CEEM Specialised Training Program
EI Restructuring in Australia

Generation issues in Australia

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Presentation outline

- Current status of the Australian generation sector
- Drivers
  - Projected supply short-falls
  - High greenhouse emissions
- Recent trends in the sector
- Driving appropriate new generation investment

Australia's energy policy objectives

- COAG's agreed national energy policy objectives
  - 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.

Policy objectives for electricity generation

- Low cost electricity generation – particularly important for energy-intensive industry development
- Immediate, short-term and longer-term security of supply
- Reductions in environmental impacts, especially greenhouse (GHG) emissions

Some challenges for Australian generation

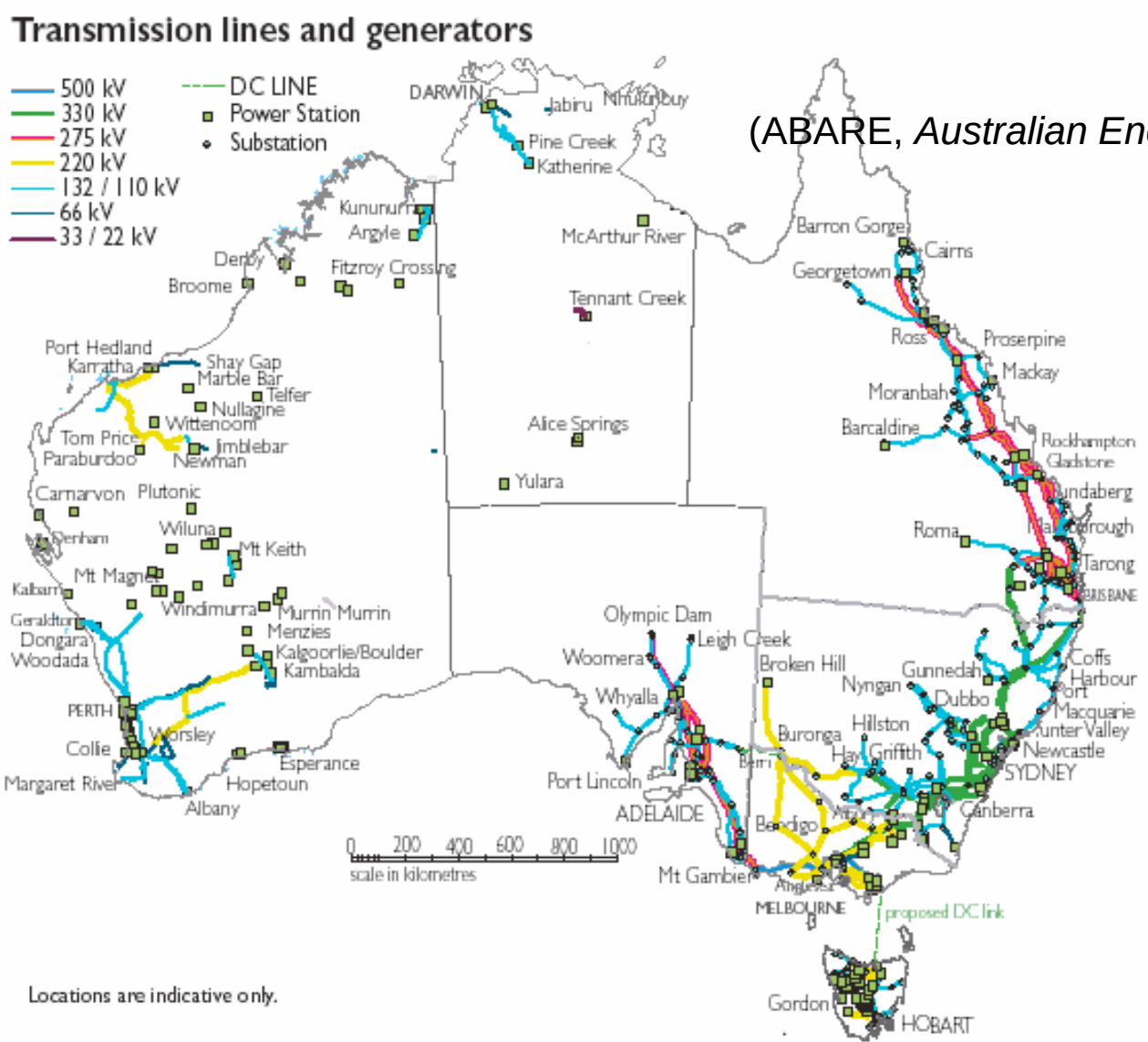
- Rapidly growing demand, particularly peak demand
- Recent large-scale blackout events, potential supply shortfalls in the medium to longer term
- Very high GHG emissions from coal dominated generation mix

=> How can appropriate investment in cleaner electricity generation be driven within competitive market context?

Current status of Australian generation sector

- Physical plant – type and locations
- Generating costs
- Commercial environment for generation companies

Australian electricity generation + Tx network



(ABARE, *Australian Energy*, 2004)

Australian electricity demand

Western Australia
~12 TWh/yr (7%)

Northern Territory
~1.5 TWh/yr (1%)

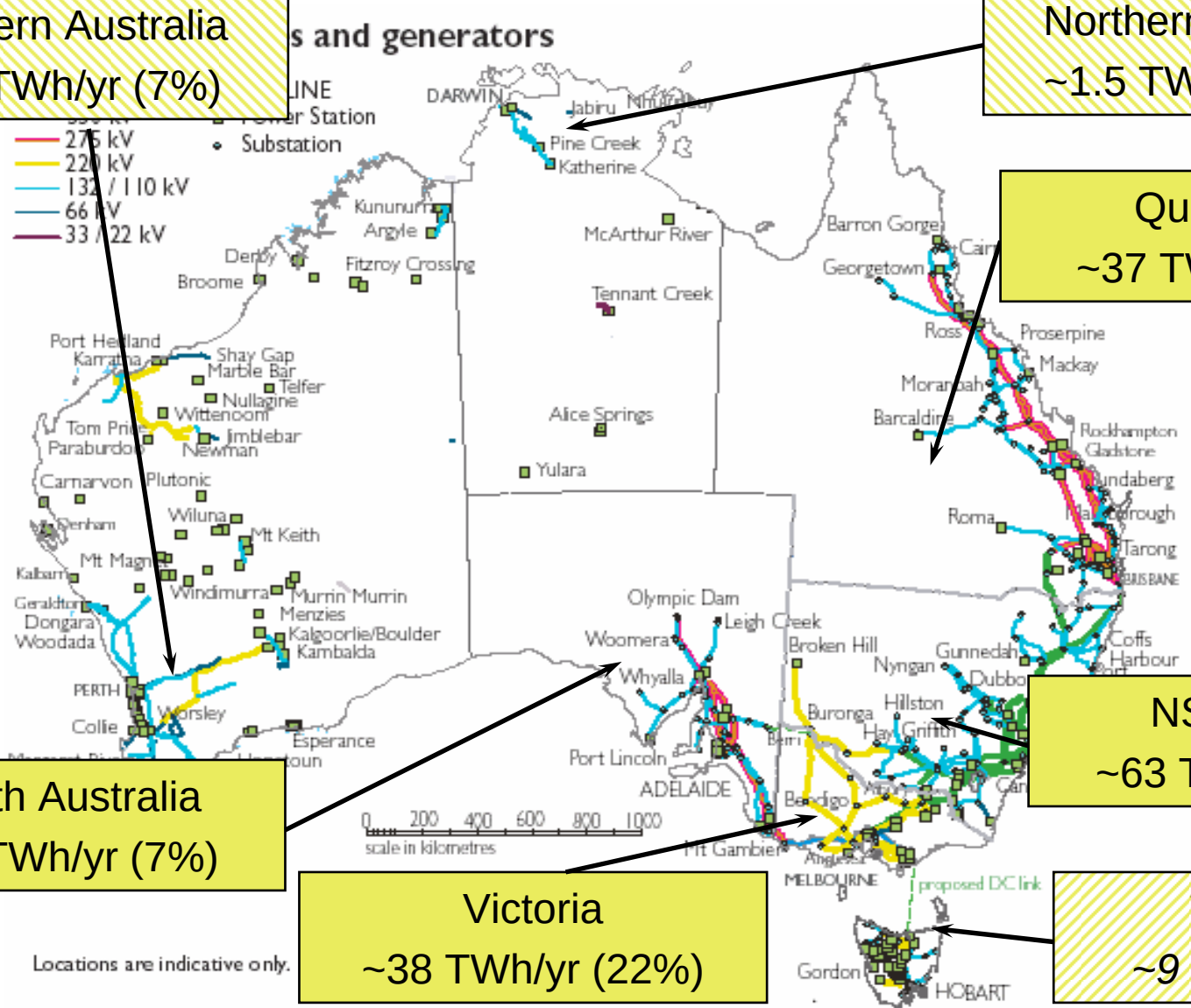
Queensland
~37 TWh/yr (21%)

NSW & ACT
~63 TWh/yr (36%)

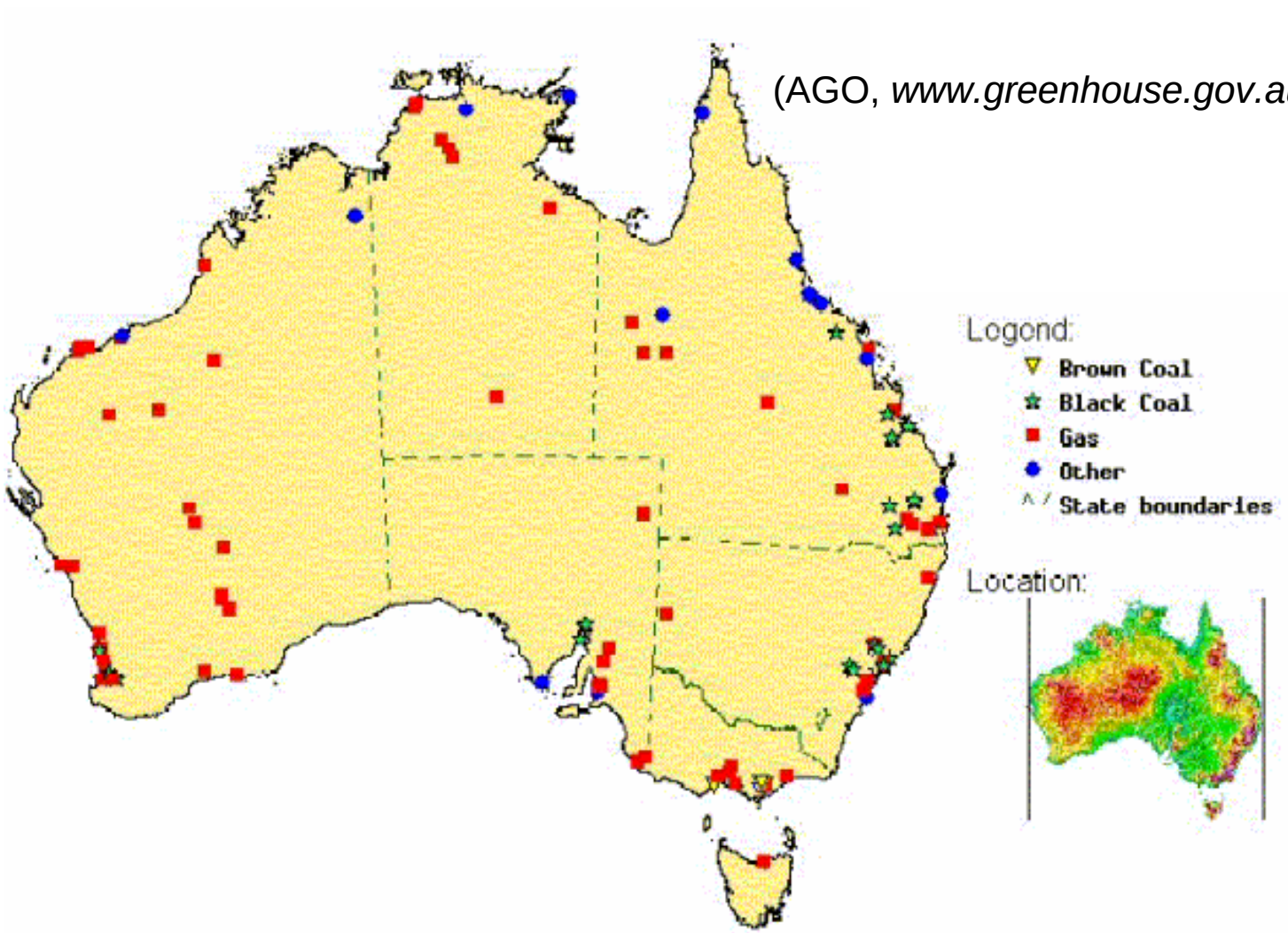
South Australia
~11 TWh/yr (7%)

Victoria
~38 TWh/yr (22%)

Tasmania
~9 TWh/yr (6%)

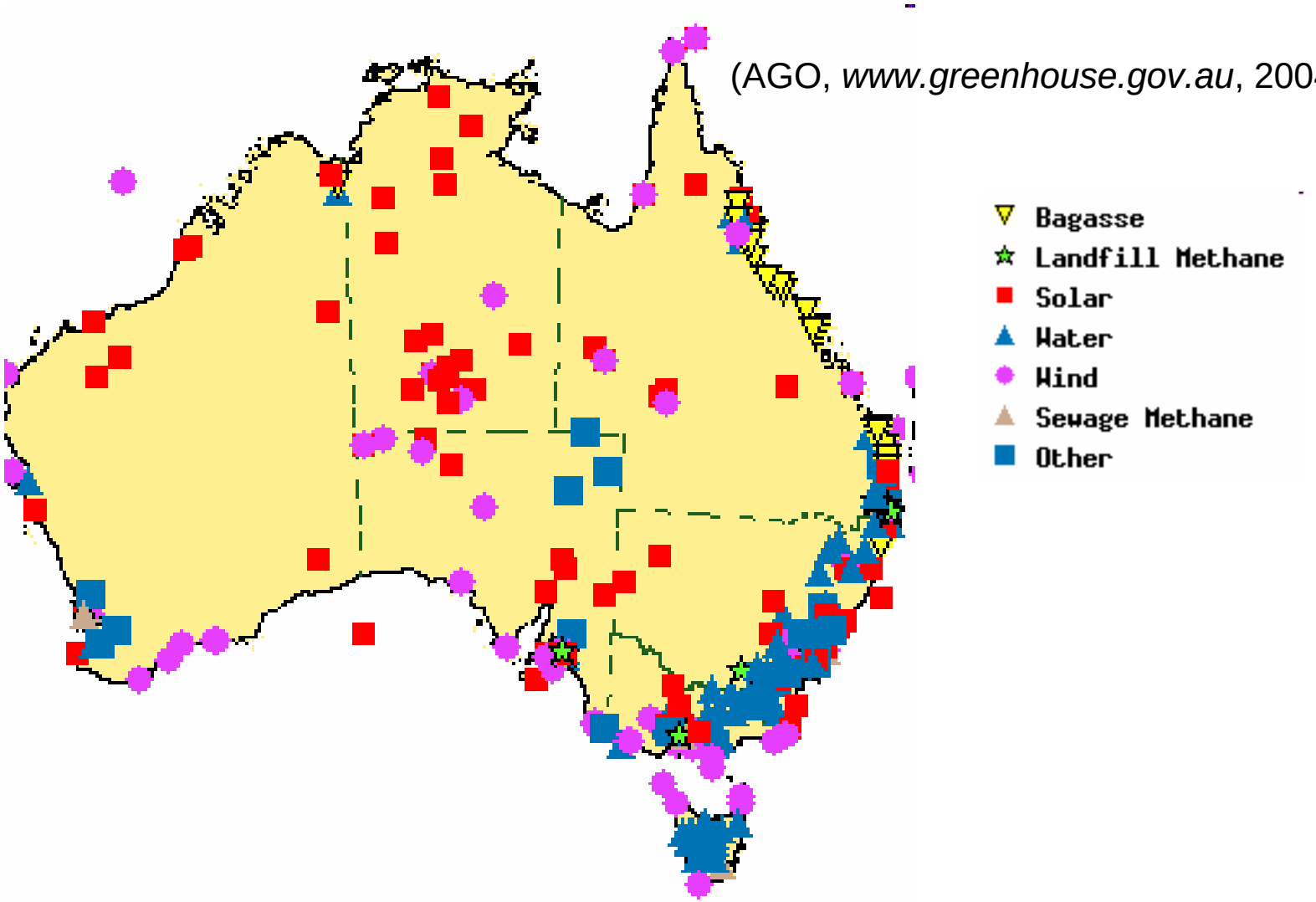


Current fossil-fuel generating plant



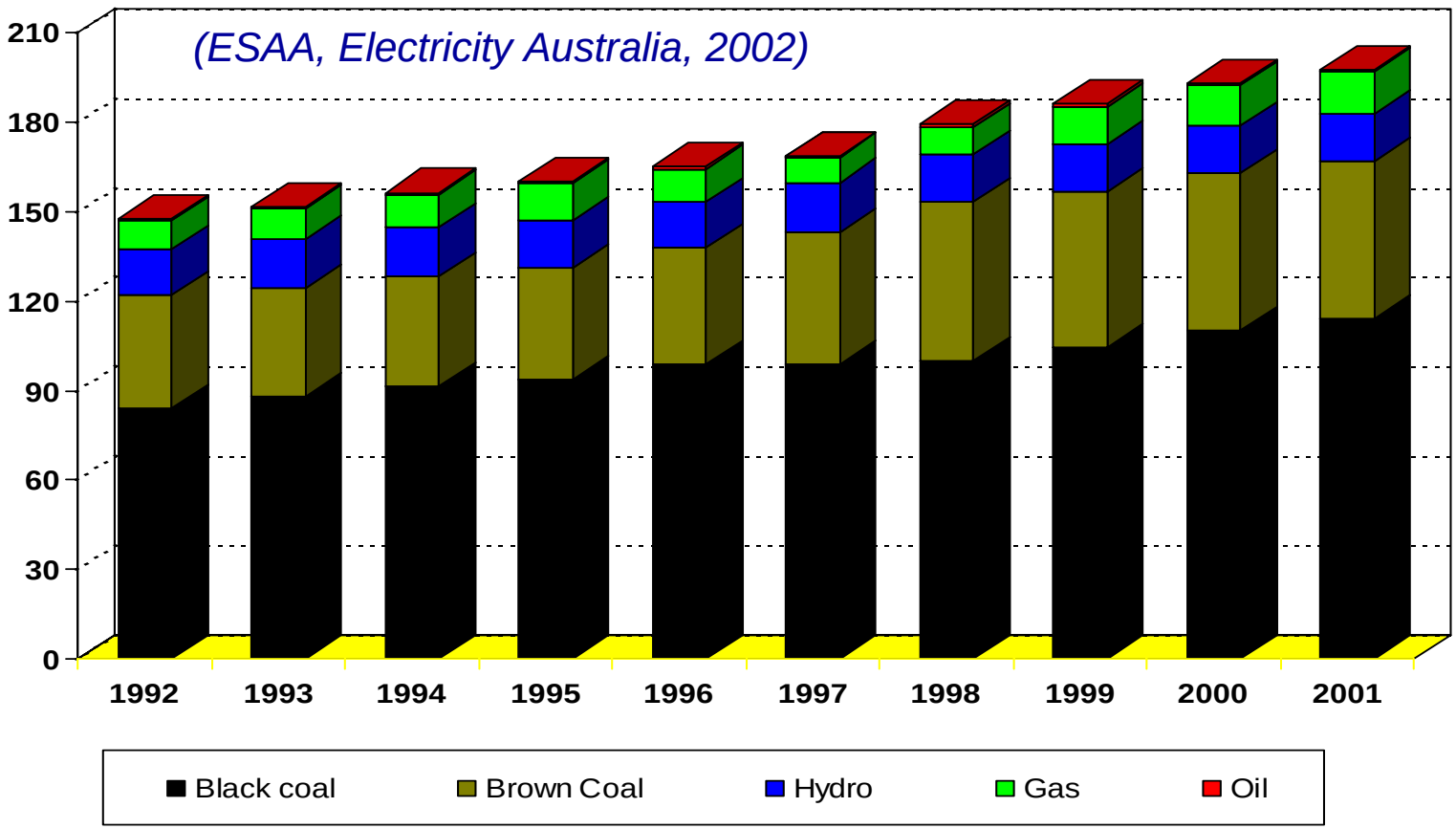
(AGO, *www.greenhouse.gov.au*, 2004)

Current renewable generating plant

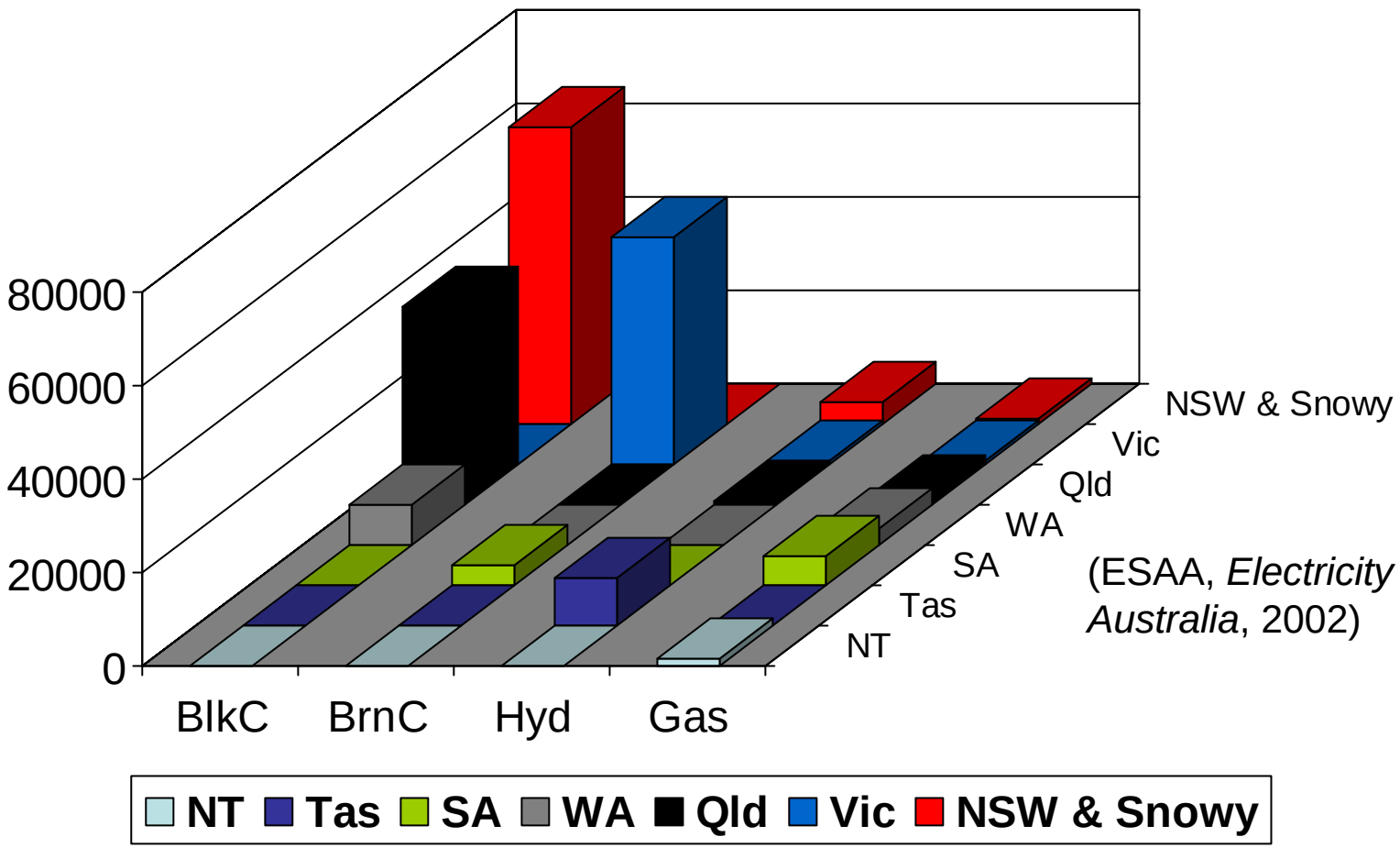


(AGO, *www.greenhouse.gov.au*, 2004)

Australia's present electricity generation mix

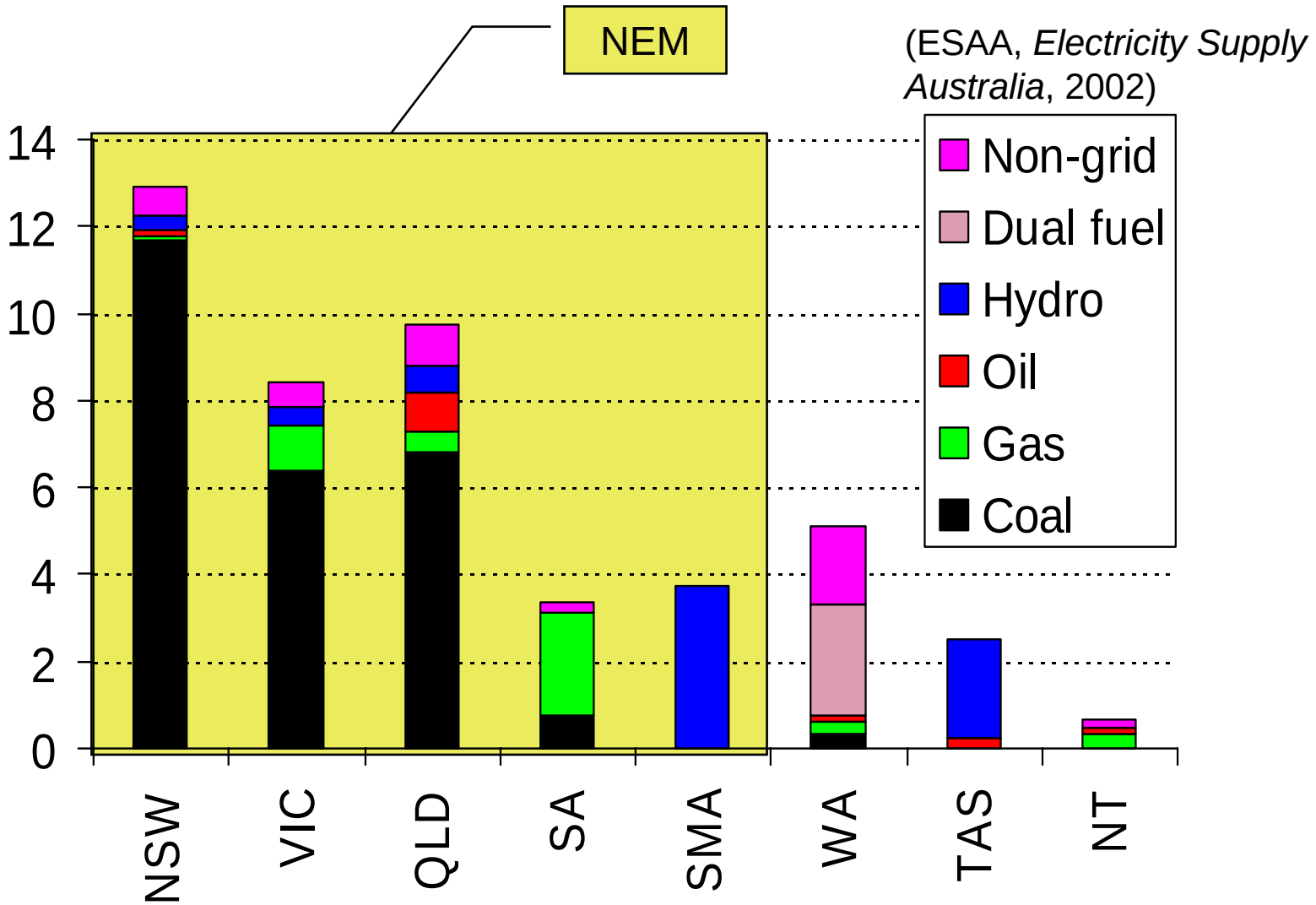


Australia's electricity generation mix by State



(ESAA, *Electricity Supply Australia*, 2002)

Installed capacity mix by NEM Region & non-NEM States



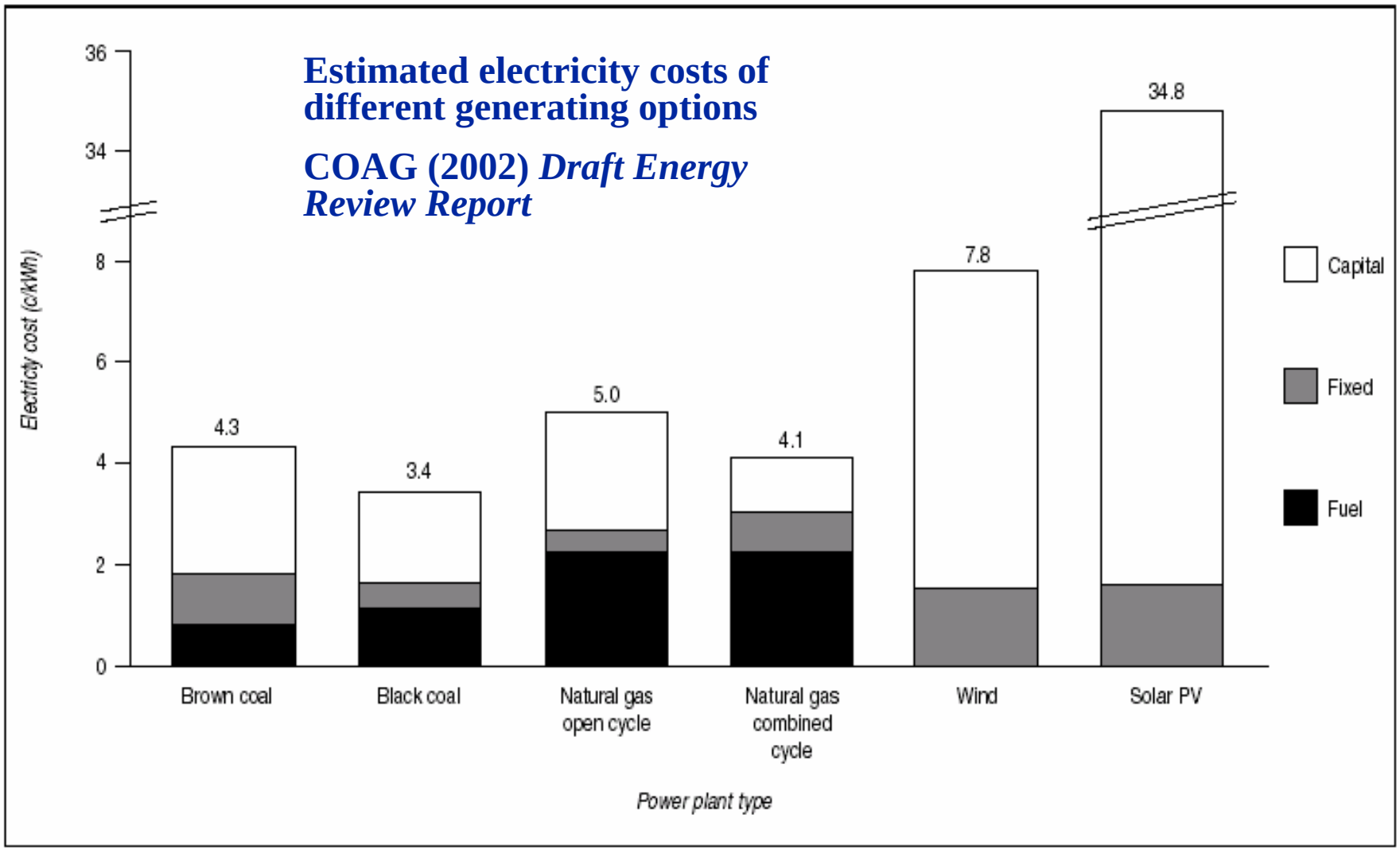
Australia's coal dependence for elec. generation

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

Country	Year	Percent of electricity from coal	Trend since 1990
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

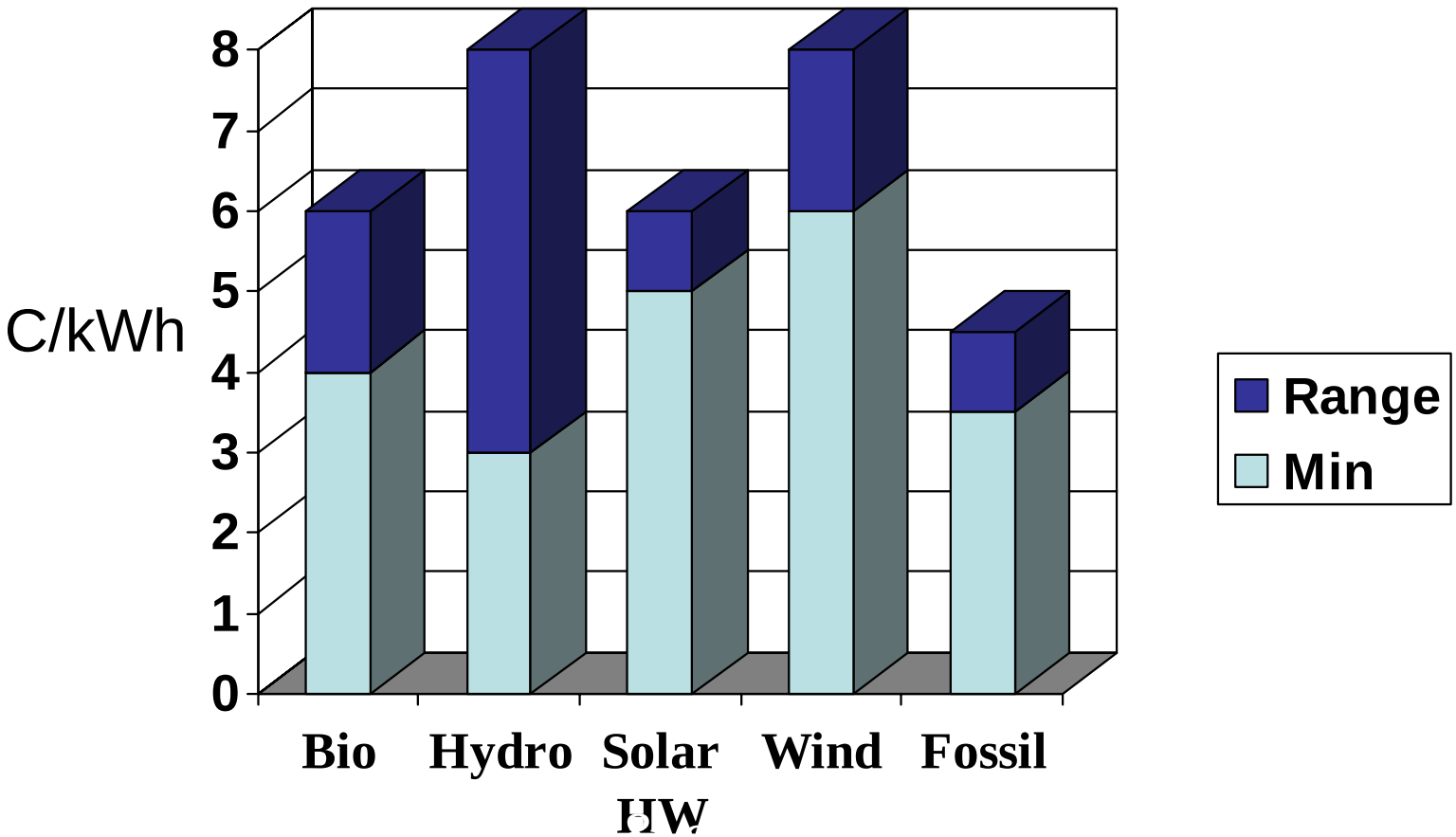
(WWF, *Coal-fired electricity and its impact on global warming*, 2003)

Generating plant costs in Australia



Estimated costs for some renewable generating plant

(AGO, www.greenhouse.gov.au, 2004)

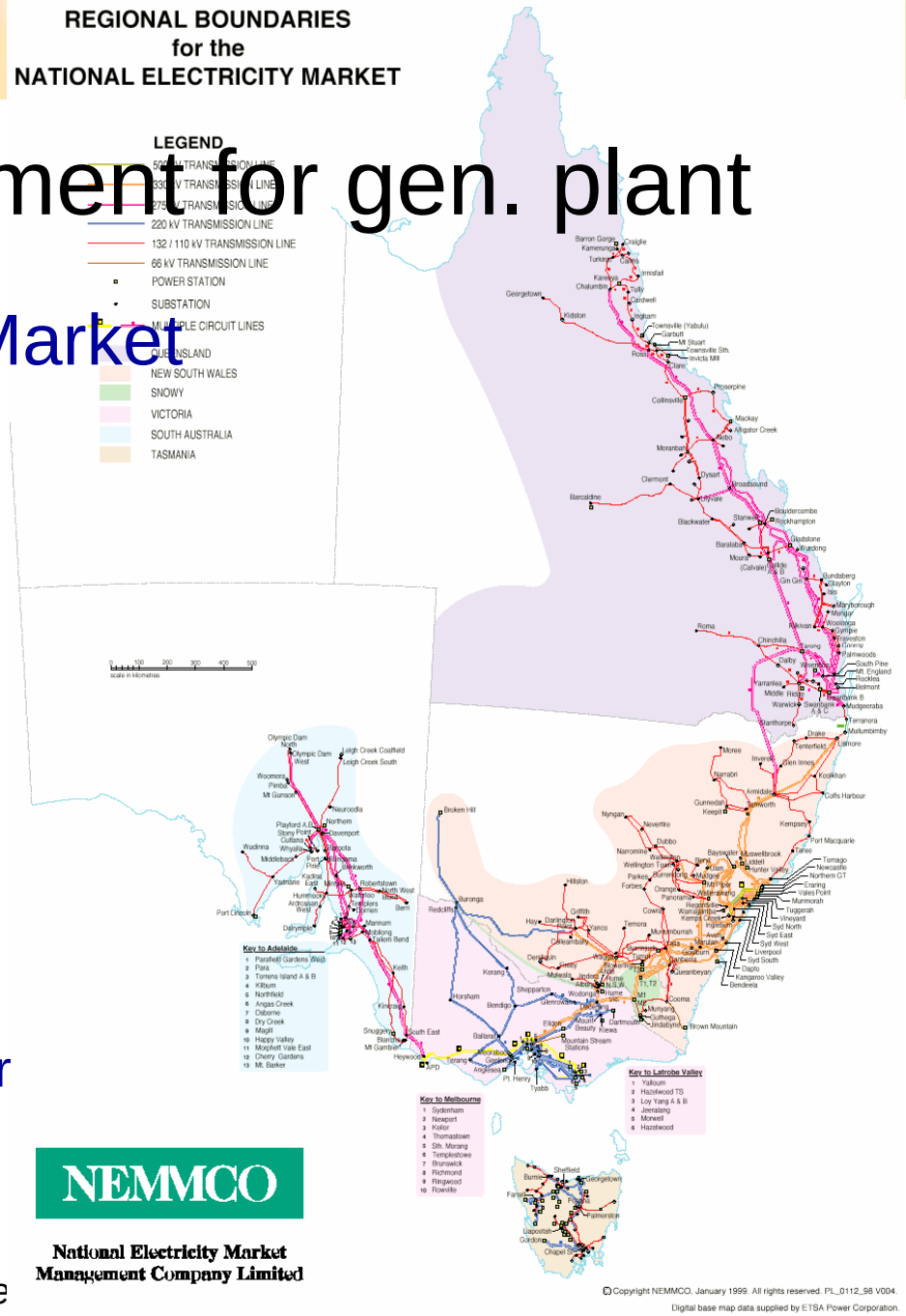


Commercial environment for gen. plant

The National Electricity Market

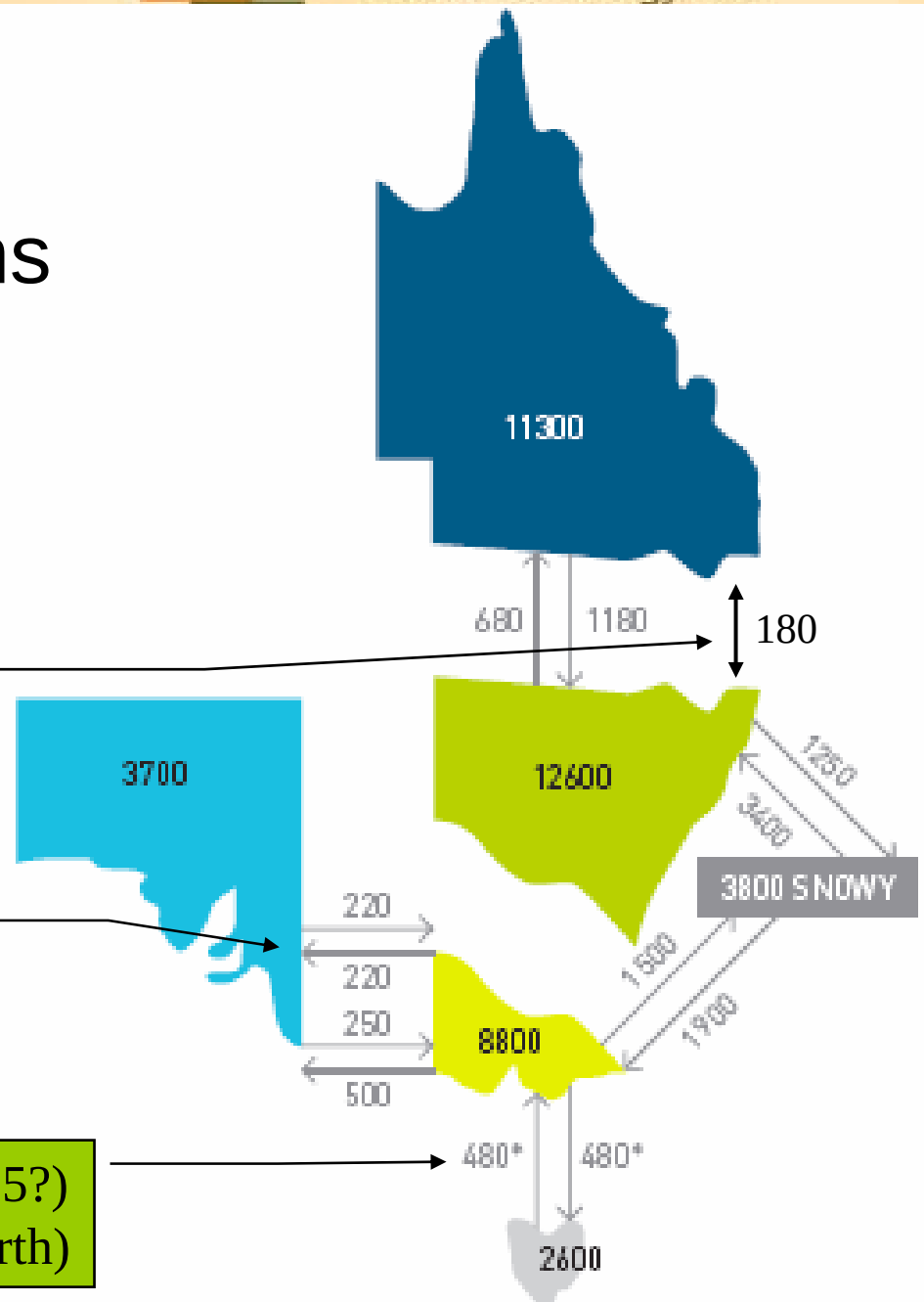
- Queensland
- New South Wales & ACT
- Victoria
- South Australia
- Tasmania (on connection to the mainland)

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



NEM market regions

(Aust. Govt, *Securing Australia's Energy Future*, 2004)



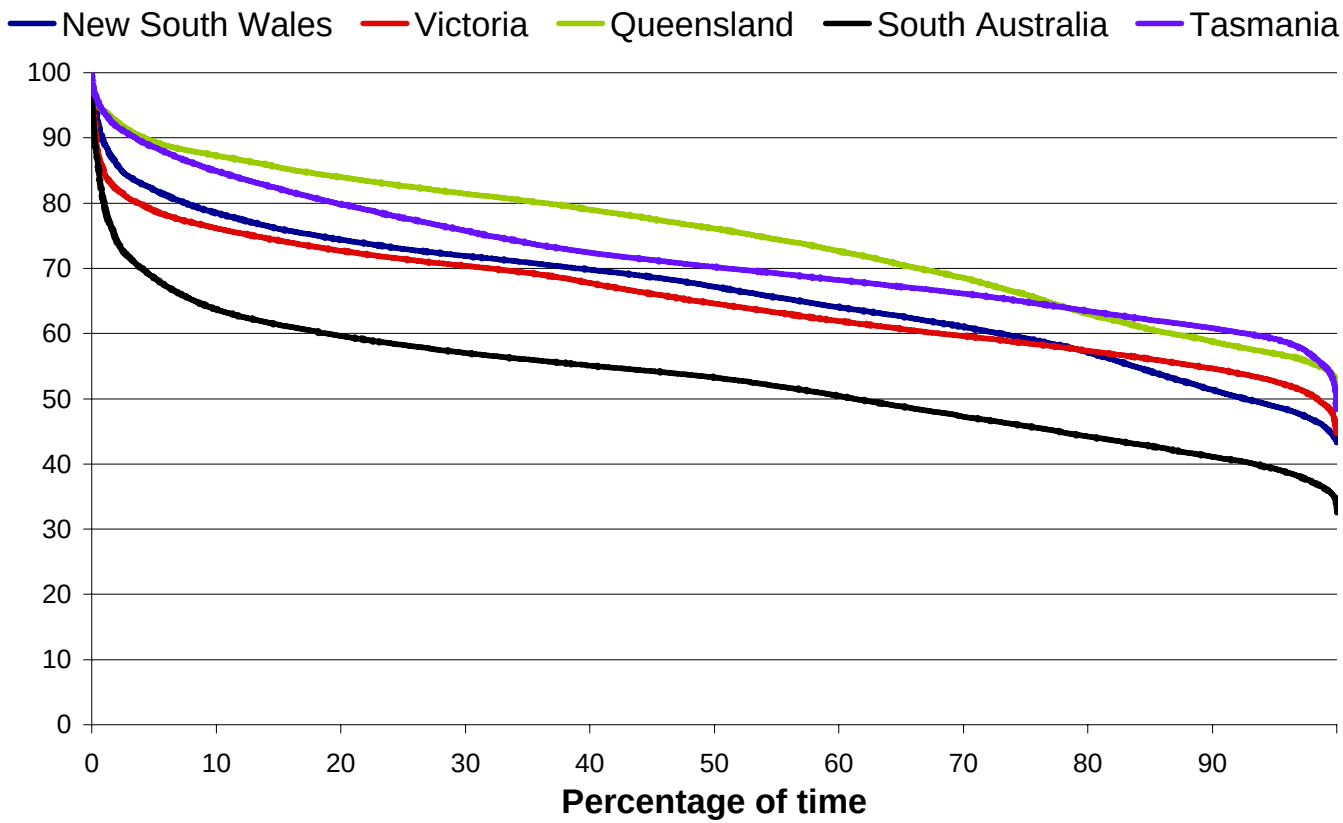
Directlink DC link, currently MNSP

Murraylink DC link, now regulated, formerly MNSP

Basslink DC link MNSP (2005?) 600MW short term rating (north)

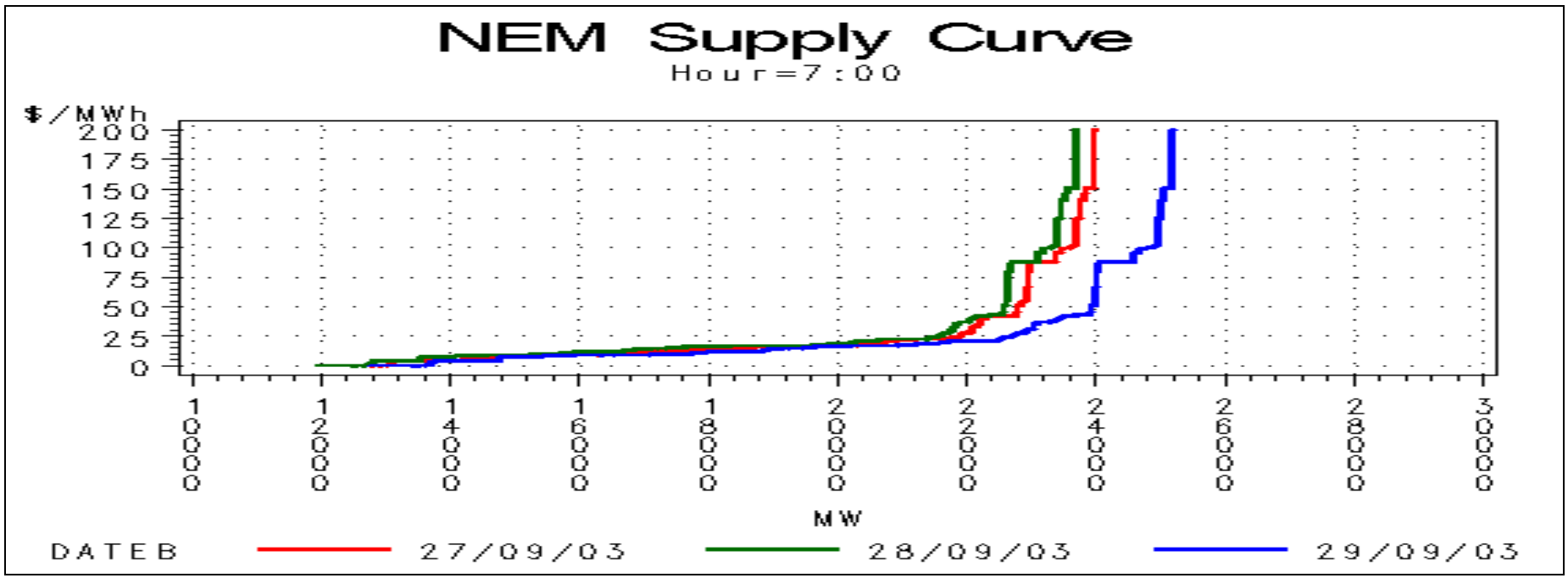
2003 Load duration curves for NEM states

(NEMMCO SOO documents, 2004)



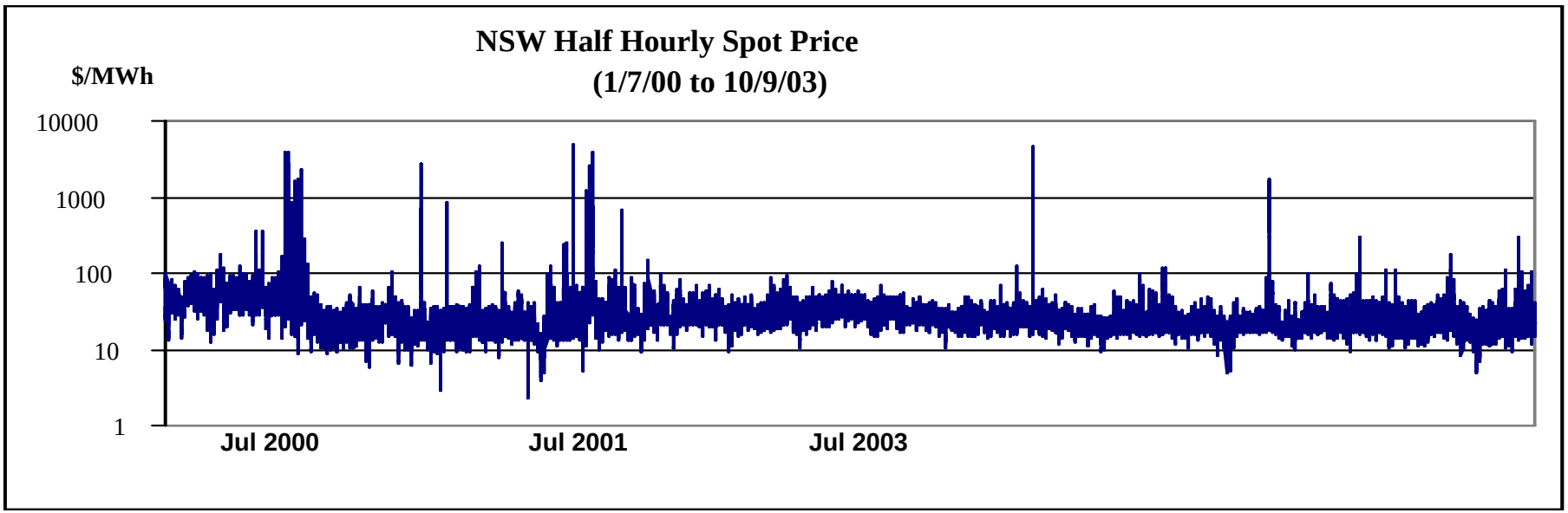
Typical NEM Supply Curves

(Delta Electricity, 2003)



Spot prices in the NEM

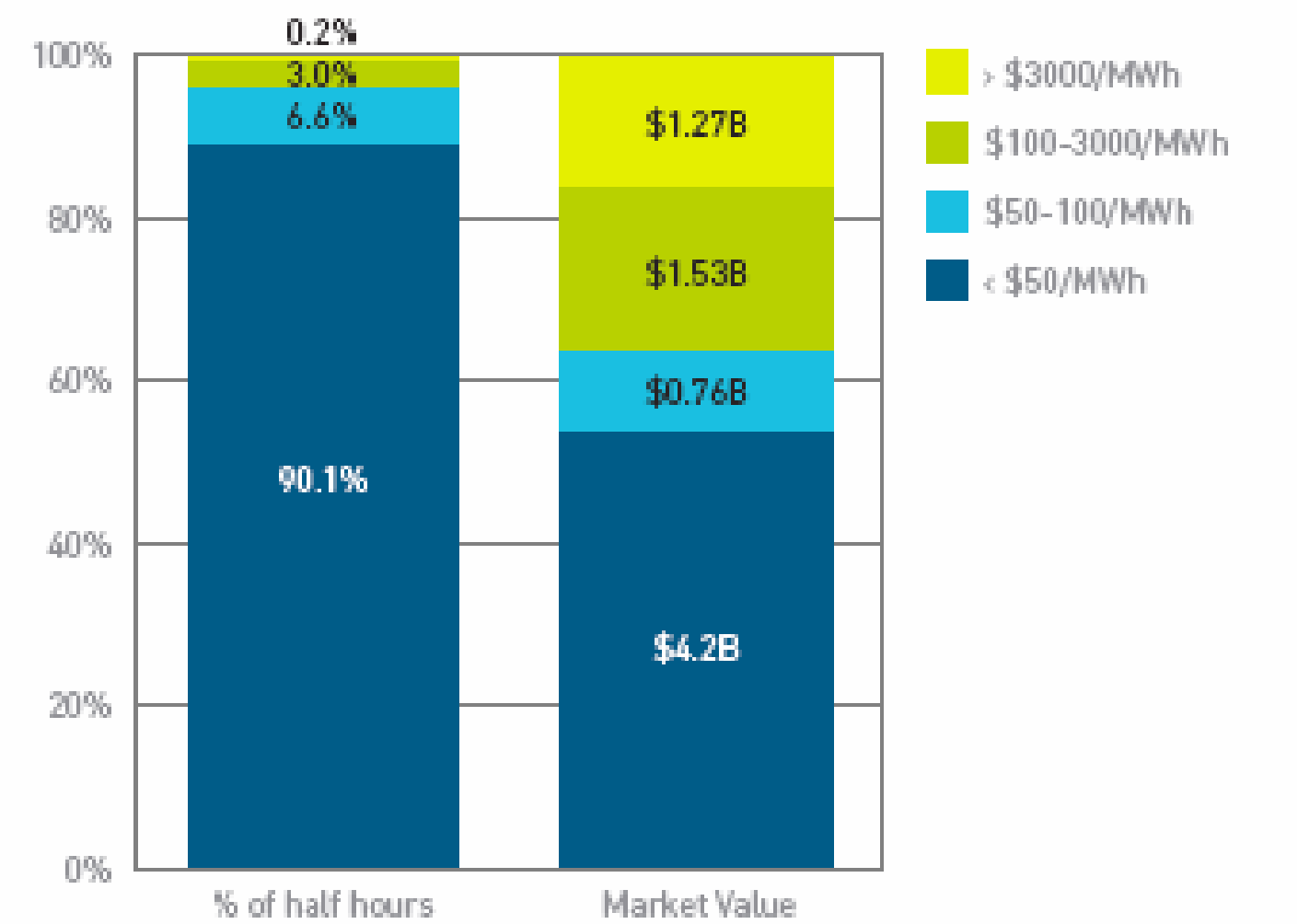
(CIRGRE, Risk Transformation for Generators in the NEM, 2004)



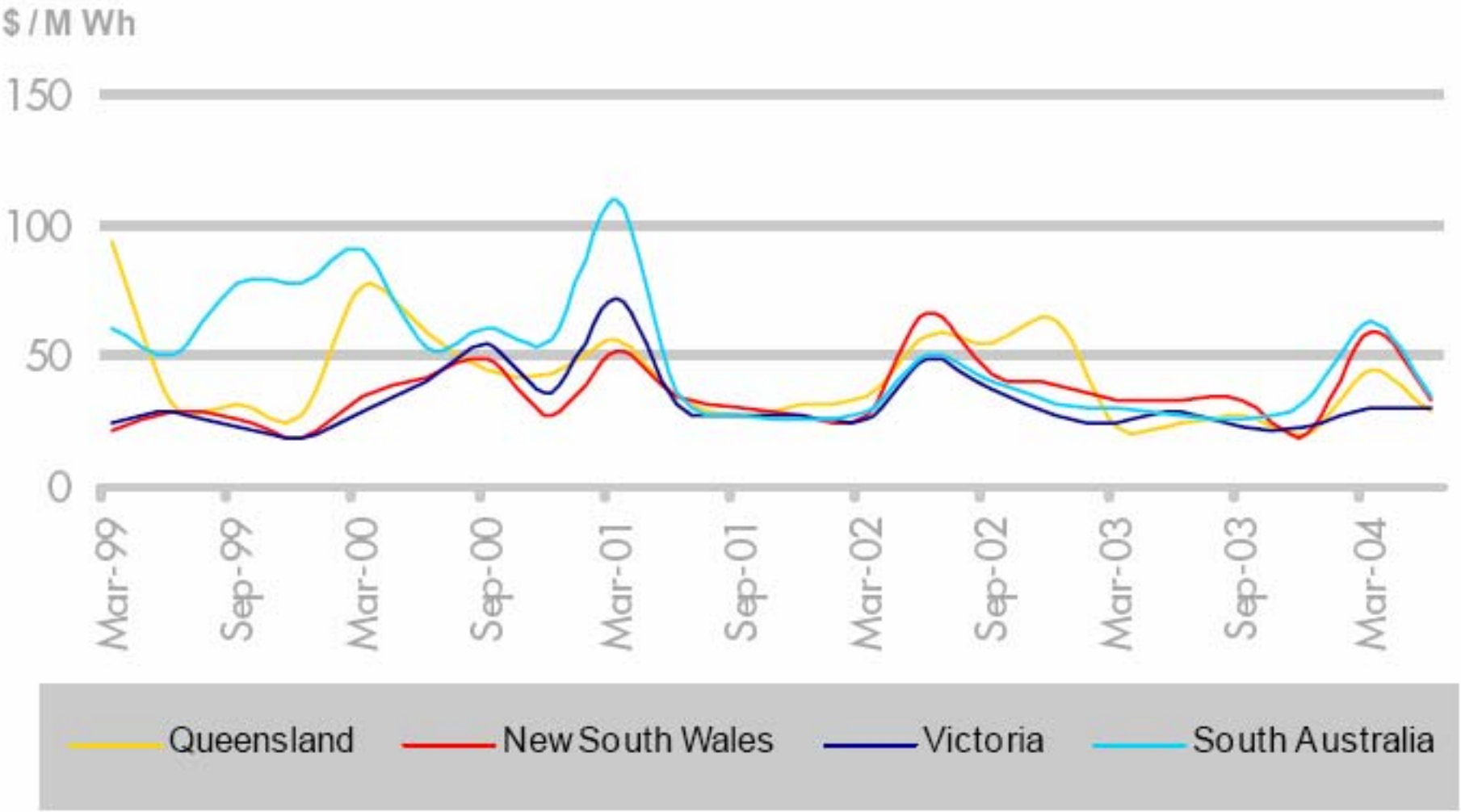
- Spot prices < $50/MWh: $23/MWh (~ 17,000 half hours)
- Spot prices > $50/MWh <$2,000/MWh: $ 7/MWh (~ 515 half hours)
- Spot prices >$2,000/MWh : $ 5/MWh (~ 5 half hours)
- **Average annual Spot price: $35/MWh (~ 17,520 1/2 hours)**

Distribution of NEM spot prices & revenues

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

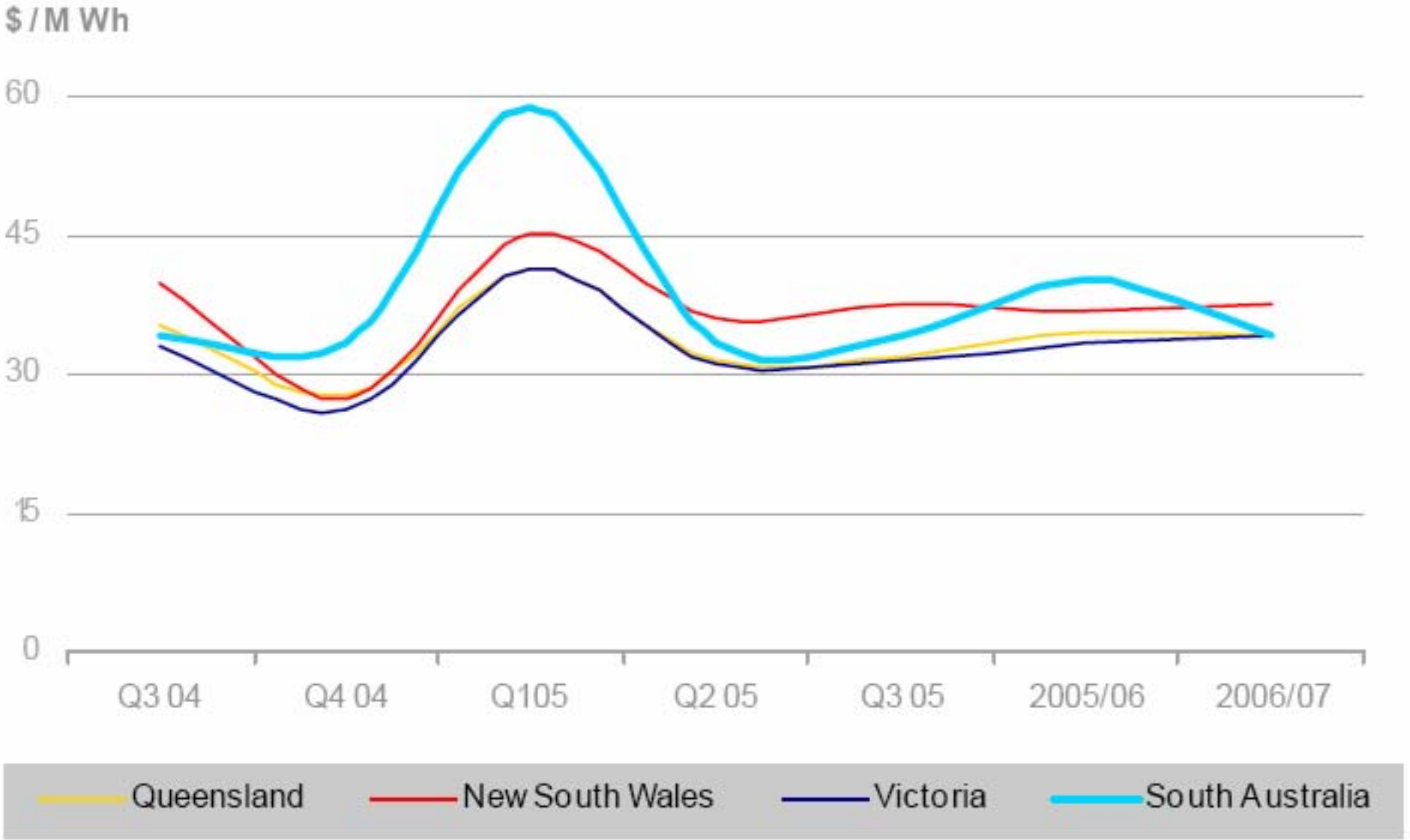


Smoothed NEM Regional Ref Prices (RRPs) since market inception (NECA, 04Q2 Stats, 2004)



Annual average RRP flat contract prices

(NECA. 04O2 Stats. 2004)



Australian Electricity Industry Value Chain

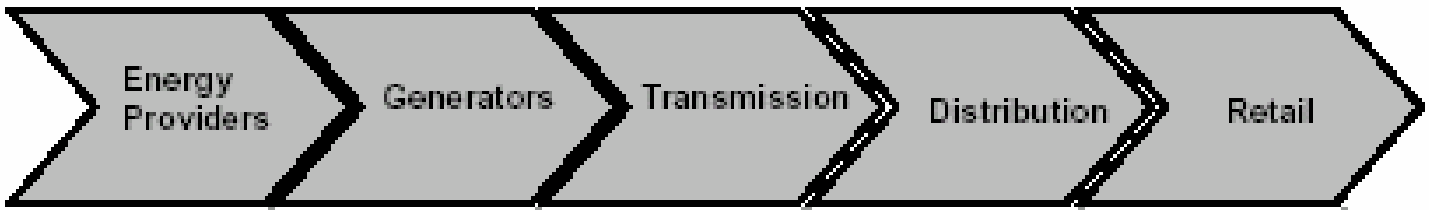
	Fuel Providers	Generators	Transmission	Distribution	Retail	Totals
Value Added	$2b	$3b	$2b	$5b	$1b	$13b
Assets (Depreciated Value)	$2b	$10b*	$6b	$26b	$3b	$47b
Rev:Asset	1:1	1:3	1:3	1:5	1:3	1:3.6
c/kW	1.2c	1.8c	1.2c	3.1c	0.6c	8c

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



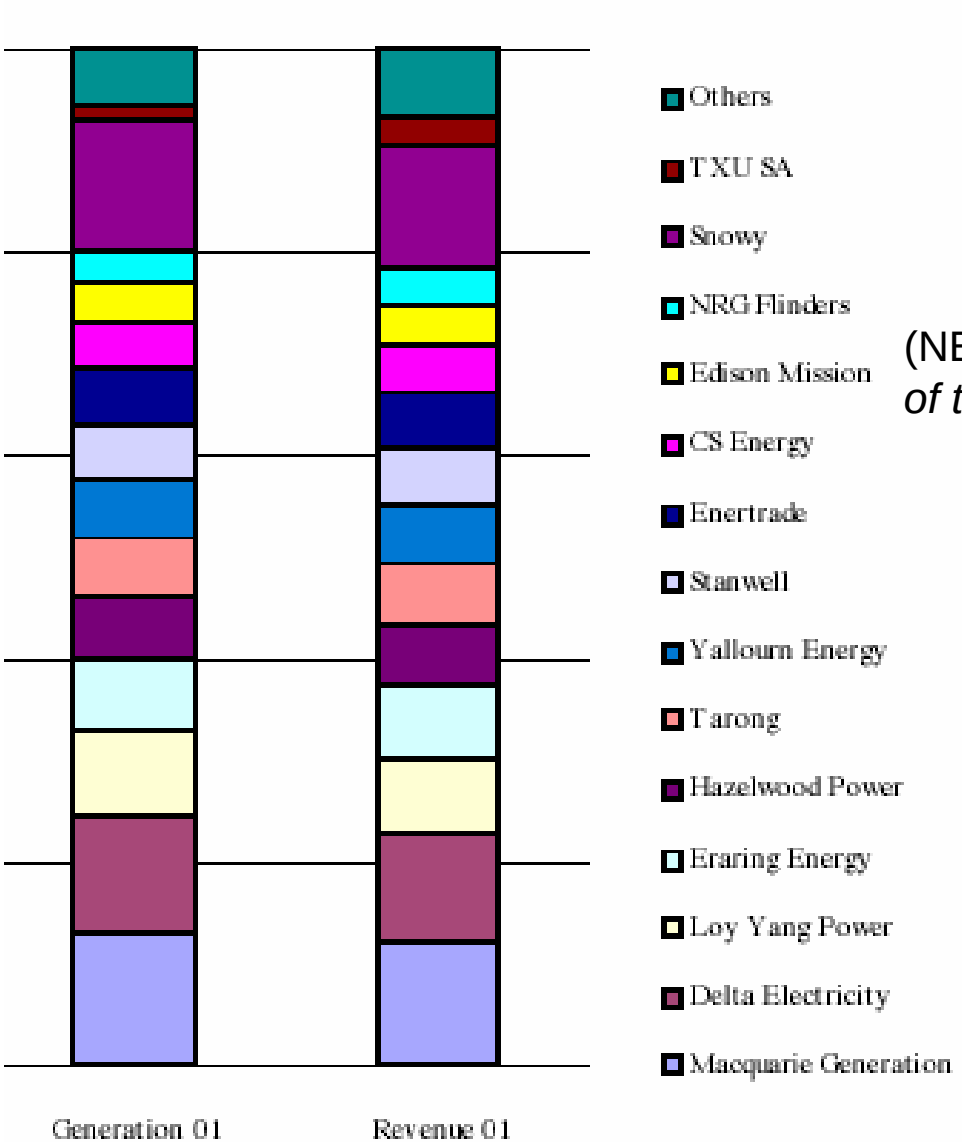
		Generators	Transmission	Distribution	Retail
% State owned	Few	70%	70%	70%	60%
Value of Assets		$7b	$4b	$18.2b	$1.8b
% Private Owned	Most	30%	30%	30%	40%
Value of Assets		$3b	$2b	$7.8	$1.2b

State Owned Enterprises = $31b (69%)

Private = $14b (31%)

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

NEM: market shares by energy & spot mkt revenue



(NECA, *Performance of the NEM*, June 02)

Electricity industry ownership issues

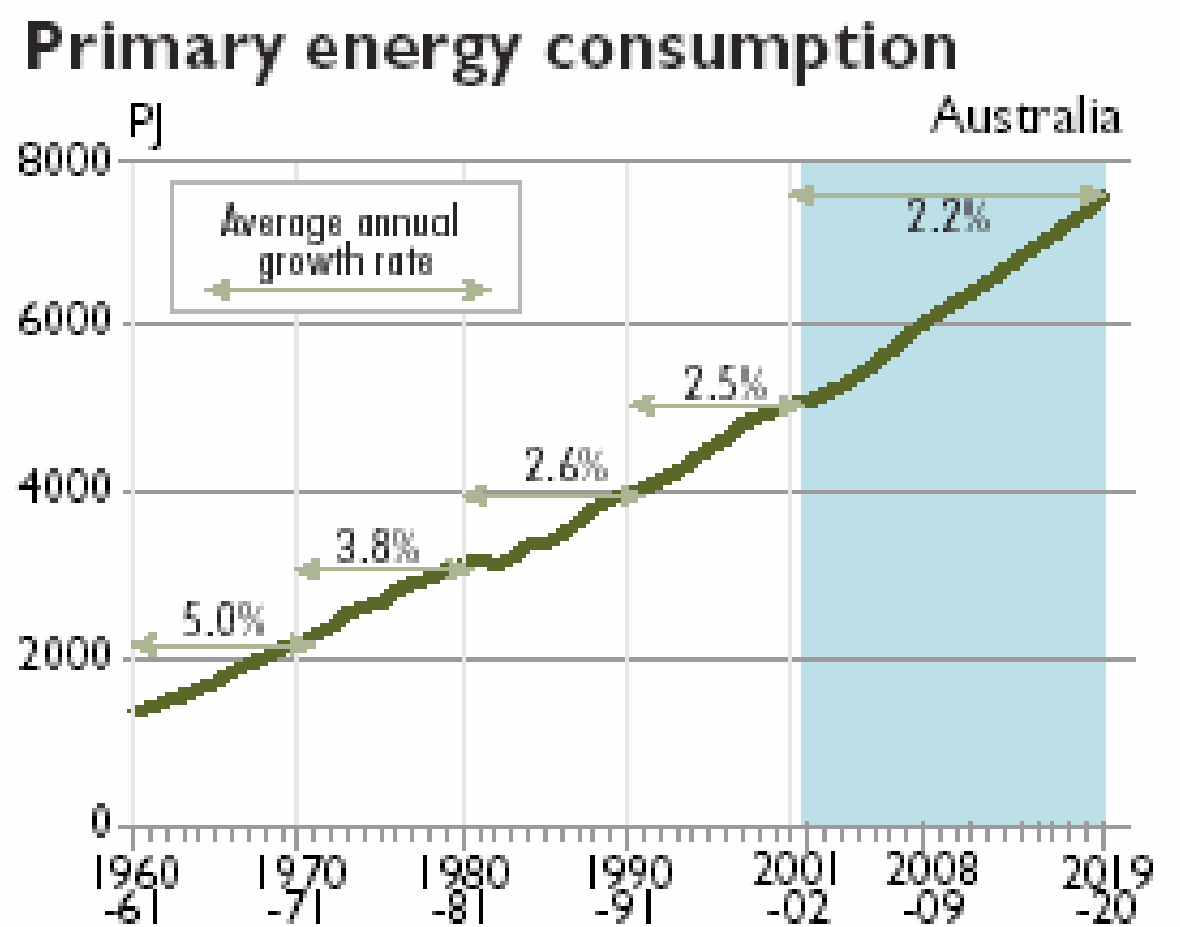
- Some concerns about private ownership:
  - Market power abuse, particularly of small end users
  - Foreign domination of a key sector of the economy
  - Vertical & horizontal concentration of ownership
  - Lack of support for innovation, sustainability & workforce development
- Some concerns about public ownership:
  - Focussed on conserving the traditional paradigm
  - Confusion of roles: equity holder vs regulator
  - Not an option for distributed resources

Recent electricity sector trends + projections

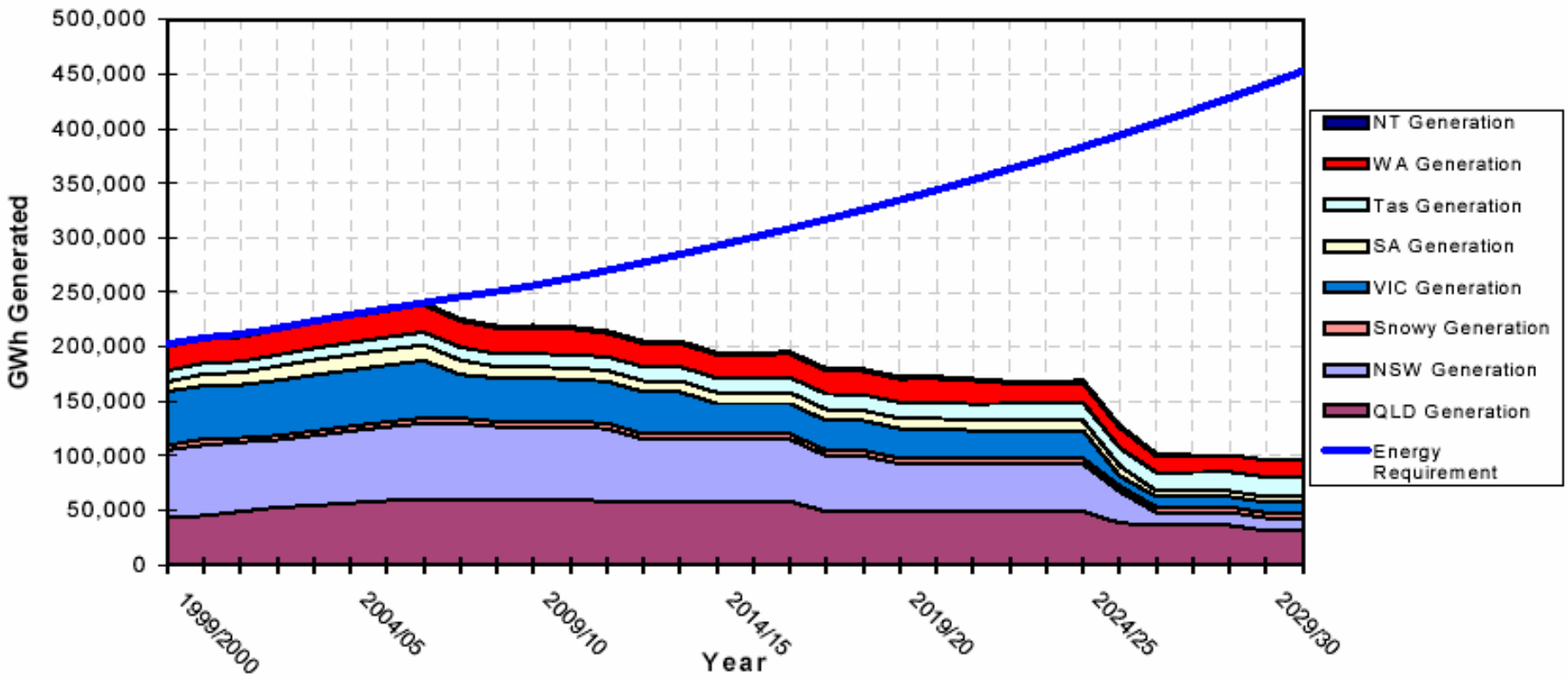
- Continuing growth in demand
- Potential supply short-falls in the medium term
- Continuing investment in coal generation, some increases in gas + renewable generation too
- Greenhouse emissions continue to increase

Australian primary energy consumption

(ABARE, *Australian Energy*, 2004)



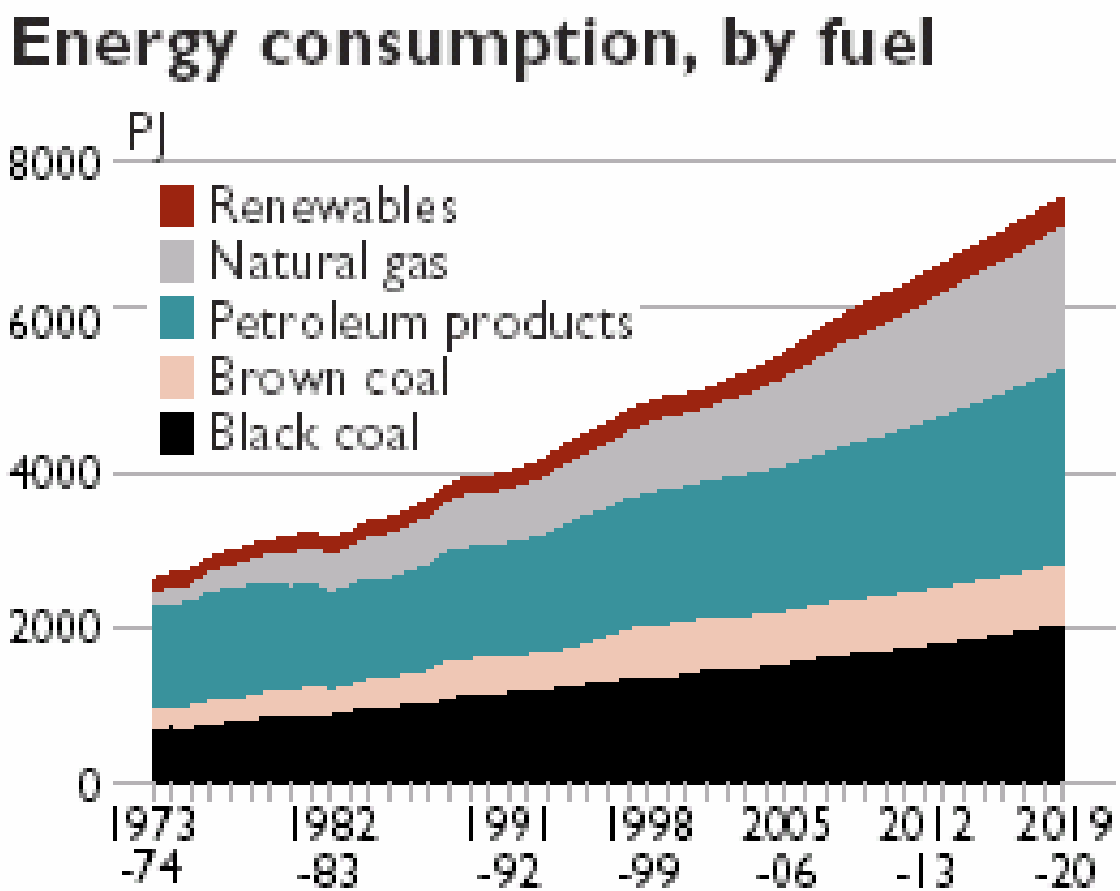
Projections of Aust. electricity supply & demand



(PMSEIC, *Beyond Kyoto*, December 2002)

Historical + projected energy consumption

(ABARE, *Australian Energy*, 2004)



NEM energy and demand trends

Table 2 Energy and Demand Growth Rates

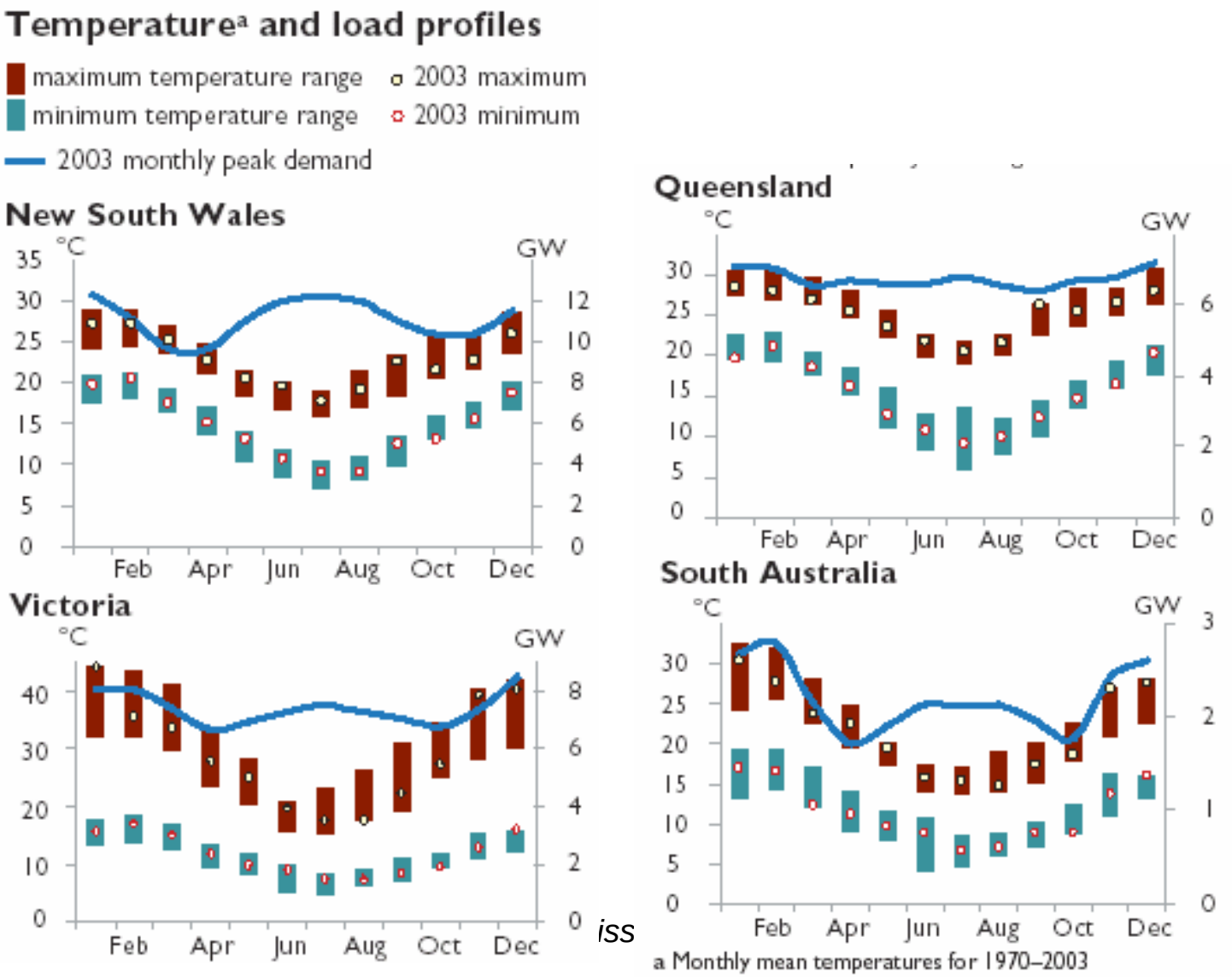
(NEMMCO SOO *Executive Summary*, 2004)

	Energy	Demand
Queensland	3.1%	2.9%
New South Wales	2.2%	2.9%
Victoria	1.9%	2.9%
South Australia	1.5%	2.8%
Tasmania	1.6%	1.6%

Table 3 Effect of Weather on Maximum Demand Projections for Summer 2004/05 (MW)

	Average Summer Weather Demand (50% POE)	Extreme Summer Weather Demand (10% POE)	Difference
Queensland	8,187	8,503	316
New South Wales	12,660	13,430	770
Victoria/South Australia	12,023	13,081	1,058
Tasmania	1,457	1,476	19

Temperature impacts on demand



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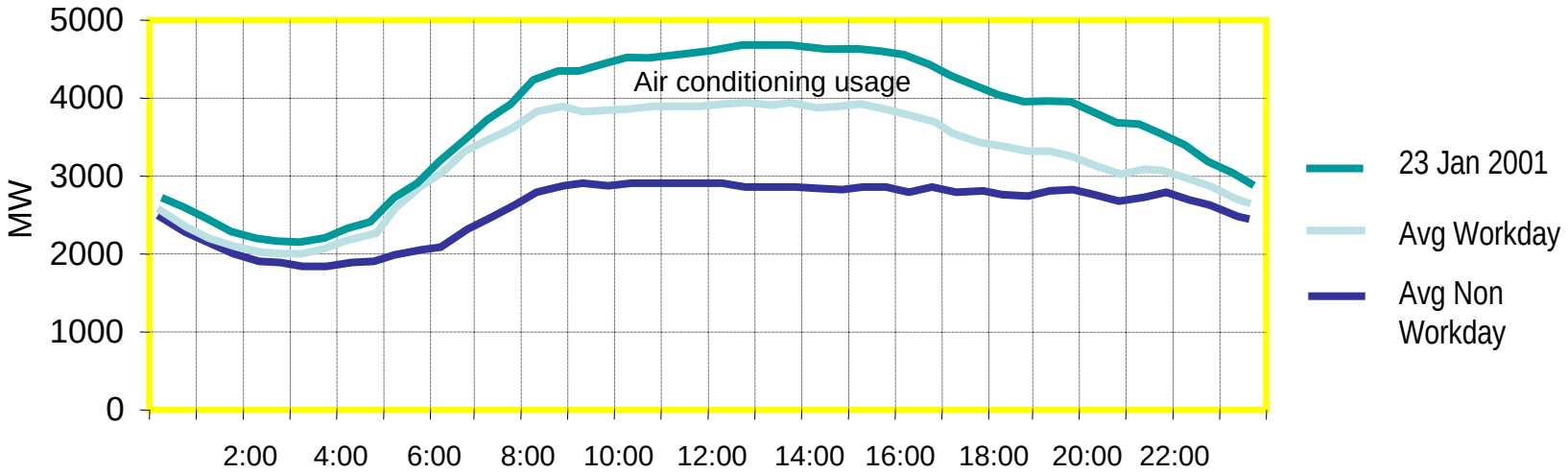
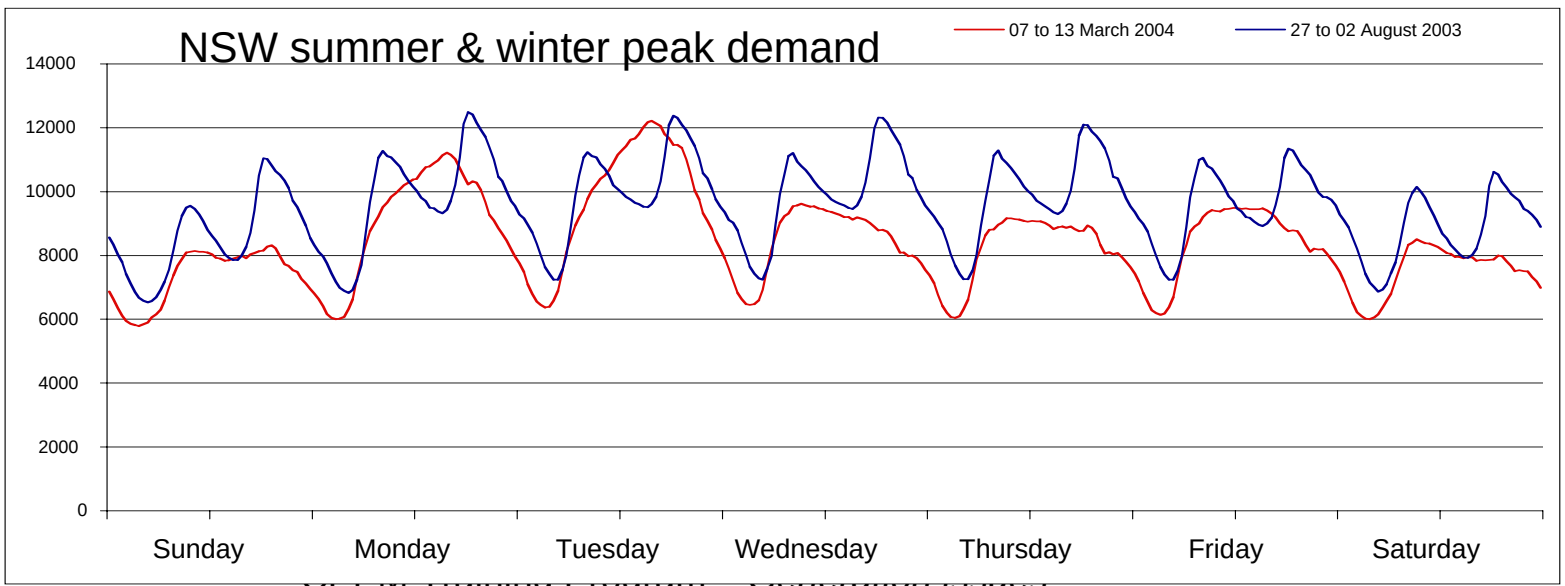
EnergyAustralia System - Summer 2000/01 Profiles - Peak and Average Days



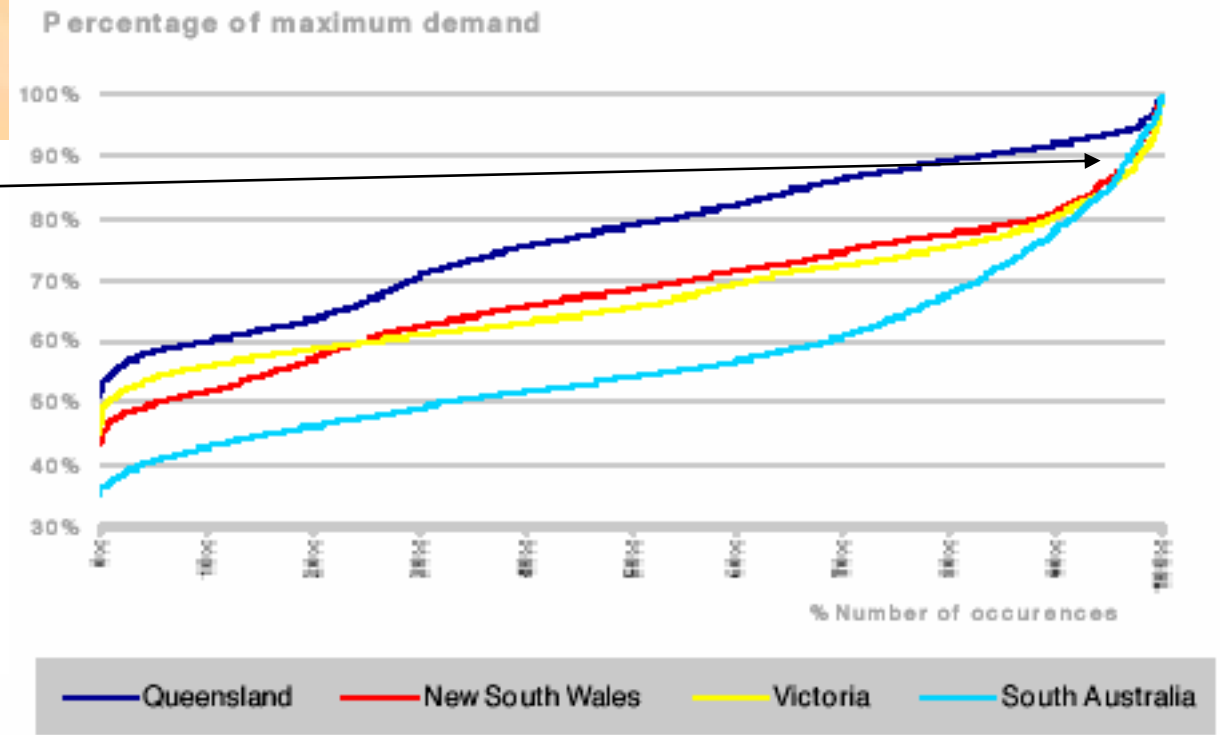


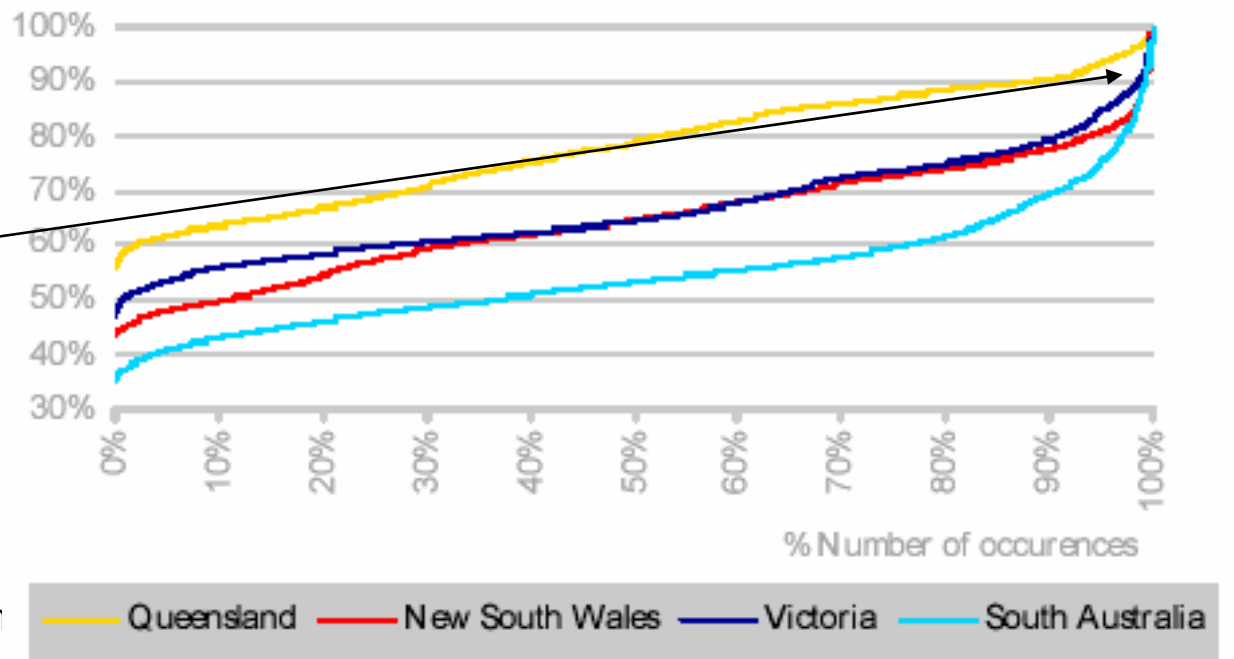
In 2001 NSW load >90% peak for ~5% of time

NEM load duration curves, January-March 2001 & 2003

(NECA quarterly Market Statistics)

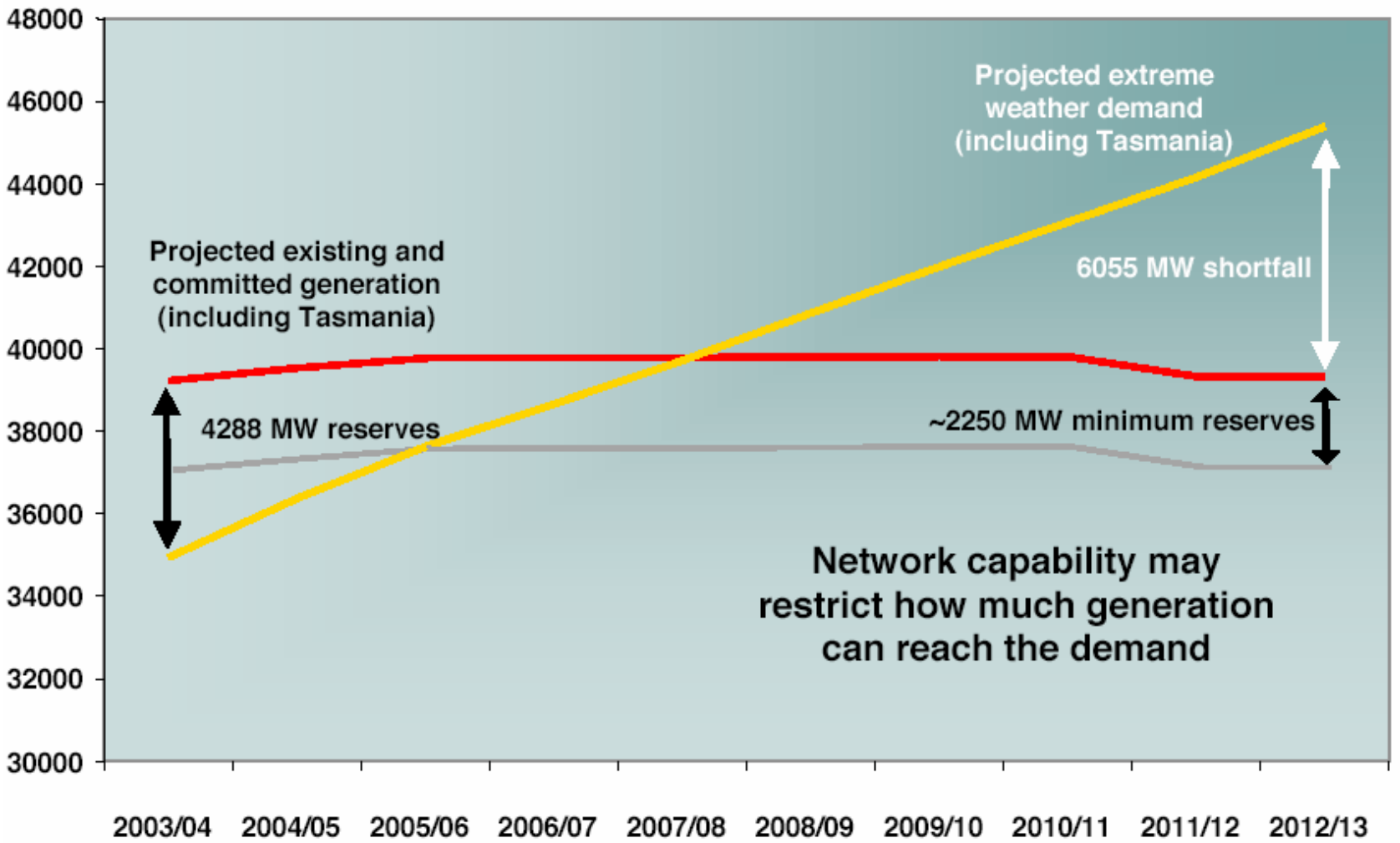
In 2003 NSW load >90% peak for <2% of time





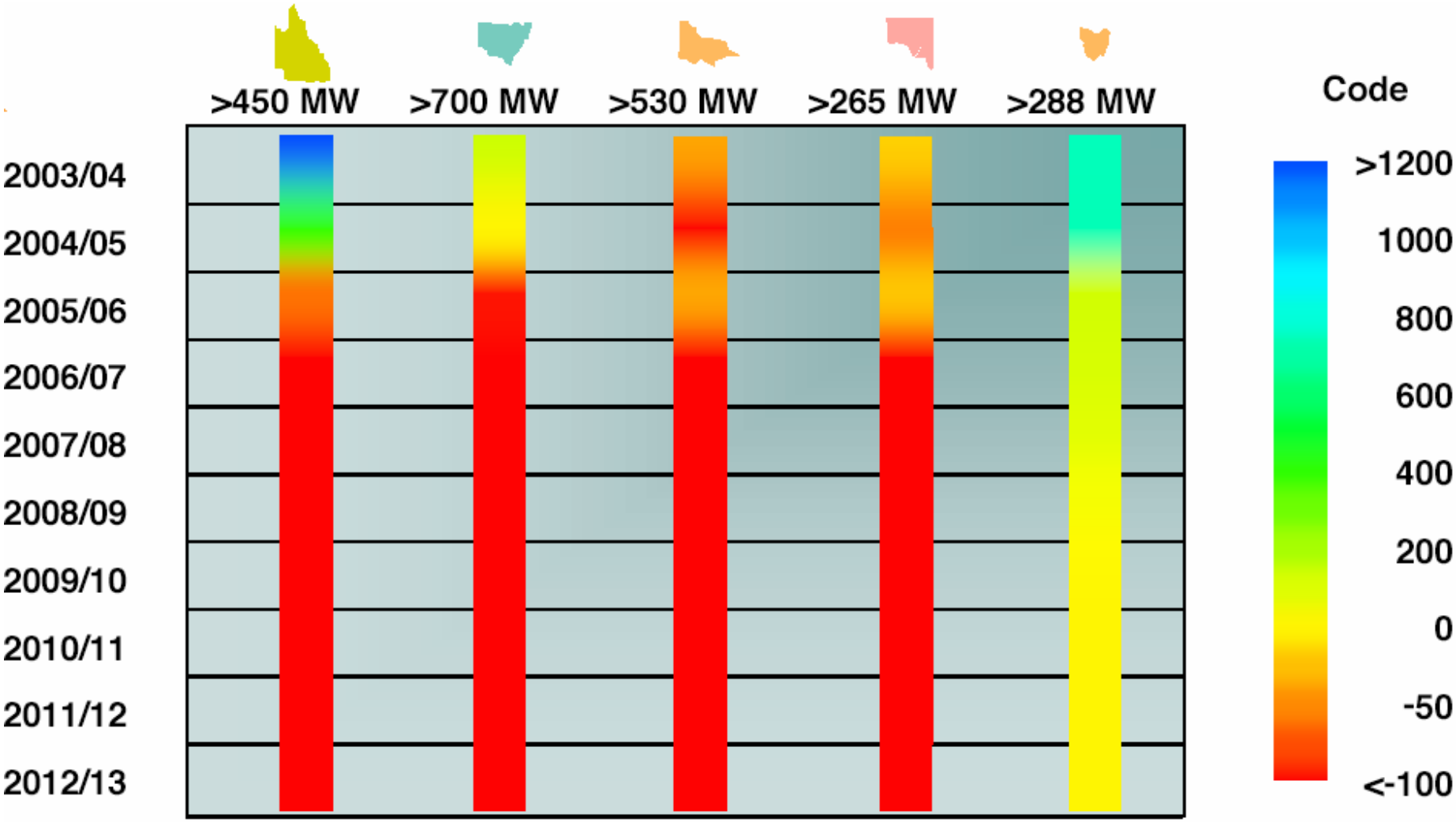
SOO: Projected gen. & summer peak demand

(Medium growth + extreme weather: *NEMMCO Statement of Opportunities, July 2003*)



SOO: Projected surplus reserves NEM states

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



SOO - key messages *(NEMMCO SOO, July 2003)*

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***

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

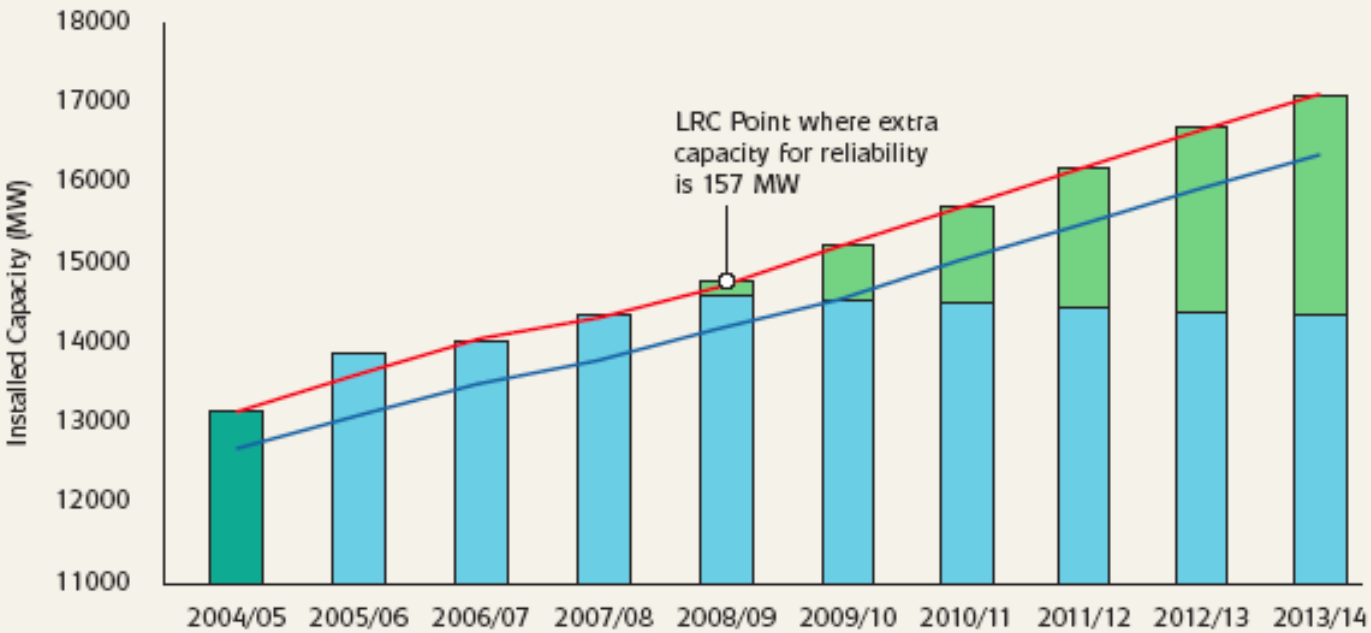
Table 5 Projected Low Reserve Conditions

	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	–

Projected NSW peak demand & installed capacity

(NEMMCO *SOO Executive Summary*, 2004)

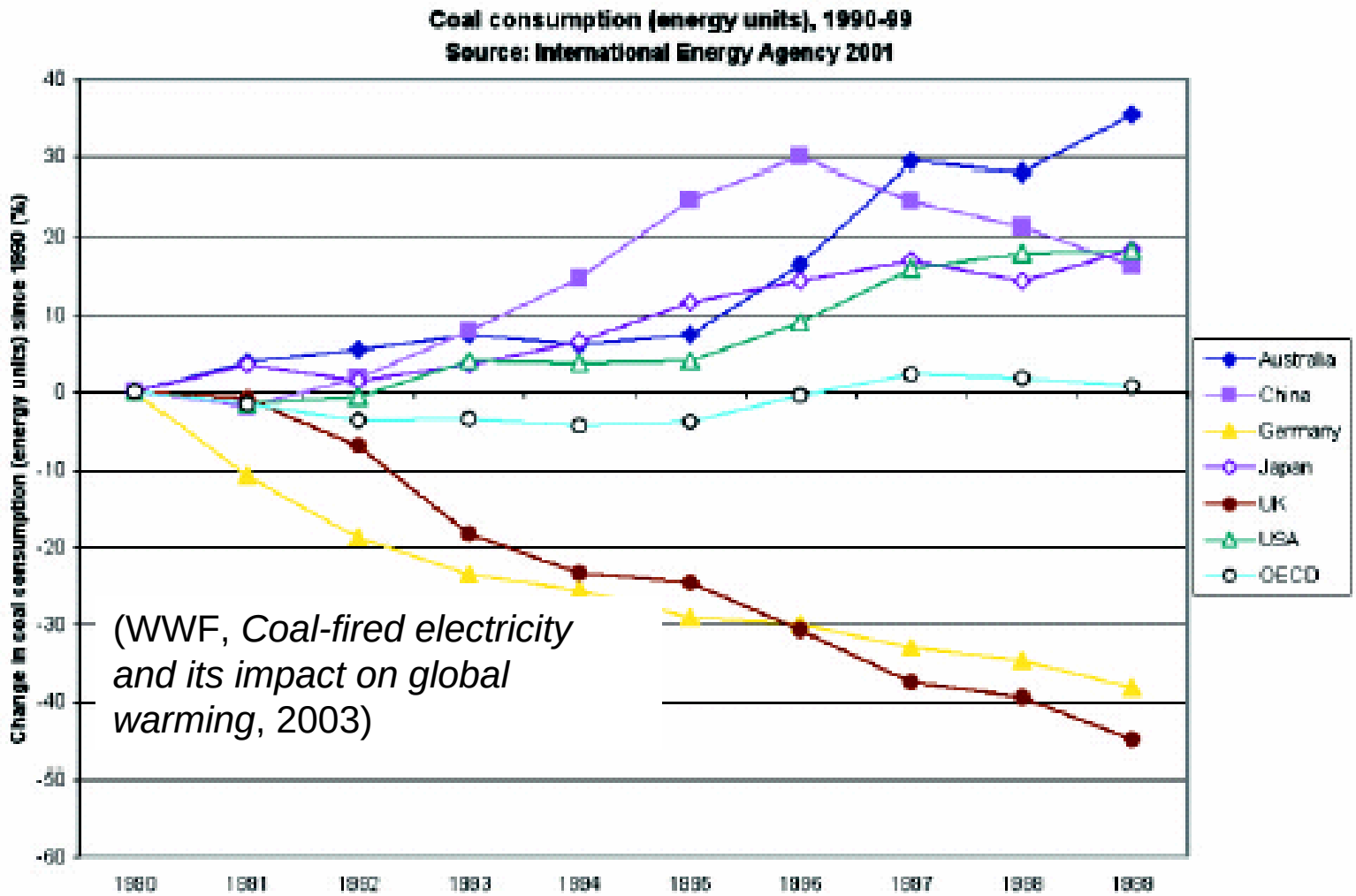
Figure 4 New South Wales Summer Outlook



- 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

Australian trends in coal generation

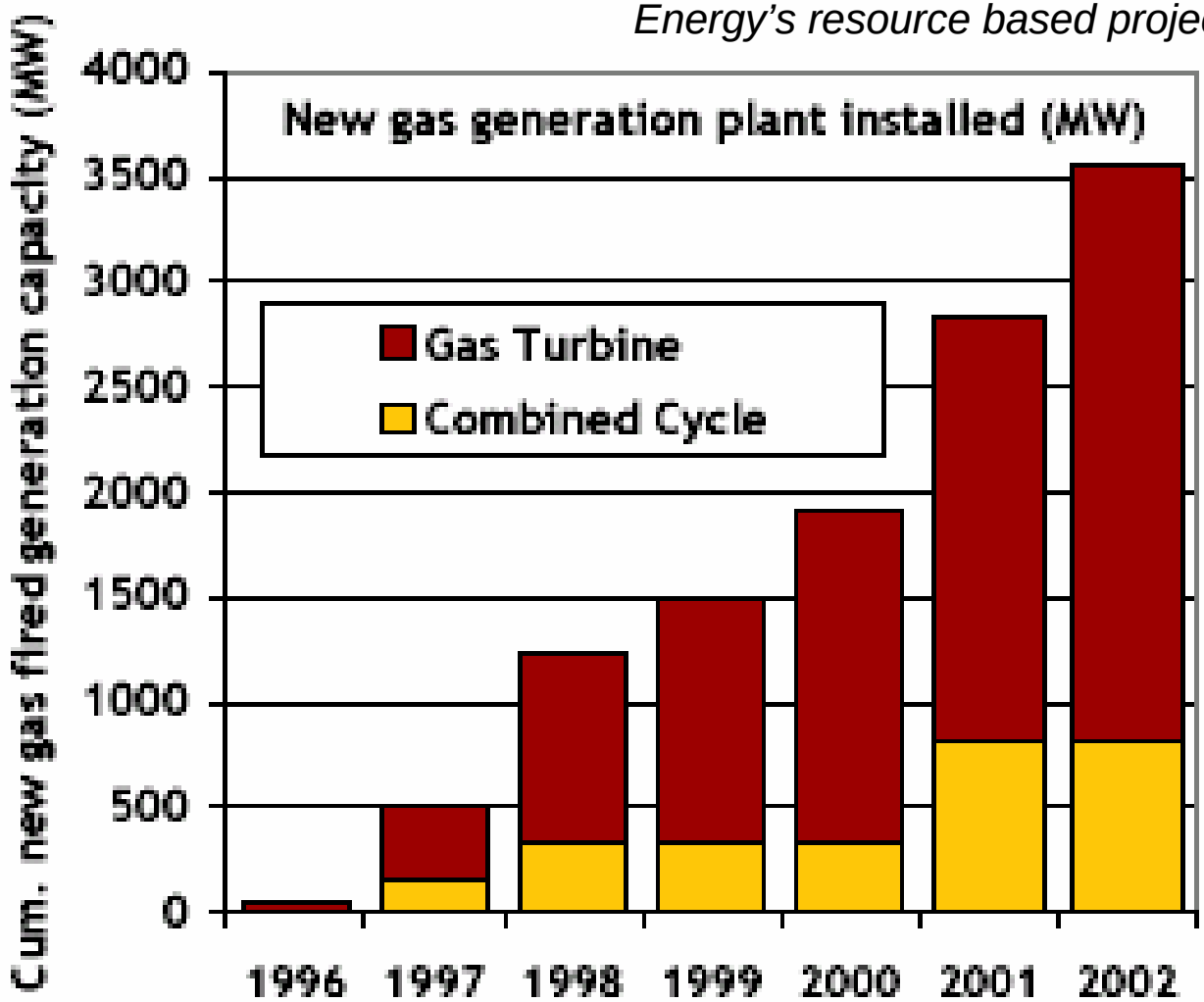
- Since 1996, 3700MW of new coal added to NEM



(WWF, *Coal-fired electricity and its impact on global warming*, 2003)

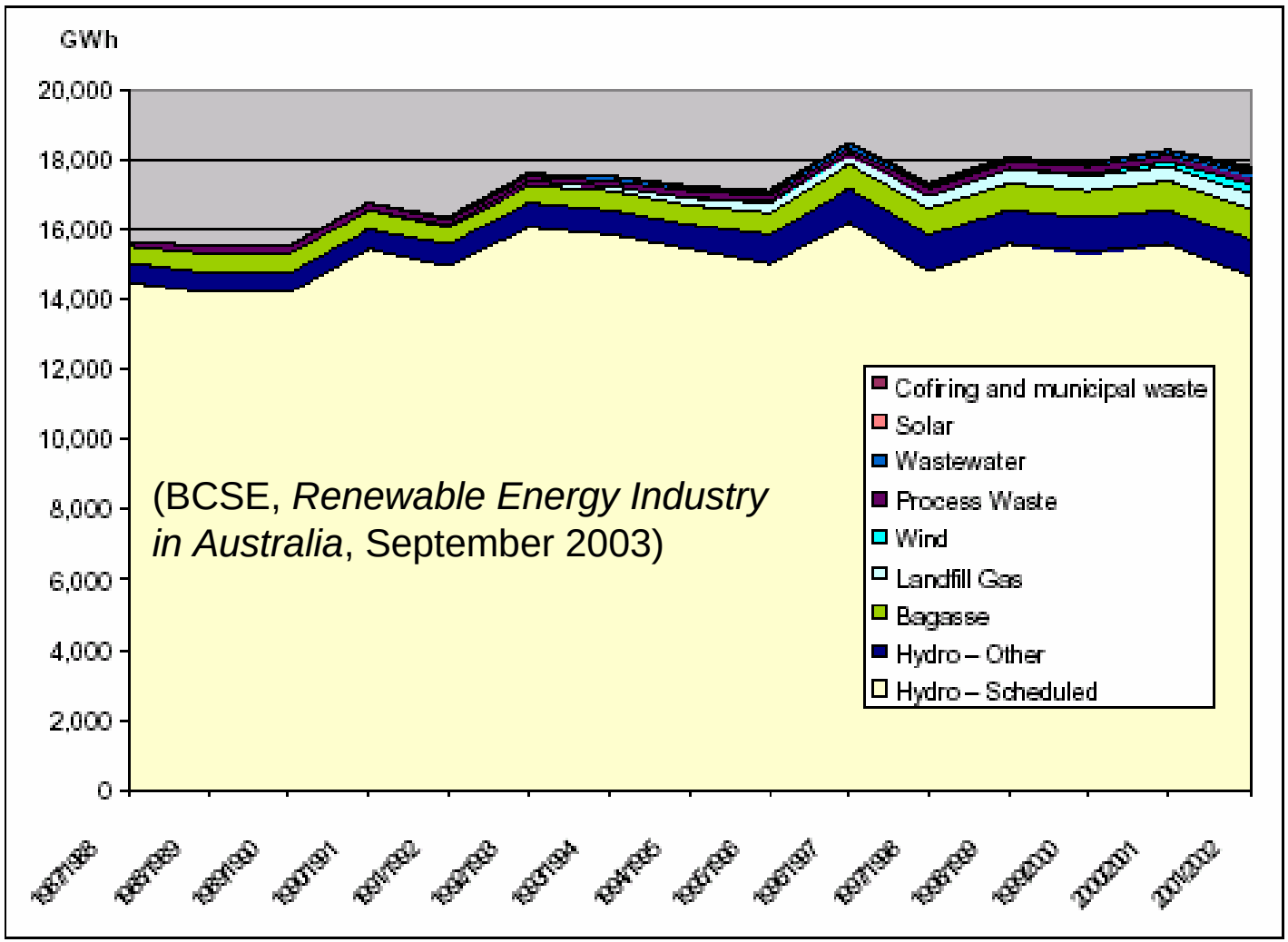
Australian trends in gas generation

(Origin Energy, *Strategic framework for Origin Energy's resource based projects*, June 2004)



Australian trends in renewable generation

Figure 1. Total historical renewable energy generation

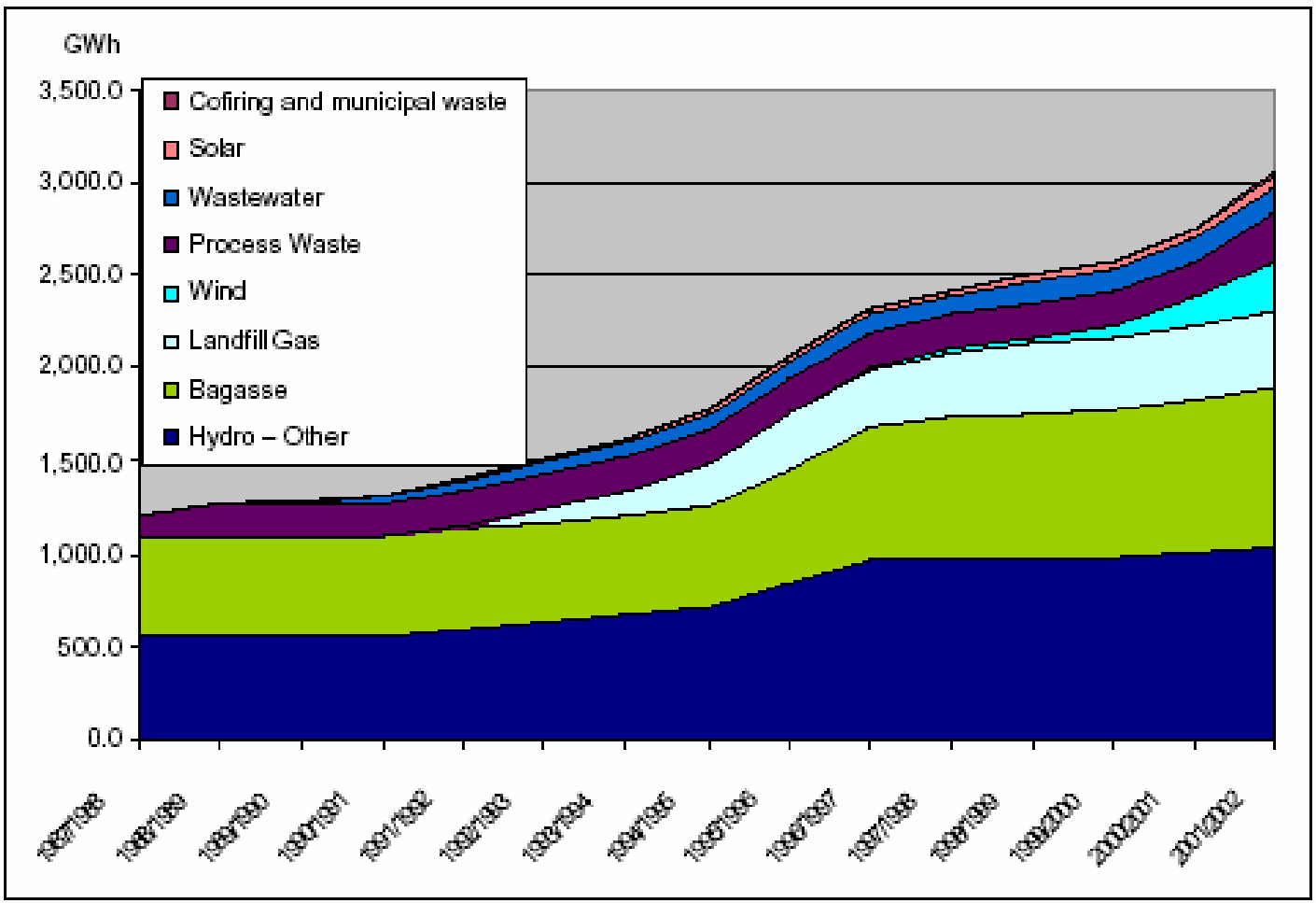


(BCSE, *Renewable Energy Industry in Australia*, September 2003)

Australian trends in non large-hydro renewables

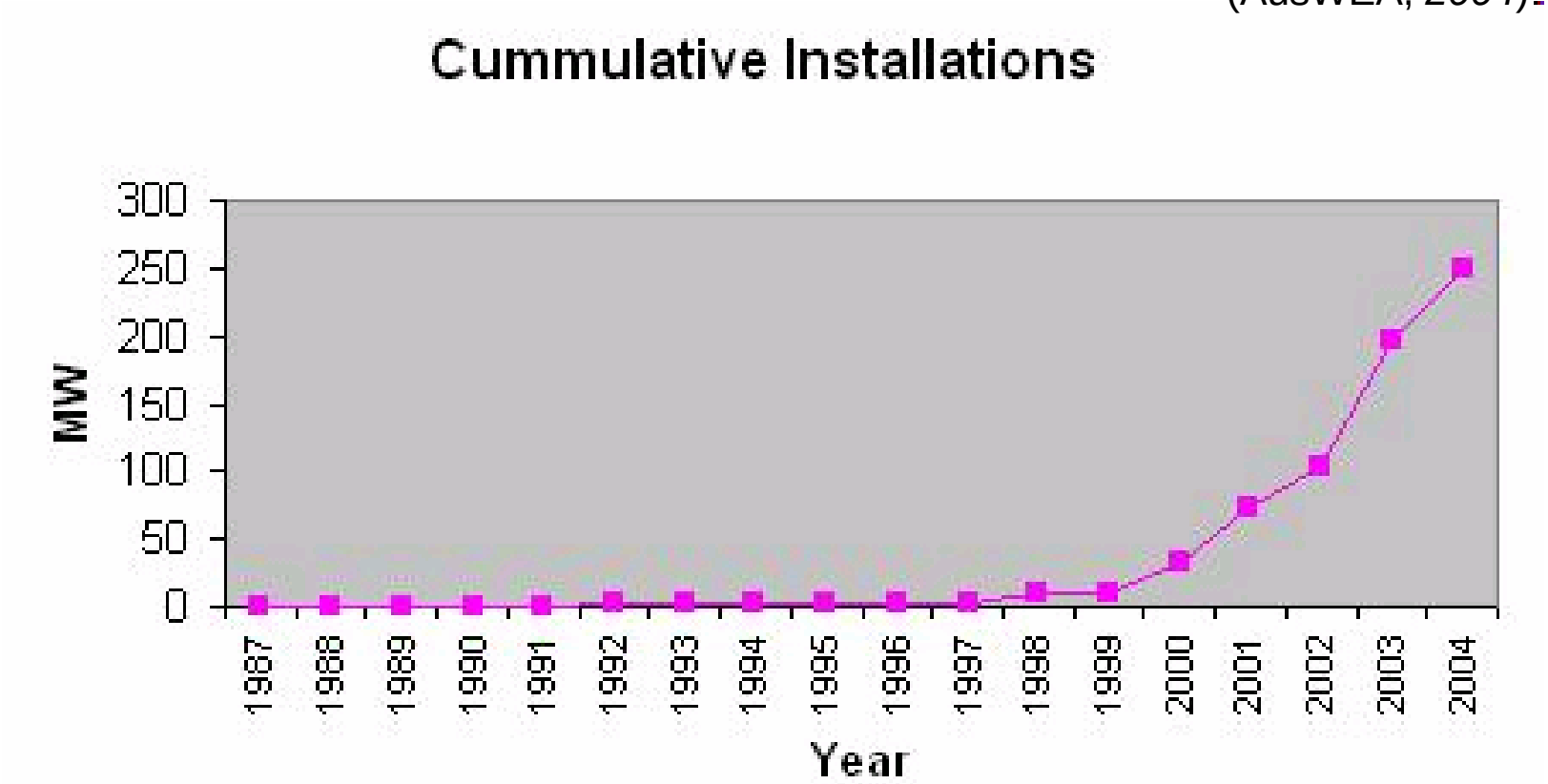
Figure 2. Total historical renewable generation (excluding scheduled hydro plant)

(BCSE, *Renewable Energy Industry in Australia*, September 2003)

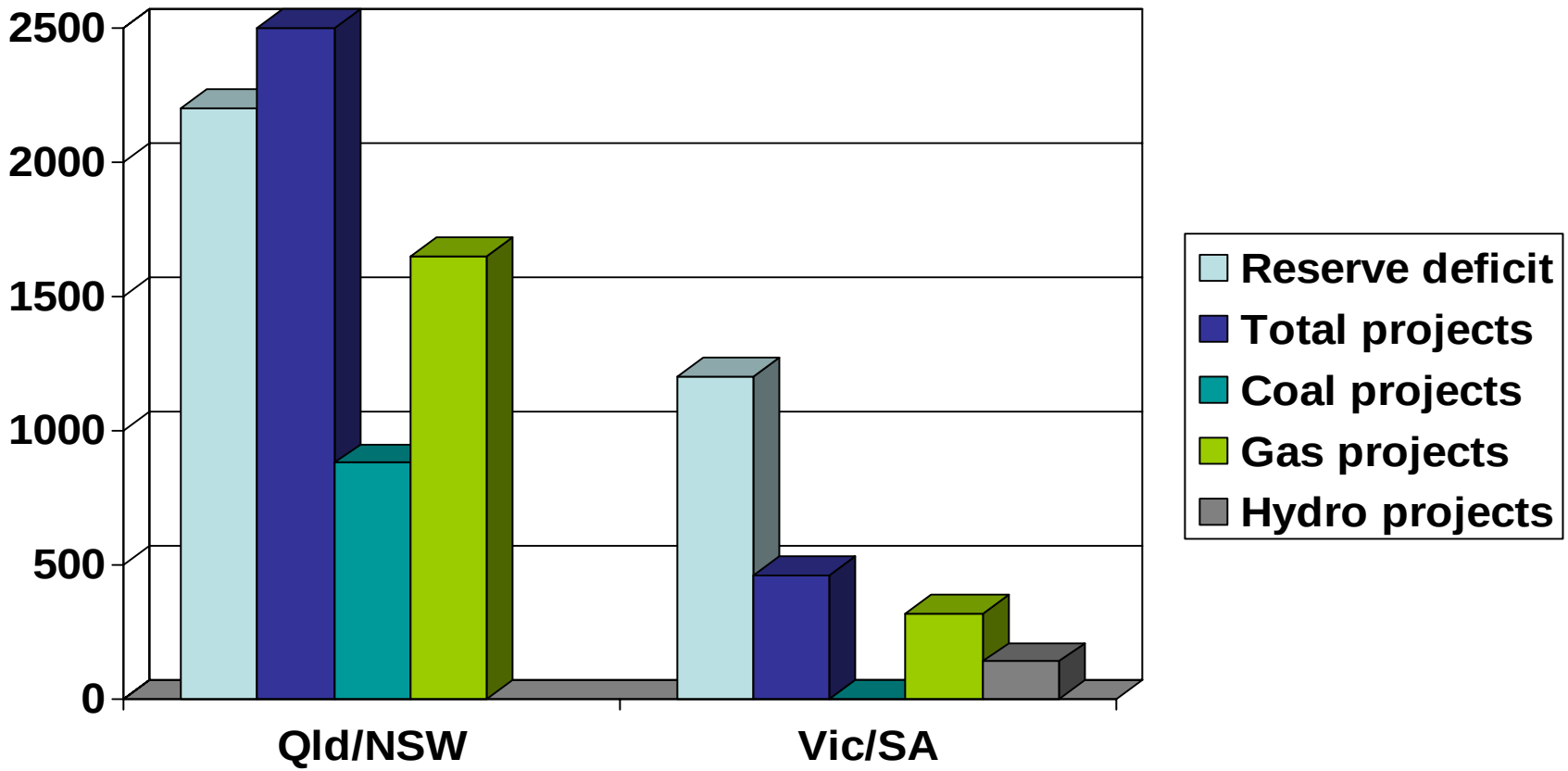


Installed Australian wind capacity

(AusWEA, *2004*).



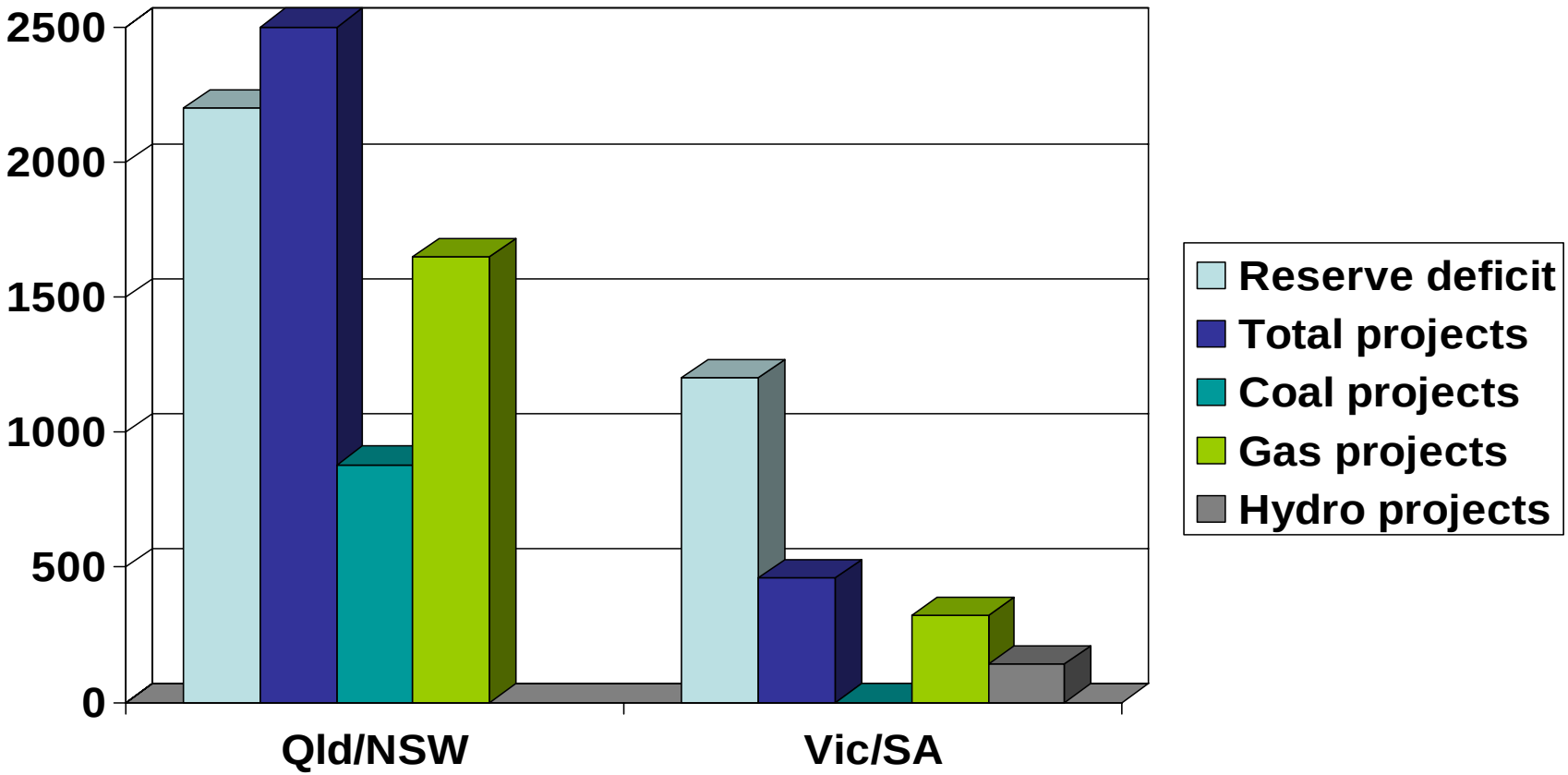
Advanced or publicly announced generation projects compared to expected reserve deficit in 2008/09



Driving appropriate generation investment

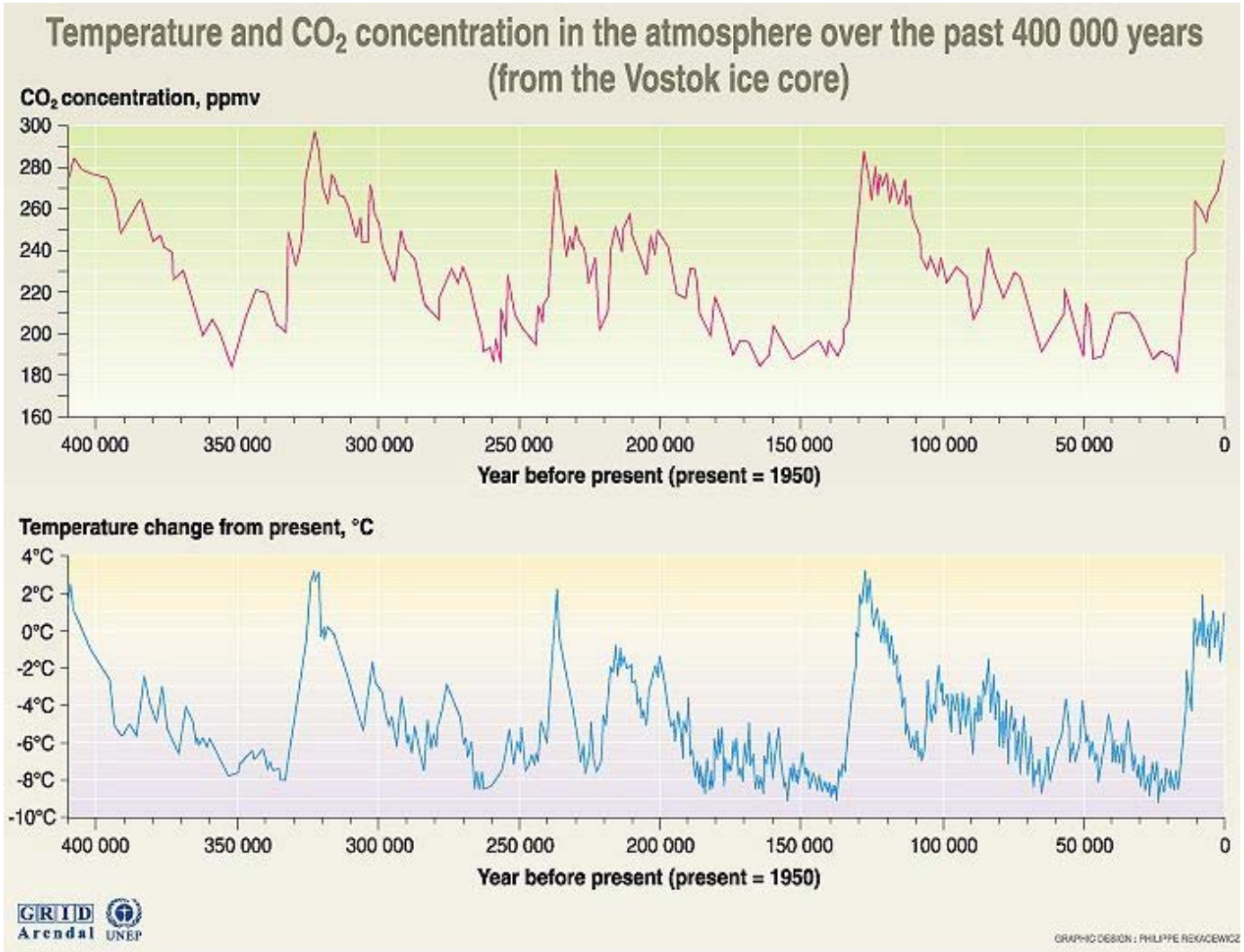
- Drivers for new investment
  - Projected supply shortfalls given growing demand
  - Greenhouse policy
- The context for appropriate investment
  - Resource availability
  - Technological options
- Policy options

Advanced or publicly announced generation projects compared to expected reserve deficit in 2008/09



The link between climate change and CO2

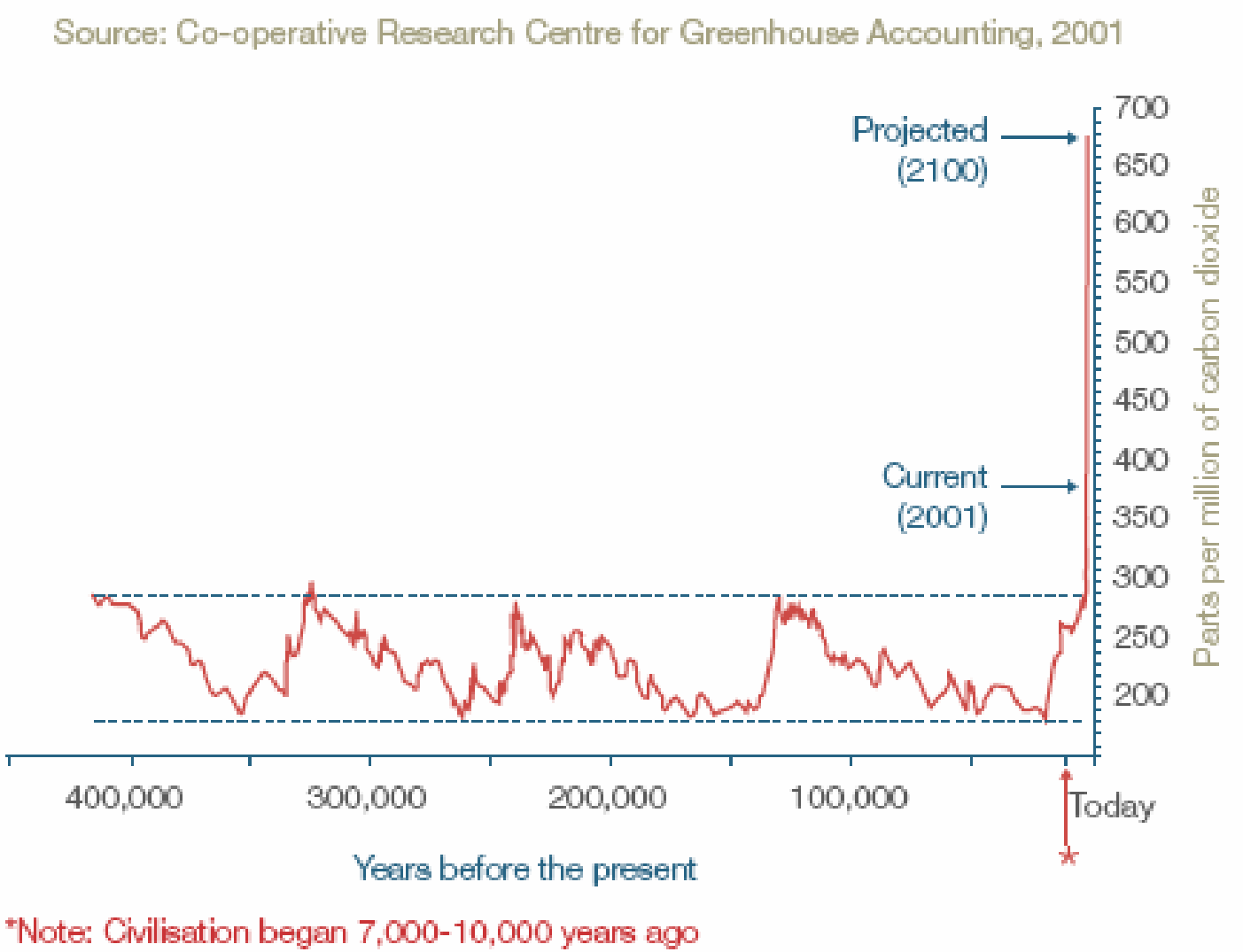
Source: http://www.grida.no/climate/vital/



Source: J.R. Petit, J. Jouzel, et al. Climate and atmospheric history of the past 420 000 years from the Vostok ice core in Antarctica, Nature 399 (3JUne), pp 429-436, 1999.

CO2 concentration in the atmosphere

(Climate Action Group, 2004)



Global temperature & atmospheric CO2

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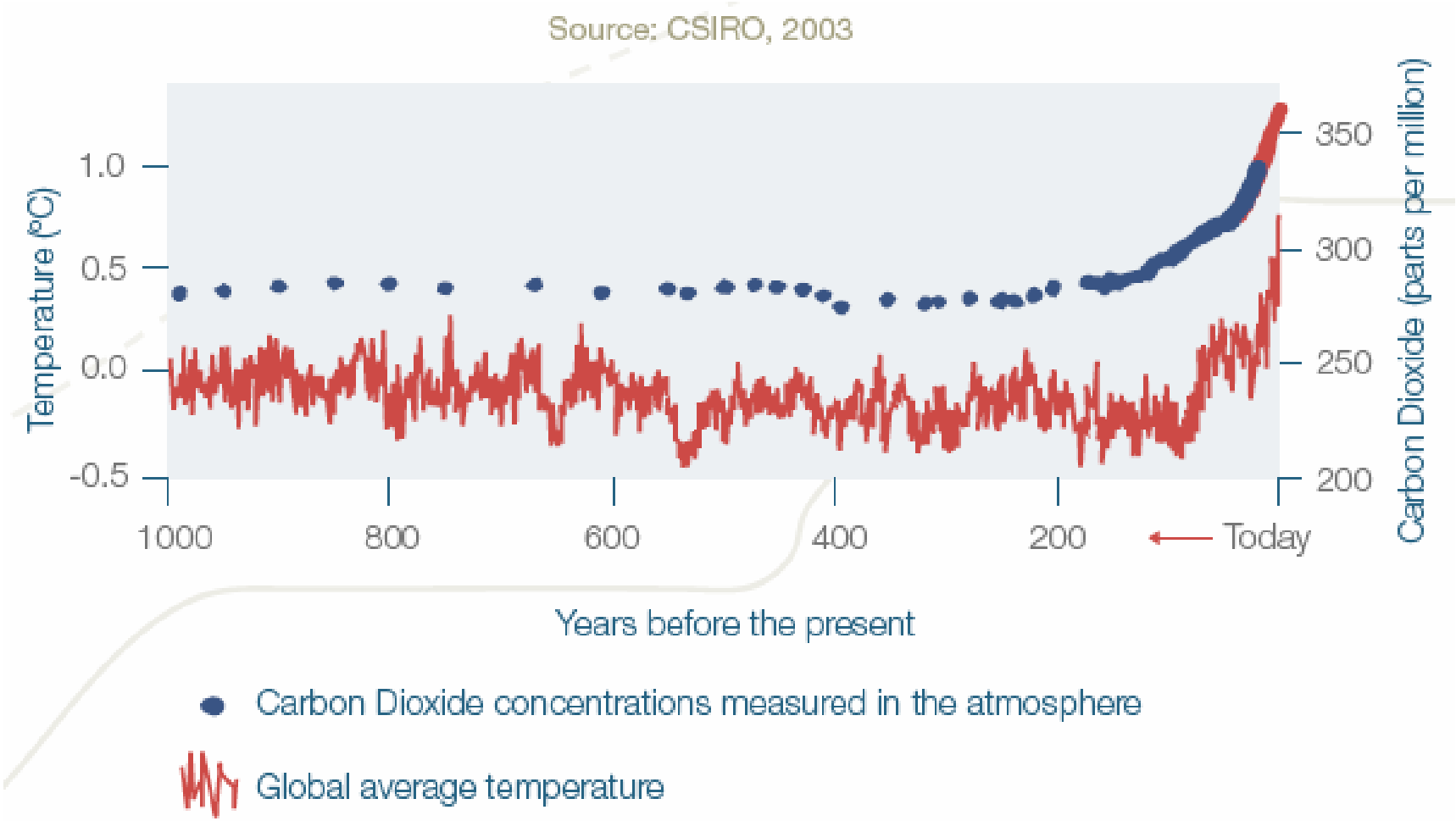

It all suggests major warming if emissions continue

(www.ipcc.ch)

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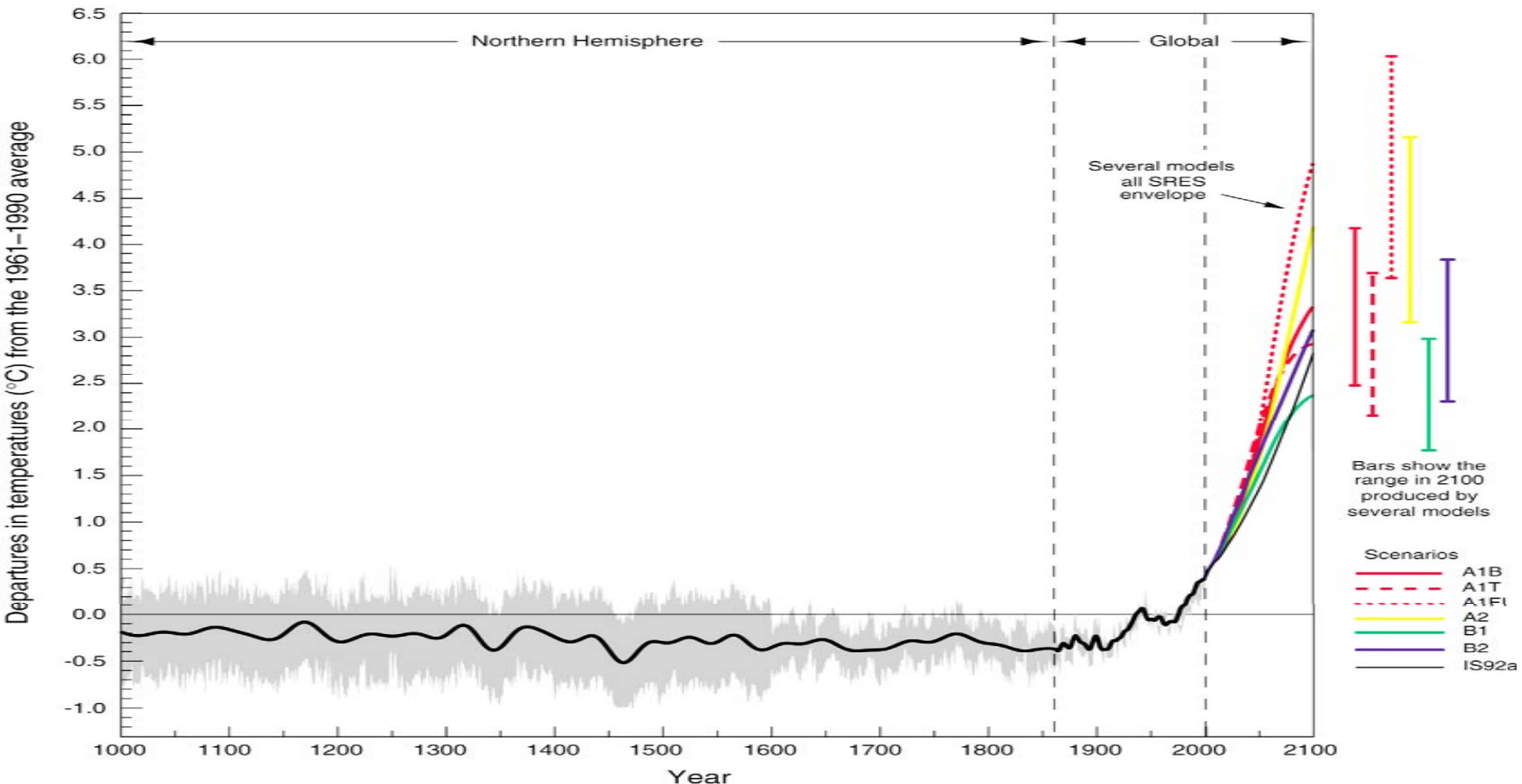
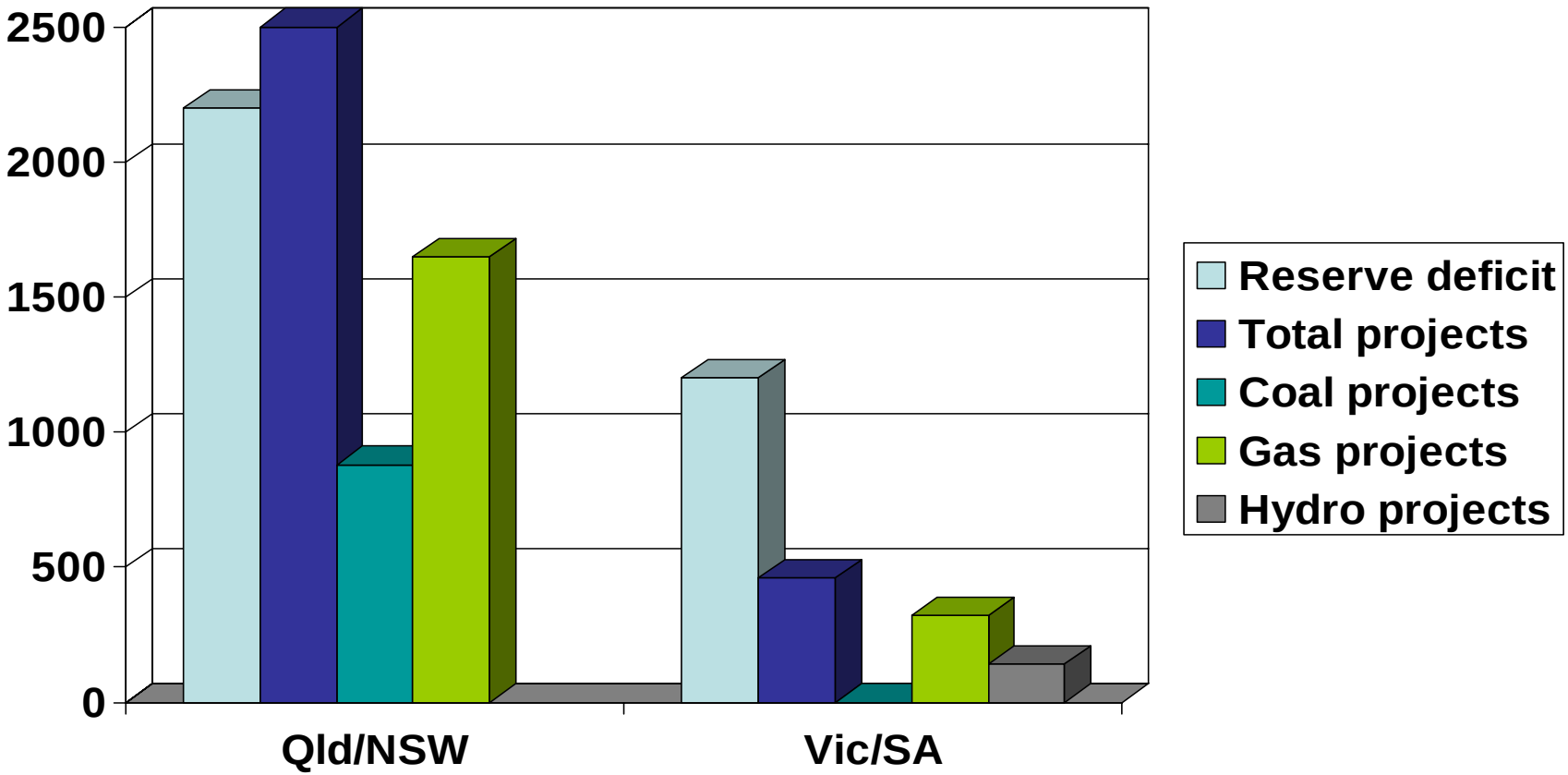


Presentation outline

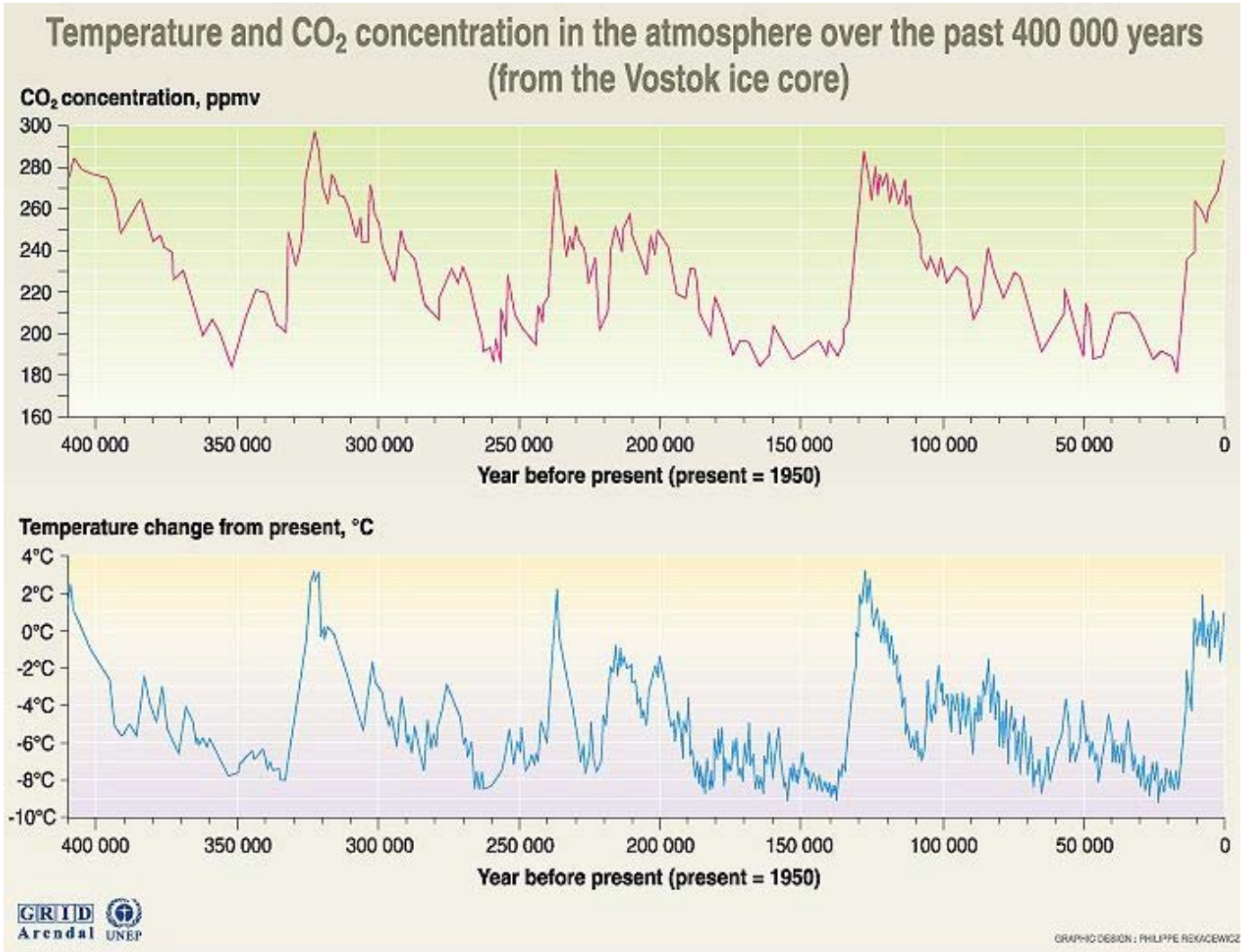
- Drivers for new investment
  - Projected supply shortfalls given growing demand
  - Greenhouse policy
- The context for appropriate investment
  - Resource availability
  - Technological options
- Policy options

Advanced or publicly announced generation projects compared to expected reserve deficit in 2008/09



The link between climate change and CO2

Source: http://www.grida.no/climate/vital/



Source: J.R. Petit, J. Jouzel, et al. Climate and atmospheric history of the past 420 000 years from the Vostok ice core in Antarctica, Nature 399 (3JUne), pp 429-436, 1999.

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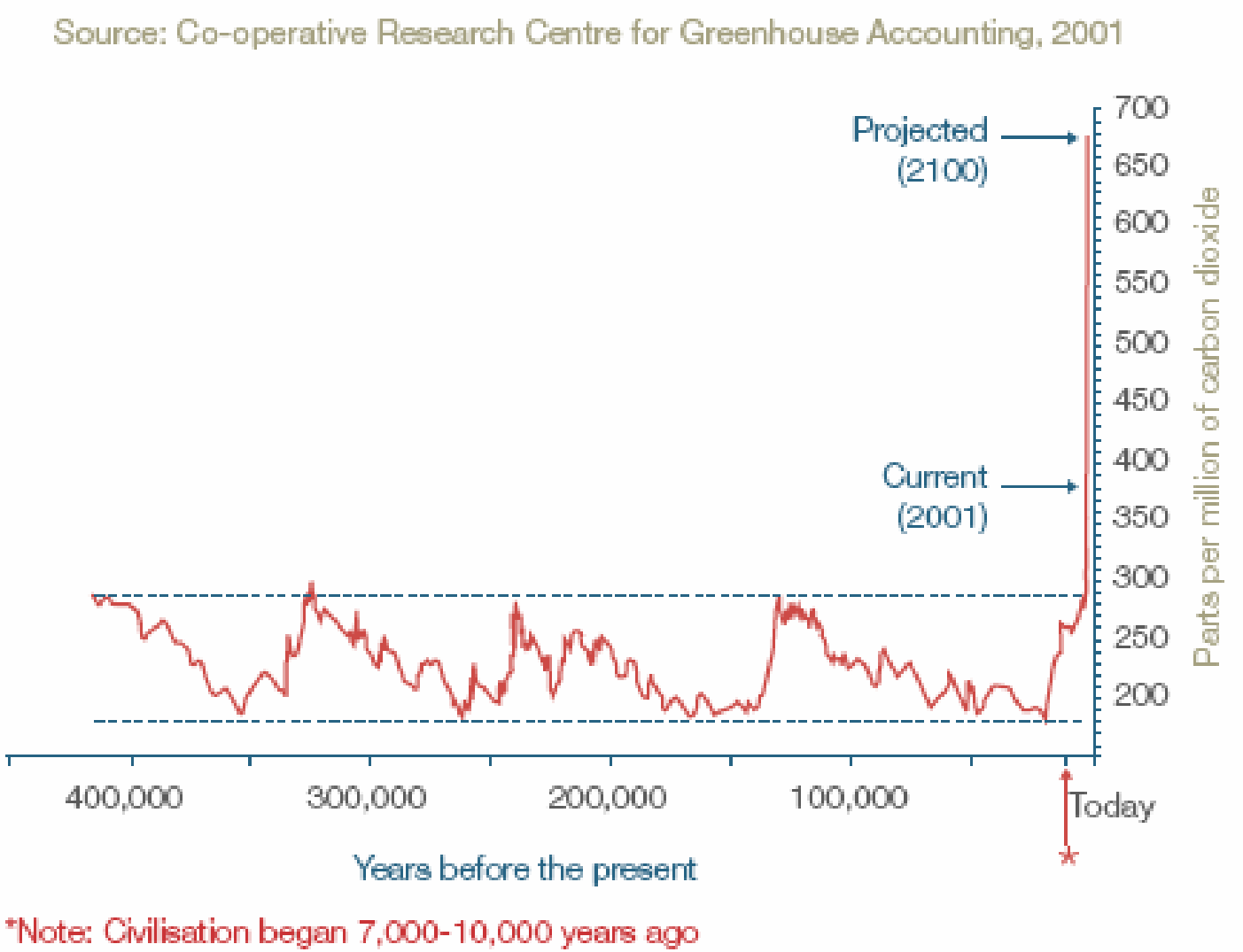

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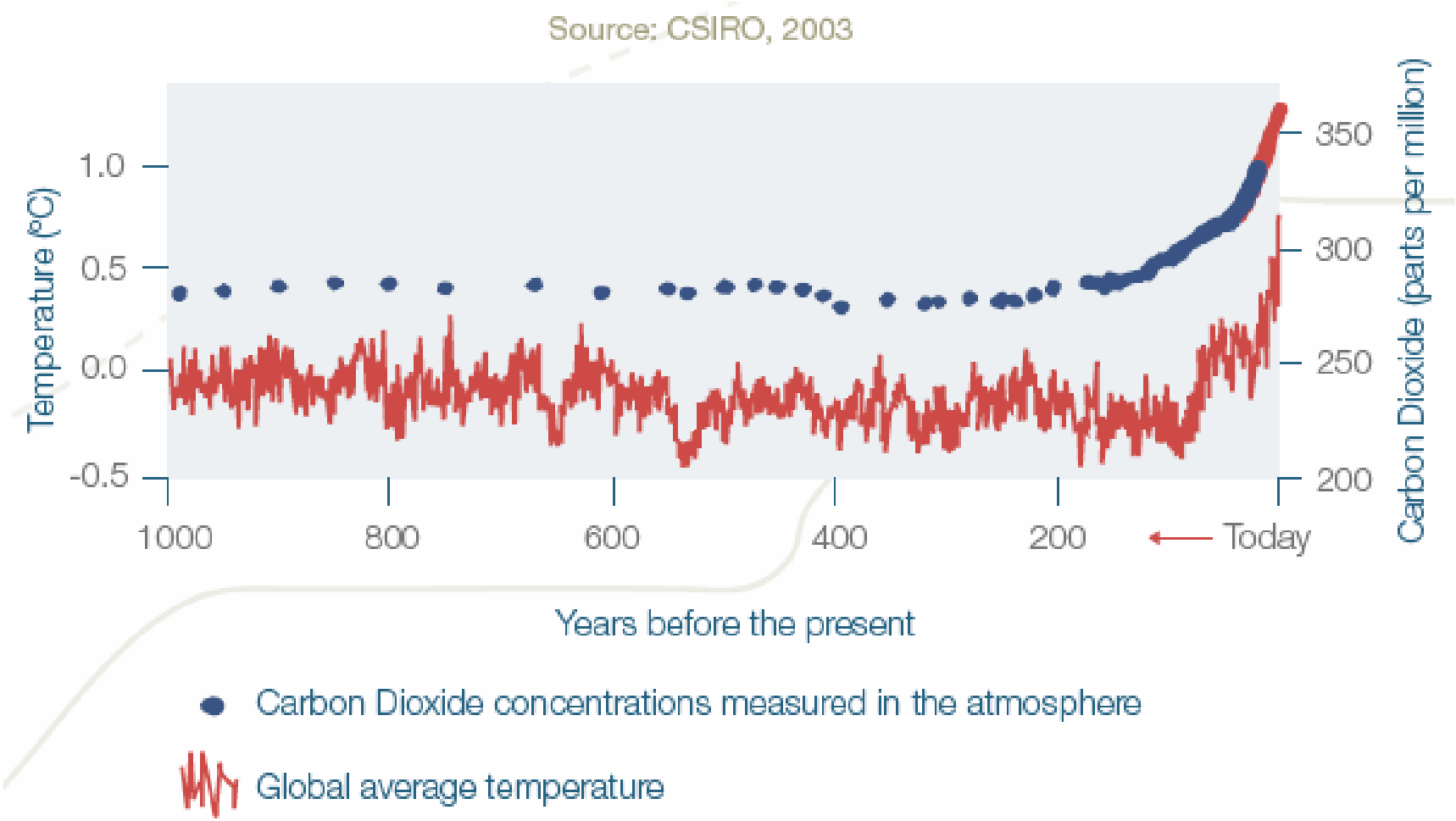

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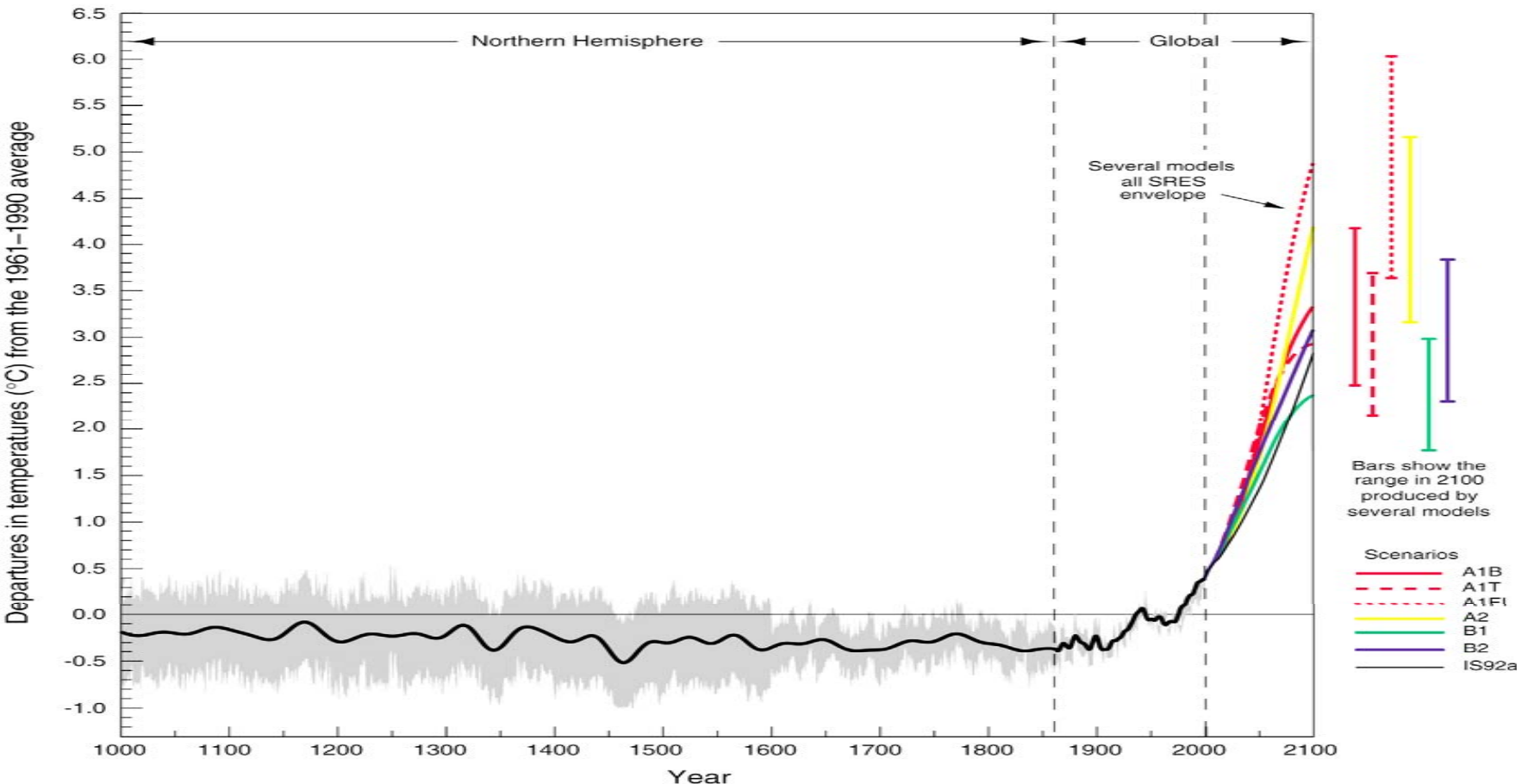


Some expected impacts on Australia

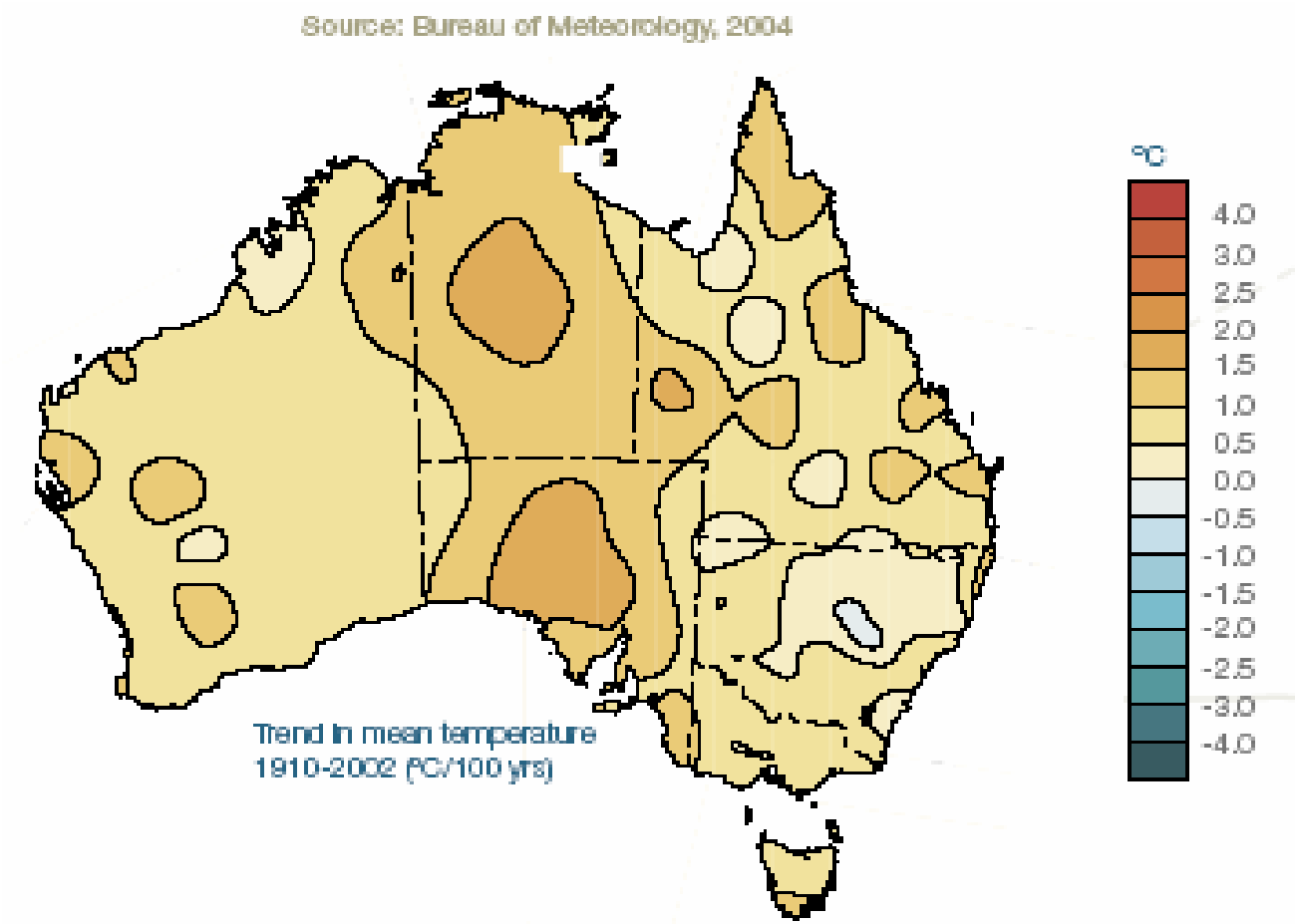
(Senate Environment Committee, 2000)

- Australia probably “very negatively affected”:
  - Large size, long coastline, soil salinity, exposure to cyclones & El Nino/La Nina cycle, economic dependence on agriculture & tourism

- Likely changes in next 50 years:
  - Higher temperatures, more frequent extreme weather events, reduced available water resources, reduced area of arable land, reduced crop & livestock yield & quality, severe damage to coral reefs

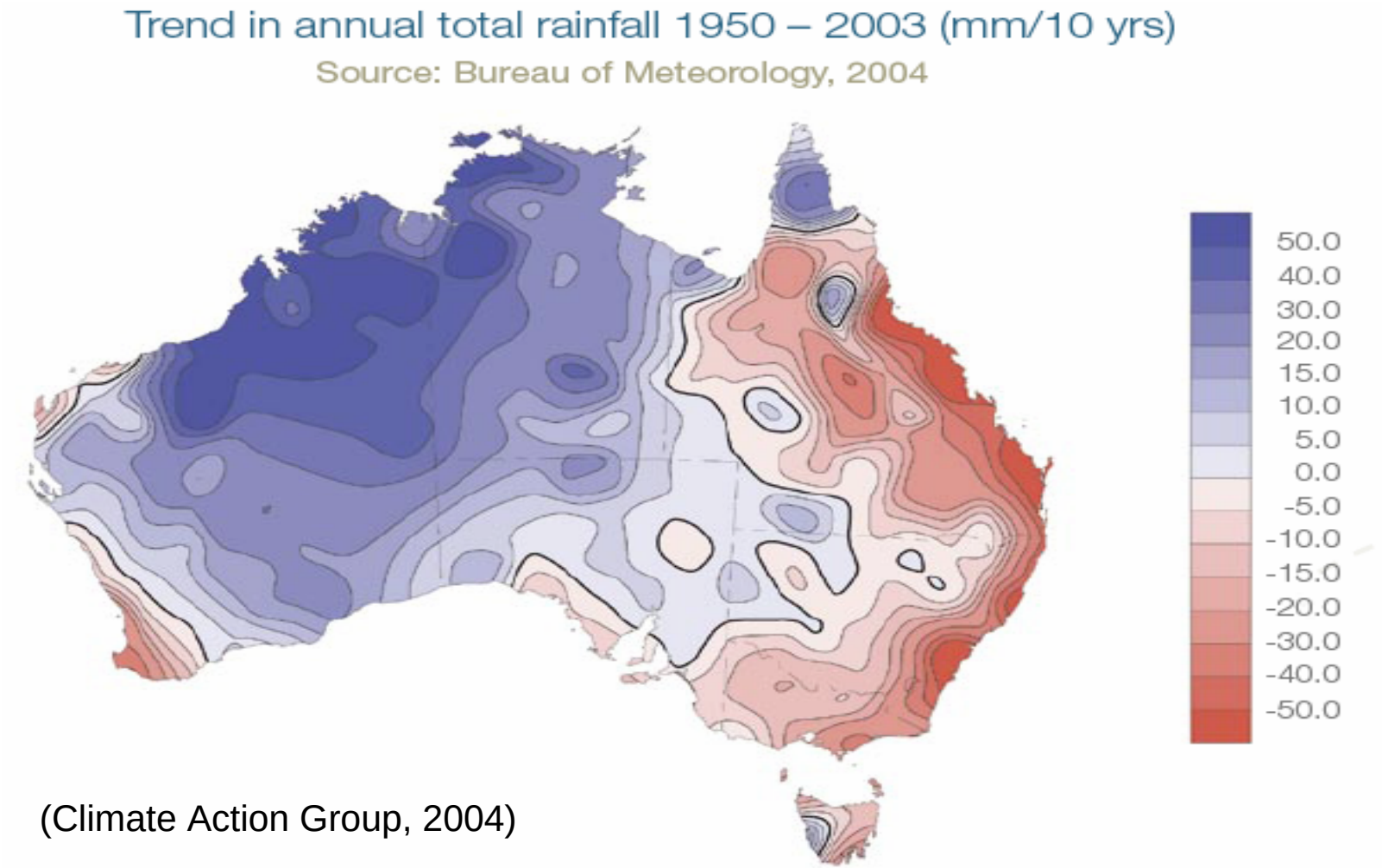
The climate is getting warmer

(Climate Action Group, 2004)



..the climate is getting drier

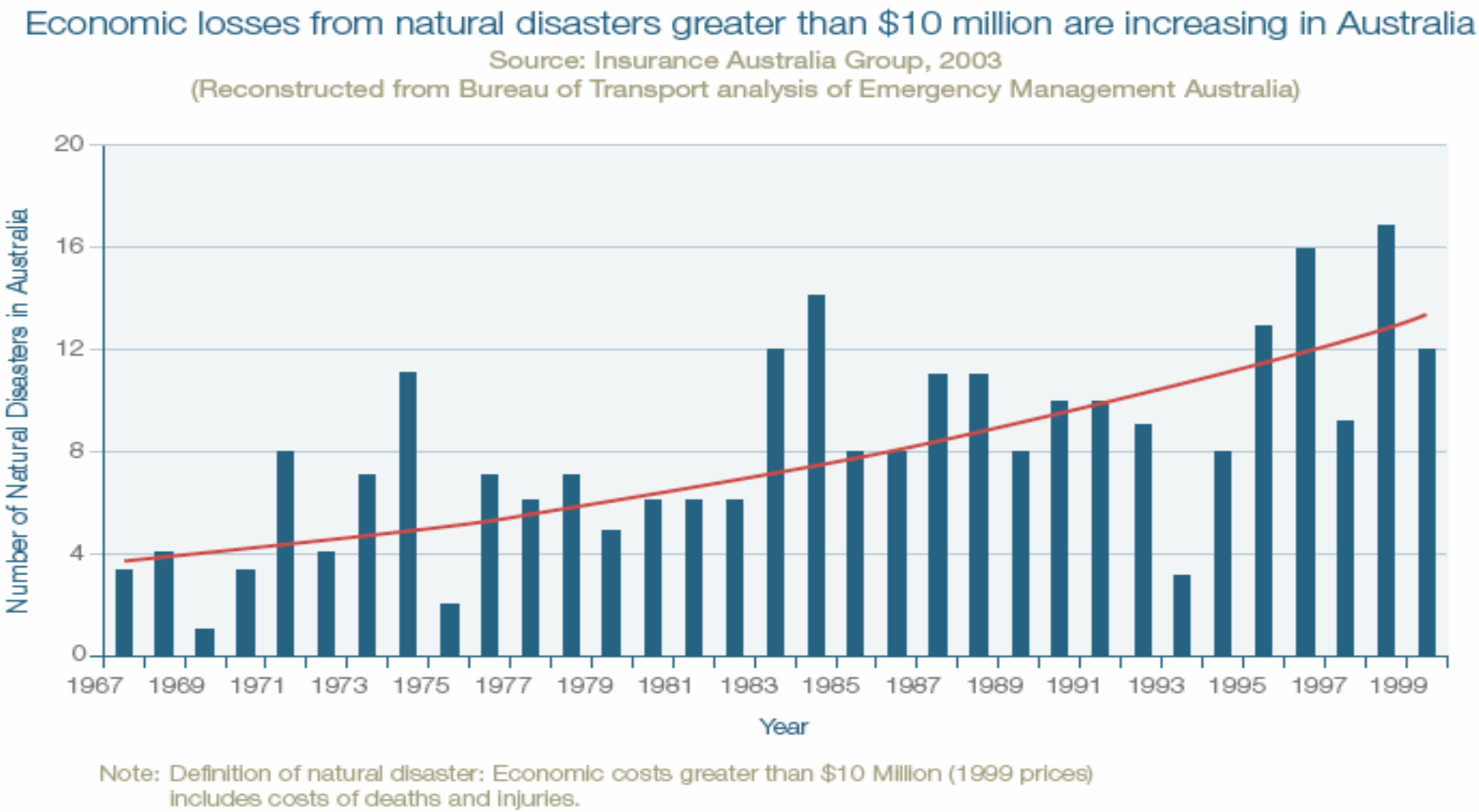
(Climate Action Group, 2004)



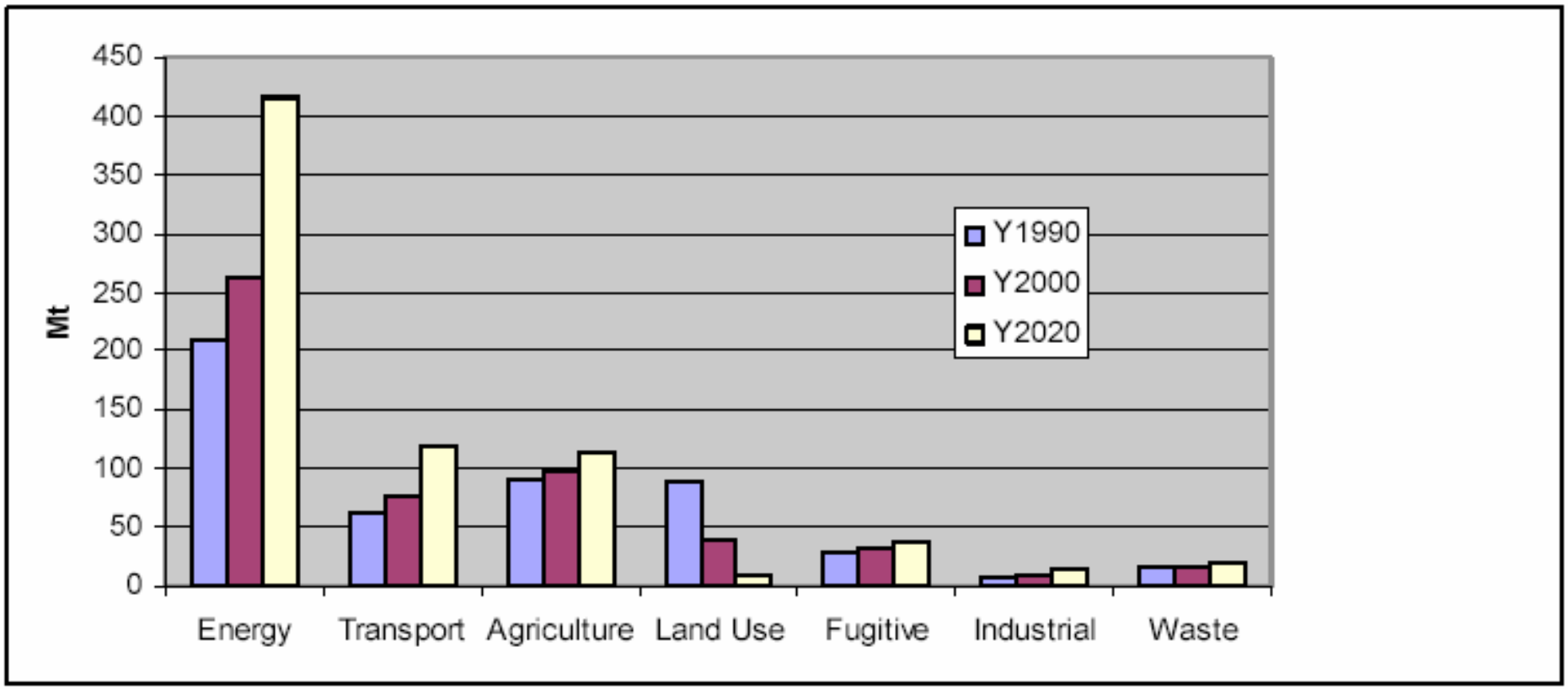
(Climate Action Group, 2004)

..extreme weather events appear to be getting worse

(Climate Action Group, 2004)

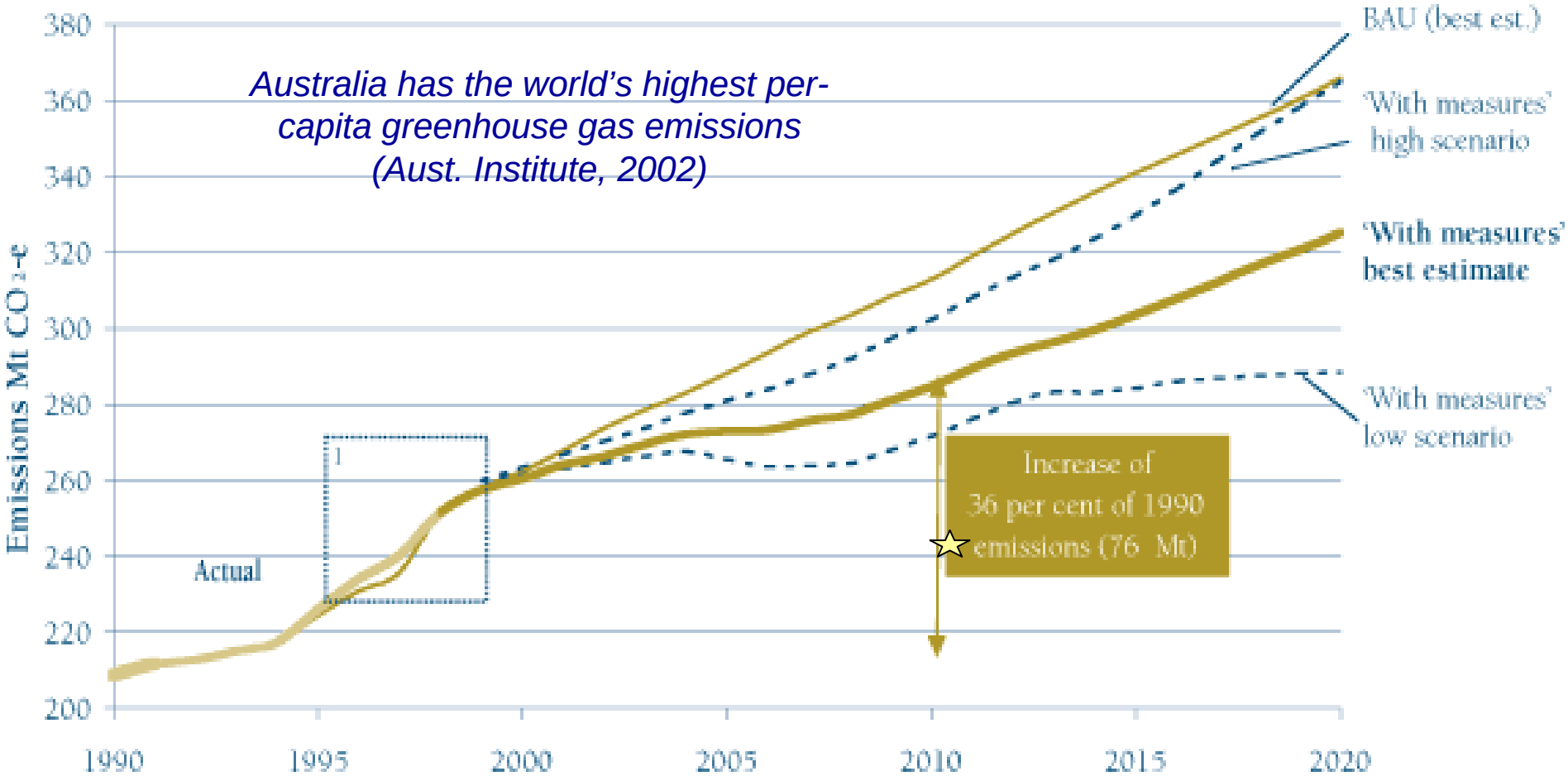


Australian CO2e emissions by sector history & projection to 2020



(PMSEIC, December 2002)

Projected emissions from Stationary Energy sector, 1990-2020



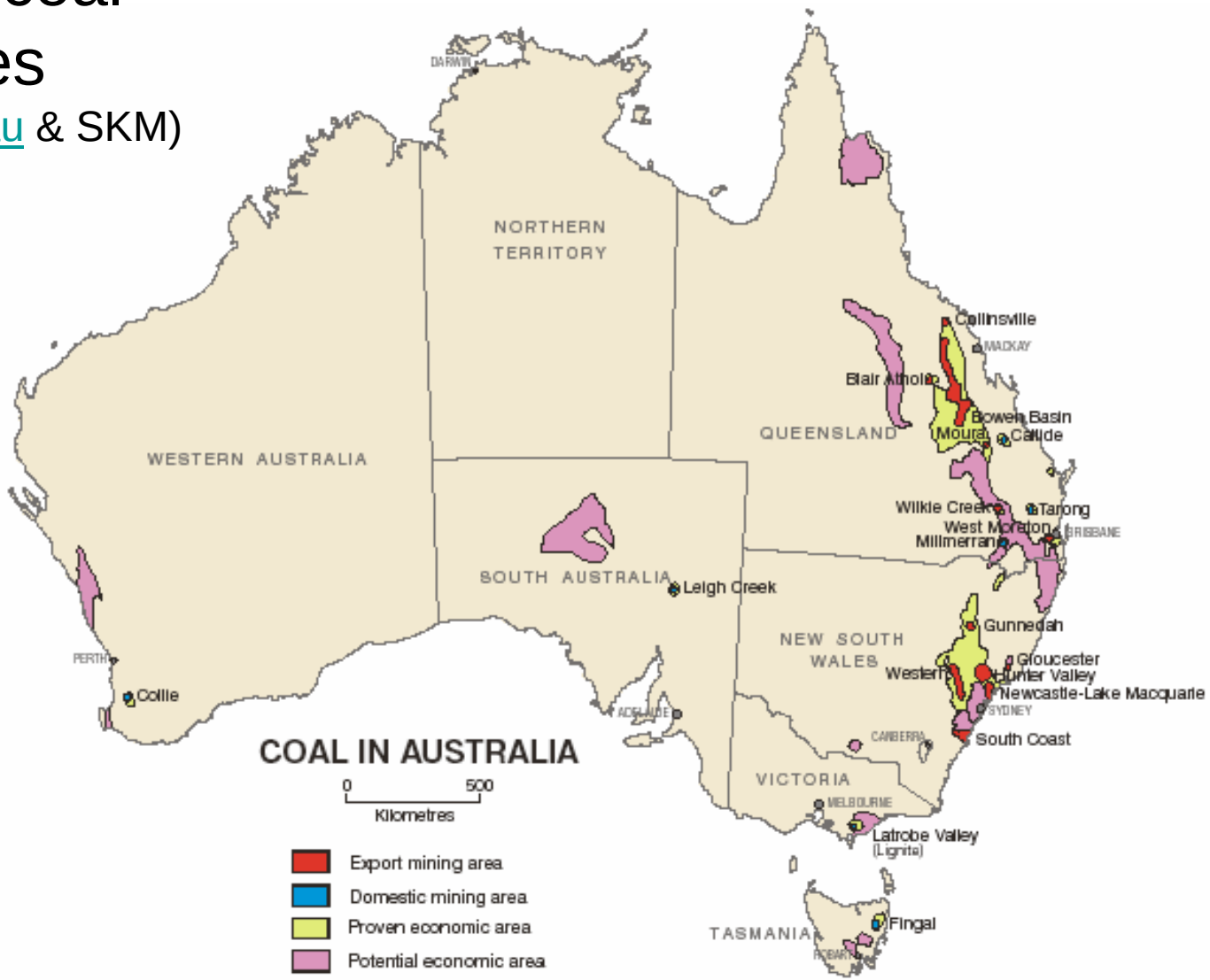
Source: Australian Greenhouse Office (2002)

Options - resources and technologies

- Availability and costs of:
  - Coal
  - Gas
  - Renewables

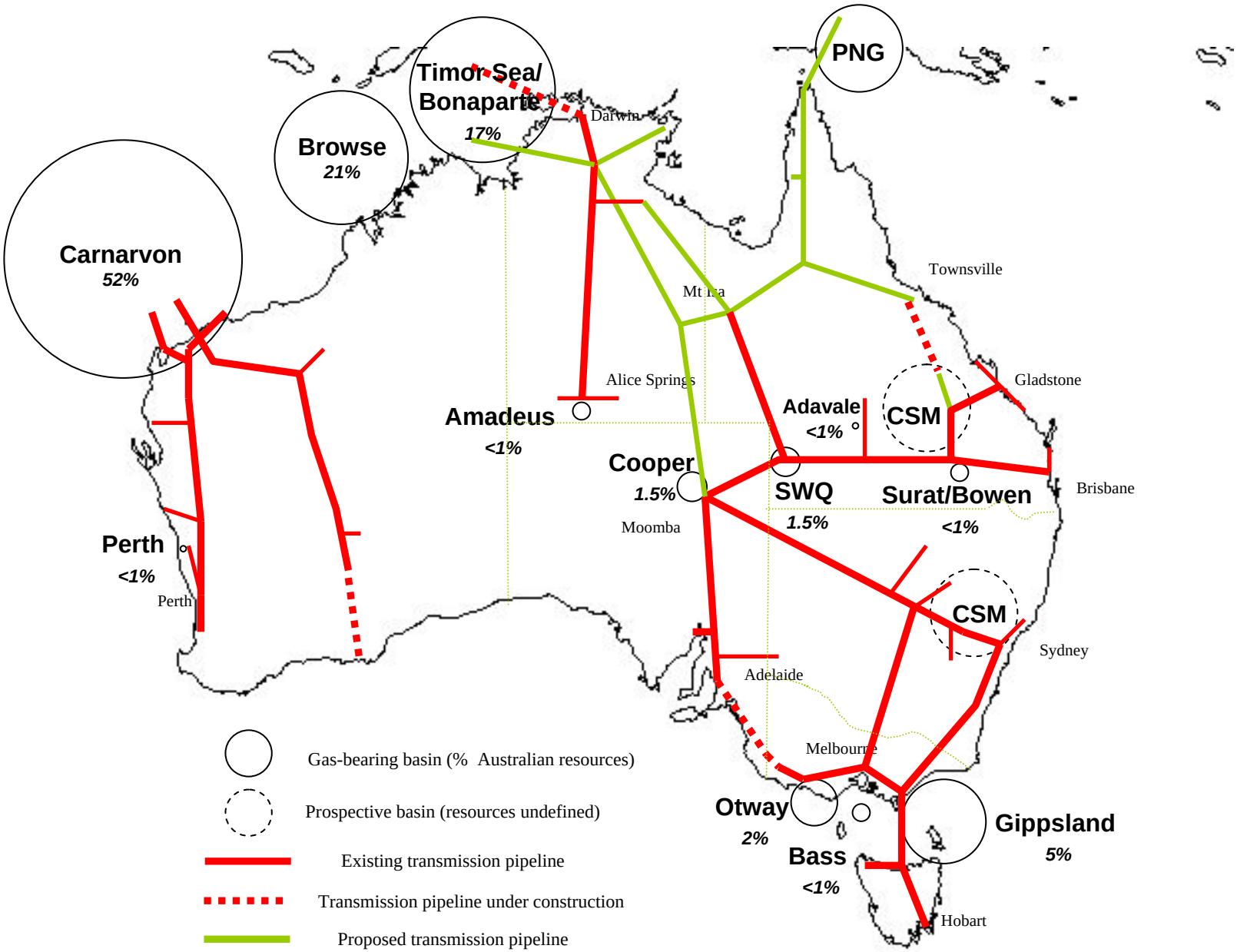
Australia's coal resources

(www.industry.gov.au & SKM)



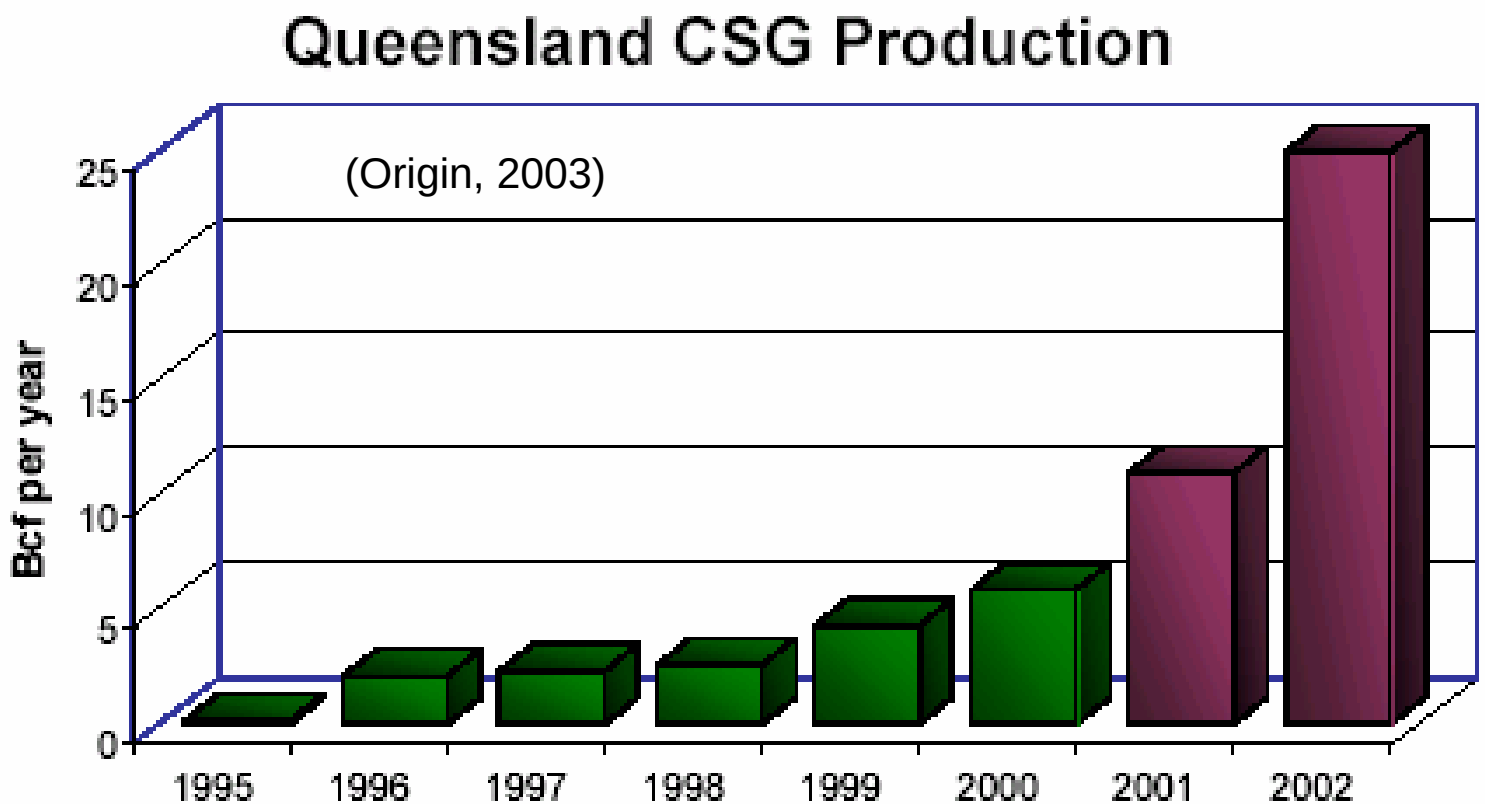
Australian gas resources

(Acil Tasman, Managing Risk in the Energy Market this Decade, *Vic. Power Conf.*, 2004.



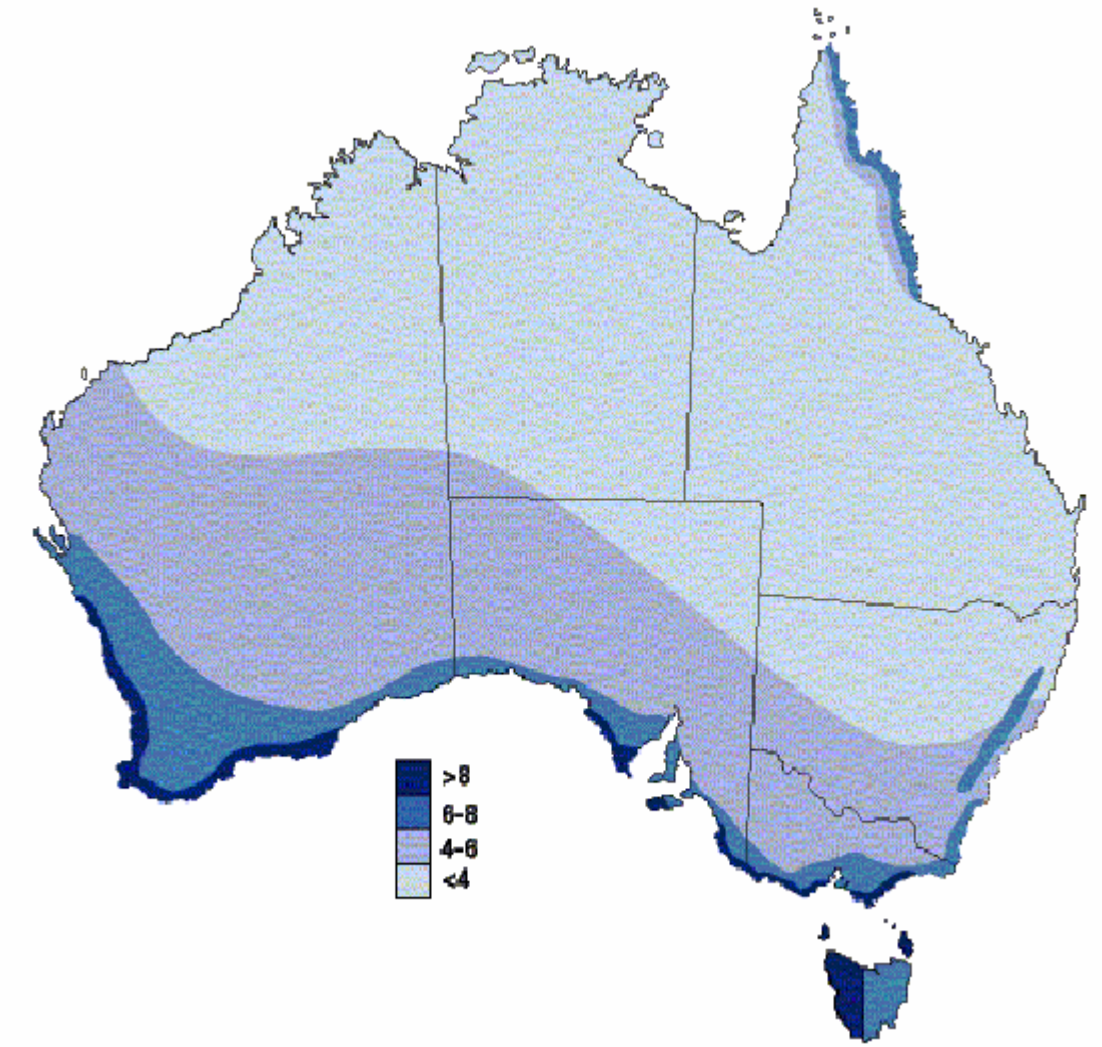
Gas reserves – CSM potential is the key

- Now 25% of Queensland electricity supply
- Potential appears large but important uncertainties



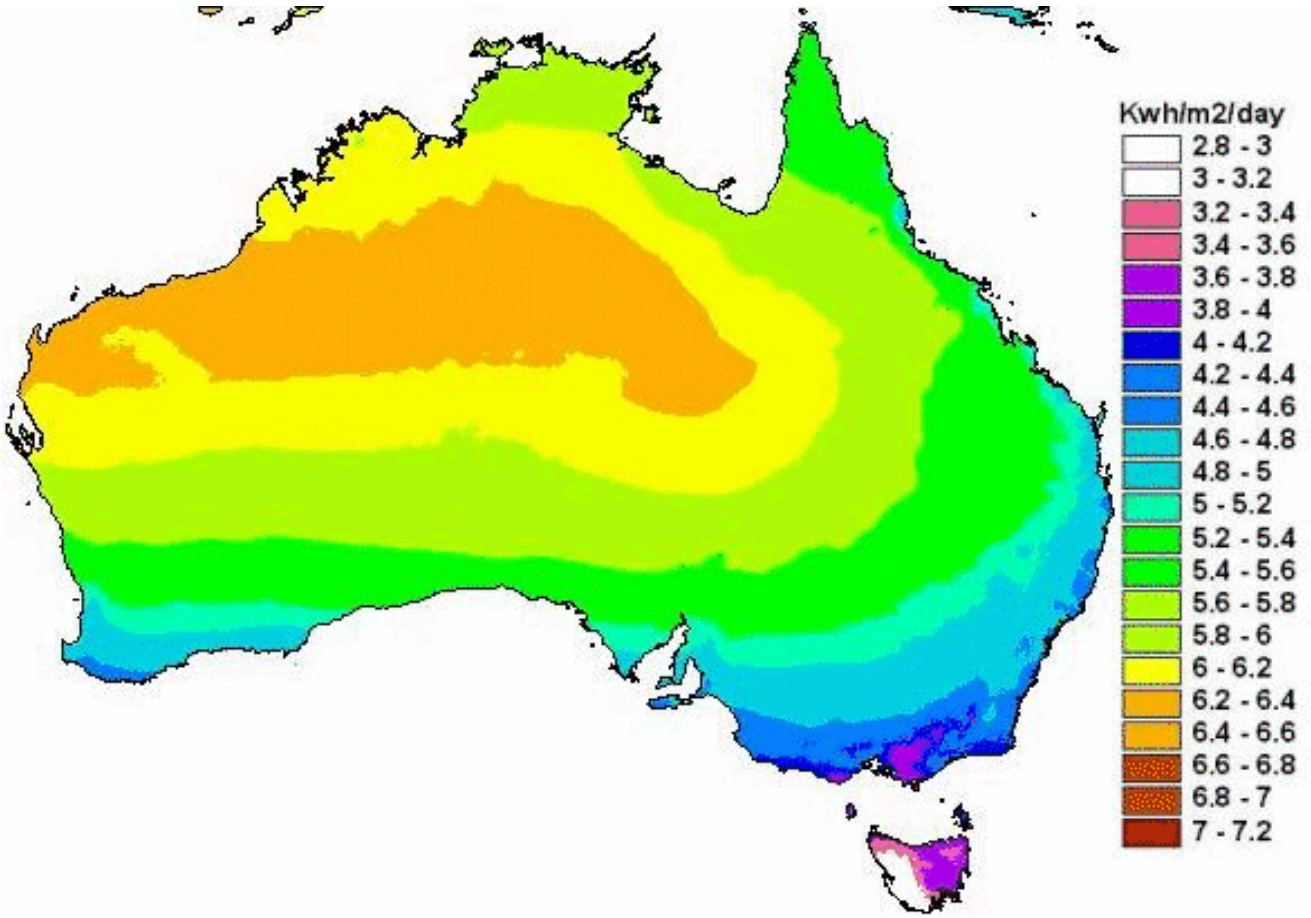
Australian wind resource

(Simple estimates of background wind – AGO)

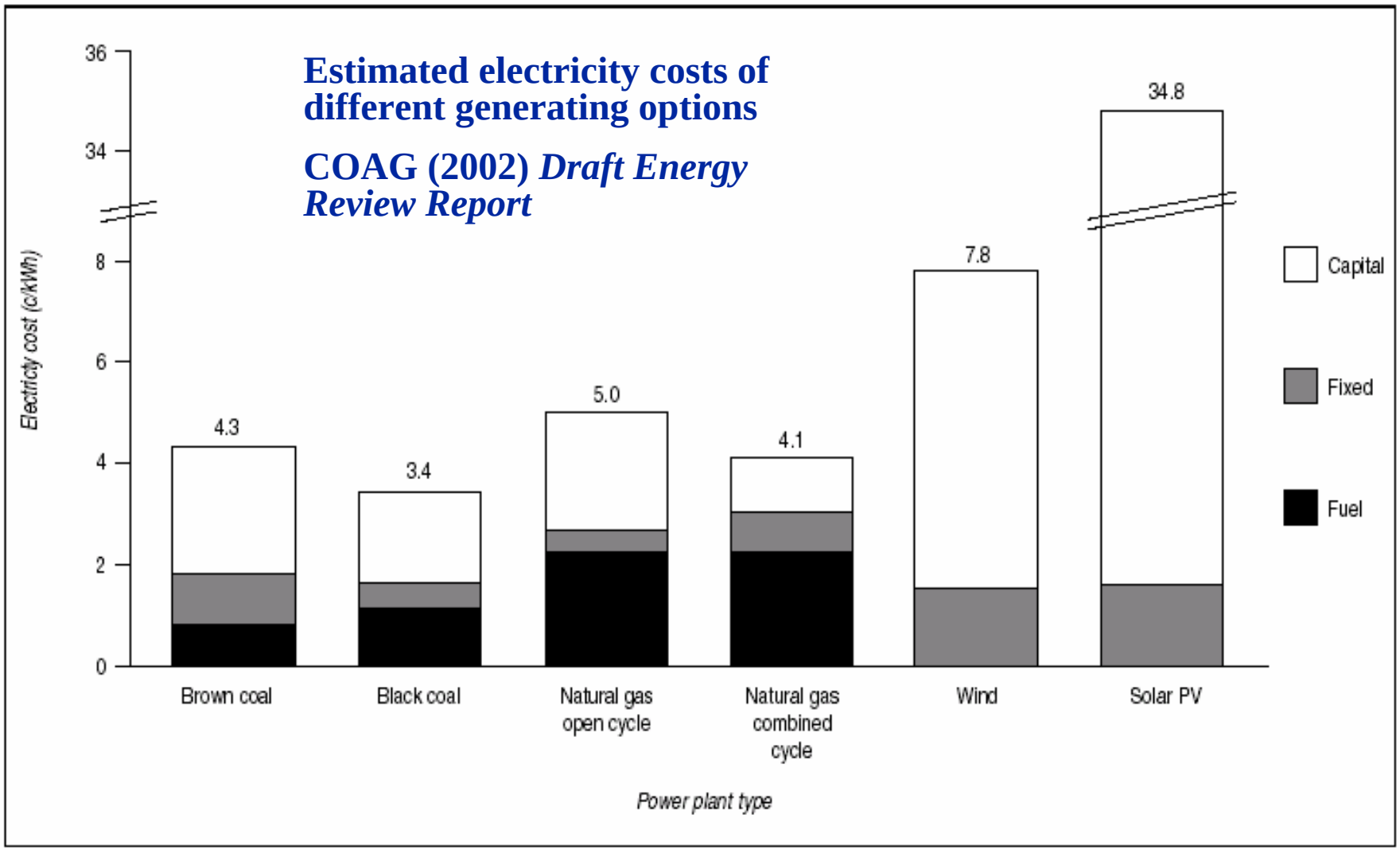


Australia's solar Resource

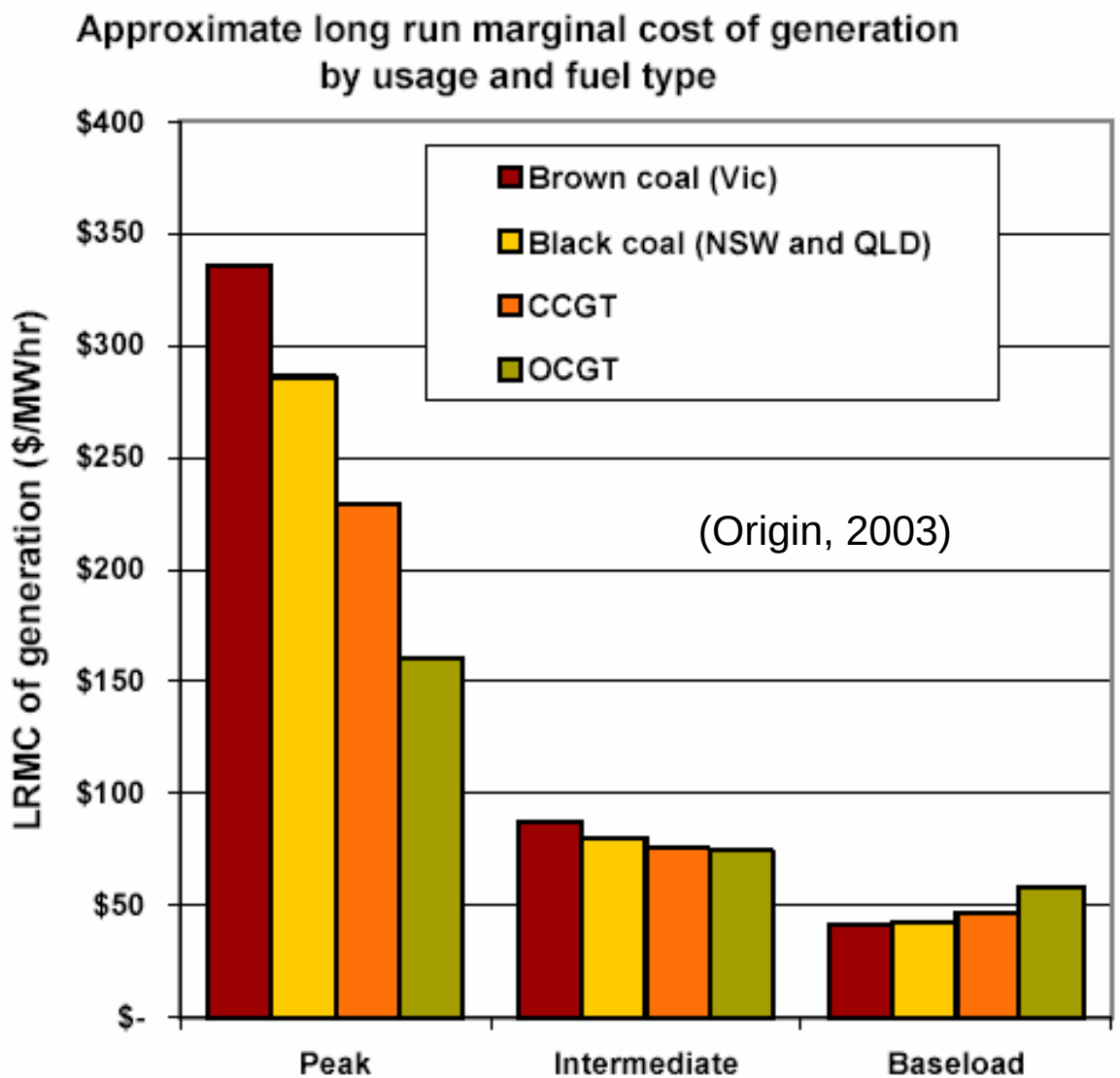
(www.greenhouse.gov.au)



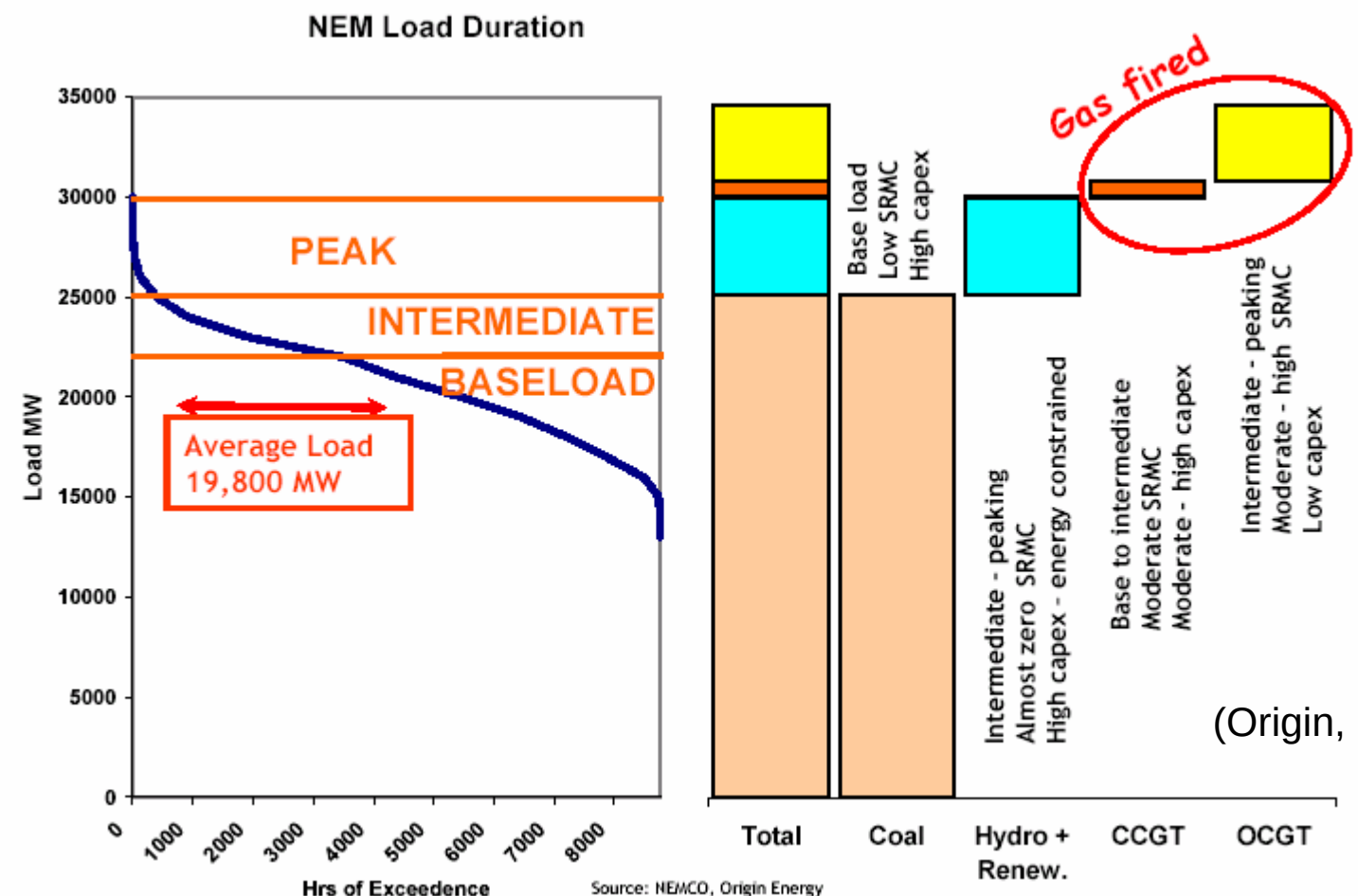
Generating plant costs in Australia



Gen. costs for baseload, intermediate + peak

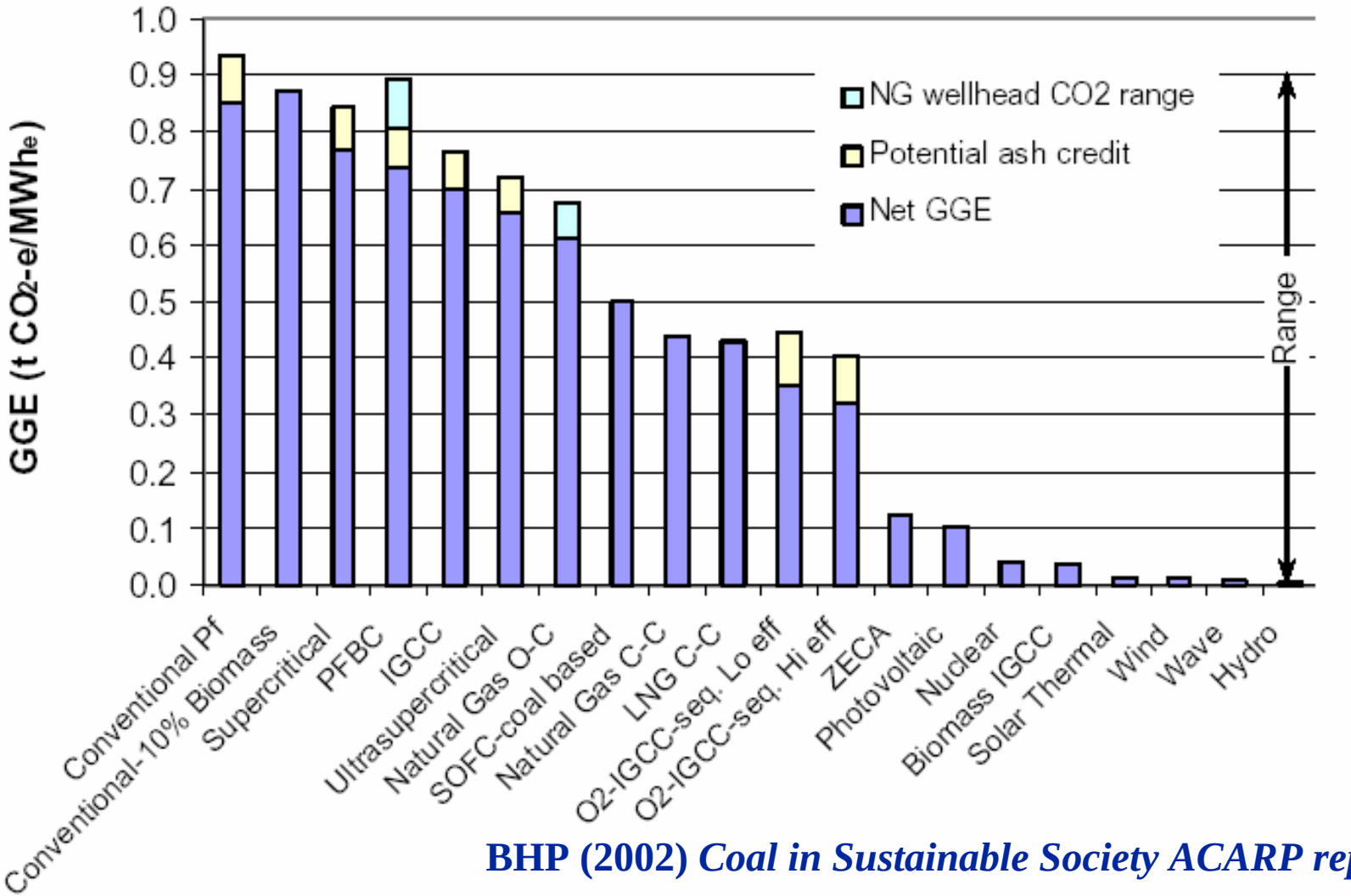


Most cost-effective supply mix



(Origin, 2003)

GHG emissions for different technologies



BHP (2002) ***Coal in Sustainable Society ACARP report.***

A range of other possible technology options

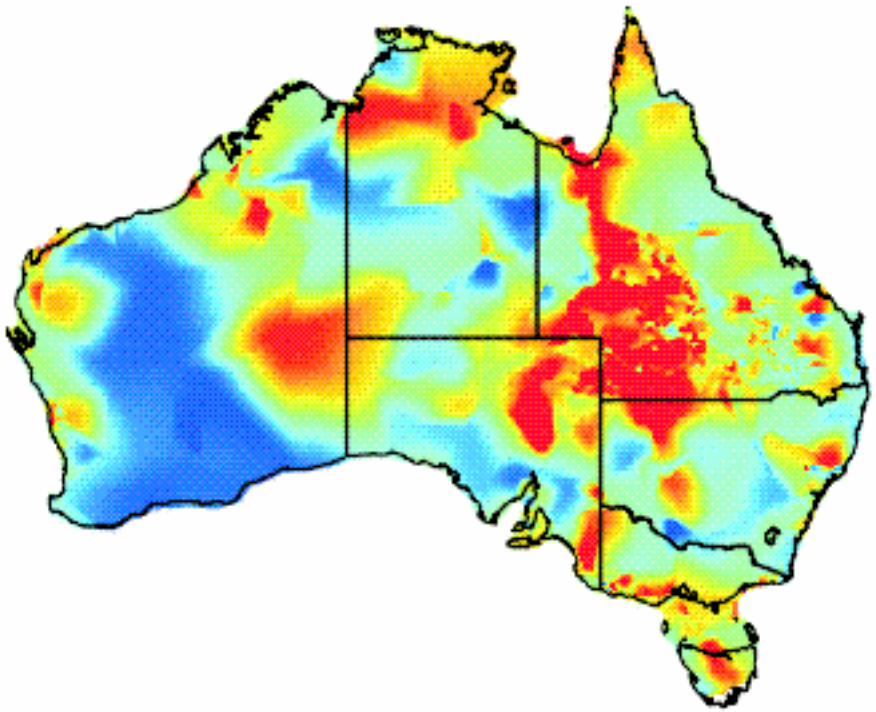
- Geothermal HDR
- Carbon Capture and Sequestration
- Distributed generation

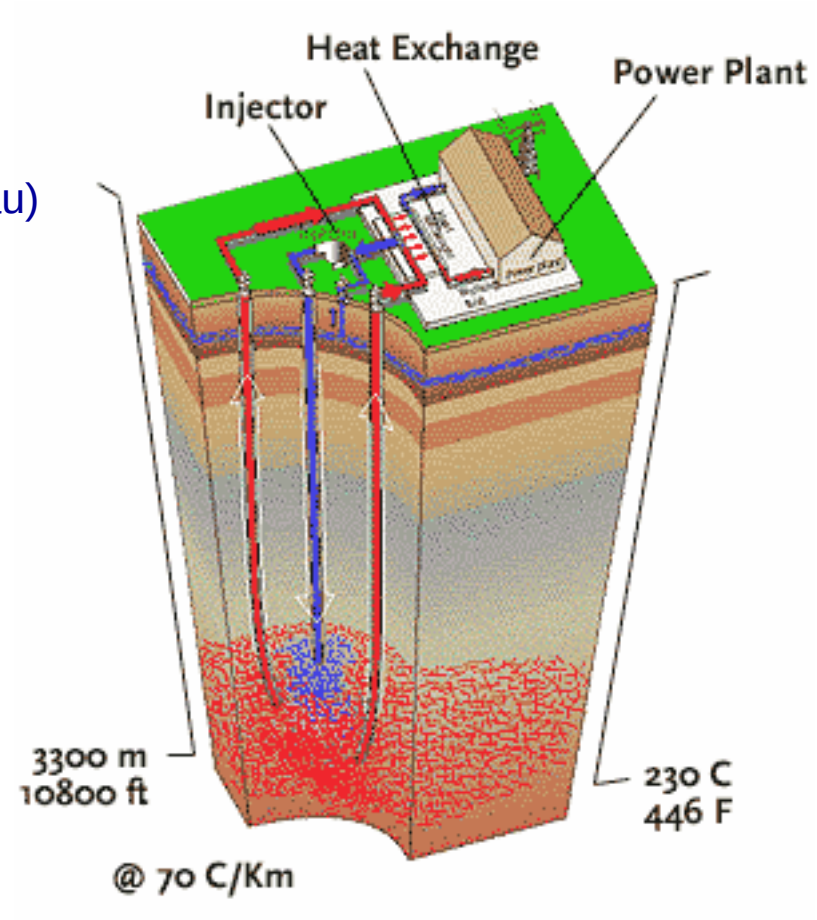
Geothermal energy - hot dry rock

Australia has plentiful hot dry rock at ~3000m (needs water injection)

Trial in Cooper Basin, SA

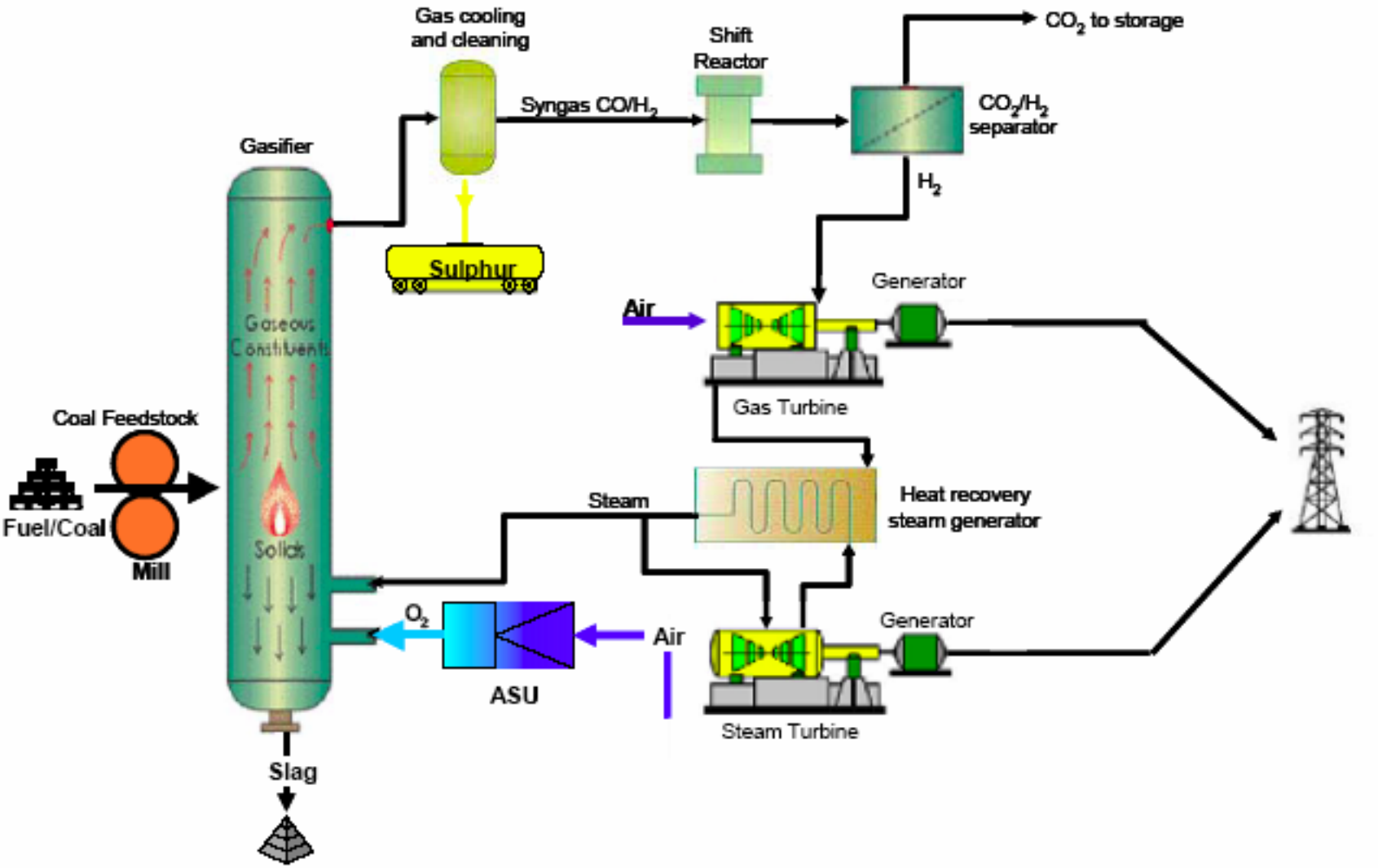
(www.greenhouse.gov.au)



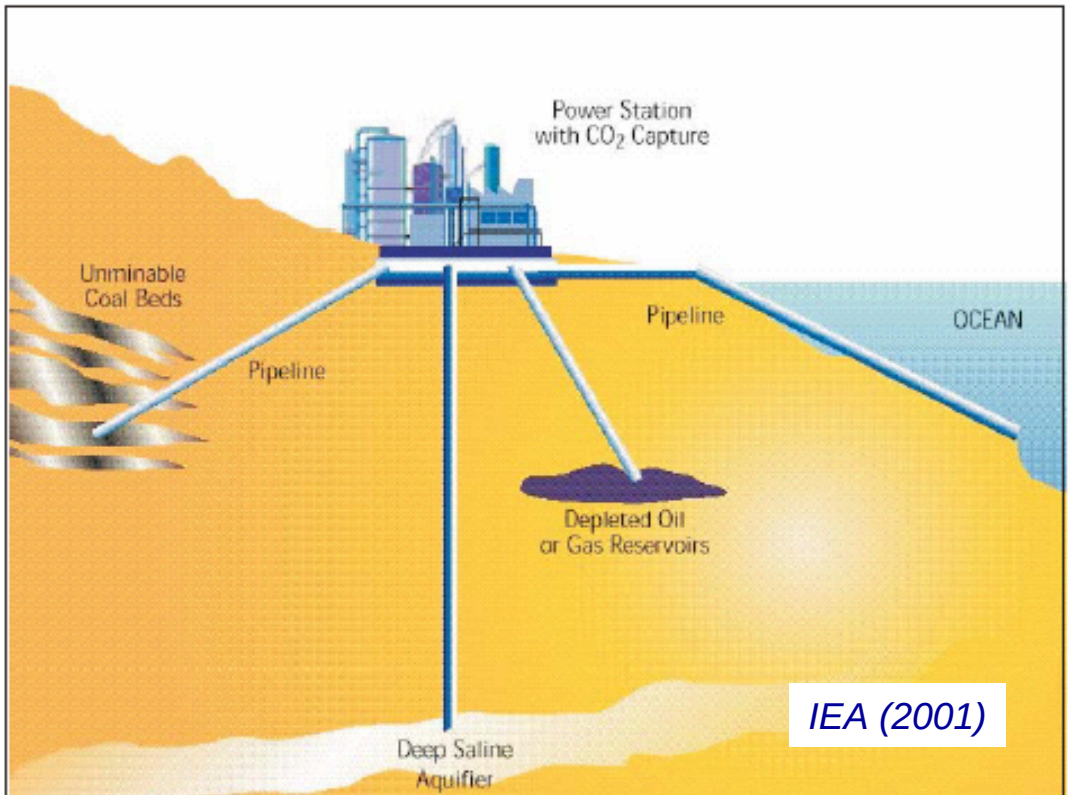


Integrated coal gasification & combined cycle with carbon collection & storage

(Simhauser, 2004)



Geosequestration



- Considerable knowledge and experience with Enhanced Oil Recovery on depleting reservoirs with injected CO2
- Limited knowledge and experience with Enhanced Coal Bed Methane through injected CO2 (New Mexico, Alberta)
- Very limited knowledge and experience with saline aquifers (one project in Norway) – not commercially important until now

Preliminary estimates of CCS abatement potential in Australia

GEODISC

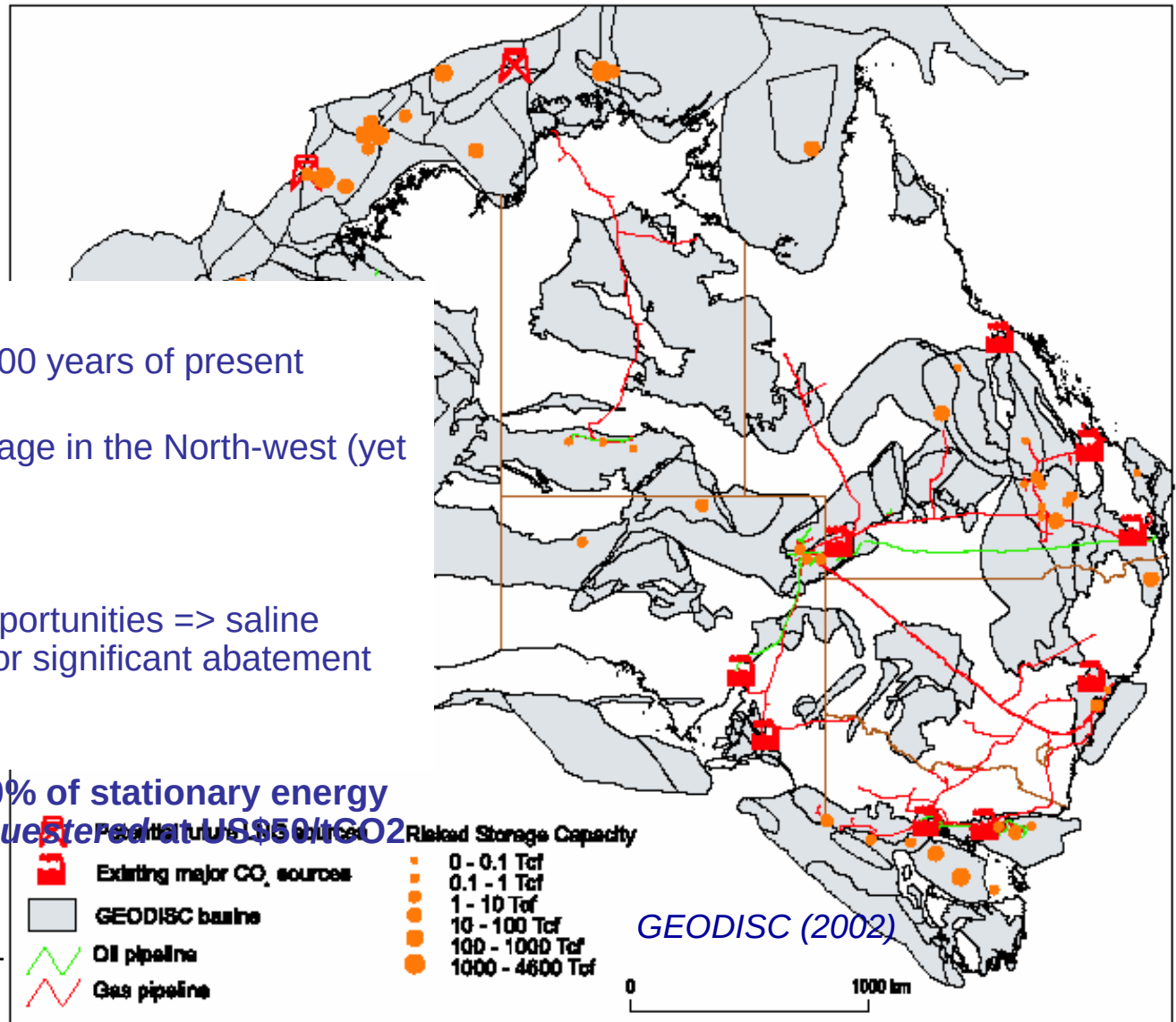
Very large potential resource (1600 years of present emissions)

But, most identified potential storage in the North-west (yet most emissions in South East)

Around 95% is saline aquifer

Very limited EOR, Coal Seam opportunities => saline storage the only realistic option for significant abatement (IEA, 2003)

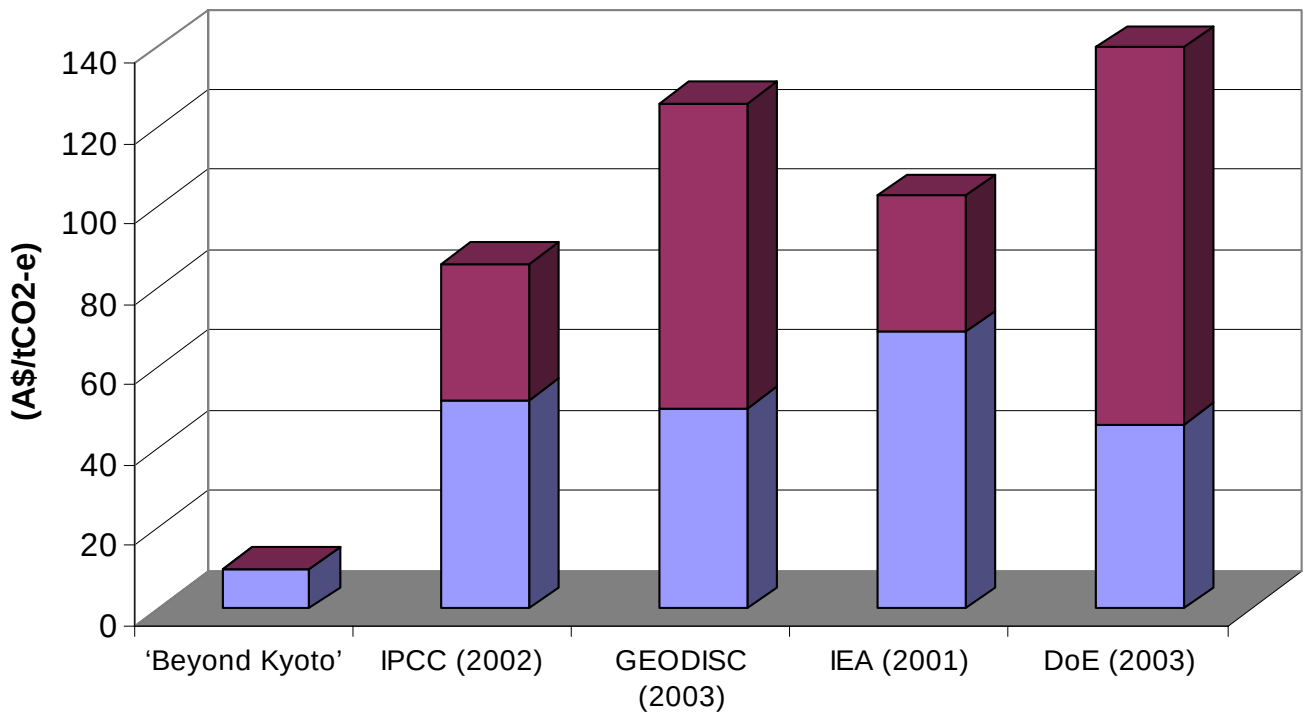
Still, GEODISC estimates 50-70% of stationary energy sector emissions might be *sequestered* at US$50/tCO2



GEODISC (2002)

Preliminary CCS assessment – estimated costs

- Costs for some projects (eg. gas fields) seem reasonably low
- Many challenges in cost estimations for coal generation CCS now and into the future… always the case for technologies that don't yet exist
  - technology not yet demonstrated integrated + at scale
  - some methodological choices critical, can be very project specific
  - possible learning effects outweighed by present uncertainties (IEA, 2003)



Distributed resources (DR)

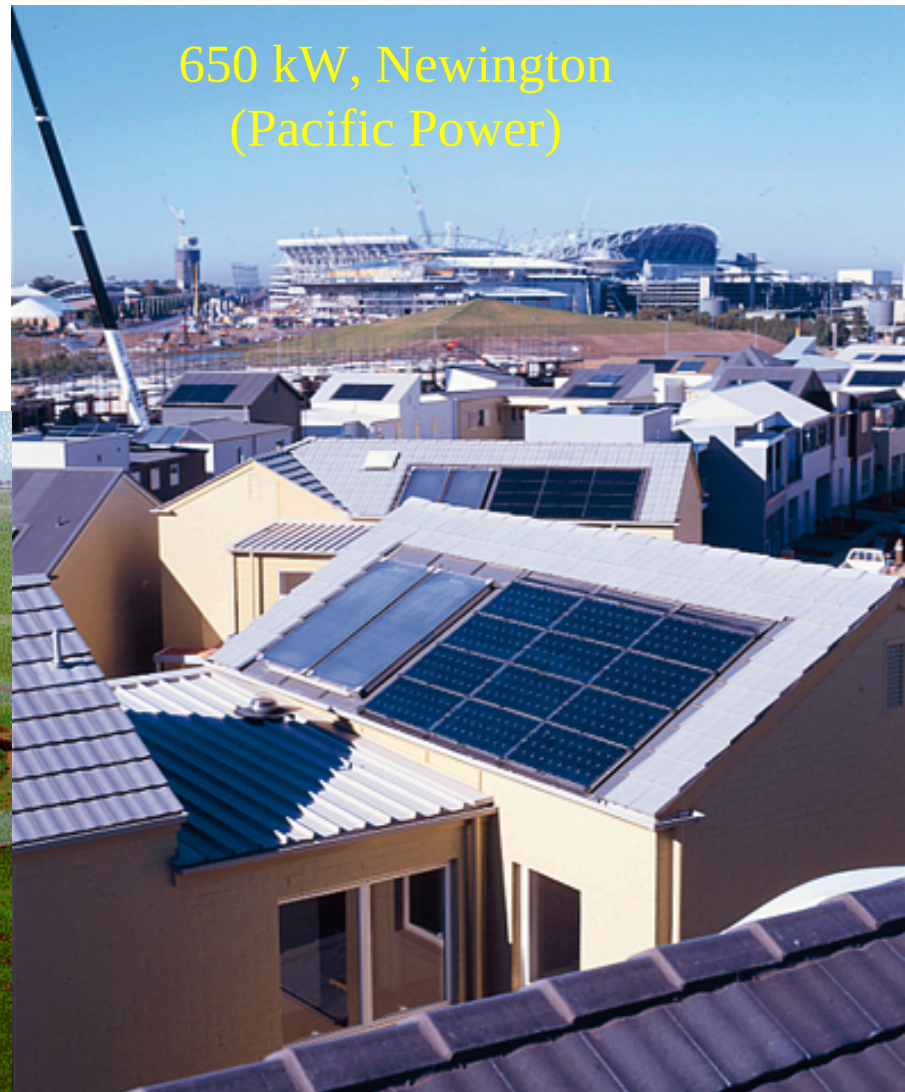
- Small generators or storage *embedded in* an electricity distribution network:
  - Cogeneration:
    - Useful heat (or cooling) as well as electricity
  - Emerging technologies:
    - Micro gas-turbines, fuel cells
  - Renewables
    - Biomass, small hydro, wind, photovoltaics
  - Reversible storage:
    - eg batteries, flywheels
- Demand-side resources

Capstone Micro-turbine

- 30 kW
- 400-480 V, 50-60 Hz
- 25% efficiency when fuelled by high pressure natural gas (LHV)
- 500 kg
- 1.9x0.7x1.3 metres
- Became commercially available in 1999

Solar energy - photovoltaics

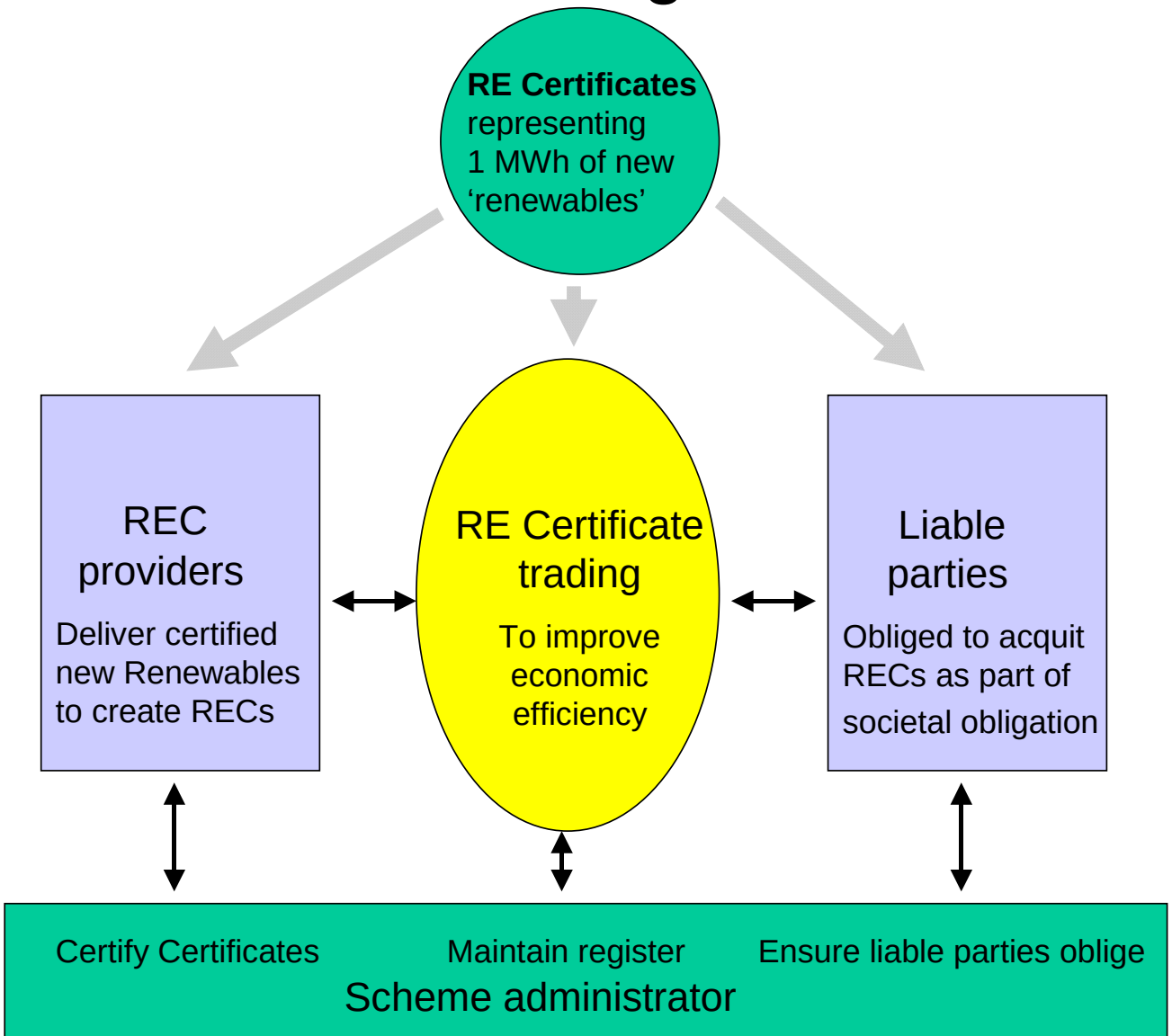
- PV cells convert solar energy directly to DC electricity
  - Use inverter to create AC
- Stand-alone or building integrated



Policy options to drive appropriate investment

- MRET
- Queensland 13% Gas Scheme
- Carbon taxes / emissions trading

MRET – a 'designer' market



Mandatory Renewable Energy Target

Renewable Energy (Electricity) Act 2000

The objects of this Act are:

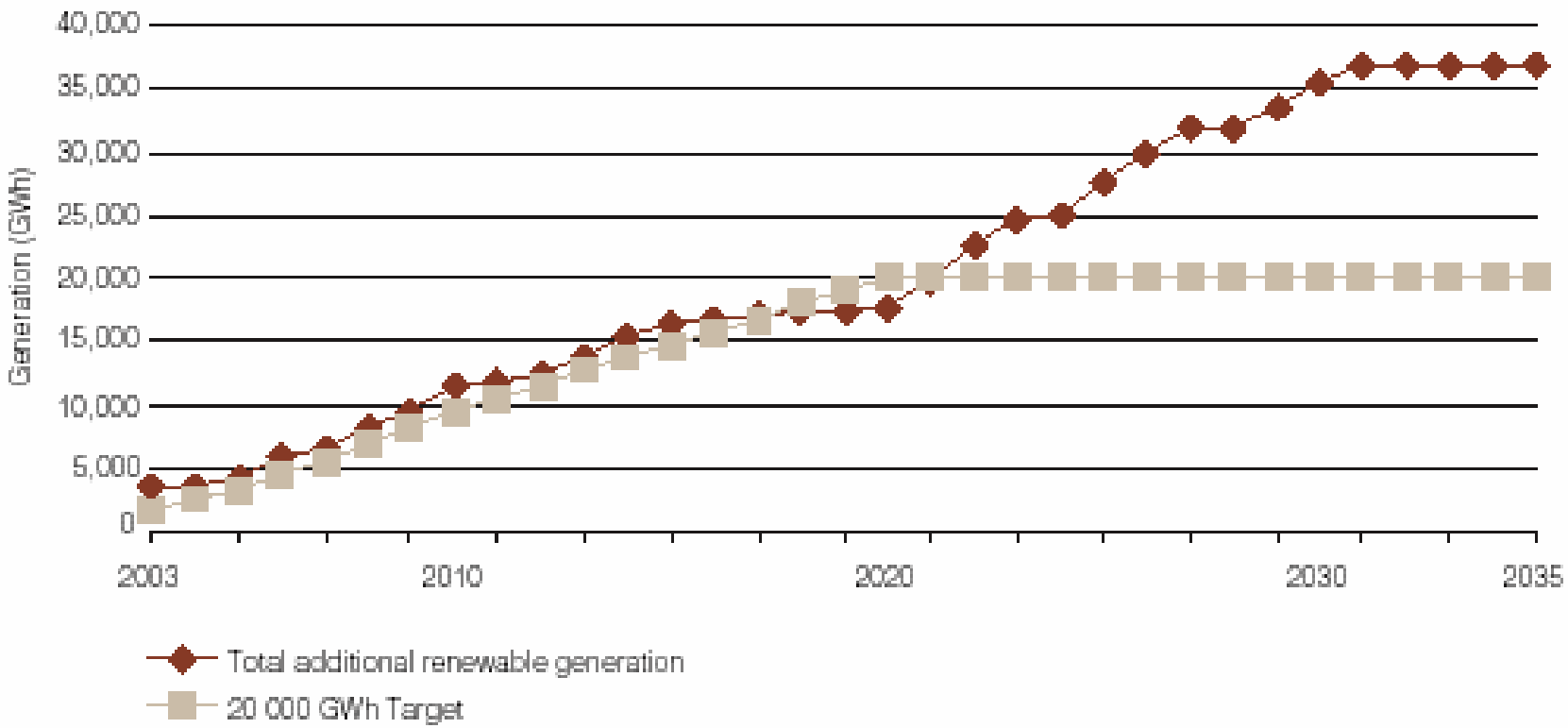
(a) to encourage the additional generation of electricity from renewable sources; and

(b) to reduce emissions of greenhouse gases; and

(c) to ensure that renewable energy sources are ecologically sustainable.

MRET Review – proposed changes to present target

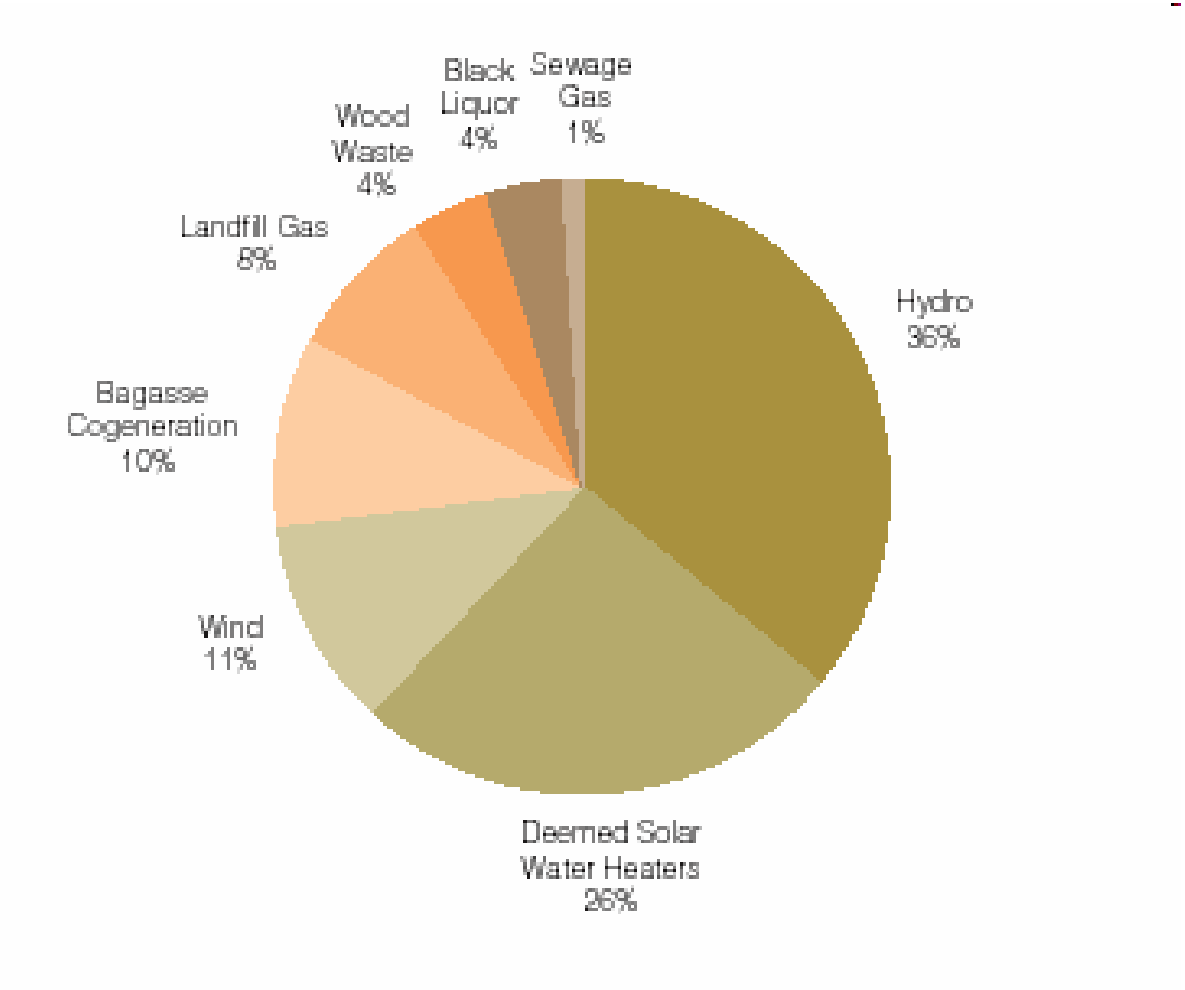
(proposed to extend 2010 target of 9500GWh through to target of 20,000GWh in 2020)



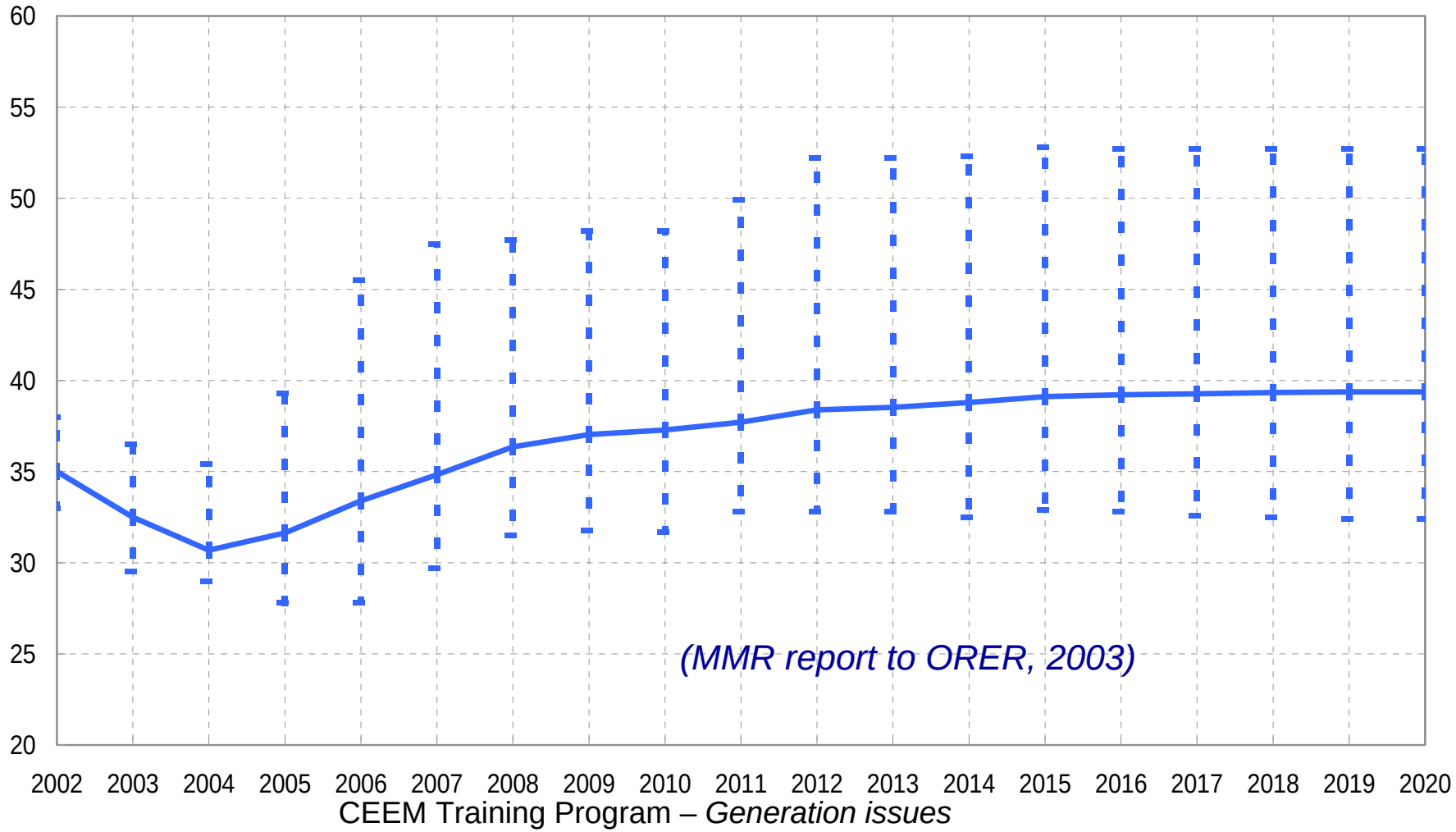
MRET performance to date

- Now operating for two years
- Ramping target easily met
- Challenges
  - Public opposition to some ‘eligible’ renewables
  - Inadequate target, in terms of settings (+2%) and objectives for greenhouse + industry development
  - Market information failures
    - Can register RECs any time => information asymmetry
    - Only annual acquittal => poor price discovery
- **Baselines**
  - **All BAU baselines are ‘made up’**
  - **Large hydro particularly problematic**
    - Baselines for hydro scheme where output limited by demand
    - Variable renewable generation and ‘The ratchet’

Actual installations – 17 August 2003

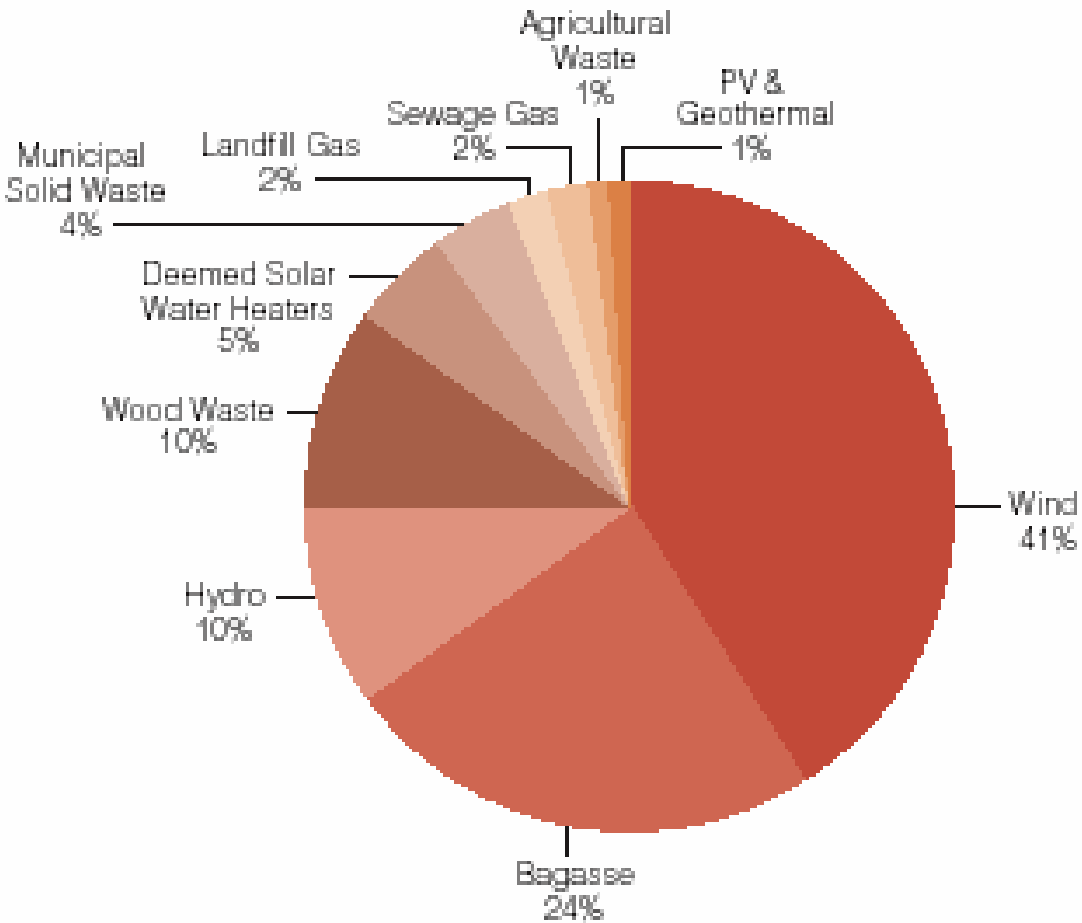


Renewable Energy Certificate price projections (A$/MWH)



Mix of renewables in 2020 with proposed settings

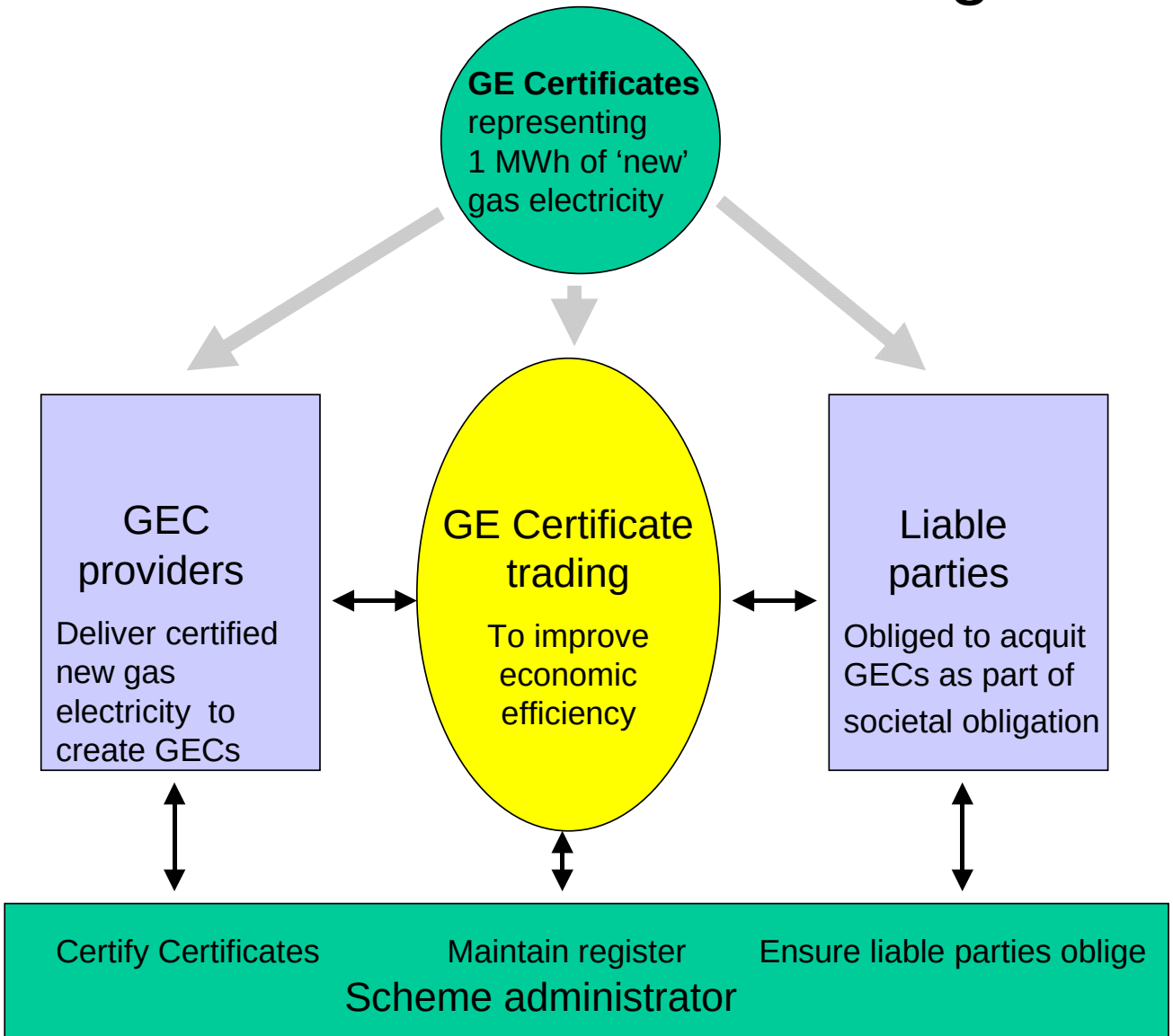
(MRET Review, 2003)



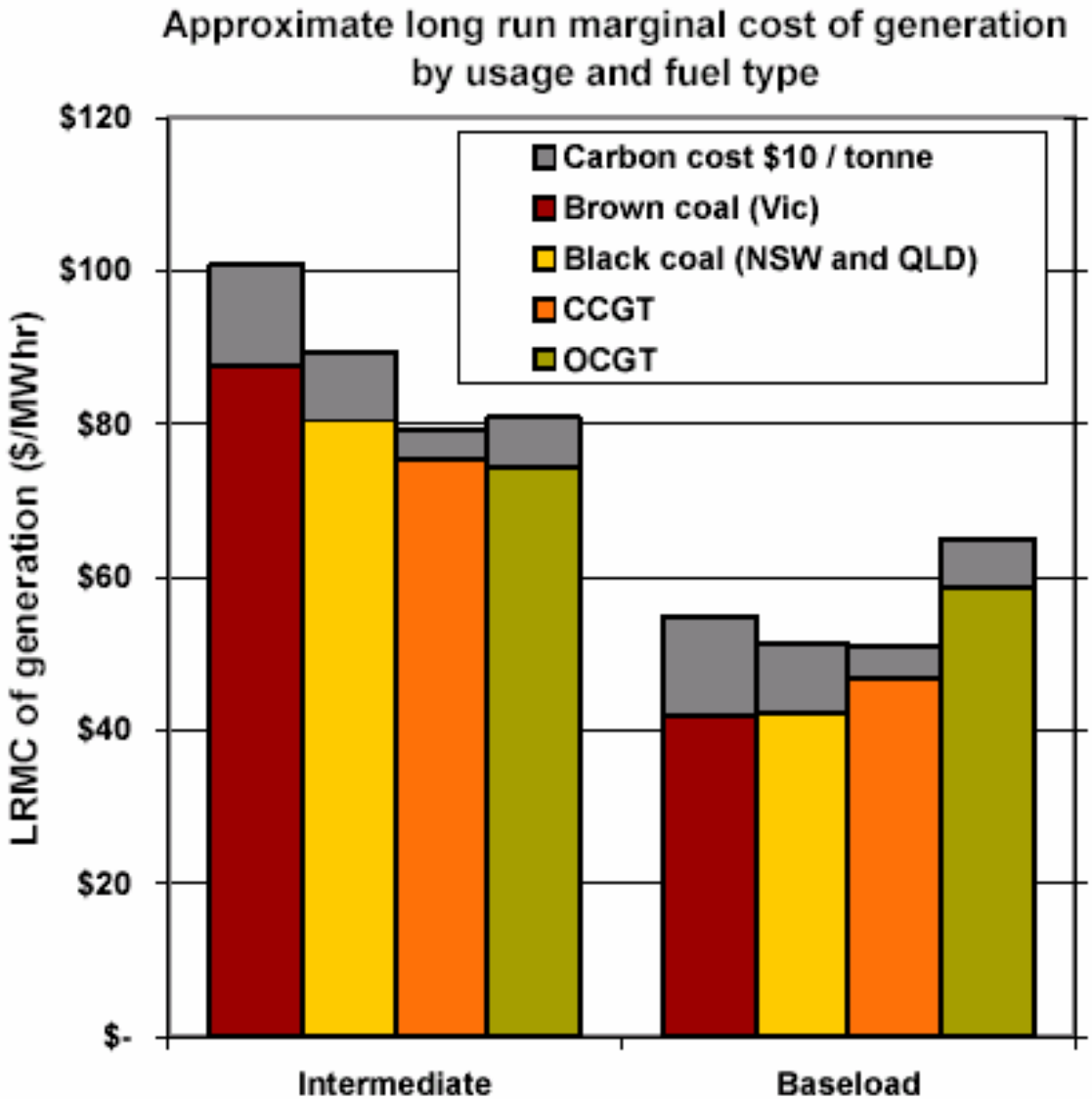
Queensland 13% Gas scheme

- >95% of Qld electricity from Coal
- Qld Government concerned about
  - "vulnerability of State's economy to the introduction of any national and international greenhouse gas abatement measures (such as the introduction of emissions trading)
- Retailers obliged to source >13% of electricity from 'new' gas-fired generation in Jan. 2005
- Settings
  - Baseline is May 2002 for generation that 'notionally' supports Queensland load

13% Gas scheme design



Possible role of a carbon tax/emissions trading



For more information…

- www.ceem.unsw.edu.au