



**University of Otago, Dunedin, New Zealand**  
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# Distributed resources in the Australian electricity industry

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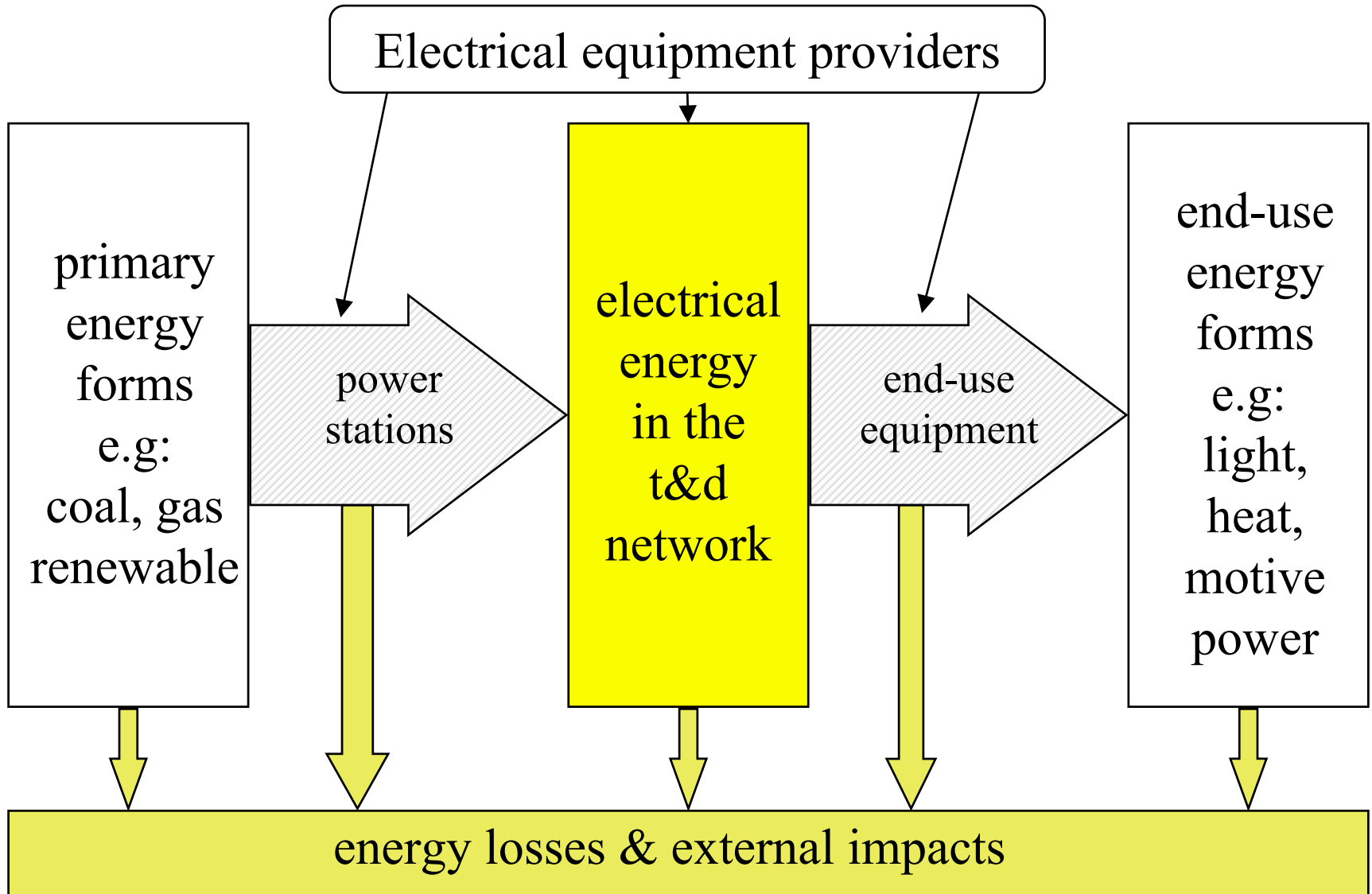
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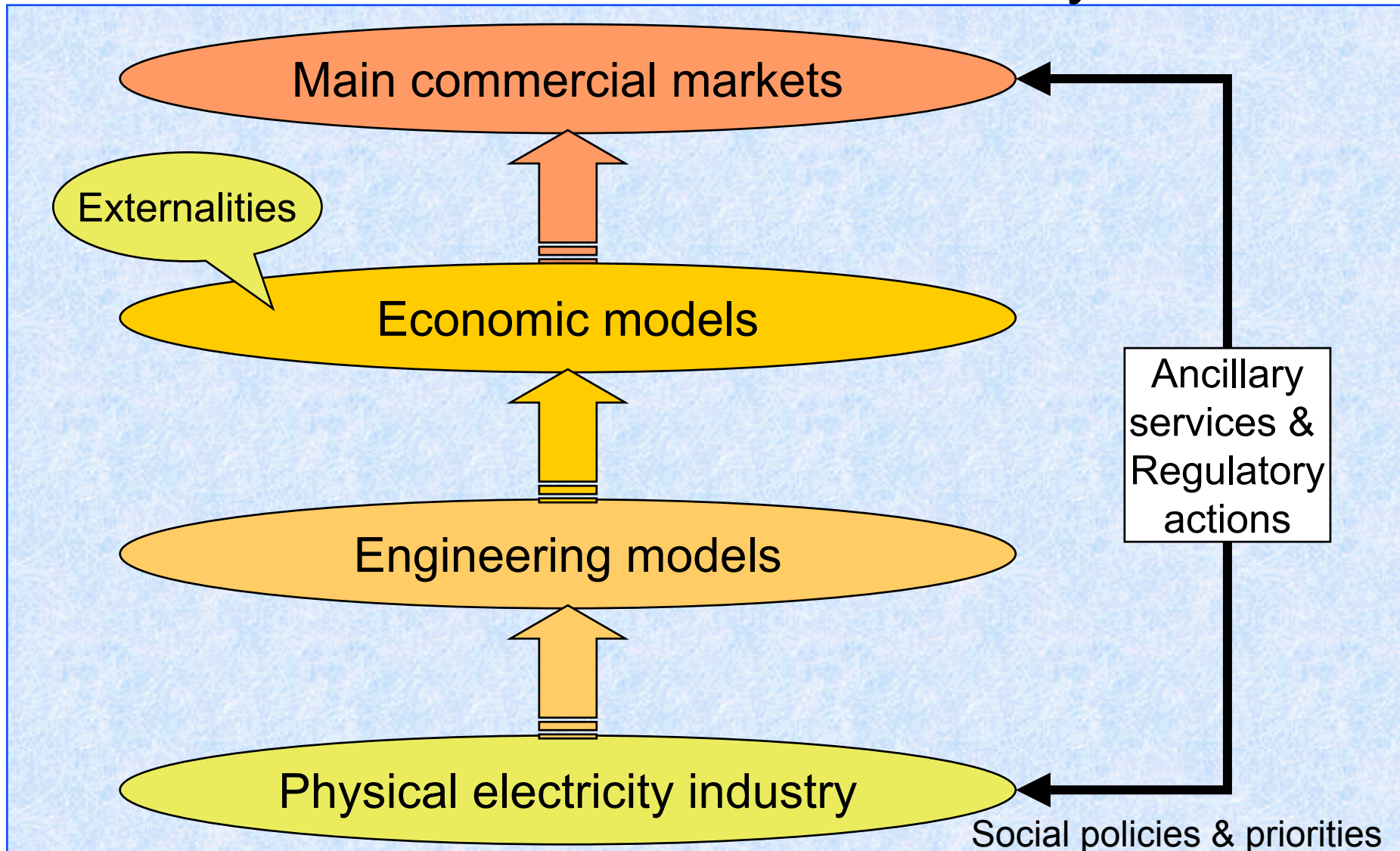
*[www.sergo.ee.unsw.edu.au](http://www.sergo.ee.unsw.edu.au)*

# The electricity industry conversion chain



- Specific properties of electrical energy:
  - No cost-effective storage of electricity
  - Instantaneous transmission & distribution
  - Energy flows according to network laws:
    - From all generators to all consumers
- Implications:
  - Supply & demand must balance at all times:
    - Active demand-side participation important
  - Electrical continuum - power station to end-use
    - Cannot assign energy from a particular power station to a particular consumer:
      - ‘pool’ rather than ‘bilateral’ physical trade
  - *Wholesale & retail activities not clearly separable*

# Trading in electricity:- an **abstraction** from reality



# 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)

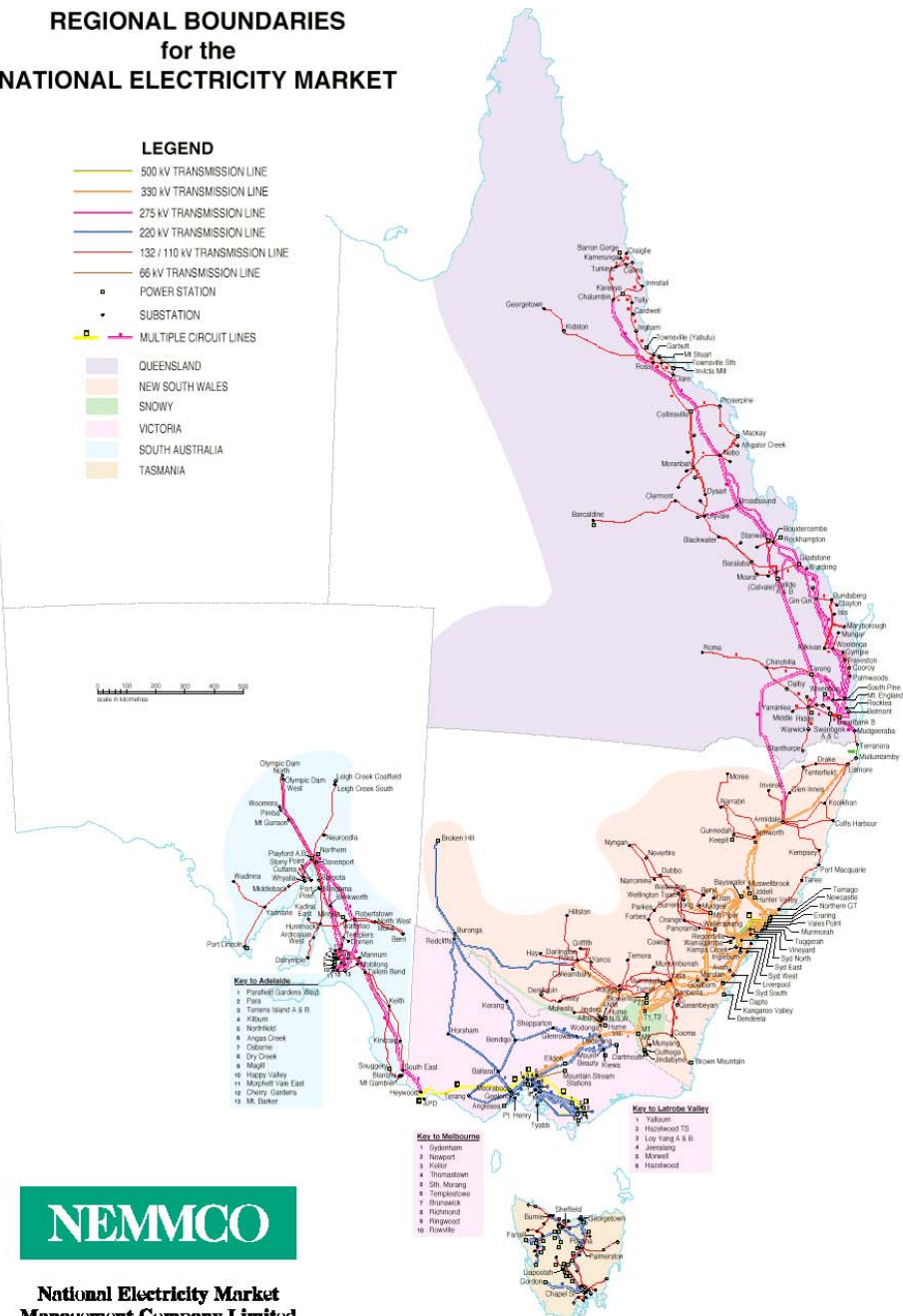
## REGIONAL BOUNDARIES for the NATIONAL ELECTRICITY MARKET

### LEGEND

- 500 kV TRANSMISSION LINE
- 330 kV TRANSMISSION LINE
- 275 kV TRANSMISSION LINE
- 220 kV TRANSMISSION LINE
- 132 / 110 kV TRANSMISSION LINE
- 66 kV TRANSMISSION LINE
- POWER STATION
- SUBSTATION
- MULTIPLE CIRCUIT LINES

- QUEENSLAND
- NEW SOUTH WALES
- SNOWY
- VICTORIA
- SOUTH AUSTRALIA
- TASMANIA

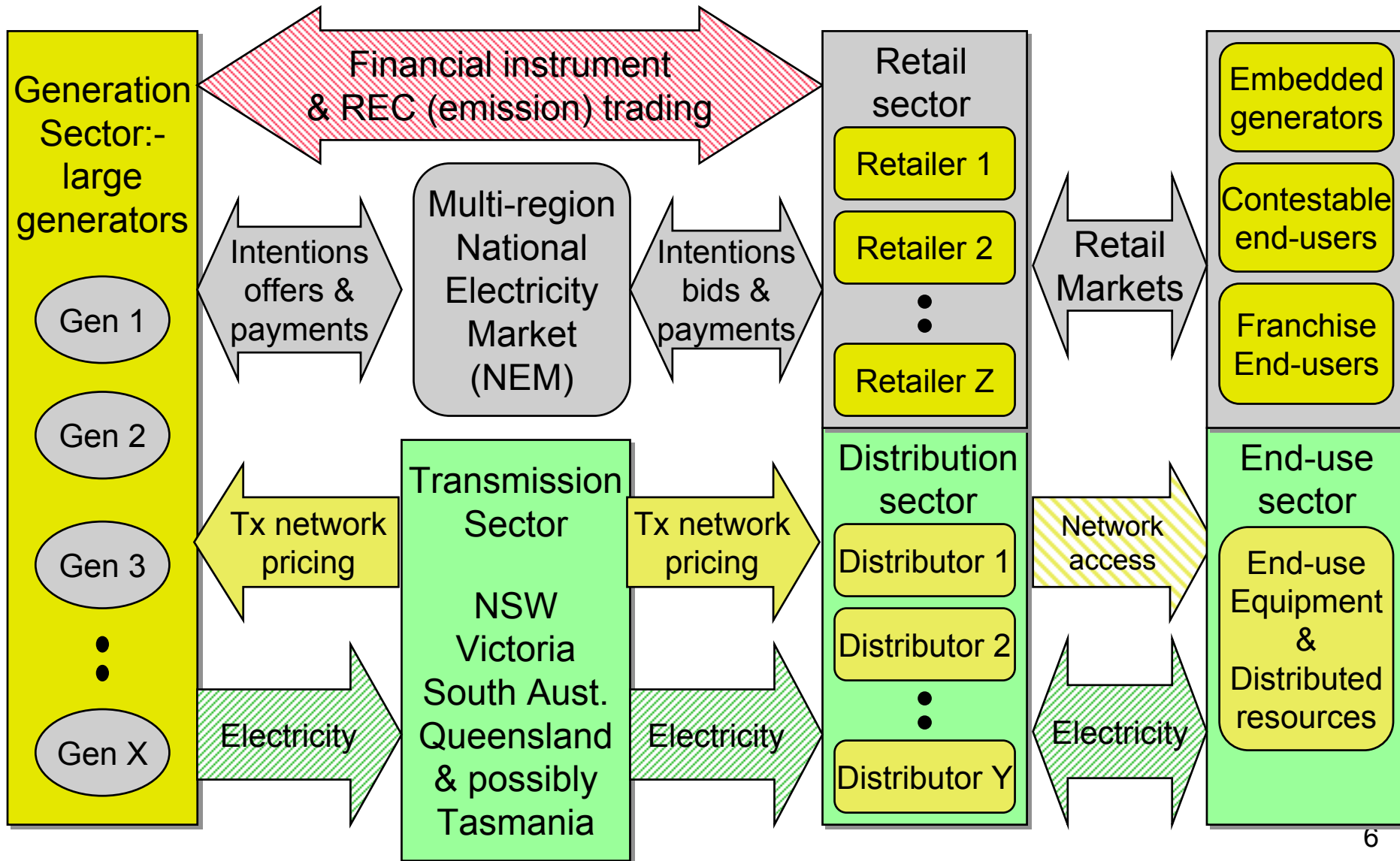
0 100 200 300 400 500  
scale in kilometres



**NEMMCO**

**National Electricity Market  
Management Company Limited**

# Electricity industry structure in SE Australia

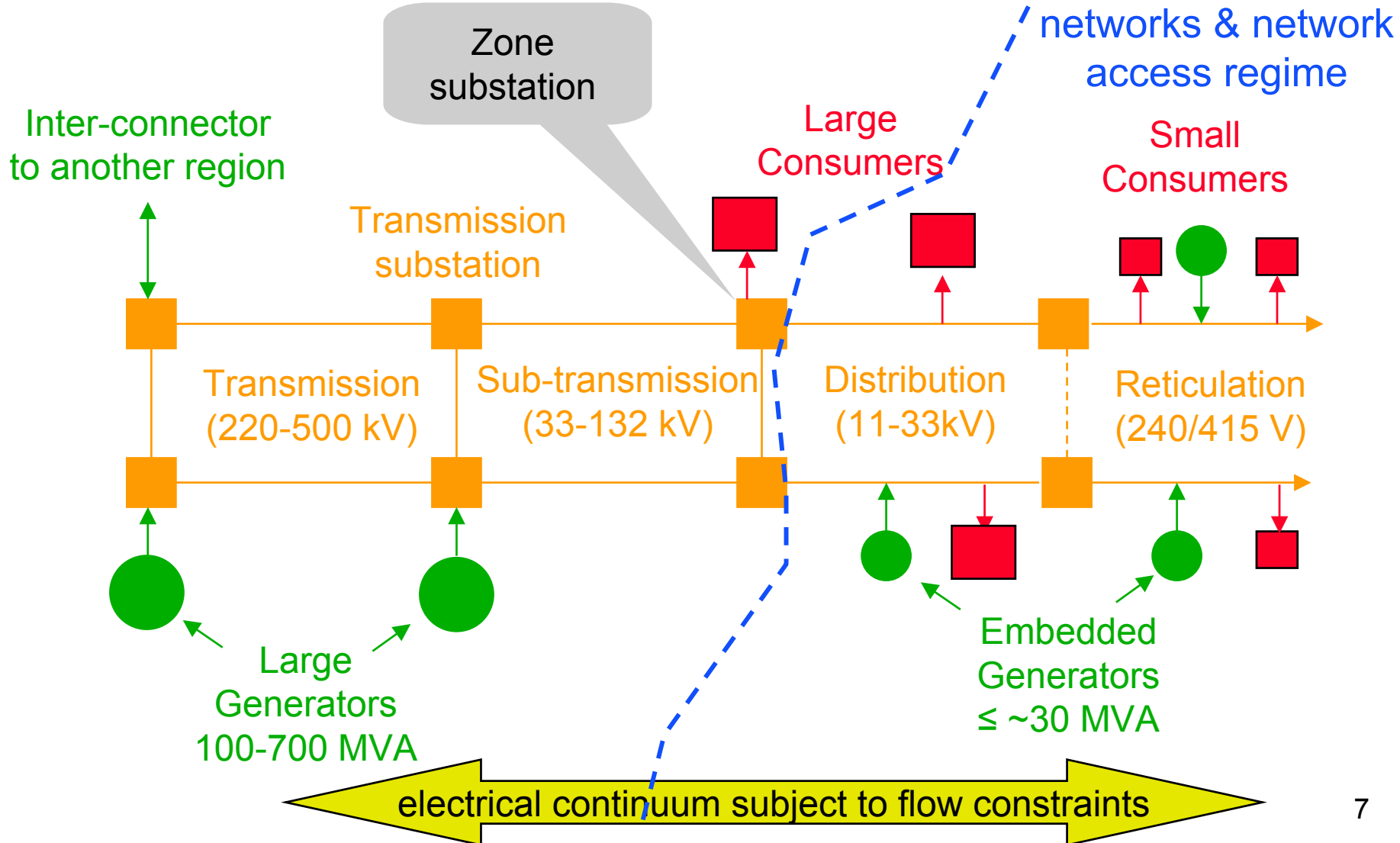


# Relationship between wholesale & retail markets

(need consistent wholesale & retail market designs)

Wholesale market on meshed network  
incorporating network representation

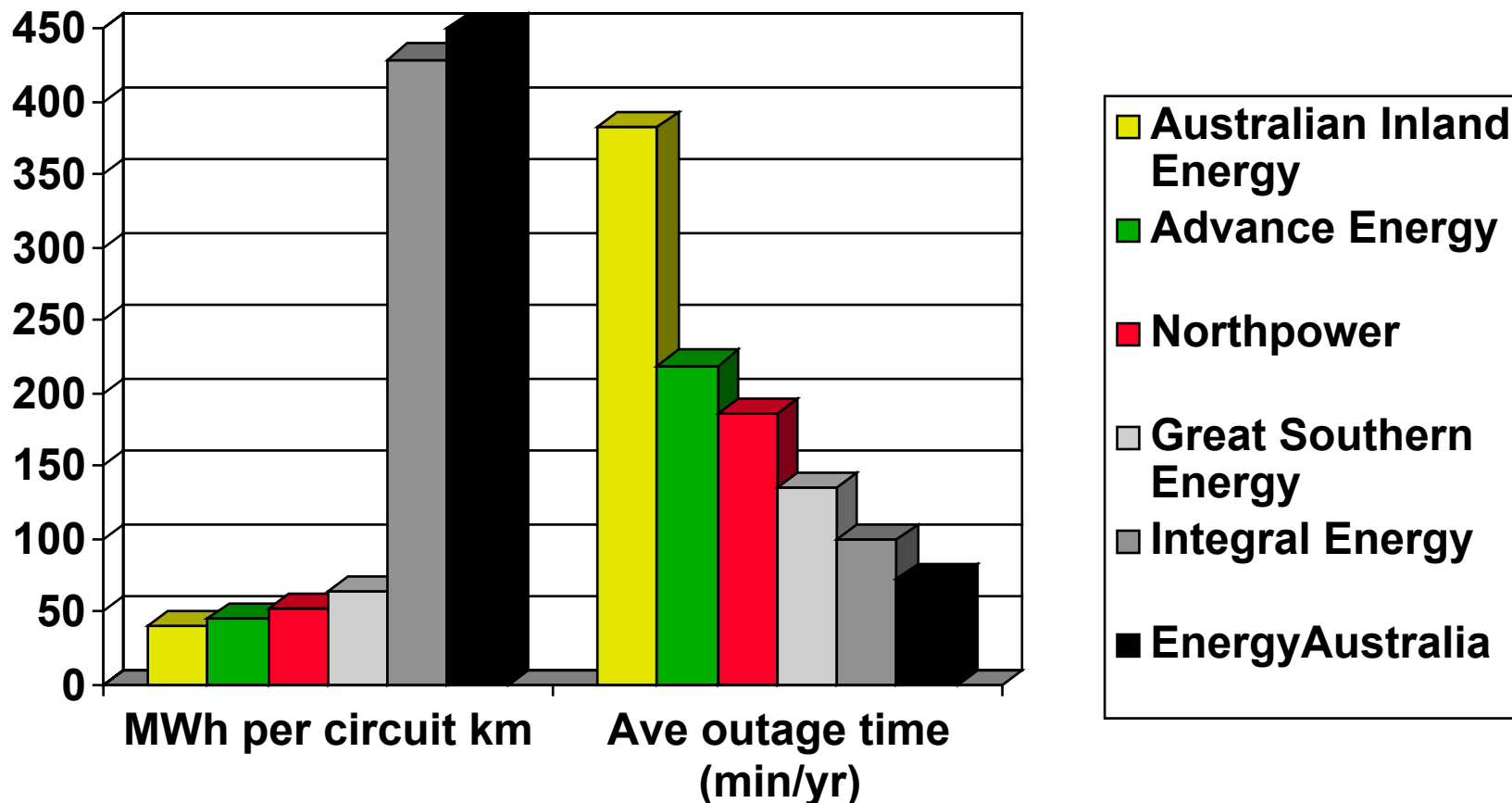
Retail markets based on radial  
networks & network  
access regime



# Variation of supply reliability with distribution network energy density

(for NSW electricity distributors)

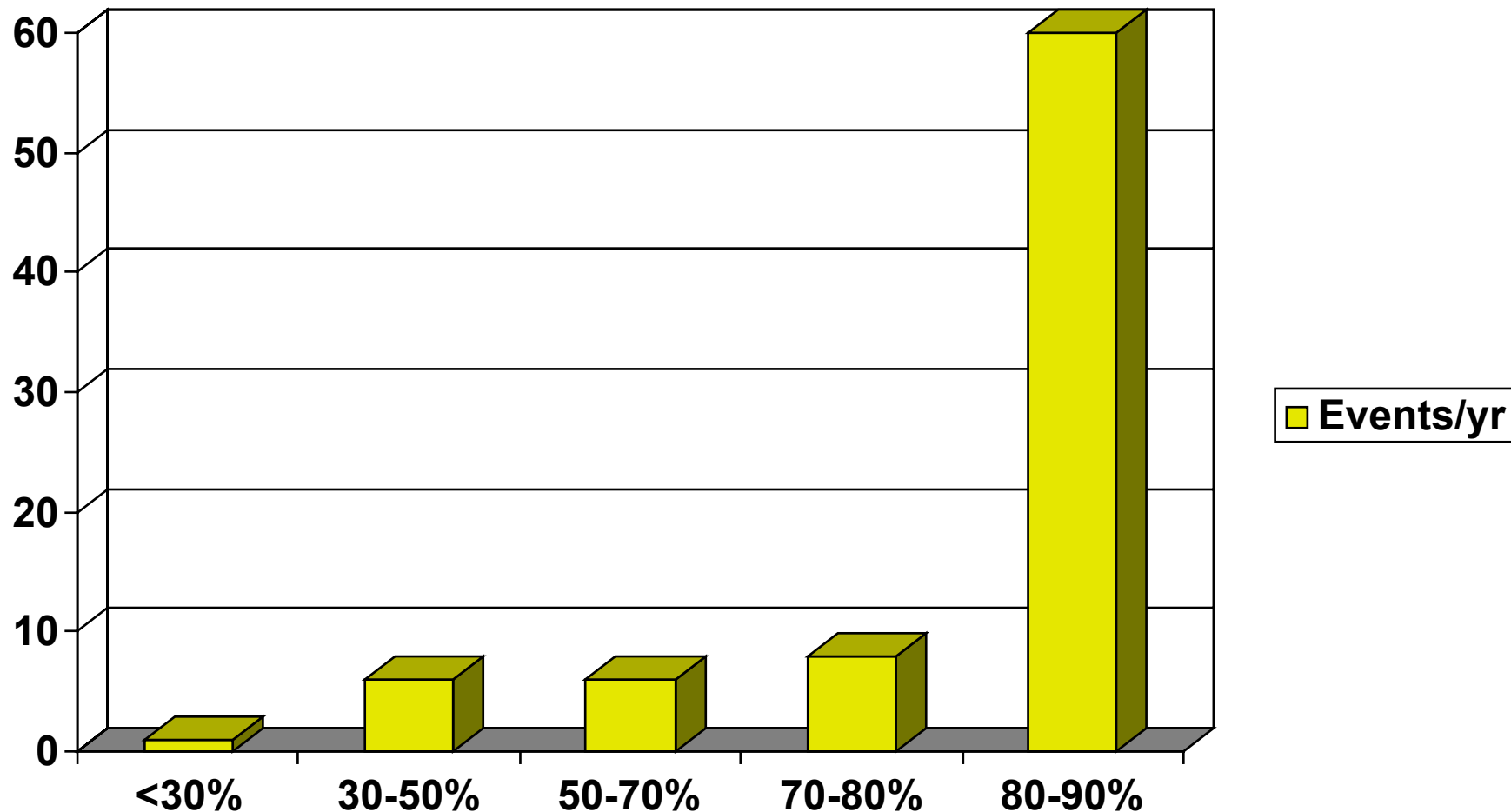
(Advance, GSE & Northpower now Country Energy)



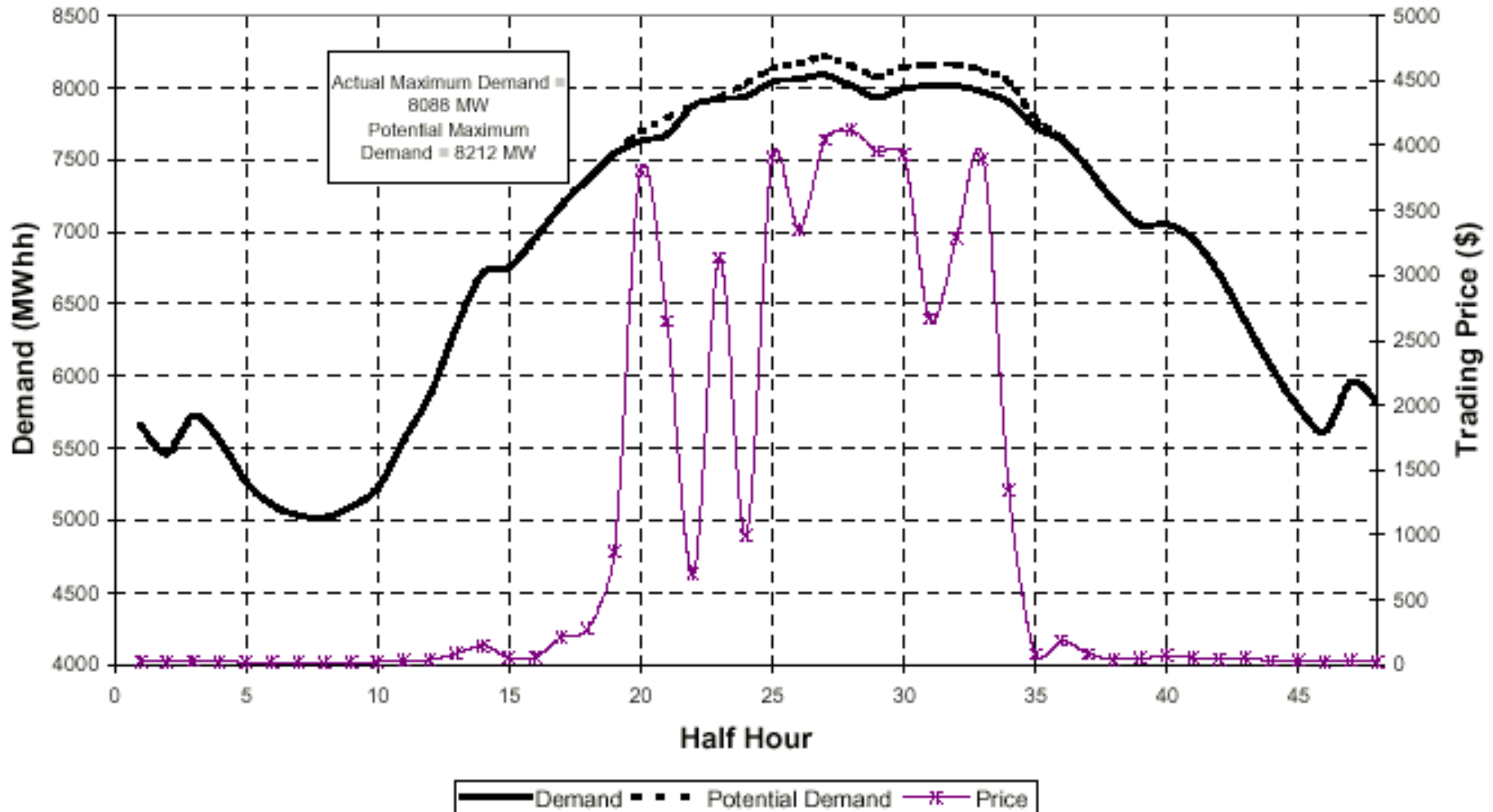


# Average voltage dip events in EnergyAustralia service territory

(EnergyAustralia Electricity Supply Standards, 1998)



# Evidence of demand side response: NEM Victorian region, 8/2/01 (NECA, 2001)



UNSW

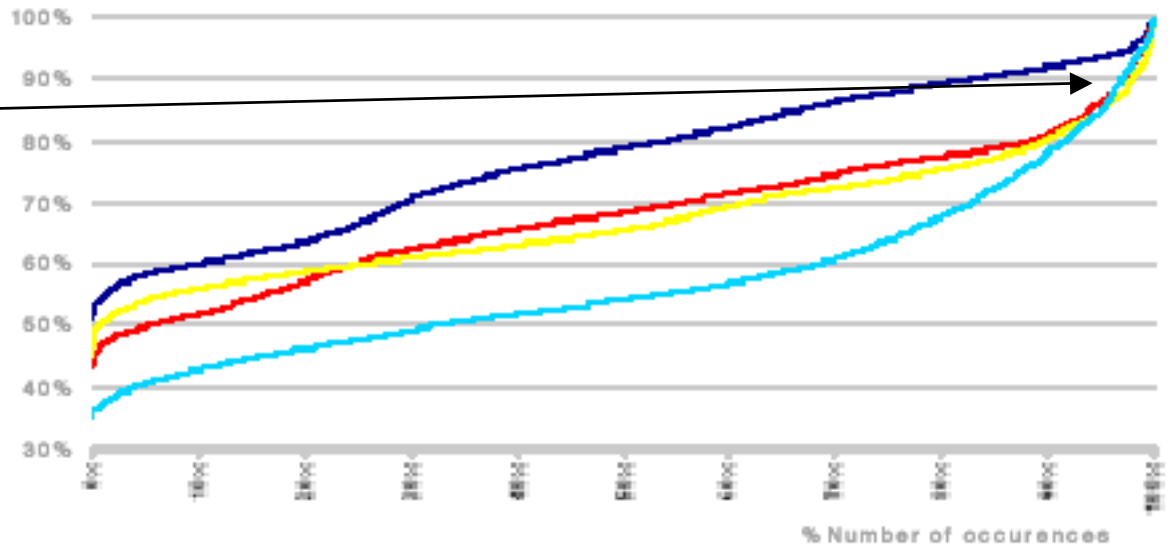
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Percentage of maximum demand

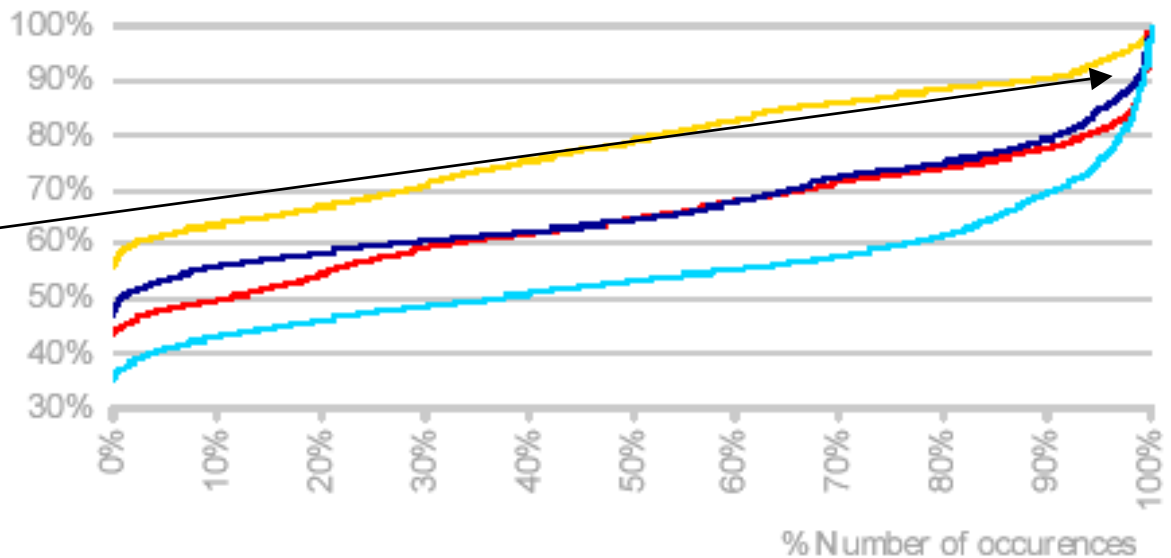
In 2001 NSW load >90% peak for ~5% of time

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

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



— Queensland — New South Wales — Victoria — South Australia



— Queensland — New South Wales — Victoria — South Australia

# Limitations of retail market design

- Multiple decision makers:
  - Equipment & appliance manufacturers
  - Building designers & owners
  - Government policy makers
- Limitations of price signals:
  - Nodal detail in spot & derivative markets
  - Distribution level impacts on availability & quality
- Inadequate metering for small end-users
  - Need interval metering that also records key indicators of quality & availability of supply

# Approaches to environmental regulation

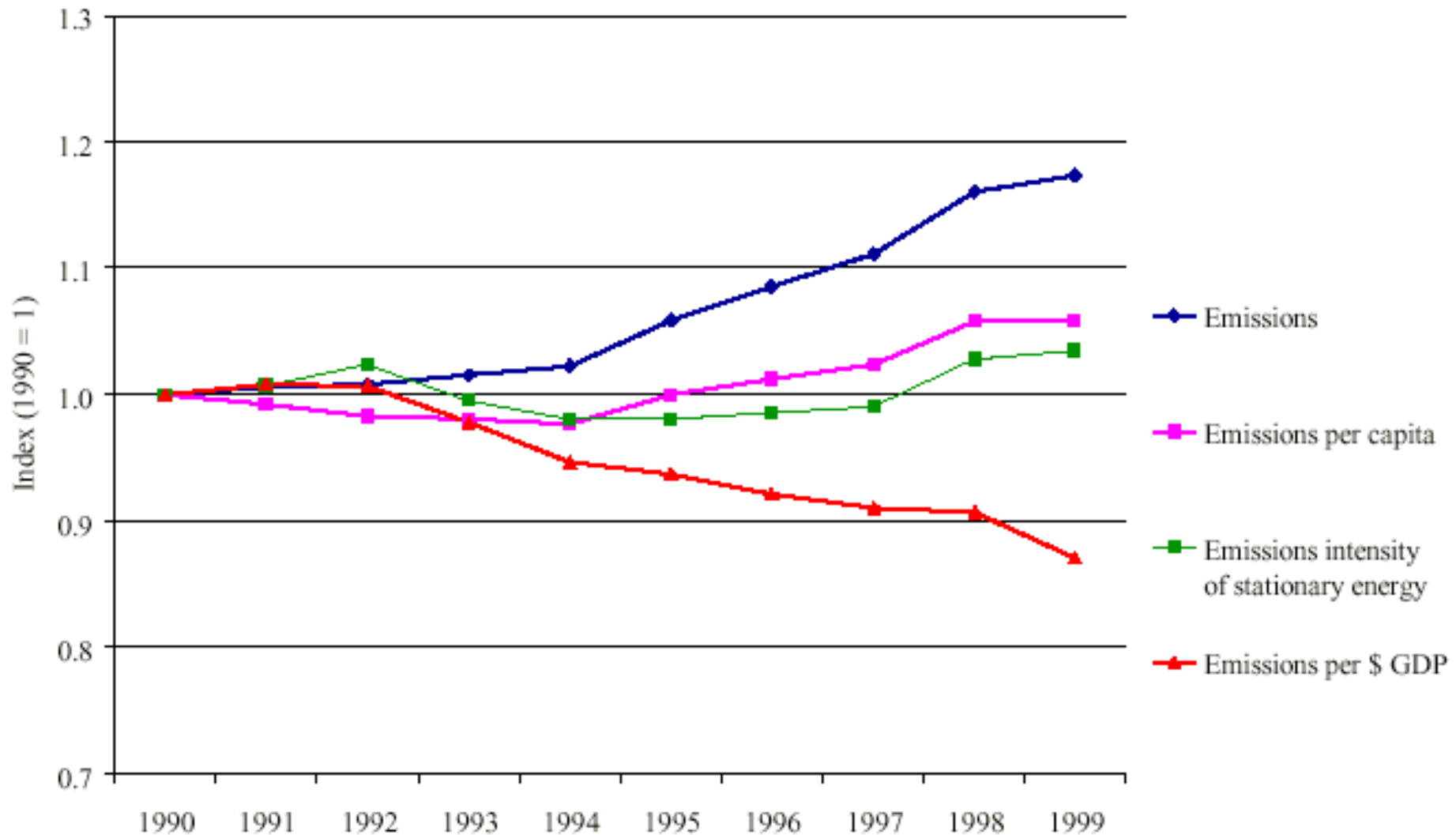
- “Command & control”:
  - Direct regulation of environmental impacts
    - Eg, prohibition of the use of CFCs
- Economic instruments (some examples):
  - Taxes on pollutants, e.g:
    - “Load-based licencing” by NSW EPA
  - Tradeable permits, e.g :
    - Hunter River salinity scheme
  - Tradeable credits, e.g :
    - MRET scheme “Renewable Energy Certificates”

# Emission trading schemes

- Cap & trade:
  - Regulated entity (RE) must surrender permits equal to its emissions in each reporting period
  - Constraining cap on total emission permits:
    - Permit trading identifies cheapest way to comply
- Baseline & credit:
  - RE credits = (assigned baseline) - (emissions)
  - Credits can be sold to non-complying RE's
- Penalty for non-compliance in either case:
  - Emission tax > the permit market-price

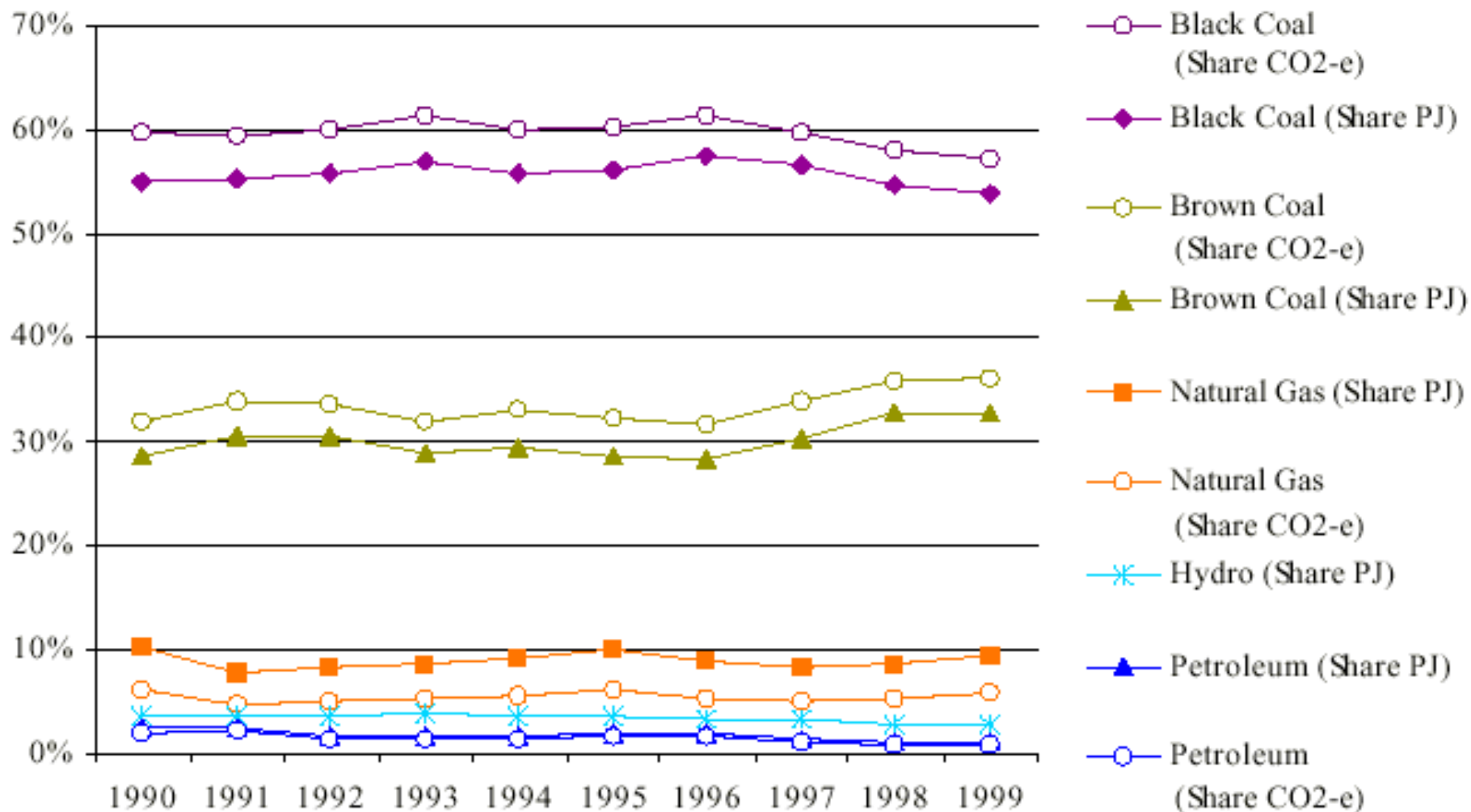
# Macro-indicators for greenhouse emissions

(source: [www.greenhouse.gov.au/inventory](http://www.greenhouse.gov.au/inventory), 2001)



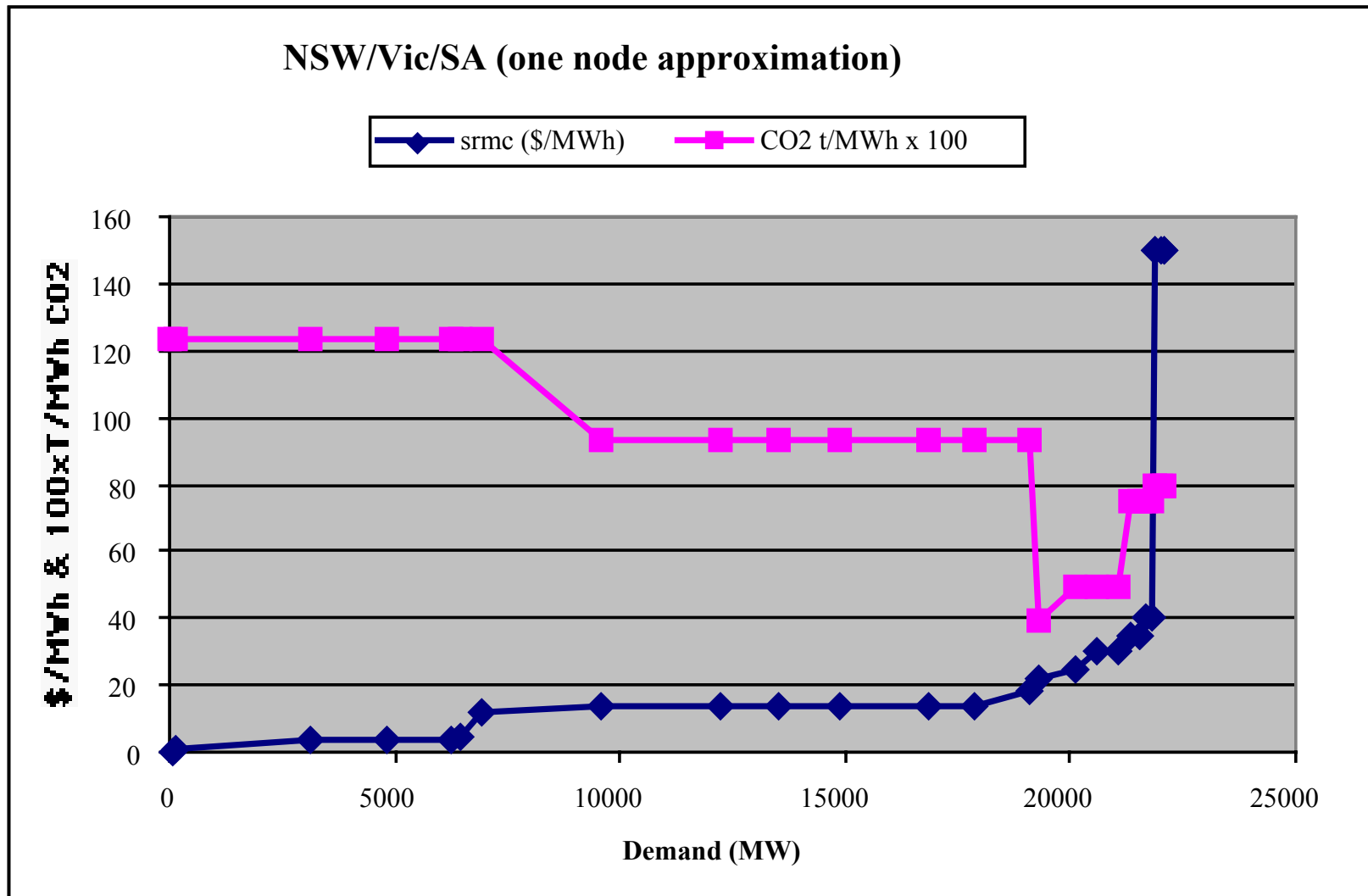
# Shares of electricity generation & related emissions, 1990-99

([www.greenhouse.gov.au/inventory](http://www.greenhouse.gov.au/inventory), 2001)

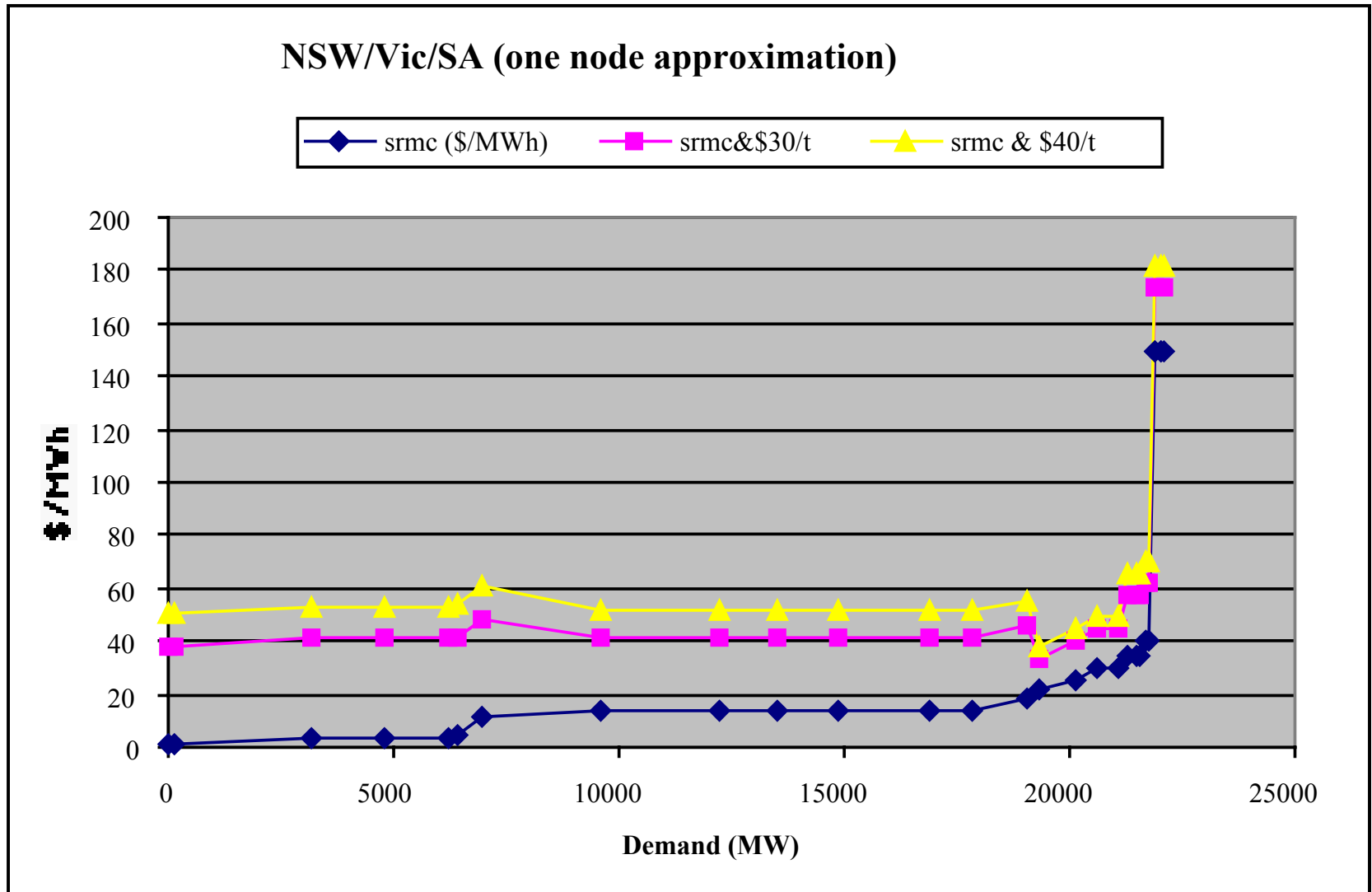




# NEM generators in order of operating cost (srmc) & generator CO2 coefficients



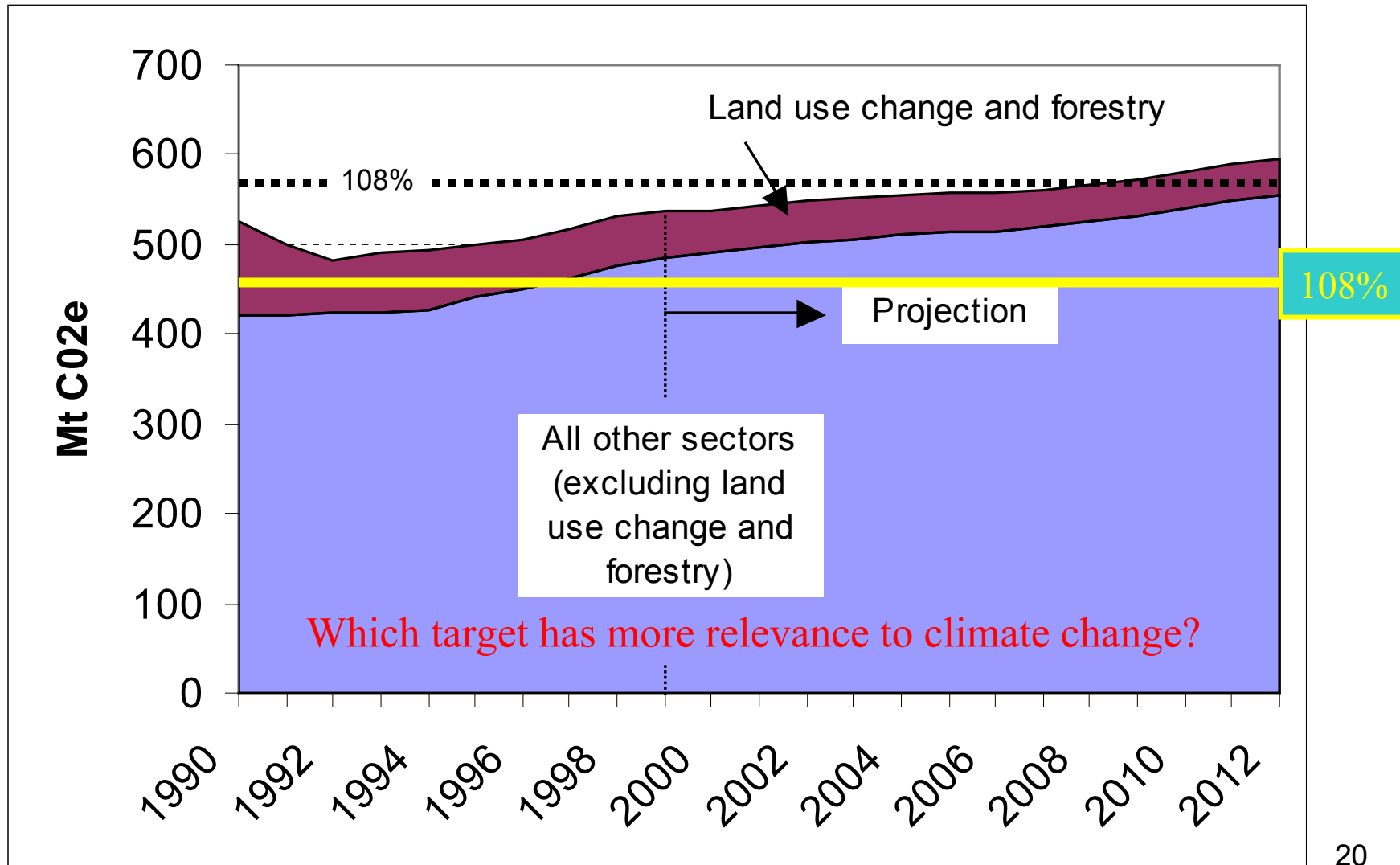
# Effect of CO2 taxes (or permits) on merit order



# Key issues in regulating by tradeable environmental instruments

- Relationship to the physical phenomenon:
  - Each instrument is an abstraction from reality
- Design of trading arrangements:
  - Markets in the instruments & their derivatives
- Effectiveness of the regulatory mechanism:
  - Measured by attributable changes in operation & construction of assets
  - Some important issues:
    - Abstraction errors (including overlap), trading efficiency, compliance

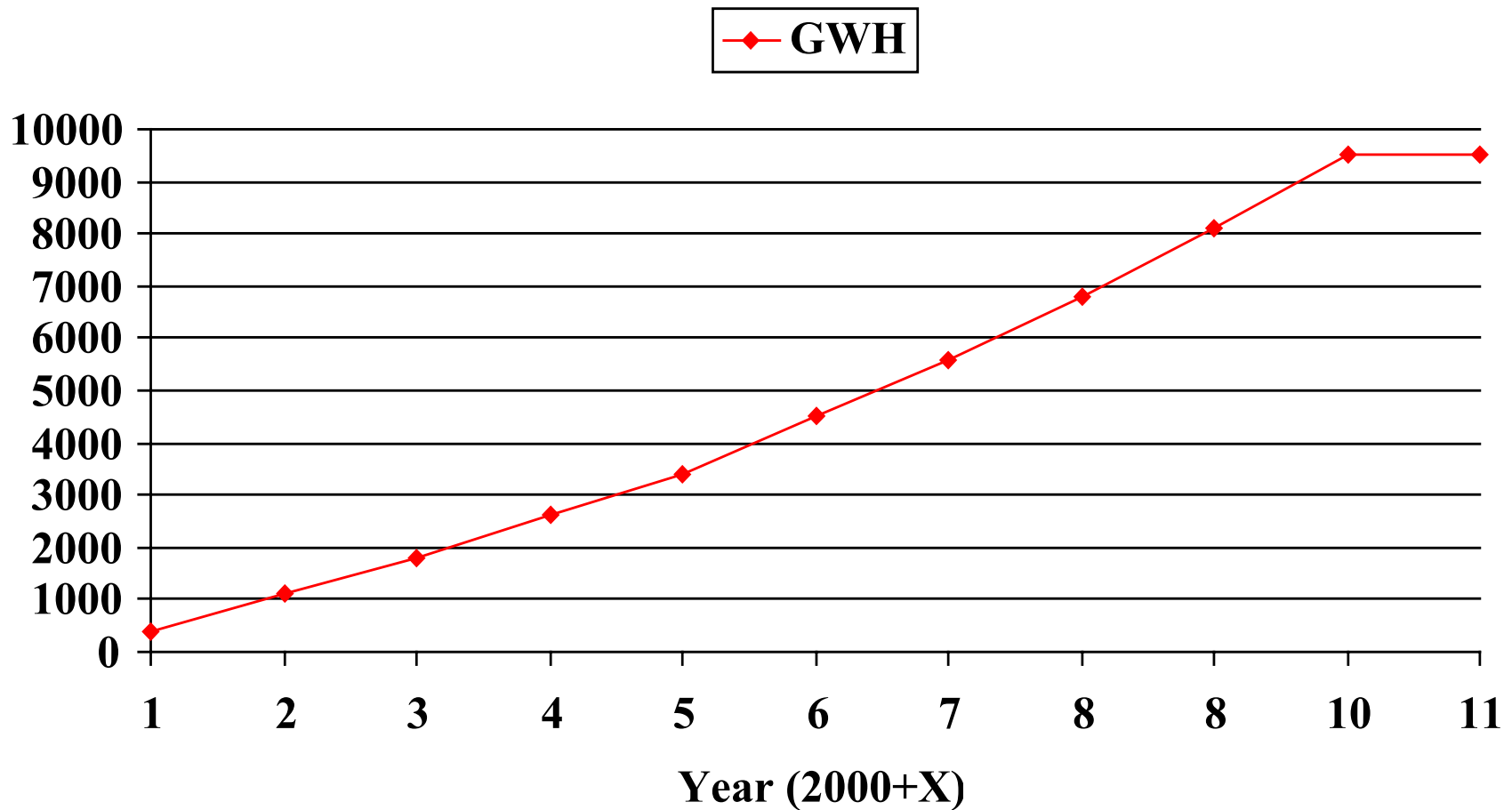
# *The issue of abstraction: Australia's Kyoto target*



# Key features of Renewable Energy (Electricity) Act 2000 ([www.aph.gov.au](http://www.aph.gov.au))

- Certificate properties:
  - Traceable to a specific MWh from an accredited facility (a nominal MWh for solar water heaters):
    - *Hence potentially a unique price*
  - Transferable & valid until surrendered
- Liable entities (grids > 100 MW “capacity”):
  - Retailers or direct wholesale buyers:
    - Not self-generators (*exempt from liability*)
    - Must surrender certificates equal to obligation:
      - By 14 February for prior calendar year
      - 10% leeway in accumulated obligation (bankable)

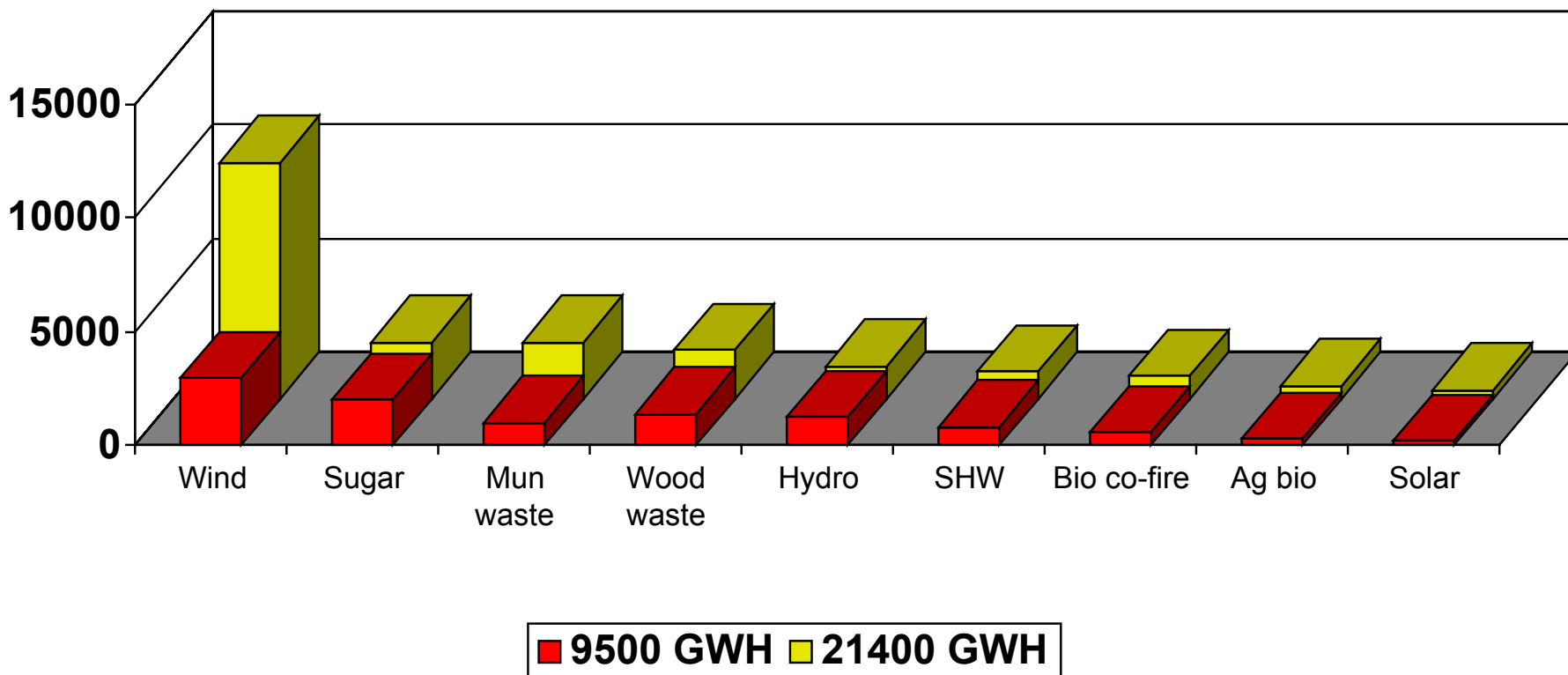
# Annual targets for electricity from “new” renewable energy



# AEA prediction of renewable energy supplied to meet MRET target of 9500 GWH pa & larger target of 21400 GWH pa

(Australian Ecogeneration Association, "Ecogeneration", Oct/Nov 2001)

*(2% is only the start of a credible climate-change response)*



## *The issue of abstraction: Renewable Energy Certificates*

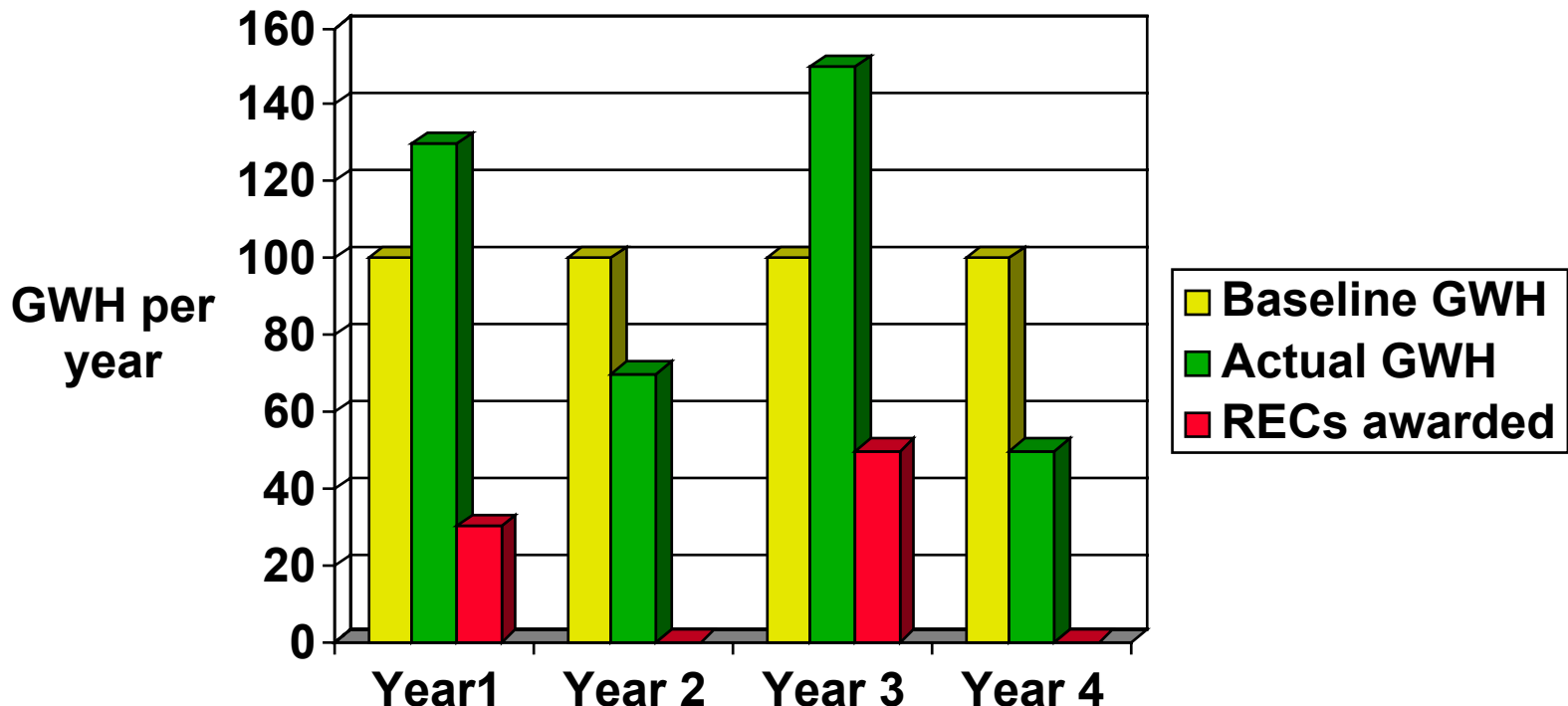
- MRET scheme REC properties:
  - Traceable to a specific MWh from an accredited facility (nominal MWh for solar water heaters):
    - Hence potentially a unique price
  - Transferable & valid until surrendered
  - Awarded above a baseline but not “clawed back” below it (“rectifier” error):
    - Baseline setting subject to error
    - Rectifier & correlated baseline errors lead to a systemic “drift error” that may reduce the delivery of physical outcomes



# MRET baseline: default is 1994-96

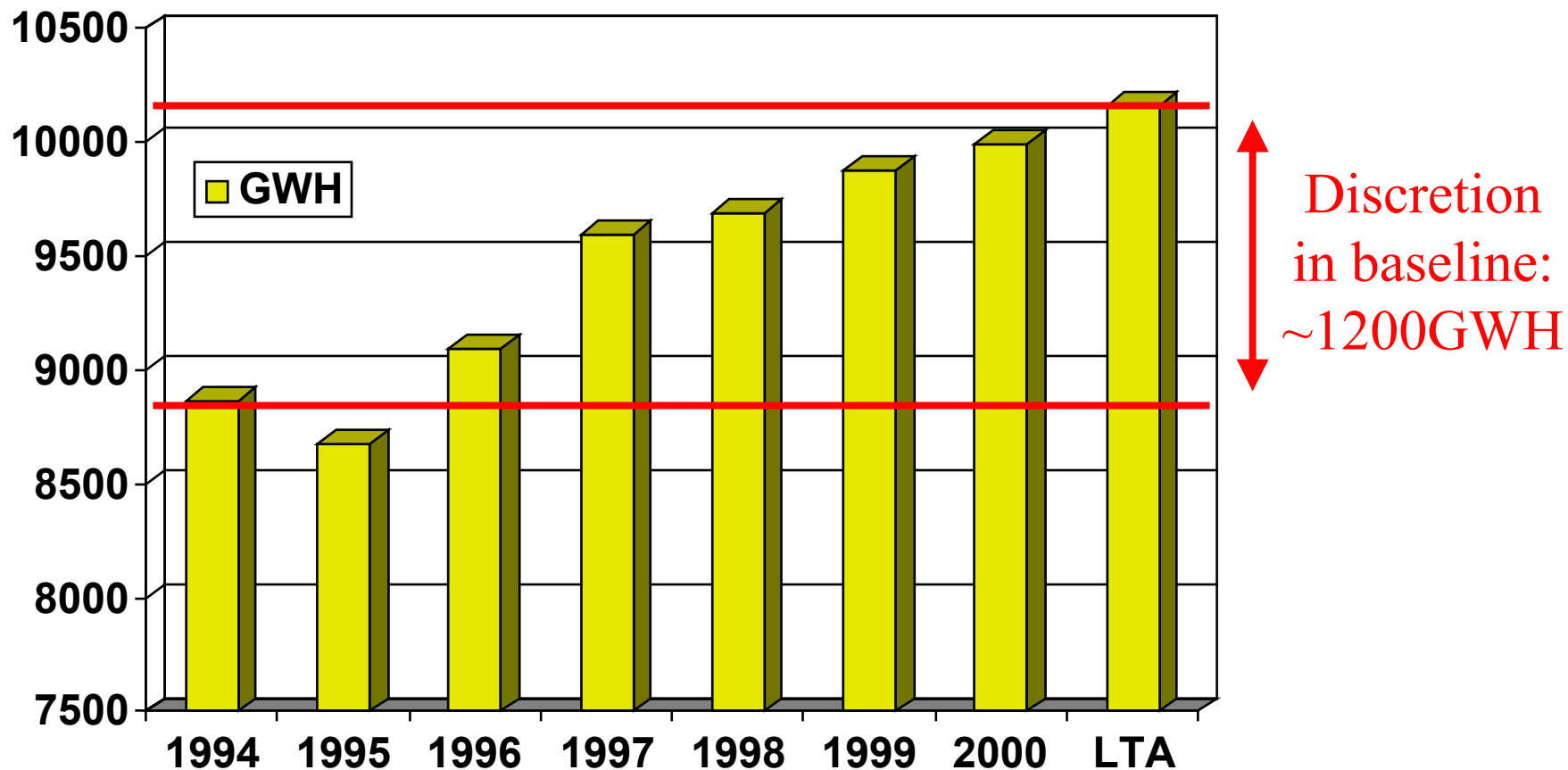
## Average output or LTA

RECs awarded above baseline but not “clawed back” below it



Rewards those generators with above-zero baseline & high annual variability  
(here 80,000 RECs over 4 years although ave. output = baseline)

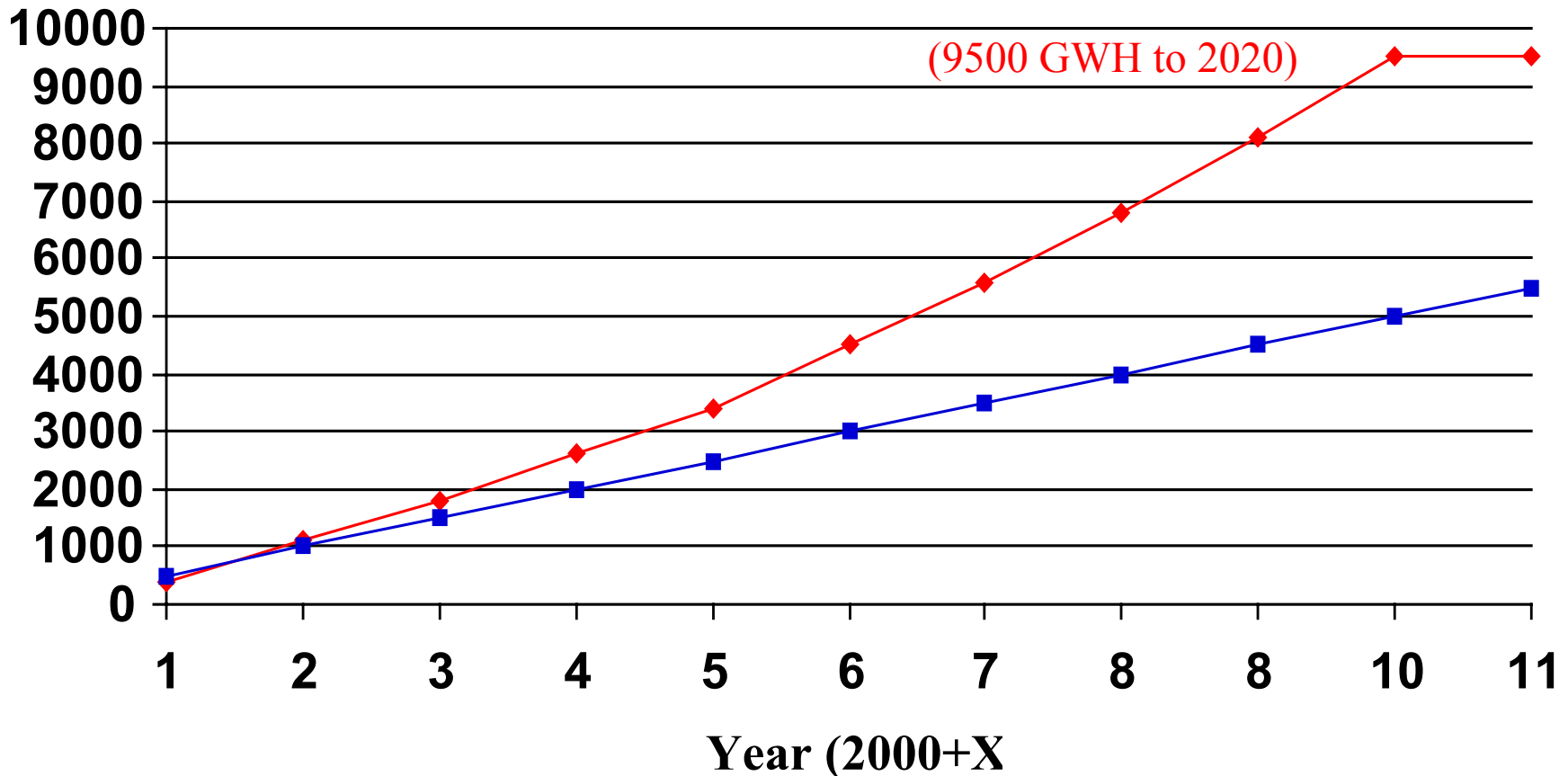
# Potential REC baseline error: Tasmanian hydro with long term storage & load growth



Note: Estimates only; actual baseline is confidential  
Data: ESAA Annual Reports

# MRET annual targets for electricity from “new” renewable energy

◆ Target ■ 500 GWH drift error



16000 GWH from existing NEM hydro plant in 2000/01

# NSW Greenhouse Benchmark Scheme

- Policy intent

- “to reduce greenhouse gas emissions associated with the production and use of electricity and to encourage participation in activities to offset the production of greenhouse gas emissions.”

(Overview to the NSW Electricity Supply Amendment Bill, 2002)

- Implementation

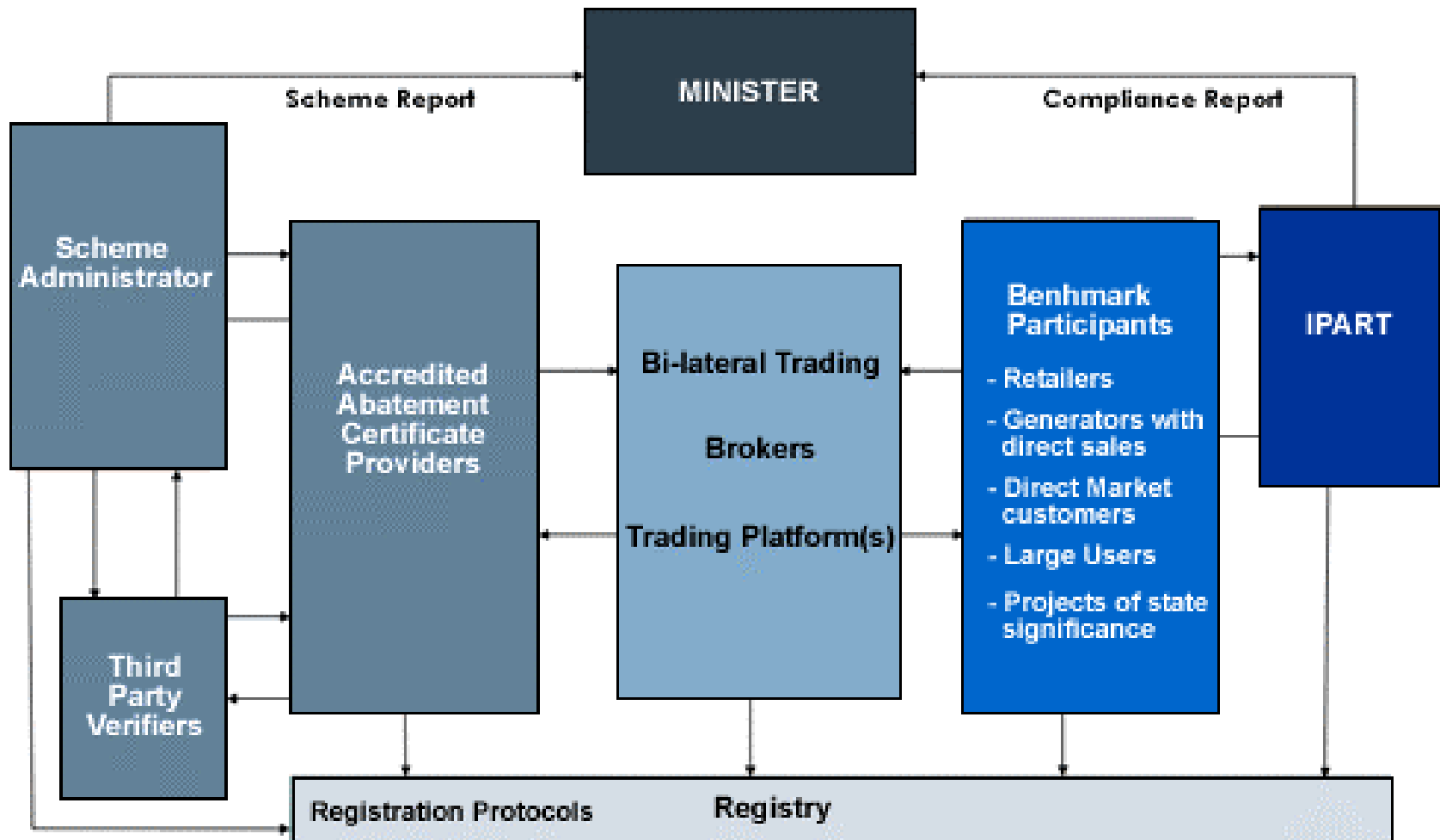
- Imputed greenhouse gas emissions targets for Benchmark Participants (retailers & large end-users)
- Baseline+credit imputed emission reduction activities
  - State-wide & activity baselines
  - Imputed reduction credit for each eligible activity

# NSW Scheme – Design

- ‘NSW greenhouse gas abatement certificates’ or NGACS (each one imputed tonne CO<sub>2</sub>)
- Accredited providers create NGACs via
  - ‘New’ low-emission generation within the NEM
  - Demand Side Abatement (DSA) activities in NSW
  - Carbon-sequestration projects in NSW
- BPs surrender NGACs equivalent to ‘their’ contribution to ‘excess’ state emissions above annual target (10.50 \$/NGAC penalty)
- Trading between BPs and providers

# NSW Retail Benchmark Scheme

([www.greenhouse.nsw.gov.au/scheme/overview.htm](http://www.greenhouse.nsw.gov.au/scheme/overview.htm))



# NSW Scheme - Concerns

- ‘Imputed’ rather than physical emissions:
  - Actual emissions could go up while imputed emissions go down:
    - Credibility of baselines, DSA & sequestration? Methane multiplier?
- Many activities have non-zero baselines:
  - Difficult to set in a credible way
- Fungibility of different categories activities:
  - Is planting trees really equivalent to building wind farms?
  - Rebound effects for DSA in the absence of price signals
- Jurisdiction: new low-emission generation anywhere in the NEM can contribute to NSW target
- Potential double counting with other policies:
  - MRET, GGAP, MEPS? Similar schemes in other states?

# Alternatives to NSW scheme

- Load-based licensing or permit cap & trade:
  - Internalise impact to give clear electricity price signal; eg suppress demand rebound effect
- Targeted industry development strategies:
  - Supply side infrastructure; eg MRET plus support for renewable energy innovation
  - Demand side infrastructure; eg EET plus support for demand side innovation
- Improvements to National Electricity Code



# Conclusions

- Strengths of Aust. electricity restructuring:
  - Efficient dispatch of existing large generation
  - Framework for decentralised decision making
- Weaknesses of Aust. electricity restructuring:
  - Limited derivative market support for investment
  - Inadequate climate change response
  - Inadequate support for distributed resources
- Key enhancements for distributed resources:
  - Improved retail market design
  - Emission trading or taxes & innovation support