



## Wind Energy in South Australia



David Swift  
Chief Executive, ESIPC



## Today's presentation

Today I plan to:

- rehearse our earlier work establishing current SA arrangements
- review the current situation with respect to these recommendations and experience with wind generation to date
- examine the future for wind generation in SA, its likely impacts and views on requirements



## ESCOSA's Request

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- On 23 December 2004 ESCOSA requested advice on:
  - licence applications for additional wind farms.
  - impacts on the long term interests of SA consumers
    - price,
    - quality of supply; and
    - reliability of electricity services.



## Our approach

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Examined wind development in SA using:

1. a detailed bottom-up analysis using local data from actual SA projects and real market conditions; and
2. a top-down review of international experience.

The two reviews combined to provide a broad basis for the report's findings.



## Our analysis of the resource

- Bottom up analysis of 4 cases of wind generation in SA, nominally:
  - 400 MW (in place or under construction)
  - 500 MW
  - 800 MW
  - 1,000 MW
- each case was based on real locations with expected sizes and technologies
- estimates were made of the pattern and nature of the wind generation for each case based on wind data from the BOM, wind proponents and experience with Starfish Hill
- basis for the determination of effects on:
  - the network
  - the power system; and
  - the market



## Outcomes of 2005 Study

- Analysis showed that the 400 and 500 MW cases were qualitatively and quantitatively different from the larger cases
  - In the 400 and 500 MW cases the variability of wind generation could be expected to increase variability and uncertainty in the market whereas in the 800 and 1,000 MW cases it was seen to dominate
  - The modelling showed that it would be difficult to:
    - project forward requirements for commitment of generators and their fuel; and
    - ensure adequate ramp rate response is available when needed.
- as the installed capacity exceeded 500MW



## Outcomes of 2005 Study

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- Power system modelling showed potential problems with voltage control and risks of voltage collapse on contingency in the higher cases
- Potential risk of cascading failures following certain severe faults due to the fault ride through characteristics of the plant being used and its lower inertia
- Need to manage network loadings in some areas as a result of high wind generation
- On the other hand; Power quality issues appeared to be being managed



## Recommendations of 2005 Study

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To maintain security and efficiency with higher penetrations of wind generation, South Australia needed to:

- require **higher technical standards** of new wind generators particularly in respect to fault ride through and reactive power
- include wind farms in the **central dispatch** process so they are managed as part of the security optimisation in the market
- introduce state-of-the-art **wind forecasting** to both inform the market and manage security
- require wind farms to be market generators and pay for **ancillary services** on a causer pays basis.



## Consistency of the advice

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- The recommendations arose from our fundamental analysis
- Comparisons undertaken as part of our review demonstrated that this advice was consistent with international experience and that other markets such as Alberta, Republic of Ireland, UK, New York etc were taking such action at far lower concentrations of wind energy
- Advised further work if cases over 1,000 MW were likely



## The situation today



## Installed Wind Farm Capacity

### POWER STATION

Lake Bonney Stage 1	80.50 MW
Cathedral Rocks	66.00 MW
Canunda	46.00 MW
Wattle Point	90.75 MW
Mt Millar <sup>[1]</sup>	70.00 MW
Starfish Hill	34.50 MW
<b>Total Installed Capacity</b>	<b>387.75 MW</b>
<b>Total Generation (2007)</b>	<b>987.7 GWhrs</b>
<b>Capacity Factor</b>	<b>32.2%<sup>[2]</sup></b>

### Notes:

- 1 Mt Millar is currently constrained to 16 MW
- 2 Excluding Mt Millar.



## Installed Wind Farm Capacity

- Experience indicates that output from the wind farms is, in aggregate, 14% lower than expected.
- This could be due to a combination of minor production losses caused by:
  - plant maintenance,
  - on-site electrical losses,
  - spatial arrangement of turbines within the wind farm reducing the energy production from some machines for some wind directions ; and
  - annual variability in wind resource.
- The maximum output of the wind farms is close to rated capacity.



## Projects underway

### ***Under Construction:***

Hallett Hill 1	94.5 MW
Lake Bonney Stage 2	159 MW
<u>Snowtown</u>	<u>98.7 MW</u>
Sub-Total	<b>352.2 MW</b>

### ***Committed:***

Hallett Hill 2	71.4 MW
<u>Clements Gap</u>	<u>56.7 MW</u>
Sub-Total	<b>128.1 MW</b>

**TOTAL in SA when all commissioned: 868.4 MW**



## Current capacity

- Three large wind farms are in various stages of construction and commissioning – together they double the installed capacity
- Experience will quickly move to the “greater than 500 MW” situation where the impacts are expected to be more pronounced
- A significant proportion of capacity will meet the specific SA licence requirements



## Progress on recommendations

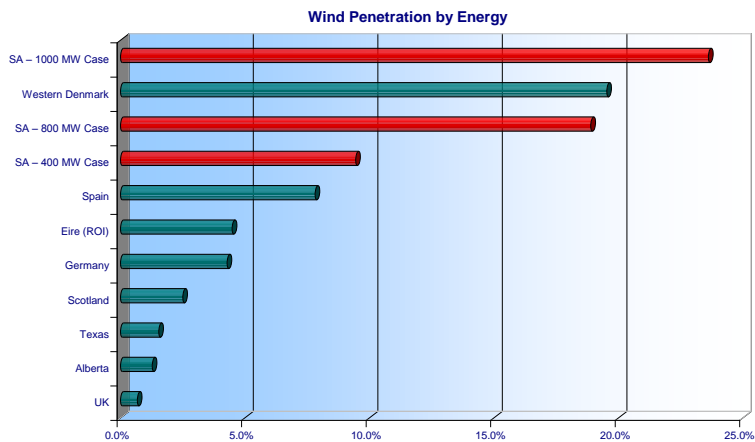
All new wind farms seeking licences in South Australia have had to:

- comply with enhanced technical standards
- cooperate with wind forecasting
- be part of central dispatch; and
- register as a market participant and pay for ancillary services

National arrangements have now been changed to incorporate much of these requirements



## International relativities





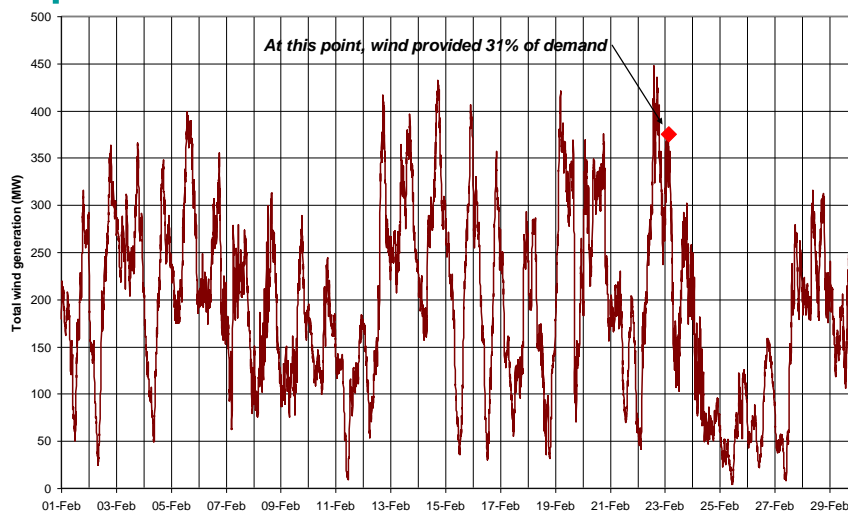
## International relativities

- International situation is changing fast. World capacity grew by 19,700 MW in 2007
- Biggest purchasers were USA, Spain and China
- However, relative to demand, South Australia rates amongst the world's most wind intensive power systems – probably currently hold second place.
- When the committed wind generation in SA is fully operational, it should supply  $\approx 17\%$  of energy demand.
- Comparable international figures for 2007 are as follows:

Denmark	18.5%	3,129 MW
Spain	9%	15,145 MW
Germany	6.3%	22,247 MW

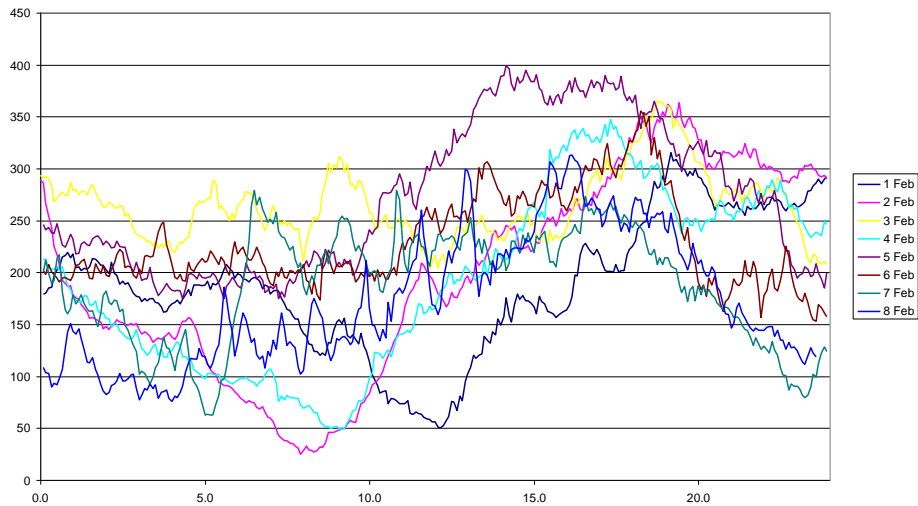


## Wind generation in February





## Wind generation in February



## Wind generation in February

- Wind generation during February varied between 4 MW and 448 MW
  - “installed” capacity is difficult to judge given the amount of plant under construction
- Five minute fluctuation in total output was up to +/-60 MW
  - excluding a few overnight j-tariff events, this is now the same as fluctuations in demand
- No security problems caused by wind
  - some wind farms have been constrained at times
  - demand forecasts are worse than historical



## The Future



## Wind generation drivers

- Wind turbine technology continues to develop and improve its scale, generation efficiency and technical characteristics
- Wind generation offers one of the cheapest sources of renewable energy from commercially bankable projects
- Production internationally continues to grow strongly



## Wind generation drivers

- Further development in Australia is dependent on a new or expanded MRET scheme promised by the Commonwealth government
  - proposed to extend mandatory renewable generation in Australia from 9,500 GWh/a to 45,000 GWh/a by 2020.
- Emission Trading Scheme will also provide support for wind
- Estimated that 50 to 70% of the renewable target might be met by wind
  - 6,000 to 9,000 MW new wind across Australia



## Wind generation drivers

- South Australia still provides some of the most competitive wind generation opportunities in Australia
  - opportunities in Tasmania limited by the nature of their power system and network
  - South Australia has some of the best mainland locations for wind generation with good wind resources and access to the power grid
- Any additional wind generation in SA takes us to a world leading situation



## Future challenges – to 1,000 MW

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- Good progress has been made
  - lays the groundwork for successful integration of around 1,000 MW
- Some network constraints will be evident at times of high wind generation due to reactive power requirements and congestion in:
  - the South-east
  - Mid-north; and
  - Eyre Peninsula



## Future challenges – to 1,000 MW

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- Wind forecasting needs to demonstrate performance and be integrated into system security management
  - Note that EirGrid monitor “negative reserve margins” as well as positive reserve plant margins
- Wind generators need to continue to meet technical standards above the lowest national standards especially:
  - reactive power; and
  - fault ride through



## Beyond 1,000 MW

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- World leadership will raise a range of technical issues
- If current SA technical standards are maintained, local security and voltage control issues should not arise.
- Issues arise from the plant displaced rather than wind generators per se
  - Voltage control in greater Adelaide area
  - Inertia
  - Ramp rate of load following plant
- Network congestion will increase:
  - processes need to be in place to relieve constraints through investment or other action where efficient to do so



## Beyond 1,000 MW

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- Higher wind generation capacity could be aided by South Australian load growth.
- Higher penetration rates could be aided by:
  - interconnector upgrades
  - accurate forecasts
  - enhancements to the power system management arrangements
  - enhancements to the network and power system through SVCs, short term storage systems, new ancillary services



## Beyond 1,000 MW

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- Intention is that the market will drive efficient investment/ sanction inefficient investment.
- There is a need to ensure market is properly informed
  - likely network constraints
  - expected future operating arrangements, costs and constraintsto assist participants to make efficient investment decisions.



## How far could we go?

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- Connection enquires and applications in SA could allow current wind generation to treble
  - Ireland aims to integrate 30% wind by 2025
- Even wind generation in SA with some constraints may be economic compared to the alternatives elsewhere
  - National equity issues may need addressing
- Exciting times ahead!