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Electricity Markets & Power System Operation in Australia

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Outline

- The process of electricity industry restructuring
- Implementation of restructuring in Australia
- Lessons from the Australian experience
- Conclusions

Electricity industry restructuring:

- Is like deciding to change from driving on the right hand side of the road to driving on the left hand side of the road. Without stopping the traffic.
- It is better not to do it at all unless:
  - You are sure you want to do it
  - You know what you want to do and how to get it done
  - You don't stop halfway
- Australia took its time to plan what to do & decide it wanted to do it. It then did the job sufficiently well.
- However, the outcome remains at risk

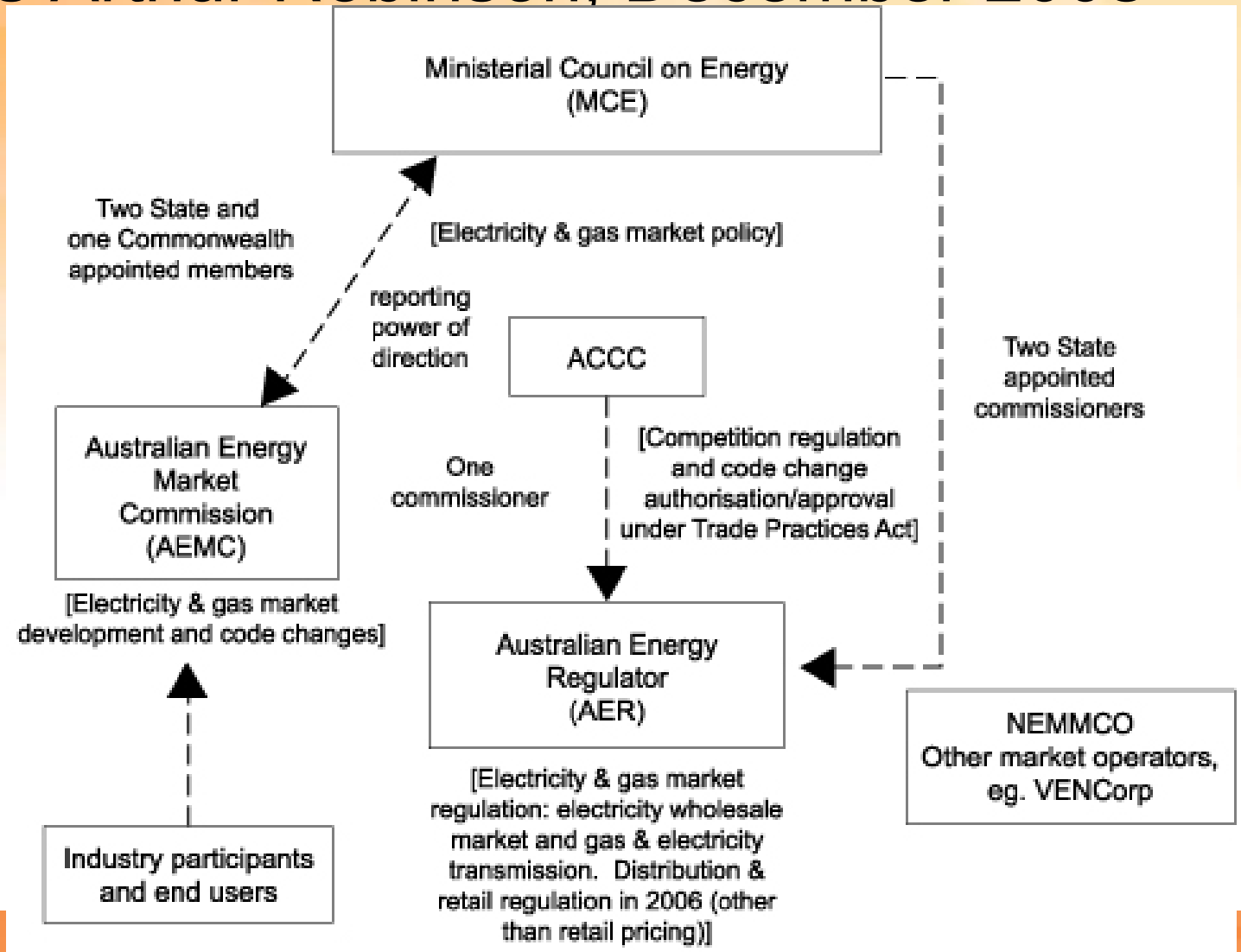
The electricity industry restructuring process:
diversifying decisions, broadening options, spreading risks

Issue	Transition	Key challenges
Structural disaggregation	*From* monopoly *To* competing firms *Plus* system operator(s)	Cultural change; Adequate competition; *Accountability*
Commercial Decision-making framework	*From* cost recovery *To* market prices	Market power; Market design fidelity; *Accountability*
Regulatory Decision-making (economic)	*From* rate of return *To* Incentive Regulation	Multiple objectives; Measuring outcomes; *Accountability*
Regulatory Decision-making (environmental)	*From* direct cost *To* full costs	Variable RE energy flows End-user participation; *Accountability*

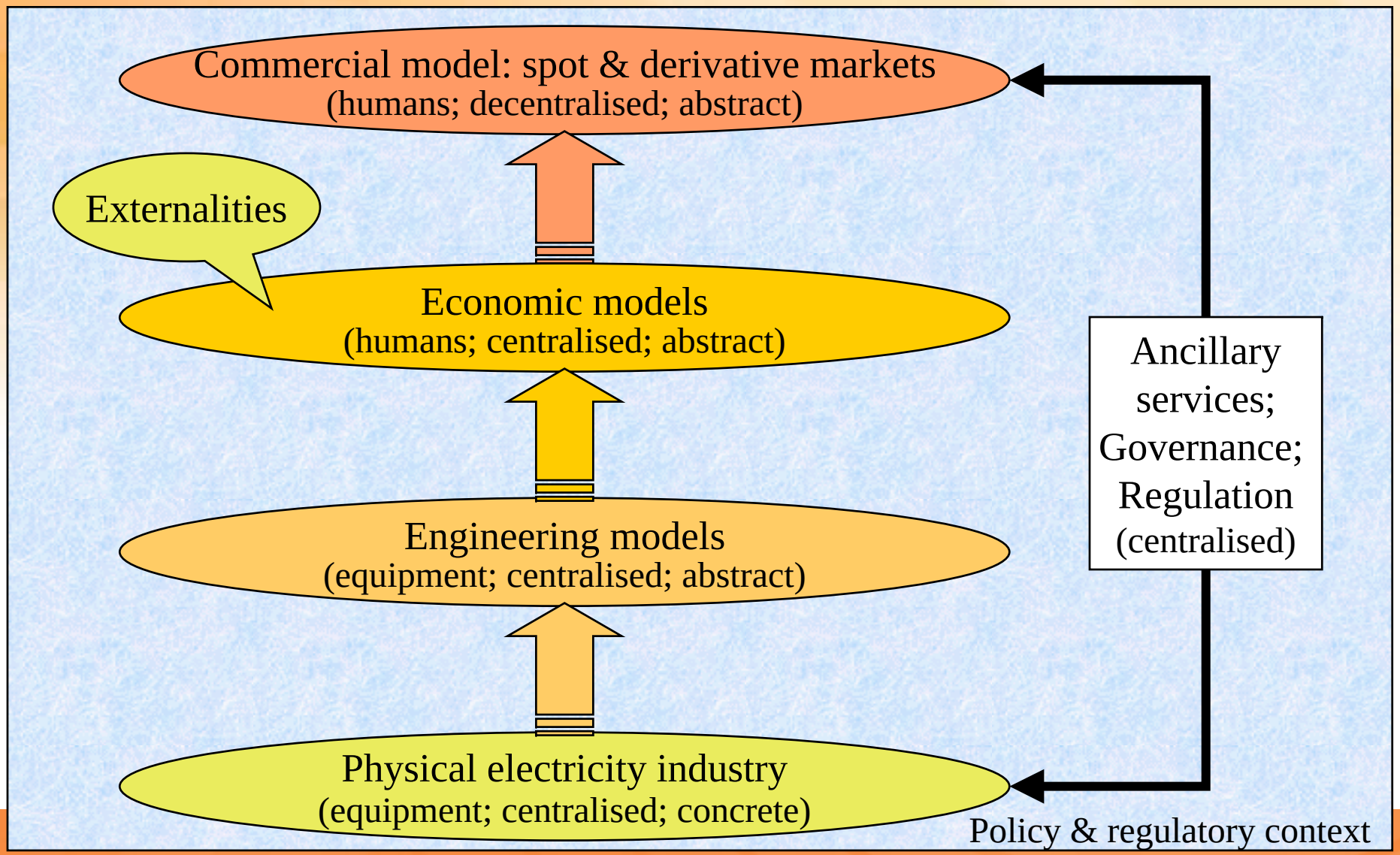
Challenges in electricity industry restructuring

- Understanding & managing industry risks:
  - From short-term operation to long-term investment
- Consistency in the decision-making framework:
  - From the short-term to the long-term future
  - From primary energy providers to end-users
  - Across the full scope of the electrical network
- Decision-making compatibility:
  - *Centralised:* governance & regulation; system operation
  - *Decentralised:* participants as individuals and in groups
- Decision-maker autonomy & accountability:
  - Participants, system operators, regulators, governments

Governance & institutions:- as seen by Allens Arthur Robinson, December 2003



Trading in electricity:- an abstraction from reality



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An electricity trading framework

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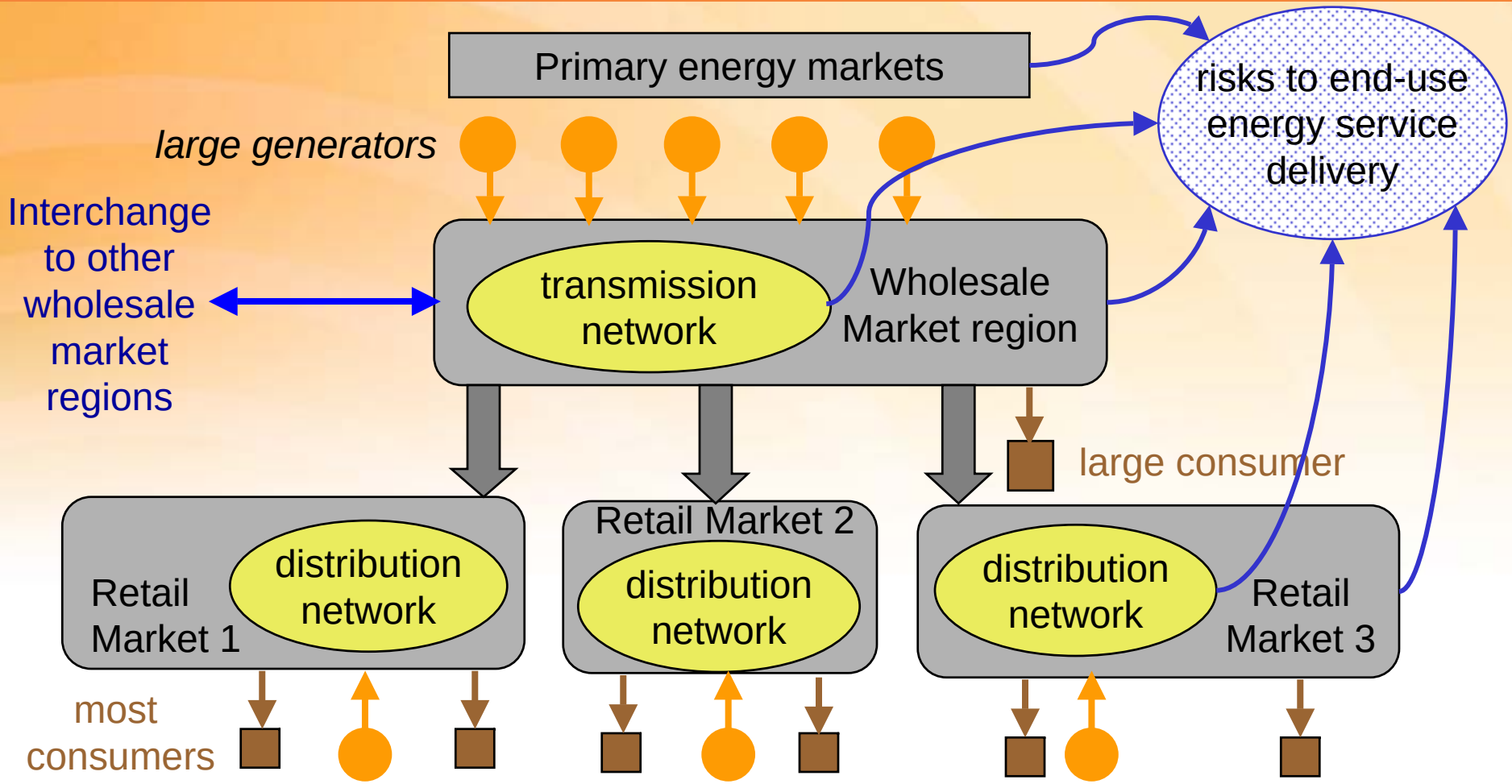

- *Small consumers, embedded generators & storage should be supported by energy service advisers*

- *Wholesale & retail market designs should be compatible*
  - *Both should include network models*

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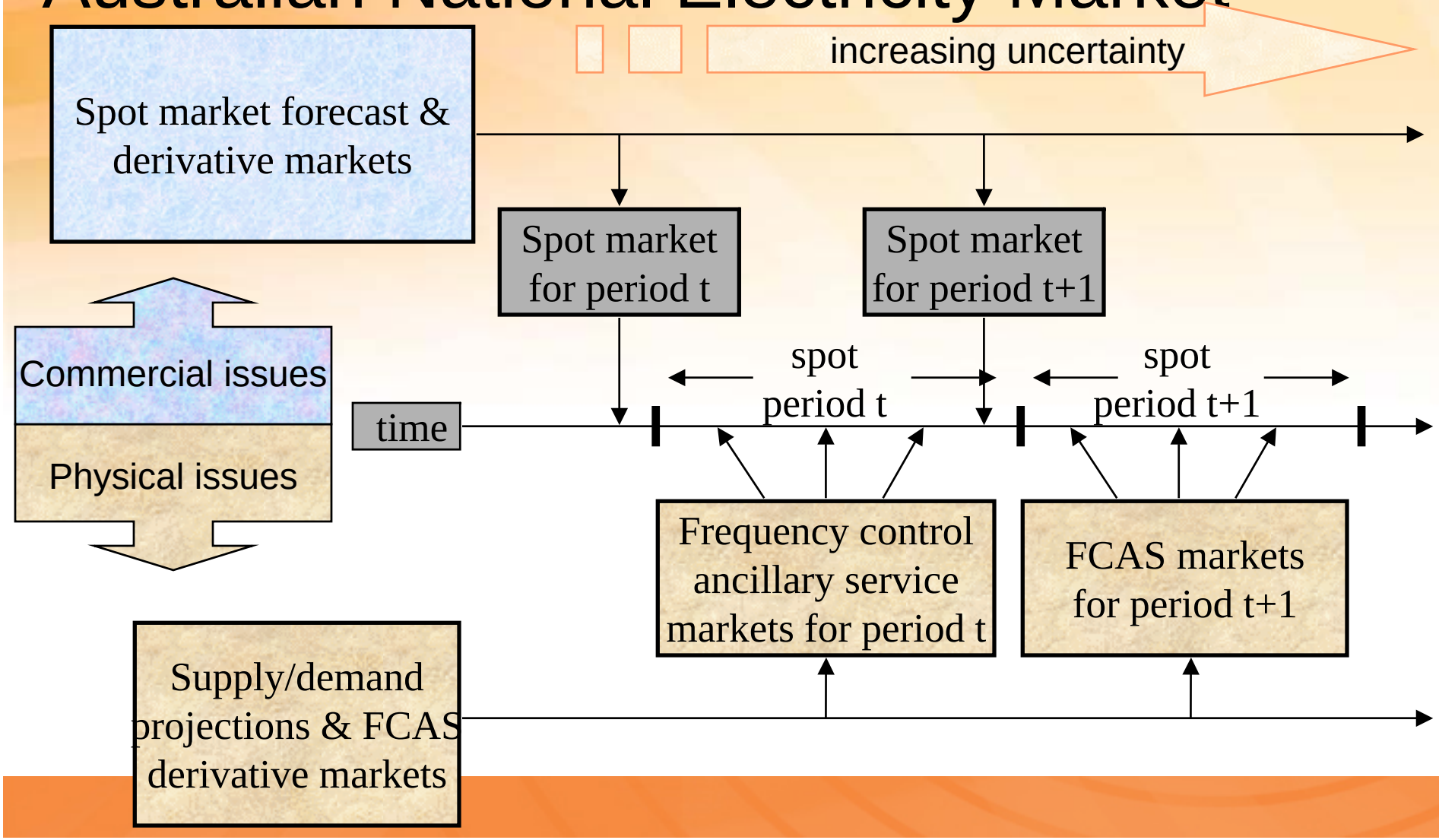
Managing supply-demand balance in the Australian National Electricity Market



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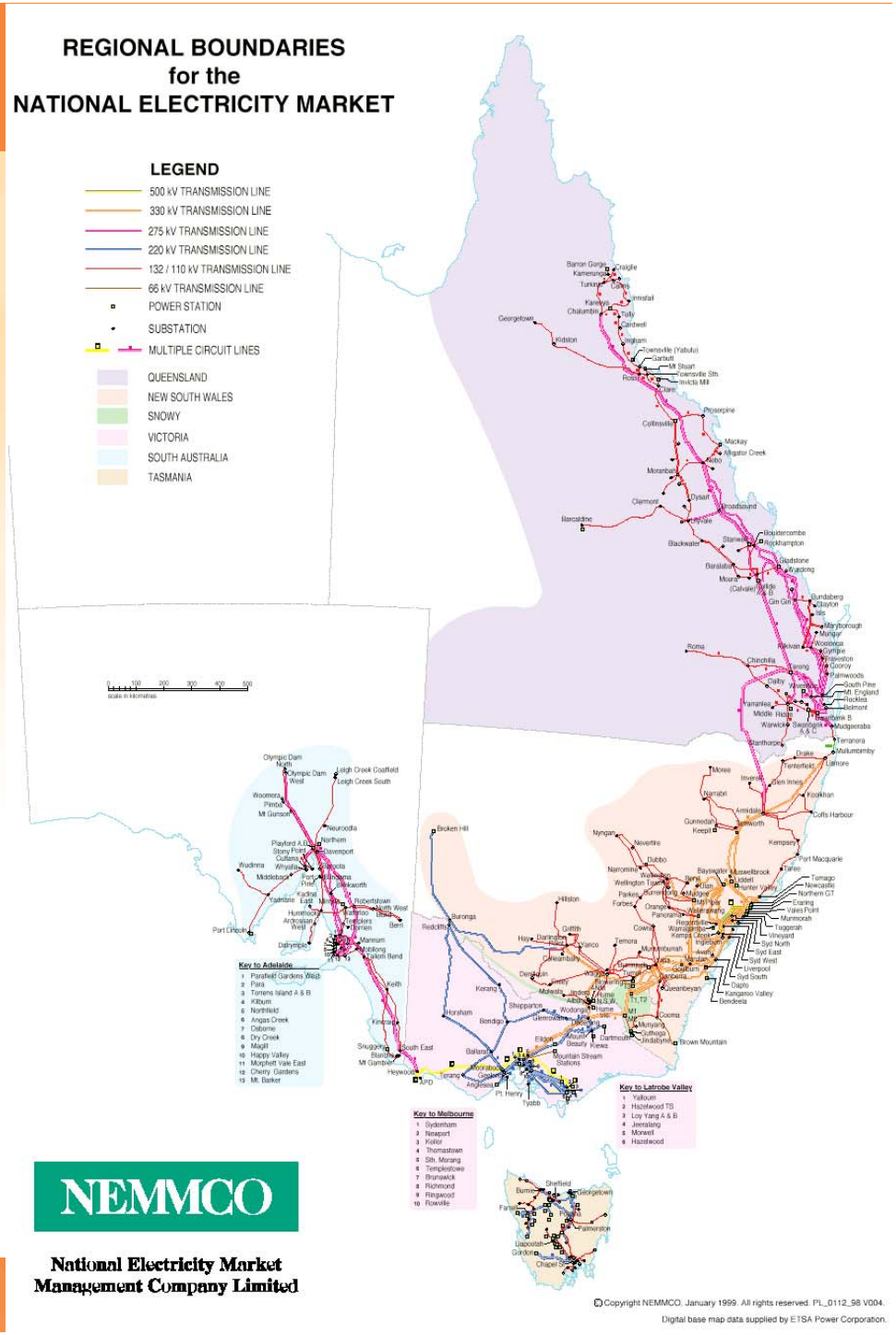
Scope of the NEM

- Queensland
- New South Wales & ACT
- Victoria
- South Australia
- Tasmania (DC link to the mainland in 2006)

NEM regions are indicated, and their boundaries need not be on state borders (e.g. two regions in NSW)



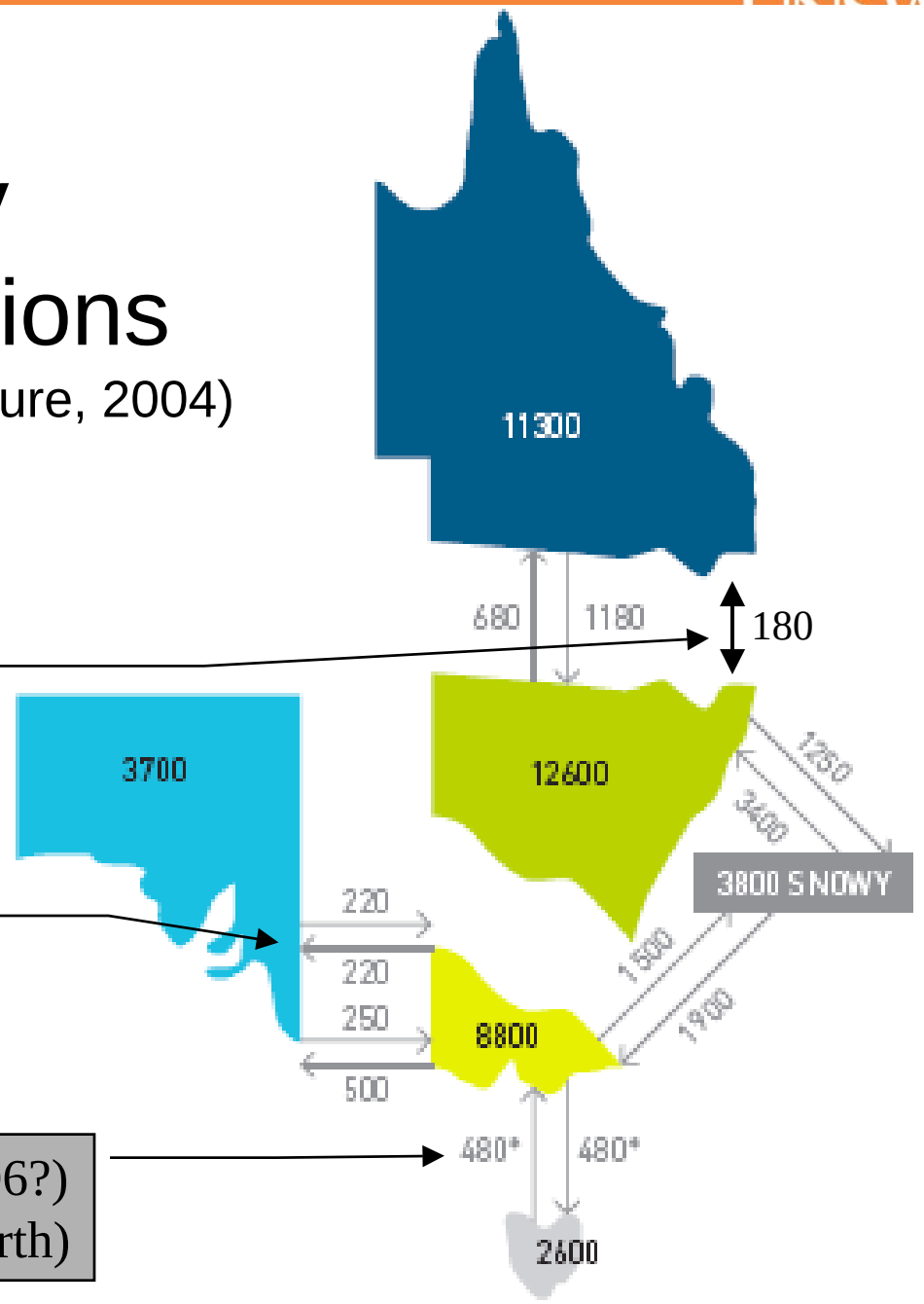
National Electricity Market market regions

(Securing Australia's Energy Future, 2004)

Directlink DC link, currently MNSP

Murraylink DC link, now regulated, formerly MNSP

Basslink DC link MNSP (2006?) 600MW short term rating (north)



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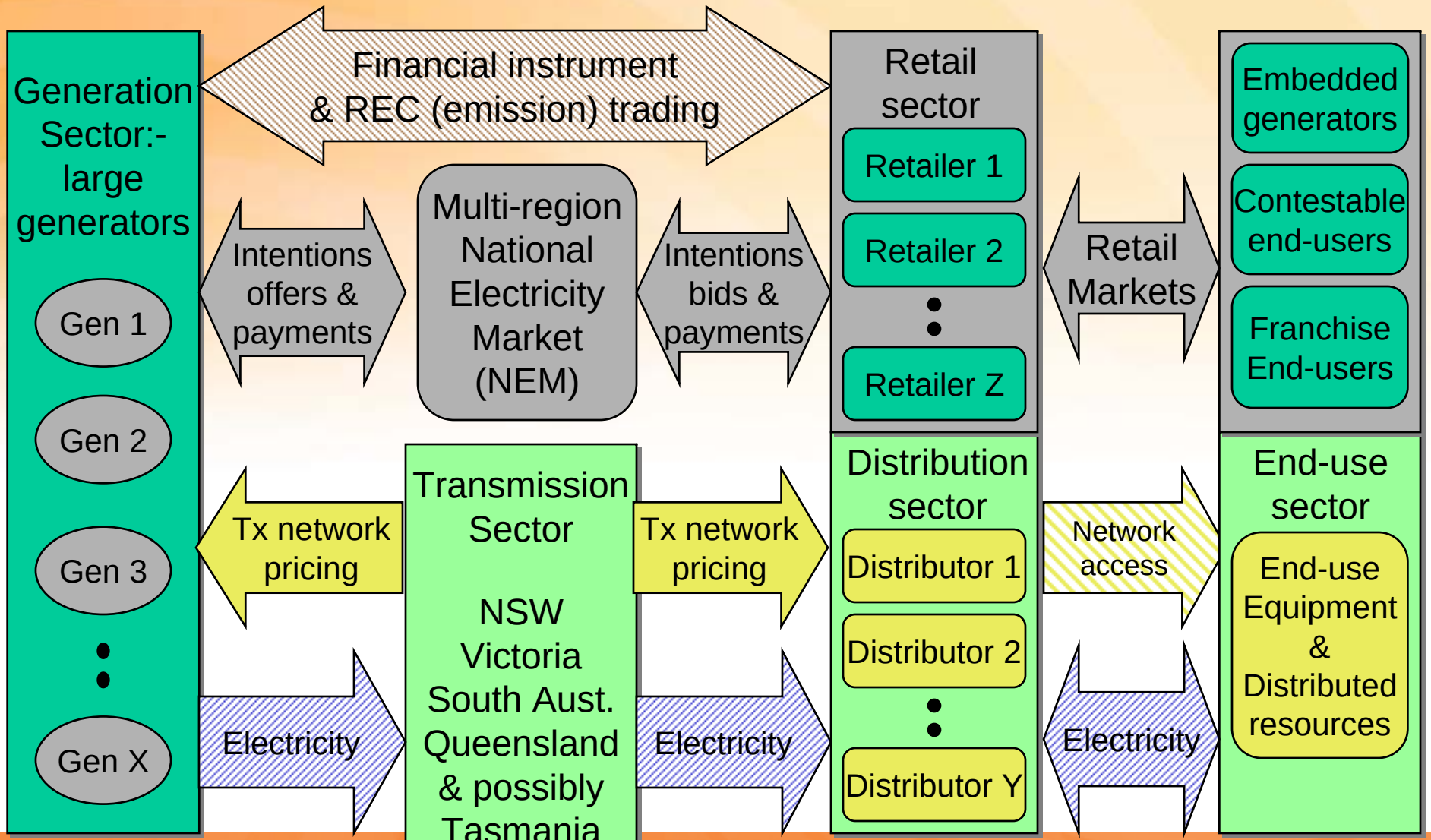
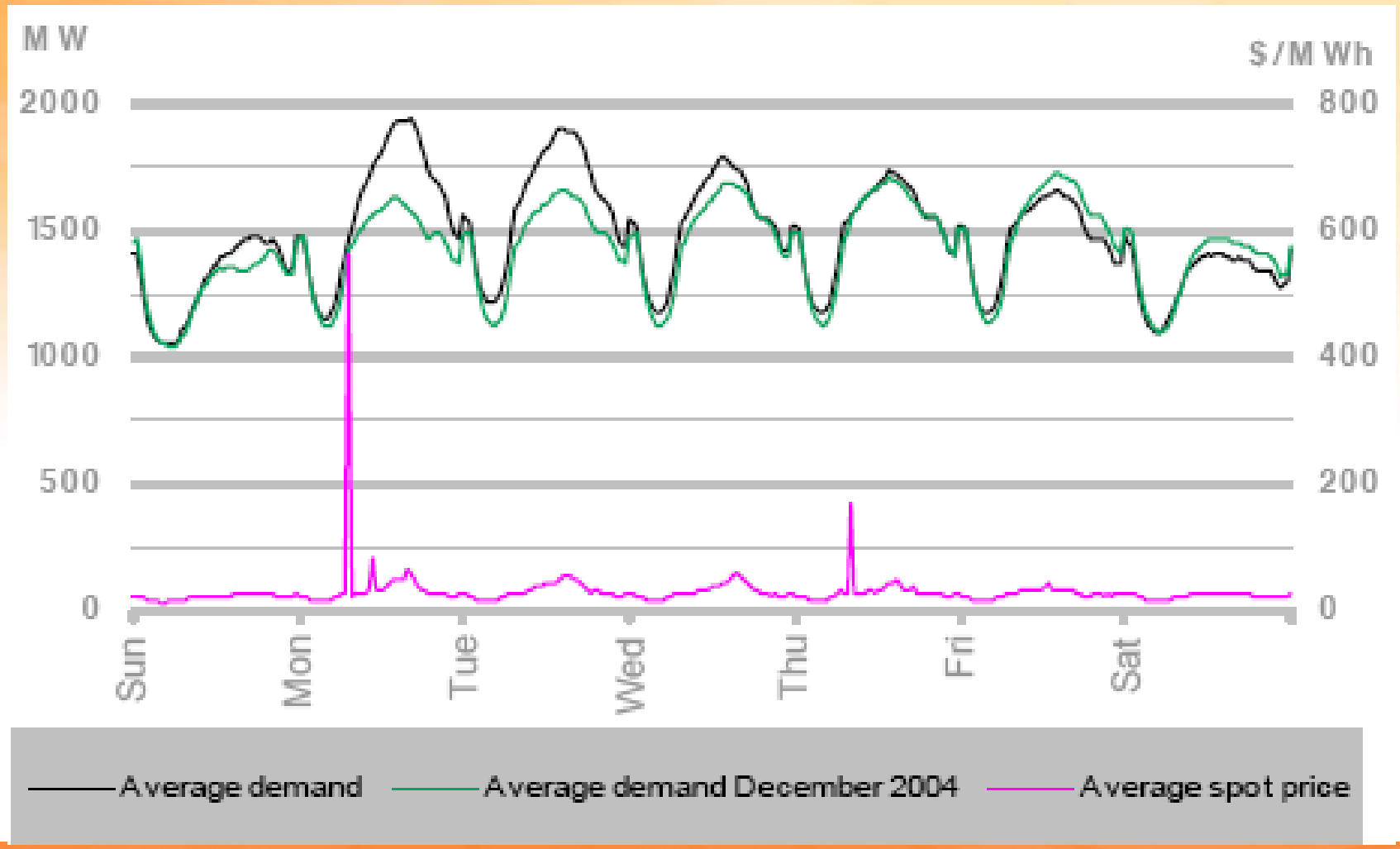
Electricity industry structure in SE Australia



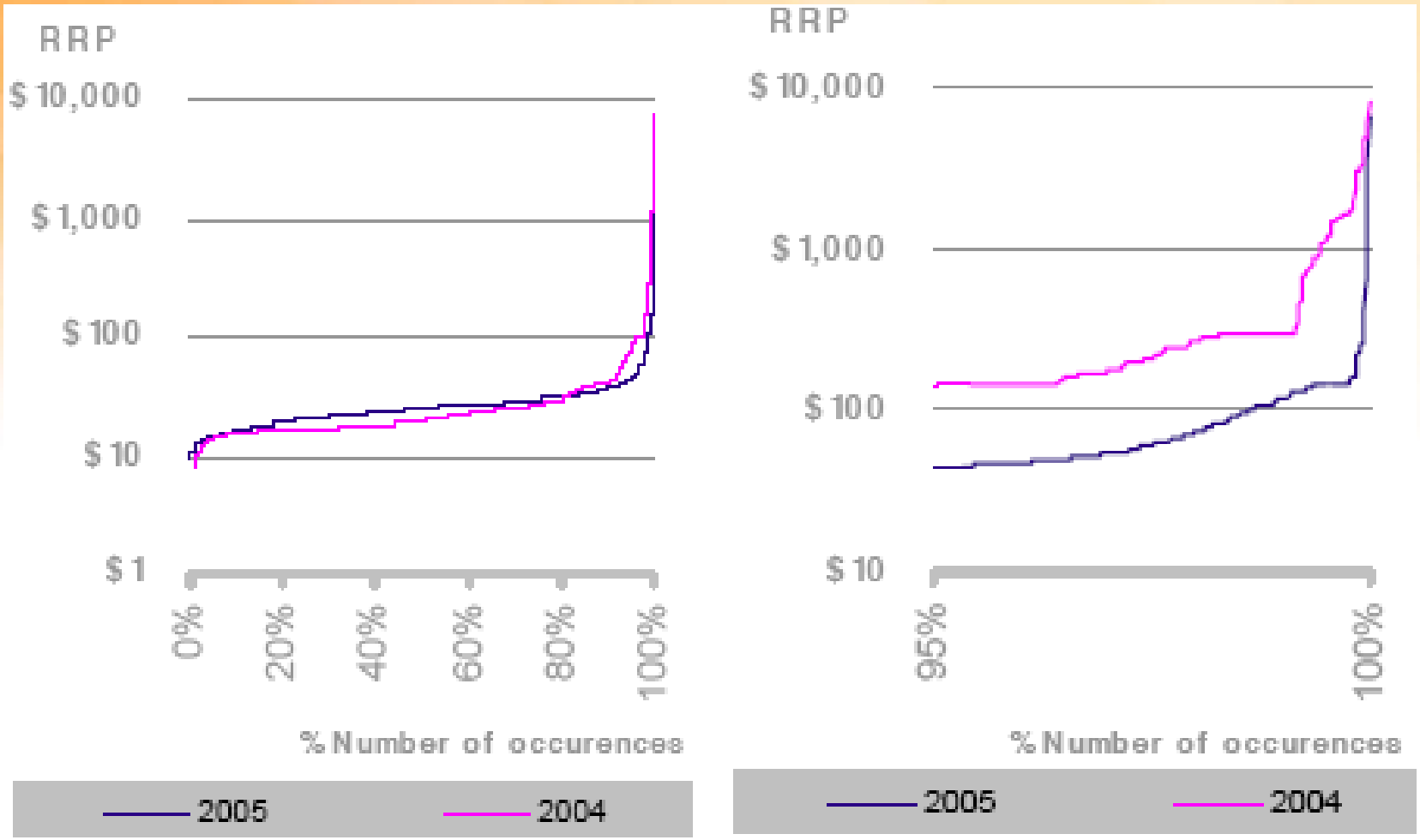
Average weekly price & demand, SA, Q1 2005

(NECA, 05Q1 Stats, 2005)

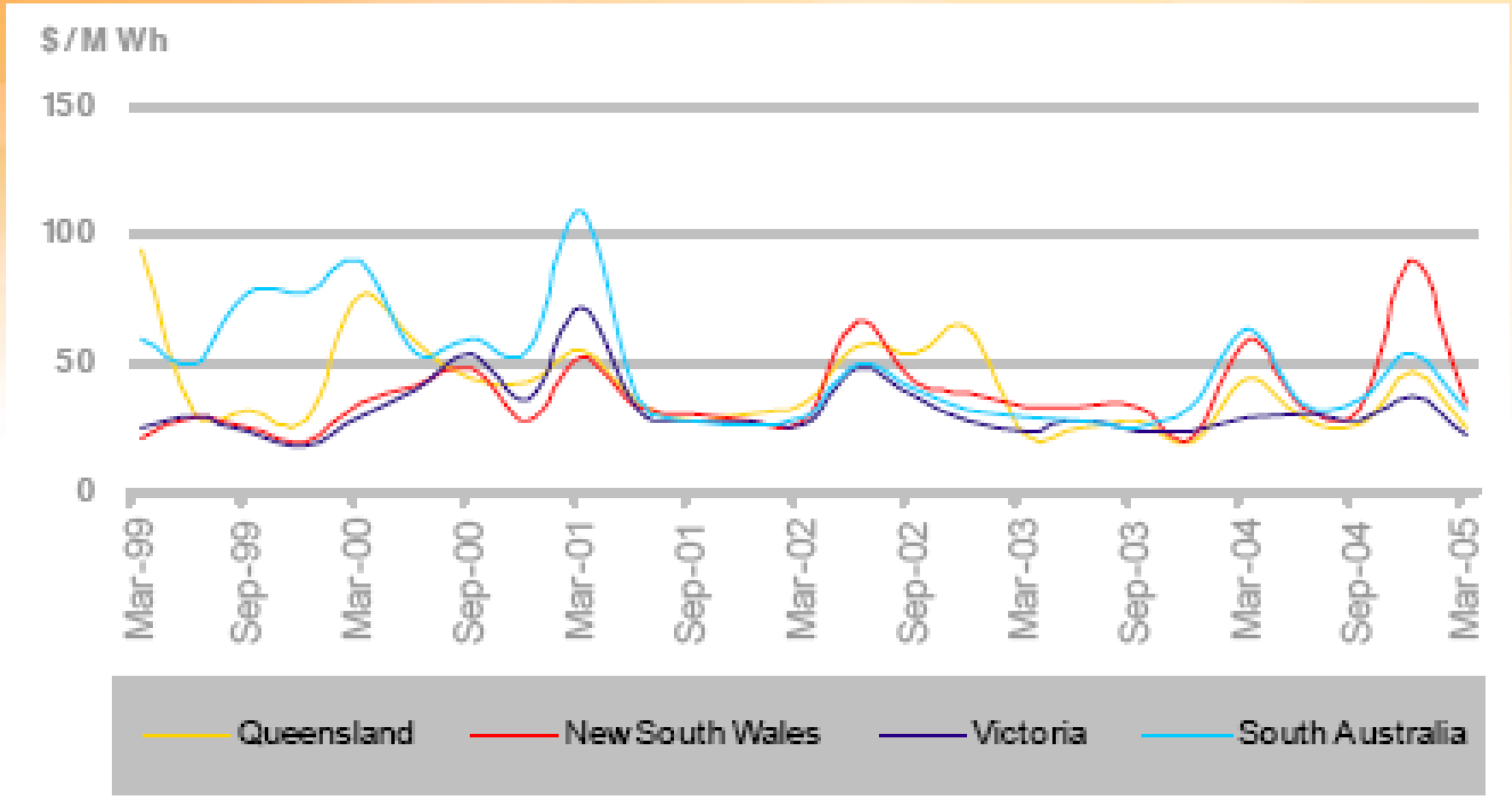


Spot price duration curve, SA, Jan-Mar 05

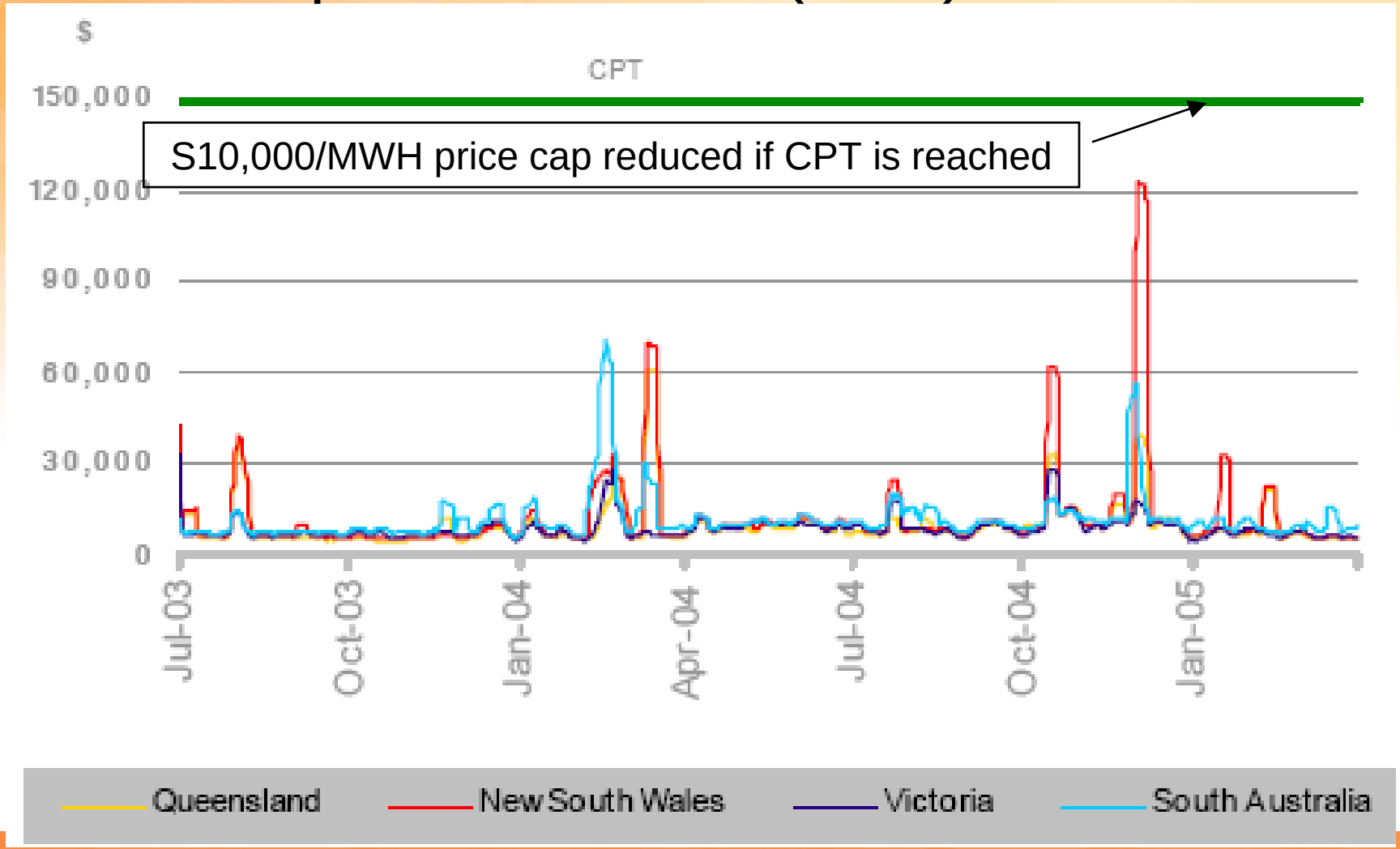
(NECA, 04Q4 Stats, 2005; half-hour spot prices)



Weekly avg. NEM spot prices since market inception (NECA, 05Q1 Stats, 2005)

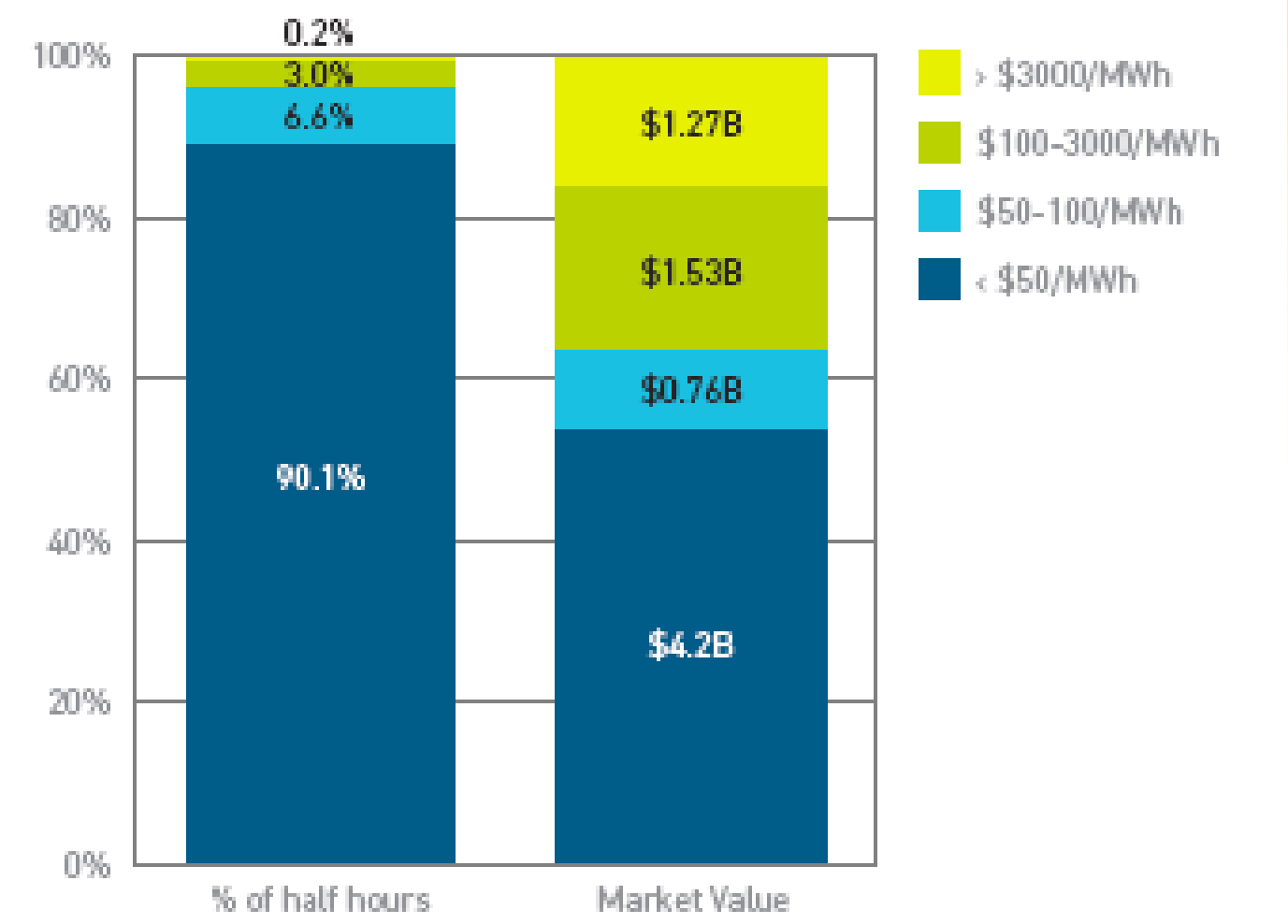


Running weekly accumulation of (336) RRPs & cumulative price threshold (CPT) (NECA, 05Q1Stats, 2005)



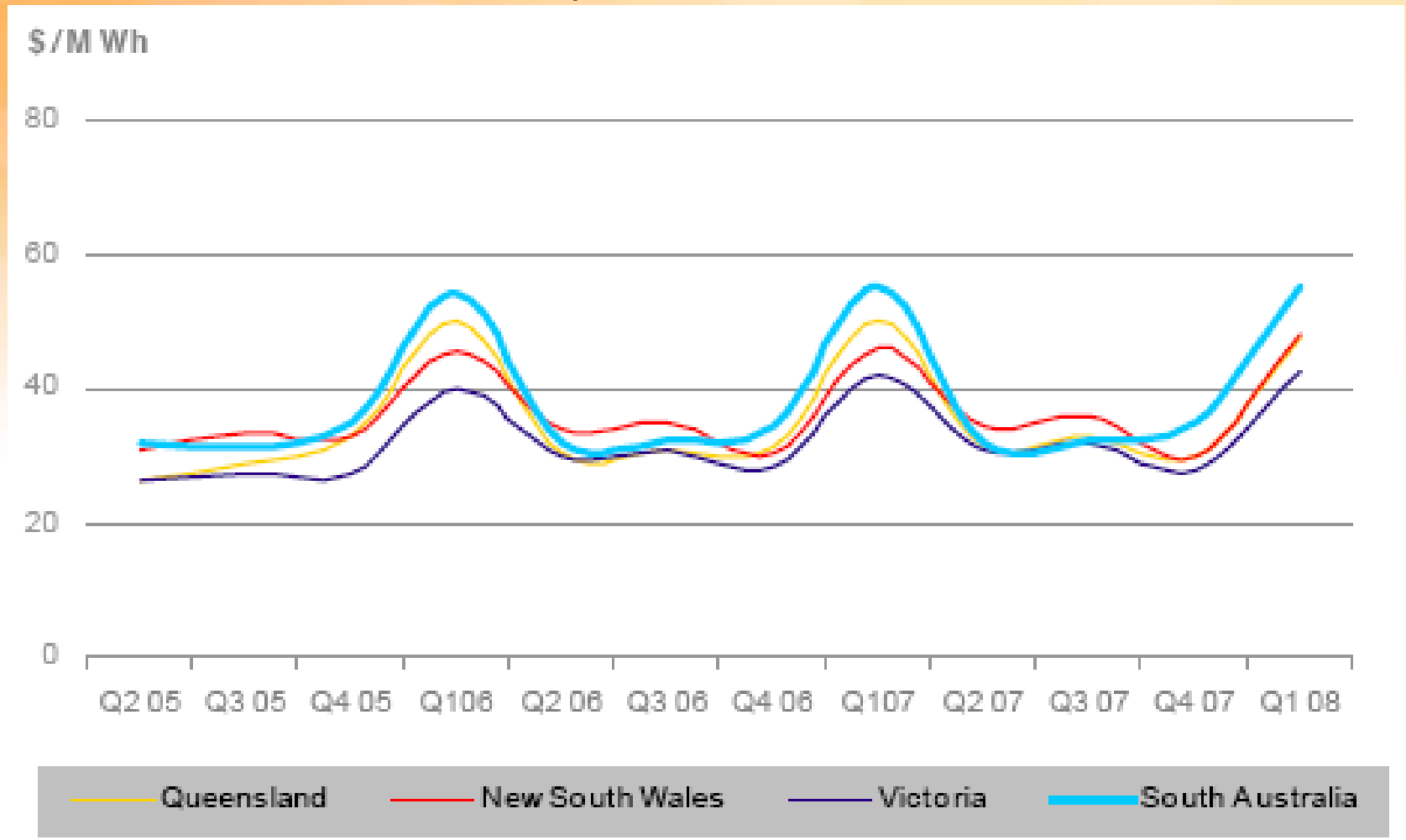
Distribution of NEM spot prices & revenues

(Federal Government: *Securing Australia's Energy Future*, 2004)



Flat contract prices, Q1 2005

(NECA, 05Q1 Statistics, 2005)



D-cyhpaTrade exchange-traded call options for NSW peak period (www.d-cyphatrade.com.au)

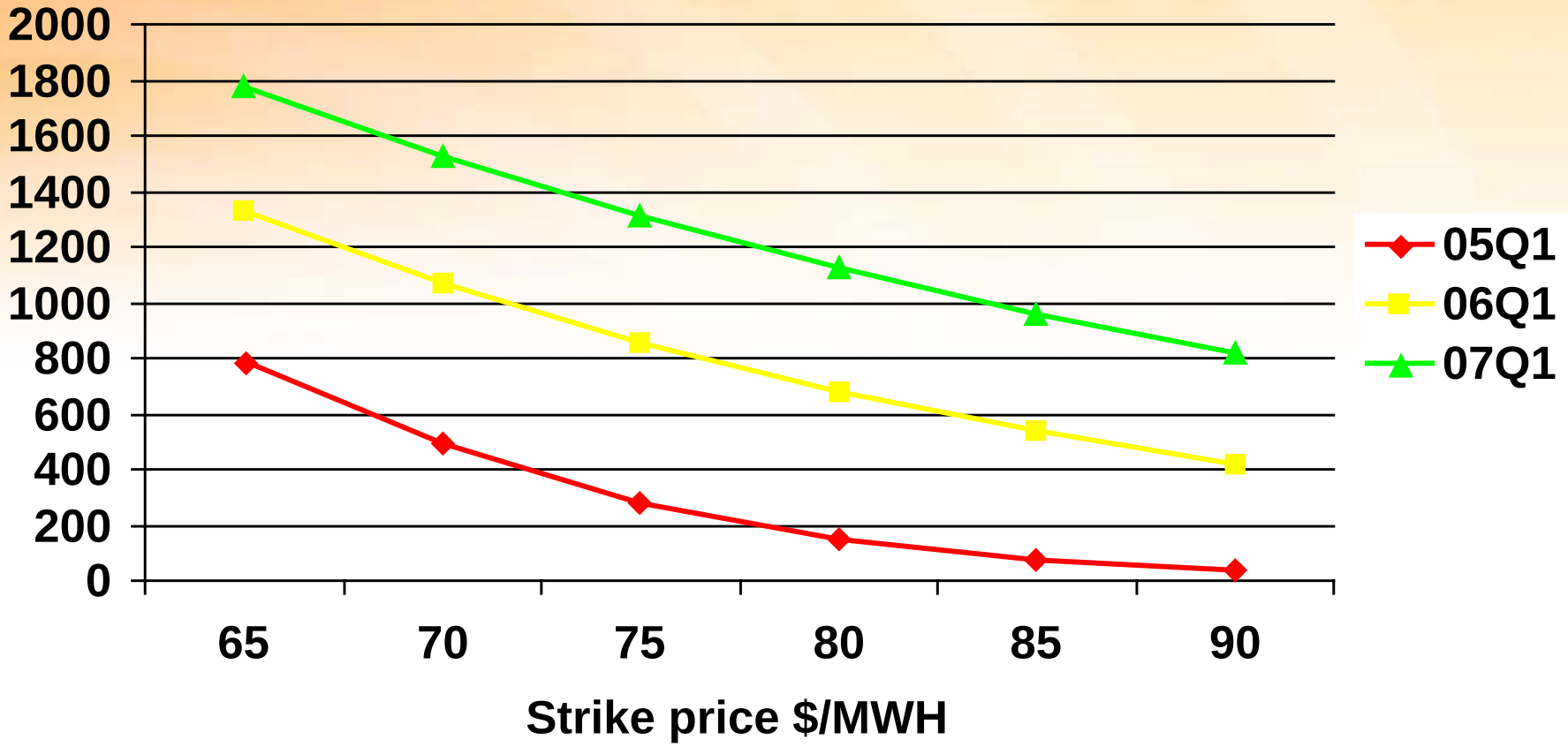
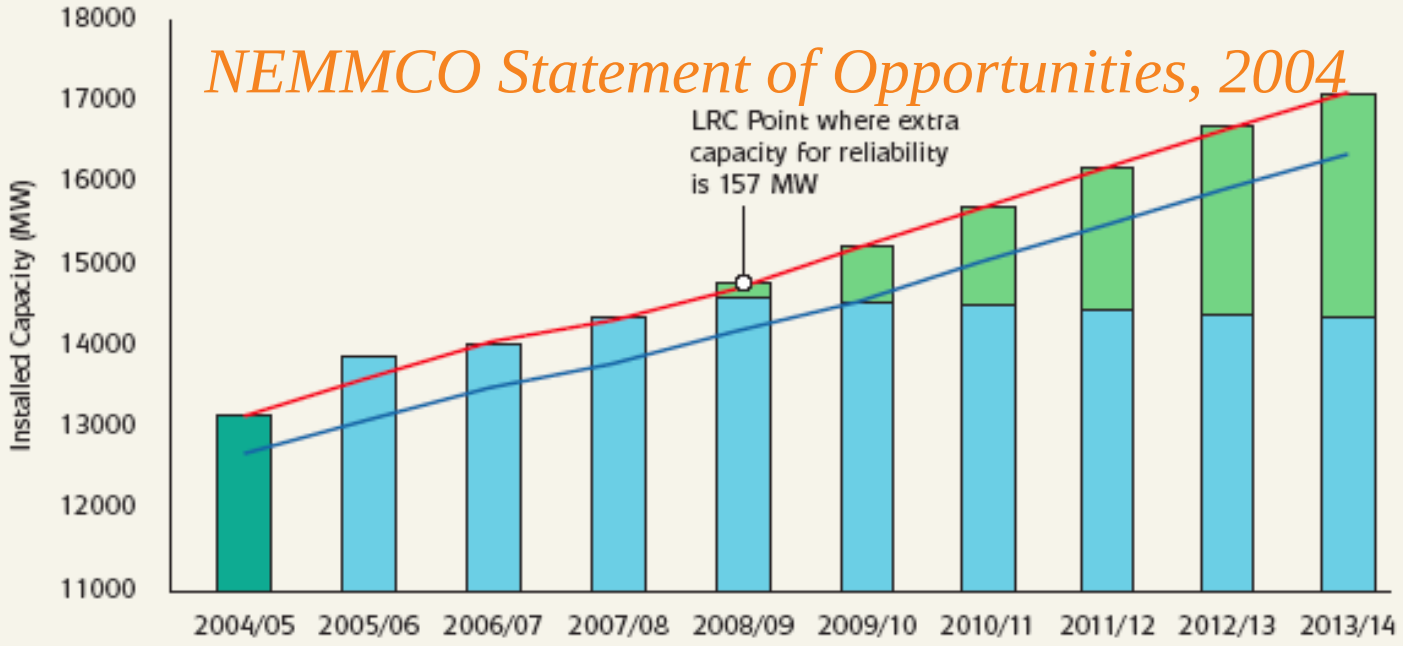
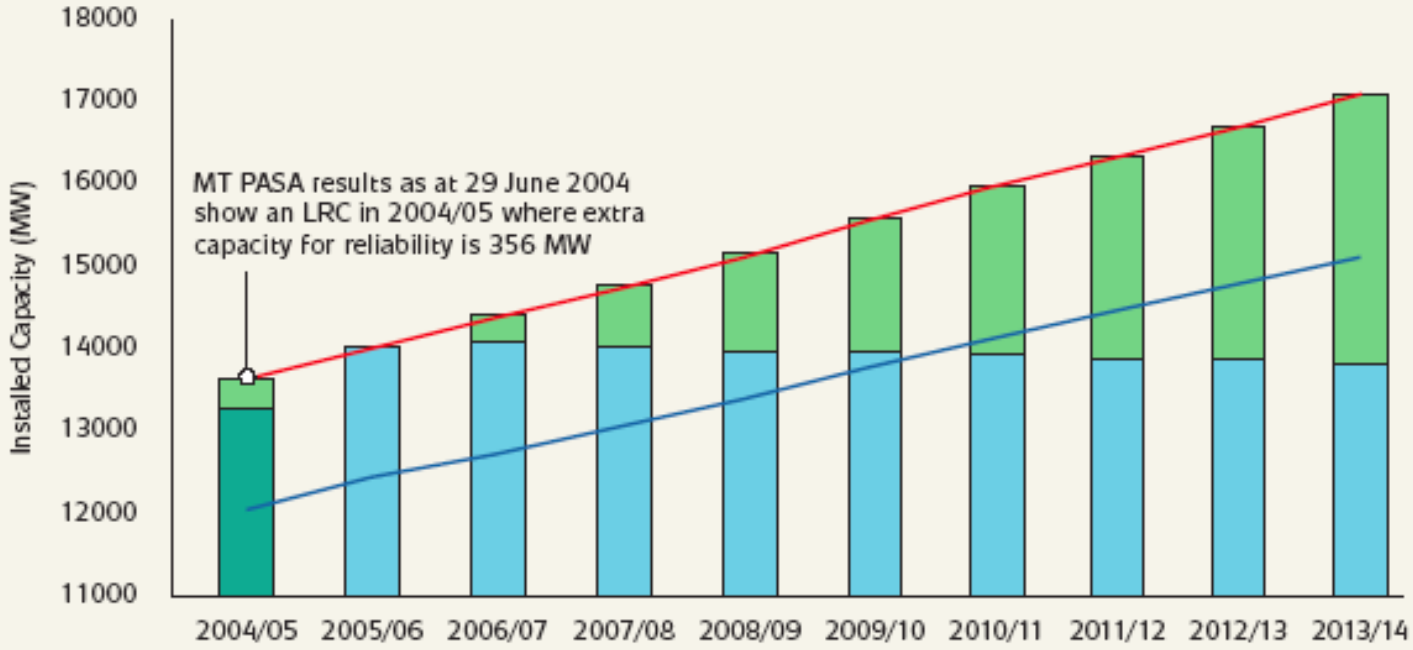


Figure 4 New South Wales Summer Outlook



- reserve capacity support from the Snowy Hydro Scheme and Queensland provide additional available capacity in 2006/07 and 2007/08
- in 2008/09, New South Wales experiences deficits, even though Queensland has additional available capacity. This is due to interconnector transfer limits from Queensland
- in 2008/09, New South Wales cannot source additional capacity from Snowy, as Victoria and South Australia are already experiencing deficits

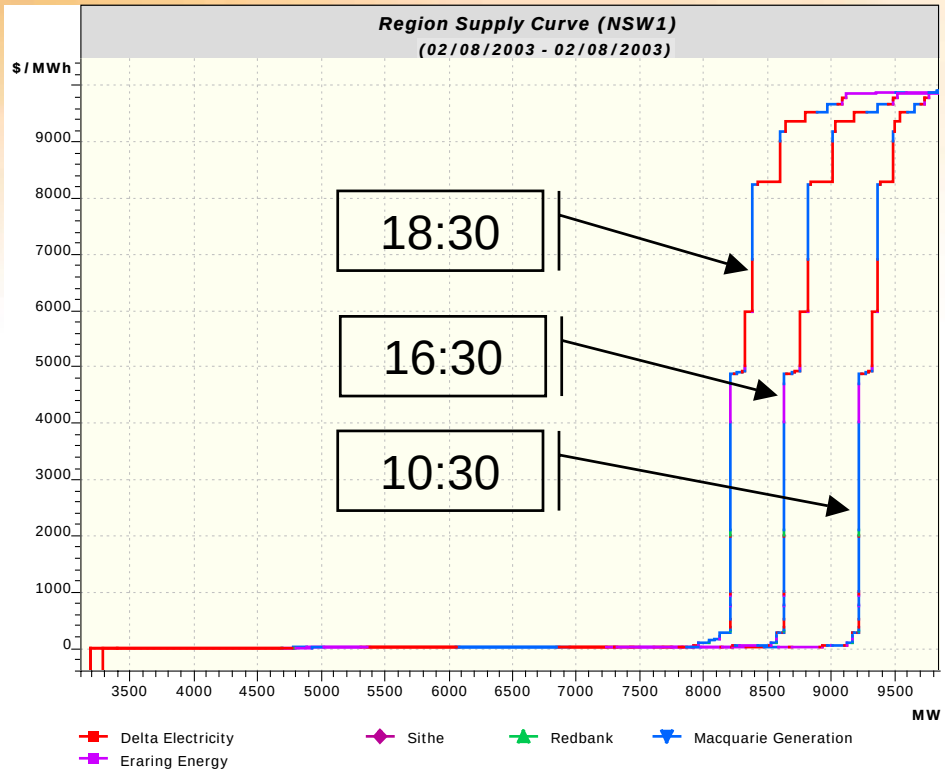
Figure 5 Victoria and South Australia Summer Outlook*

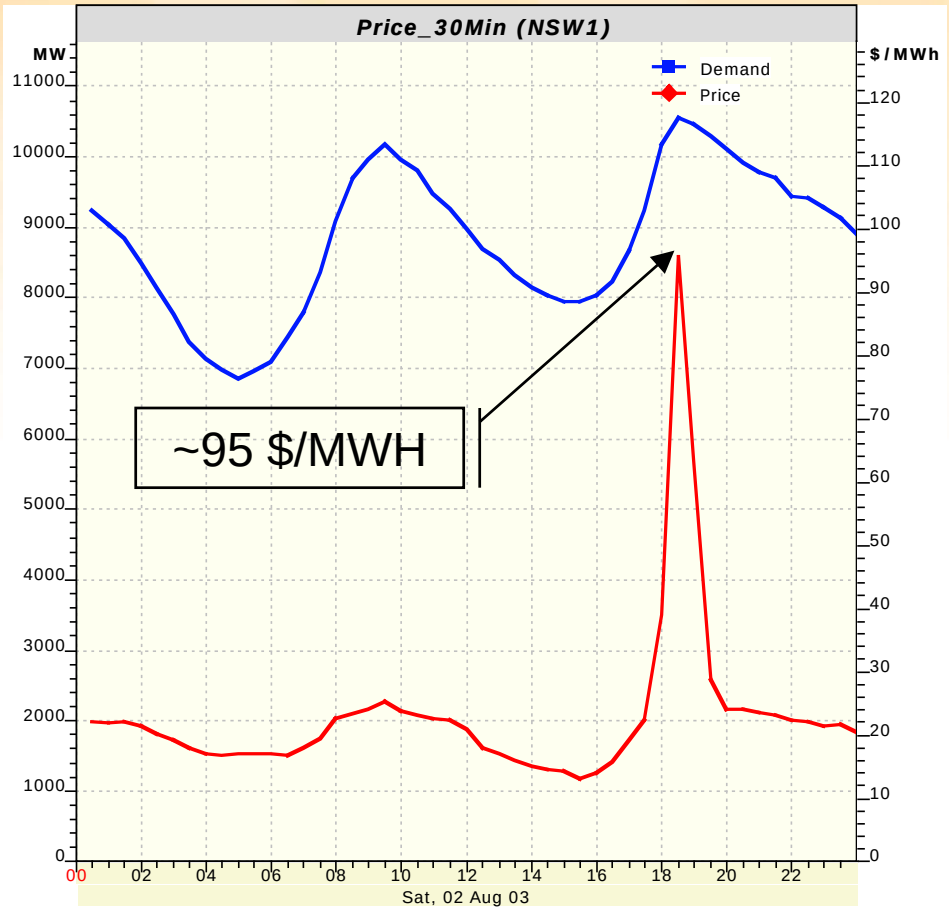


- from 2005/06 onwards, following commissioning of Basslink, there is an additional available capacity of 600 MW to the Victoria and South Australia region
- an LRC point occurs in the following year (2006/07), when the Extra Capacity for Reliability is 321 MW
- in 2006/07 and 2007/08, reserve support from Snowy, New South Wales and Queensland is limited by the capability of the Snowy to Victoria interconnector

Changing generation offer to raise spot market price (2/8/03)

graph courtesy of Stuart Thorncraft &
Intelligent Energy Systems EMIS facility (www.iesys.com.au)
(possible demand-side responses: derivative contract or reduce demand)





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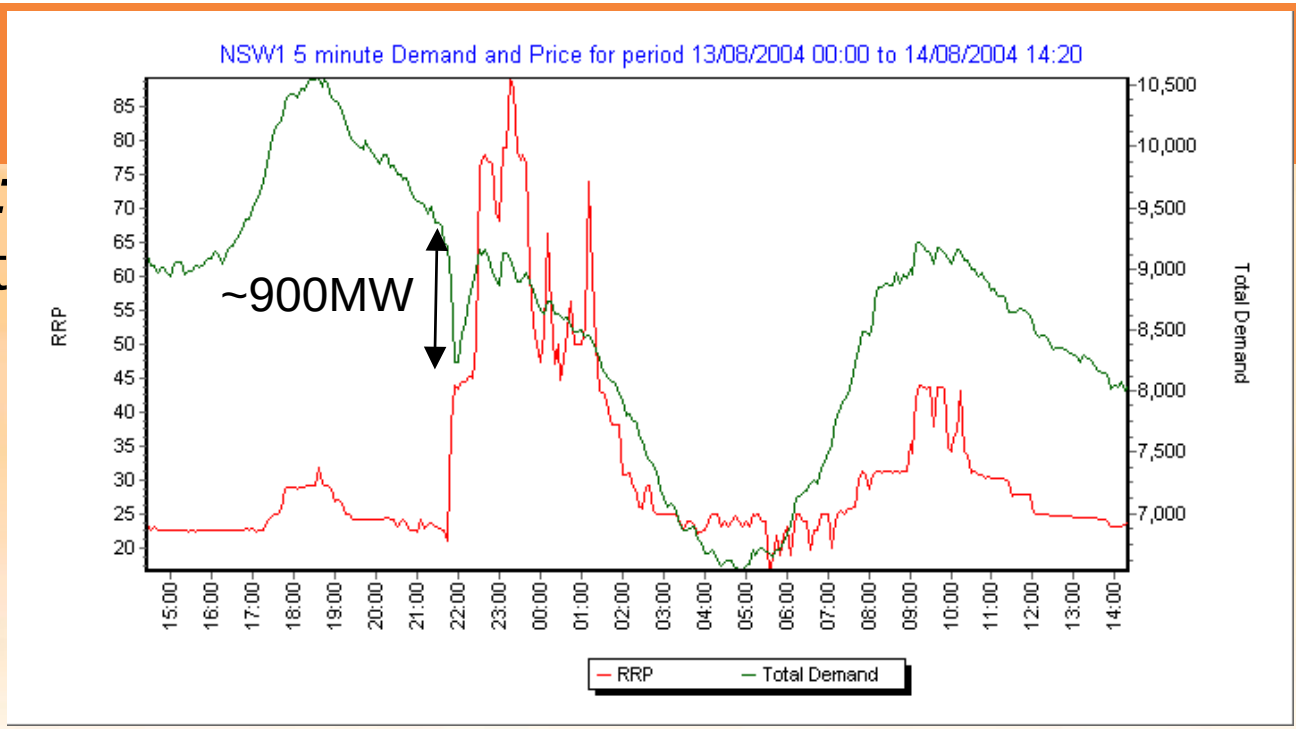
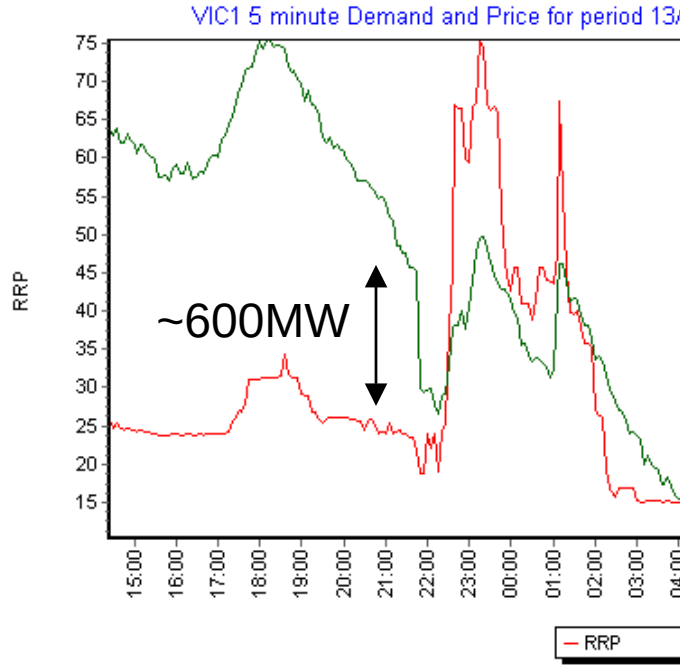
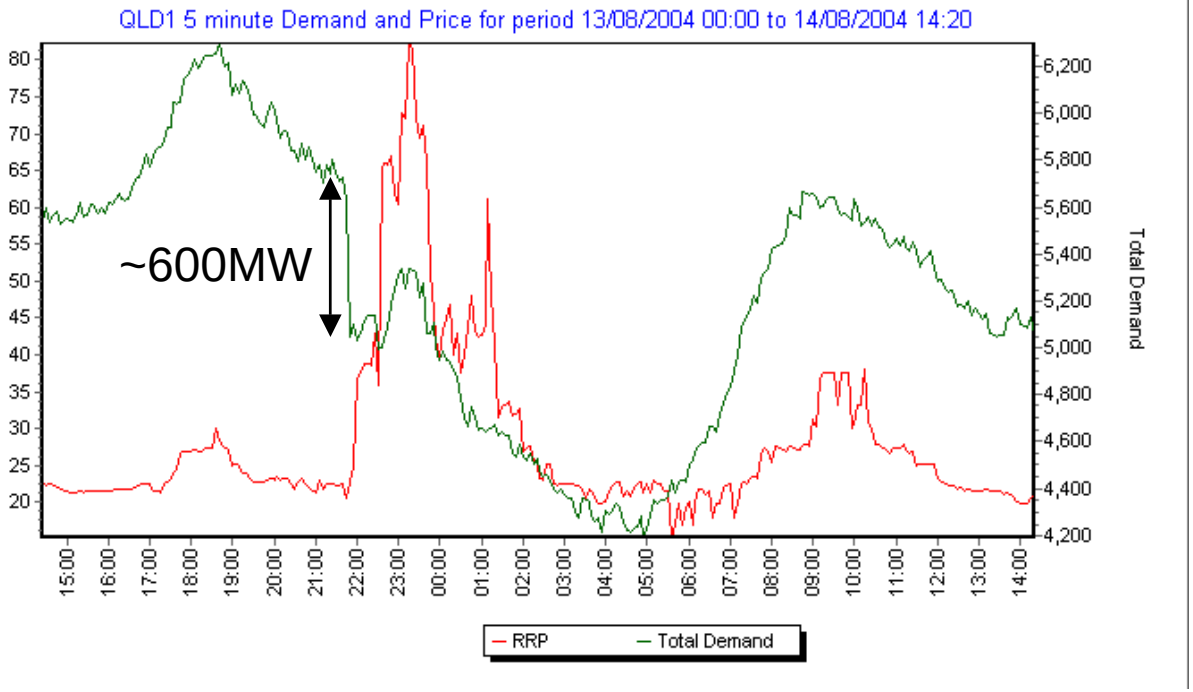
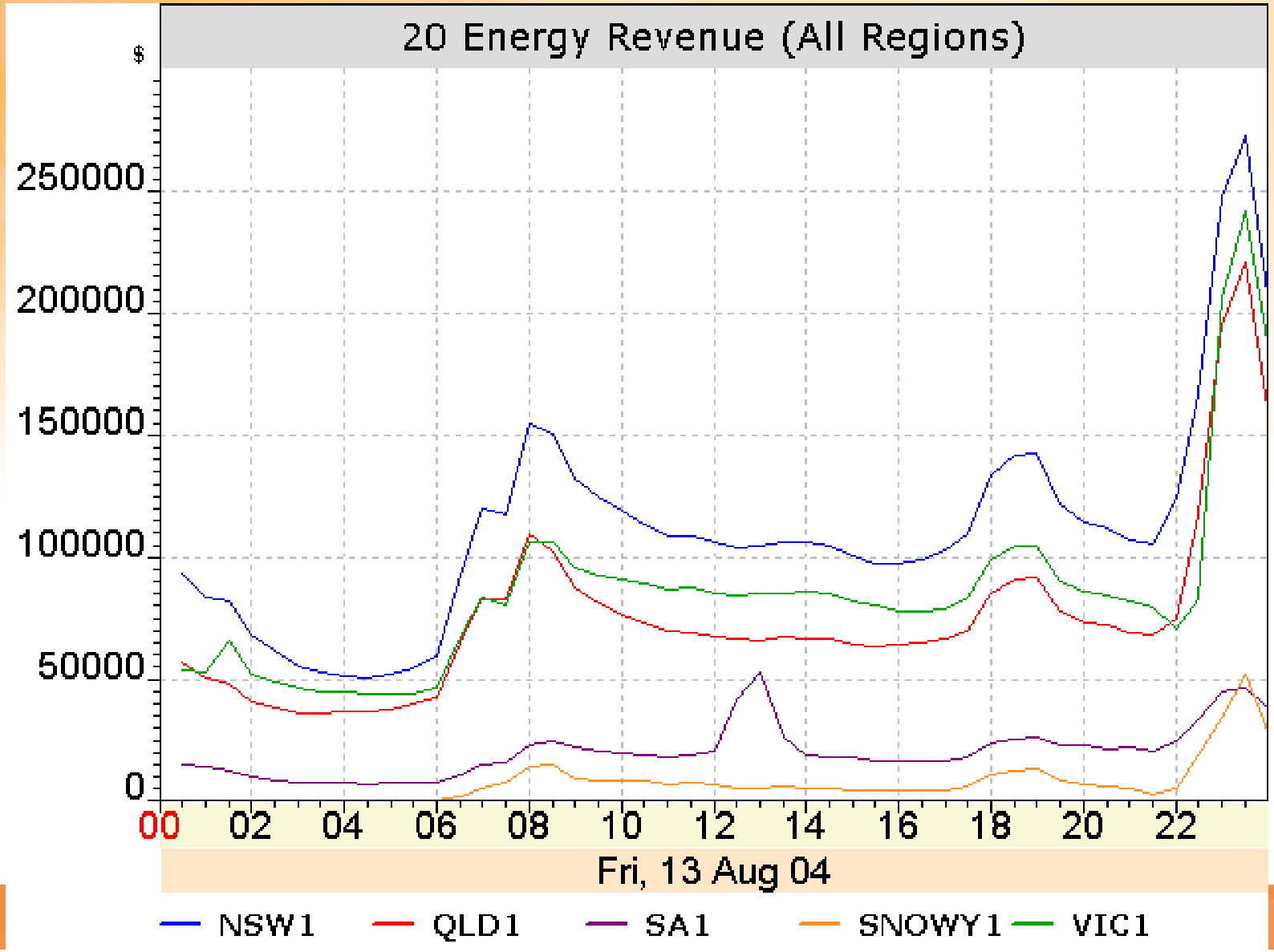
Robustness example:
Transformer failure at 2142, 13 Aug 04:
3,100MW gen lost;
Frequency 48.9Hz;
2,100 MW load shed in NSW, Qld, Vic, SA
(www.nemmco.com.au)



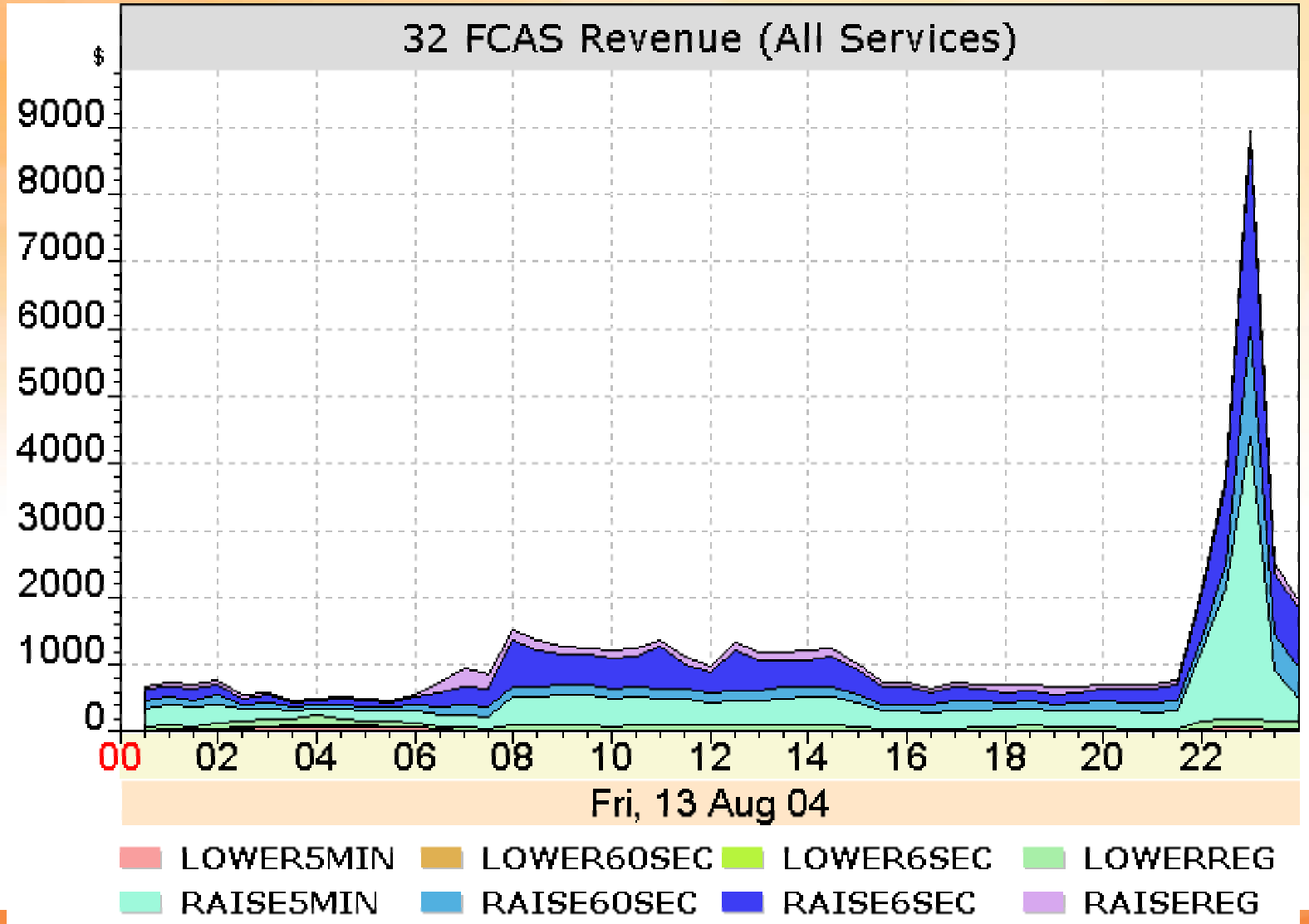




Robustness example: NEM energy revenue, 13/8/04



Robustness example: NEM FCAS revenue 13/8/04



Conclusions on the Australian experience

- Successful electricity restructuring required:
  - Care in developing & maintaining consensus
  - A high level of professionalism in key roles
  - Extensive peer-review, auditing & testing of market design
    - Experimental economic techniques used to test design
- Australian NEM uses a coherent design approach:
  - Decision making & risk management framework
  - Applied consistently to engineering & commercial issues, recognising strengths & weaknesses of each
  - Design works successfully with a weak network, weather-sensitive demand & a growing level of wind generation

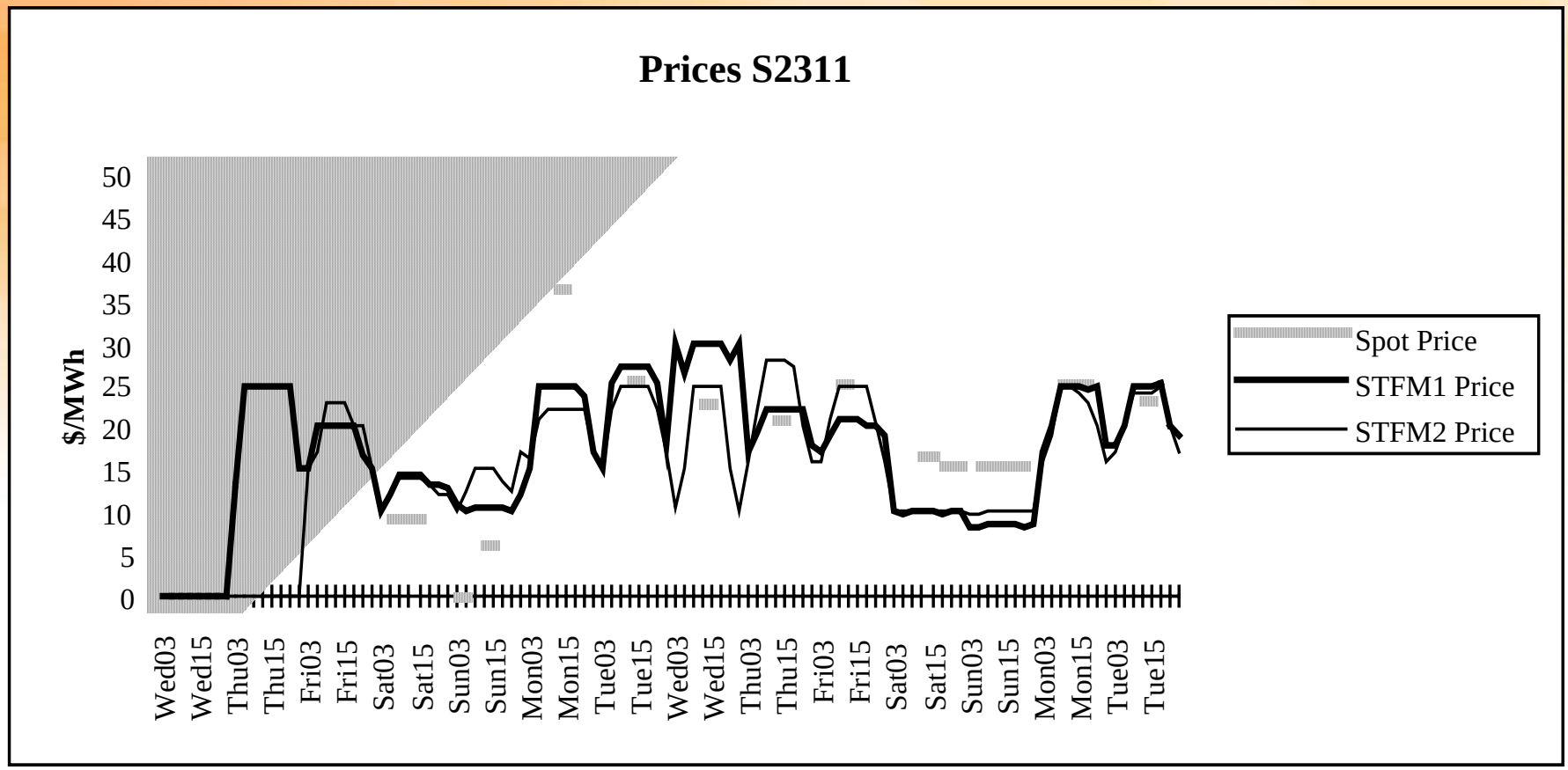
1995 NEM rules trading experiments

- Implemented key features of the NEM rules:
  - NEM bid and offer structure & network loss functions
  - Multi-region spot market with embedded network model
  - 1 & 2 day ahead STFMs with embedded network model
  - Short term PASA with broadcast warnings of constraints
- Provided a sufficiently realistic trading environment:
  - Key participant characteristics
  - Uncertainty in availability, weather
  - Reporting on trading activity & simple decision support
- Operated faster than real time:
  - 2 weeks of trading per day with 3 hour spot market period
    - NEM rules use a half-hour spot market interval
- Used for education as well as formal experiments:
  - >1,000 participants prior to actual market start

Technology types in '95 NEM simulation model

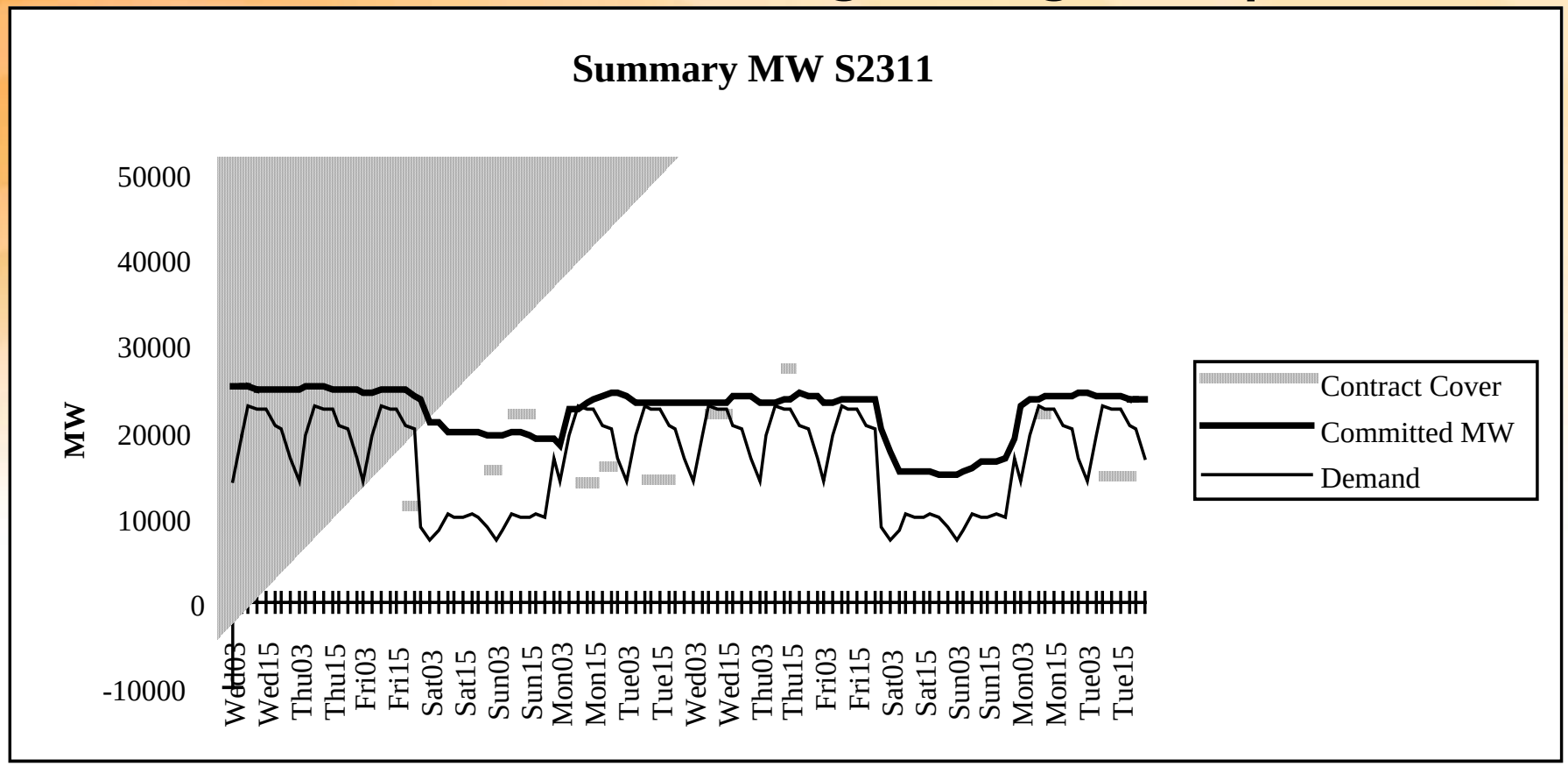
- Seven thermal generator portfolios (subject to outages):
  - Fast start generators (instantaneous start)
  - Slow start generators:- all other thermal plant (self commitment)
    - Max & min load; hot, warm & cold start-up times
    - Start-up costs; fixed & variable operating costs
    - Mean time to fail, mean time to repair, cost of repair
- One hydro generator:
  - Headpond capacity & initial level, inflow rate, pumping
- Seven demand side participants (uncertain temperature):
  - Retail tariff load (daily & weekly patterns, temp. coef't)
  - Demand management (psuedo generator with op. cost)
- One reserve participant (small thermal plant)

Simulation results: single region prices



Occasional zero spot prices. After the initialisation phase, the STFM prices provide reasonable predictions of average spot prices

Simulation results: single region quantities



Contract cover is a compromise between generator interests and demand side interests. Some contract speculation evident on the final Monday. Generators de-committing at weekends but not overnight.

Outcomes from trading experiments

- A sophisticated simulation package can adequately represent NEM market trading conditions:
  - Operational focus; two weeks of simulated trading per day
  - Suitable for exploring operation of market rules & for training
- Experiments demonstrate that generators can exercise market power if insufficient competition:
  - Only under outage conditions for single region experiments:
    - Largest generation participant then had ‘must run’ plant
  - Most of the time in each region for five region experiments:
    - Single or larger generation participant in each region had ‘must run’ plant because of tie-line flow constraints
  - Forward contract cover can protect a buyer from the effects of spot market power

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Key references *(these & other publications at www.ceem.unsw.edu.au):*

1. H R Outhred & R J Kaye (1996), "Incorporating Network Effects in a Competitive Electricity Industry: An Australian Perspective", Chapter 9 in M Einhorn & R Siddiqi (eds), *Electricity Transmission Pricing and Technology*, Kluwer Academic Publishers.
2. H R Outhred (2003), "Some Strengths and Weaknesses of Electricity Industry Restructuring in Australia", Paper 235, Proceedings of IEEE PowerTech '03 Conference, Bologna, 23-26 June, ISBN 0-7803-7968-3.
3. H R Outhred (2004), "The Evolving Australian National Electricity Market: An Assessment" in *Power Progress: An Audit of Australia's Electricity Reform Experiment* edited by Graeme Hodge, Valarie Sands, David Hayward and David Scott, Australian Scholarly Publishing, Melbourne, ISBN 1 74097 034 9, 2004.