-fired power station and its open-cut coal-mine occupy typically 50–100 square km.

Although a single wind turbine is indeed intermittent, this is not generally true of a system of several wind farms, separated by several hundred kilometres and experiencing different wind regimes. The total output of such a system generally varies smoothly and only rarely experiences a situation where there is no wind at any site (Sinden 2007). As a result, this system can be made as reliable as a conventional base-load power station by adding a small amount of peak-load plant (say, gas turbines) that is only operated when required.

Computer simulations and modelling show that the integration of wind power into an electricity grid changes the optimal mix of conventional base-load and peak-load power stations. The method is to include wind power as a negative load in Equations *(1)* and *(2)*. Empirical data are used for the probability distribution of wind power (Martin and Diesendorf 1982).

The result is that wind power replaces base-load with the same annual average power output. However, to maintain the reliability of the generating system at the same level as before the substitution, some additional peak-load plant may be needed. This back-up does not have to have the same capacity as the group of wind farms. For widely dispersed wind farms, the back-up capacity only has to be one-fifth to one-third of the wind capacity. In the special case when all the wind power is concentrated at a single site, the required back-up is about half the wind capacity (Martin & Diesendorf 1982; Grubb 1988a & b; ILEX 2002; Carbon Trust & DTI 2004; Dale et al. 2004; UKERC 2006).

Furthermore, because the back-up is peak-load plant, it does *not* have to be run continuously while the wind is blowing. Instead the gas turbines can be switched on and off quickly when necessary. Since the gas turbine has low capital cost and low fuel use, it may be considered to be reliability insurance with a small premium.

Of course, if a national electricity grid is connected by transmission line to another country (for example, as Western Denmark is connected to Norway), it does not need to install any back-up for wind, because it purchases supplementary power from its neighbours when required and sells excess wind energy to its neighbours. In practice it makes little difference whether a generating system installs a little of its own back-up or purchases it from neighbours.

Solar electricity

Because it is still very expensive to store electricity on a large scale, grid-connected solar electricity from photovoltaic (PV) modules is not stored. If and when advanced batteries become less expensive, PV electricity would become base-load. Meanwhile, even without storage, a large amount of solar PV can substitute for coal and/or gas combusted in intermediate-load power stations. Furthermore, by orienting the solar collectors to the north-west instead of to the usual north (in the southern hemisphere), the peak in solar generation overlaps to a large degree with the broad daily peak in Summer demand (Figure 1b). Thus, statistically speaking, even solar electricity without storage has a degree of reliability during the daytime.

Solar energy can be stored at low cost as heat in water, rocks or thermochemical systems. Therefore, solar thermal electricity with thermal storage can supply base-load and can be just as reliable as base-load coal.

New technological developments in solar electricity, coupled with expanding overseas markets, will gradually bring down prices.

Conclusion

Combinations of efficient energy use and renewable sources of electricity can replace electricity generating systems based on fossil fuels and nuclear power. With renewable sources, base-load electricity can be provided to the grid by bioenergy, hot rock geothermal, solar thermal electricity with thermal storage in water, rock or thermochemical systems, and wind power with a little back-up from gas turbines. Natural gas and coal seam methane can also substitute for some base-load coal-fired power stations, although supplies of these gases are limited in eastern Australia. Intermediate load can be supplied by solar PV electricity without storage, when it becomes less expensive. When natural gas supplies become scarce, gas turbines used for peak-load supply can be fuelled by liquid or gaseous fuels produced from biomass.

By 2040 renewable energy could supply over half of Australia's electricity, reducing CO_2 emissions from electricity generation by nearly 80 per cent (Saddler, Diesendorf & Denniss 2004; Diesendorf 2007a & b). In the longer term, there is no technical reason to stop renewable energy from supplying 100 per cent of grid electricity. The system could be just as reliable as the greenhouse-intensive fossil-fuelled system that it replaces. Taking account of the high costs of greenhouse impacts (Stern 2006), the barriers to a sustainable energy future are neither technological nor economic, but rather are the immense political power of the big greenhouse gas polluting industries: coal, aluminium, iron and steel, cement, motor vehicles and part of the oil industry.

Actually, there is one constraint on a renewable electricity future. Growth in demand has to be levelled off, or there will not be enough land for wind and bioenergy. In the long run, this would entail a change in the national economic structure and the stabilisation of Australia's population.

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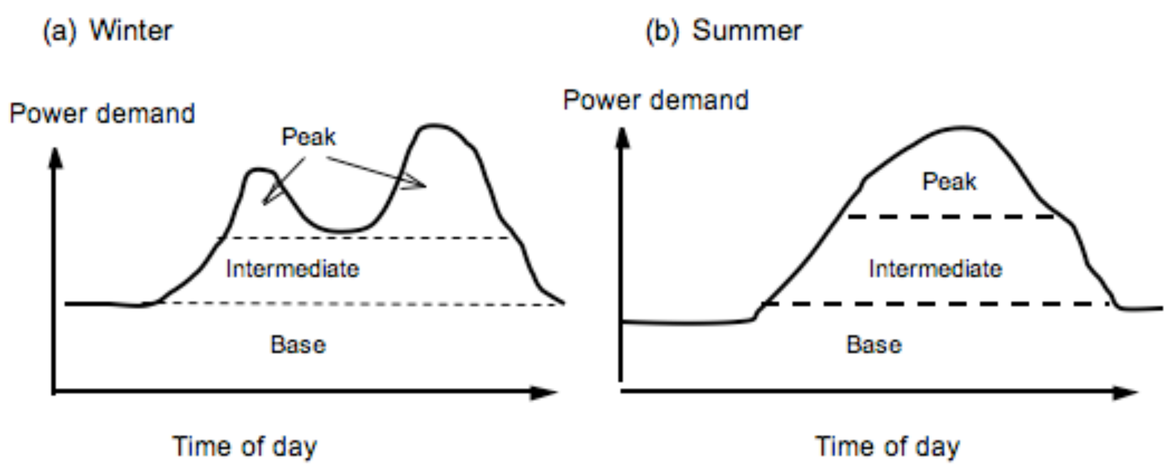
Figure 1: Typical power demand (load) by time of day in (a) winter and (b) summer

In Winter the two peaks occur at breakfast and dinner time. In Summer the single broad peak occurs in early to mid-afternoon.



spectators Report

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Baseload vs Wind – a dumb argument

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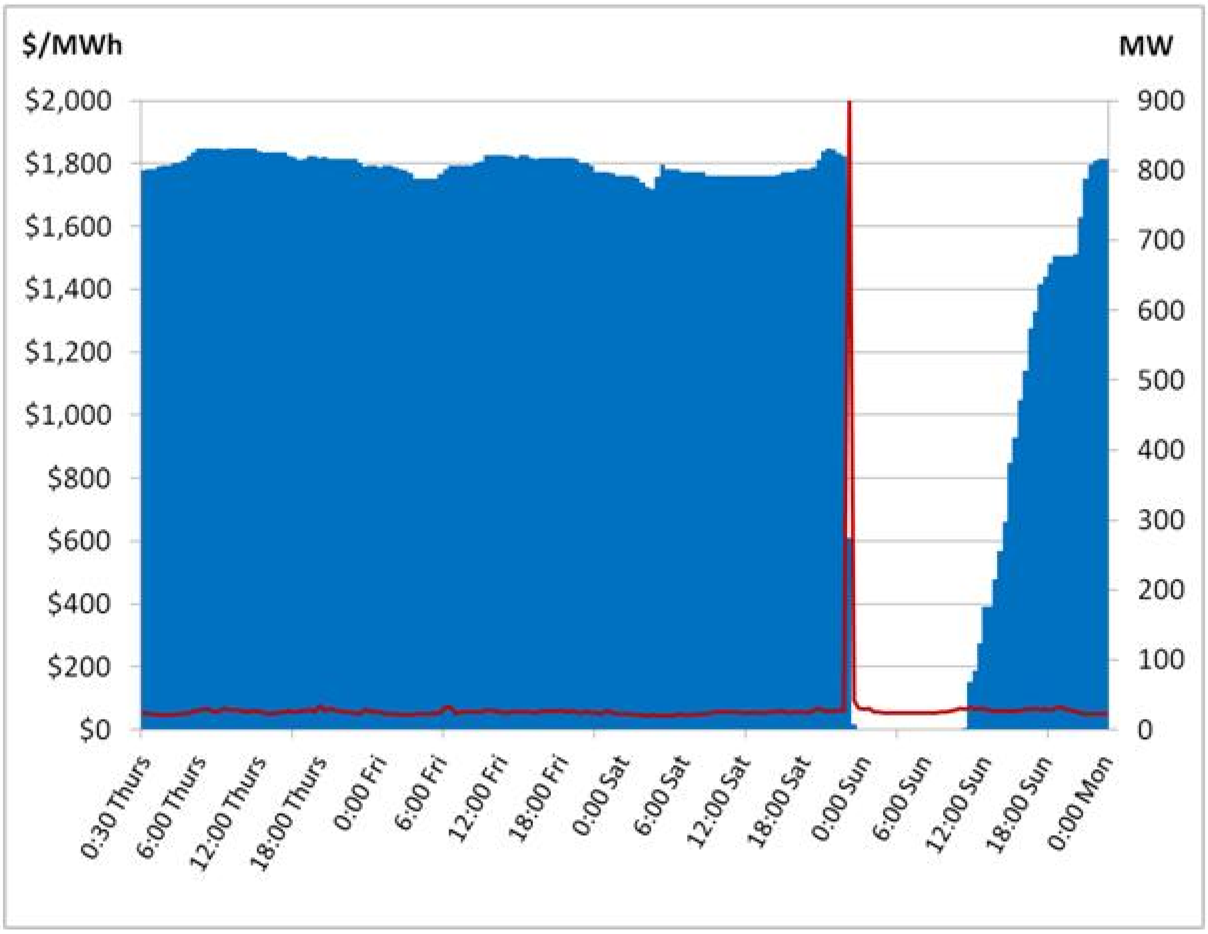
On Saturday night, the wholesale electricity market price skyrocketed in Queensland from $63 per megawatt-hour at 10:10pm to $11,499 at 10:15pm. What happened is illustrated in the chart below taken from NEM Review [1], although smeared into 30 minute intervals.

It serves as a lesson that the concept of 'baseload' power stations equalling reliability is hopelessly simplistic, and wind power's variability is not some huge unprecedented issue for system reliability.

The solid blue is the sent-out generation of the Millmerran coal-fired power station in Queensland, and the red line is Queensland wholesale prices.

For Thursday, Friday and much of Saturday, Millmerran did what good old baseload generators are supposed to do – oscillating its output not all that far from about 800MW (scale on right hand of chart). But then in the space of just 5 minutes, 800 MW simply vanished for all intents and purposes. Consequently the red line of prices skyrocketed as other generators scrambled to replace the lost capacity (scale on the left-hand but, because data is smeared over 30 minutes, the extreme price of $11,499 is obscured).



Source: NEM Review [1]

To maintain a very high level of electricity supply reliability it is not a matter of simply having baseload power. No single power plant, irrespective of fuel type, is 100 per cent reliable – things invariably go wrong. Sometimes it might be a mechanical failure with the plant, or a power line fault, or even a fire or flood in a coal mine (both of which have afflicted Victorian brown coal generators).

So given the fact that no power station can deliver the 99 per cent+ reliability we want; we need to focus on the degree to which we can manage failures when they inevitably happen. This comes down to three factors:

1) The size of generating capacity loss;

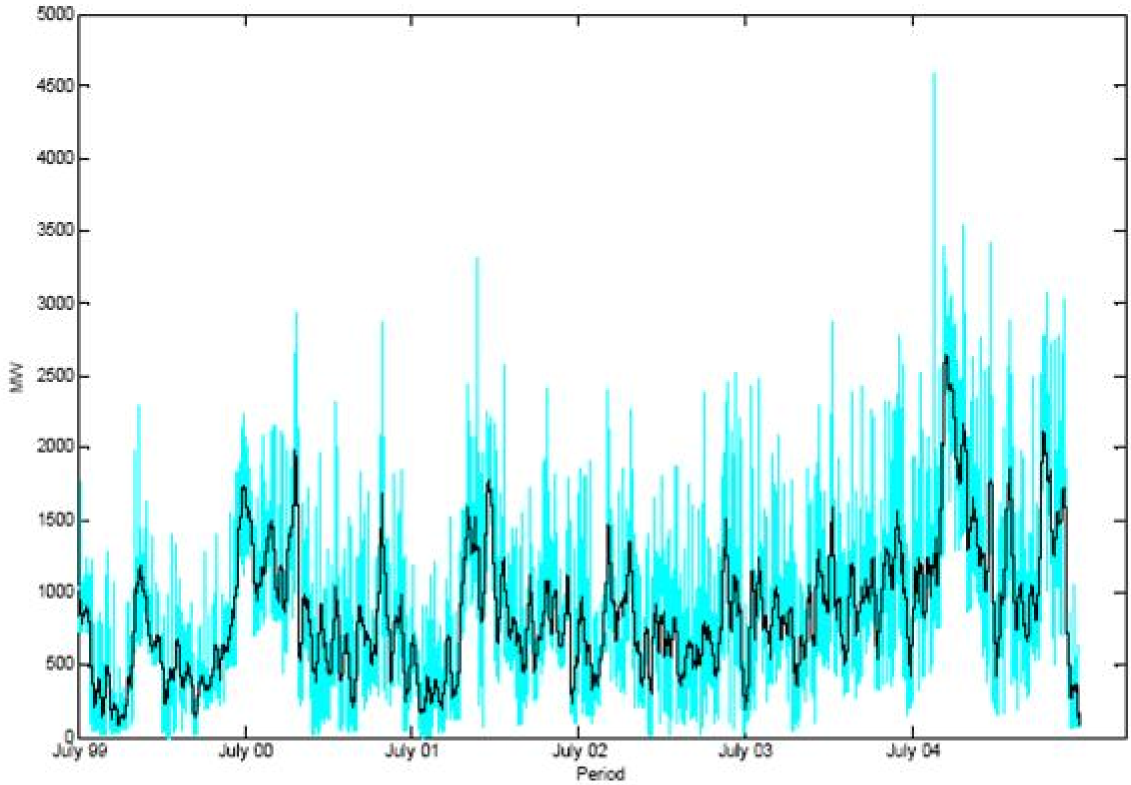
2) The speed of that capacity loss; and

3) The ability to predict the loss in advance.

Because thermal power plants take time to ramp-up output, the smaller, slower and more predictable the loss of generating capacity, the easier it is to bring on other plant to replace any loss. The Millmerran event scores badly on all these counts: 800MW, lost within 5 minutes and completely unable to have been predicted. But note prices still managed to recover to low levels quite quickly.

This is not an isolated case as shown in the chart below. No it's not the wind farm output in northern Germany. It is the amount of power station capacity out of action in the National Electricity Market due to unexpected failures of some kind (known as forced outages). Losses of capacity spiking up by several thousand megawatts within a day are common.

Capacity subject to forced outages across the NEM



Source: ROAM Consulting prepared for NEMMCO (now AEMO)

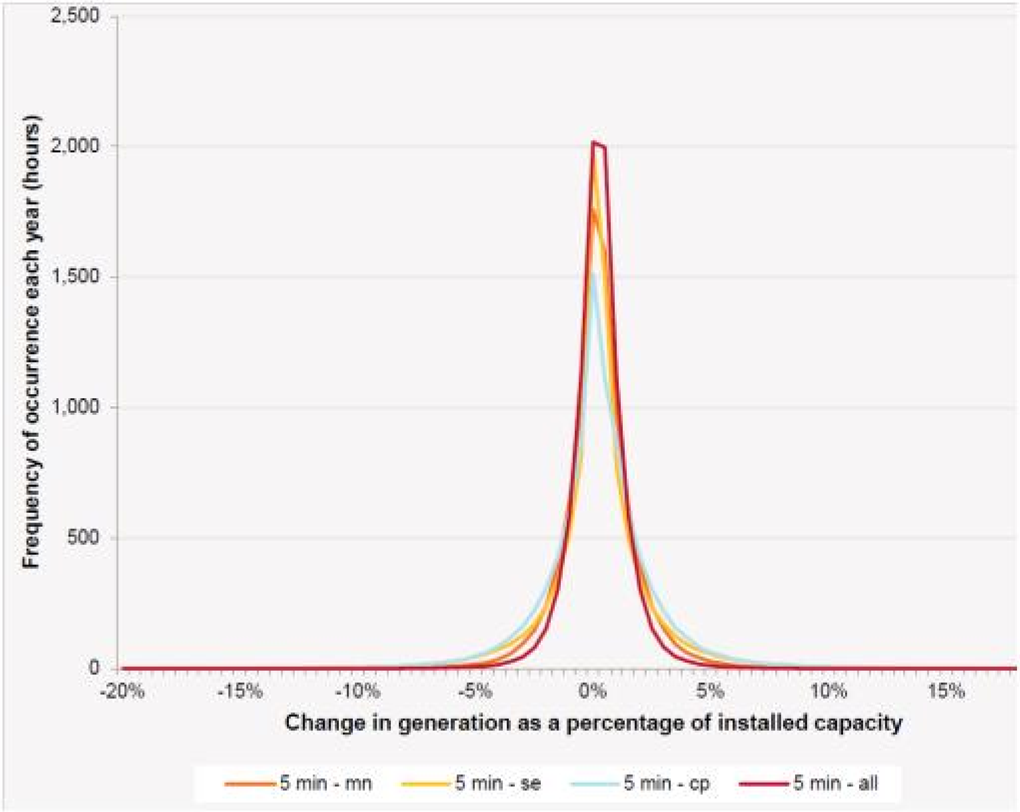
There's no point pretending that wind power is the perfect source of power. Unfortunately it's subject to the vagaries of the wind which aren't all that well correlated with electricity demand. But within the very short five minute time period you aren't exposed to any greater risk of large, sudden losses of generation capacity than coal power plants.

That's because wind power turbine units are much smaller than coal units (3MW or less versus around 200 to 750MW for coal), and wind farms are smaller than coal power plants (rarely above 200MW vs 1000 to 2000MW for coal). Therefore you don't get the same dramatic losses of generating capacity when something goes wrong.

If we take the example of South Australia, where there is 1205MW of wind installed, AEMO found that the maximum loss of capacity within a five minute period was 294MW, or about a 25 per cent drop.

Also such large short-term variations are extremely rare. The chart below illustrates that South Australian wind power very rarely experiences changes in output greater than 5 per cent of installed capacity within a five minute period (each line represents a different region with the red representing all wind farms aggregated across SA).

Change in wind power output within 5 minute period as proportion of installed capacity

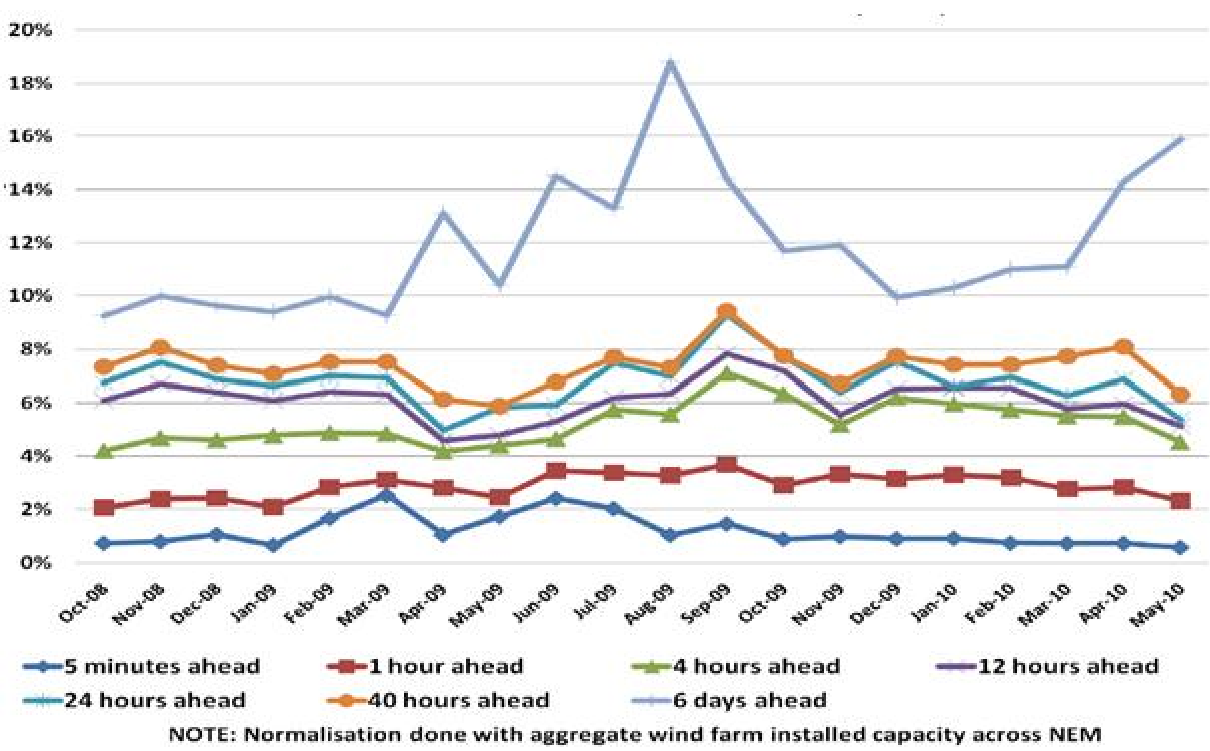


Source: AEMO (2012) South Australian Wind Study Report 2012

Now on top of this wind has another advantage relative to a coal plant outage – changes in output can be predicted quite accurately several hours ahead.

The chart below shows the forecasting error for the NEM Wind Energy Forecasting System at different time periods in advance. Even 24 hours ahead the system's level of error is less than 10 per cent. This allows other generators to receive plenty of notice about major losses of wind output and get themselves ready to fill any gaps.

NEM-wide forecasting error for the Wind Energy Forecasting System – Oct 2008 to May 2010 (Normalised mean absolute error)



Source: AEMO (2010) Australian Wind Energy Forecasting System (AWEFS) overview

No power source is perfect: Gas can be quick but is expensive; hydro is even quicker but highly constrained by rainfall; coal is cheap but big and slow plus highly polluting.

Wind is plentiful, free of pollution, but not controllable. However it is predictable, and the rate of change in output is something we are already used to managing.

Source URL: http://www.businessspectator.com.au/article/2013/3/12/climate/baseload-vs-wind-%E2%80%93-dumb-argument#comment-0

Links
[1] http://v6.nem-review.info/