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Electricity industry restructuring in Australia

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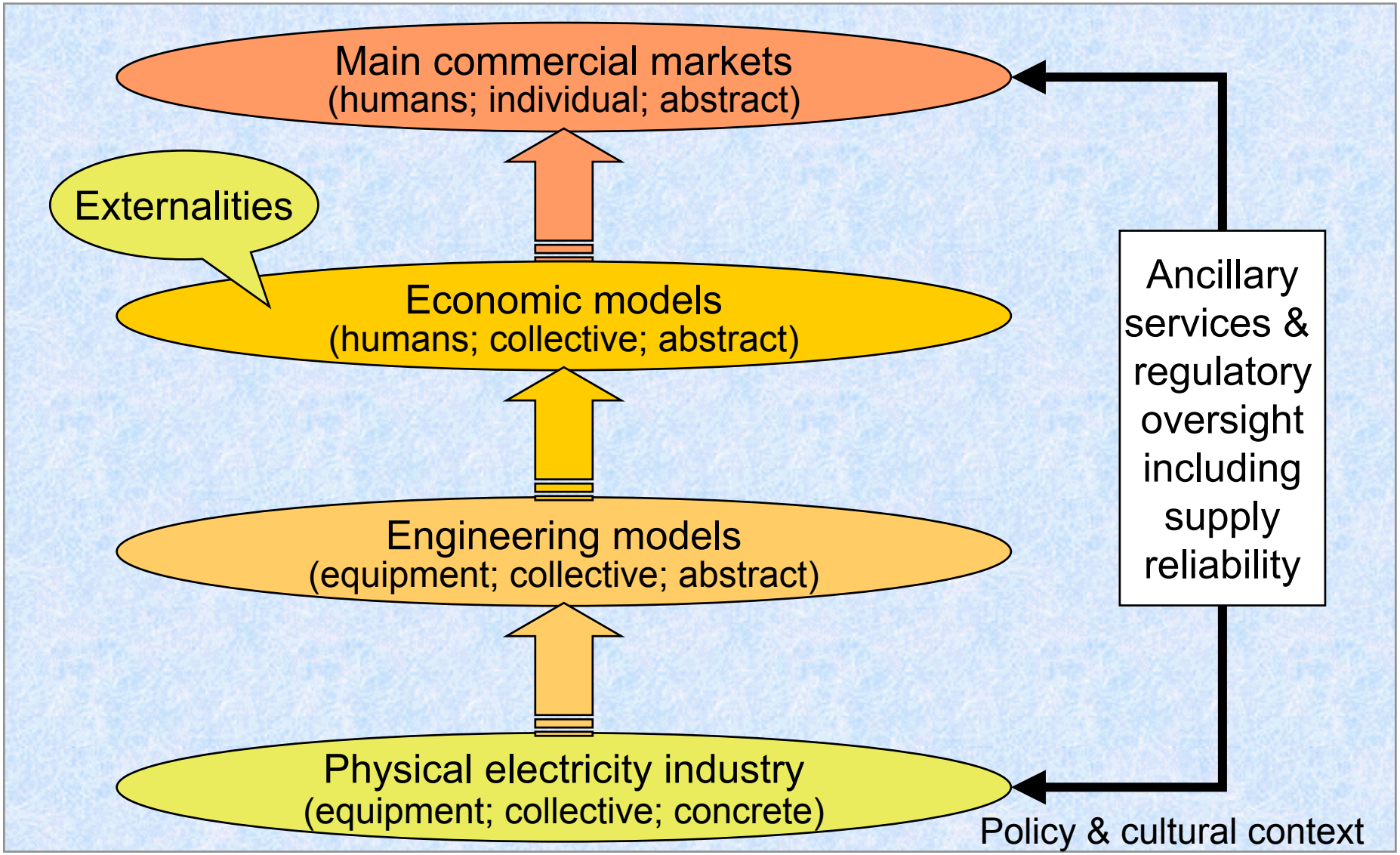
Electricity industry restructuring: a complex design process

- A design process *within a cultural context:*
  - Industry-specific laws, codes & markets
- A mix of technical, economic & policy issues:
  - Physical behaviour continuous & cooperative
  - Commercial behaviour individual & competitive
- Restructuring is still a learning situation:
  - A "social experiment" with few "safe exits"
  - No complete successes, some notable failures
  - Must solve commercial, technical & institutional challenges *to keep the lights on at the right price*

Key lessons to date (Joskow, May '03):

- Electricity market design:
  - Doesn't matter much when:
    - Demand is moderate, supply elastic, ownership not concentrated & transmission not congested
  - Does matter when this is not the case, eg:
    - Few hours when demand high & network congested
- Key aspects of good market design:
  - (approximate) nodal pricing
  - Derivatives including financial transmission rights
  - Consistent energy and ancillary service markets
  - Retail markets with spot & forward pricing

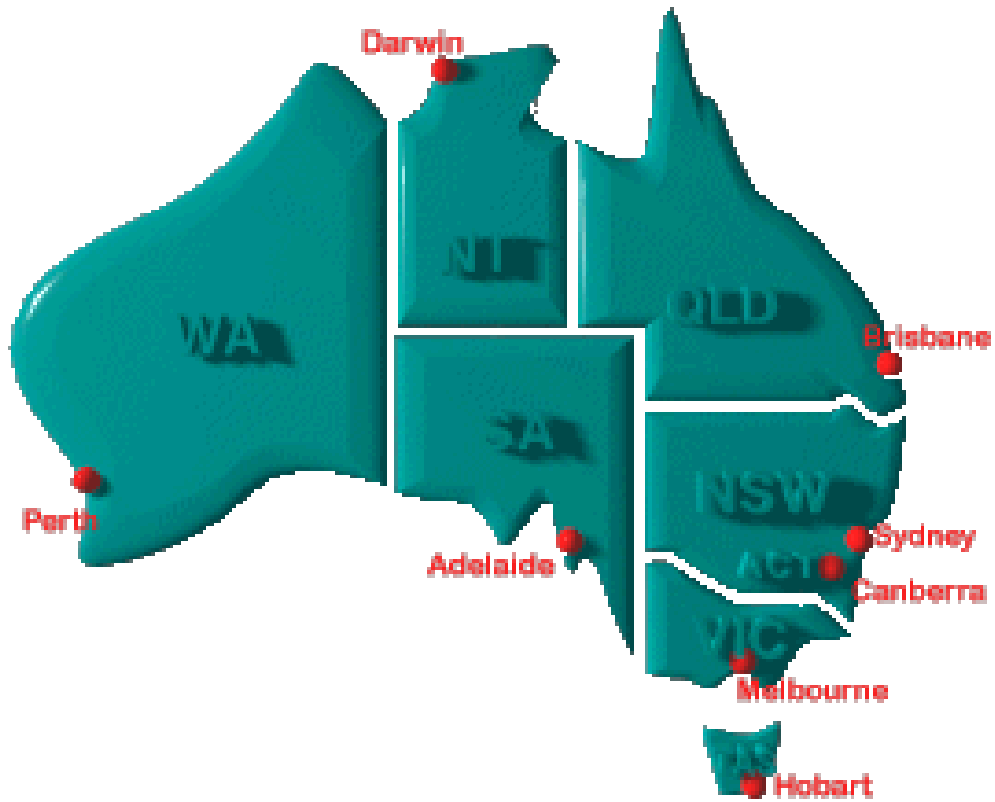
The central challenge of electricity restructuring: *to make economics & engineering compatible*



Comparison of SMD & Australian National Electricity Market

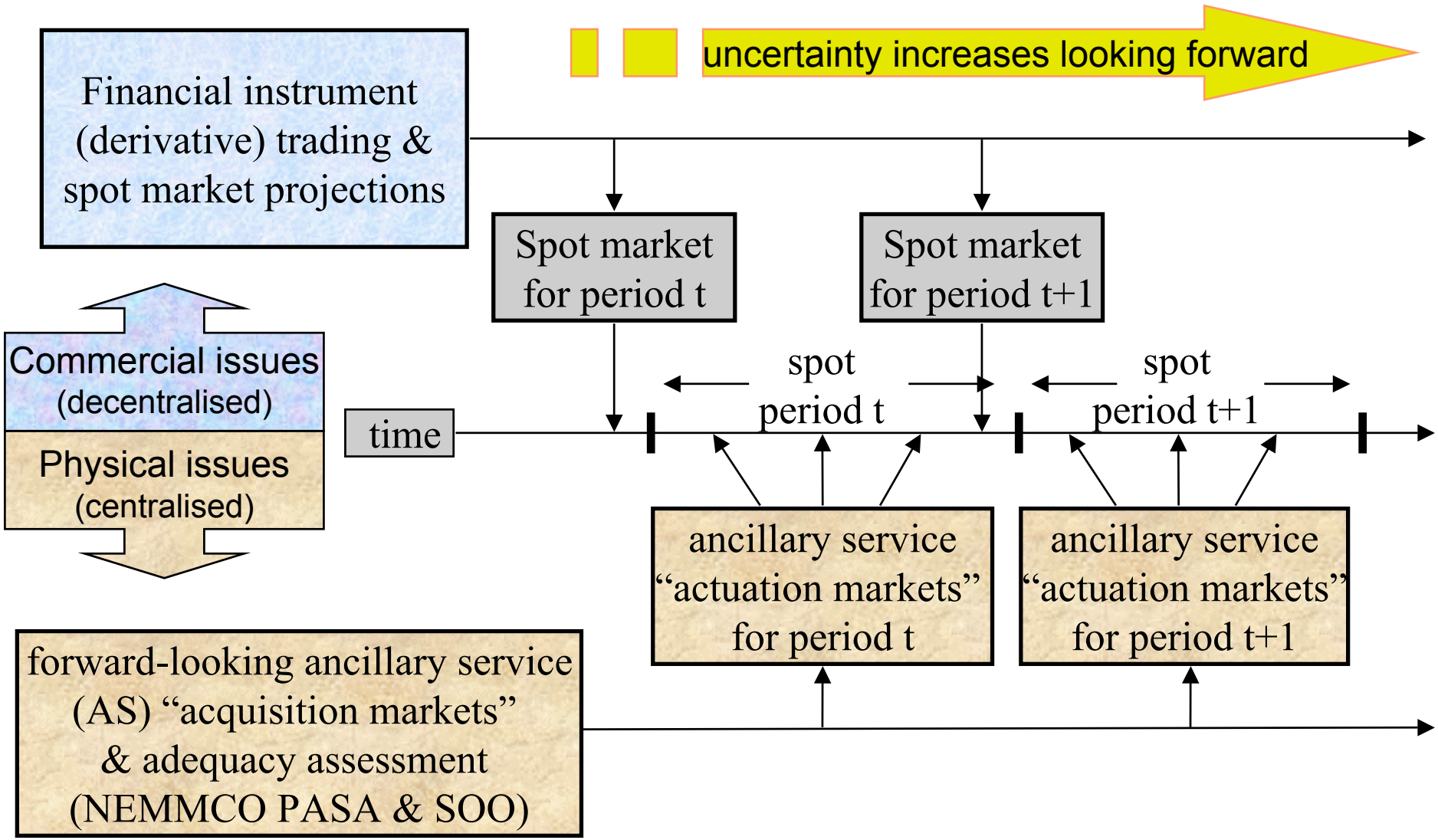
Standard market design	Australian NEM
Independent RTO	Single independent RTO, ISO & market operator
Day-ahead market with central unit commitment	Ex-ante 5/30 minute market without unit commitment
LMP & FTRs	Hub & spoke LMP & FTRs; Merchant transmission
Resource adequacy requirement	High price cap $10,000/MWH +10-yr gen & network outlook
No network rate pancaking	No wheeling or pancaking
Market power mitigation	Market power mitigation

The Australian approach to electricity industry restructuring



Timeline for electricity trading

(locational detail & active demand-side participation matter)



Australia: COAG restructuring process

- 1899:
  - Courses on electricity industry restructuring
- 1990-2:
  - COAG agreed to consider reform (1990)
  - Industry Commission report (1991):
    - Poor investment decisions:- excess capacity
    - Excessive staff levels & cross subsidies in pricing
    - *Recommended a competitive 'national grid'*
  - National Grid Management Council formed:
    - Implement COAG policy on electricity restructuring
  - National Grid Protocol, First Issue (Dec 1992)

Australia: COAG restructuring process

- 1993: NGMC 'Paper trial' of two options:
  - Interconnected regional pools:
    - Including network losses & interconnector flow constraints
  - Centralised commitment, capacity contracts, CFDs
- 1994-98:
  - Competition policy & Trade Practices Act
  - Federal & state-level regulators established
  - Development of National Electricity Code:
    - Trading experiments & training using NEM design from 1995
  - NSW & Victorian markets started '94 & '96; joined in 1997
  - Updated Queensland market started 1997
  - NEM commenced 13 December 1998
- 2002:
  - Council of Australian Governments' energy market review

COAG Response to the Review
(Ministerial Council on Energy, 11 December 03)

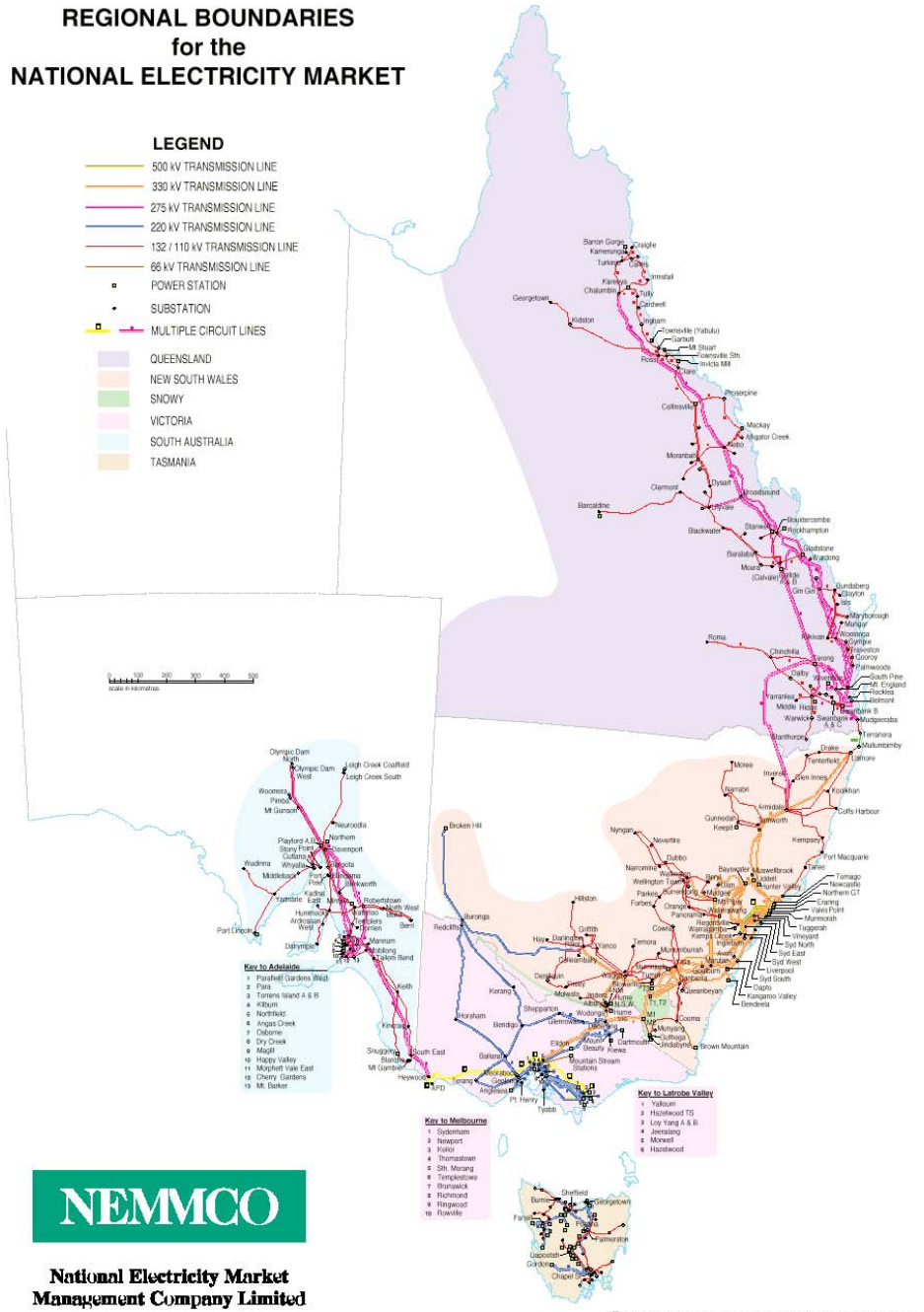
- MCE recommends to COAG the establishment of:
  - A single energy market governance body
  - A new national legislative framework
  - Two new statutory commissions from 1/7/04:

    (electricity & gas markets & networks)
    - Australian Energy Market Commission:
      - Rule making & market development (replacing NECA)
    - Australian Energy Regulator
      - To be constituted as autonomous part of ACCC)
      - Market & network regulation
- National network planning process with apparently less emphasis on merchant transmission

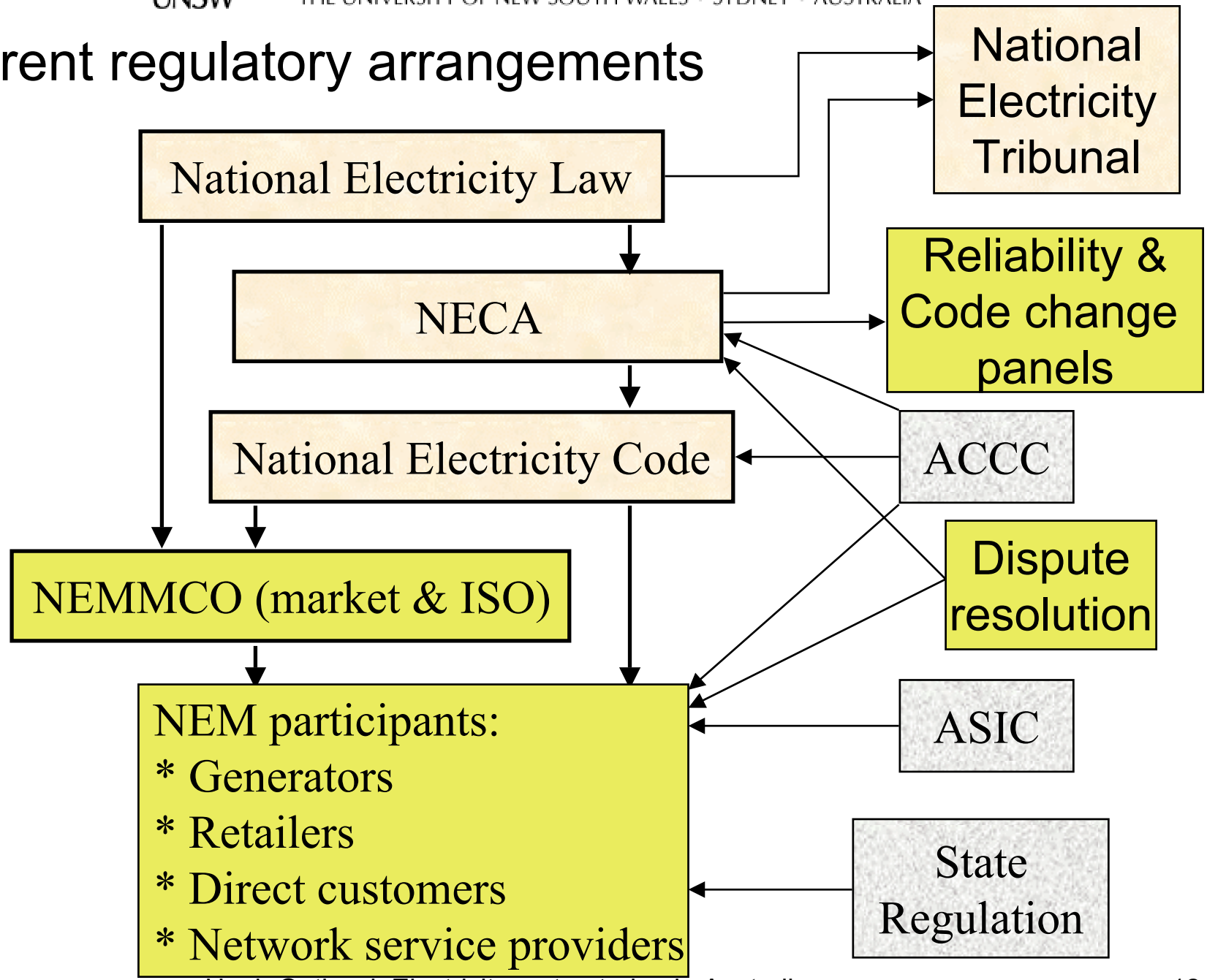
Scope of the NEM

- Queensland
- New South Wales & ACT
- Victoria
- South Australia
- Tasmania (on connection to the mainland)

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



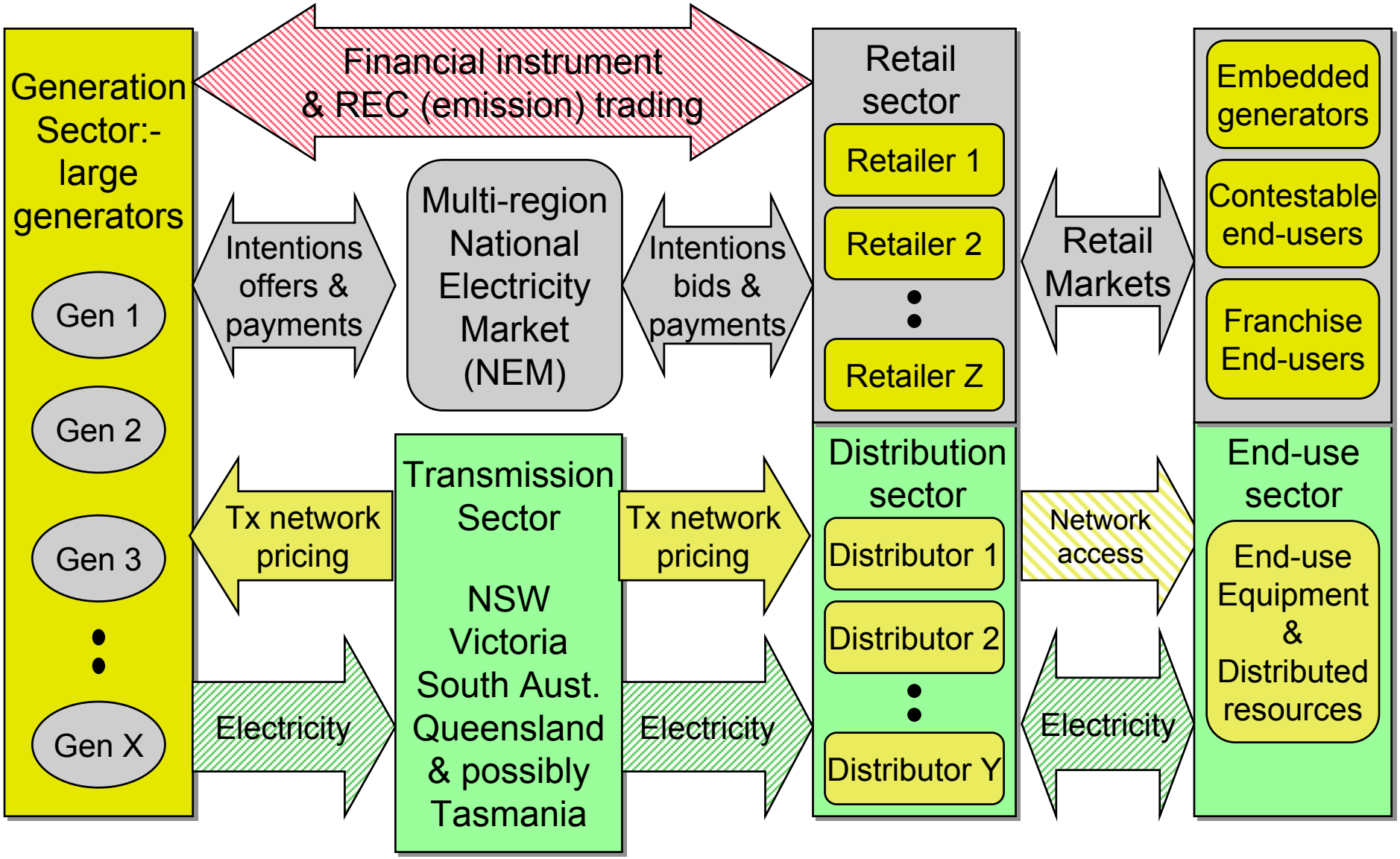
Current regulatory arrangements



Key NEM features

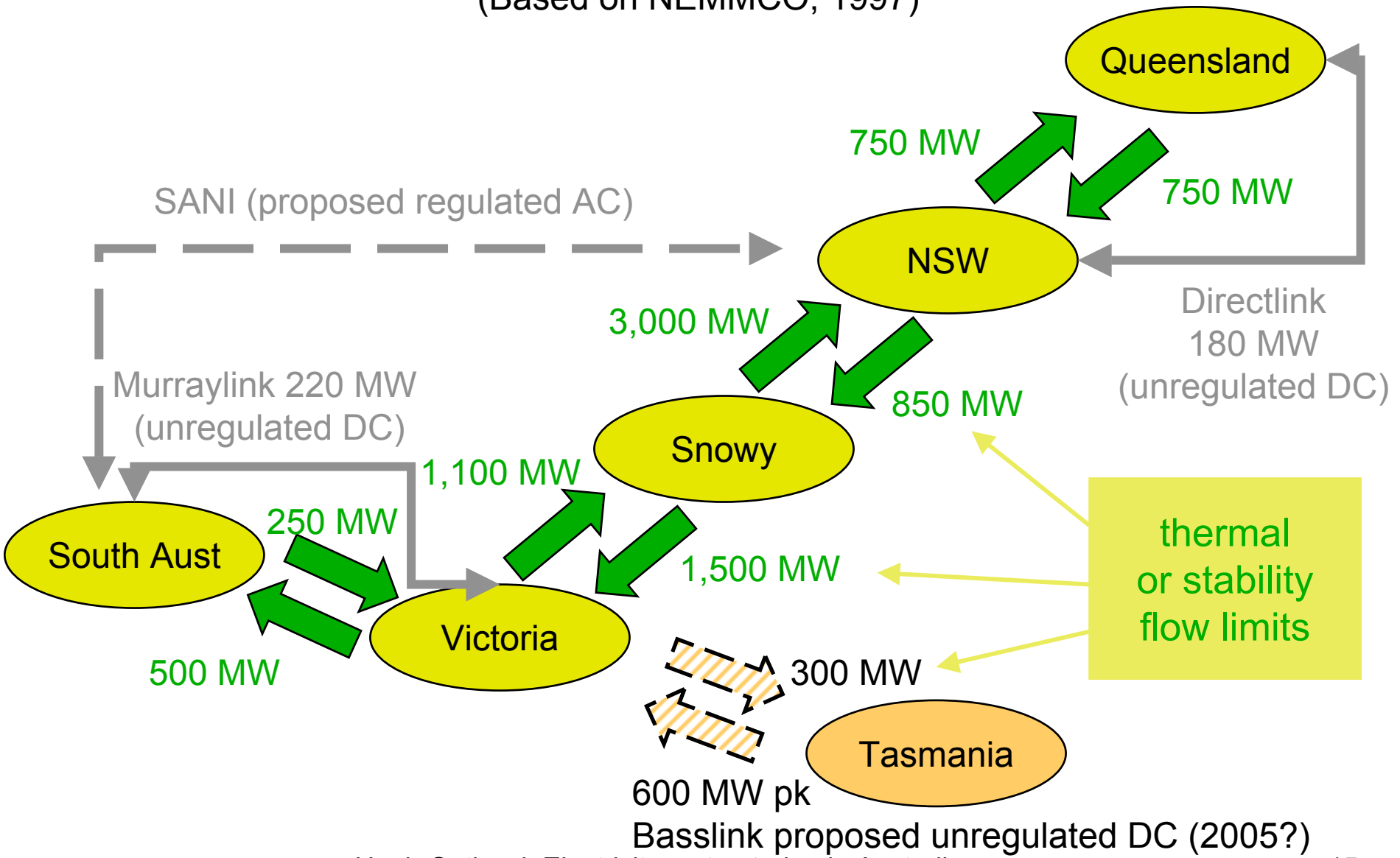
- NEM covers all participating states:
  - Hub & spoke approximation to nodal pricing
  - Ancillary services, spot market & projections
  - Derivative trading, including auctions of inter-regional settlement residues (FTRs)
  - State-owned market & system operator: NEMMCO
  - Compulsory participants in NEM:
    - All dispatchable generators & merchant links > 30 MW
    - Network service providers & retailers
- Contestable consumers may buy from NEM

Electricity industry structure in SE Australia



NEM regional spot market model

(Based on NEMMCO, 1997)



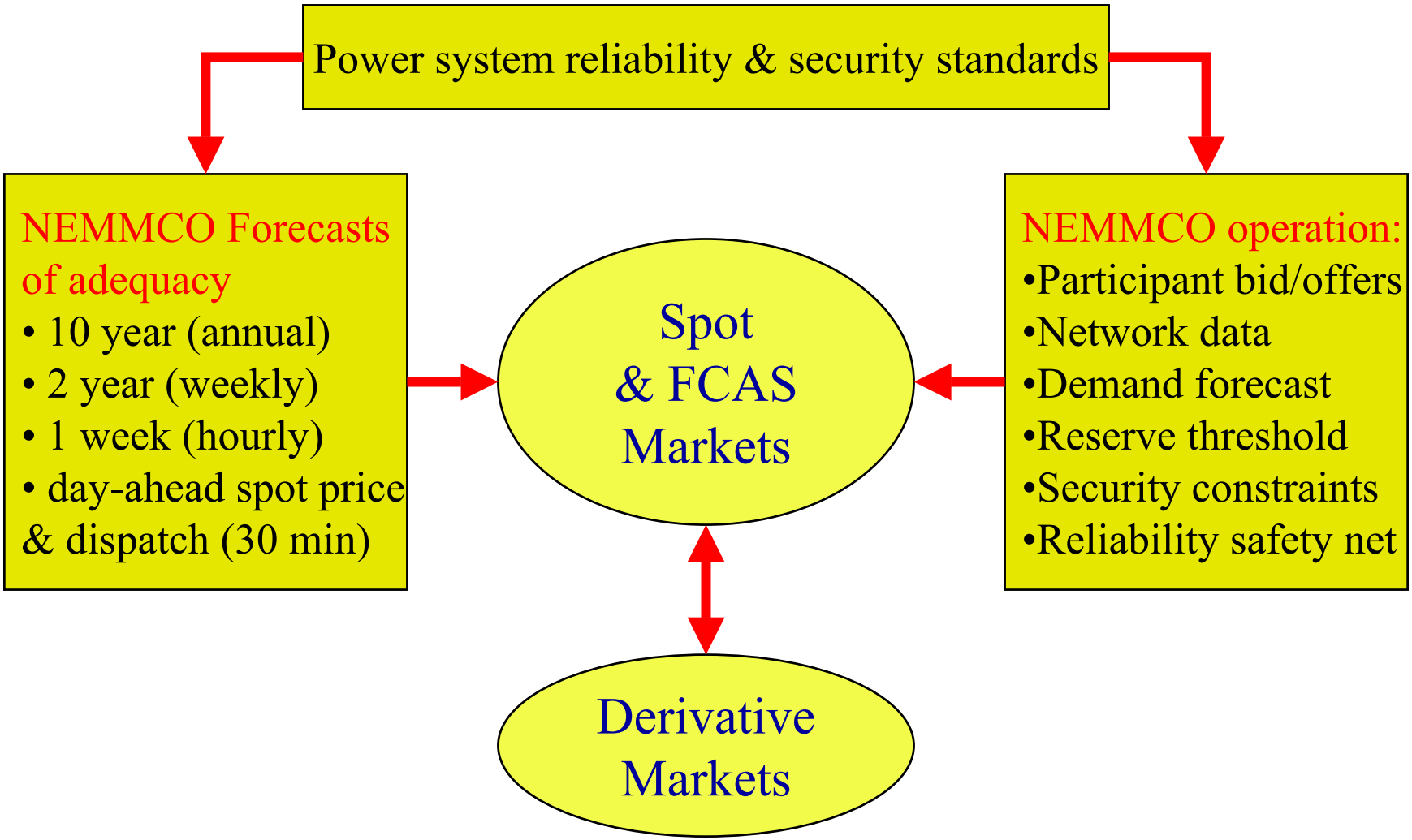
Region boundaries & inter-connectors

- Regions boundaries selected so that:
  - Transmission constraints are rare within a region
  - Frequently-occurring constraints are placed on region boundaries
- Region boundaries to be reset as required:
  - Whenever a constraint occurs > 50 hours/year
- An merchant inter-connector is allowed if:
  - dispatchable so that it can bid like a generator:
    - 'Directlink' operating since July 2000:
      - 180 MW DC link between NSW & Queensland regions

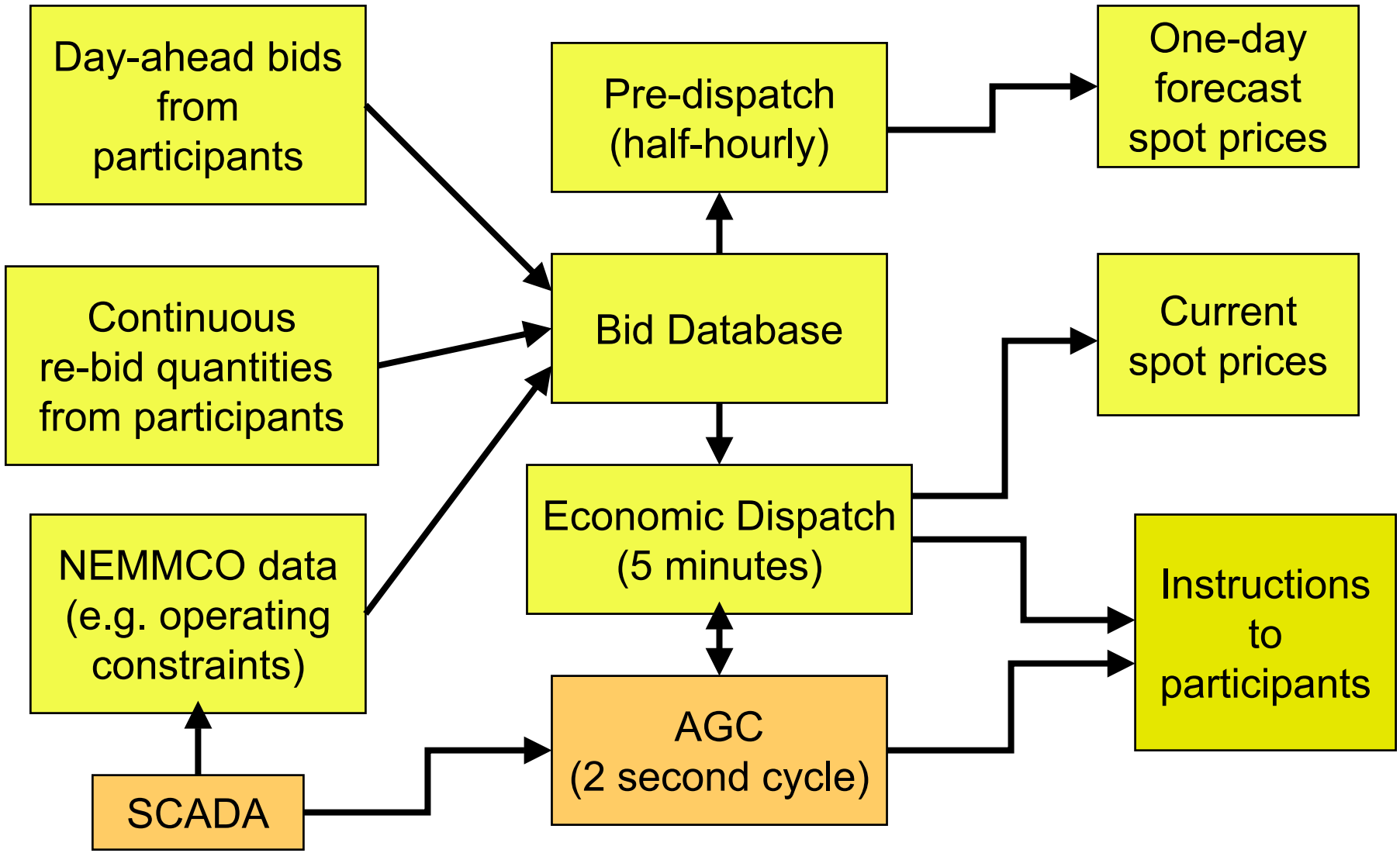
Modelling regulated interconnectors & intra-region location

- Regulated interconnector between 2 regions
  - Modelled by a linearised marginal loss function:
    - A 'dynamic' network loss factor that depends on flow
    - Flow limits (security or thermal criteria)
- Locational effects within regions
  - Modelled by 'static' network loss factors (LFs)
    - Annual average of estimated half-hour marginal losses for each generator node & group of consumer nodes
  - Intra-regional constraints not modelled but a 'constrained-on' generator cannot set price

NEM processes for managing supply-demand balance

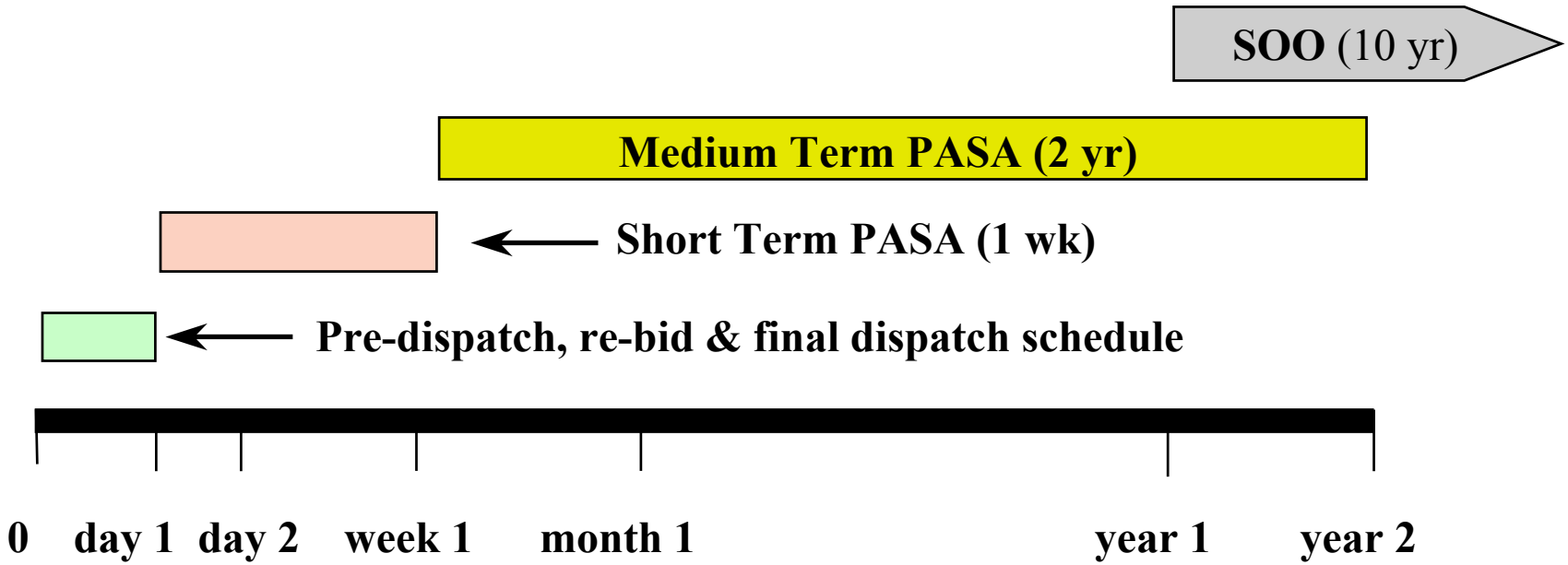


NEM Pre-dispatch, Dispatch & AGC



Dispatch, Pre-dispatch, PASA & SOO

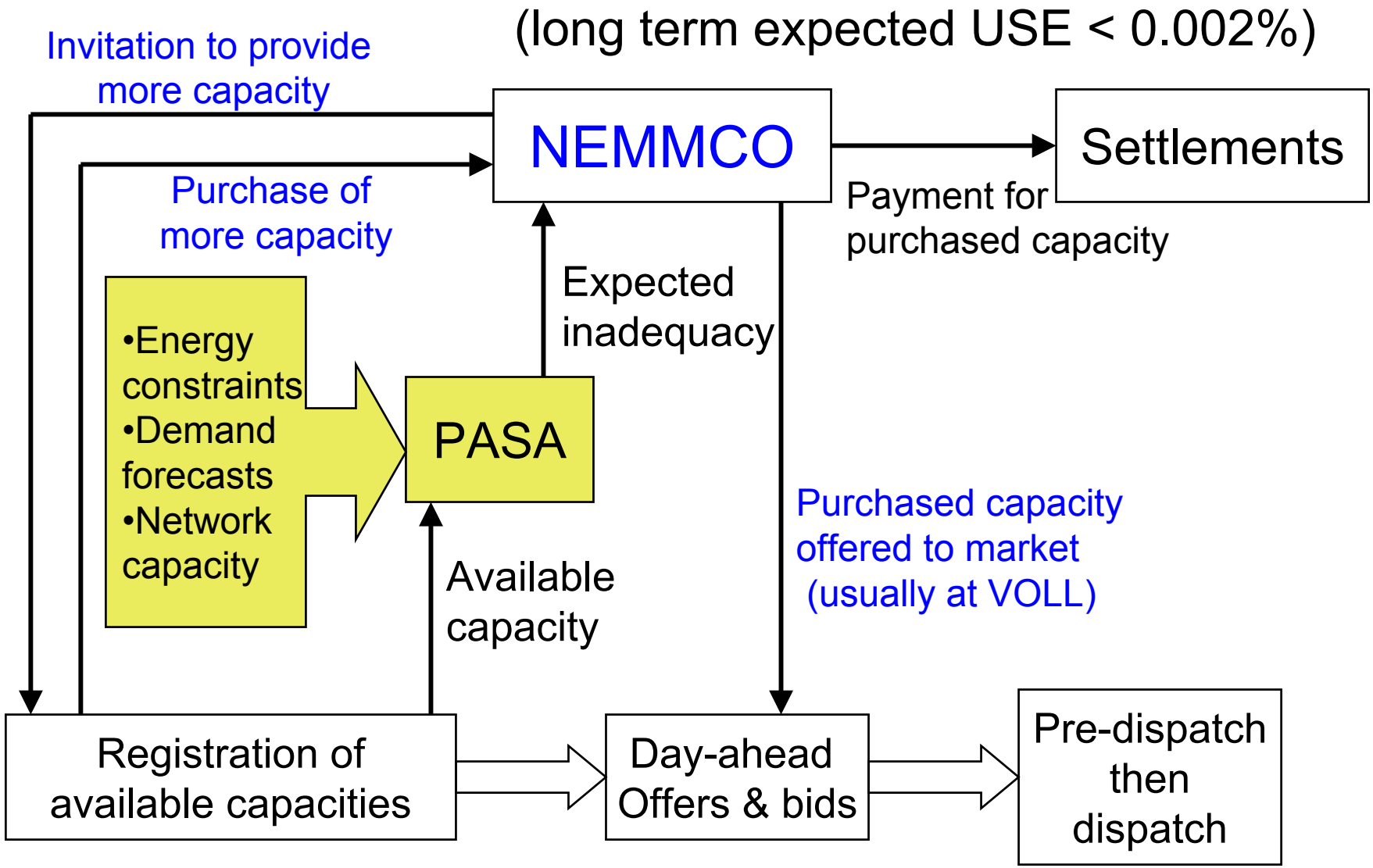
(source: NEMMCO)



Statement of opportunities (SOO) is intended to inform generation and network investment decisions (10 year horizon, yearly update)

Medium term projection of system adequacy (PASA) is intended to inform near-term reliability assessment and reserve trader process (2 yr horizon, weekly update)

PASA & reserve trader



Derivative trading in support of NEM

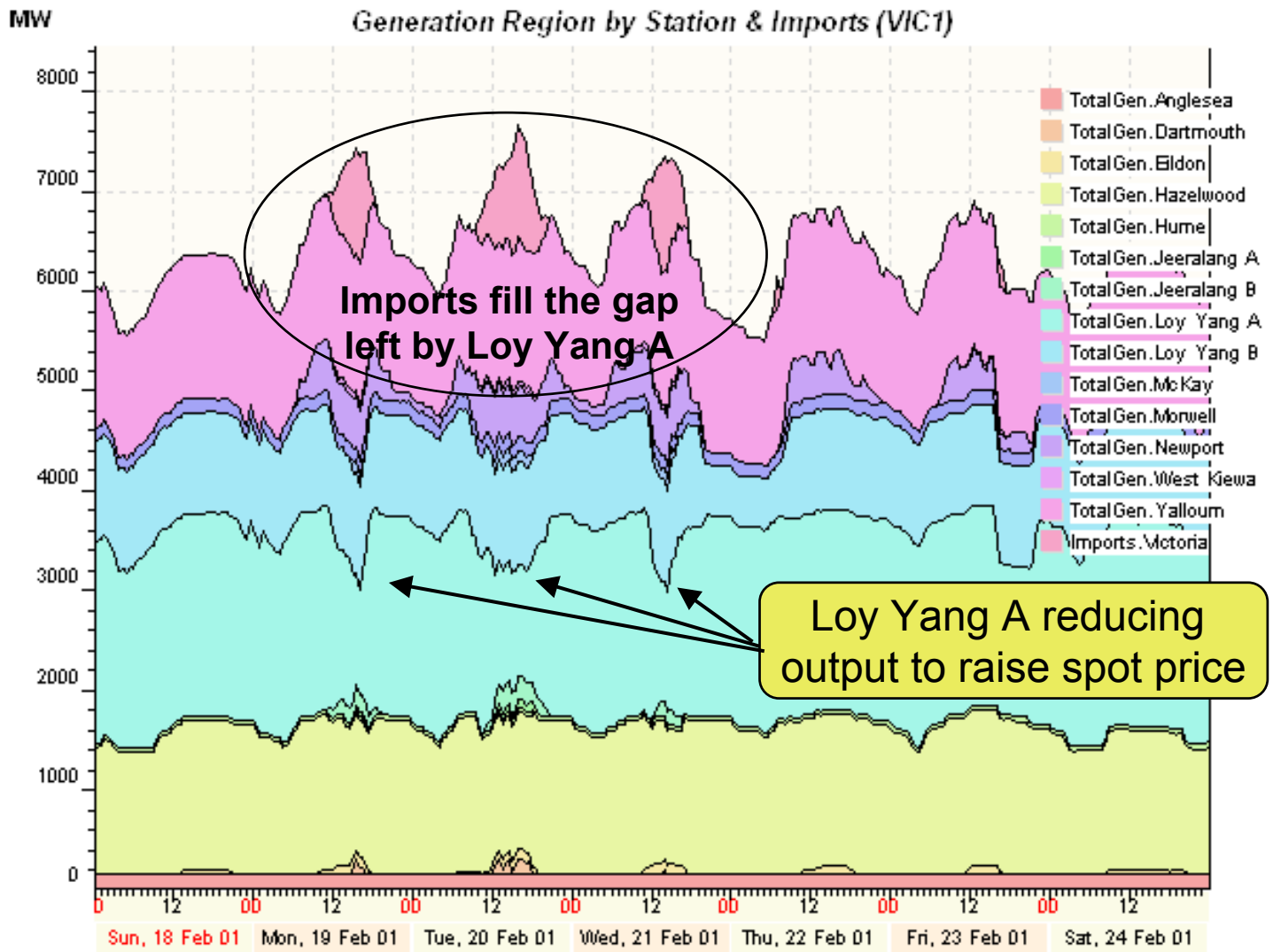
- Trading in swap & cap contracts:
  - Bilateral trading
  - Over-the-counter instruments
  - Exchange-traded CFDs (swaps)
- Inter-regional hedges:
  - Specialised form of financial instrument:
    - to manage regional price difference risks
    - funded by interconnector settlement residues
  - NEMMCO inter-regional settlement residue auctions:
    - Commenced in 1999

Key derivative markets

- Forward contracts (futures)
  - Expected spot price for a defined load shape & period (eg flat annual demand)
  - 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

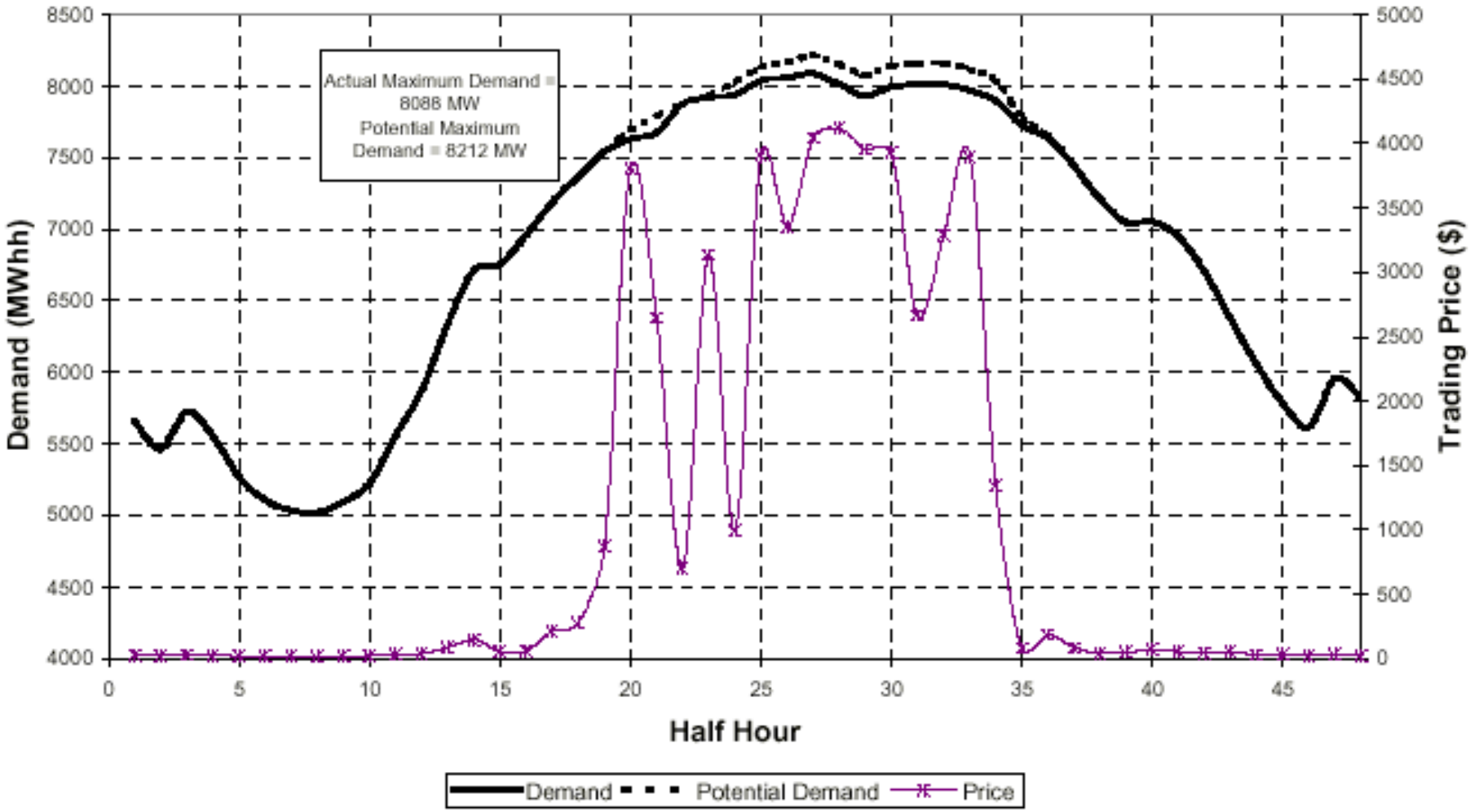
Reducing generation to raise spot market price

(graph courtesy of Intelligent Energy Systems EMIS facility)

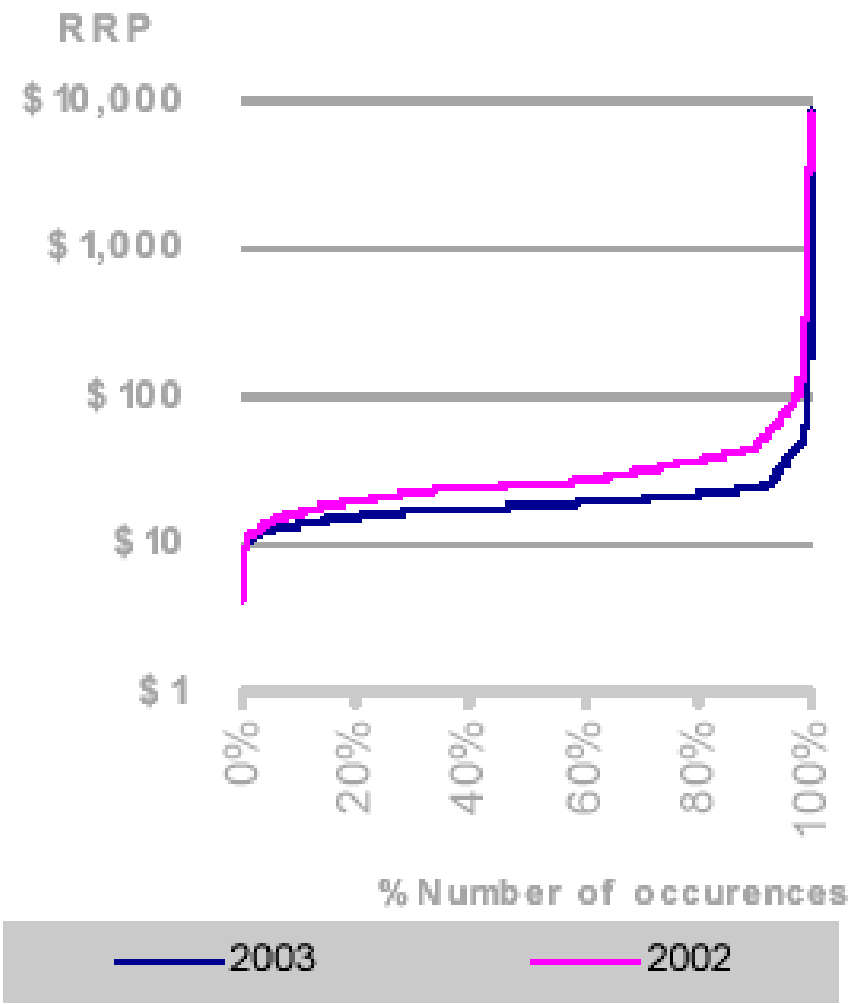


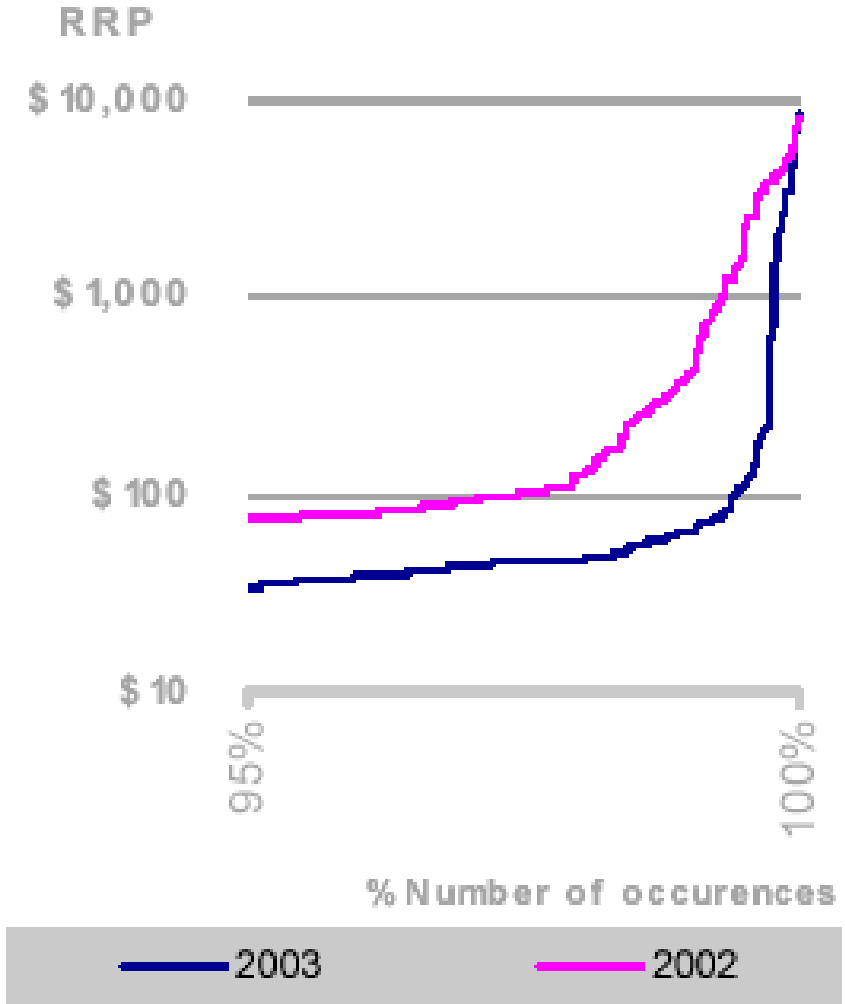
Demand side response to high spot price: NEM Victorian region, 8/2/01 (NECA, 2001)

(note: derivative contract cover usually high)



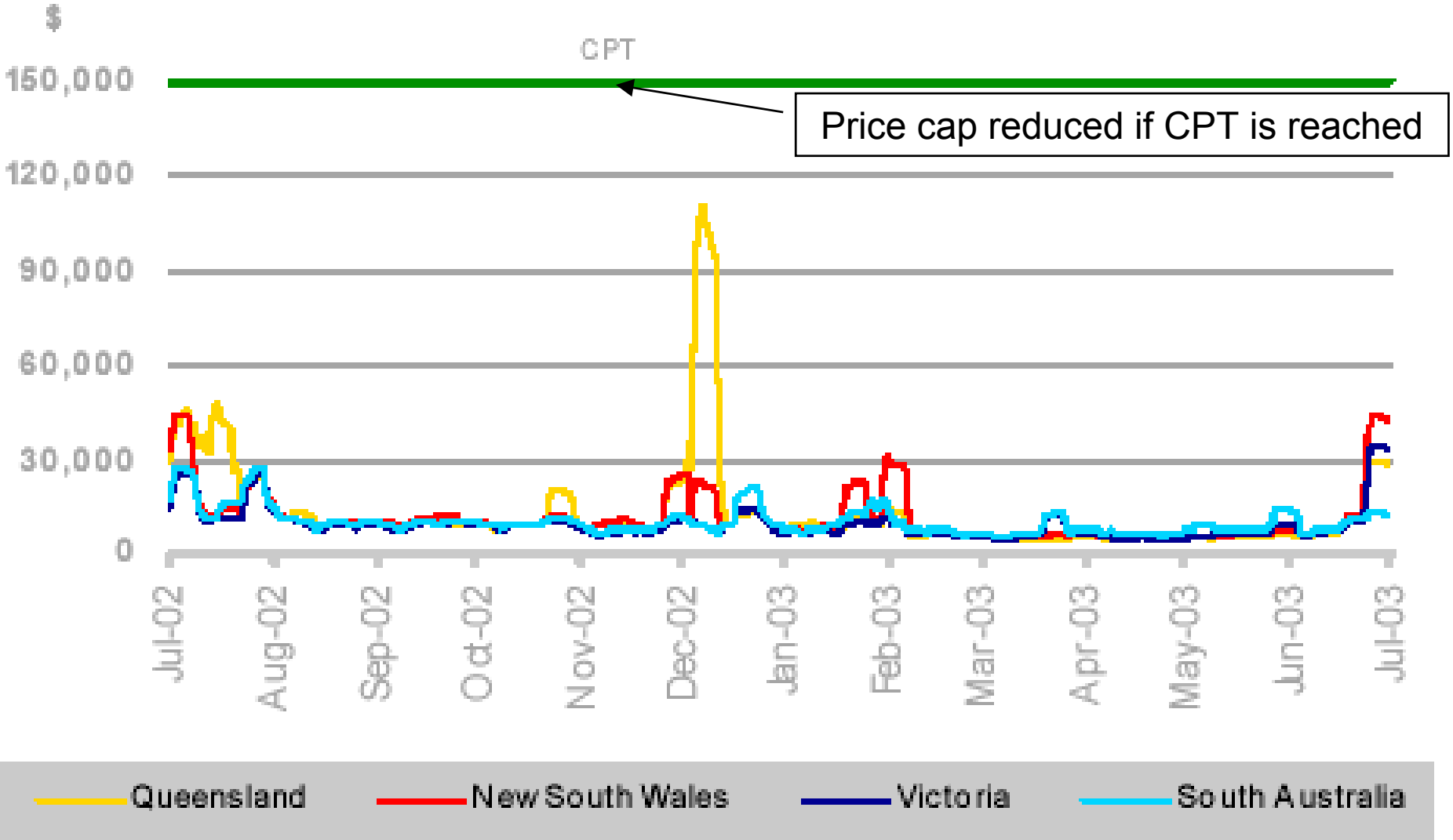
Cumulative spot price duration curve, NSW July-September 2003 (NECA, 03Q3 Stats, 2003)



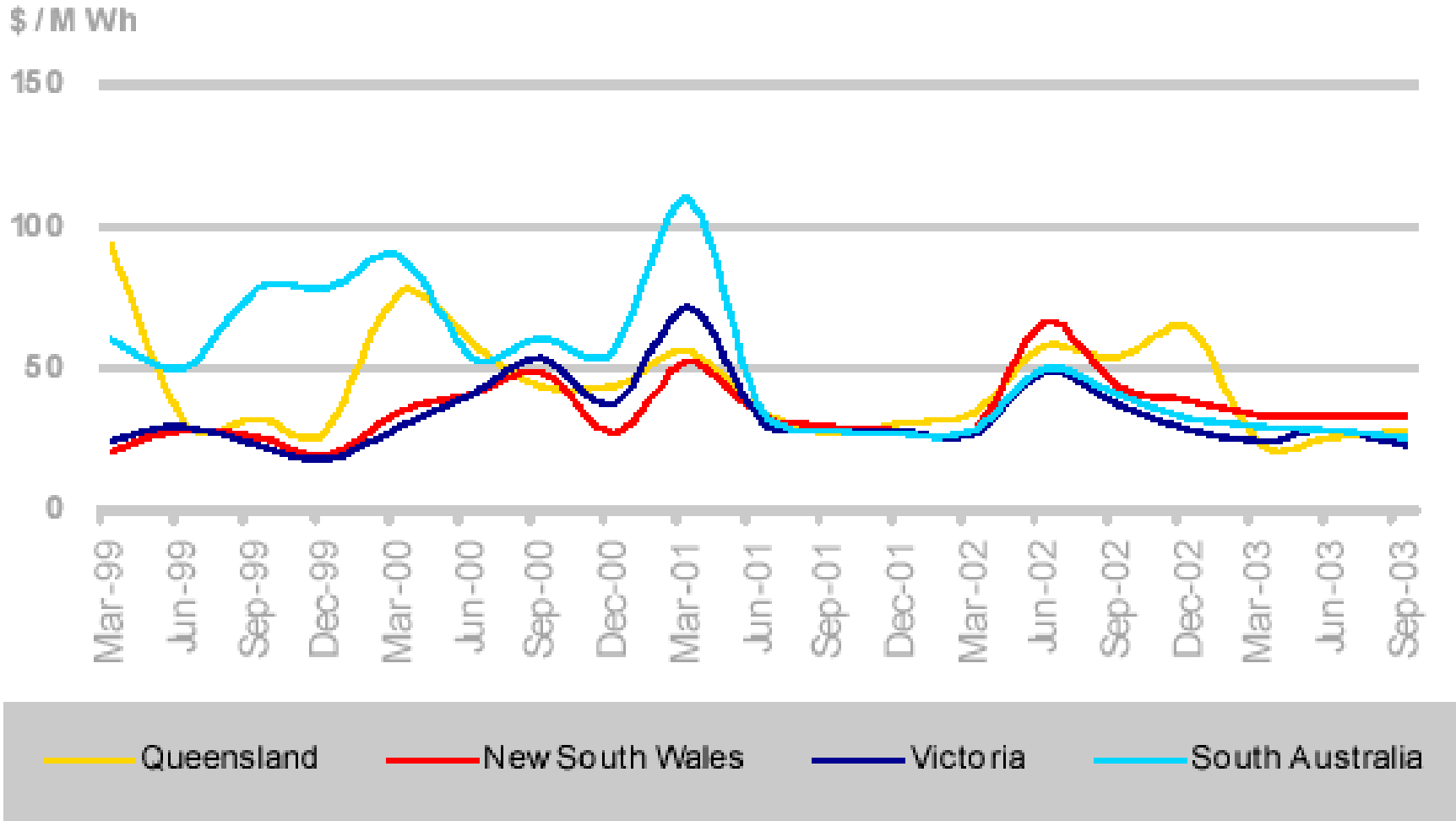


Running weekly accumulation of (336) RRPs & cumulative price threshold (CPT)

(NECA, 03Q2 Stats, 2003)



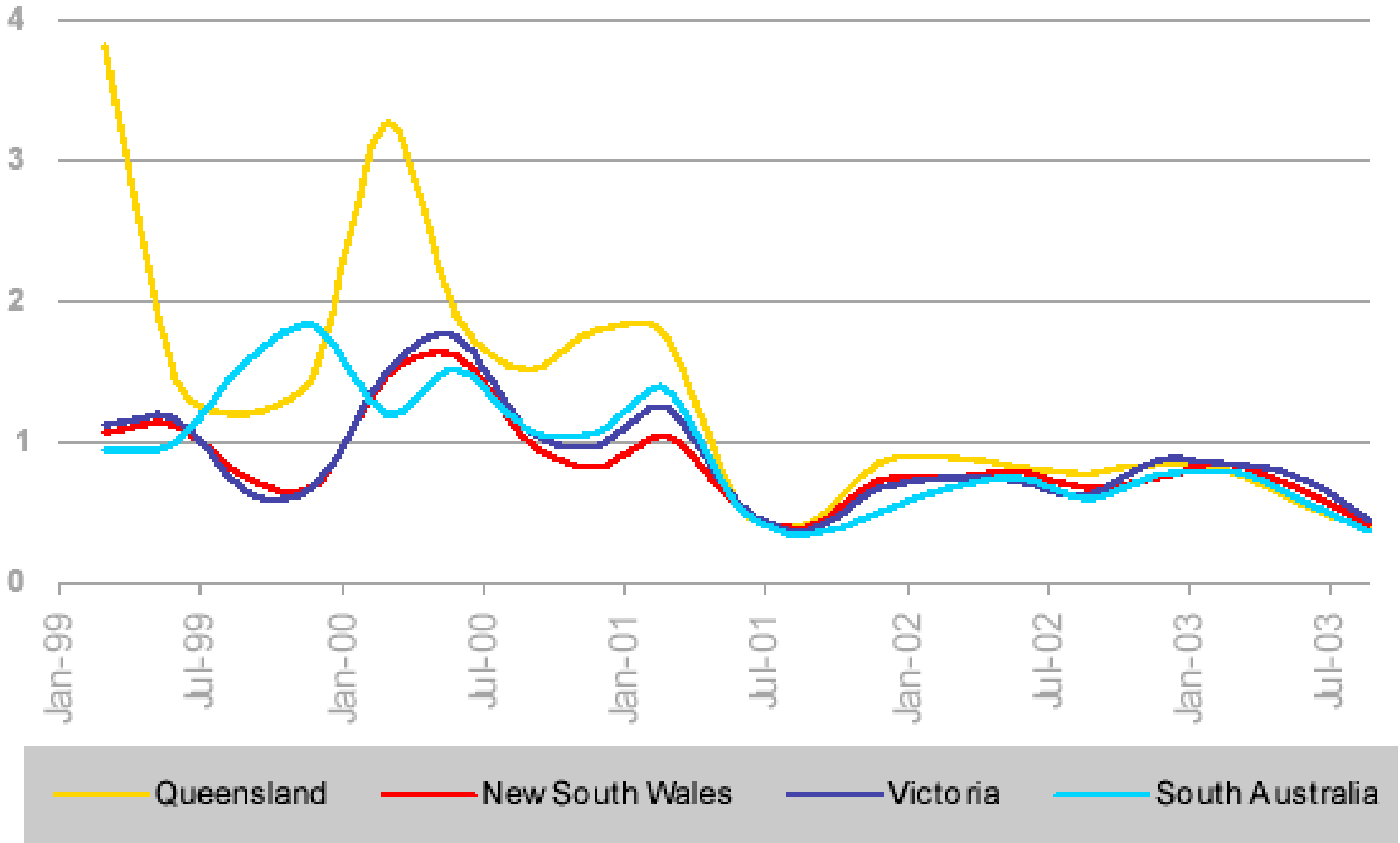
Smoothed NEM Regional Ref Prices (RRPs) since market inception (NECA, 03Q3 Stats, 2003)



NEM quarterly spot price volatility

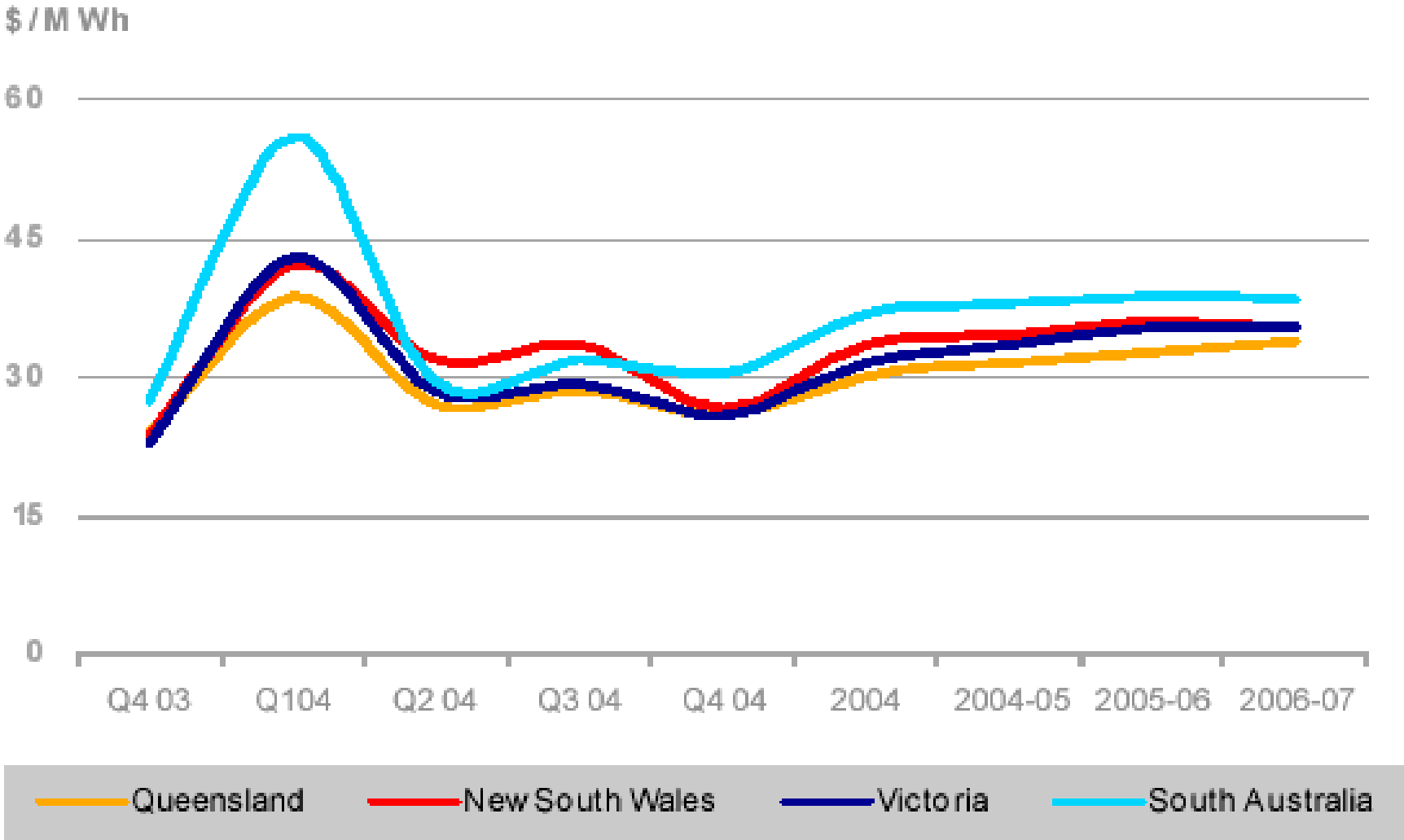
(range of central 75% of spot prices divided by median)

(NECA, 03Q3 Stats, 2003)



Average one-year flat contract prices

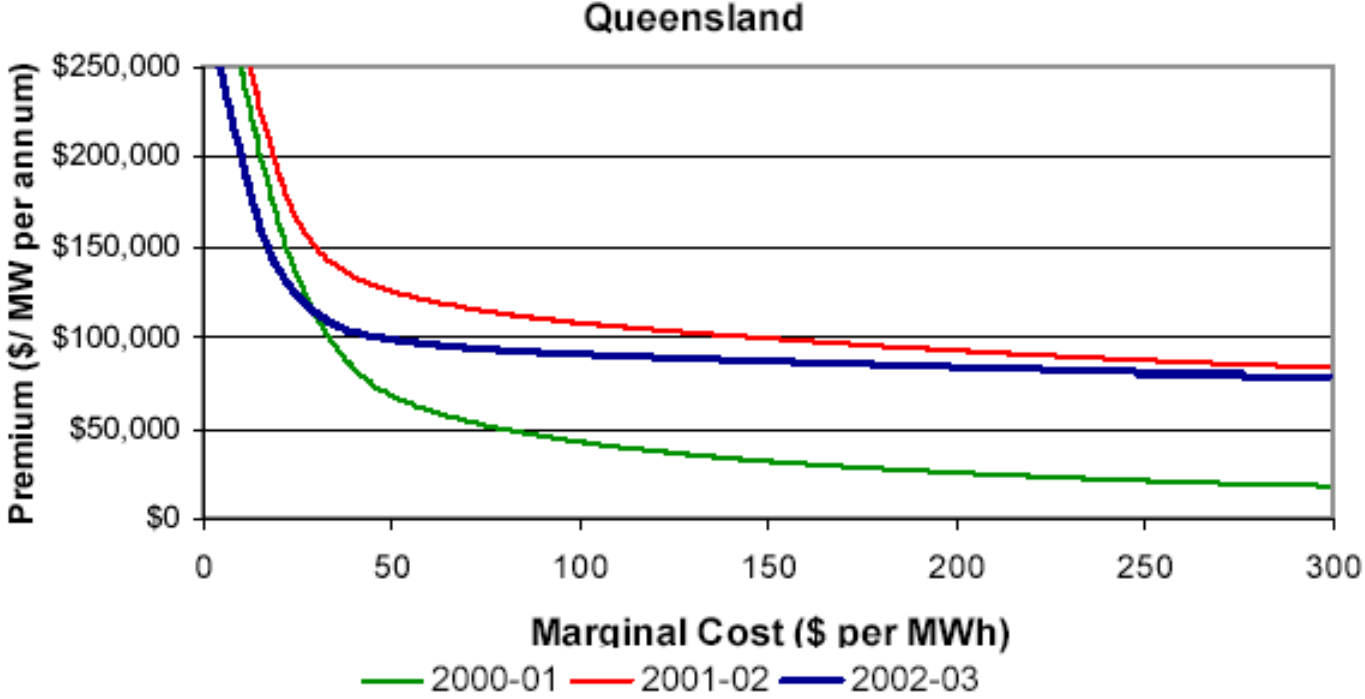
(NECA, 03Q3 Stats, 2003)

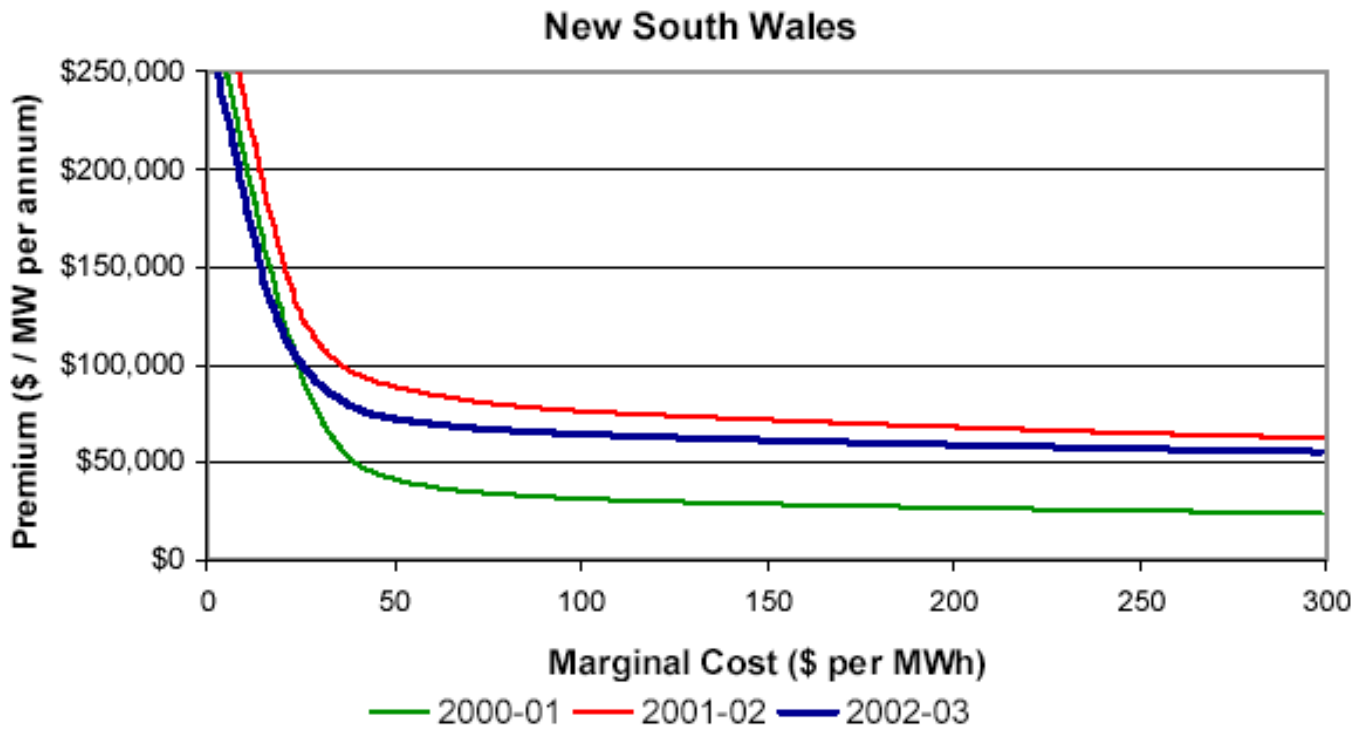


Call option premiums for Qld & NSW

Marginal price = strike price

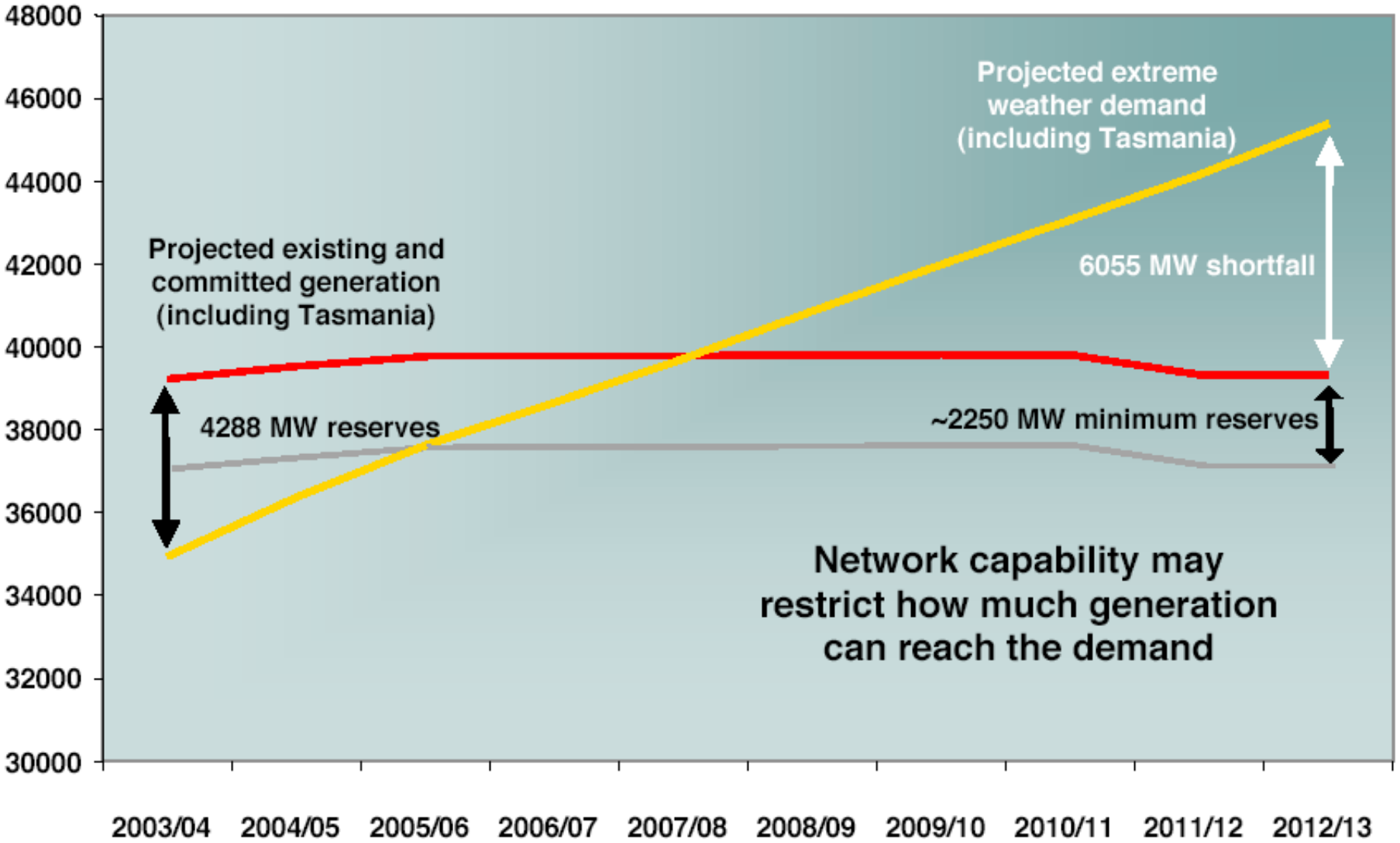
(Tavis, 2003)





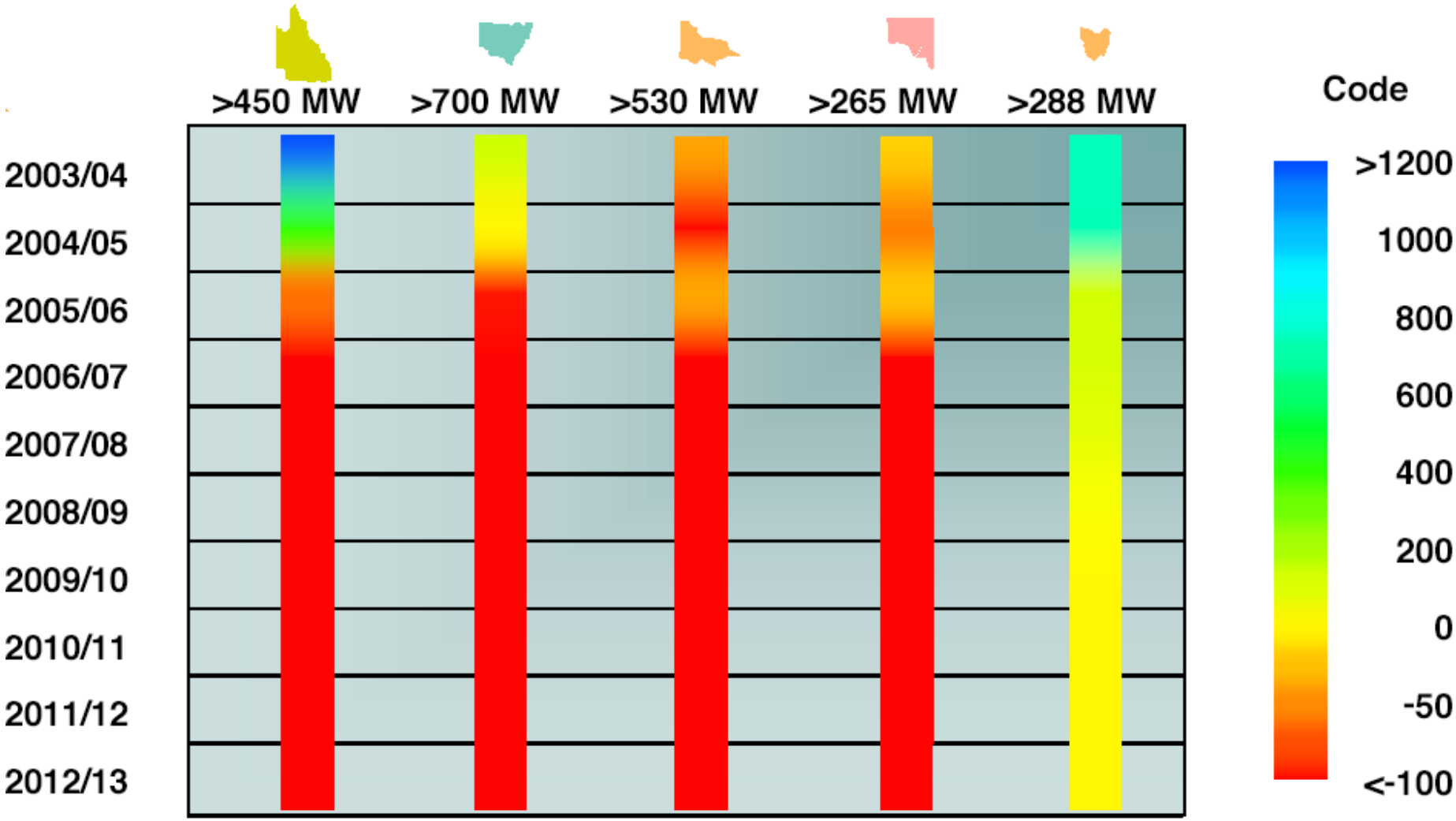
SOO: Projected gen'n & summer peak demand

(Medium growth + extreme weather: NEMMCO SOO, July 03)



SOO: Projected surplus reserves NEM states

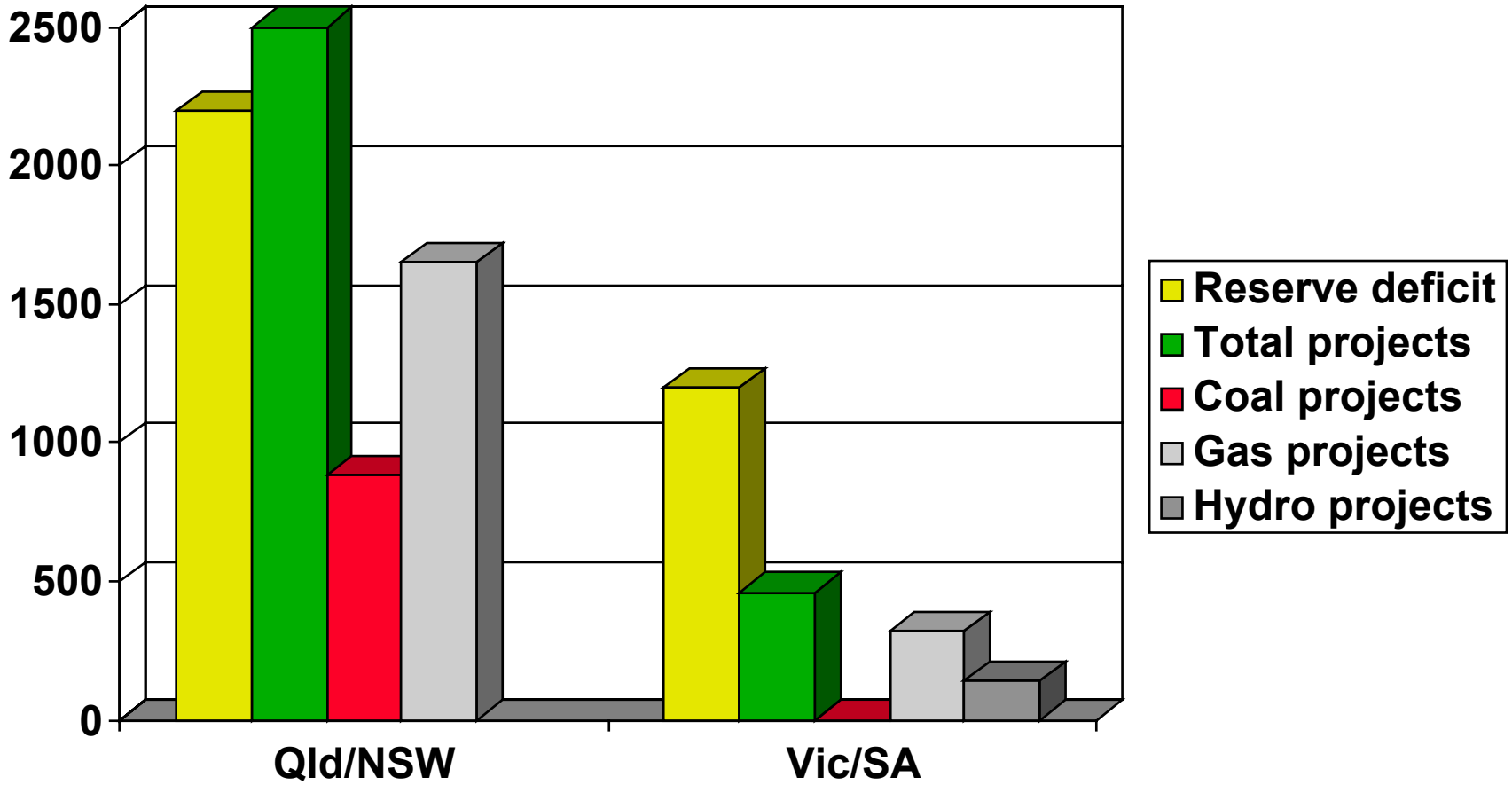
(Medium growth + extreme (10% POE) weather, NEMMCO SOO, July 03)



Four key messages (NEMMCO SOO, July 03)

1. Demand growth	***Strong in NSW and Queensland 1000-1400 MW a year NEM-wide***
2. Reserves declining	***NEM-wide decline in reserves due to demand***
3. Investment required	***"Needle peaks" impact on mix of base load - peaking - demand side***
4. Interconnection	***Will not by itself help supply-demand balance beyond 2005-06***

Advanced or publicly announced generation projects by fuel type & compared to expected reserve deficit in 2008/09



Potential market design enhancements

- AS, spot & derivative market issues (NEM & retail):
  - Potential to improve FCAS & NCAS arrangements
  - Boundary between FCAS & 5/30 minute spot market
  - More market regions to improve network representation
  - Monopoly derivative market compatible with spot market
  - Interval meters that record availability & quality of supply
  - Spot & forward retail tariffs that include FCAS & NCAS
- Network services:
  - Spot & forward network service tariffs that include NCAS
  - Resolve conflict between merchant & regulated network services
- Sustainability:
  - Emission taxes/permits plus support for innovation

Conclusions: Australian restructuring

- Strengths of Aust. electricity restructuring:
  - Efficient dispatch of existing large generation
  - Sound 10-year start to the transition process
- Weaknesses of Aust. electricity restructuring:
  - State-level governance & ownership issues
  - Inadequate environmental outcomes
  - Regulated vs unregulated network services
  - Inadequate signals for distributed resources
  - Room for improvement in market design:
    - Ancillary service, spot & derivatives, network services
    - Compatible retail market design & metering