



Presentation to
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Electricity industry restructuring in Australia – outcomes to date and future challenges

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CEEM established ...

- *to formalise* growing shared research interests + interactions between UNSW researchers
 - Faculties of Engineering, Business (Economics and Management), Arts and Social Sciences, Science, Institute for Env. Studies...
- *through UNSW Centre* aiming to provide Australian research leadership in interdisciplinary analysis + design of energy and environmental markets
- *focussing in the areas of*
 - Energy markets – spot, ancillary and derivatives – within restructured electricity industries
 - Related environmental markets – emissions trading, renewable obligations, Greenpower...
 - Wider policy frameworks and instruments for achieving overall energy and environmental objectives



Some current CEEM research efforts

- Facilitating wind integration in the NEM
 - 2 strands: forecasting and control of wind energy, and market design to facilitate wind energy
- Renewable energy policy support options in restructured industries
 - MRET, Victorian RET, proposed NSW RET
- Modelling participant behaviour in elec. markets
 - Interactions between spot and derivative markets
- Emissions Trading Schemes + options for Australia
 - Experimental economics studies on market design
- Technology assessment for sustainable energy policy frameworks
 - Energy efficiency, gas and cogeneration, renewables, CCS, nuclear options
- Economic modelling of Distributed Energy
- Energy efficiency policy – regulation, financial mechanisms
- Policy frameworks for technology innovation
 - Emerging renewables, Carbon Capture + Storage (CCS)



Presentation outline

- Energy restructuring in Australia
- Design of NEM + its governance
- NEM performance
- Emerging challenges
 - Growing peak demand
 - Climate change
 - Facilitating intermittent renewable generation

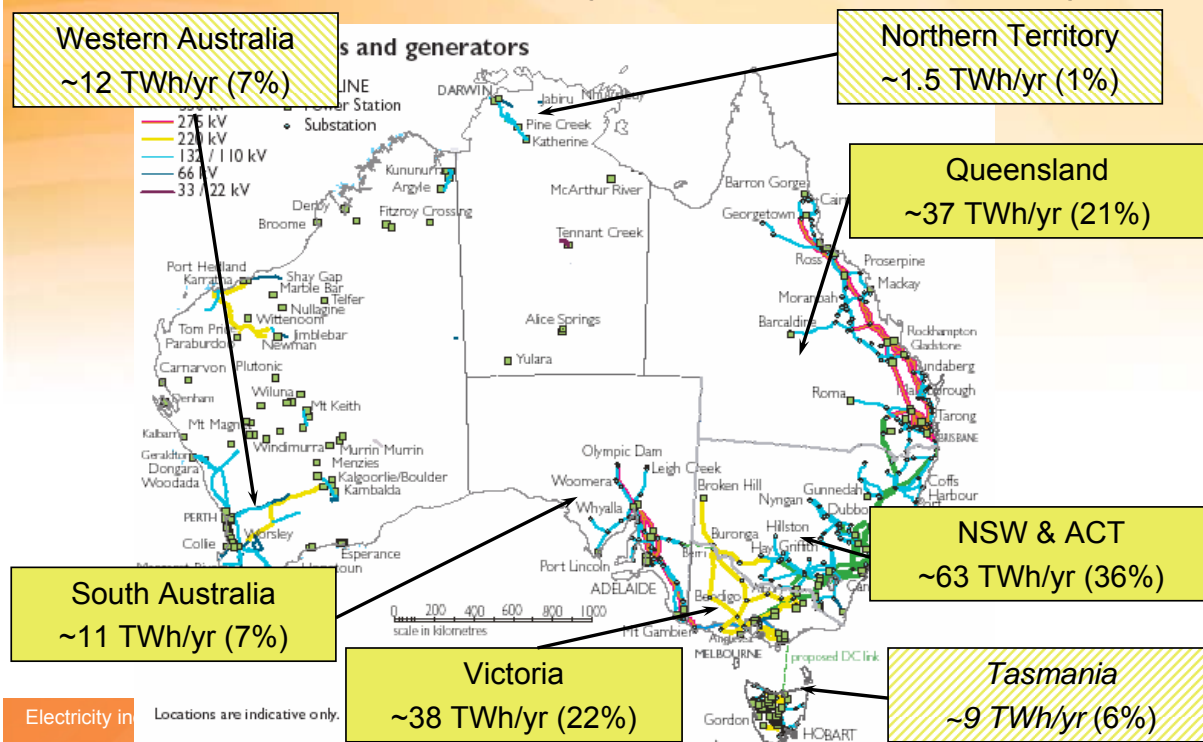


Traditional Australian EI model

- As seen in many parts of the world:
 - Statutory authorities supervised by a Minister or State Owned Corporations (SOCs):
 - Mainly vertically integrated monopolies
 - Separate State Networks and jurisdictions
 - Decision making political, “behind closed doors”:
 - Few formal procedures for decision making
 - Politicians negotiate tradeoffs



Australian electricity demand + supply





Australia's coal dependence for elec. gen

Table 1: Percentage of electricity generated from coal in selected countries

Country	Year	Percent of electricity from coal	Trend since 1990	(WWF, <i>Coal-fired electricity and its impact on global warming</i> , 2003)
Poland	2000	96	Steady at saturation	
South Africa	2000	about 92	rising slightly towards saturation	
Australia	2000	78	Steady	
PR China	1999	75	small increase over the decade	
India	1999	75	small increase	
Czech Republic	2000	73	Steady	
Germany	2000	53	fallen slightly	
USA	2000	52	Steady	
Denmark	2000	47	big decline as gas and wind increase	
Korea	2000	42	big increase	
UK	2001	37	big decline since 1986	
Japan	2000	22	big increase	
Thailand	1999	18	small decrease	
Vietnam	1999	12	big decrease	

Ele

7



Evolution of EI restructuring in Australia

- Development of COAG process in late 80's
 - Formal interface between Federal & State governments
- National Competition Policy, *1993 Hilmer Report*.
 - Facilitate competition where effective & pro-competitive regulation where not; Treat public & private firms equally; uniform market rules of conduct where possible; access regimes for essential facilities
 - **Highlighted potential value of energy industry 'reform'**
- Competition Reform Act, 1995
 - Amended TPA + new Competition & Consumer Commission (ACCC):
- *Now well over a decade of energy industry restructuring*
 - *National Electricity Market (NEM) incorporating NSW, QLD, VIC, ACT, SA (+ now TAS) established in 2000*
 - *More limited changes in Gas industry*
 - *A mix of national + jurisdictional (State + Territory) roles*



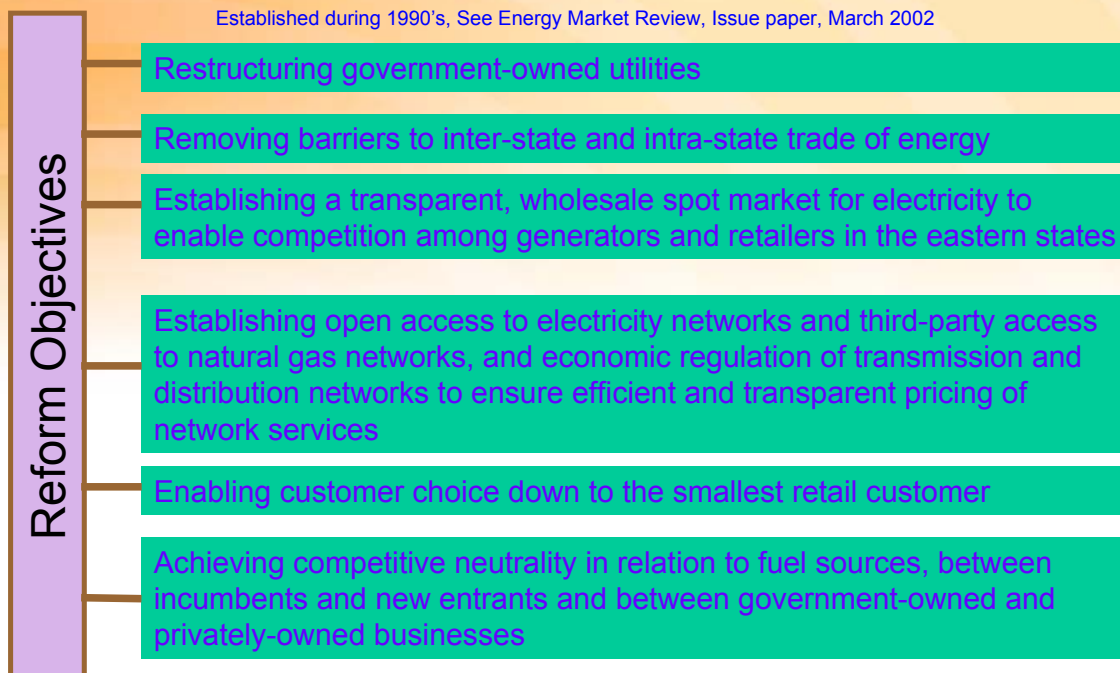
Australia's energy policy objectives

- COAG's agreed energy policy objectives (2001)
 - Encouraging **efficient** provision of reliable, **competitively-priced** energy services to Australians, underpinning **wealth** and **job creation** and improved **quality of life**, taking into account the needs of **regional, rural and remote** areas;
 - Encouraging responsible **development** of Australia's energy resources, technology and expertise, their efficient use by industries and households and their exploitation in export markets; and
 - Mitigating local and global **environmental impacts**, notably greenhouse impacts, of energy production, transformation, supply and use.

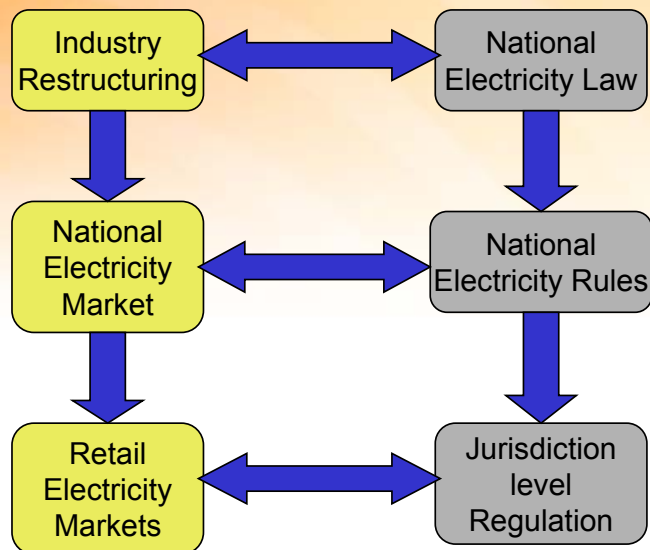


Major objectives of Australian Energy Market Reform

Established during 1990's, See Energy Market Review, Issue paper, March 2002



Australian electricity restructuring process



Governance

- Broad policy – Ministerial Council on Energy
- Regulatory roles

ACCC (Federal TPA)	AER (Federal TPA)	AEMC (SA law)
<ul style="list-style-type: none"> ▪ Anti-competitive conduct ▪ Mergers & acquisitions ▪ Consumer protection 	<ul style="list-style-type: none"> ▪ Transmission econ. regulation ▪ Distribution econ. regulation (1/1/07) ▪ Licence regime? 	<ul style="list-style-type: none"> ▪ NEM rule making & development ▪ Gas market rule making & devel. ▪ Complying with MCE directives



National Electricity Law: Overall objective for the National Electricity Market (NEM)

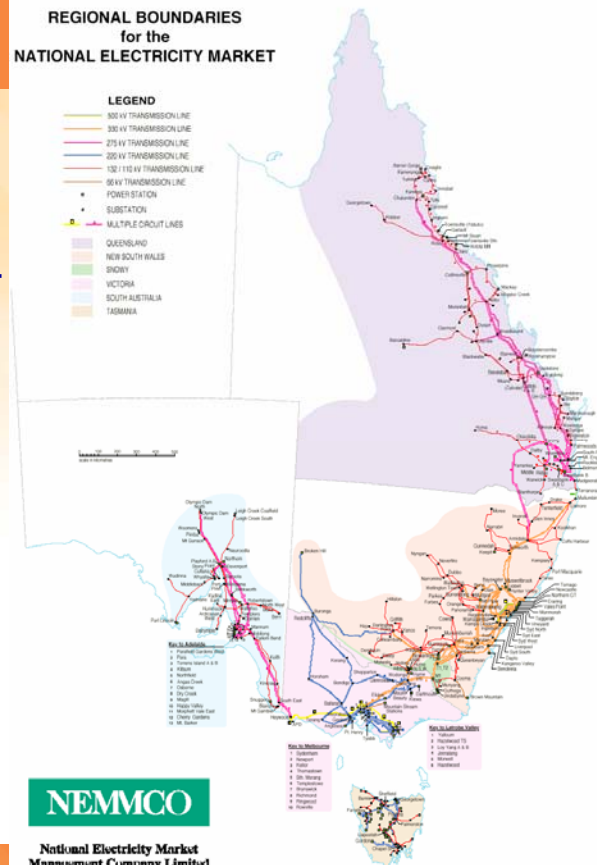
- **NEL Section 7:**
 - The national electricity market objective is to promote efficient investment in, and efficient use of, electricity services for the long term interests of consumers of electricity with respect to price, quality, reliability and security of supply of electricity and the reliability, safety and security of the national electricity system
- **A difficulty with this objective:**
 - Ambiguity of the wording with respect to interpretation of terms & trade-offs between sub-objectives



The NEM

- Queensland
 - New South Wales & ACT
 - Victoria
 - South Australia
 - Tasmania
- (Basslink in 2006)

Commenced operation in 1999





Features of National Electricity Rules (NER)

- NEM covers all participating states:
 - A multi-region pool with intra-regional loss factors
 - Ancillary services, spot market & projections
 - Auctions of inter-regional settlement residues
 - Operated by NEMMCO (owned by states)
- Compulsory participants in NEM:
 - All dispatchable generators & links > 30 MW
 - Network service providers & retailers
- Contestable consumers may buy from NEM



Managing uncertainty in the NEM

Time scale	Issues	Mechanisms
< 5/30 minutes	<ul style="list-style-type: none"> ▪ Uncertain energy flow ▪ Contingencies 	<ul style="list-style-type: none"> ▪ Ancillary services (<i>frequency & voltage</i>)
30 minutes to several days	<ul style="list-style-type: none"> ▪ Uncertain energy flow ▪ Inter-temporal links, eg. <i>unit commitment</i> 	<ul style="list-style-type: none"> ▪ Ex-ante spot market ▪ Short-term derivatives ▪ Security constraints
Weeks to years: <i>operation</i>	<ul style="list-style-type: none"> ▪ Inter-temporal links, eg. fuel, maintenance 	<ul style="list-style-type: none"> ▪ Long-term derivatives ▪ Security management
Years to decades: <i>investment</i>	<ul style="list-style-type: none"> ▪ Resource mix ▪ Externalities ▪ Policy uncertainty 	<ul style="list-style-type: none"> ▪ Long-term derivatives ▪ Security management ▪ Policy settings



NEM regions (NEMMCO SOO, 2006)

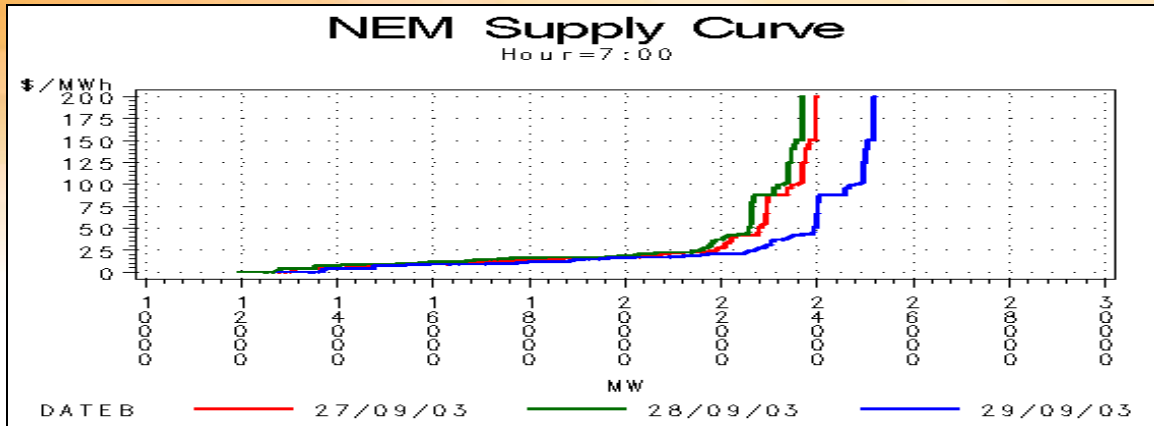


Spot market offers & bids

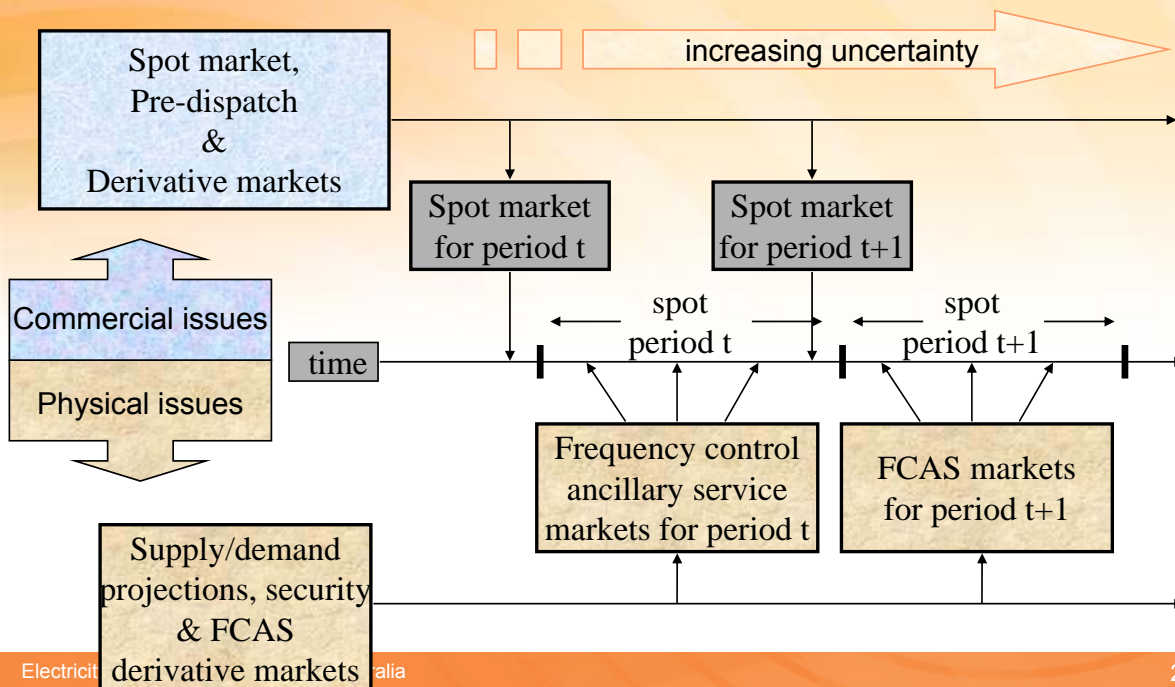
- Generators, retailers & direct end-users:
 - Price-quantity curve (sell or buy) for each half hour:
 - ≤ 10 daily prices, quantities changeable until dispatch
 - 5-minute demand forecast is bid at \$10,000/MW (VoLL)
- Dispatchable links between regions:
 - Flow offer curve based on price difference
- Bids & offers ranked to give dispatch stack:
 - Considering loss factors & inter-tie constraints
 - Operating levels are set for all dispatchable resources
 - 5 minute price(s) set by marginal dispatchable resource:
 - Half-hourly averages are calculated in 'real time'



NEM Supply curve at 7am on 27, 28 & 29 September 2003 (Saturday-Monday) (T Baker, Delta)



Managing supply-demand balance in NEM





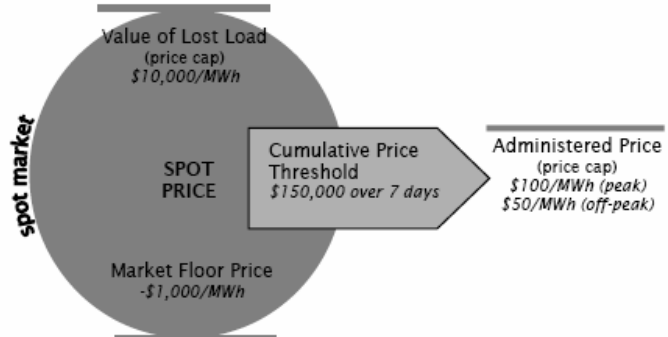
NEM transmission level reliability target, spot market mechanisms & intervention to meet it (AEMC Reliability Review, 2006)

Electricity industry restructuring in

STANDARD

RELIABILITY STANDARD
0.002% unserved energy

MECHANISMS

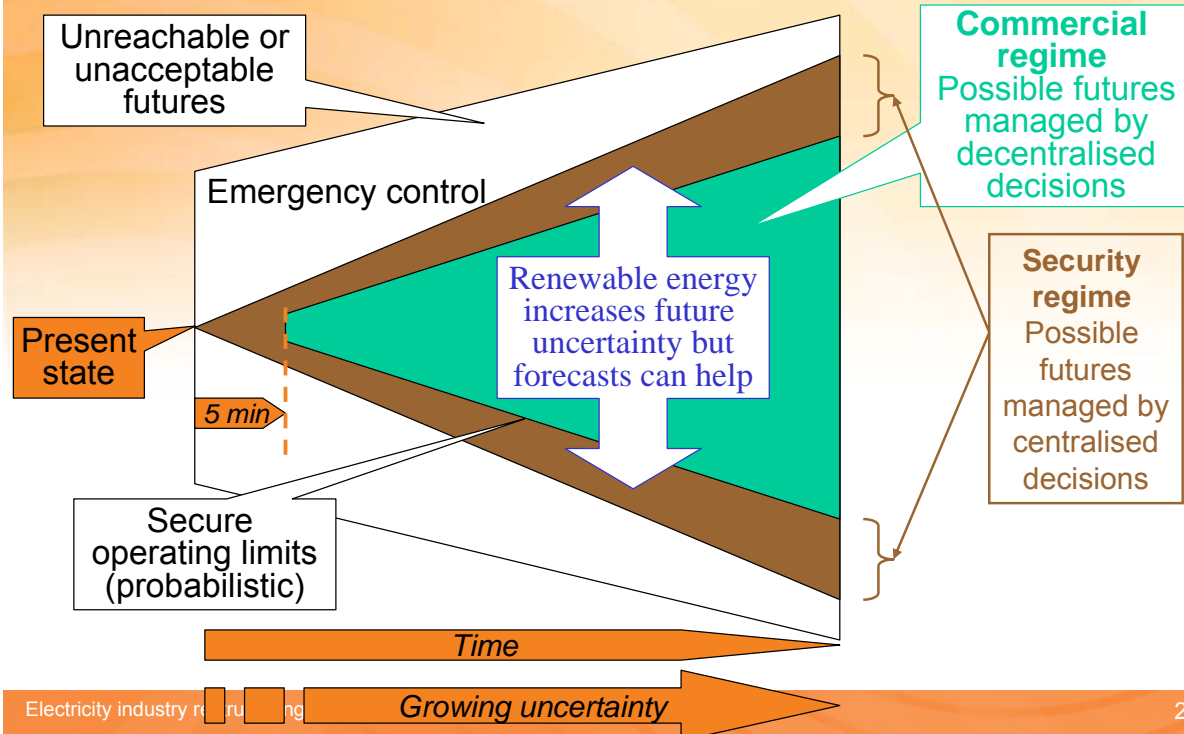


INTERVENTION

RELIABILITY SAFETY NET

- reserve trader settings
- reliability directions

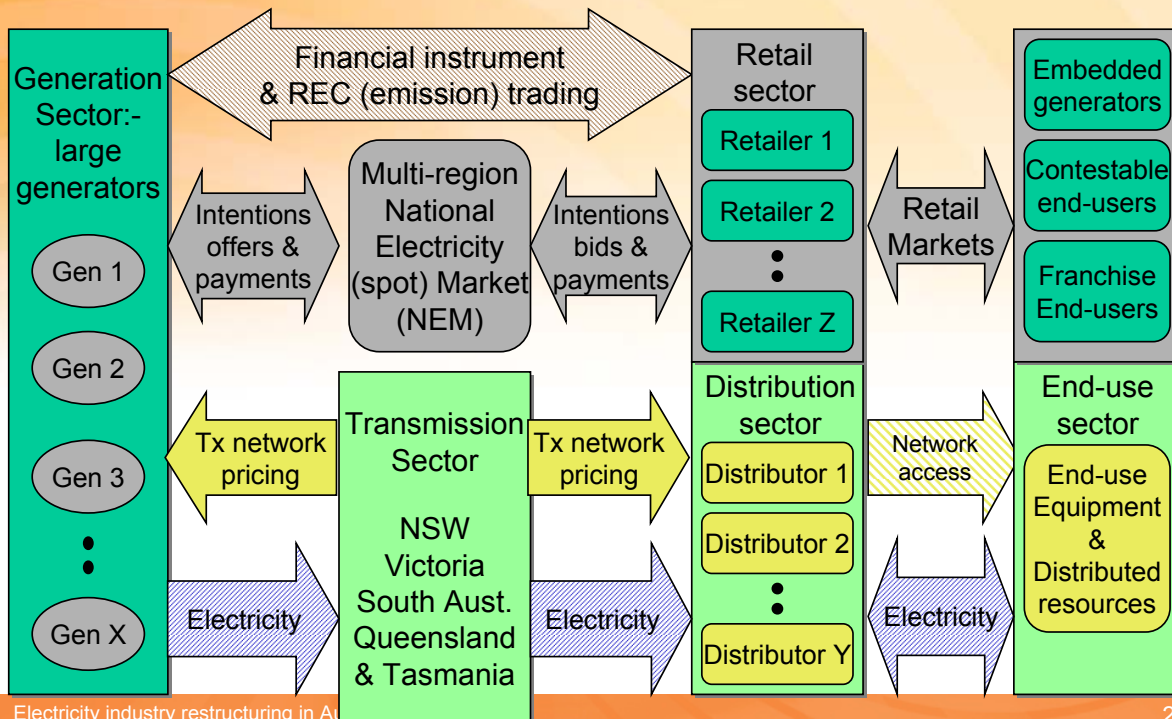
Security & commercial regimes (global & local)



Key derivative markets

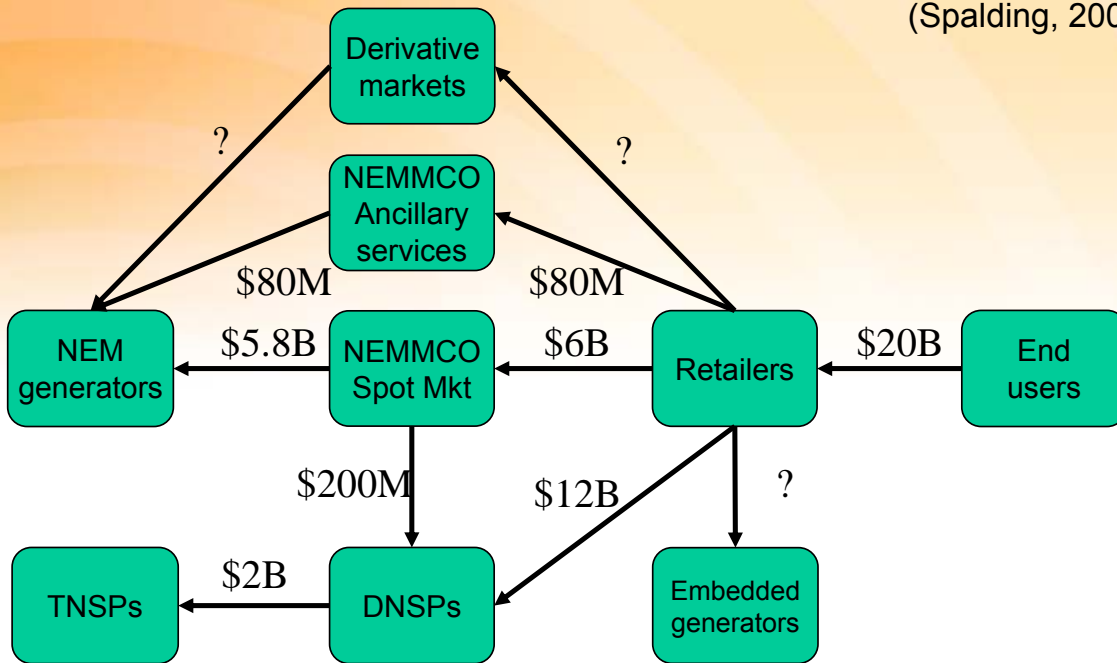
- Forward contracts (futures) (~\$6 billion pa)
 - Expected spot price for a defined load shape & period (eg constant MW for one year)
 - Either OTC or exchange traded
- Call options
- Renewable energy certificates
 - Available to qualifying generators
 - Increasing to 9,500 GWH pa at 2010 then constant to 2020 (~\$200 million pa)

Electricity industry structure within NEM



Cash flow in SE Australia electricity industry

(Spalding, 2006)



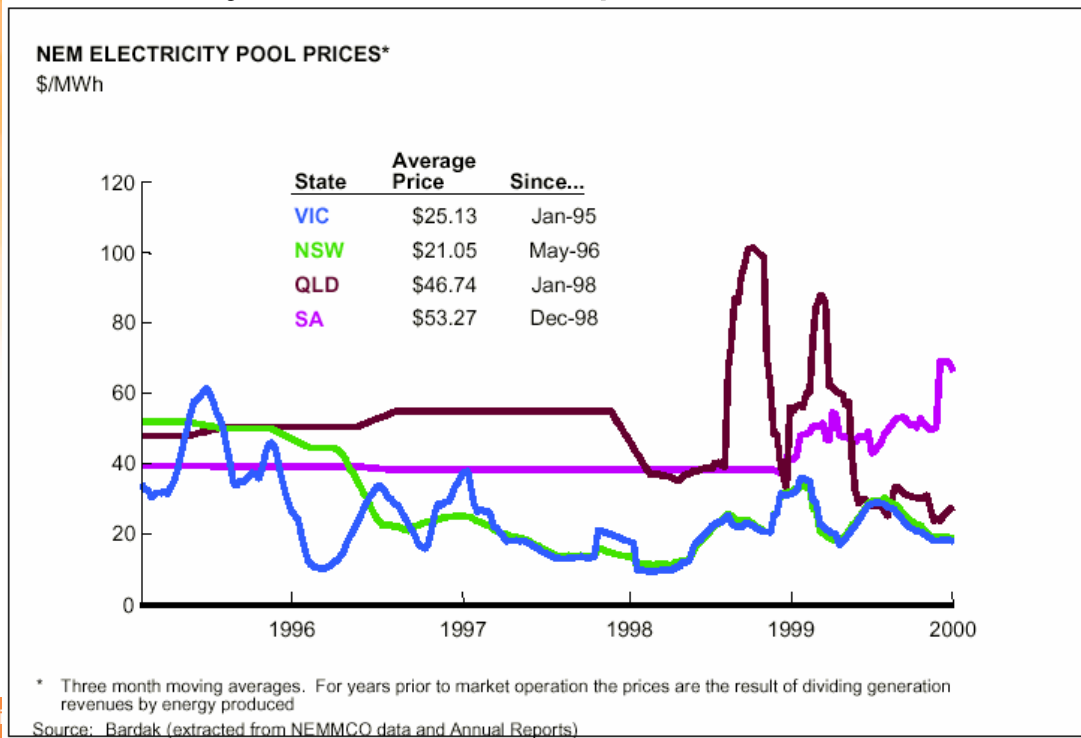
Current ownership status of the Australian electricity supply industry

Public ownership	Private ownership
Most in NSW, Tasmania, WA & NT	<ul style="list-style-type: none"> • Victoria: all privately owned • South Australia: all leased • Queensland: private retailers

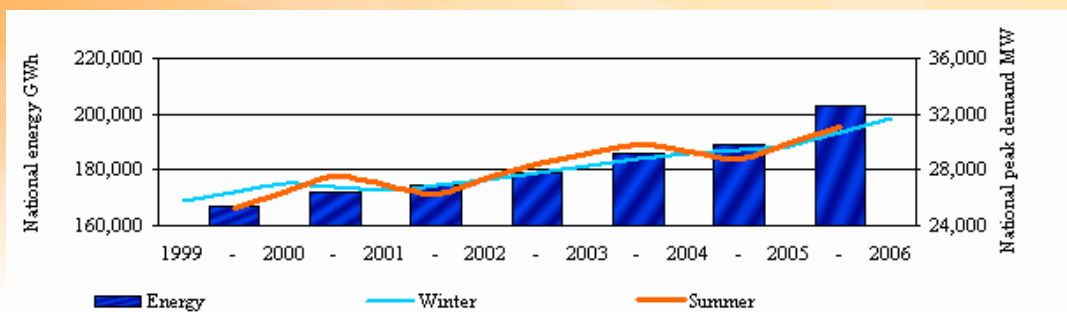
- There are privately owned retailers in most states:
 - Qld recently sold Energex retail & part Ergon retail
- There are concerns about existing or potential concentration of ownership in most states:
 - Snowy sale was cancelled
- Tallawarra NSW 400MW CCGT will be privately owned
- End-use is largely privately owned.



Price history for NEM & its precursors (BCA, 2000)



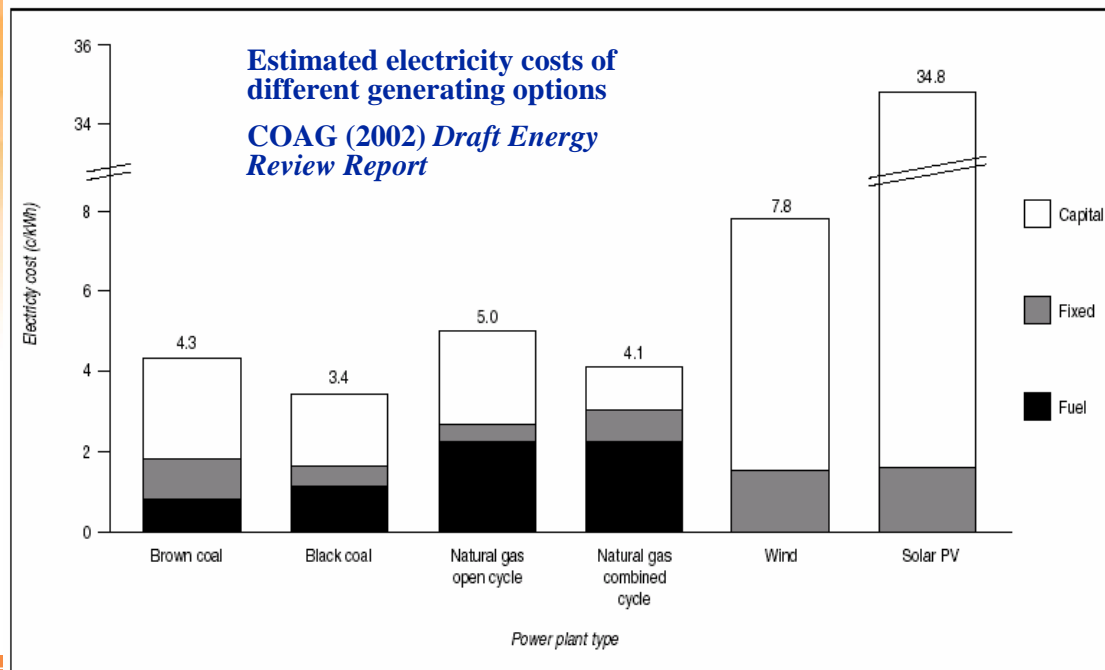
NEM peak demand & energy (12/98 to 12/06) (AER long term analysis)



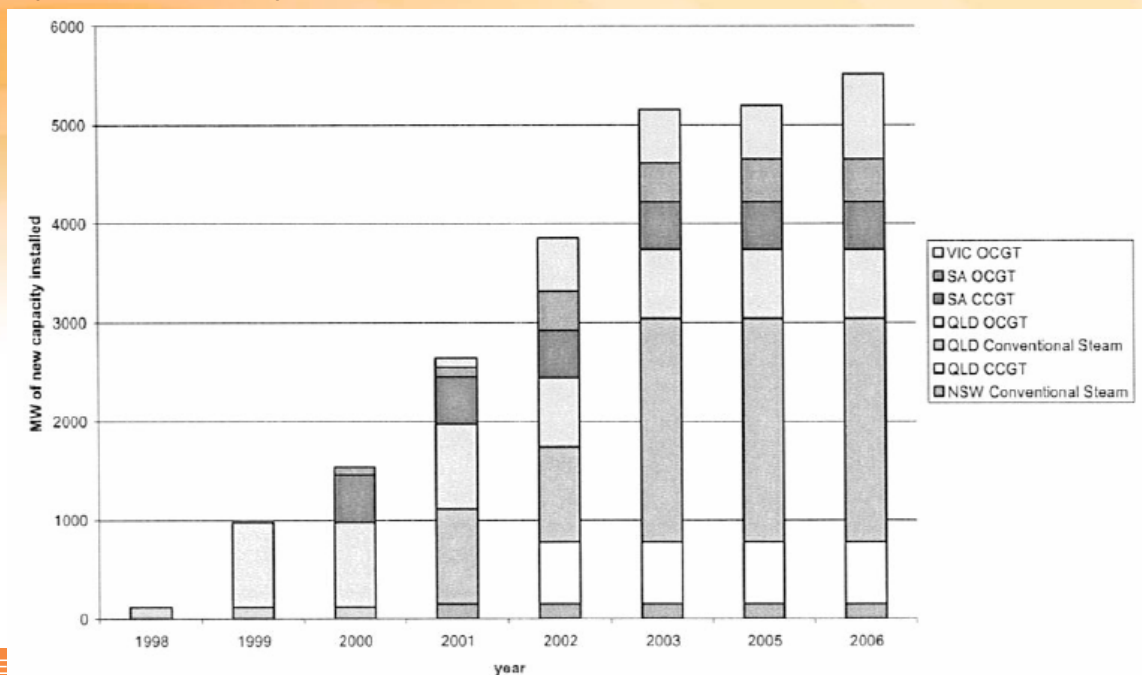
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Generating plant costs in Australia

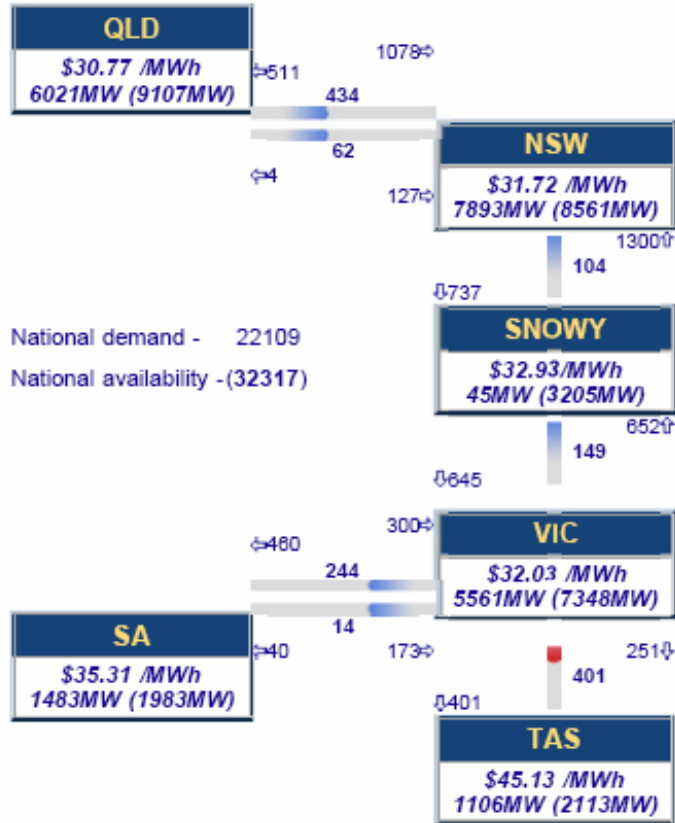


Generation commissioned in NEM 98-06 (ESIPC, 2006)





Last updated at Sat, 31 March 2007 (8:30 pm)



NEM spot market snapshot

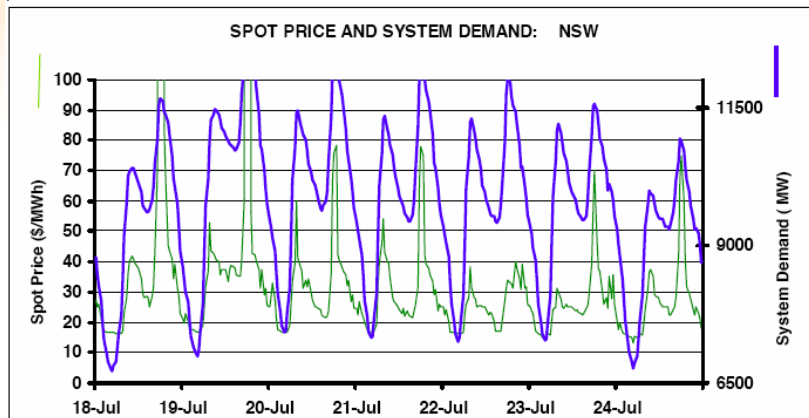
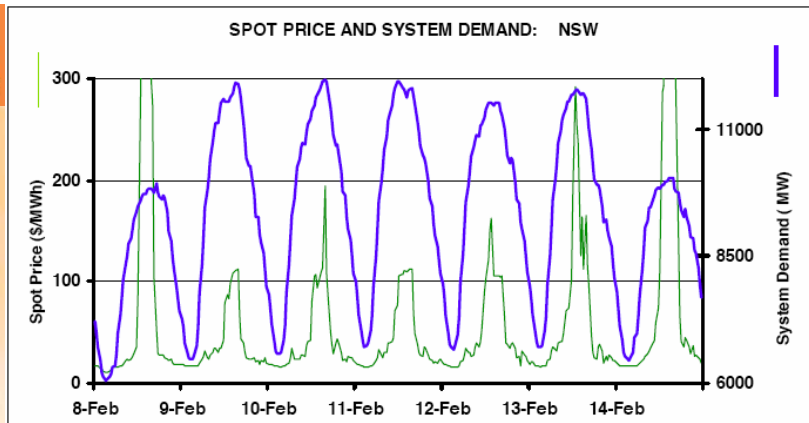
(AER, 31/3/07)

Electricity industry restructuring in Australia



NEM NSW region demand & price, summer & winter peaks 2004

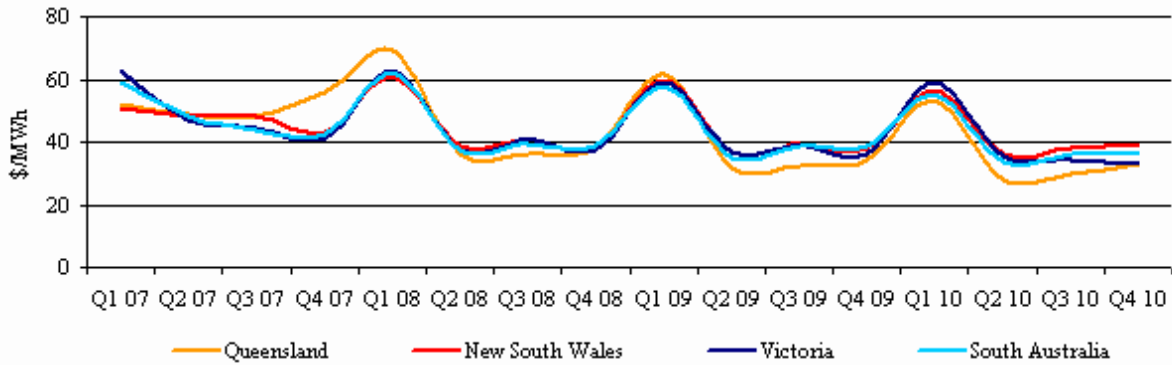
(NEMMCO, 2004)



Electricity industry restructuring in Australia



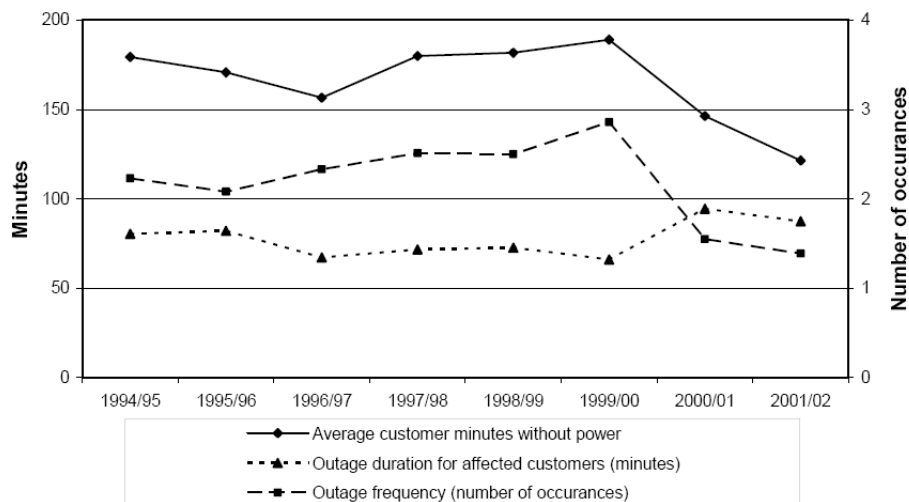
Quarterly base load contracts, Q1, 2007 (AER long term analysis)



Electricity supply reliability outcomes (PC, 2005)

- Some general improvement

Figure 4.2 Electricity supply reliability, Australian average

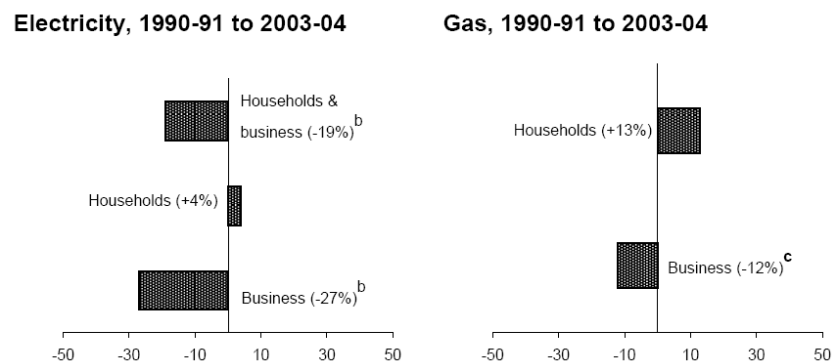


Some outcomes of restructuring to date

- Improved economic efficiency
 - But still questions regarding future outcomes given capital intensive nature of industry, starting point for restructuring
 - *Most modeling exercises estimating industry + wider economic benefits of only limited value*
 - Largely supply-side focussed efficiency improvements
- Security + reliability reasonably well managed
 - But ongoing challenges for commercial arrangements + attempting to manage low-risk/high-consequence events
 - and diversity between + within jurisdictions
- Equity + environmental outcomes?

Equity outcomes

Figure 4.1 Real price changes in infrastructure services^a



- At least part of this divergence intentional – reduction of cross subsidies
- For vulnerable consumers, “Limited amount of evidence suggesting that:
 - price rises for households in regional areas may have been somewhat higher than for their counterparts in metropolitan areas; and
 - increases in household prices .. have generally been greater for households with low demand and often lower incomes” (PC, 2005)
- *Different jurisdictions have had markedly different outcomes*
 - Different policy + regulatory positions; CSO arrangements, other support mechanisms



Climate change outcomes

- Stationary energy sector responsible for half of Australian greenhouse emission
- CoAG national energy policy objectives include need for action on climate change but EI restructuring has no specific env. objectives
- However, original expectation by some that would help “14 MtCO₂ reduction from BAU in 2010”:
(Commonwealth Govt, *Climate Change: 2nd Communication to IPCC*, 1997)
 - Efficient competition in supply by gas + renewables
 - More sensible patterns of energy use
- Instead, likely outcome is increased emissions wrt BAU (CoAG, 2002)
 - Low cost of coal fired generation, immature gas market
 - Reduced emphasis on EE from lower prices
 - Current failure to price greenhouse emissions
 - Market design and regulation that favours incumbents Supply-side orientation of reforms to date



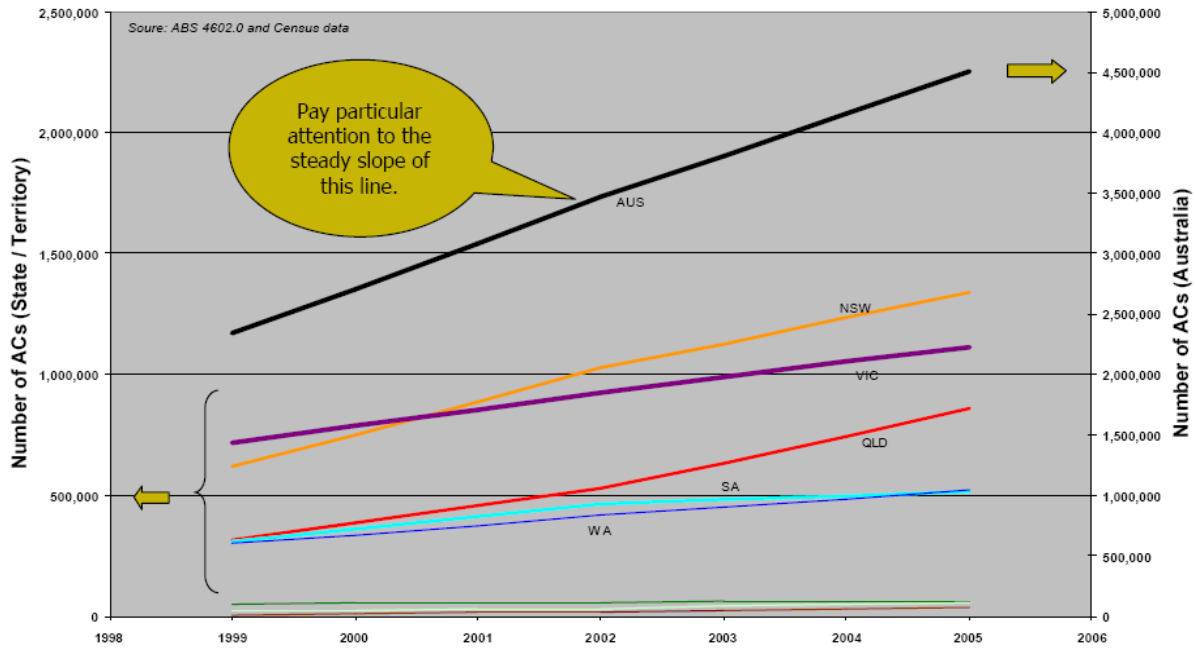
Growing pressures on restructuring

- Continuing growth in peak demand
 - Energy an essential good but also growing discretionary + ‘conspicuous consumption’ energy services; eg. Air Conditioning, industry development
 - Estimated to require \$24b investment in Tx + Dx infrastructure over next 5 years; this is regulated expenditure
 - This growth will also require major investment in new peaking plant
 - Current market arrangements smear these costs, potentially perverse outcomes
- Growing climate change concerns
 - Protecting the climate seems likely to require major (60-80% by 2050), rapid (peaking within decades) global emissions reductions
 - Australian per-capita emissions 2 X > developed world average, 5-10 X > developing world
 - Emission reductions will impose direct costs on EI
- Facilitating integration of intermittent renewables

=> Underlying cost structure of industry likely to grow



Air conditioning trends (Washusen, 2005)

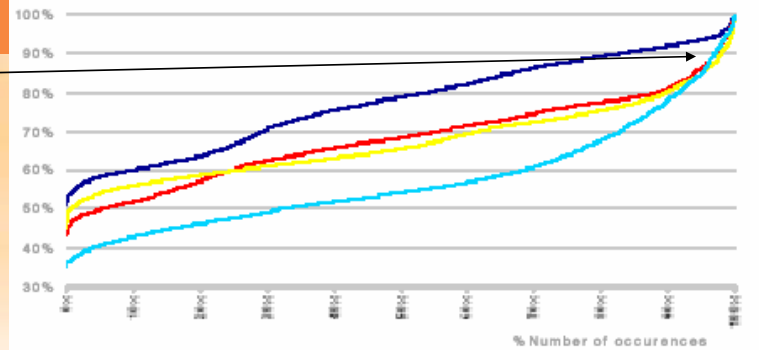


In 2001 NSW load >90% peak for ~5% of time

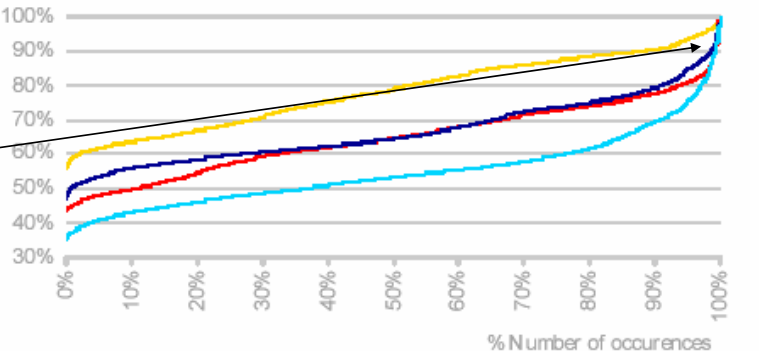
NEM load duration curves, January-March 2001 & 2003 (NECA quarterly Market Statistics)

In 2003 NSW load >90% peak for <2% of time

Percentage of maximum demand



Legend: Queensland (blue), New South Wales (red), Victoria (yellow), South Australia (cyan)

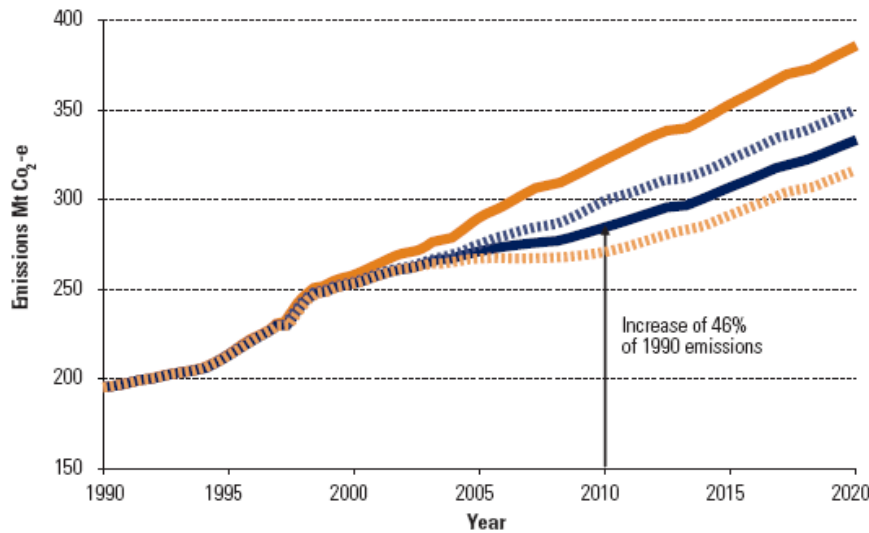


Legend: Queensland (blue), New South Wales (red), Victoria (yellow), South Australia (cyan)



Stationary energy GHG emission projections see continuing growth (Australian 4th Comm. to UNFCCC, 2006)

Figure 5.1 Emissions from the Stationary Energy sector (Mt CO₂-e), 1990 to 2020

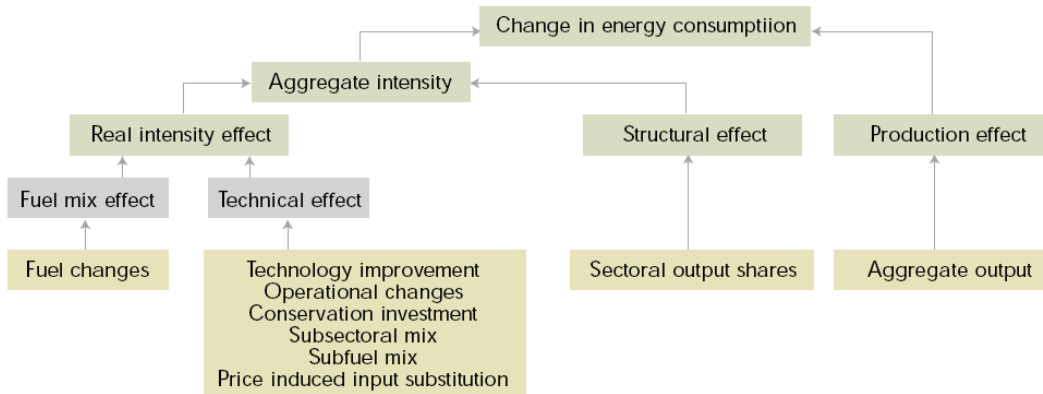


█ Business as usual █ 'With measures' best estimate
▬▬ 'With measures' high estimate ▬▬ 'With measures' low estimate



Measuring energy intensity in Australia

A Factored components of changes in energy use



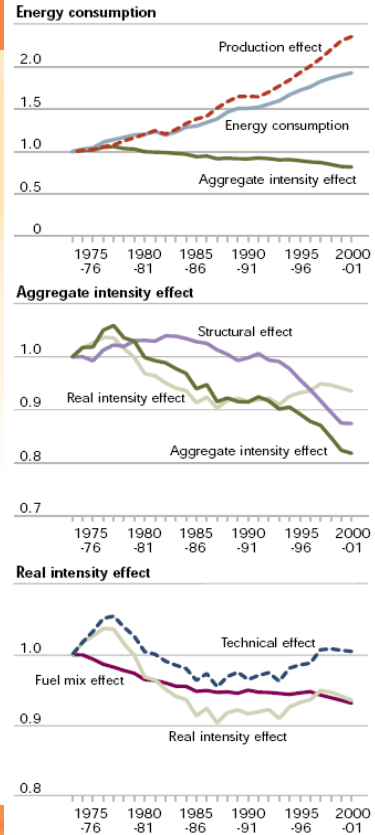


Energy outcomes

- Moderate structural impacts
- Mainly adverse fuel mix impacts over last 20 years
- Technical effect (incl. efficiency) has been worsening over last 20 years

Electricity industry restructuring in Australia

D Factored indexes of Australian total energy consumption



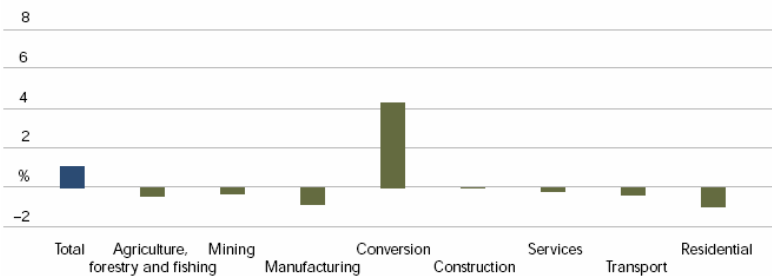
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CO2 impacts

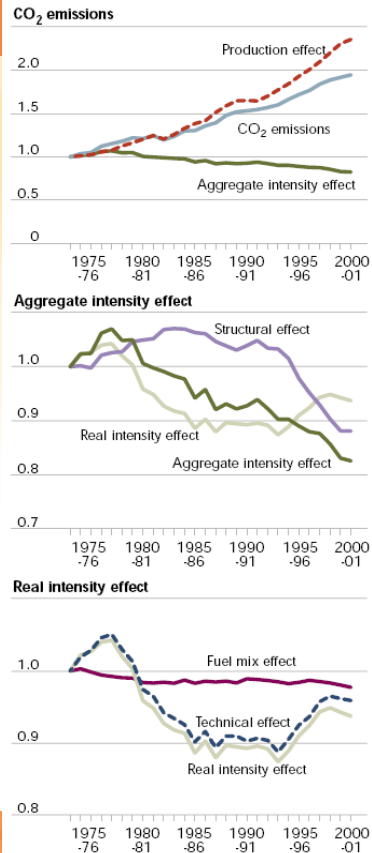
- Emissions intensity of electricity sector has worsened

Y Changes in Australian CO₂ emissions real intensity, by sectoral component-total energy consumption, 1994-95 to 2000-01



Electricity industry restructuring in Australia

U Factored indexes of Australian CO₂ emissions- total energy consumption





Current status of Australian wind generation

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

Transmission lines and generators

- 500 kV
- 330 kV
- 275 kV
- 220 kV
- 132 / 110 kV
- 66 kV
- 33 / 22 kV

- DC LINE
- Power Station
- Substation

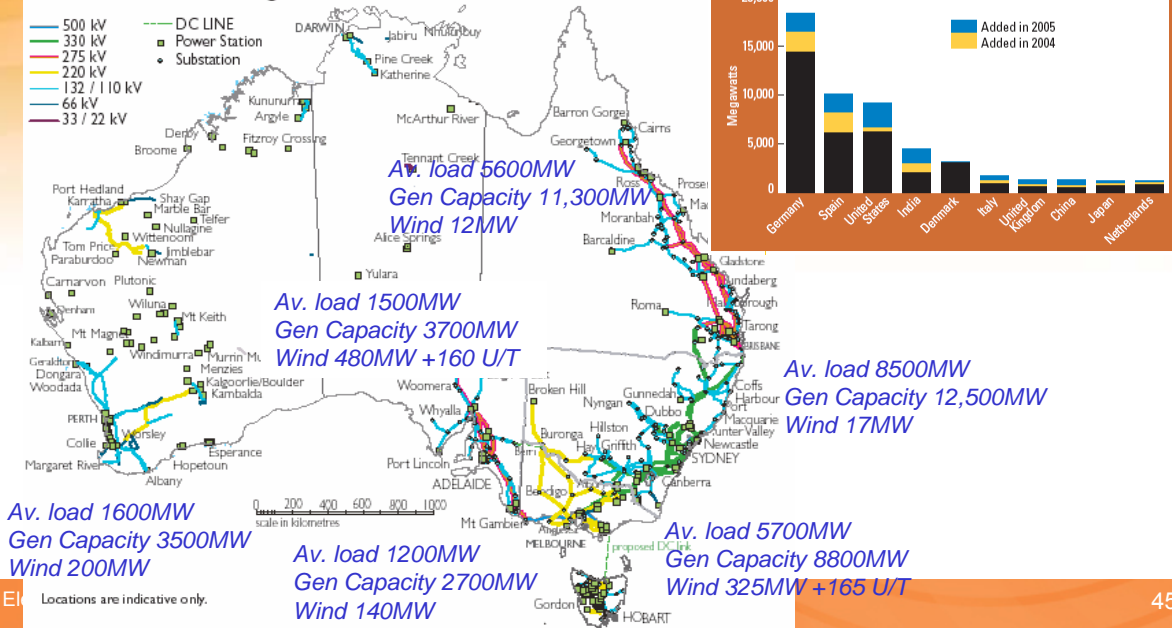
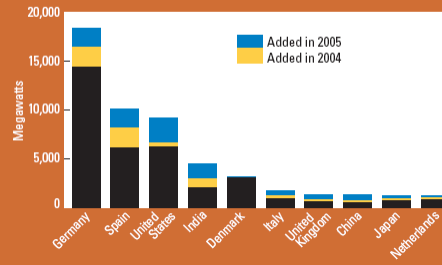


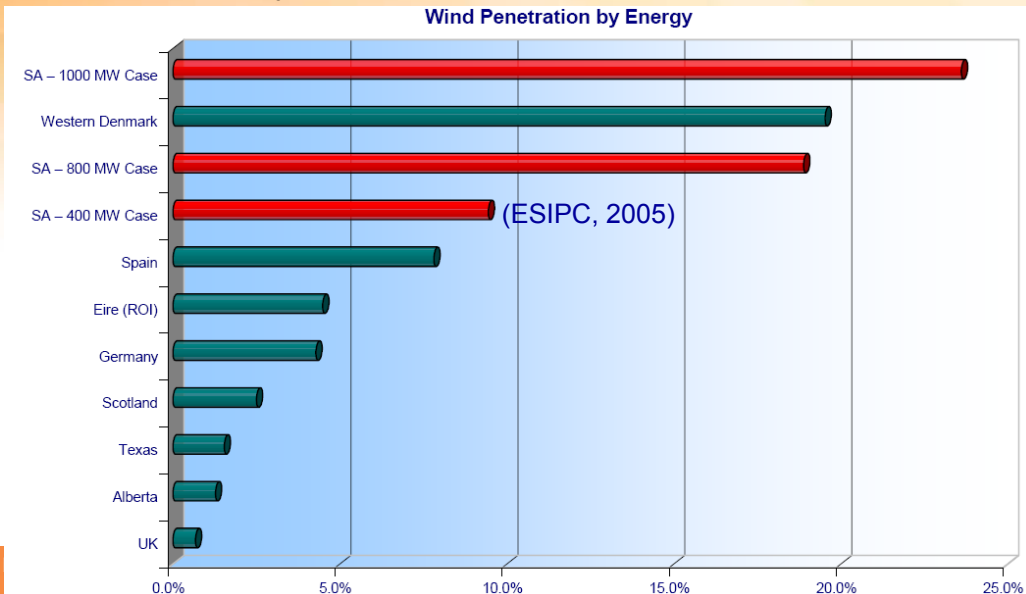
Figure 2. Wind Power Capacity, Top 10 Countries, 2005



Wind penetrations

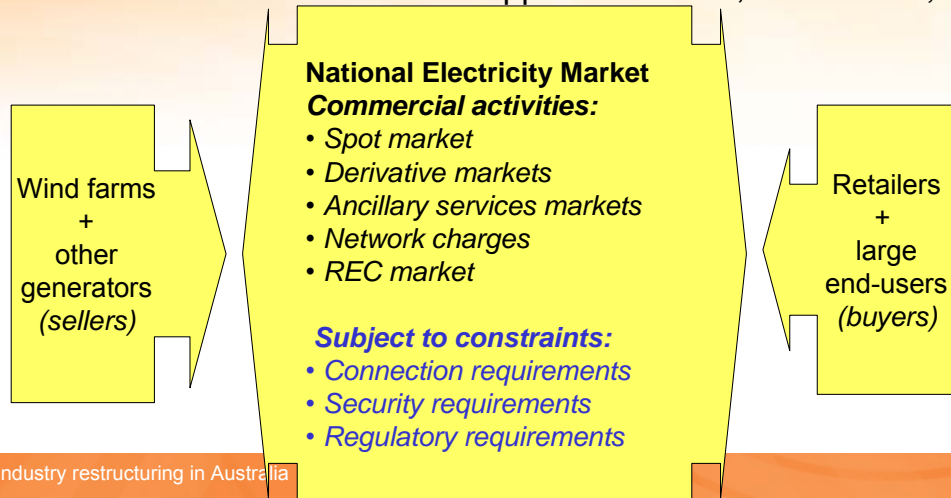
- Current Australian wind generation ~ 1% penetration
- Victorian 10% target might see ~5% Victorian penetration
- India currently around 3% penetration (Wikipedia.org)

Wind Penetration by Energy



Commercial context for wind integration in NEM

- Wind classified in NEL as Intermittent generation
 - “A generating unit whose output is not readily predictable, including, without limitation, solar generators, wave turbine generators, wind turbine generators and hydro generators without any material storage capability”
- Currently classified as non-scheduled, can be market or non-market
- Additional ‘environmental’ market support via MRET, *soon VRET, NRET?*



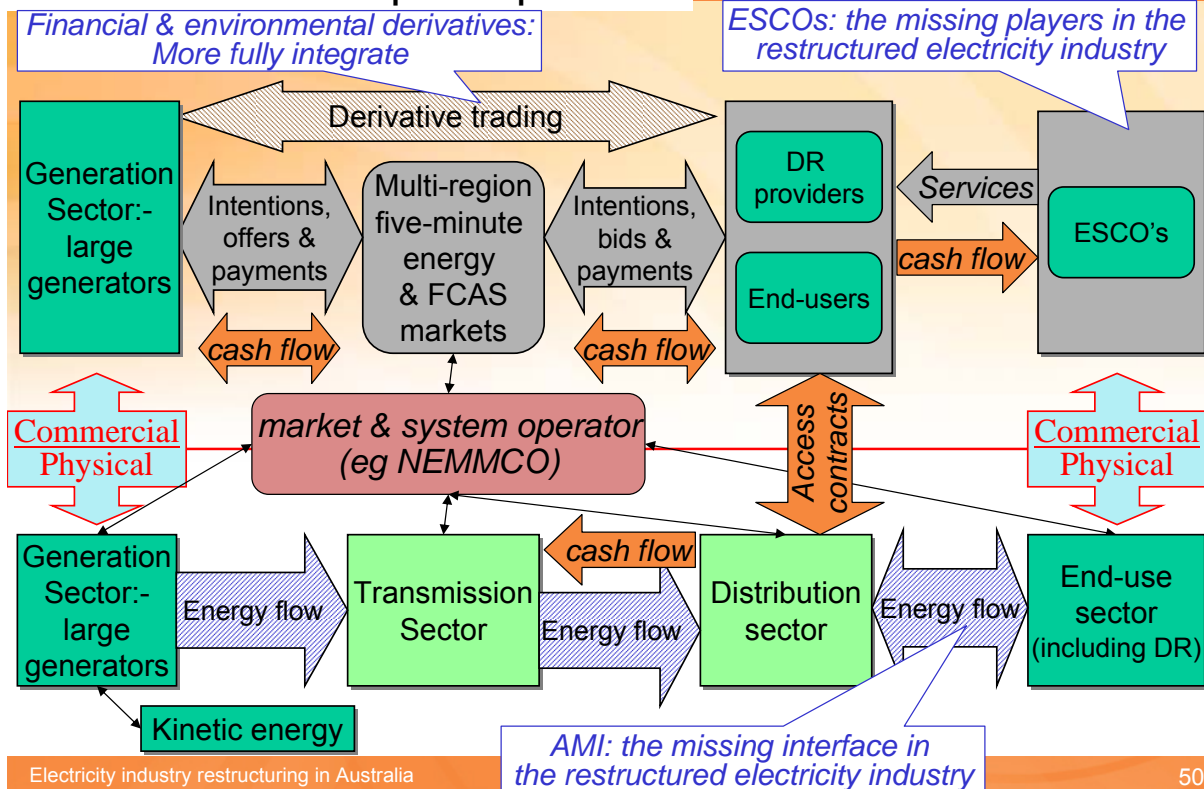
Current MCE reform agenda

- *Governance and Institutions.*
- *Economic Regulation*
 - Establish national Dx and retail framework
- *Retail Pricing*
 - Phase out energy retail price regulation where effective competition can be demonstrated
- *End-user Participation*
 - Implement new consumer advocacy arrangements.
 - Consider demand side response options
- *Energy Efficiency*
 - Implementation of the NFEE (Stage 1)
 - Response to PC Inquiry, Consideration of the NFEE (Stage 2)
- *Renewable and Distributed Generation*
 - Issues paper on options available in NEM to max. benefits of DG
 - Development of code of practice for embedded DG
 - Development of policies to facilitate increased penetration of wind

Conclusions

- Electricity industry restructuring in Australia:
 - World-leading model but implementation incomplete
- Exhibits strong path-dependence:
 - Objectives, physics, structure & ownership, supply-side bias, “business as usual” projections
- Lacks clear consensus on future directions:
 - *We are not sure where we are going but we know we are not there...*
- Key unresolved issues:
 - Sustainability; coherent decision-making framework; network role; end-user participation

Enhanced NEM structure with active end-user participation





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Thank you... and questions

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