



Centre for Energy and
Environmental Markets

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Facilitating high wind penetrations within the Australian National Electricity Market – renewable policies and market design issues and opportunities

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Power Systems*

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Wind energy's diverse values

- Energy
 - depends on investment + operational costs compared against benefits of energy provision + alternative supply options
 - *significant temporal + locational variability + uncertainty determined by desired energy services, combined investment + operational characteristics of all demand + generation*
- Environmental
 - greenhouse emission reductions – depends on other generation options and has relatively little temporal + locational variation
 - regional air + water benefits, amenity costs
- Social
 - possible investment + job outcomes with industry development



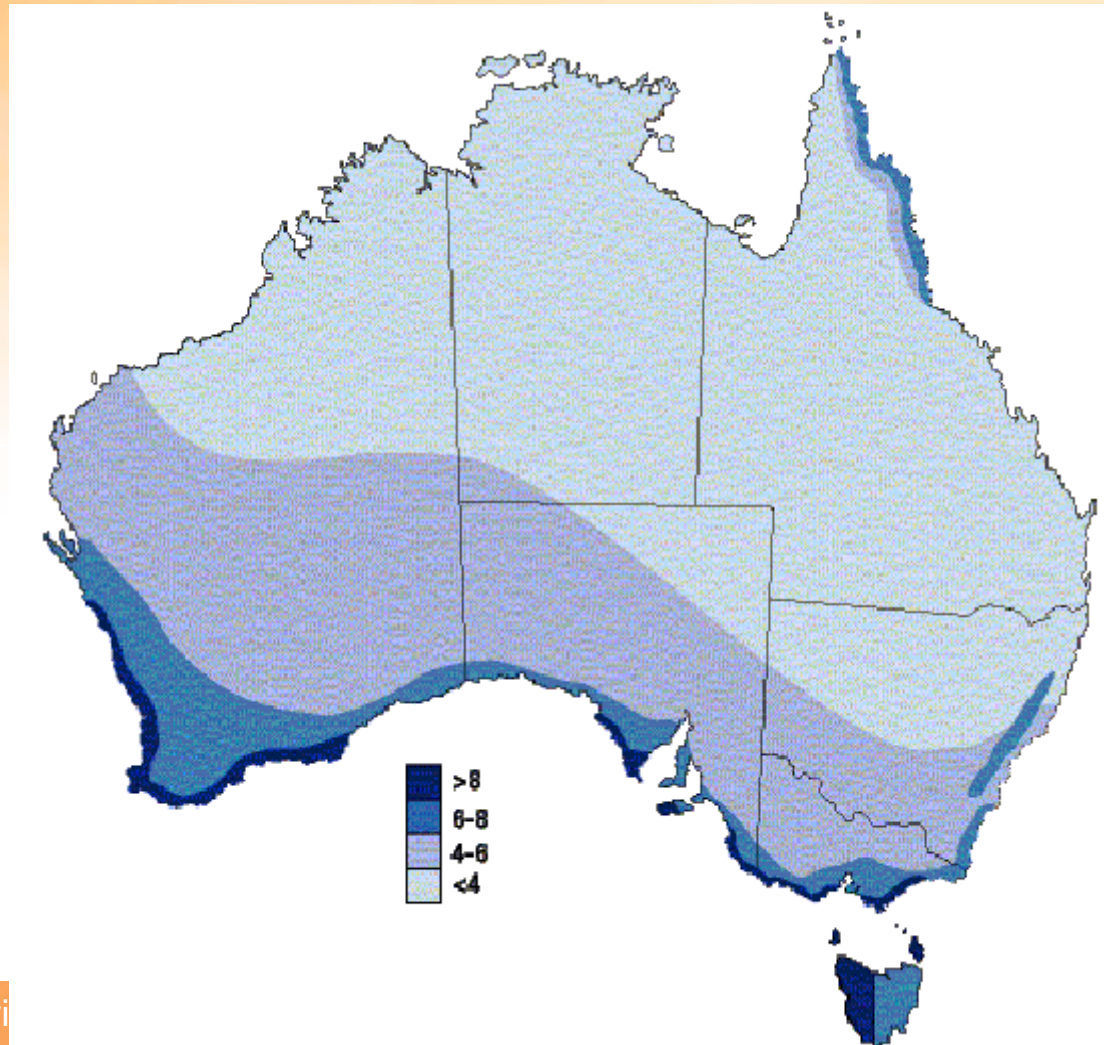
The wind facilitation challenge

- Maximise total energy, environmental + social values of wind
- For high wind penetrations, maximising energy value becomes more challenging
 - ‘best’ windfarm sites taken early
 - Increasingly significant integration costs
 - *network connection + management*; match of wind with existing Tx + Dx
 - *security*; particularly wrt possible large + unexpected aggregate regional or system-wide swings in wind power production
 - *economic operation + investment*; implications for other generation of highly variable + somewhat unpredictable low-operating cost wind power
- Key electricity industry issues
 - How well do industry arrangements mesh underlying economic energy value with commercial signals to market participants?
 - *...and in particular, wrt new technology + participants*
 - *Wind the first significant generation with a highly variable, somewhat unpredictable + non-storable primary energy source*
 - *Now testing the adequacy of industry arrangements around the world*
 - Interactions with specific renewable policy support measures



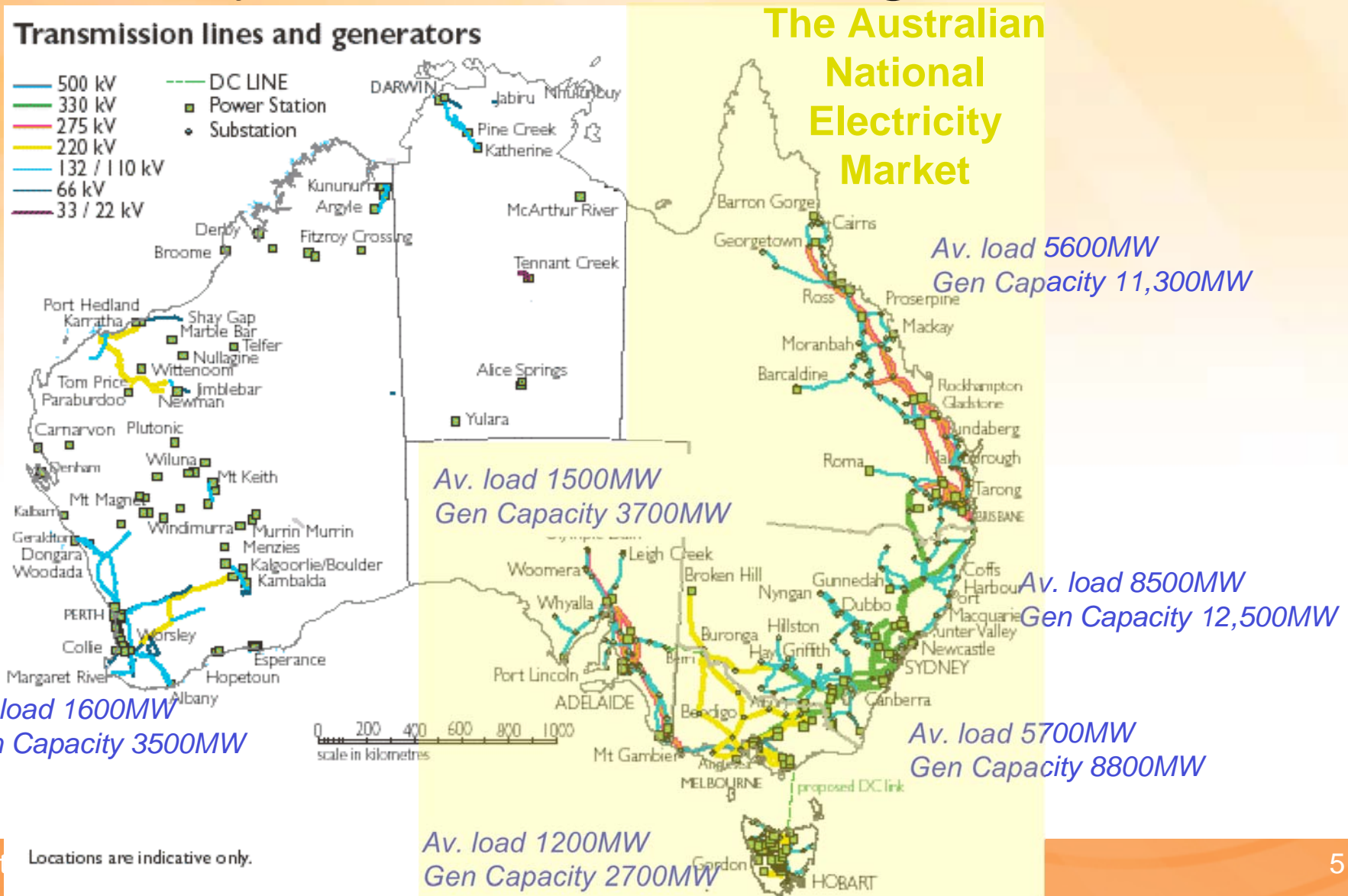
The Australian wind resource

(Simple estimates of background wind – Australian Greenhouse Office)





Electricity demand, Tx and generation

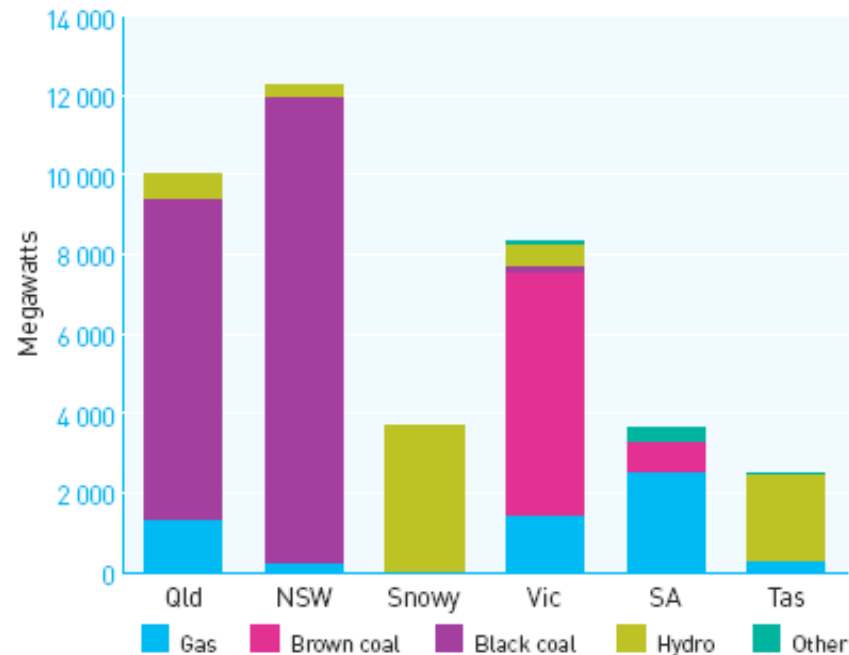




NEM in summary...

(AER, *State of the Energy Market 2007*)

Figure 1.7
Regional generation capacity by fuel source, 2007



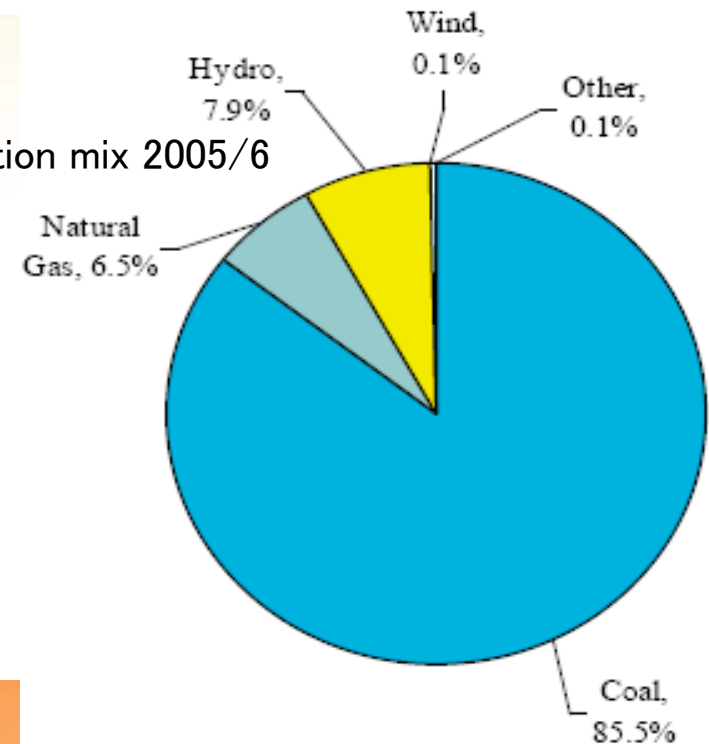
Note: Excludes power stations not managed through central dispatch.

Data source: NEMMCO

Table 2.1 NEM at a glance

Participating jurisdictions	NSW, Qld, Vic, SA, ACT, Tas
NEM regions	NSW, Qld, Vic, SA, Snowy, Tas
Registered capacity	43 130 MW
Number of registered generators	263
Number of customers	7.7 million
NEM turnover 2006-07	\$13 billion
Total energy generated 2006-07	206 TWh
National max winter demand 2006-07 (21 June 2007)	32 688 MW
National max summer demand 2006-07 (5 February 2007)	31 796 MW

NEM Generation mix 2005/6
(NECA, 2008)





Features of National Electricity Rules (NER)

- NEM covers all participating states:
 - A multi-region gross pool with intra-regional loss factors
 - Spot market hybrid 5/30 min (dispatch/commercial)
 - 8 Frequency Control Ancillary Services markets for < 5min
 - No capacity market or equivalent; participants determine unit commitment through energy spot market bidding strategy
 - Centralised projections – day ahead, 1 week (STPASA), 2 years (MTPASA) and 10 years (Statement of Opportunities)
 - Operated by NEMMCO (owned by states)
- Compulsory participants in NEM:
 - All dispatchable generators & links > 30 MW (unless intermittent)
 - Network service providers & retailers
- Networks
 - Regulated monopoly NSPs obliged to provide non-discriminatory access; technical connection standards, 'shallow' connection costs
- Outside formal NEM rules + arrangements...
 - Range of OTC + exchange derivative markets used to manage spot price risk + underpin investment



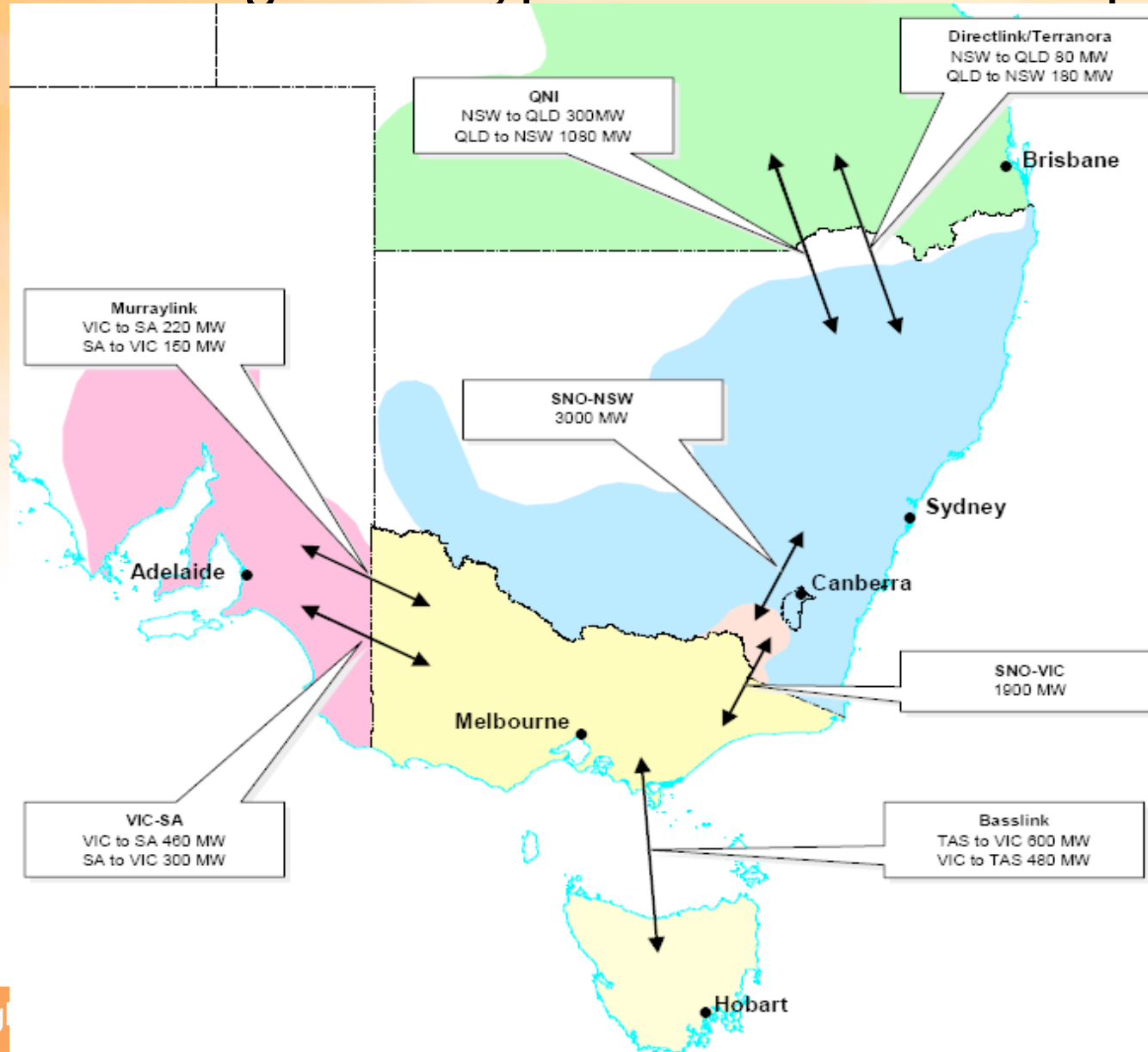
Spot market operation

- Scheduled generators
 - offer Price-Quantity curve (<11 pairs) for each half hour day ahead
 - Can be changed (rebid) right up to dispatch (<1min 'gate closure')
 - Can also bid in ancillary service capabilities into FCAS regulation + contingency markets
- Retailers, large customers + storage can choose to bid
 - ...but very little load formally participates
 - NEMMCO unscheduled demand forecast 'bid in' at \$10000/MWH
- Bids & offers ranked to give dispatch stack:
 - Considering loss factors & inter-tie constraints
 - ... and co-optimised with ancillary service enablement dispatch
 - 5min dispatch for scheduled generation + loads, + prices for each region (spot + FCAS) averaged to 30min for commercial exchange
 - *Note that only commercially accountable price in spot market operation is 5/30 min (day-ahead pre-dispatch prices advisory only)*



Present NEM regions + typical interconnect capacities

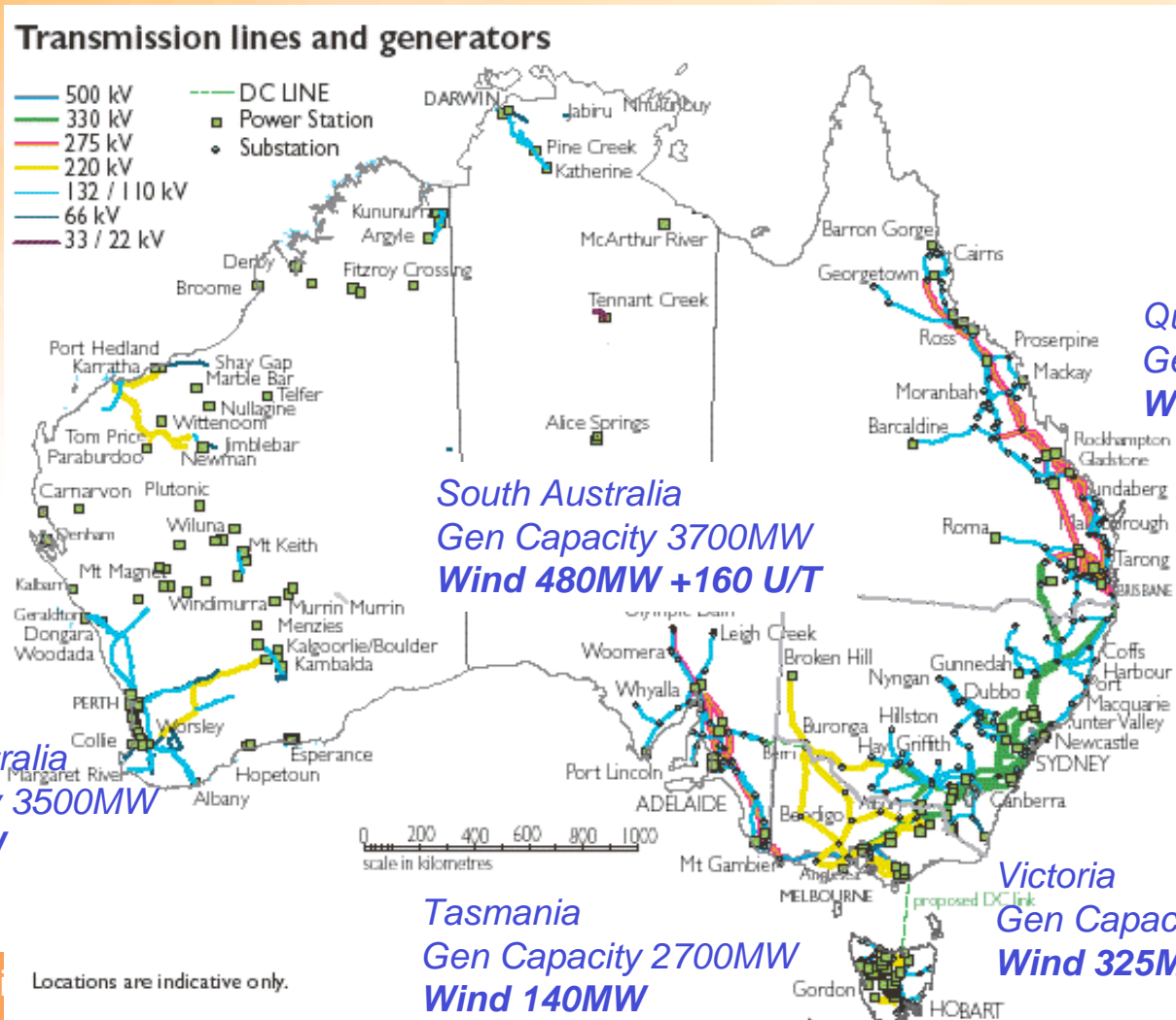
(NECA, 2008)





Current status of Australian wind generation

Recent estimates of state average load, total installed generation capacity and wind installed or under construction (ausWEA, ESAA)



Queensland
Gen Capacity 11,300MW
Wind 12MW

South Australia
Gen Capacity 3700MW
Wind 480MW +160 U/T

New South Wales
Gen Capacity 12,500MW
Wind 17MW

Western Australia
Gen Capacity 3500MW
Wind 200MW

Tasmania
Gen Capacity 2700MW
Wind 140MW

Victoria
Gen Capacity 8800MW
Wind 325MW +165 U/T



The changing status of wind in the NEM

- **Non-scheduled**
 - Existing category for intermittent gen – wind treated as negative demand
 - Can only be curtailed for system security or key network issues
 - Don't pay for FCAS
 - Recent changes:
 - technical connection standards relevant to wind generators
 - Historical windfarm outputs published
 - Centralised wind forecasting system (AWEFS) in progress
- **Scheduled**
 - South Australia currently requires new wind farms to register as scheduled
 - Submission of dispatch offers
 - Compliance with targets
 - Causer-pay for ancillary services
 - Ability to offer ancillary services
 - Publication of individual outputs:- forecast, offered & actual
- **Semi-Scheduled**
 - Specifically intended for intermittent gen >30MW + compulsory from March 2009
 - Submission of dispatch offers
 - Causer-pay for ancillary services
 - Ability to offer ancillary services
 - Are treated as positive supply
 - If involved in a constraint
 - Compliance with targets if less than forecast

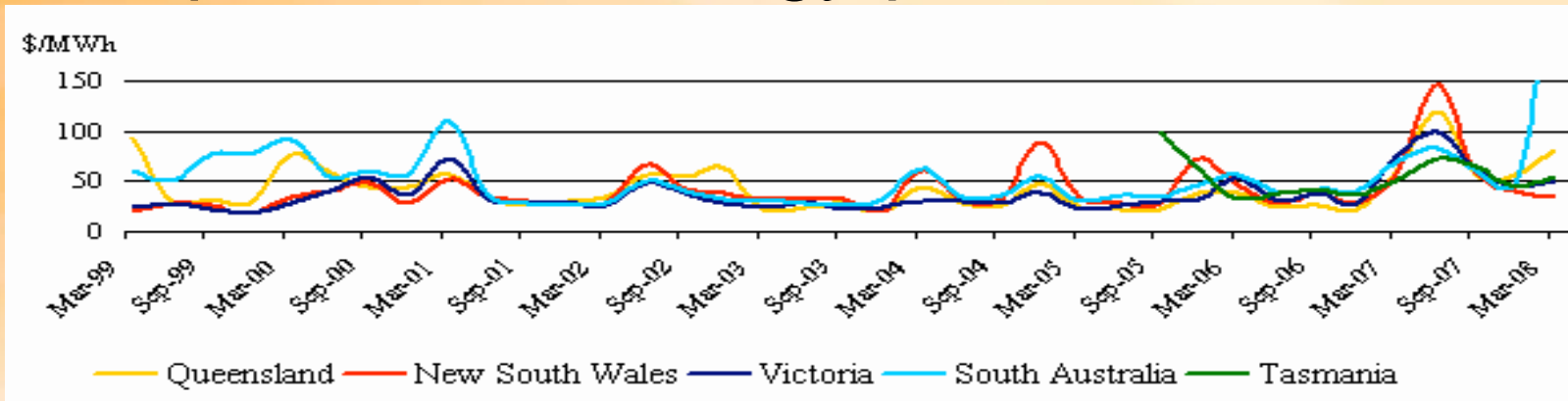


Facilitating wind integration in the NEM

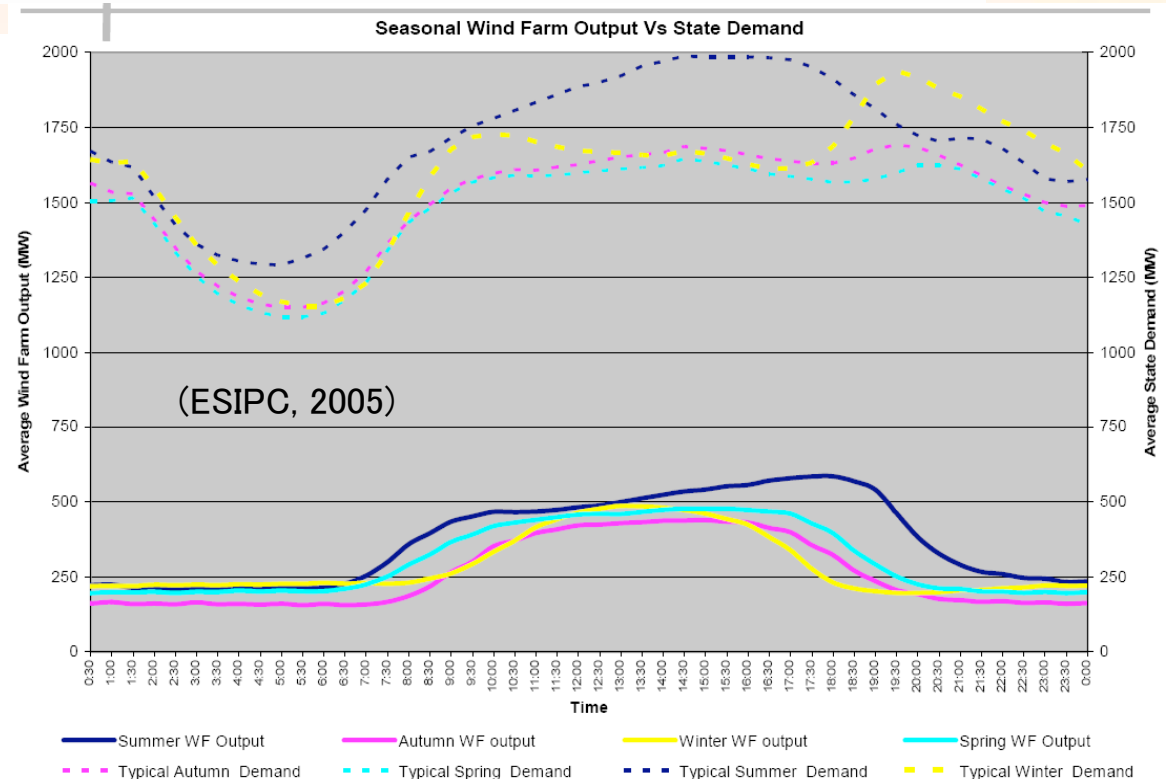
- Current market design relatively supportive
 - Supply/demand balance for energy + FCAS via gross pool, not mainly bilaterally
 - Transparent regional prices for all market participants that reflect considerable locational, temporal and uncertainty value of electricity
 - Potential for 5min rebidding lets all participants revise offers with improving forecasting information + creates strong incentives to enhance short-term operational flexibility
- Wind as non-scheduled generation
 - Generates whenever wind is blowing (possibly s.t. to N/W constraints)
 - Operate as “price takers” although high penetrations will impact prices
 - Value of wind energy depends on region + intra-regional location, + how regularly wind farms producing when spot prices are high
can be reasonably good correlation seasonally and daily cycle
- Market enhancements
 - Historical SCADA information for major windfarms published
 - NEMMCO has interim and progressing major Forecasting System (AWEFS)
 - Forecasts from 5 min to 2 years, windfarm level and regional aggregations, + including uncertainty estimates
 - More formal participation by wind in the NEM – a price of success



NEM spot market energy prices (Quarterly, www.aer.gov.au)



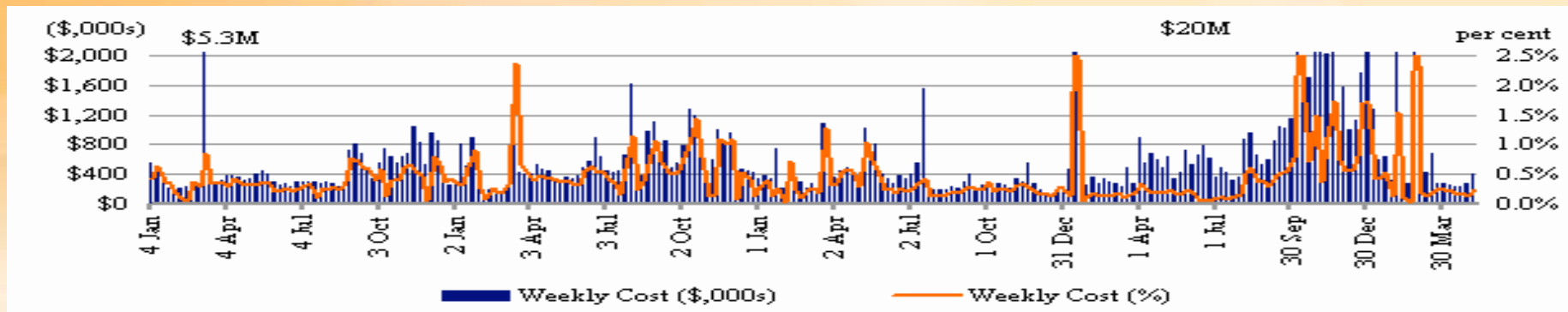
- Significant regional differences
- Wind can be good match to daily demand + price variations
- Recent prices considerably higher than long-term av.
- Wind in derivative mkts?
 - Standard CFDs + options fixed volume with major risks if short on generation
 - Opportunities for 'smoothing' contracts
 - *All participants have interest in good forecasts*





NEM frequency control ancillary services

(Quarterly volume weighted, www.aer.gov.au)



- At present, FCAS costs low wrt spot market revenue
- Impacts of increased wind unlikely to be very significant under present arrangements (Thorncraft et al, 2008)
- Reasonable that wind should contribute to FCAS as scheduled or semi-scheduled
- Will also be opportunities for wind to offer FCAS capabilities

(Thorncraft et al, 2008)

Table 4. FCAS cost recovery implications for a wind farm in the NEM

Class	Service Name	Cost Recovery Implication for wind farm
Regulation	Regulation raise	Assessed under the causer-pays methodology.
	Regulation lower	
Frequency	6-second raise	A wind farm would be charged in proportion to energy production.
	60-second raise	
	5-minute raise	
	6-second lower	A wind farm would not pay for lower contingency services.
	60-second lower	
	5-minute lower	



Mandatory Renewable Energy Target



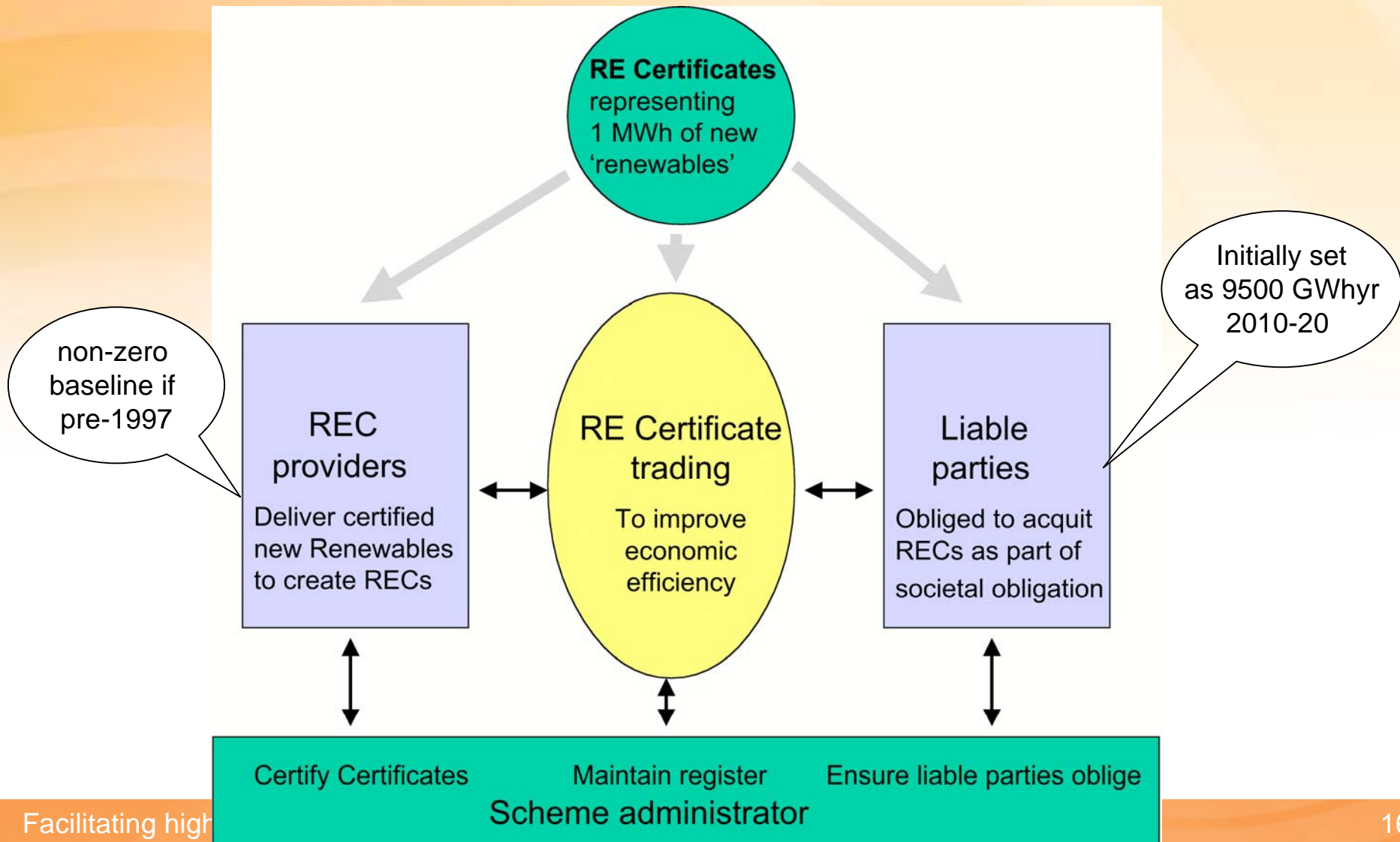
Renewable Energy (Electricity) Act 2000

The objects of this Act are:

- (a) to encourage the additional generation of electricity from renewable sources; and
- (b) to reduce emissions of greenhouse gases; and
- (c) to ensure that renewable energy sources are ecologically sustainable.



MRET – a ‘designer’ market





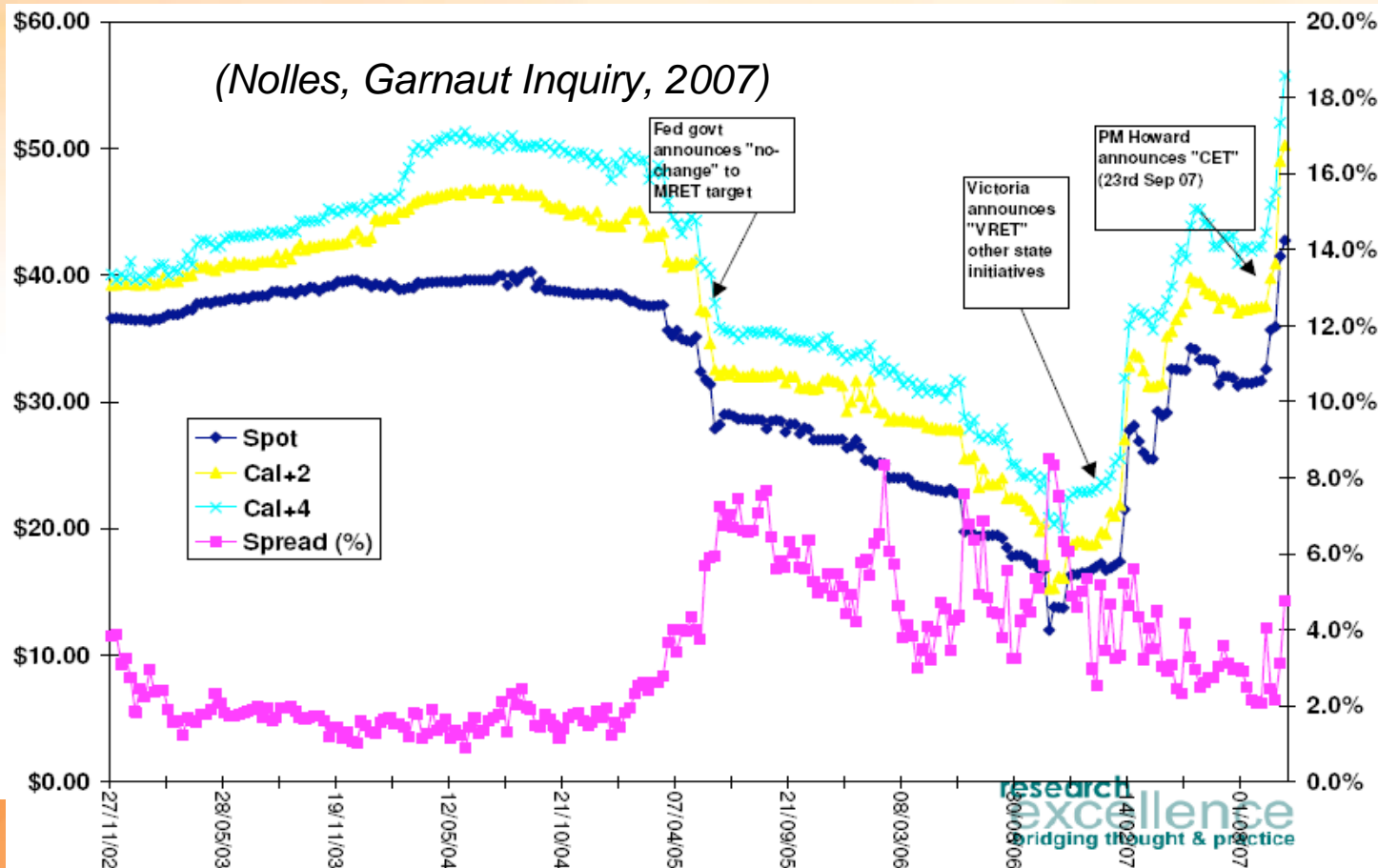
MRET performance

- The good
 - Facilitates integration of renewables into NEM
 - Provides additional revenue above energy mkt revenue; for existing projects typically order of 50% of cashflow is from RECs
 - Modest ramping target easily met + considerable new investment
 - Apparent efficiency – highly competitive RECs market with low project costs by international standards
 - Technology flexibility has proved valuable
 - eg. biomass an expected winner but slow uptake in practice
=> wind + others filled the gap
- **However**
 - Inappropriate baselines for ‘old hydro’
 - Boom + Bust cycle due to fixed end-date (2020)
 - Considerable regulatory uncertainty has significant price impacts



The REC market

- Little liquidity (+ hence price discovery) for forward prices through trading
 - Most projects financed via PPAs or other direct contracts
- Prices vulnerable to regulatory change
 - => *potential challenges in driving investment & industry development*

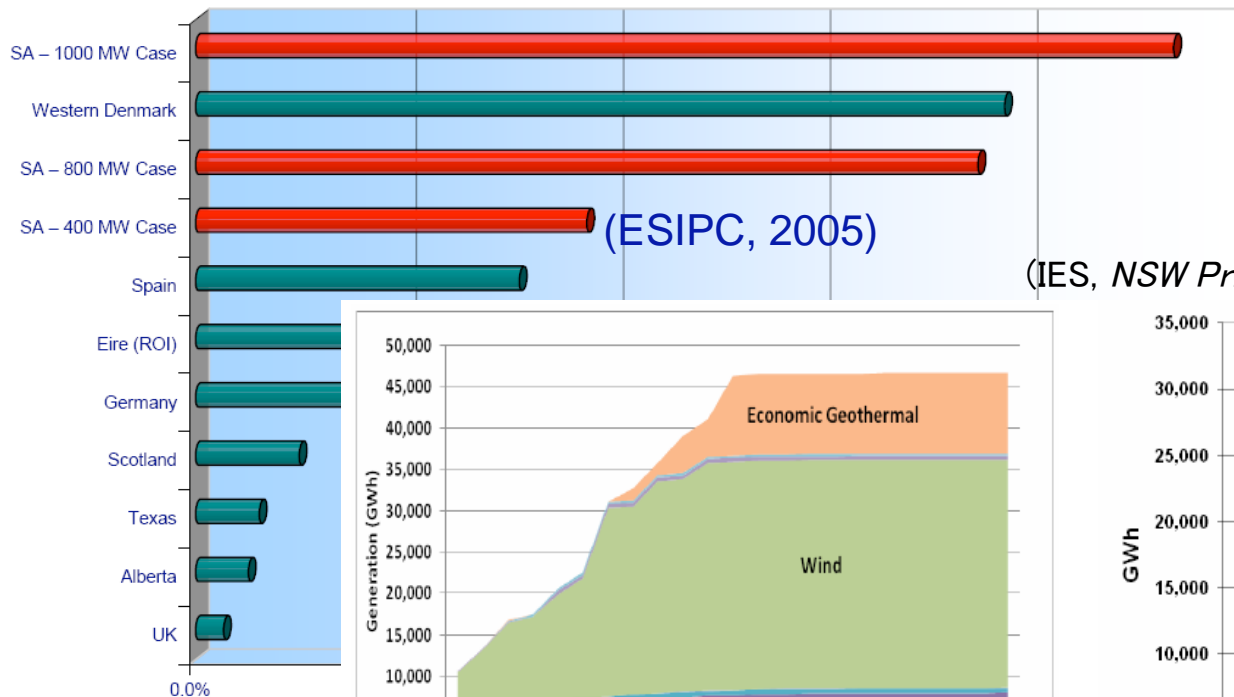




Now, wind penetrations set to rise significantly

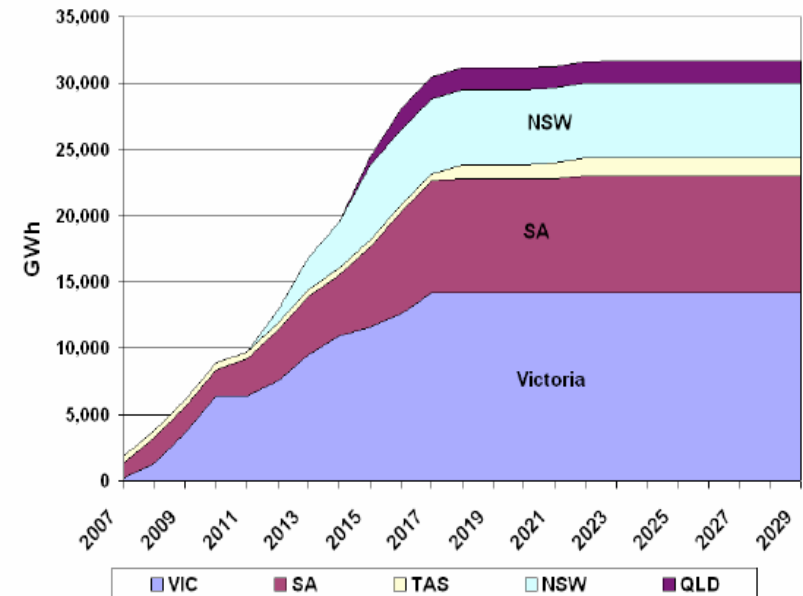
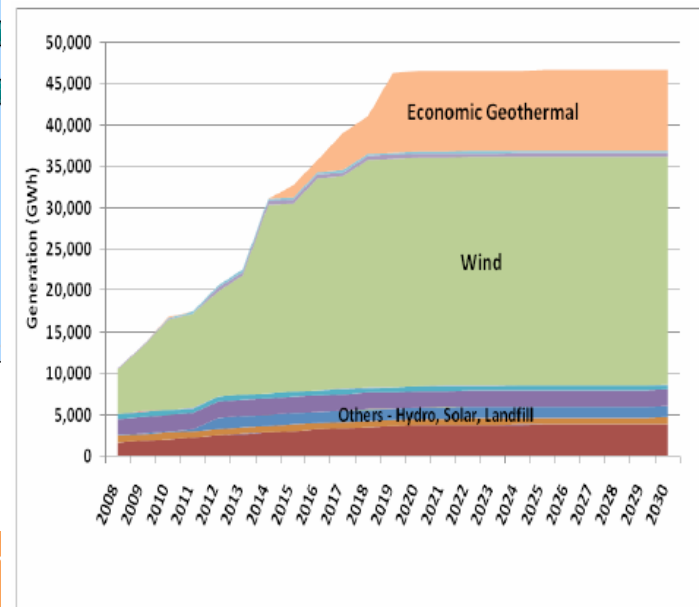
- New Renewable Target of 20% by 2020 might see 10GW of wind
 - Note that scheme expansion rules still to be finalised
 - Possible very high penetrations in SA + Vic; a major challenge for NEM

Wind Penetration by Energy



(ESIPC, 2005)

(IES, NSW Privatisation Conference, 2008)



Facilitating high wind



Conclusions

■ NEM

- Infused with uncertainty – *a key to driving competition*
 - Generators can rebid with 5 min notice, don't know dispatch beyond 5 min
- Some success in commercialising costs + benefits
 - Spot/forward markets price current/future uncertainty for all generators
 - FCAS markets set frequency ancillary services costs
 - Principle of 'causer pays' although difficult in practice
- Formal objectives of equal treatment... although difficult in practice

■ Wind

- Currently unscheduled generation + outside many NEM processes
 - NEMMCO has very limited opportunities to direct behaviour yet remains accountable for maintaining system security
- Already 'sees' many of NEM's commercial signals; reasonable that they 'see' more of costs + benefits they bring to NEM + society
- Wider environmental + industry development value needs to be recognised with 'external' policy support; new 20% by 2020 target