UNSW World Energy Congress Symposium

A new UNSW Research Centre for Energy and Environmental Markets

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The question… and answer up front

- **Q   Why establish such a Centre?**

- **A   Because** energy and environmental markets are important, yet challenging…
  - *When might market-based approaches be appropriate?*
  - *How might such markets be designed?*
  - *How might we try and fix markets that aren't working?*

  and answering these questions seems likely to require a focussed inter-disciplinary approach

Why have government?

- A possible economist's (and Australian National Competition Policy) perspective
  - *For when the market does not provide efficient outcomes for society; ie. market failures*
    - Monopolies: The Failure of Competition
    - Public Goods
    - Incomplete markets
    - Information failures
    - The "Business Cycle
    - ***Externalities***

A government role in energy?

- 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**
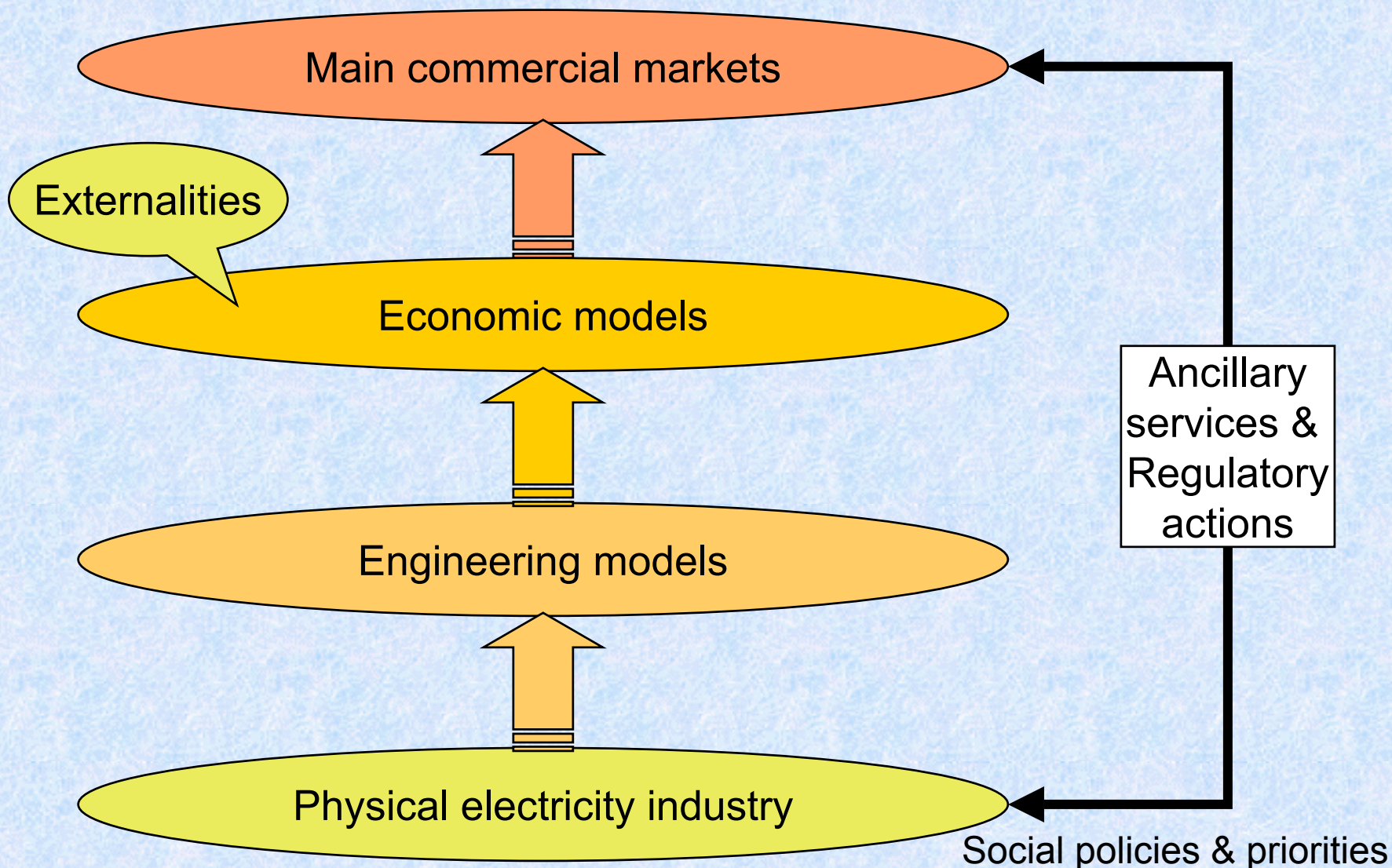   - *Climate change and other environmental impacts, energy security, social impacts*

Energy market restructuring

- The last two decades have seen worldwide efforts to restructure energy markets for reasons including
  - Improve economic efficiency by introducing competition & facilitating new entry
  - *Assumes effective markets & sound legal environment*

- Enhance accountability to end-users & society through 'customer choice':
  - *Assumes 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:
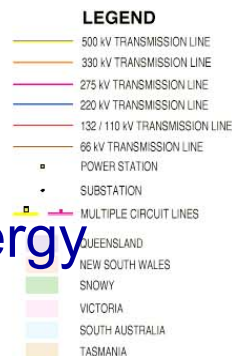 - *Creates moral hazard for politicians*

The electricity industry – models to aid understanding

Main commercial markets

Externalities

Economic models

Engineering models

Physical electricity industry

Ancillary services & Regulatory actions

Social policies & priorities

The Australian NEM

- **Physical properties of electrical energy**
  - No cost-effective storage
  - Instantaneous transmission & distribution
  - Energy flows according to network laws from all generators to all consumers

=> Implications
  - Supply & demand balance at all times
  - Electrical continuum - power station to end-use means can't assign energy from particular power station to particular consumer
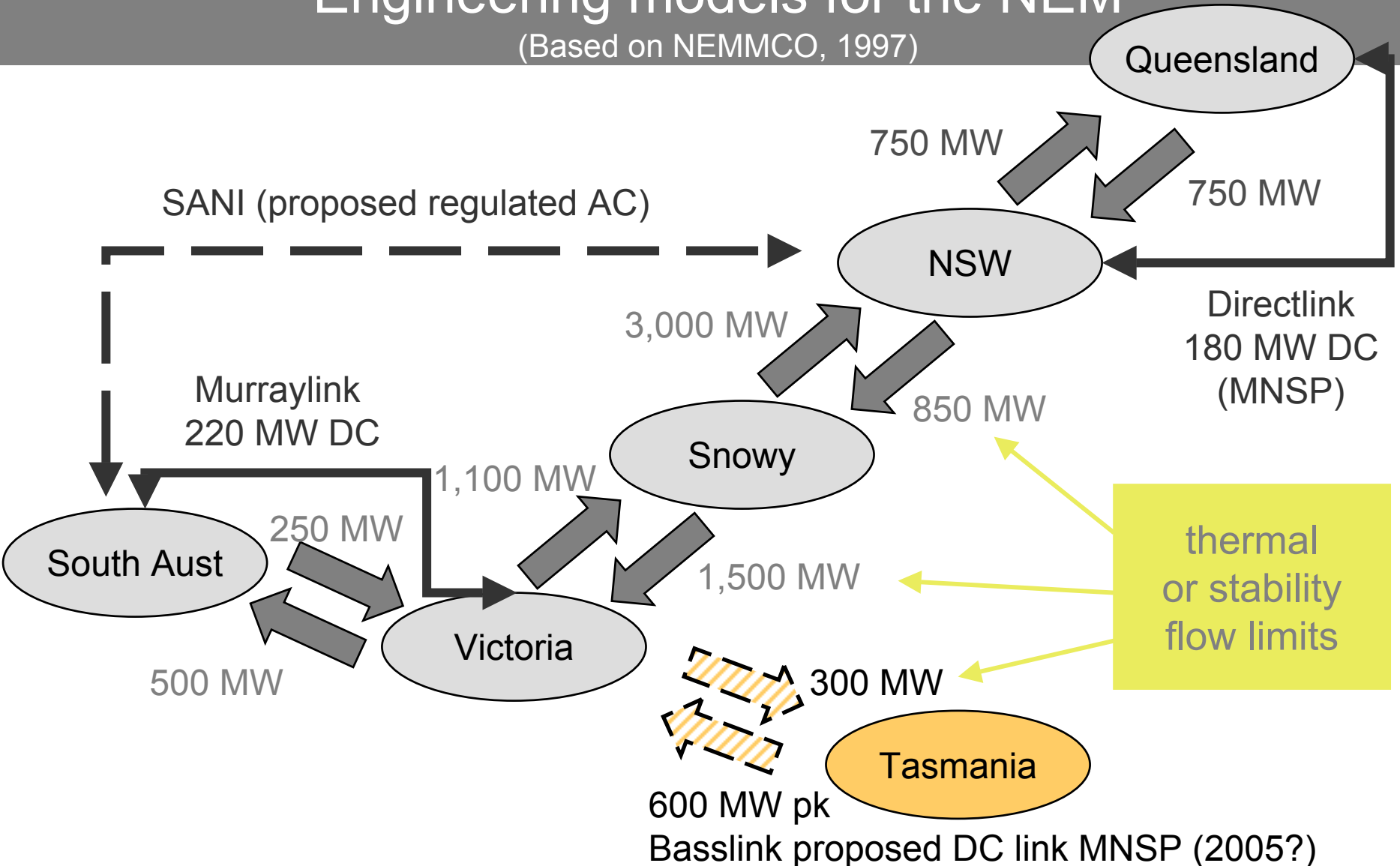
REGIONAL BOUNDARIES
for the
NATIONAL ELECTRICITY MARKET

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

NEMMCO

National Electricity Market
Management Company Limited

Engineering models for the NEM
(Based on NEMMCO, 1997)

Queensland

750 MW

750 MW

SANI (proposed regulated AC)

NSW

Directlink
180 MW DC
(MNSP)

3,000 MW

850 MW

Murraylink
220 MW DC

Snowy

1,100 MW

250 MW

1,500 MW

thermal
or stability
flow limits

South Aust

Victoria

500 MW

300 MW

Tasmania

600 MW pk
Basslink proposed DC link MNSP (2005?)

Economic models for the NEM
(from Bardak, "Pool prices in the NEM", 2003)

NSW SRMC 2002
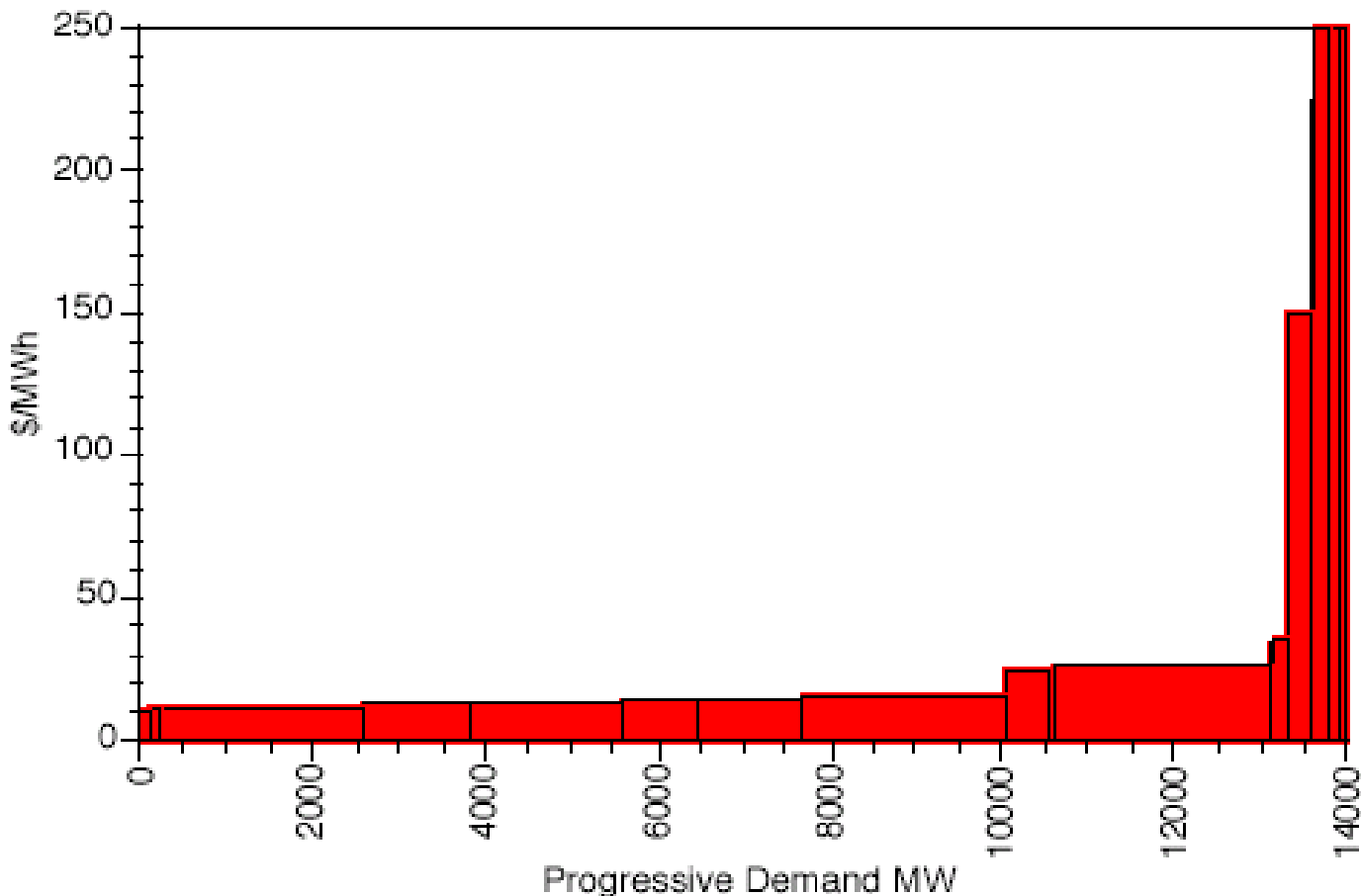
Commercial models for the NEM
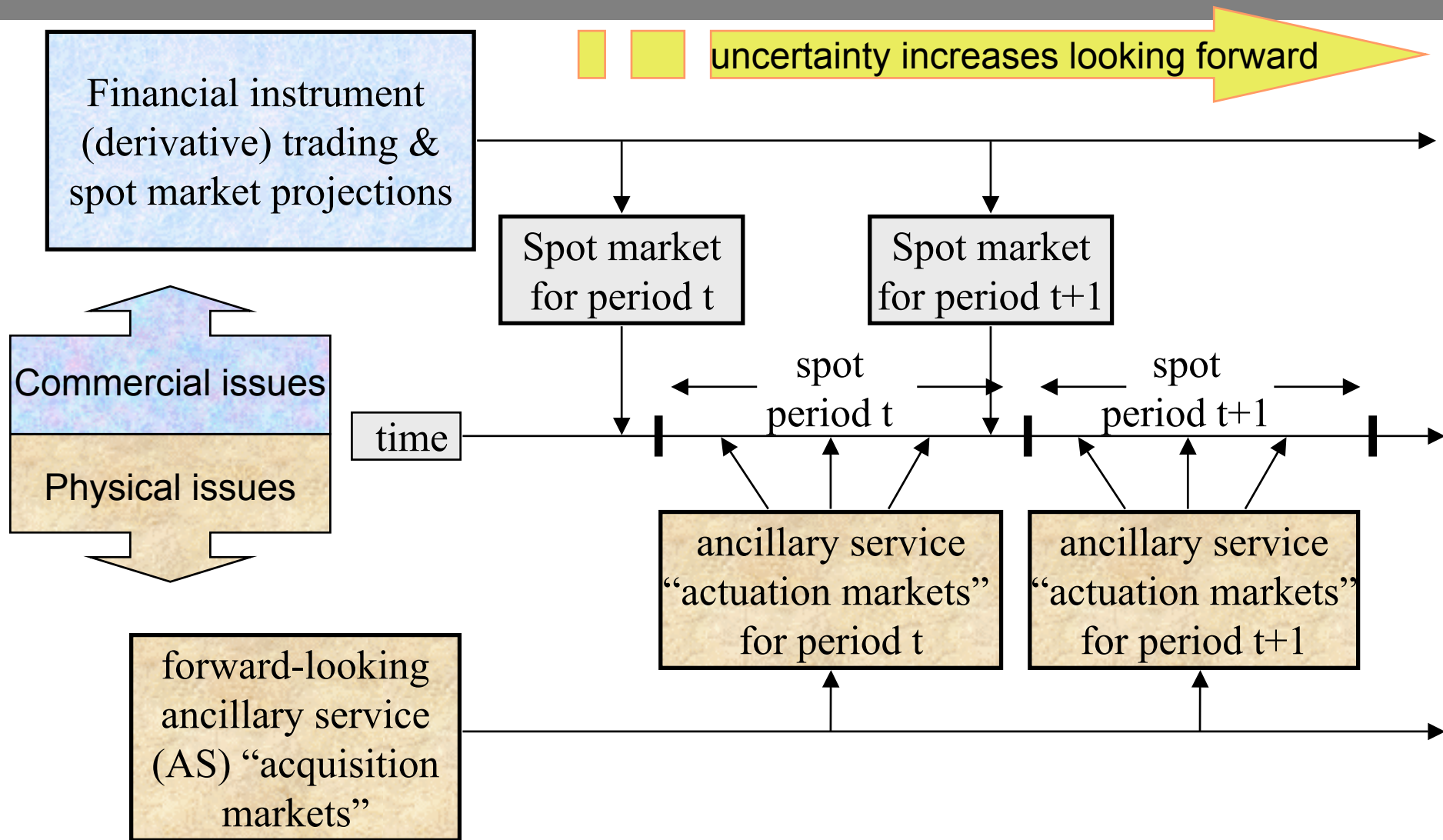
The NEM and environmental externalities

Australia has the world's highest per-capita greenhouse gas emissions (Aust. Institute, 2002)
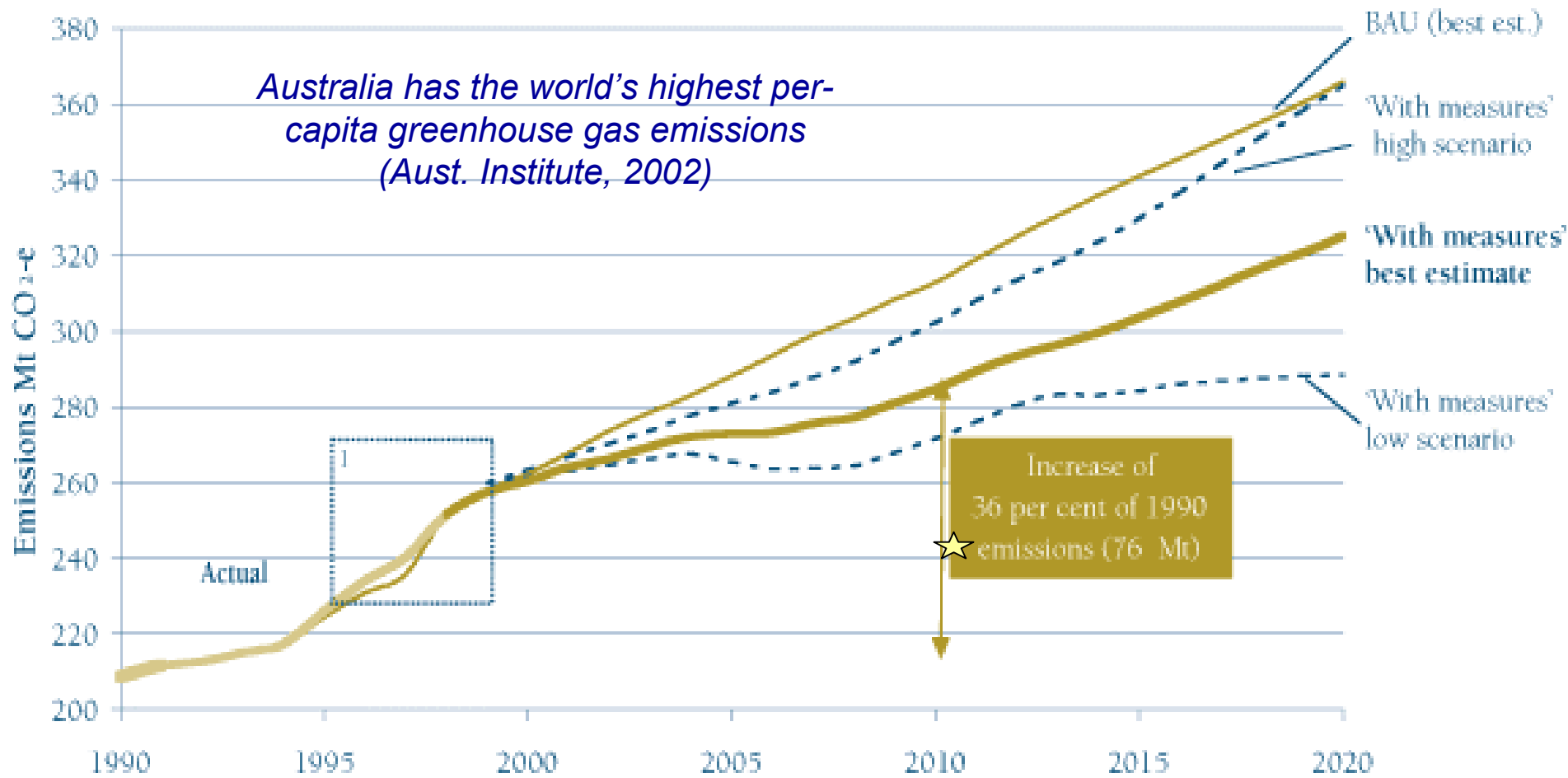
Source: Australian Greenhouse Office (2002)

Enviro markets – 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 – a 'designer' market

RE Certificates representing 1 MWh of new 'renewables'

REC providers

Deliver certified new Renewables to create RECs

RE Certificate trading

To improve economic efficiency

Liable parties

Obliged to acquit RECs as part of societal obligation

Certify Certificates   Maintain register   Ensure liable parties oblige

Scheme administrator
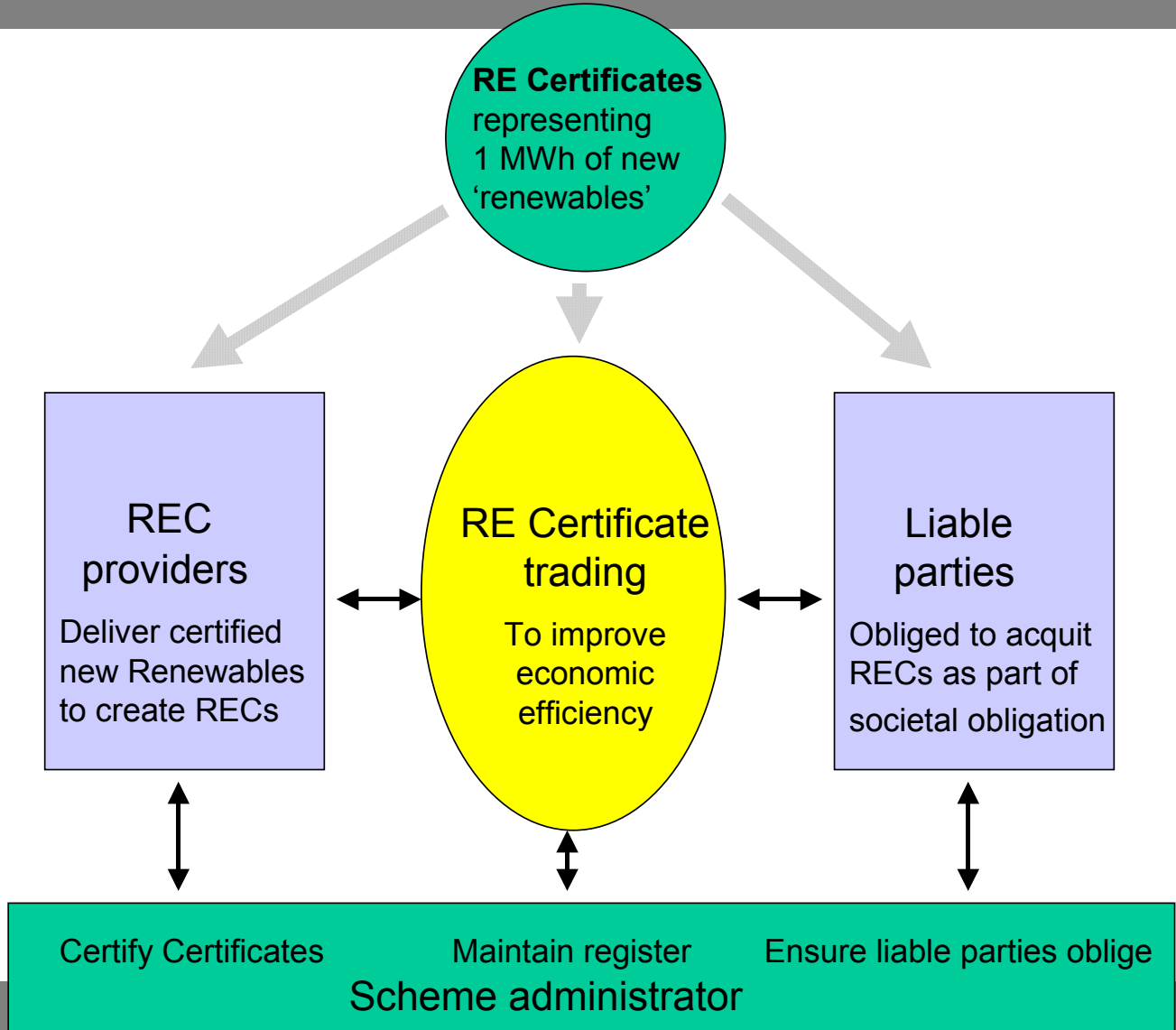
Tools for assessing market design + structure

- Economics – eg. general competitive market theory

- Experience with existing, similar markets

- 'Common-sense' assessment

- Mathematical analysis – Cournot + Bertrand paradigms, game theory…

- **Experiments**
  - 'Trial + error' simulations to explore possible market outcomes

  - Simulations guided by 'intelligent' market participants

    Experimental subjects
    Software agents
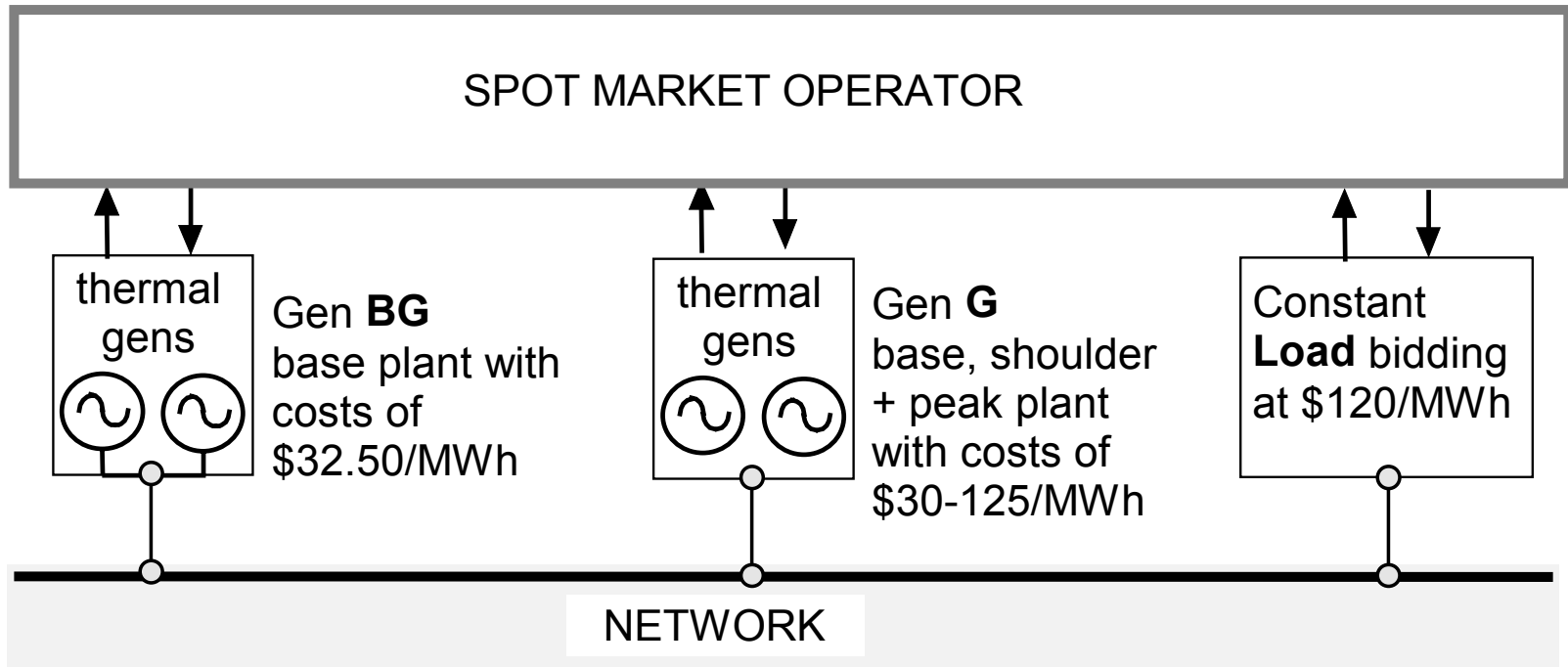
Exploring a RECs market with experimental economics

Trial run for MRET experimental trading game
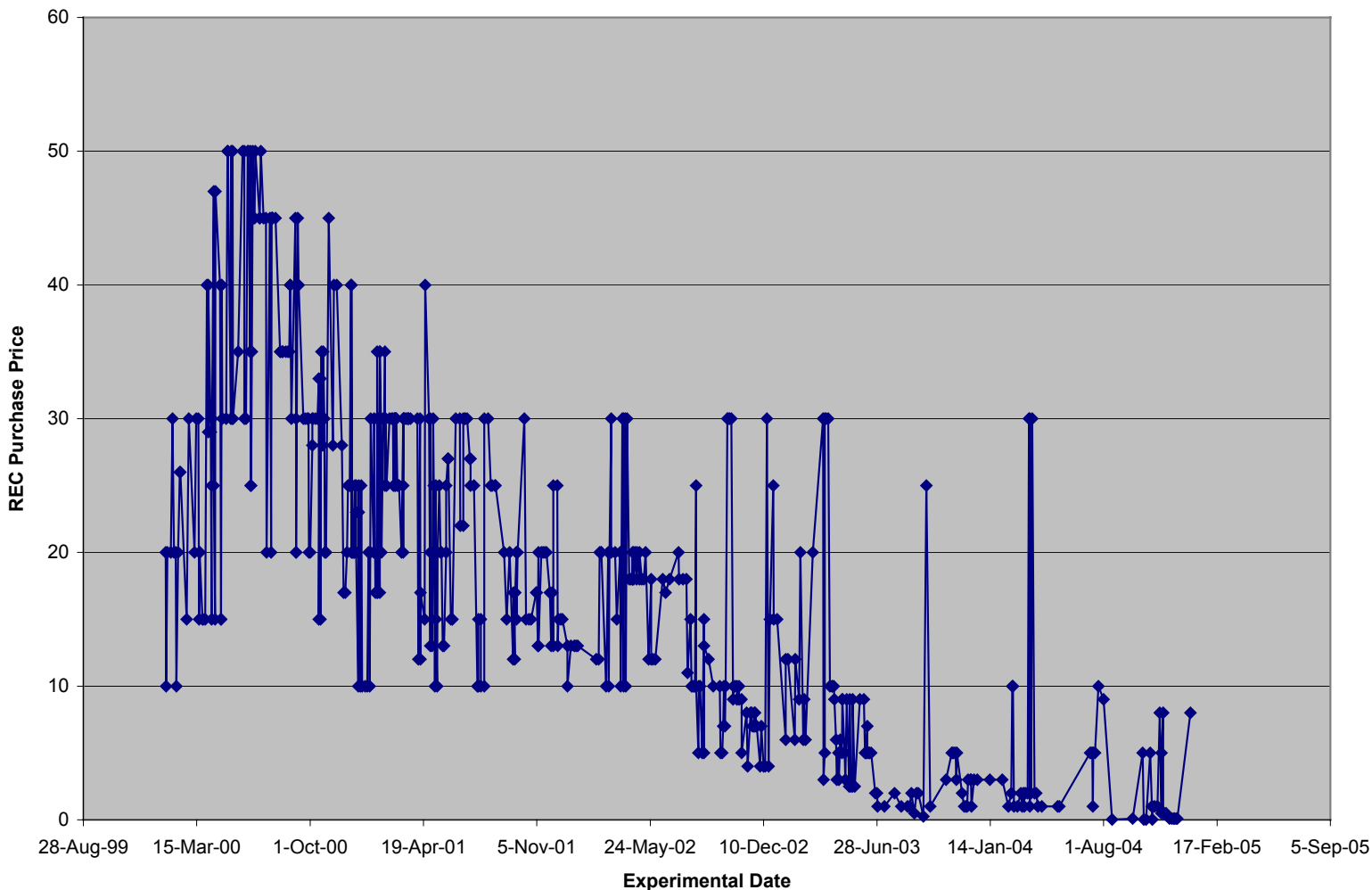
Using AI agents and evolutionary programming
(eg. simple power system with 2 generators)

SPOT MARKET OPERATOR

thermal gens

Gen **BG** base plant with costs of $32.50/MWh

thermal gens

Gen **G** base, shoulder + peak plant with costs of $30-125/MWh

Constant **Load** bidding at $120/MWh

NETWORK

EP Results

- ## Simple problems:
  => EP + game theory agree

- ## Complex problems:
  => EP shows useful insights beyond standard game theory
  Eg: BG and G 'fighting' over dispatch for Load that either can fully meet: *Go for dispatch volume or work together to increase price (no Nash equilibrium)*

  Range of market price $/MWh and G and BG surplus (profit) outcomes if none, or only one is attempting strategic behaviour
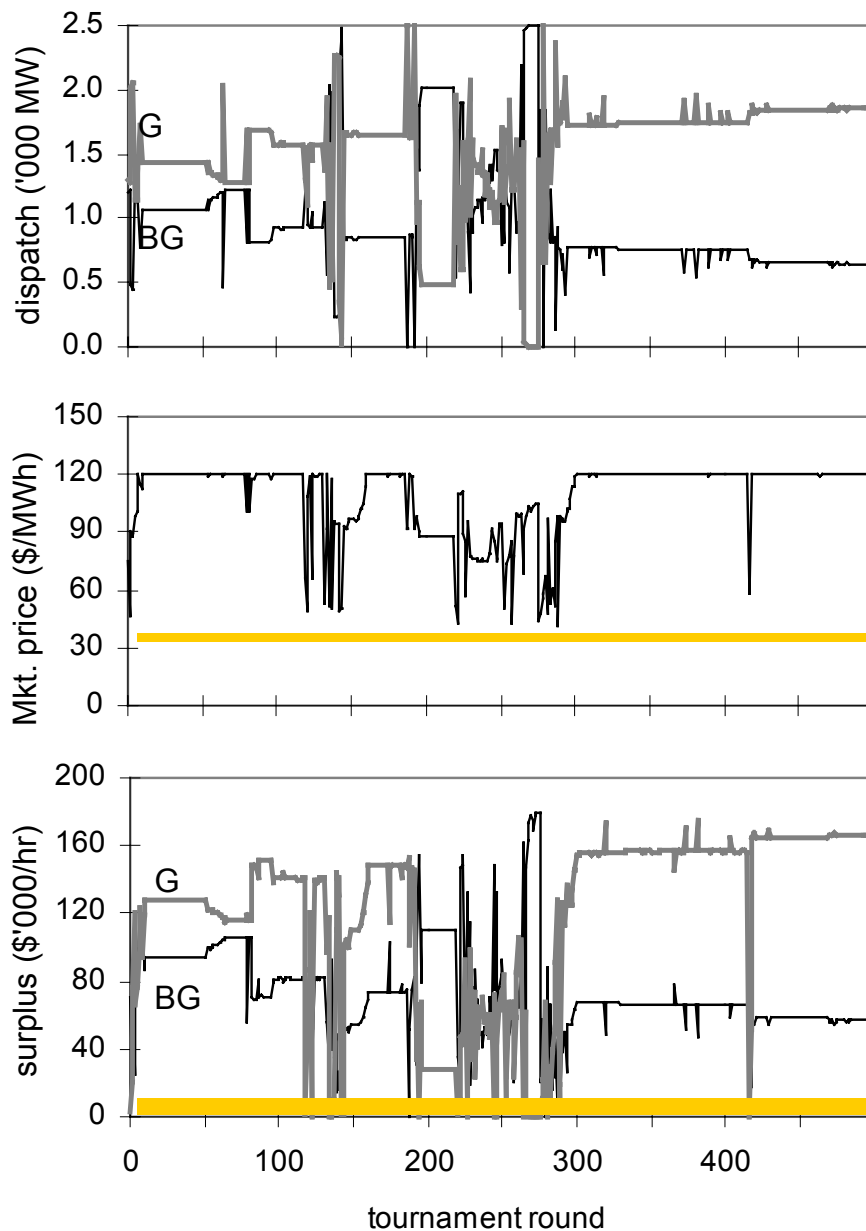
Centre for Energy + Environmental Markets (CEEM)

Established…

– *to formalise* growing interest + interactions between UNSW researchers in Engineering, Commerce + Economics… + more

– *through UNSW Centre* providing Australian research leadership in interdisciplinary design, analysis + performance monitoring of energy + environmental markets, associated policy frameworks

– *in the 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

For more information…..

www.ceem.unsw.edu.au