Centre for Energy and Environmental Markets

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Possible merit order impacts of wind in the Australian NEM

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Merit Order Effect

- **Merit order** - ranking available sources of energy, especially electrical generation, in ascending order of their short-run marginal costs of production to efficiently prioritise dispatch
  Merit order effect - Impact of bringing new generation into existing merit order: impacts on dispatch, costs (and prices)
  - Strong theoretical basis, not just an issue for renewables or electricity
- Some key assumptions, simplifications
  - Dispatch constraints, inter-temporal links wrt SRMC – unit commitment?
  - Bidding wrt operational characteristics, SRMC – market power?
  - With respect to electricity prices, changing customer 'schedules of fees' wrt spot wholesale prices – what of ancillary services, derivatives prices?
  - Potential impacts on other industry investment – eg more OCGT for wind – and hence Long Run Costs and pricing for continued industry viability?

Growing published literature… and claims

- Eg. EWEA Literature Review, 2008

  An increased penetration of wind power:

  – Reduces wholesale spot prices.
  – replaces CO2-intensive production technologies.
  – can replace part of the base load
  – Consumers pay lower prices.

Recent work – more ambitious methods, greater appreciation of complexities, uncertainties?

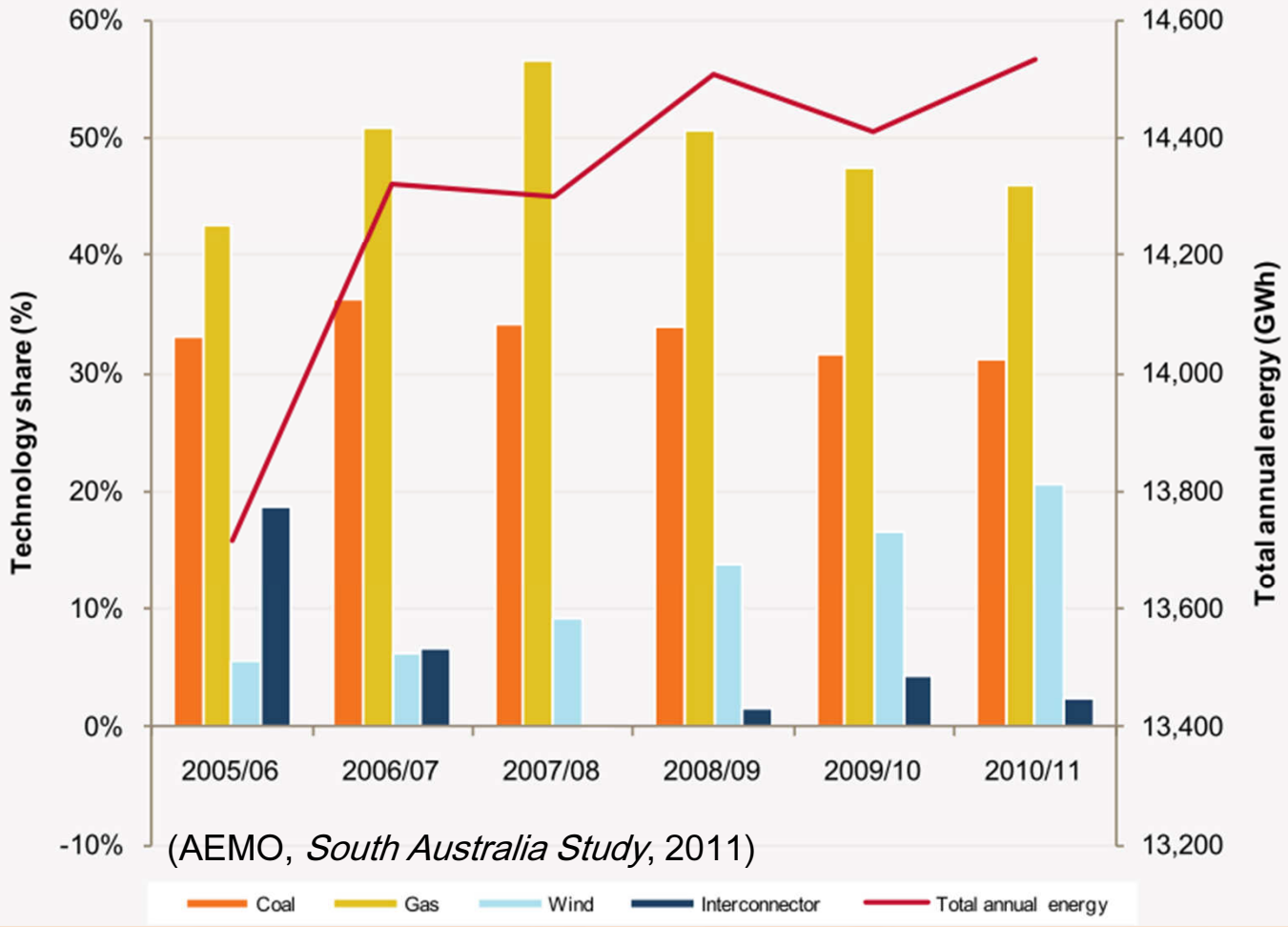
- **theoretical modelling / simulation** - simplify mkt interactions so that behaviour under different conditions can be analysed,
  - "in the long run the impact of wind on price will be negated by the increase in more expensive flexible generation. This result suggests that while in the short run wind can be considered to be reducing price due to the merit order effect, in the long run the reactions of other firms will tend to counteract these reductions." (Green and Vasilakos, 2010)
- **empirical analysis** - investigate actual participant behaviour through statistical or econometric analysis of market data.
  - "rising wind generation does indeed tend to reduce the level of spot prices, it is also likely to enlarge the spot-price variance. The key policy implication is that increasing use of price risk management should accompany expanded deployment of wind generation." (Woo, 2011)

CEEM research - Wind's energy value

- Energy value of wind in an Electricity Industry depends largely on its match with underlying cost drivers such as time and location varying demand, availability of other generators
- Energy value of wind declines as penetrations increase
  - generation without inherent energy storage has lower value than conventional gen with storable energy sources (coal, gas, hydro)
- Variability and unpredictability of wind in SA currently being managed by conventional generation in SA (and NEM more widely through interconnection to Victoria and hence beyond)
  - Significant 'complementary resources' competition in wholesale market
- **Key question:** does electricity market design and associated policies appropriately 'price' wind's energy value? Do other policies appropriately price wind's enviro and societal values?

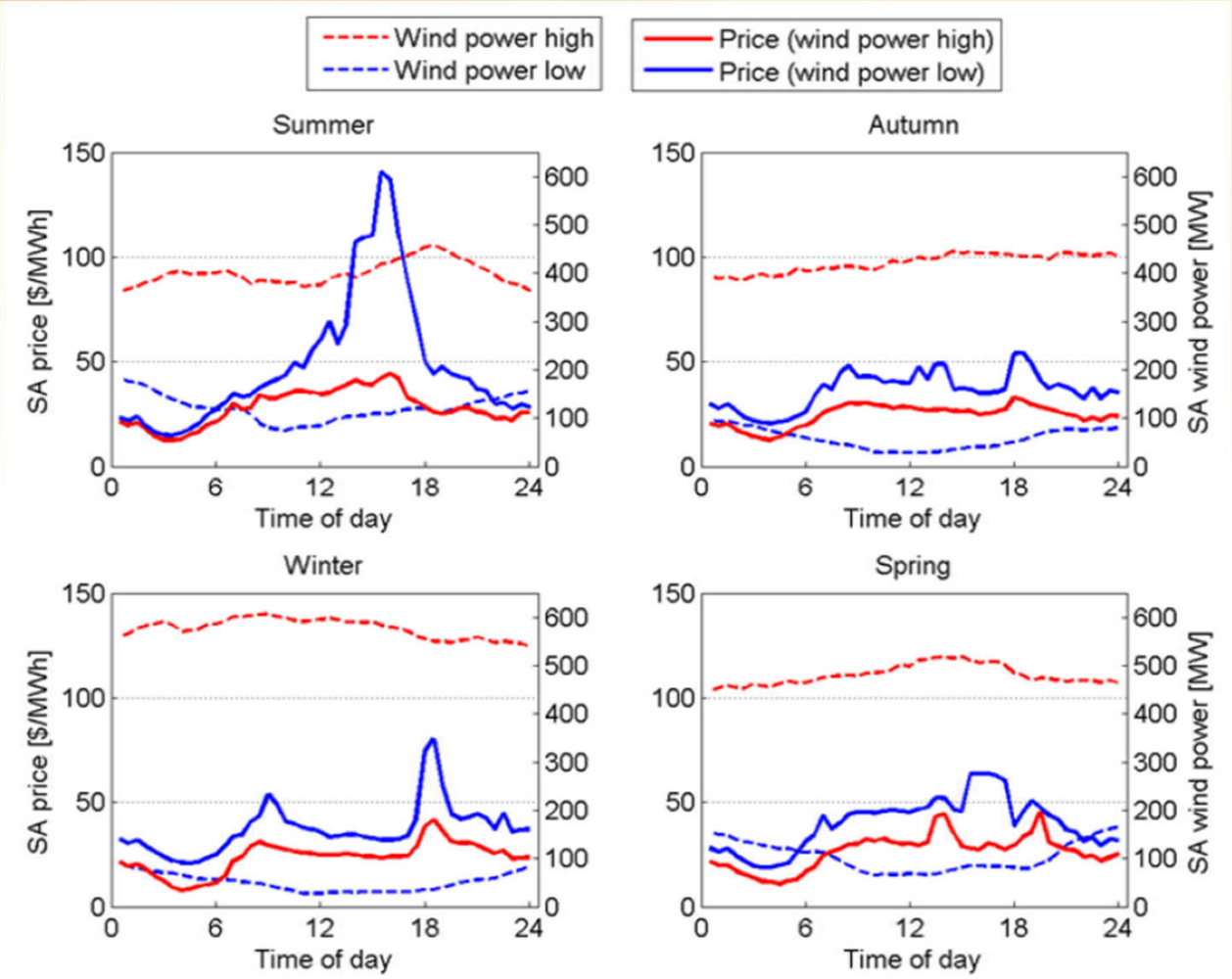
South Australia a world leading wind jurisdiction for empirical analysis

Figure 4-1 — South Australian energy by technology



(AEMO, *South Australia Study*, 2011)

SA wind and wholesale spot prices (2009-10 data)



(Cutler, Boerema, MacGill and Outhred, *Energy Policy J.*, 2011)

Wind energy 'value' in NEM?

Financial year 2009-10	SA	VIC	NSW
Min/Max demand (MW)	814/3121	4082/10047	5692/13885
Installed wind generation (MW)	868	439	170
Wind penetration (% annual energy)	17.8	2.1	0.5
Volume weighted price for all wind farms	47.4	32.2	66.7
Volume weighted price for all other generators	90.1	42.1	52.4
Absolute price difference	42.7	9.9	-14.3
% Difference for wind below VWP_d	51.8%	23.7%	-27.3%

(Cutler, Boerema, MacGill and Outhred, *Energy Policy J.*, 2011)

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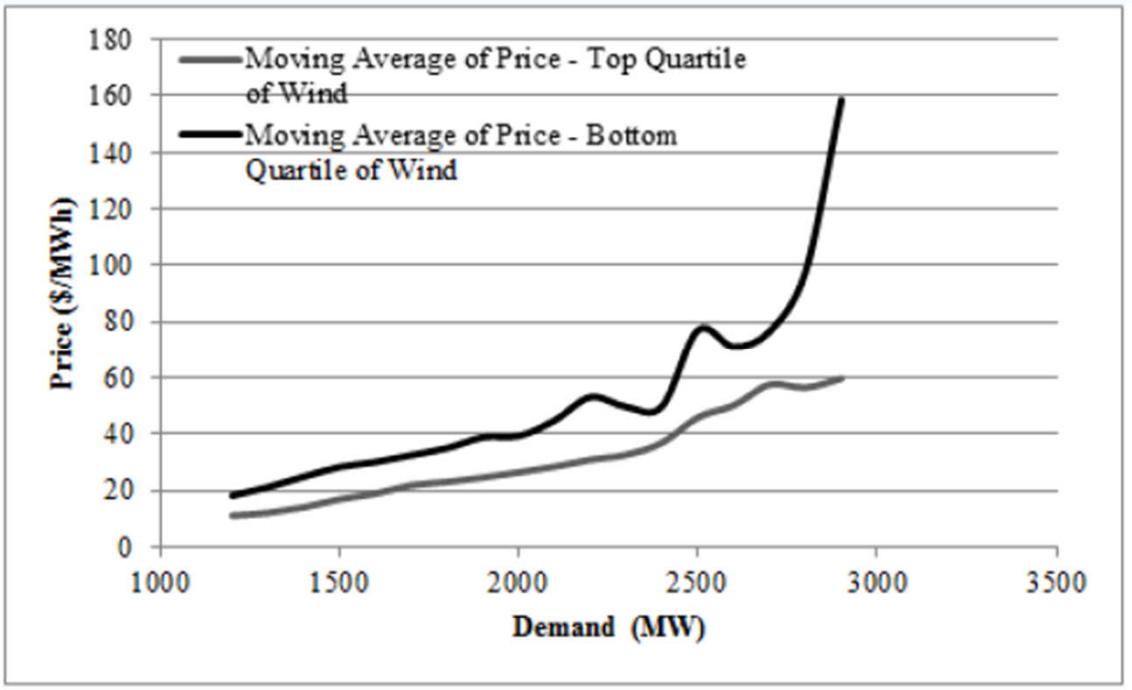
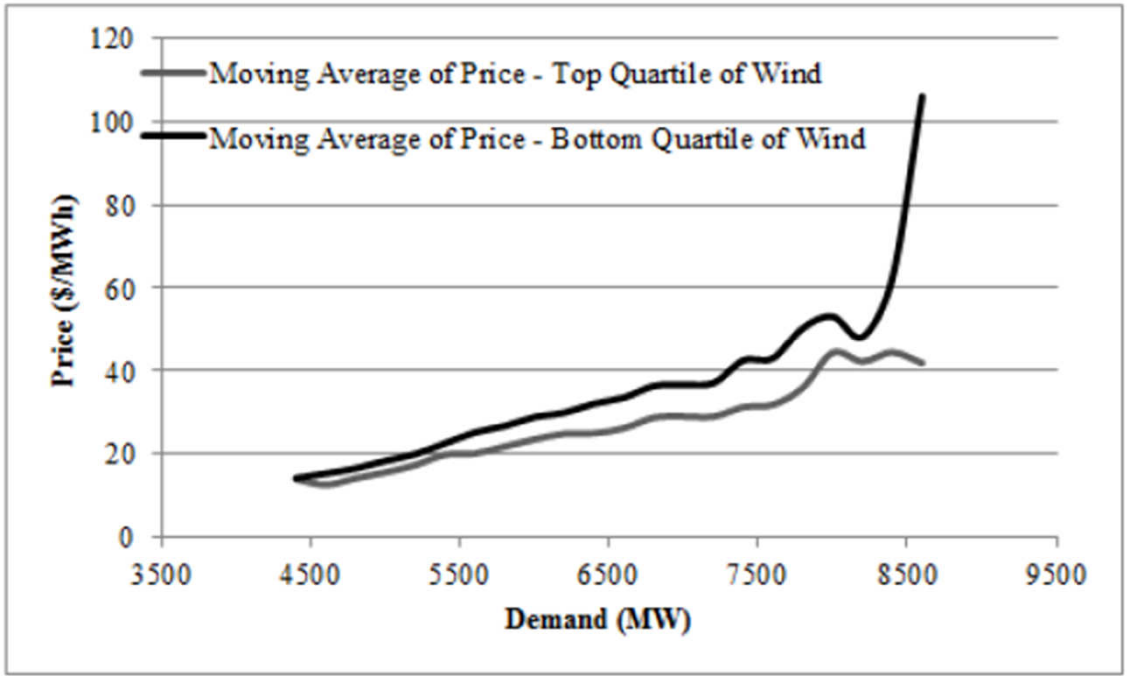
CEEM Research – Merit Order Effects in SA and VIC

Wind clearly appears to be impacting wholesale spot prices though note complexities of such analysis wrt overall price impacts, particularly in the longer-term.



(Forrest, S., *Engineering Honours Thesis*, UNSW, 2011)



Necessary econometrics assumptions

- Explanatory variables exogenously determined (outside mkt)
  - Likely largely valid for wind as driven by natural phenomenon, however, increasing wind dispatch
  - demand is perfectly inelastic with price
- Variables omitted from the analysis are largely uncorrelated eg. generator or Tx line outages
- Complexities associated with interconnection flows
  - Other state regional demand incorporated but remains challenging
- Price truncation
  - Truncate prices to 0-$415/MWh.
  - Analysis when including extreme high and low price events actually suggests similar answers but far lower model fit

Preliminary findings

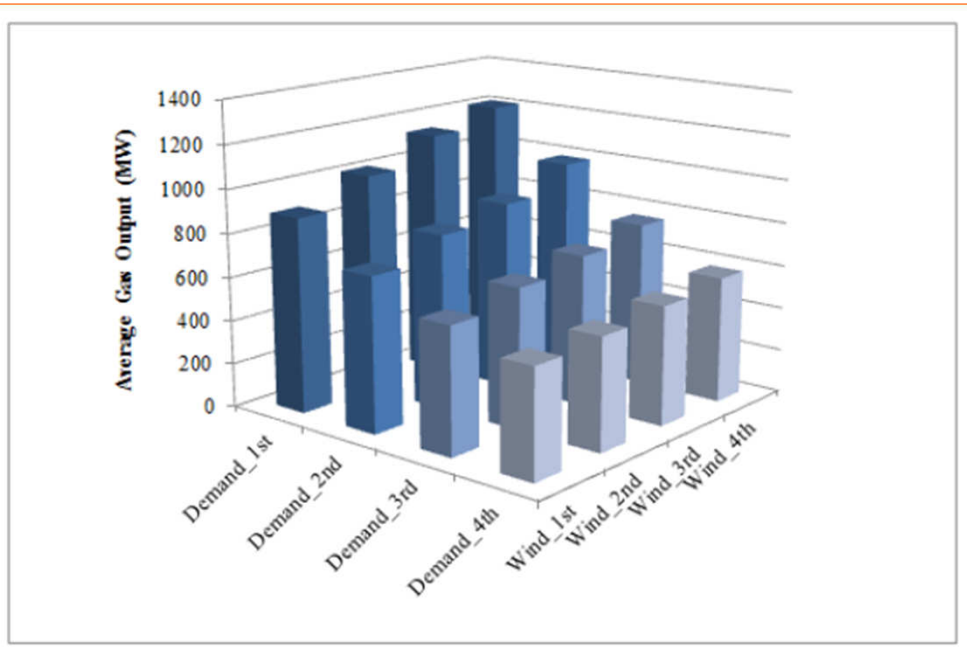
(02/2009-02/2011data – Forrest et al, 2012, unpublished)

- Estimated impact of a MWh of wind
  - SA: -0.091%/MWh (-2.28c/MWh at median price)
  - VIC: -0.072%/MWh (-1.69c/MWh at median price)
  - *Reasonably comparative results with other international research work to date (eg. Woo et al for ERCOT)*

- Estimated total price impact of existing wind in SA and VIC

	SA	VIC
Total Merit Order Effect	$7.35/MWh	$1.96/MWh

SA wind offsetting mainly gas but also some coal generation



(Forrest, S., *Engineering Honours Thesis*, UNSW, 2011)

Figure 16: Average natural gas output across wind and demand quartiles

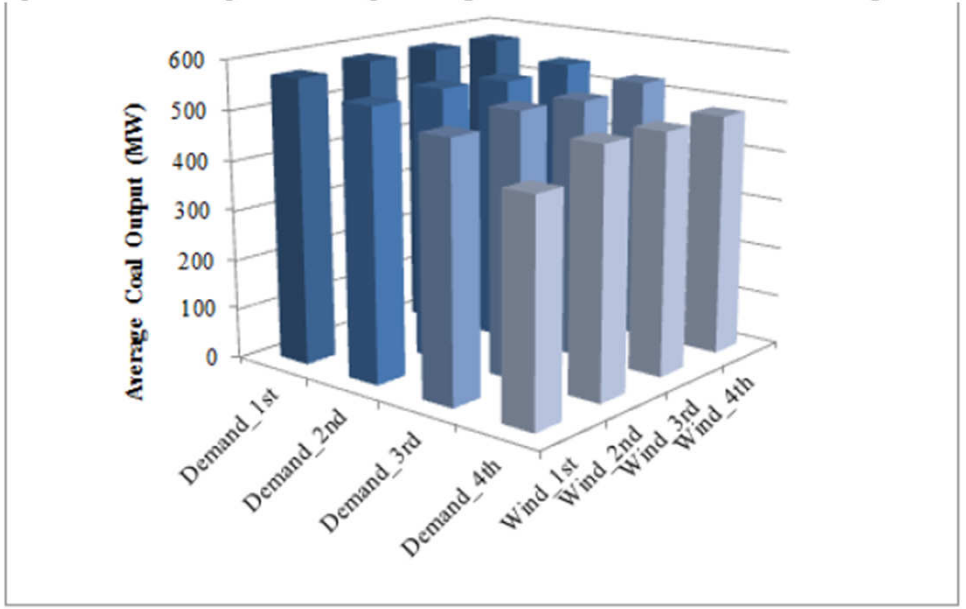
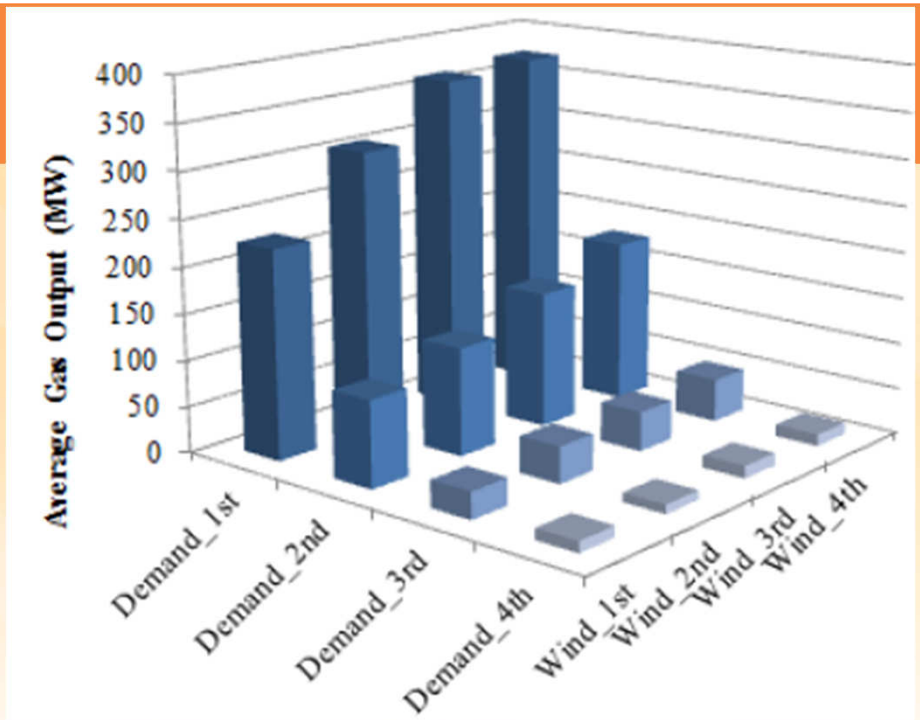


Figure 22: Average SA brown coal output across wind and demand quartiles

VIC wind also off-setting gas and coal generation, but in different proportions



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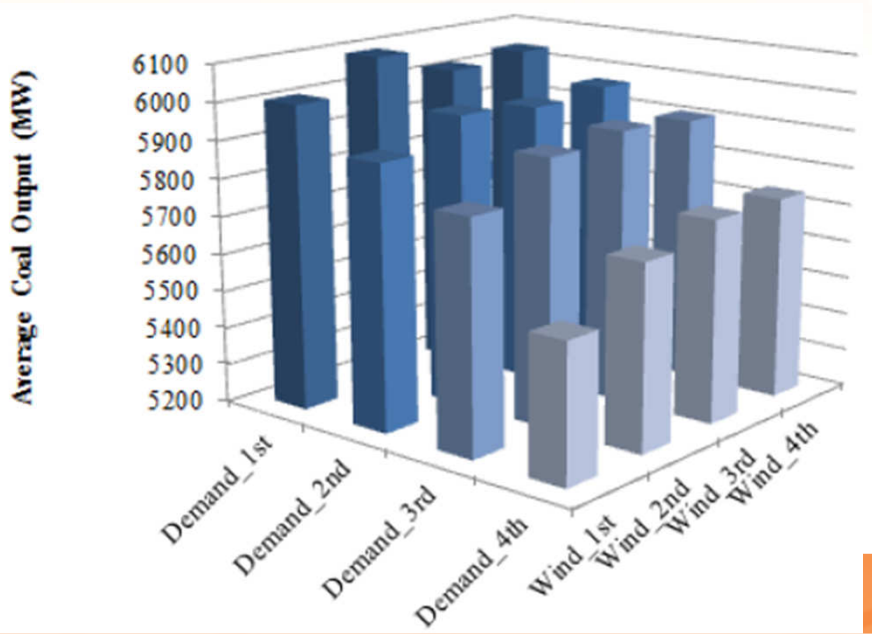

Q: Does wind power increase electricity costs?

- Wind has high capital but low operating costs.
- It's 'direct' long-run costs are significantly higher than existing coal and gas generation options in Australian context
  - about double depending on assumptions about future coal, gas prices
- However, if 'indirect' environmental externality costs are considered, wind almost certain to have lower 'costs' than current coal generation
  - Broad estimates of regional air pollutant costs of NSW coal-fired power stations $13-15/MWh (ATSE, 2008)
  - Stern Review suggests CO2 externality costs of approx. US$75/tCO2, increasing NSW coal-fired generation costs by approx. A$80/MWh
  - *Note that air pollutants a regional externality with NSW health and lost productivity costs. Climate change a 'global' externality cost – at present our coal-fired gen subsidised by rest of the world and future generations*

Q: Does wind in NEM increase electricity prices?

- Wind generation clearly impacts wholesale electricity market prices, however difficult to quantify and likely highly dynamic
  - SA and VIC analysis suggests spot price reductions at high wind times
  - Depends on evolving behaviour of wind and other market participants
  - Many further uncertainties such as potential impacts of rapid wind changes to increase prices, longer-term mkt dynamics
- Wind impacts retail prices both through wholesale price impacts but also REC obligations on retailers
  - Complex relationship between wholesale electricity and REC prices
  - Seems highly likely that all of our supply-side options to reduce emissions will increase electricity costs – coal is 'cheap'
- Key complexities and uncertainties remain
  - Short and longer-term market participant bidding responses
  - Customer 'schedules of fees', other market prices (AS, derivative mts)
  - Potential impacts on other industry investment – more OCGT for wind?
  - Long Run Marginal Costs and pricing for continued industry viability?

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Thank you… and *questions*

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