



The impact of wind on electricity prices in the Australian National Electricity Market

Iain MacGill

Associate Professor, School of Electrical Engineering and Telecommunications
Joint Director (Engineering), CEEM

MEI Forum – How are renewable technologies impacting the price of electricity?

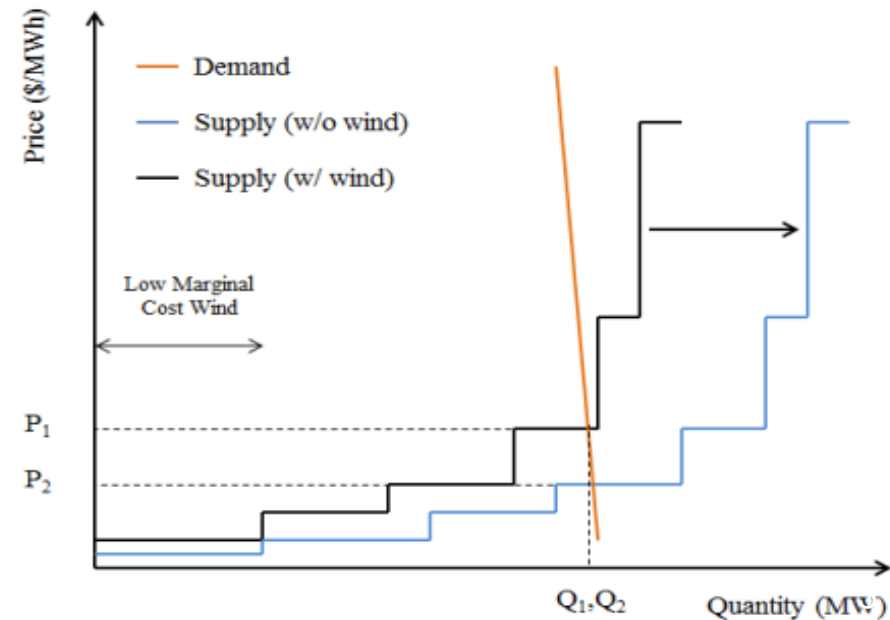
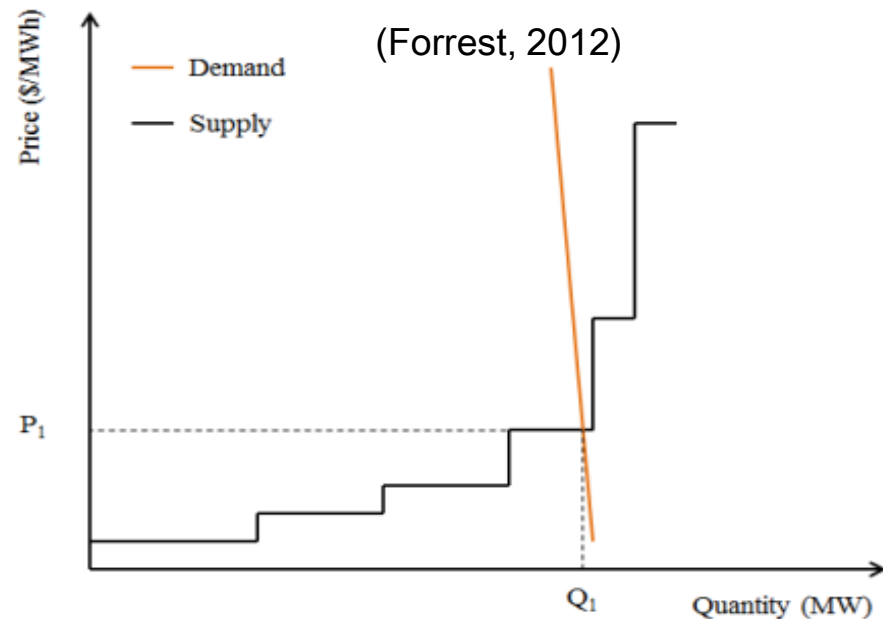
University of Melbourne, June 2013

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
 - Measurable impacts in electricity industries around the world
 - Not just an issue for renewables or electricity; eg. Nuclear, Demand, Hydro Merit Order Effects have all occurred in electricity industries around the world

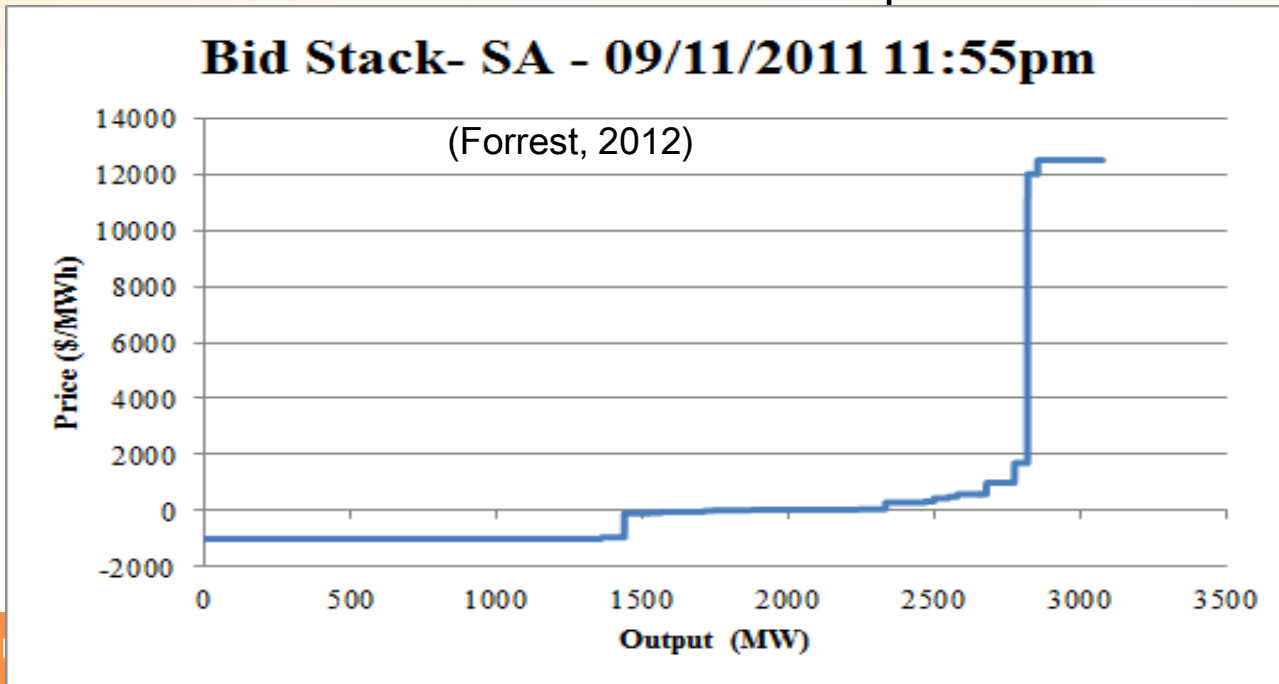
Merit order in theory for a restructured EI

- Generation incentivised to offer generation at operating cost
- Any change in availability of low-cost generation (or demand) may change wholesale dispatch price, perhaps volume if price sensitive demand
- Overall industry *operational cost* saving from change in total operating costs of dispatched generation – cheaper gen replaces more expensive.
- Surplus (profit) transfer from generators to buyers, and between generators, from price change



Merit order in practice

- Generator offers reflect range of considerations
 - Plant technical characteristics, realities of security constrained dispatch
 - Derivative contract positions, market strategies, market power
- Longer term drivers
 - prices have to be sufficient to encourage appropriate existing plant to stay, new investment to be delivered as required



Merit order impacts part of the policy debate

- *In 2007, the time frame for increasing the share of Victoria's electricity consumption from renewable sources to 10 per cent was extended from 2010 to 2016. A range of factors, such as the interests of existing generators, the renewable energy industry and Victorian electricity consumers, were considered in extending the target. **However, the extension occurred primarily to alleviate the concerns of brown coal generators that the 10 per cent target would deliver too much renewable energy generation too quickly, which would reduce wholesale electricity prices and adversely affect existing generators.** (Victorian Auditor General, 2011)*
- MOE role in policy process not necessarily transparent, recent work including MEI, CEEM relevant in highlighting these issues

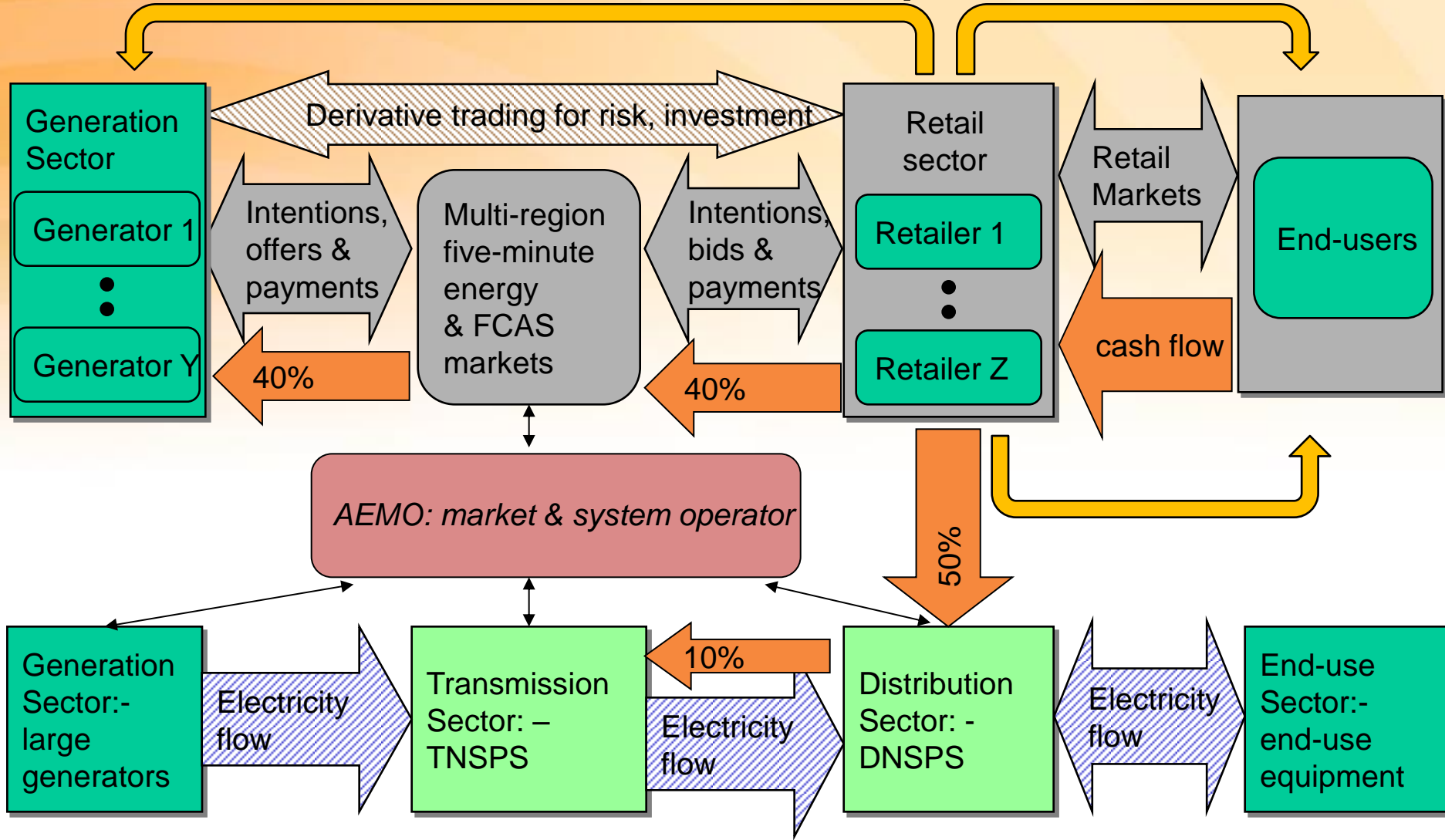
More general framework – economic value of highly variable, partially unpredictable renewables

- Energy value of renewables in an Electricity Industry depends largely on its match with underlying cost drivers such as time and location varying demand, availability of other generators
- *Marginal* energy value of RE declines as penetrations increase
 - An issue with virtually all generation technologies
 - generation without inherent energy storage has lower value than conventional gen with storable energy sources (coal, gas, hydro)
- Variability + unpredictability significant but complex implications
 - Significant ‘complementary resources’ competition in wholesale market that can assist in managing this variability + unpredictability
- **Of course**, Environmental, energy security and other values of RE increase with greater deployment

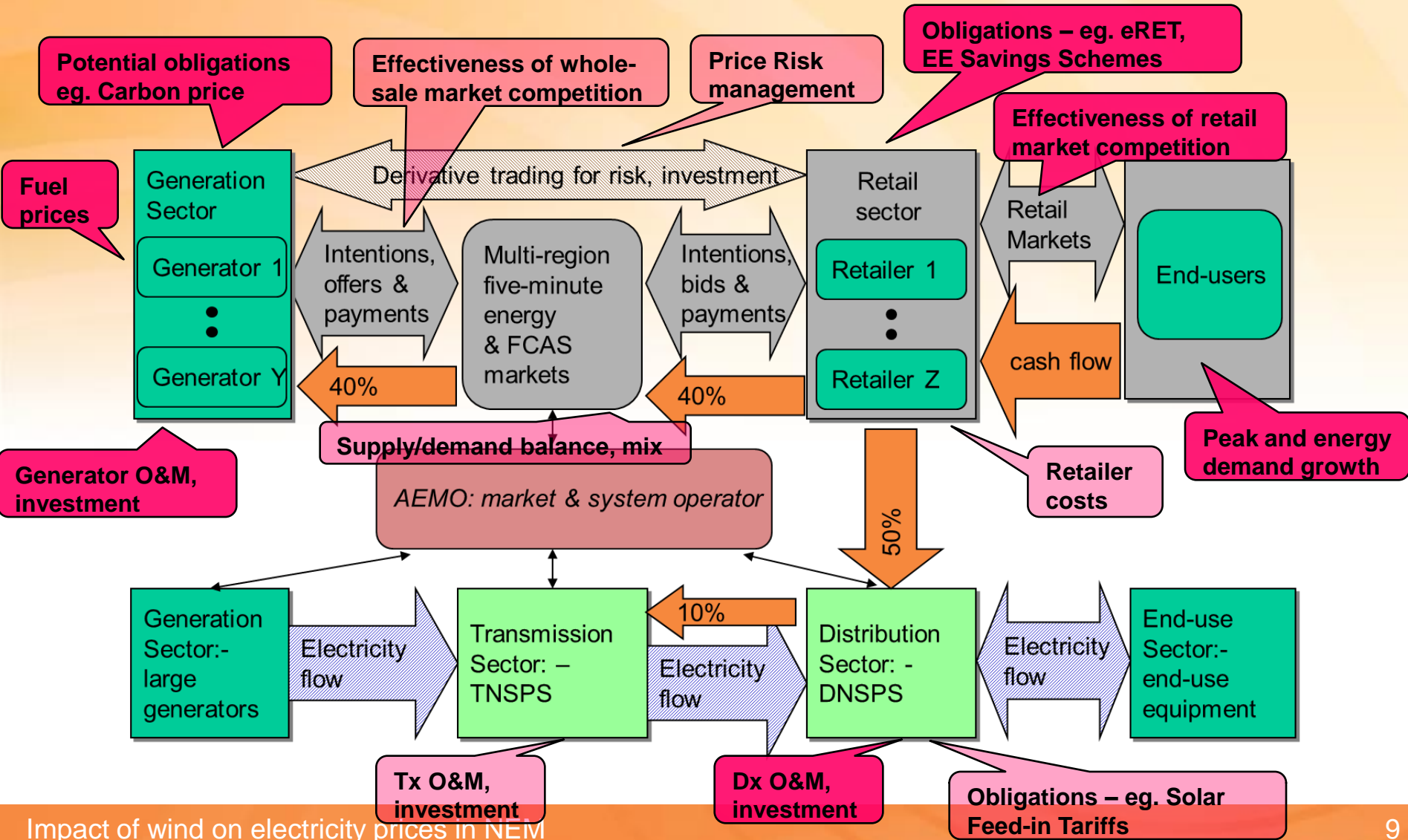
Estimating the Merit Order Effect

- Electricity market model/simulation that can be run with and without the inclusion of RE
 - potential to capture longer-term effects
 - requires consideration of counterfactual BAU scenario
 - market models have significant limitations
- Time-series analysis of historical electricity market data
 - Doesn't require assumptions about alternative scenarios
 - can only analyse short-term effects; not investment implications etc
 - Difficult to resolve impact of RE in context of other potential market drivers
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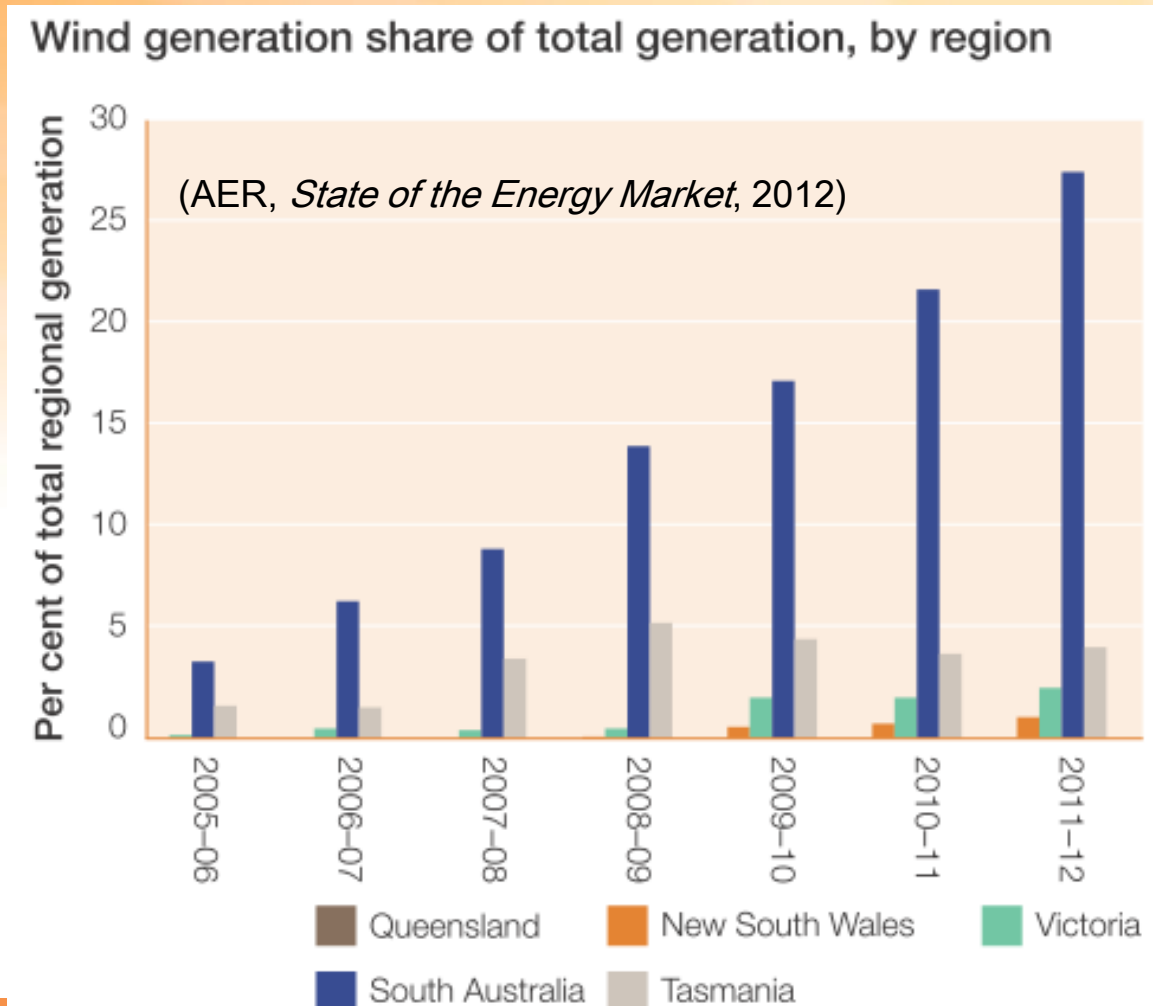
Value in the NEM – costs, prices, tariffs...



.. many drivers of cost, price outcomes



South Australia a world leading wind jurisdiction for empirical analysis

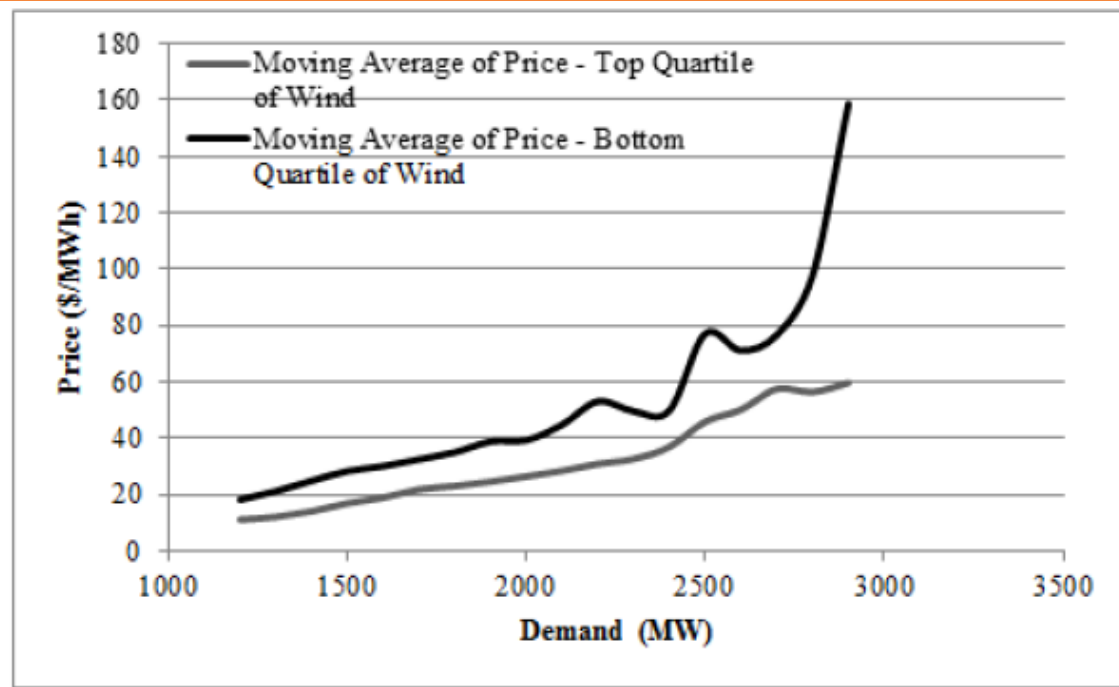




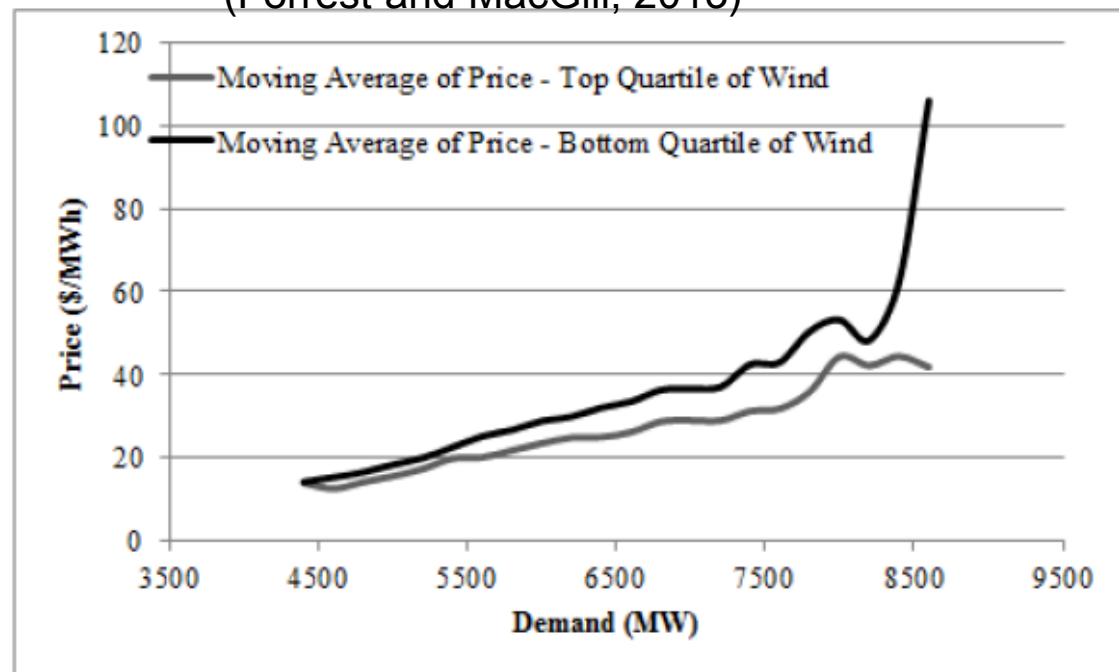
Commercial value in wholesale market

Wind, as with any other gen investment shifts mkt outcomes & hence revenue of all market participants. In a restructured electricity industry, such impacts an intended outcome.

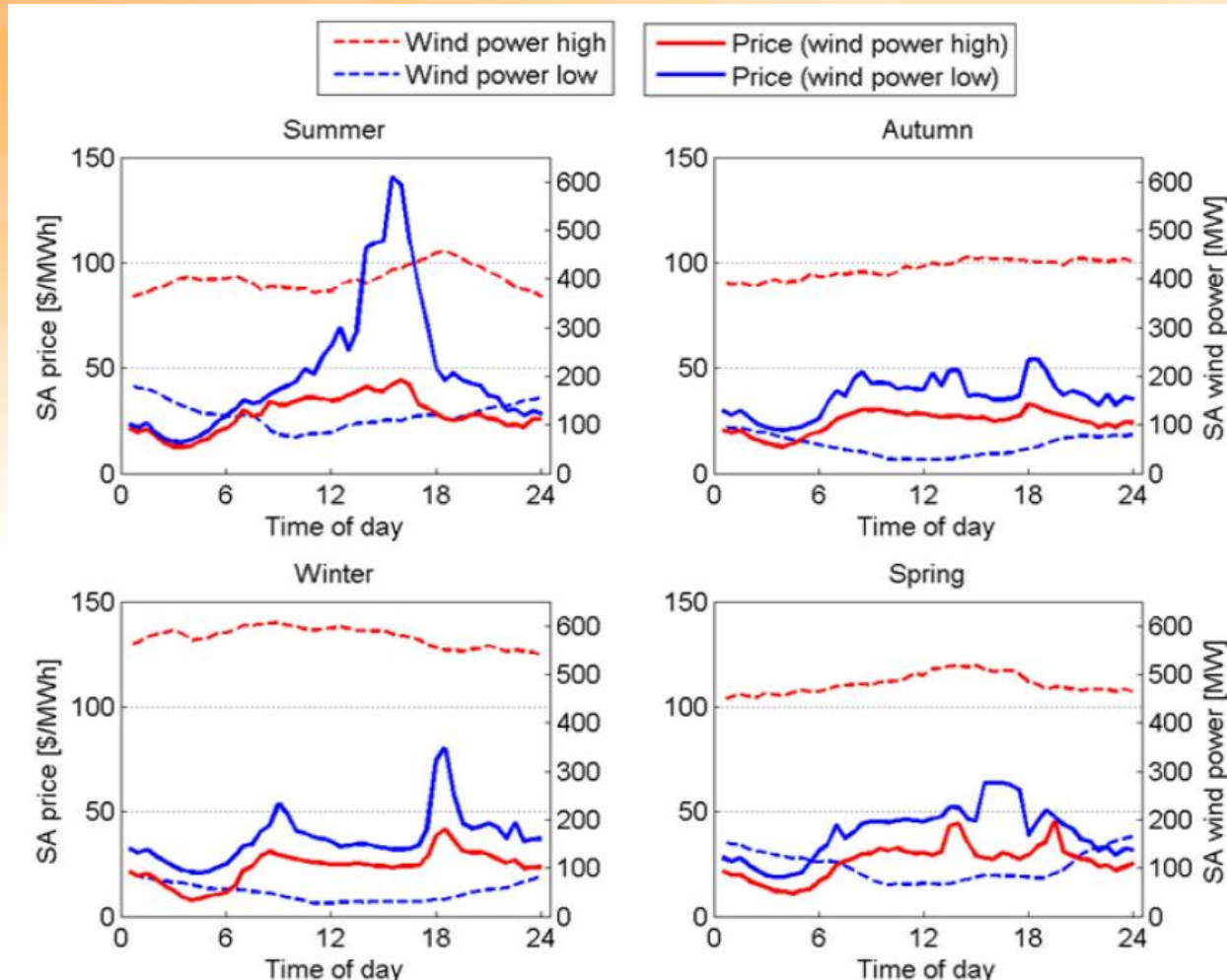
Wind clearly appears to be impacting wholesale spot prices in SA (above) and VIC (below) *but note complexities of such analysis wrt overall impacts, particularly in longer-term, also wrt ancillary, derivative prices)*



(Forrest and MacGill, 2013)



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



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

Wind energy 'value' in NEM?

At high penetrations wind generation earns less than more dispatchable generation – appropriate outcome as technology without primary energy storage has lower value in electricity industry than generation that does

| 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)

Some findings to date

- *Caution required - significant assumptions required*
 - *Including price truncation, relationships between VIC and SA wind*
- **Estimated total price impact of wind in NEM**
 - South Australia 2/2009-2/2011 -\$7.30/MWh
 - Victoria 2/2009-2/2011 -\$1.96/MWh
 - (Forrest and MacGill, 2013)
 - NEM overall Pre carbon price 6/2011-6/2012 -\$2.30/MWh
 - NEM overall Post carbon price 7/2012-5/2012 -\$3.30/MWh
 - (Cludius, Forrest and MacGill, 2013 forthcoming)

Table 4: Reduction in wholesale price due to the RET, \$/MWh

| | With carbon | | | Without carbon | | |
|------------------------|-------------|-----------|-----------|----------------|-----------|-----------|
| | 2011-2015 | 2016-2020 | 2021-2025 | 2011-2015 | 2016-2020 | 2021-2025 |
| South Australia | 3.59 | 16.12 | 12.83 | 4.53 | 17.54 | 18.95 |
| Victoria | 6.79 | 14.05 | 14.42 | 6.94 | 16.14 | 25.13 |
| NSW | 3.59 | 4.40 | 2.13 | 2.69 | 6.11 | 8.96 |
| Queensland | 3.90 | 3.54 | 3.02 | 3.08 | 4.76 | 8.55 |

By comparison
(SKM, 2013)

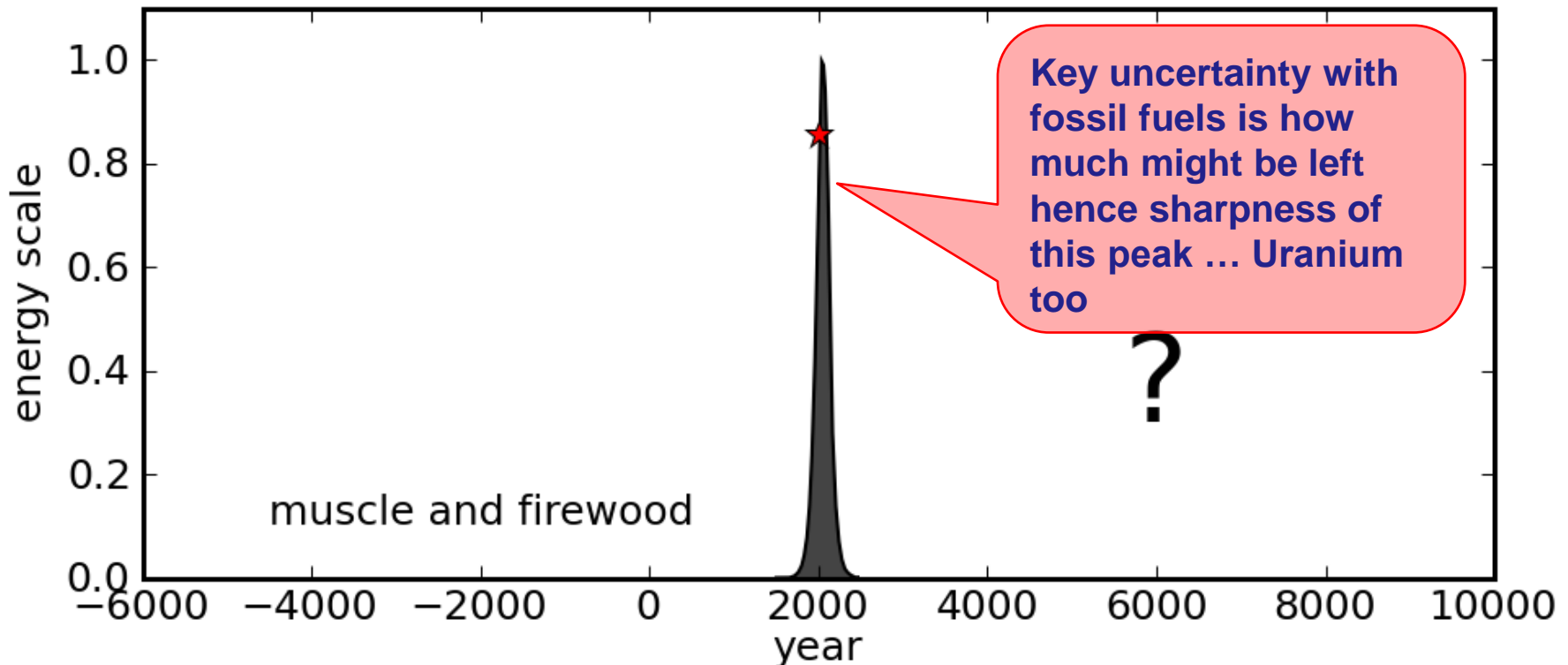
Q: Does wind in NEM increase electricity prices?

- Wind clearly impacts wholesale electricity mkt prices
 - 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 – eg. potential impacts of rapid wind changes, market power, longer-term investment dynamics on prices
- 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 ‘direct’ electricity costs, *but prices?*
- Key question – which prices for whom?
 - Wind is reducing wholesale market prices received by all generators
 - Some large industries receiving major exemptions from RET, likely also seeing lower wholesale prices
 - Retail customers may not receive falling wholesale market prices
 - A ‘safe’ climate is worth paying for

Taking a longer-term perspective, 100% renewables a question of when.. and how

- *Our only technically feasible option*
- *Wind and PV seem well placed to play major role*

(Murphy, <http://physics.ucsd.edu/do-the-math/>, 2012)





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