Centre for Energy and Environmental Markets

UNSW THE UNIVERSITY OF NEW SOUTH WALES SYDNEY • AUSTRALIA



Electricity Industry Restructuring and its implementation in Australia

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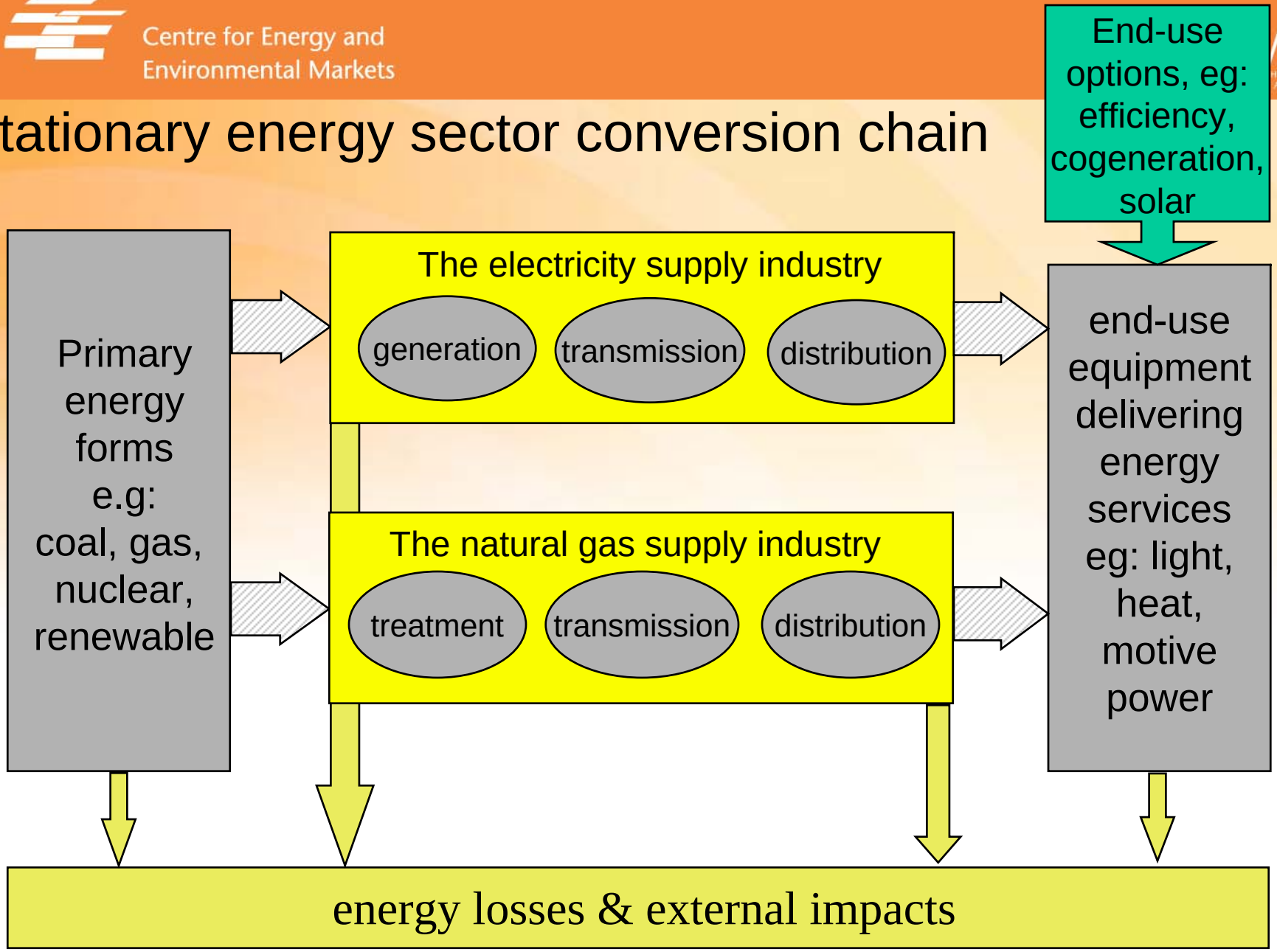
CEEM established …

- *to formalise* growing interest + interactions between UNSW researchers in Engineering, Commerce + Economics, Arts + Social Sciences, Science, AGSM, IES…
- *through Research Centre* undertaking research in interdisciplinary design, analysis + performance monitoring of energy + environmental markets, associated policy frameworks
- *in areas* of
  - Physical energy markets (with an initial focus on ancillary services, spot market + network services for electricity + gas)
  - Energy-related derivative markets (financial + environmental including interactions between derivative and physical markets)
  - Policy frameworks and instruments in energy and environment
  - Experimental market platforms and AI 'intelligent agent' techniques to aid in market design
  - Economic valuation methodologies
- www.ceem.unsw.edu.au

Outline

- The process of electricity industry restructuring
- Implementation of restructuring in Australia
- Restructuring & environmental outcomes to date
- Future directions
- Conclusions

Stationary energy sector conversion chain



Key issues for the electricity industry

- Key component of stationary energy sector
  - High quality secondary energy form
    - Expensive to make but flexible to transport + use
  - Competes with other energy sources to deliver end-use services
  - …yet also relies on these other sources
- Significant externalities:
  - Environmental
    - eg Australian EI responsible for 35% of GHG emissions
  - Social (an “essential good”)
- Is an infrastructure industry
  - *(Definition: essential elements forming the basis of a system)*
  - Essential – product or service can’t be produced without it
  - Natural monopoly elements – certainly in physical networks
- Specific physical properties

The electricity industry is different…

Cars

- Can be touched seen, & stored, last for years
- Consumer choice promotes competition:
  - Each consumer can buy a specific car
  - Each manufacturer can control product quality
- Spatial separation of buyer & seller not a serious issue

Bilateral trade works well:

- *Can use normal commercial framework although cars have infrastructure + externality issues that still have to be addressed*

Electricity

- Intermediate energy form:- invisible, ephemeral, fungible
- consumer receives mixed flow of energy from all stations:
  - A consumer can't choose a power station
  - Power station can't control quality of delivered energy
- Location matters because of network losses & constraints

*Bilateral trade **doesn't** work well:*

- *Must design & implement appropriate decision making framework to manage EI characteristics, infrastructure + externality issues*

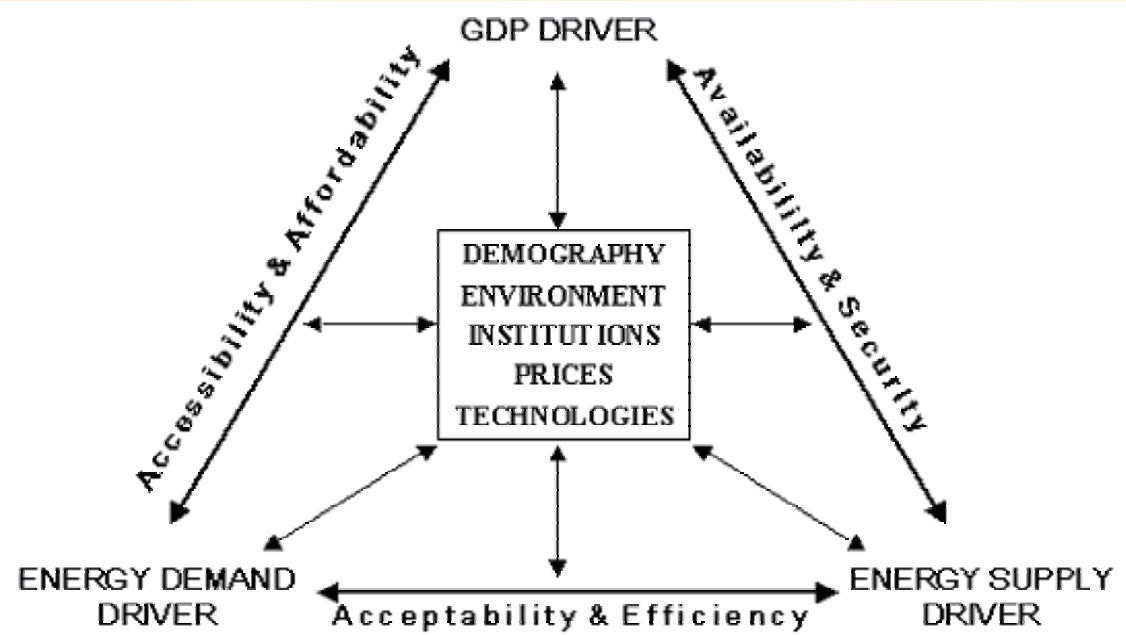
Decision making

- A **decision** is the commitment to irrevocably allocate valuable resources *with consequences*. **Decision making** is the cognitive process of selecting a course of action from among multiple alternatives. (Wikipedia.org)
- Decision-making framework
  - What objectives
  - What decisions *(available choices)*
  - How are they taken *(process)*
  - Who takes them *(individuals, groups – always challenging)*
- Good decision making likely to require
  - Well informed decision makers
  - With a good process that includes all stakeholders
  - Autonomy for the decision maker (decision theirs to make)
  - …but also accountability
- For electricity, a likely continuum between centralised (government) and decentralised (commercial) frameworks

Electricity industry objectives

- economic: minimum cost / maximum benefit
- security: reliable supply to consumers
- environmental management

- Maximise overall benefits of trade (IBOT)
  - Starting point is desired energy services
  - Seek most efficient way to meet these



Processes: single decision maker
eg. vertically integrated *electricity supply utility*

- Britain, New Zealand, Australia, etc:
  - Statutory authority supervised by a Minister
  - Decision making political, “behind closed doors”:
    - Politicians negotiate tradeoffs
- USA:
  - Regulated private monopoly (in most cases)
  - Regulatory commission & formal public hearings

Centralised (monopoly) decision making

- Risks
  - Low efficiency
  - low innovation
  - stakeholder capture
- Process issues
  - Transparency
  - Stakeholder consultation processes
  - Separation of powers between those who make the rules, put them into operation and judge them

Centralised planning: eg. EC NSW

- Generation planning, investment and operation all undertaken by Electricity Commission of NSW
- NSW elec. consumption +9%/year in 1960-70s, +6%/year up to early 1980s, then 3%/year (excluding Al smelters)
- In 1984
  - NSW system has 10,000MW of coal plant, 320MW of gas turbines, 3000MW of Hydro
  - 2640MW Bayswater under construction + due on-line 1985-6, 1320MW Mt Piper committed + due 1992-3, 660MW Tallawarra C announced
  - Projected reserve margin >60% for rest of decade and beyond…
  - Agreements in place for greater coordinated development between Vic, NSW and SA

Commission of Inquiry into Electricity generation planning in NSW - 1985

- Tasked to examine and report on:
  - Recommended generation plan including size, type, location and timing of future projects
  - Appropriateness of current procedures + gen. planning
  - Guidelines for appropriate allocation of coal resources

Commission findings – generation plan

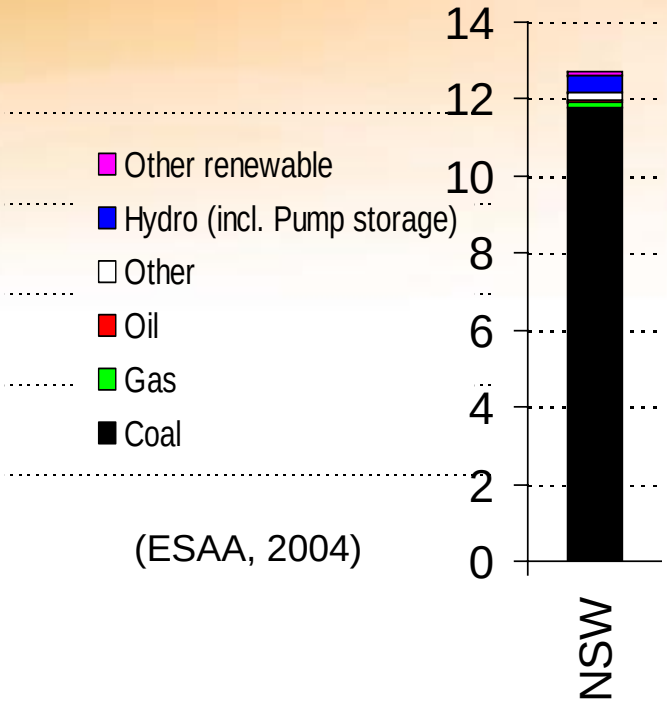
- Require better tactical + strategic planning
- Options for deferring new baseload investment proposed by ECNSW
  - more focus on value of >interconnection with Vic than ECNSW presently gives it
  - more gas turbines rather than base-load coal will save $$ (approx. 300MW of peaking per 600MW of base)
  - Explore dry cooling options, CCGT, load management
  - Need better + more transparent forecasting process

Commission findings - process

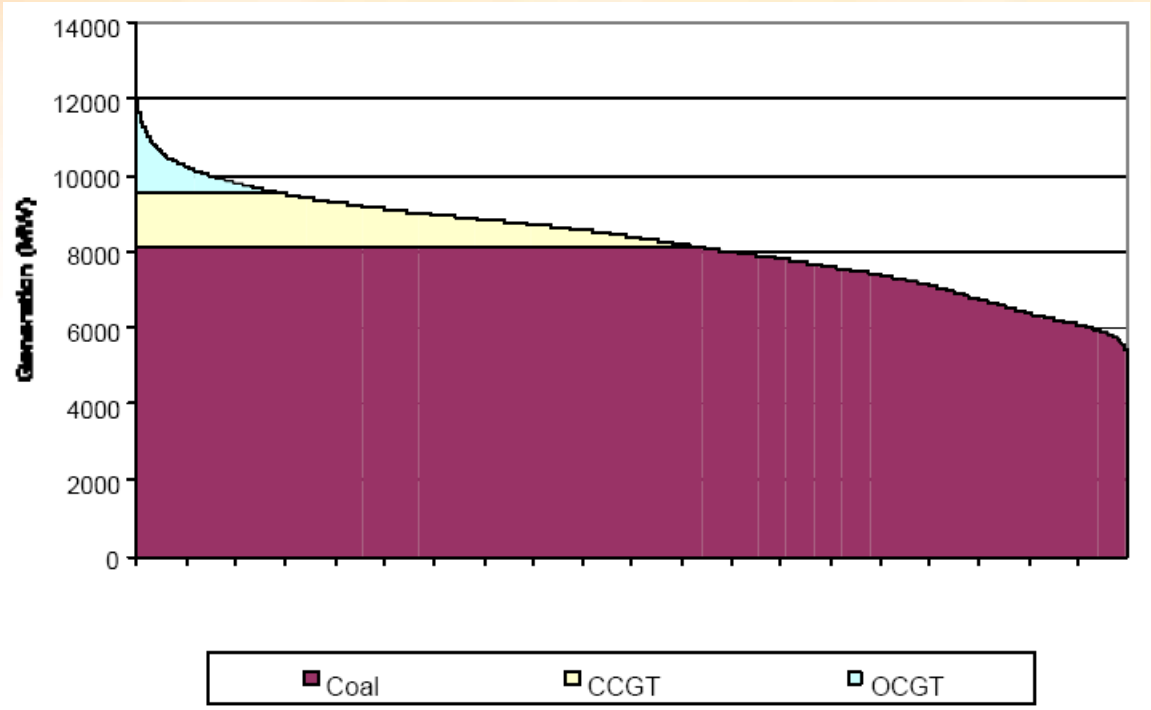
- NSW gen planning suffers from procedural problems as well as lack of consultation with public in industry which is totally funded by consumers
- Gen. projects large scale + lead times makes it difficult to exercise adequate political control
- Without clearly laid down guideliness + external scrutiny, large technological organisations often develop monopolistic practices + internal culture remote from broader social + political concerns
- Such organisations can inefficiently allocate societal wealth: *excess capacity will cost NSW several $billions*
- Need clearly articulated understanding of longer-term objectives, well resourced independent agency with overview role, formal public processes with high transparency

The NSW situation in 2004

Existing NSW plant mix is still biased towards base-load generation + adequate for present demand despite no significant new plants since Mt Piper



(ESAA, 2004)



IES "Optimal plant mix" for NSW (IES 2004 report to IPART)

Processes - Markets

- A **market** is a mechanism which allows people to trade, normally governed by the theory of supply and demand, so allocating resources through a price mechanism and bid and ask matching so that those willing to pay a price for something meet those willing to sell for it. (Wikipedia.org)

- **In essence, another possible framework for decision-making**

Electricity industry restructuring objectives

- Improve economic efficiency by facilitating competition & new entry, which assumes:
  - Effective markets & sound legal & policy frameworks
- Enhance accountability to end-users & society through 'customer choice', which assumes:
  - End-users become active participants in the industry
  - End-users are independent agents who make "informed" decisions & efficiently manage the associated risks:
- Implement a market-based approach to social & environmental externalities:
  - Assumes political will to regulate non-monetary impacts
- Release government funds by asset sales:
  - Creates a moral hazard for politicians

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*

Where competition may be introduced

(IEA, 2002)

Table 1

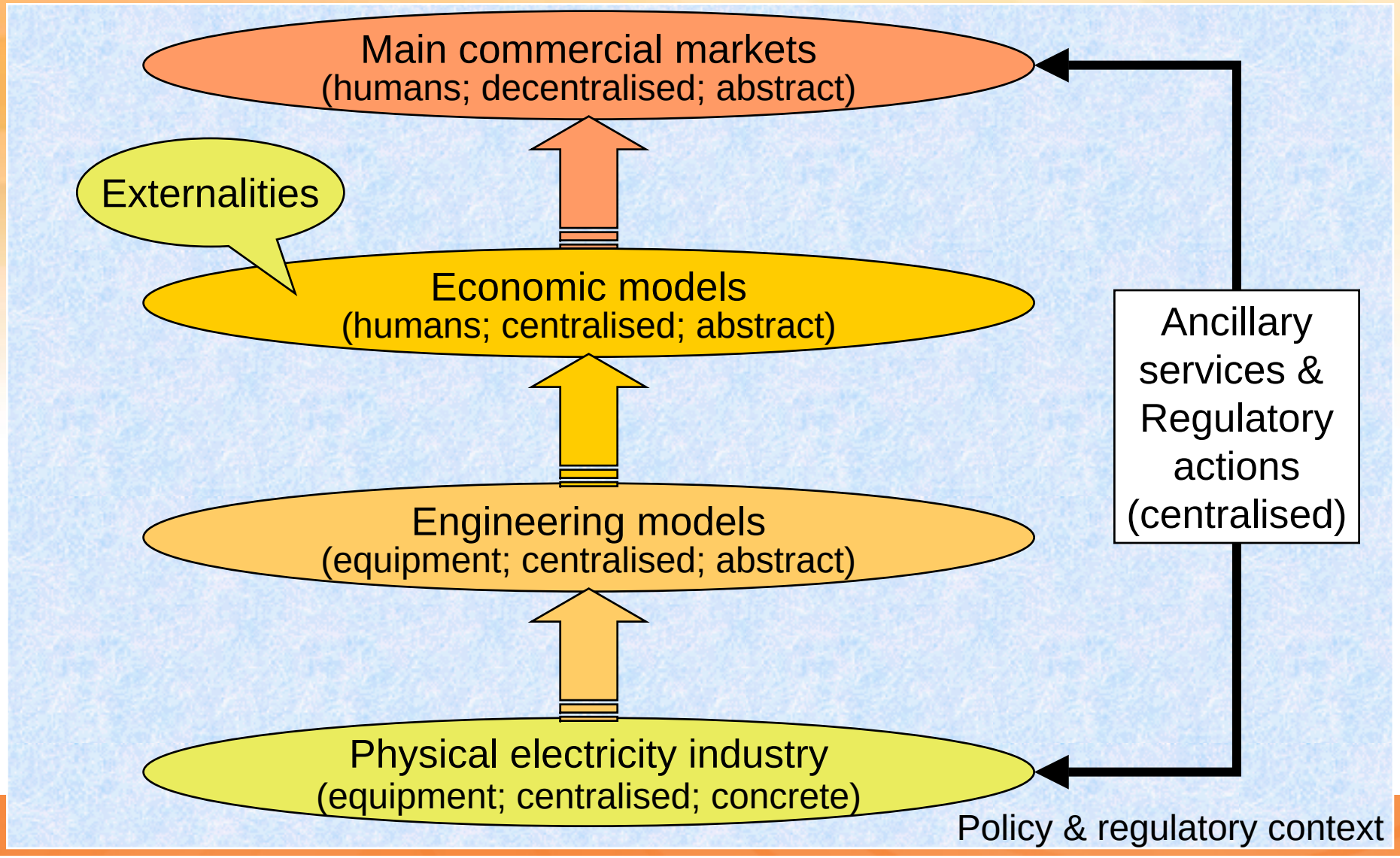
Functional Structure of the ESI

Function	Key Economic Characteristics	Implications
Generation	• Limited scale economies at plant level • Co-ordination economies at system level • Complementarity with transmission	Potentially competitive
Transmission	• Network externalities • In general not a natural monopoly • Large sunk costs	• Investment incentives need special attention • One grid but possibly several owners
Distribution	• Often a natural monopoly • Large sunk costs	No competition
System Operation	• Monopoly (due to technical constraints)	No competition
End user Supply	• Limited scale economies • No special features	Potentially competitive
Related Services: • **Power Exchanges** • **Financial Contracts** • **Construction and maintenance of assets**	No special features	Potentially competitive

Can energy markets solve all our challenges?

- Possible *energy* market failures:
  - Monopolies
    - *Generally concentrated supply-side*
  - Public Goods
    - *Essential services, contribution to growth*
  - Incomplete markets
    - *Electricity networks are shared - require high levels of coordination*
  - Information failures
    - *Under-utilised energy efficiency options*
  - The "Business Cycle"
    - *Capital intensive, long-lived investments*
  - **Externalities**
    - *Climate change, energy security, social impacts*

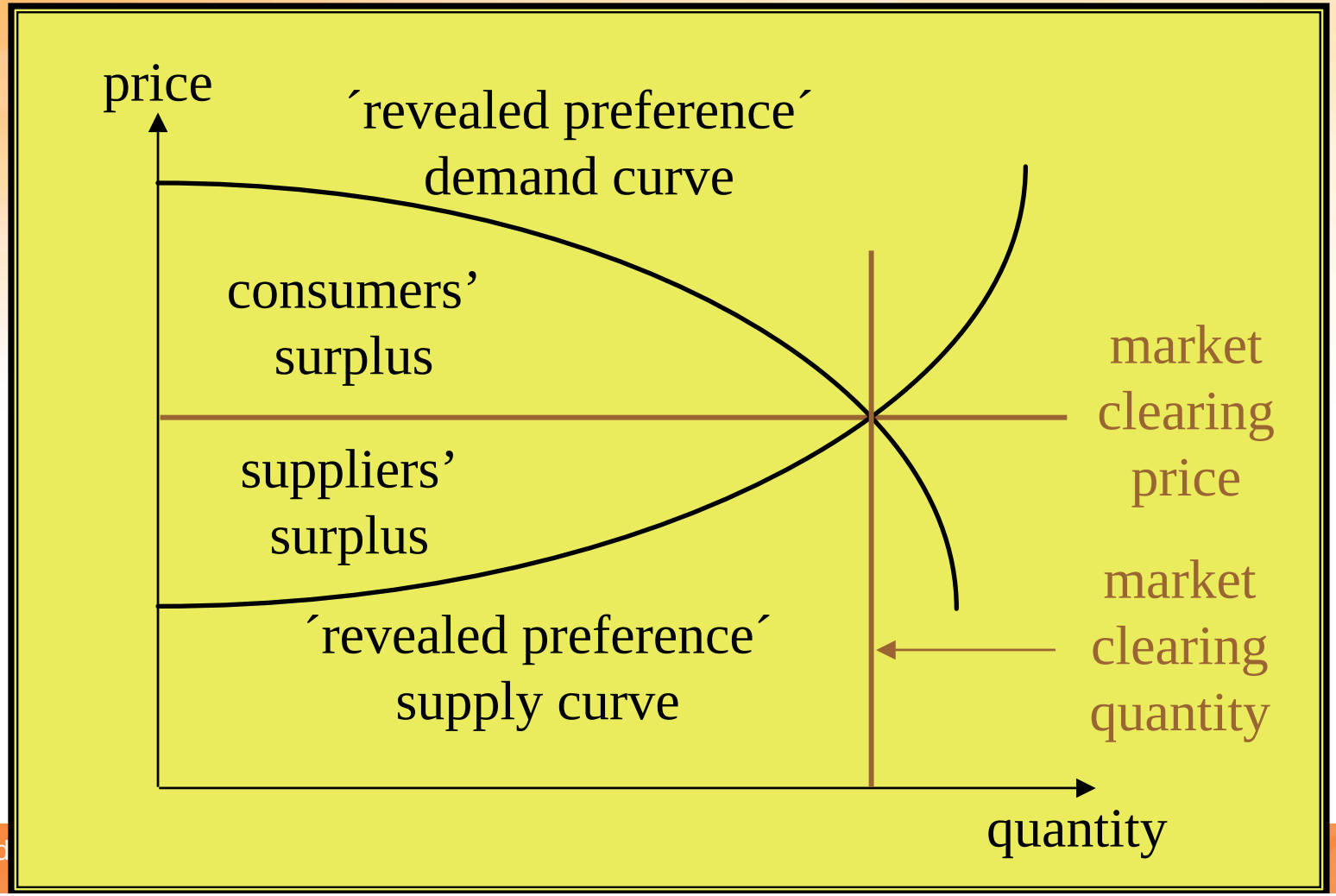
Trading in electricity:- an abstraction from reality



Decentralised (economic optimisation)

- Spot market energy traded as a commodity:
  - Energy (that meets QOS criteria) traded at spot prices in successive short spot market intervals
- Financial instruments:
  - Related to future spot market prices:
    - Convey expectations of future spot market behaviour
    - Allow risk management
- Ancillary services:
  - Resources that maintain quality of supply

Ideal market clearing process
(single auction or many bilateral trades)



There are potentially many markets…

Electricity Spot Market

Derivatives Markets

AFMA

Gas & Other Fuel Markets

Renewable Energy Market

2% target for retailers or $40/MWh penalty by 2010

Major objectives of Australian Energy Market Reform

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

Reform Objectives

- Restructuring government-owned utilities
- Removing barriers to inter-state and intra-state trade of energy
- Establishing a transparent, wholesale spot market for electricity to enable competition among generators and retailers in the eastern states
- Establishing open access to electricity networks and third-party access to natural gas networks, and economic regulation of transmission and distribution networks to ensure efficient and transparent pricing of network services
- Enabling customer choice down to the smallest retail customer
- Achieving competitive neutrality in relation to fuel sources, between incumbents and new entrants and between government-owned and privately-owned businesses

The terminology of restructuring

- Is this process
  - Market reform
  - Deregulation
  - Restructuring
  - Liberalisation
  - Privatisation

NEM development milestones

ACCC established in 1995 to administer Trade Practices Act 1974 and Prices Surveillance Act 1983

Policies, law, regulation and rules

1991, Australian Government Industry Commission initiated restructuring electricity industry (estimated benefit in order of $6 billion); National Grid Management Council (NGMC) was established in July.

1993, National Competition Act 1993 (Hilmer Report)

April 1995, Inter-state governmental agreement. Electricity Supply Act 1995

1995/6, draft of National Electricity Code (NEC), to ACCC(Nov.1996). Authorized by ACCC,30/7/1998

1996, established regulatory regimes for transmission, distribution, retail licensing, safety and environmental performance

1996, **National Electricity (South Australia) Act 1996**

Industry restructuring

1994-1995 VIC, disaggregation and privatization of generation, distribution and retail sectors

1993-1998 SA, disaggregation and privatization of generation and retail sectors

Oct. 1994, VICPOOL
May 10,1996, NSW wholesale market

1995-1996 NSW, disaggregation of generation and merger of distribution and retail sectors

1997-1995 QLD, disaggregation and privatization of generation and retail sectors

May 1996, NECA and NEMMCO were founded

May 4, 1997, NEM stage 1, NSW, VIC, ACT, SA

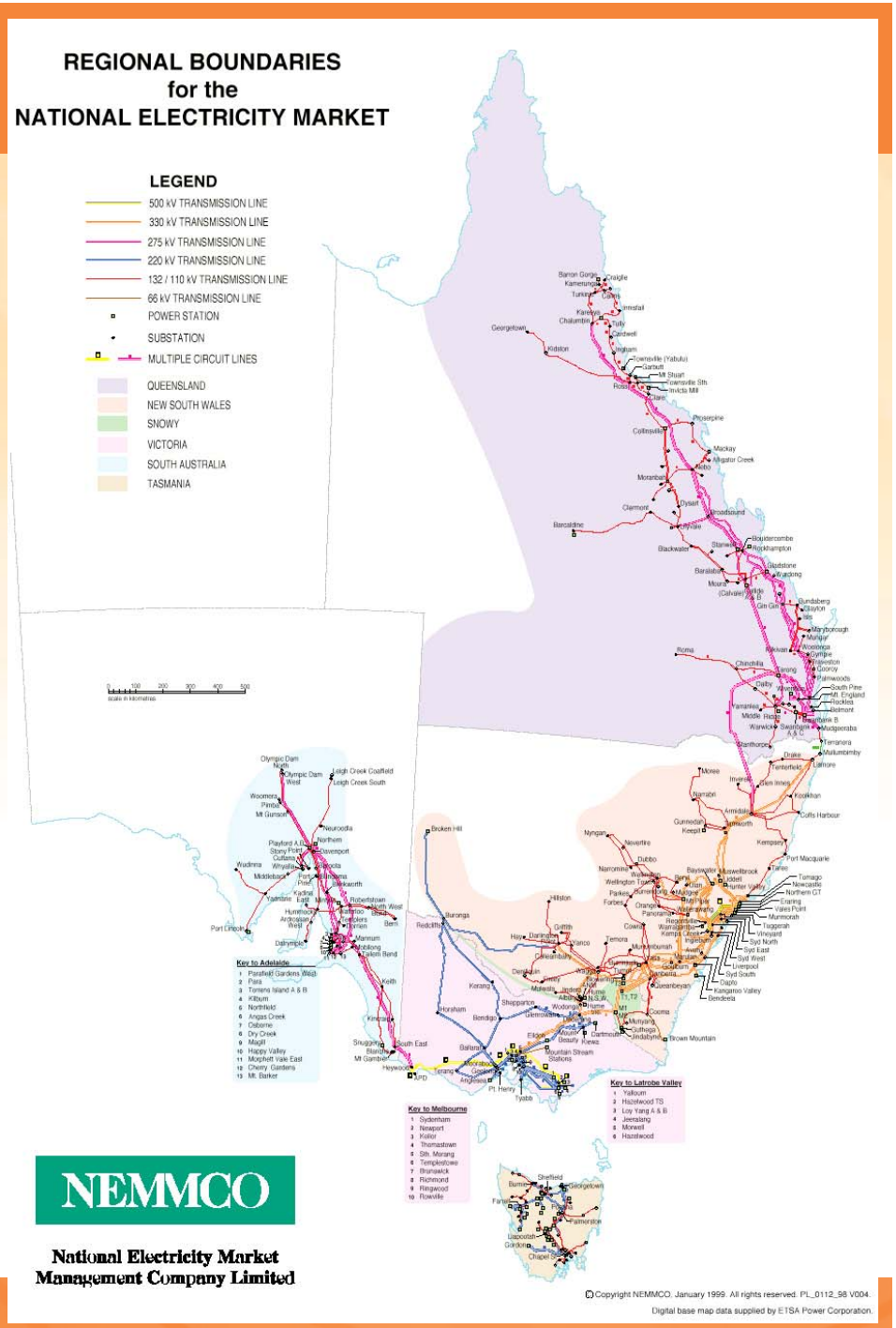
Dec 13, 1998, NEM commenced operation

Jan 18, 1998, QLD connected to NEM1

Scope of the NEM

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

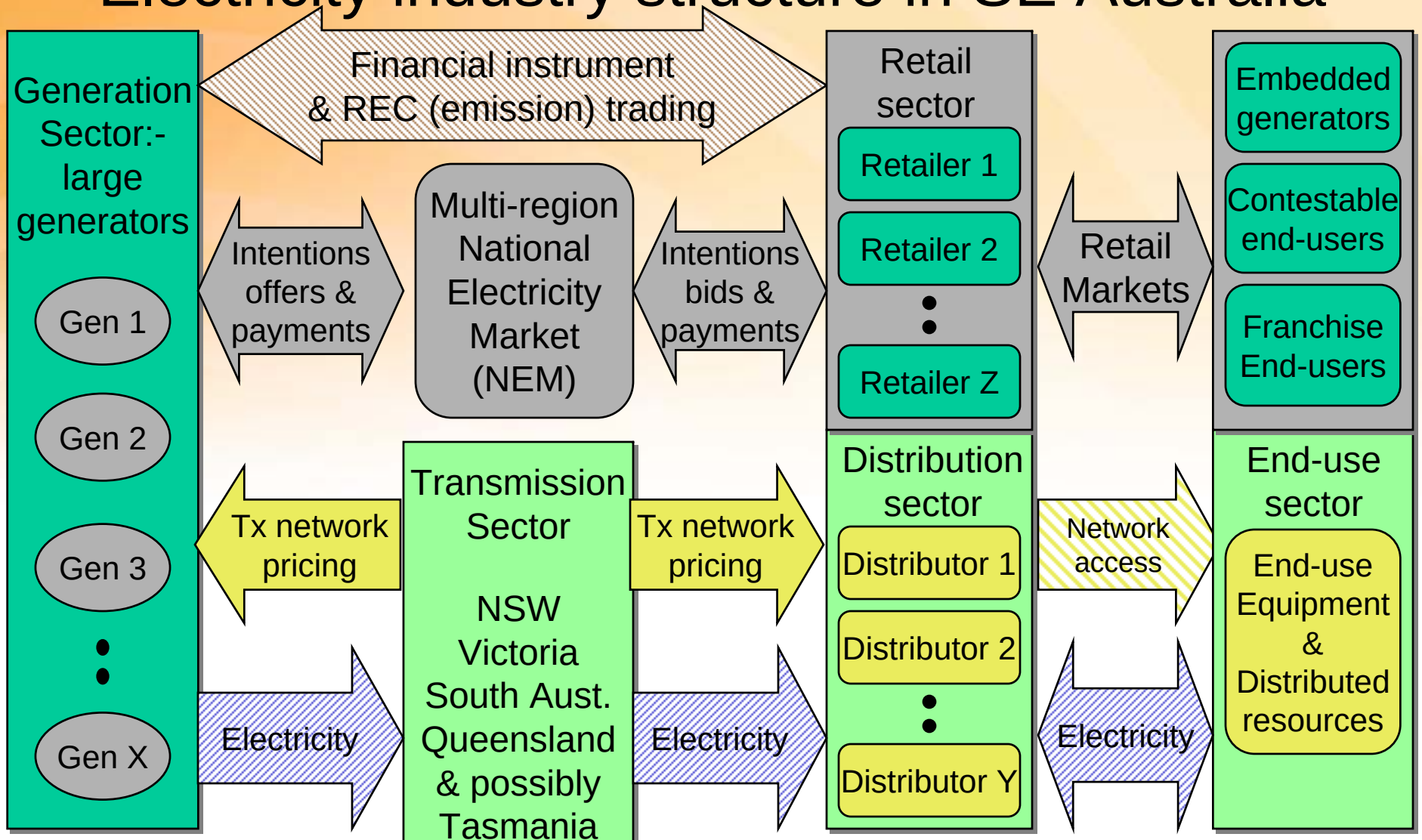
NEM regions are indicated, and their boundaries need not be on state borders (e.g. two regions in NSW)



Key NEM features

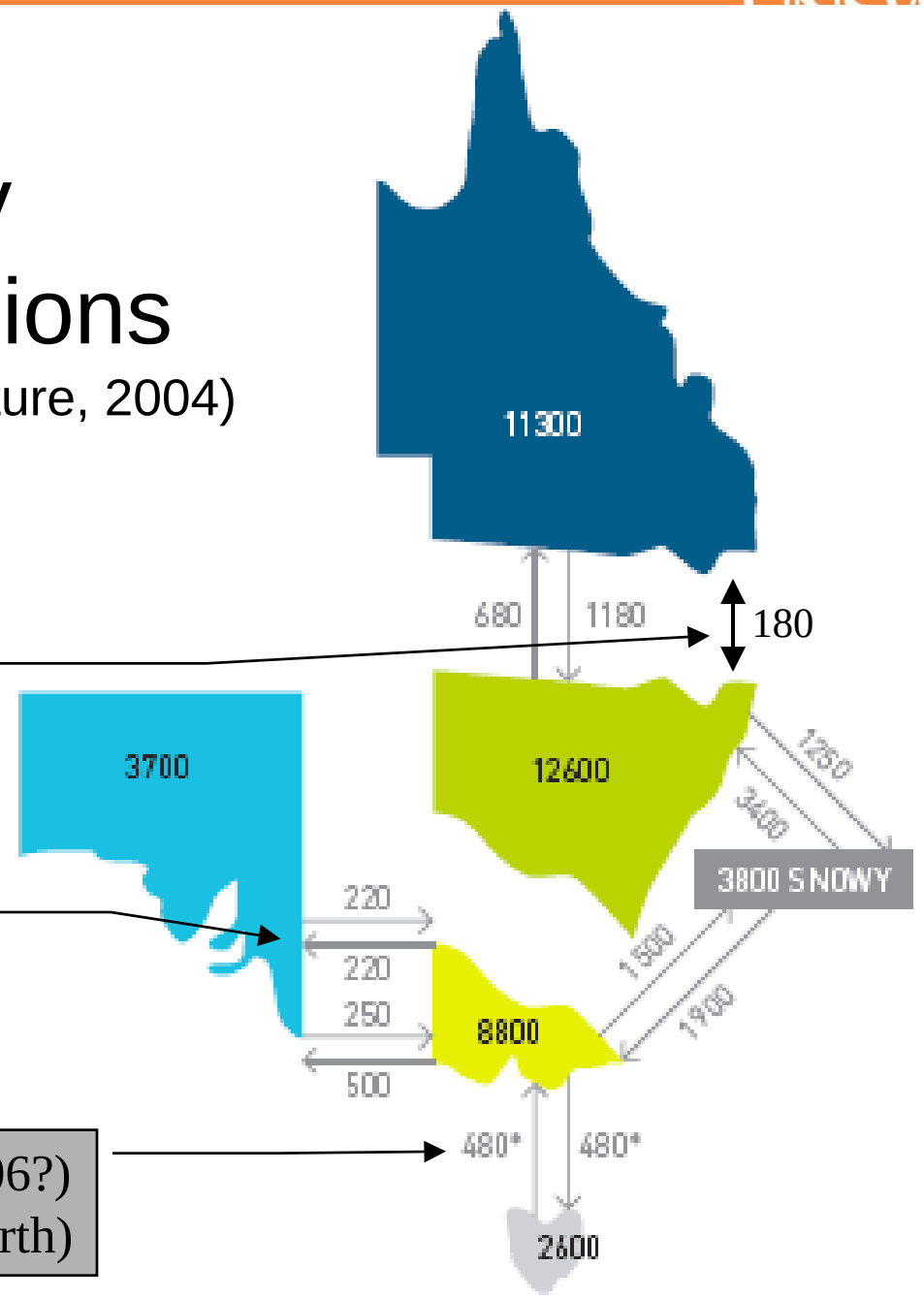
- NEM covers all participating states:
  - A multi-region pool with intra-regional loss factors
  - Ancillary services, spot market & projections
  - Auctions of inter-regional settlement residues
  - Operated by NEMMCO (owned by states)
- Compulsory participants in NEM:
  - All dispatchable generators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

Electricity industry structure in SE Australia



National Electricity Market market regions

(Securing Australia's Energy Future, 2004)

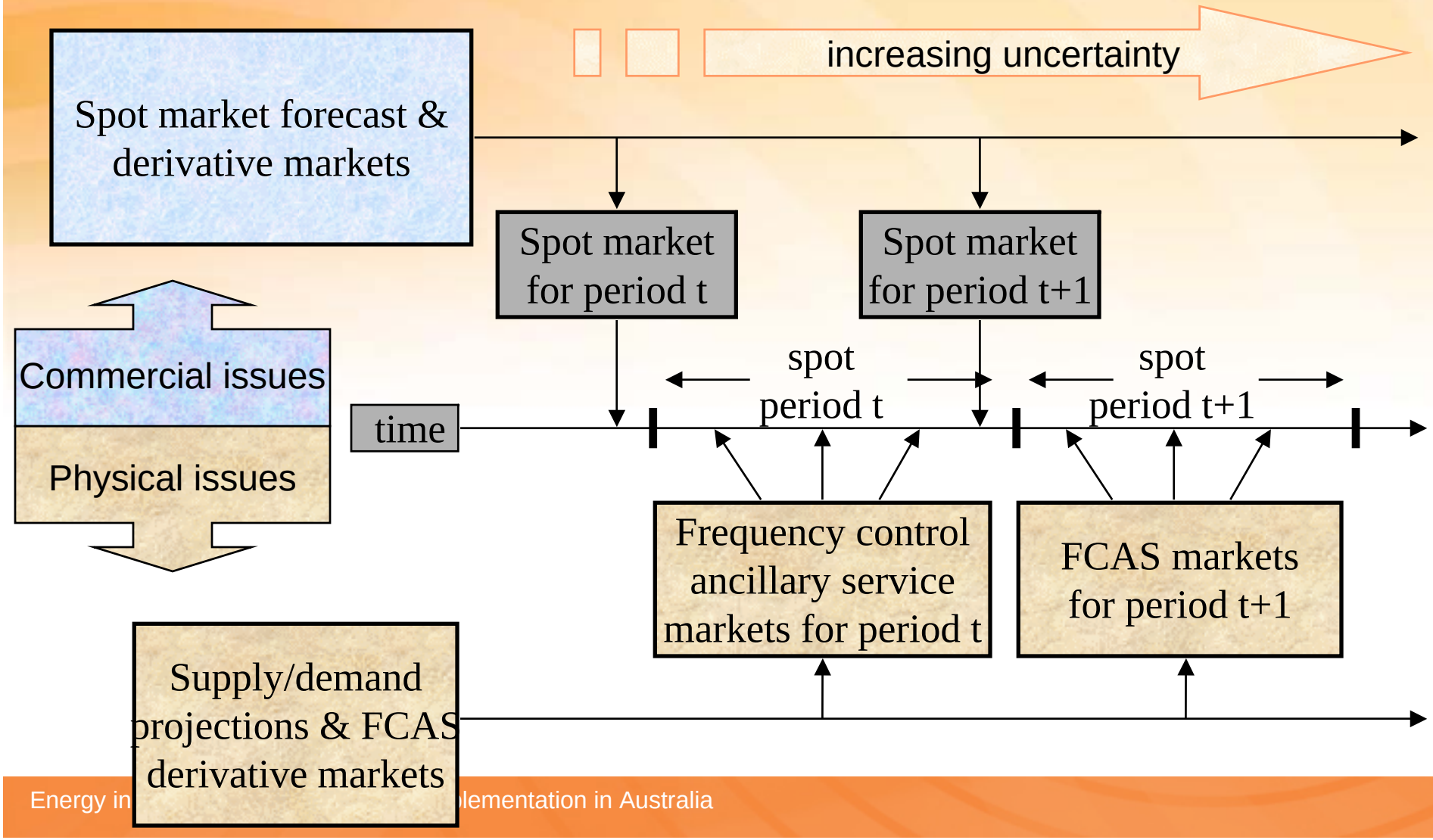


Directlink DC link, currently MNSP

Murraylink DC link, now regulated, formerly MNSP

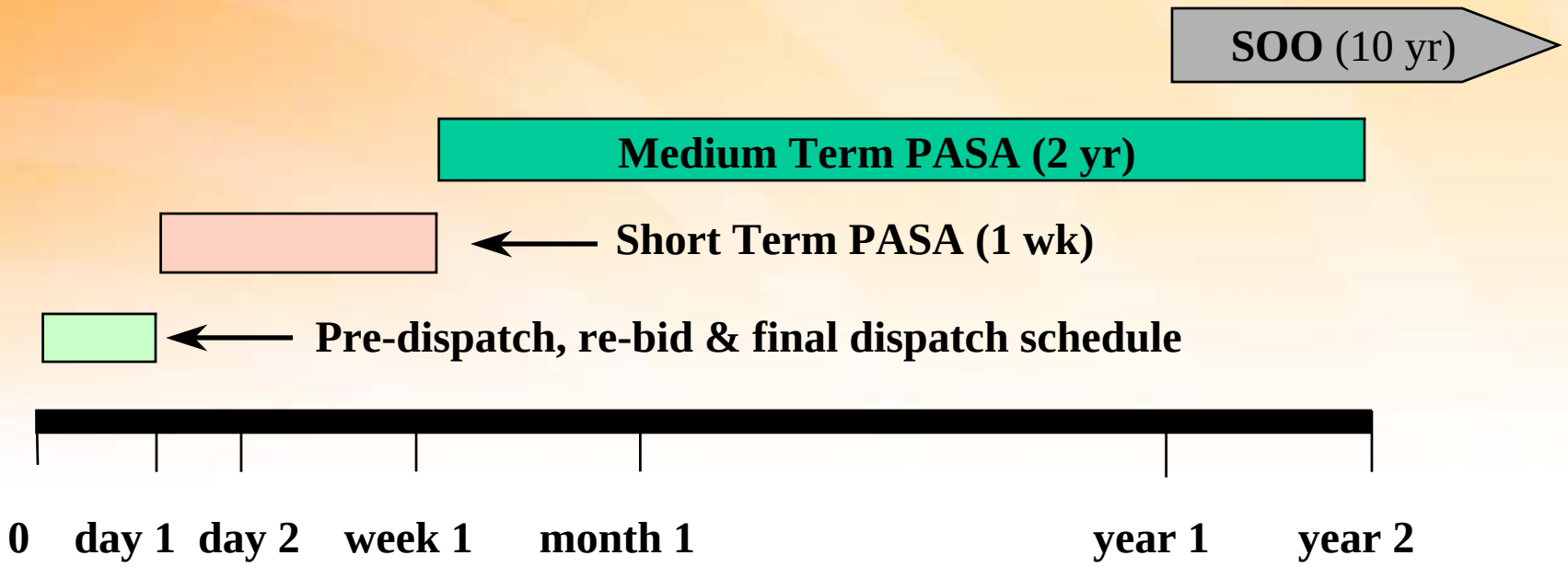
Basslink DC link MNSP (2006?) 600MW short term rating (north)

Managing supply-demand balance in NEM



Dispatch, Pre-dispatch, PASA & SOO

(source: NEMMCO)



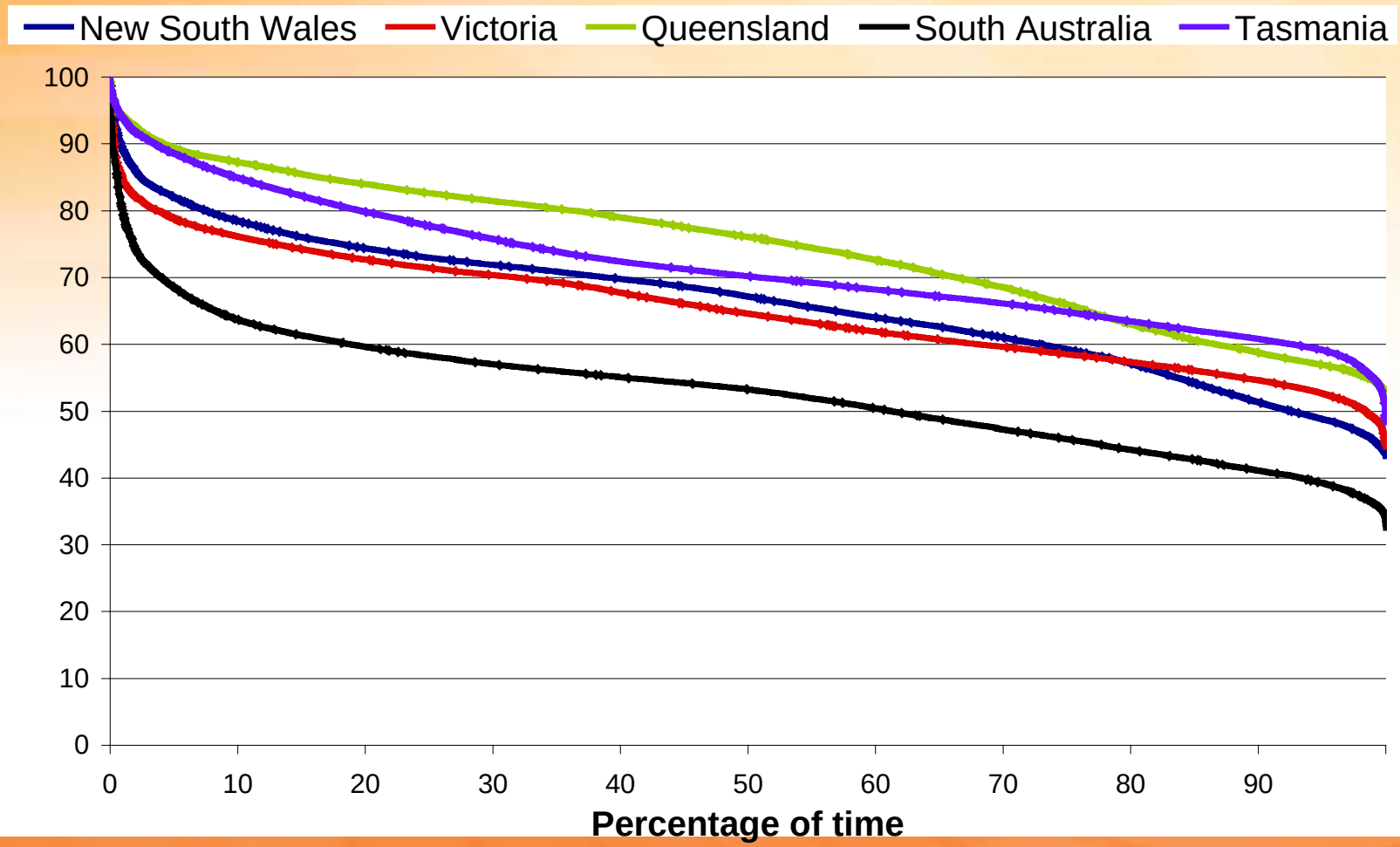
Statement of opportunities (SOO) is intended to inform generation and network investment decisions (10 year horizon, yearly update)

MT Projection of System Adequacy (PASA) is intended to inform near-term reliability assessment and reserve trader processes (2 year horizon, weekly update)

Key derivative markets

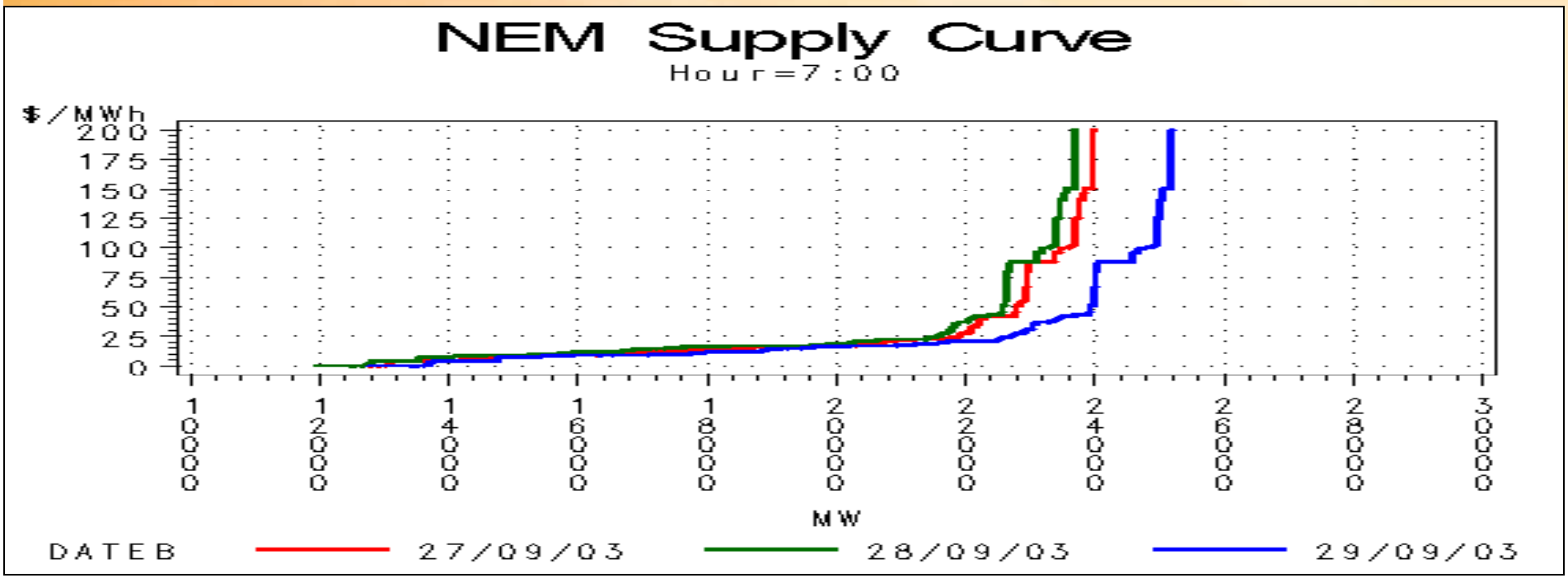
- Forward contracts (futures)
  - Expected spot price for a defined load shape & period (eg flat annual demand)
  - Either OTC or exchange traded
- Call options
  - 'Insurance' against unexpectedly high spot market prices
- Renewable energy certificates
  - Available to qualifying generators
  - Increasing to 9,500 GWH pa at 2010 then cont. to 2020

2003 Load duration curves for NEM states
(NEMMCO SOO documents, 2004)

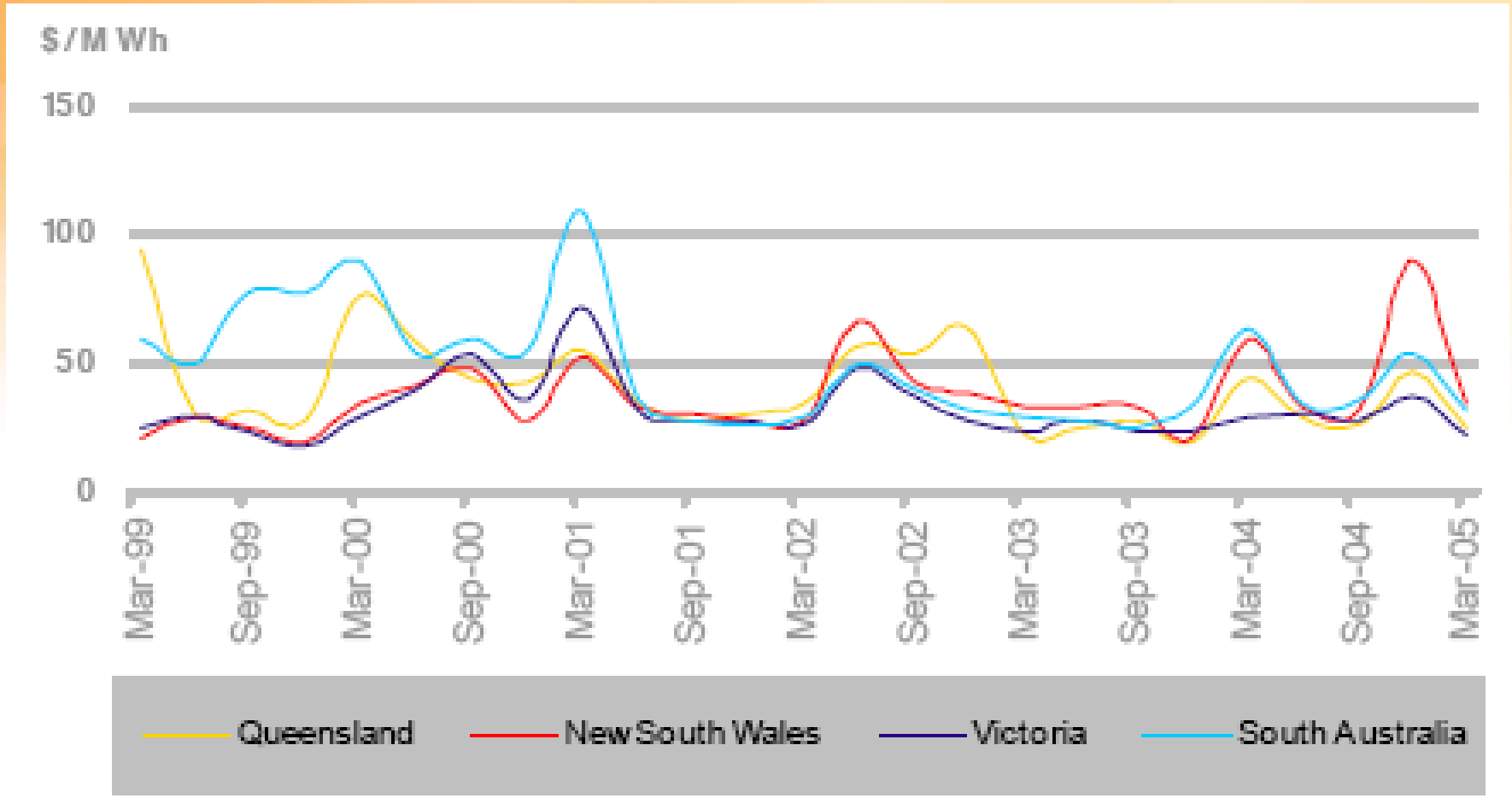


Typical NEM Supply Curves

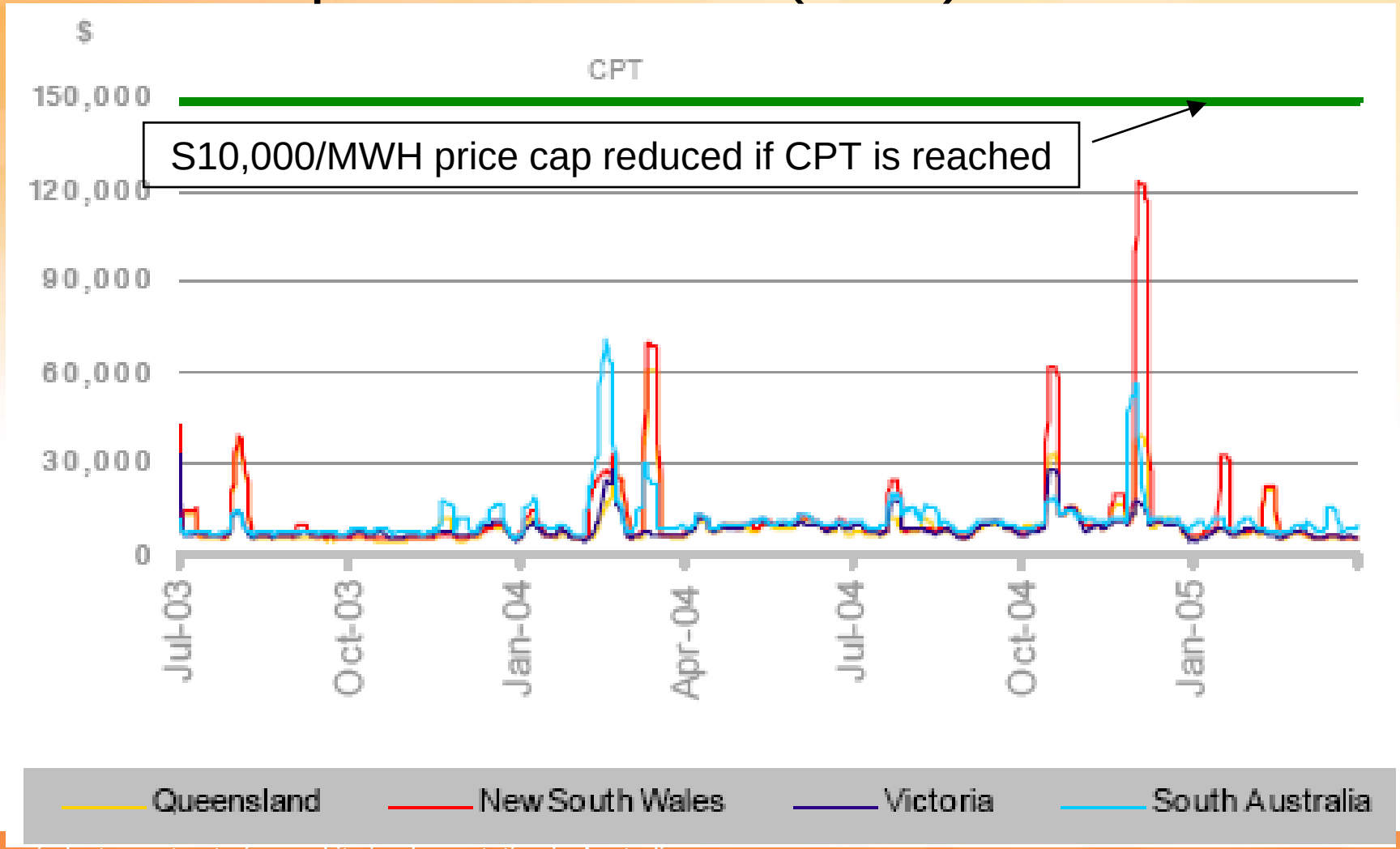
(Delta Electricity, 2003)



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

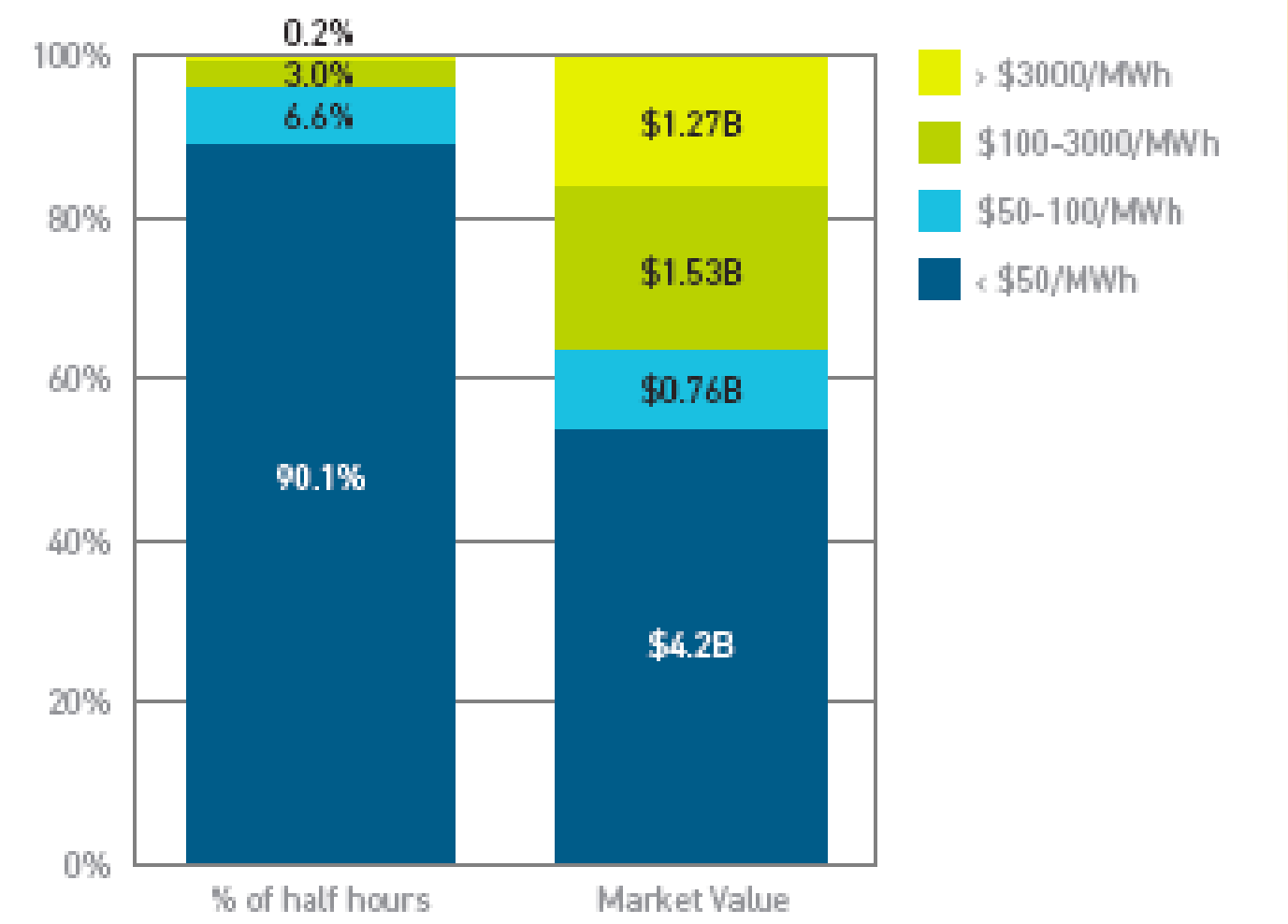


Running weekly accumulation of (336) RRPs & cumulative price threshold (CPT) (NECA, 05Q1Stats, 2005)



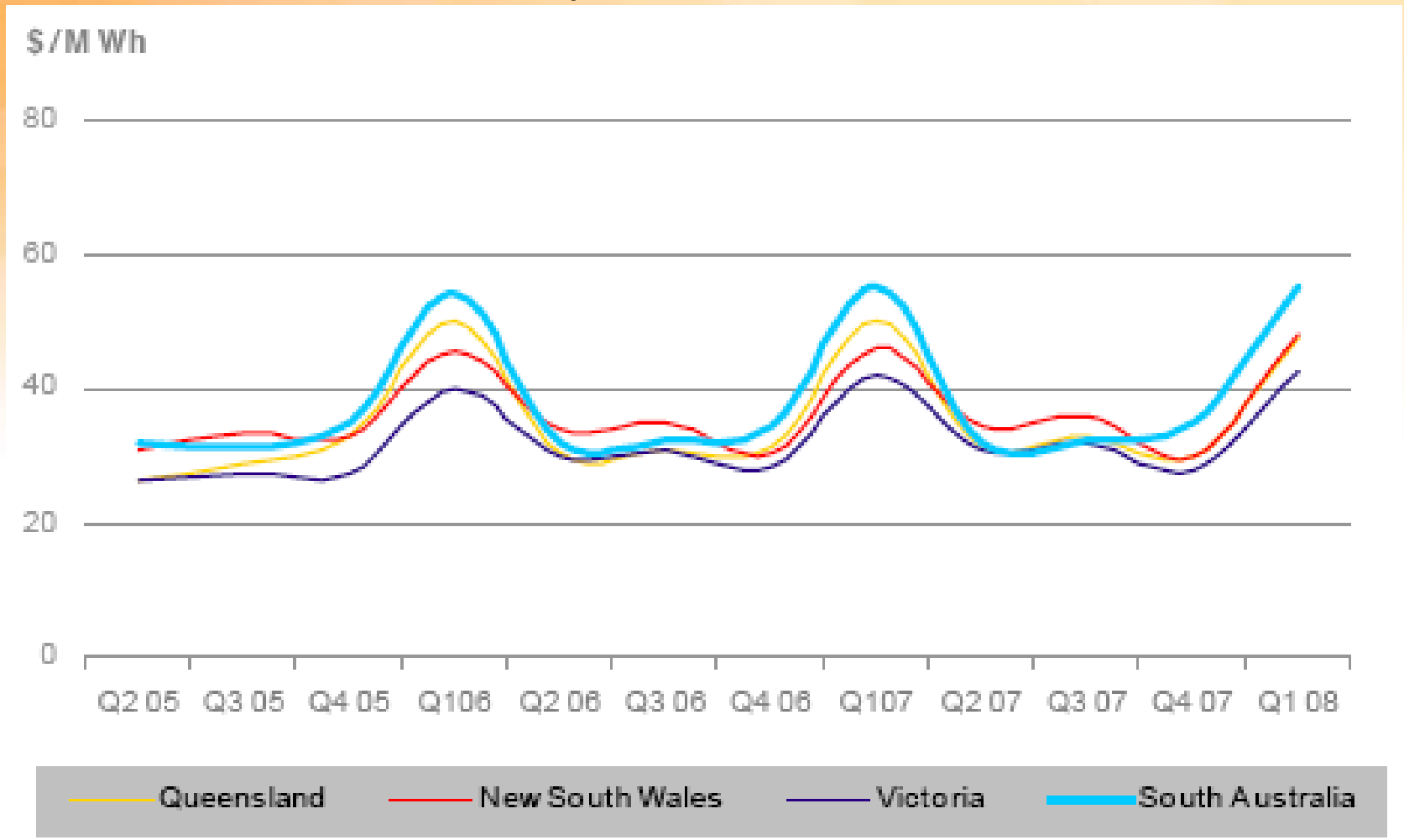
Distribution of NEM spot prices & revenues

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

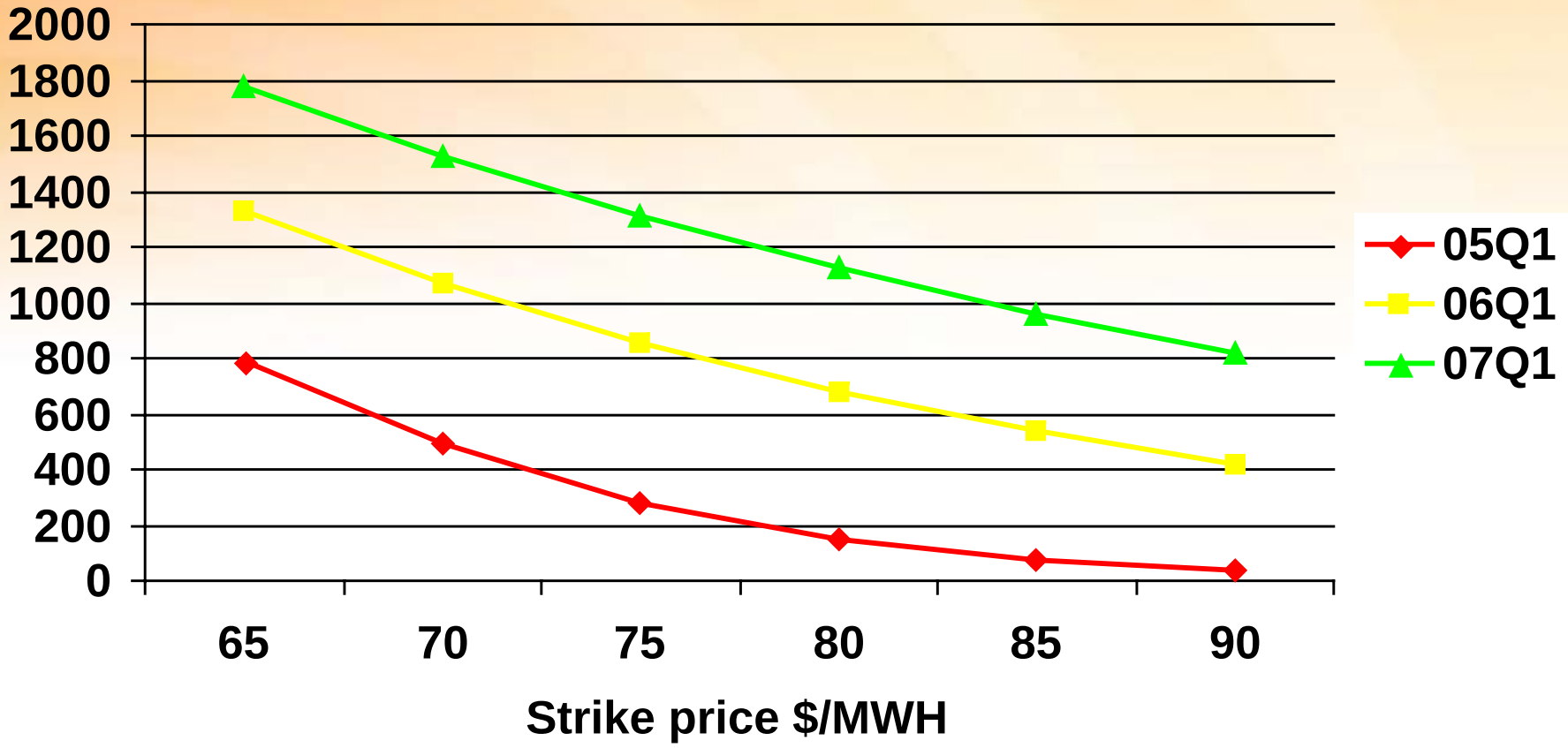


Flat contract prices, Q1 2005

(NECA, 05Q1 Statistics, 2005)



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



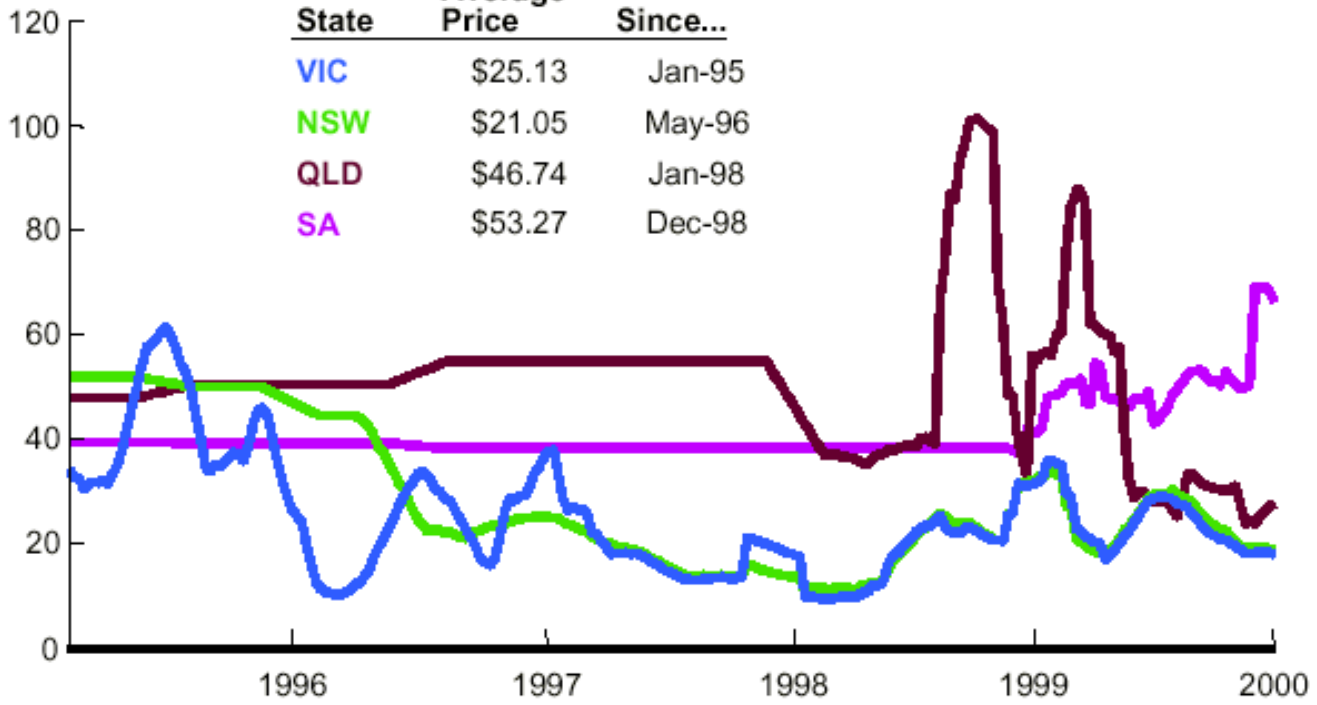
Price history for NEM & its precursors

(Business Council of Australia, 2000)

NEM ELECTRICITY POOL PRICES*

$/MWh

State	Average Price	Since...
VIC	$25.13	Jan-95
NSW	$21.05	May-96
QLD	$46.74	Jan-98
SA	$53.27	Dec-98



* Three month moving averages. For years prior to market operation the prices are the result of dividing generation revenues by energy produced

Source: Bardak (extracted from NEMMCO data and Annual Reports)

Australian Electricity Industry Value Chain

	Fuel Providers	Generators	Transmission	Distribution	Retail	Totals
Value Added	$2b	$3b	$2b	$5b	$1b	$13b
Assets (Depreciated Value)	$2b	$10b*	$6b	$26b	$3b	$47b
Rev:Asset	1:1	1:3	1:3	1:5	1:3	1:3.6
c/kW	1.2c	1.8c	1.2c	3.1c	0.6c	8c

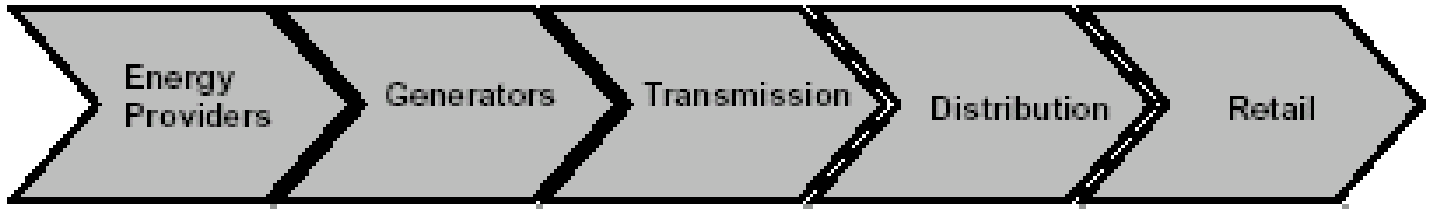
Source: Derivation of figures from annual reports of participants and the NEMMCO SOO

* Written down asset value; replacement value is approx. $40b

(Bach Consulting, Report to NEMMCO on Risk Management in the NEM, 2003)

NEM Ownership – Private and Government

State And Private Asset Ownership In The National Electricity Market



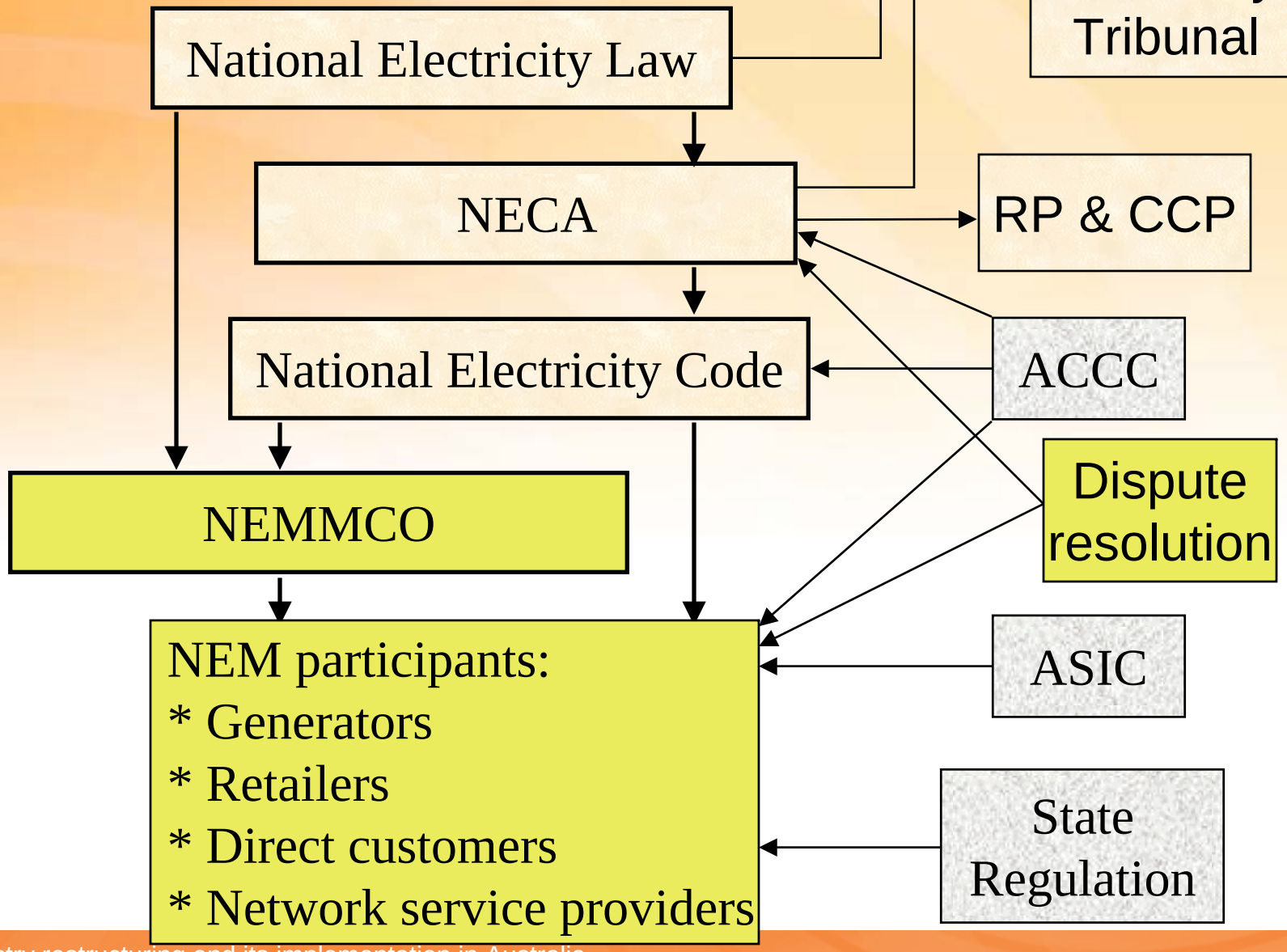
		Generators	Transmission	Distribution	Retail
% State owned	Few	70%	70%	70%	60%
Value of Assets		$7b	$4b	$18.2b	$1.8b
% Private Owned	Most	30%	30%	30%	40%
Value of Assets		$3b	$2b	$7.8	$1.2b

State Owned Enterprises = $31b (69%)

Private = $14b (31%)

(Bach Consulting, Report to NEMMCO on Risk Management in the NEM, 2003)

NEM Regulation… as it was



So, what's next?

Security outcomes from 2004 SOO

(NEMMCO, 2004)

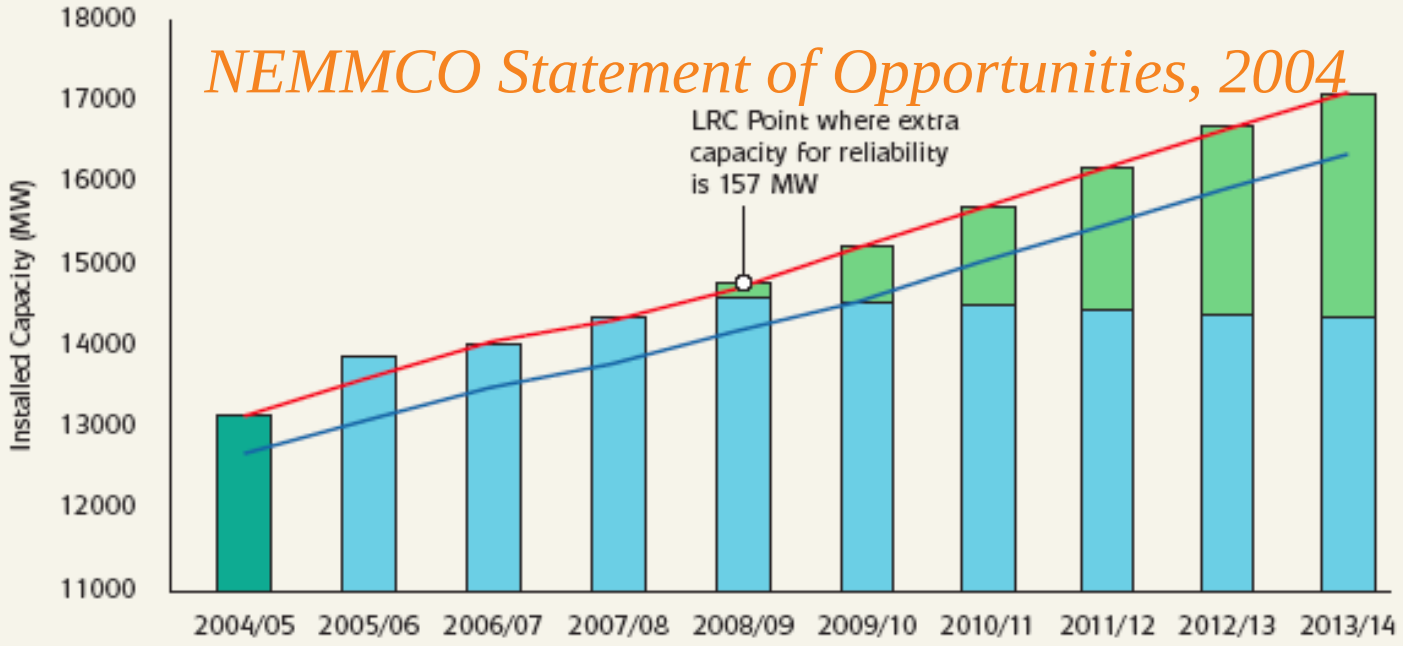
Table 1 Minimum Reserve Level Changes from 2003 SOO (MW)

	Queensland	New South Wales	Victoria and South Australia	Tasmania
SOO 2004	610	–290	530	144
SOO 2003	450	700	795	288
Change	+160	–990	–265	–144

Table 5 Projected Low Reserve Conditions

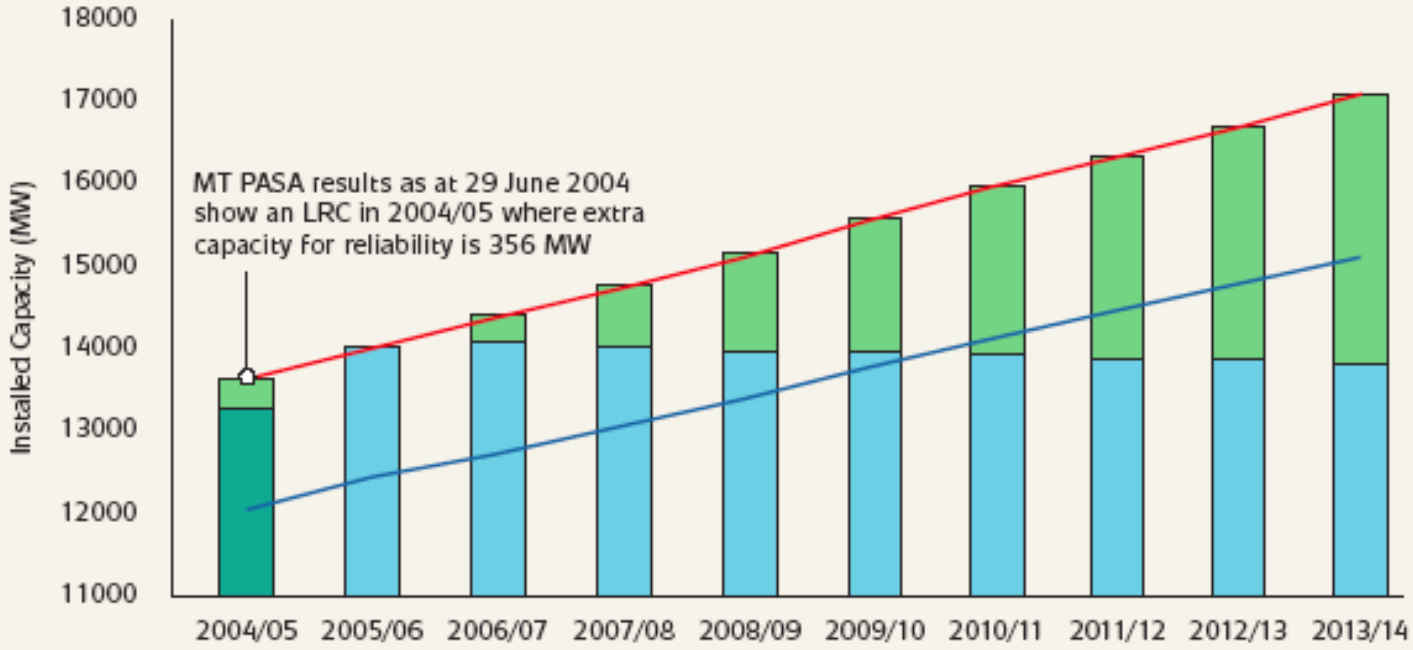
	LRC Point	Reserve Deficit
Queensland	2009/10	132 MW
New South Wales	2008/09	157 MW
Victoria/South Australia	2004/05[1]	356 MW
(combined)	2006/07	321 MW
Tasmania	Beyond 2013/14	–

Figure 4 New South Wales Summer Outlook



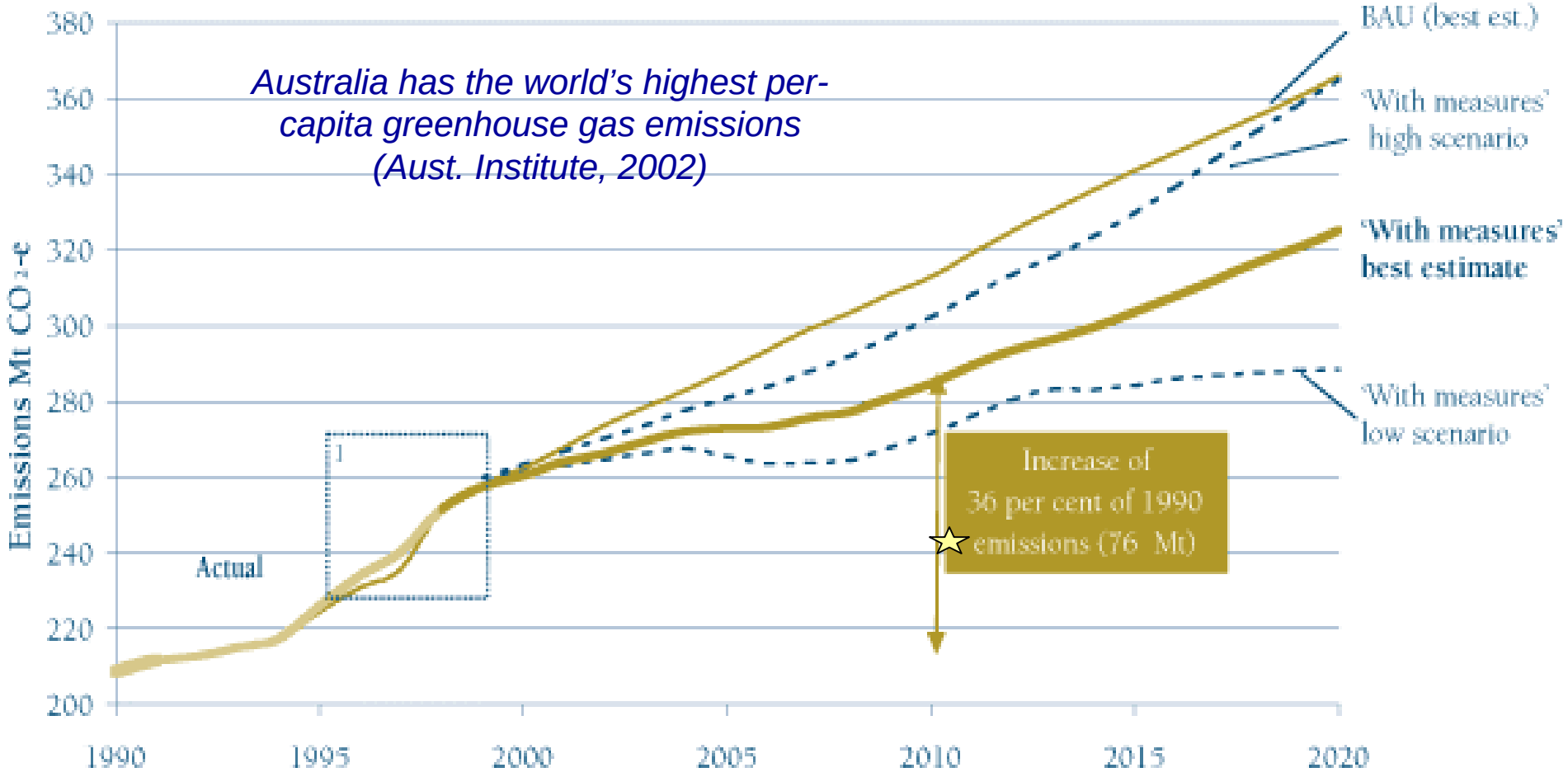
- reserve capacity support from the Snowy Hydro Scheme and Queensland provide additional available capacity in 2006/07 and 2007/08
- in 2008/09, New South Wales experiences deficits, even though Queensland has additional available capacity. This is due to interconnector transfer limits from Queensland
- 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

Projected emissions from Stationary Energy sector, 1990-2020



Source: Australian Greenhouse Office (2002)

Getting it wrong? – the NEM & climate change

- Aust. National Electricity Code doesn't include specific environmental objectives
- However, expectation by some that Aust. Electricity Industry restructuring would help (14 MtCO2 reduction from BAU in 2010):
  (Commonwealth Govt, *Climate Change: 2nd Communication to IPCC,* 1997)
  - Efficient competition in supply by cogen + renews
  - More sensible patterns of energy use through incentives for investment in EE
  - Greater penetration of natural gas

What actually happened?

- Instead, now projected to increase 0.1MtCO2 above BAU (CoAG, 2002)
  - Low cost of coal fired generation in Australia
  - Current failure to price greenhouse emissions
  - Excess electricity capacity that has depressed prices
  - Relatively immature and inflexible gas market
  - Reduced emphasis on EE from lower prices
  - Market design and regulation that favours incumbents (eg. advantages coal against new entrants like DG)
  - Supply-side orientation of reforms to date

COAG Response to Parer Review
(Ministerial Council on Energy Communique, 1/8/03)

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

    (electricity (& later gas) wholesale market & transmission)
    - Australian Energy Market Commission (AEMC):
      - Rule making & market development, replacing NECA
    - Australian Energy Regulator (AER)
      - Wholesale market & transmission regulation & possibly distribution & retail; partly taking over ACCC role
- Undertake comprehensive transmission review & consider national planning function

COAG Response to Parer Review, ctd
(Ministerial Council on Energy Communique, 1/8/03)

- Examine options to enhance user participation, including interval metering
- Respond to current Productivity Commission review of National Gas Access Regime
- Review upstream gas arrangements
- Address greenhouse emissions from energy sector on a national basis with an Emissions Trading System

MCE program summary (12/03)

Denotes stakeholder consultation

MCE denotes MCE decision point

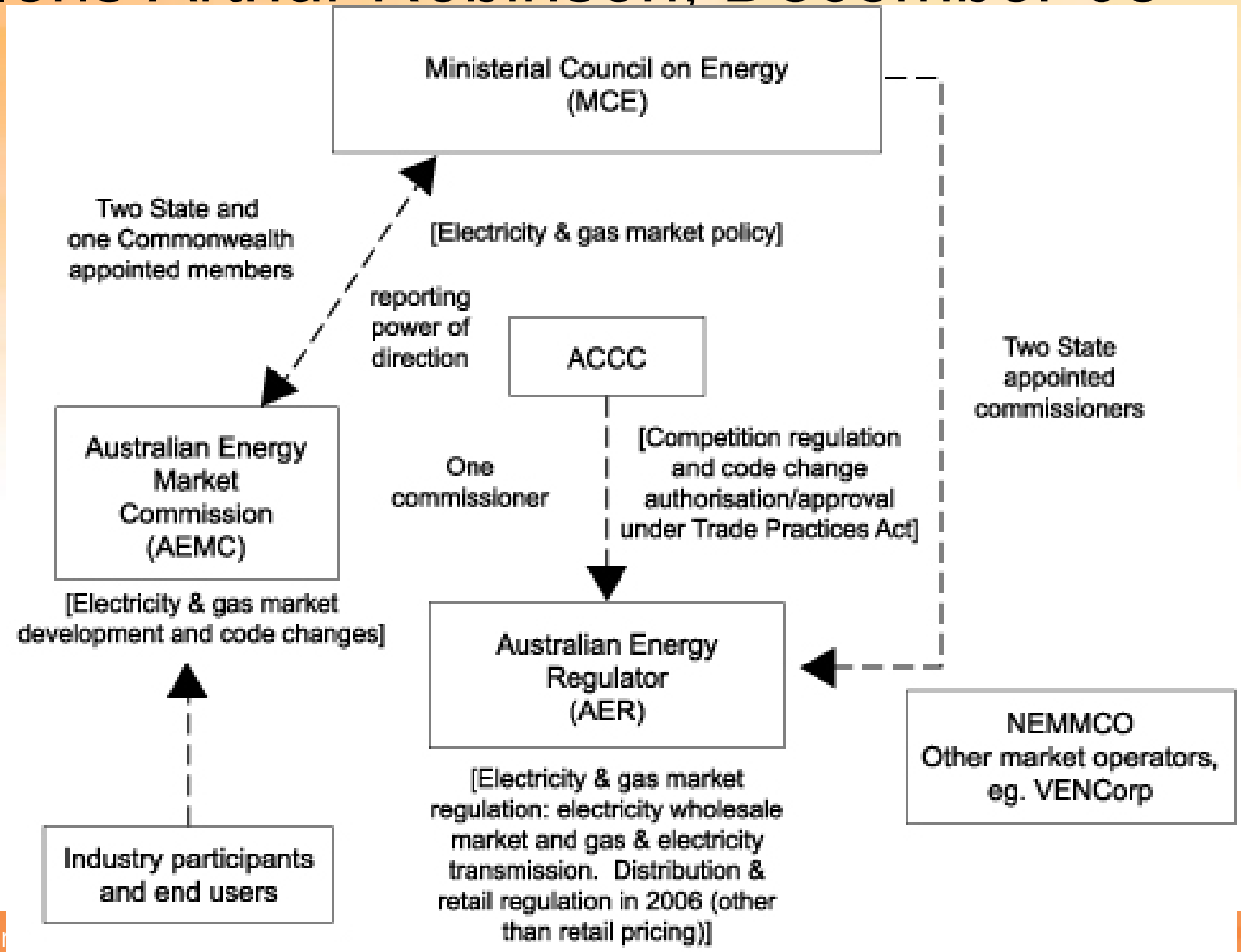
Projects	Qtr 4 / 2003	Qtr 1 / 2004	Qtr 2 / 2004	Qtr 3 / 2004	Qtr 4 / 2004	2005
1. Governance & Institutions [SA]						
Inter-Governmental Agreement	MCE note framework	SCO draft IGA	MCE approve IGA	CoAG endorse IGA		
National Legislation	MCE consider legislative models	MCE finalise legislative framework. SCO develop draft bills	MCE approve bills. Bills introduced in parliaments	Legislation enacted		
Establish AEMC & AER	SCO draft structure & operations paper	MCE endorse structure & operations paper	Commissioners selected	Operations commence		Transfer gas transmission*
MOU between ACCC-AEMC-AER	SCO draft framework	SCO develop MOU	MCE finalise negotiation & approve MOU	MOU implemented		
NECA & NGPAC Transition	SCO draft transition paper	SCO endorse transition plan		NECA dissolved		NGPAC dissolved (subject to PC gas review)
Subsume NEMMF into MCE	SCO review NEMMF work program	NEMMF work program continues under SCO/MCE		NEMMF dissolved		
2. Economic Regulation [Vic]						
Energy Access		SCO draft issues paper on national approach	MCE endorse preferred approach	SCO develop national approach (subject to MCE decision and consideration of PC gas review)		MCE agree national structure
Distribution & Retail	MCE agree policy & timing	SCO develop framework paper	MCE endorse framework paper	SCO develop detailed national structure		MCE agree national structure

Projects	Q4/03	Q1/04	Q2/04	Q3/04	Q4/04	2005
3. Electricity Transmission [Qld]						
Transmission Regulatory Reform	MCE endorse policy framework	Commission study on regional boundaries. Commence agreed code changes	MCE consider boundary report. Remove market biases	Implement new regulatory test and transmission availability incentives	Implement new transmission pricing	
National Transmission Planning	NEMMCO commence scoping ANTS.	MCE finalise new planning process	First ANTS produced	Implement last resort power		
4. User Participation [Tas]						
○ *Demand side response* ○ *Interval metering* ○ *Full Retail Contestability*	SCO develop issues paper	SCO prepare draft report	MCE approve user policy	Implementation commences		
5. Gas Market Development [NT]						
MCMPR Upstream Issues	Advice requested from MCMPR	MCMPR review unproduced areas for 3rd party access		MCE respond to MCMPR review		
PC Gas Access Review	PC issue draft report		PC issue final report	SCO draft response to report	MCE respond to PC review	
6. Program Coordination [C'wlth]						
Market Consultation	MCE endorse consultation plan	Market consultation (as above)	Consultation continues, as appropriate			

Denotes stakeholder consultation

MCE denotes MCE decision point

Governance & institutions in Australia:- as seen by Allens Arthur Robinson, December 03



Conclusions - energy sector decisions

- Long-term infrastructure choices:
  - Asset lives of 50 years or more
- Large externalities (impacts on non-participants):
  - Climate change (fossil fuels)
  - Nuclear fuel cycle risks (nuclear power)
  - Various adverse impacts (renewable energy forms)
- Difficult to quantify risks:
  - Low probability, high impact
  - Non-stationary (history may not be a good predictor)
- Can be classified as ‘social experiments’:
  - Should only be undertaken with informed consent

Conclusions - restructuring

- A restructured EI is a “designer” industry:
  - Industry-specific laws, codes, markets
- Mix of technical, economic & policy issues:
  - Physical behaviour continuous & cooperative
  - Commercial behaviour individual & competitive
- Restructuring is still a learning situation:
  - Some disasters & no complete successes
  - Some difficult issues, eg:
    - Network services; ancillary services; retail markets
  - Current COAG / MCE process very important

Conclusions – market design for the EI

- A transparent process that includes all stakeholders
- An appropriate balance and compatibility between:
  - Centralised decision-making - short term (engineering) to long term (policy)
  - Decentralised decision-making (commercial) - operation and investment
- Equal consideration for all system resources
  - Foster competition: don't favour incumbent technologies + participants against 'new entrants' - eg. Demand-side options, distributed generation
- Support appropriate innovation to meet emerging challenges + change

  Focus on dynamic efficiency issues
  - Technical or productive: reduce costs of production
  - Allocative: most appropriate choices b/n supply + demand options
  - **Dynamic:** support innovation + response to change
    - new technologies, social expectations, environmental impacts
- Careful consideration of interactions with other related markets
- Allocate costs + benefits to participants as appropriate to extent possible
  - Commercialise industry objectives – eg. internalise externalities

Conclusions from the Australian experience

- Successful electricity restructuring requires:
  - 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
- Also requires a coherent implementation:
  - Decision making & risk management framework:
    - Technical, commercial, social & environmental risks
  - A mix of engineering & commercial techniques, recognising strengths & weaknesses of each
  - Able to work successfully with a weak network, weather-sensitive demand & a growing level of renewable energy

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