CEEM Specialised Training Program

EI Restructuring in Australia

Iain MacGill and Hugh Outhred
Centre for Energy and Environmental Markets
School of Electrical Engineering and Telecommunications
The University of New South Wales
i.macgill@unsw.edu.au
www.ceem.unsw.edu.au

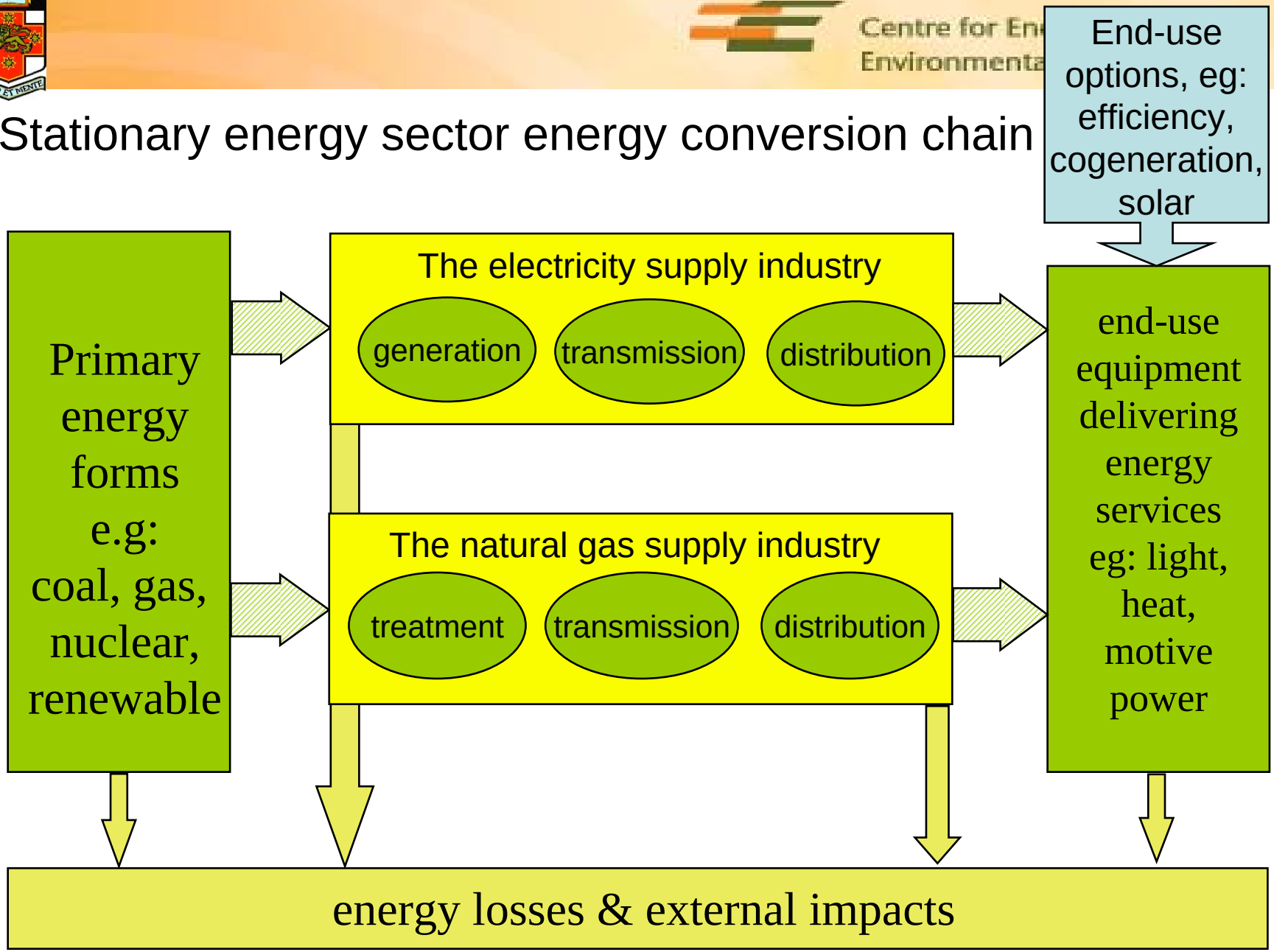
Course overview

- Introduction to EI restructuring
- Australian NEM
  - Design
  - Performance (including market power issues)
  - Associated derivative markets
- Key EI restructuring issues
  - Network and ancillary services
  - Security of supply
  - Regulation (including environmental management)
  - Structure and ownership
  - Intermittent generation
- Future directions in EI restructuring
  - International experience
  - Australian NEM reform

Introduction to EI restructuring - *Outline*

- The policy context:
  - Infrastructure industries & natural monopolies
  - Restructuring objectives
- Perspectives on the electricity industry:
  - Physical, engineering, economic, commercial, regulatory, policy
- Design of the electricity trading environment
- Issues in practical implementation
- Regulatory functions
- Conclusions

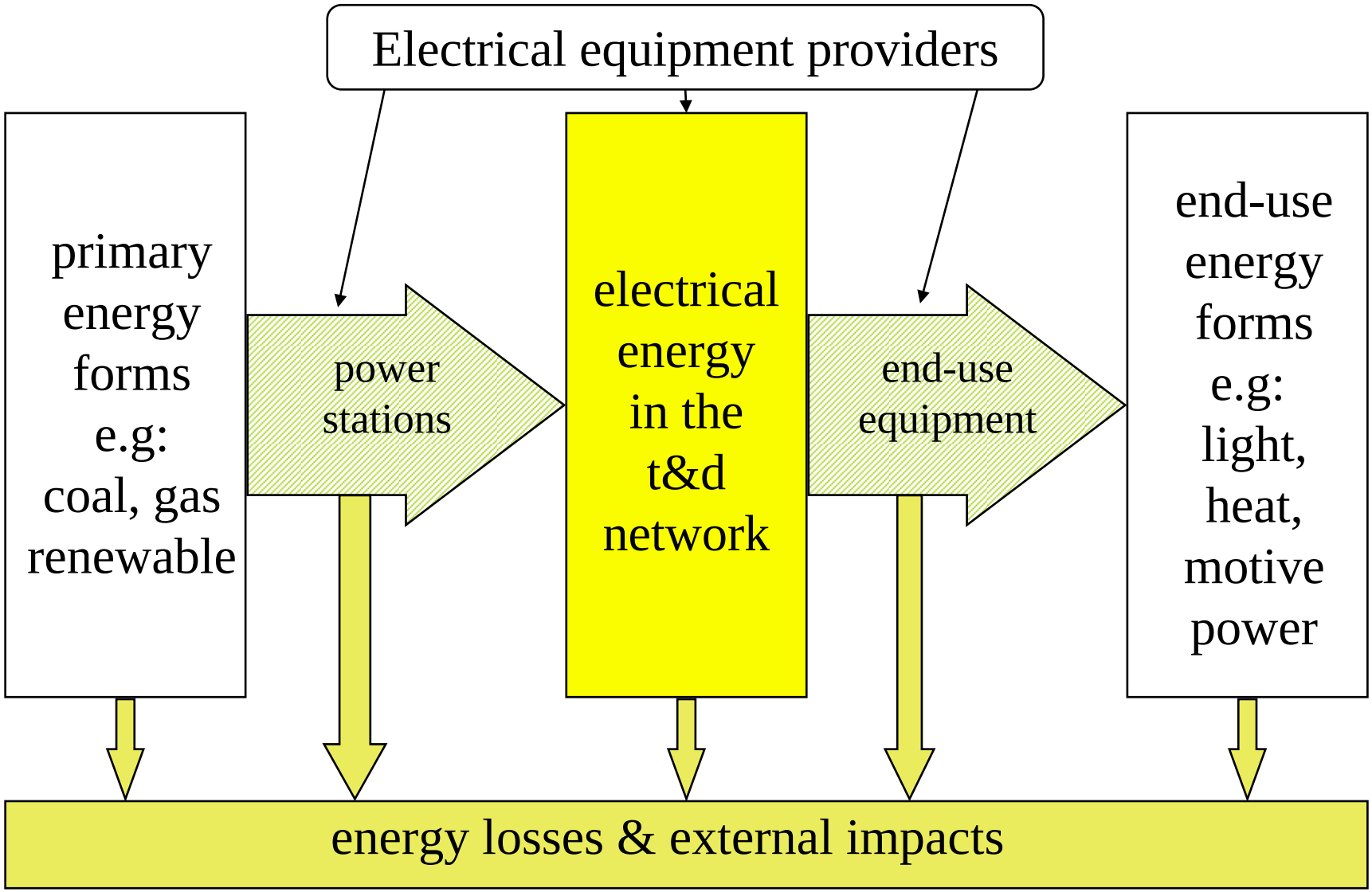
Stationary energy sector energy conversion chain



Key issues for the electricity industry

- Part of the stationary energy sector:
  - In competition with other energy vectors to deliver end-use energy services
- Significant externalities:
  - Environmental (eg climate change)
  - Social (eg “essential good”)
- Characteristics of electricity:
  - A high quality, secondary energy form:
    - Expensive to make but flexible to transport & use
  - Specific physical properties

The electricity industry conversion chain



The electricity industry is different…

- 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 end-use equipment
- Implies the ultimate "just in time" industry:
  - Supply & demand must balance at all times
    - Generator output determined by end-use equipment
    - Supply & demand side options are equally valid
  - Cannot assign energy from a particular power station to a particular consumer:
    - 'pool' rather than 'bilateral' trade
  - Wholesale & retail activities not clearly separable:
    - Retailers don't have a clear role in an electricity industry

Comparing the car & electricity industries

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*

Electricity

- Intermediate energy form:- invisible, ephemeral, fungible
- A consumer receives a mixed flow of energy from all power 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 does NOT work well:

- *Must design & implement a trading regime that works for electricity*

What is the role of 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***
  - Energy markets seem to face all these *challenges*

What role for governments 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*
  - Externalities
    - *Climate change, social impacts*
  - Information failures
    - *Under-utilised energy efficiency options*
  - The "Business Cycle"
    - *Capital intensive, long-lived investments*

Infrastructure industries

- A definition of infrastructure:
  - Essential elements forming the basis of a system
- Examples of infrastructure industries:
  - Communications,electricity,gas,water,transport
  - Provide inputs to products or services
  - Often capital intensive with long asset lives
- An infrastructure industry is only essential if:
  - A particular product or service cannot be produced without it
  - No alternative product or service can be made without it

"Natural monopoly" industries

- Definition:
  - Most efficient if production undertaken by a single firm to meet demand when price=SRMC
    - Always true for "increasing returns to scale", ie average cost decreases as production increases
- Some infrastructure industries may be both essential & natural monopolies, eg:
  - Electricity distribution networks
  - However, the demand side of the electricity industry is not a natural monopoly

Traditional models for infrastructure industries

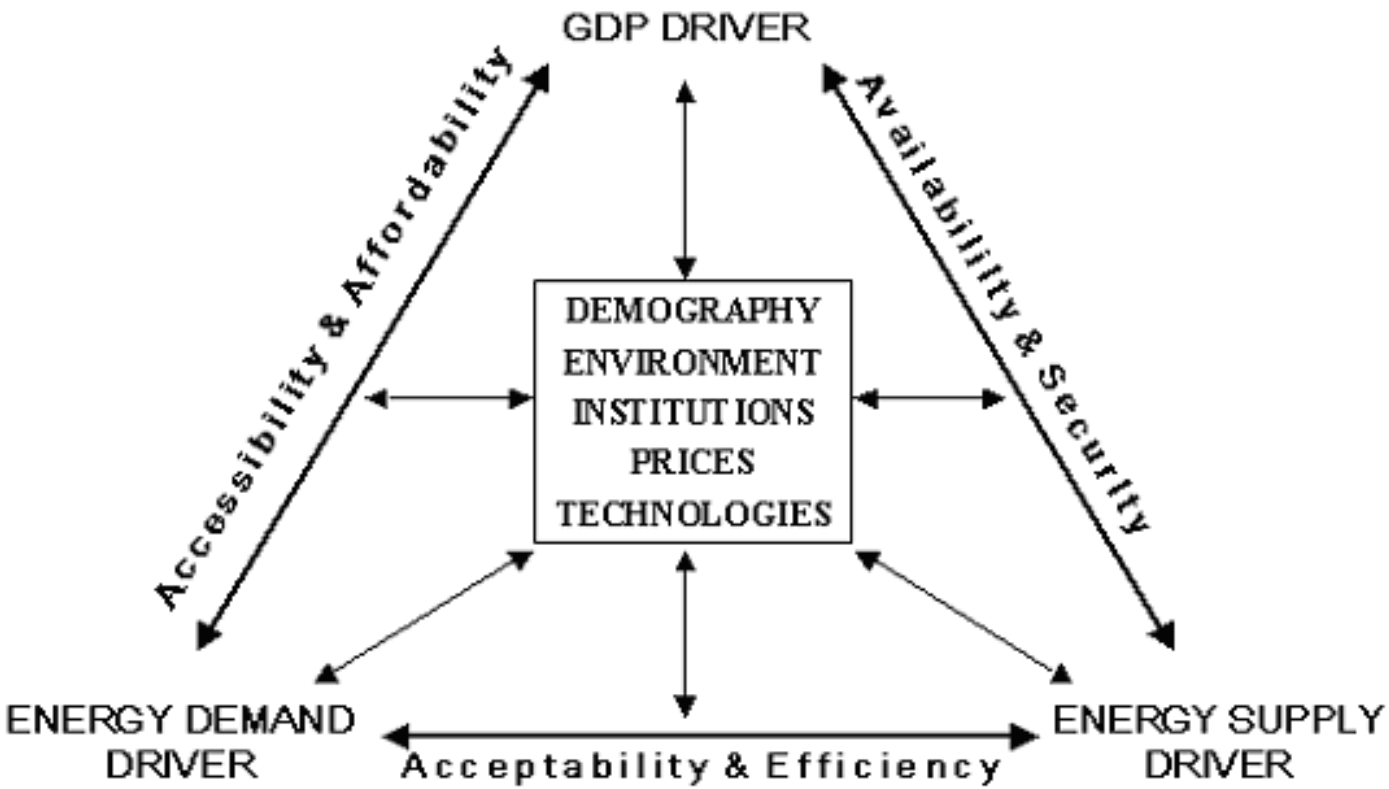
- Britain, Australia, etc:
  - Statutory authorities supervised by a Minister:
    - Usually vertically integrated monopolies
  - Decision making political, “behind closed doors”:
    - Politicians negotiate tradeoffs
- USA (in some cases):
  - Regulated private monopolies
  - Politically appointed regulatory boards
  - Formal public hearings

How do governments act?

- To begin, through **Public Policies**
  - Pattern of government decisions and actions to solve public problems – serving the public interest
    Laws & Meyer(1999)

Policy drivers + goals in energy

(World Energy Council, *2004 Statement*)



Drivers

- *GDP Driver*, describes the demographic, institutional and technology feedbacks on GDP growth;
- *Energy Demand Driver*, covers the nature and evolution of energy consumption in stationary, mobility and electricity services and how they impact the environment;
- *Energy Supply Driver*, which deals with the availability and cost of energy and their feedbacks on prices or the prospects for economic growth and energy demand.

Goals

- *Energy accessibility central to economic development*
- *Energy acceptability linked to energy demand.*
  - *Over time, demand tends to evolve towards cleaner and more sophisticated energy uses, driving primary supply in direction of cleaner and more versatile fuels;*
- *Energy availability is the key for the first two drivers*
  - *sustained energy supply shocks or crises hamper economic development and force societies to adapt to a more costly energy world.*

Australian energy policy

- COAG has agreed to the following national energy policy objectives: (COAG ENERGY POLICY DETAILS: 8 JUNE 2001)
  - 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.

Other *possible* national energy policies

- We will have four goals for our energy policy *(UK Energy White Paper):*
  - to put ourselves on a path to cut the UK's carbon dioxide emissions - the main contributor to global warming - by some 60% by about 2050 with real progress by 2020;
  - to maintain the reliability of energy supplies;
  - to promote competitive markets in the UK and beyond, helping to raise the rate of sustainable economic growth and to improve our productivity; and
  - to ensure that every home is adequately and affordably heated.

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

Economic efficiency objectives

- Allocative efficiency:
  - Appropriate choice between goods & services:
    - For example, electricity versus gas
- Technical or productive efficiency:
  - Cheapest method to produce a good or service:
    - Best available technology & work practices
- Dynamic efficiency:
  - Support innovation & response to change:
    - R&D & technological change
    - Environmental impacts, social expectations, etc.
  - Very important in a capital intensive industry

Other drivers for change in infrastructure industries

- Improving theoretical understanding:
  - Imperfect regulation versus imperfect markets
  - A theory of electricity spot pricing from 1979
- Evolving political context in western world:
  - Emphasis on individual choice & accountability
- Challenging conditions for central planning:
  - Slow & uncertain growth in demand
  - Technological progress creating new options:
    - Eg metering, communications & demand-side options
  - Growing environmental concerns

Microeconomic reform

- *Objective* - to improve economic efficiency
  - Particularly challenging for infrastructure:
    - Potential for natural monopolies in essential goods & services
- *Means* - reduce barriers to competition, eg:
  - Remove monopoly franchises & introduce competition
  - Break-up large state-owned enterprises
  - Privatise state-owned enterprises
  - Improve strategies for industry regulation
- *Assumptions:*
  - Economic efficiency is the key public interest issue
  - Competition is the preferred mechanism

How do governments act on policies?

- "Governments engage in three main activities:
  - they tax
  - they spend and
  - **they regulate**.

  Regulation is the least understood.. but… has a broader and more far-reaching impact on economic growth, development of the rule of law and government effectiveness than do tax and fiscal policies."
  (*Margaret Beardow referencing Scott Jacobs of the OECD*)

The terminology of restructuring

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

A – market reform

Council of Australian Governments
Energy Market Review

- Aust. Competition + Consumer Commission
  "Reforming Australia's Electricity Market" Utility Congress, 2002

B – Deregulation

"The National Electricity Market (NEM) commenced operation on 13 December 1998, as part of the process of **deregulation** of the Australian power industry."

Electricity competition and your business

Deregulation of the energy industry will allow you to choose your electricity and natural gas retailer.

C - Restructuring

- Reform?

  re·form _ P **Pronunciation Key** (r -fôrm)
  v. **re·formed, re·form·ing, re·forms**
  v. tr.

  1.To improve by alteration, correction of error, or removal of defects; put into a better form or condition.

  a.To abolish abuse or malpractice in: *reform the government.*

  b.To put an end to (a wrong). See Synonyms at correct.

  2.To cause (a person) to give up harmful or immoral practices; persuade to adopt a better way of life.

- Deregulation? - Changing role yet certainly still required
- Liberalised? – European terminology
- Privatisation? – not necessarily involved

Key issues in design of fully restructured EI

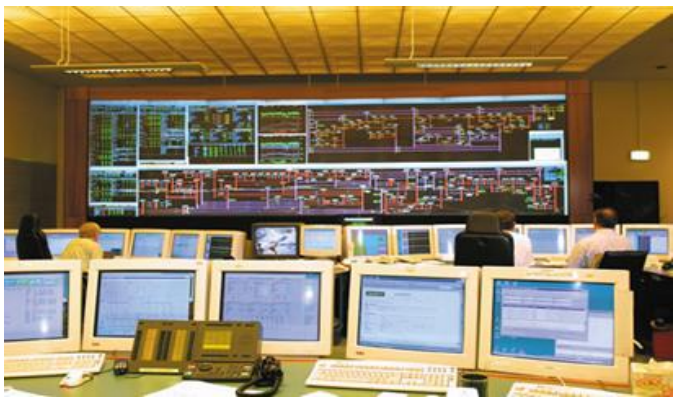
- Fungibility & ephemerality of electrical energy:
  - A *flow* industry with short-term uncertainty in, & shared responsibility for, location-specific availability & quality
- Inherent market incompleteness & inefficiency:
  - Temporal & locational averaging; important externalities
  - Imbalance between large & small participants; gaming
  - Long-term risks due to asset longevity & capital intensity
- Inevitable residual *central decision making* by:
  - System operators, Network Service Providers, Regulators
- Unavoidable interaction between:
  - Cooperative (centralised) decision making and
  - Competitive (decentralised) decision making

The electricity industry restructuring process

Issue	Transition	Key challenges
Industry structure	*From* monopoly *To* competing firms	Cultural change; Adequate competition; *Accountability*
Commercial framework	*From* cost recovery *To* market prices	Market power; Market design fidelity; *Accountability*
Industry regulation	*From* rate of return *To* Incentive Reg'n	Multiple objectives; Measuring outcomes; *Accountability*
Sustainability	*From* direct cost *To* full costs	Variable RE energy flows End-user participation; *Accountability*

There are potentially many markets…

Electricity Spot Market



Derivatives Markets

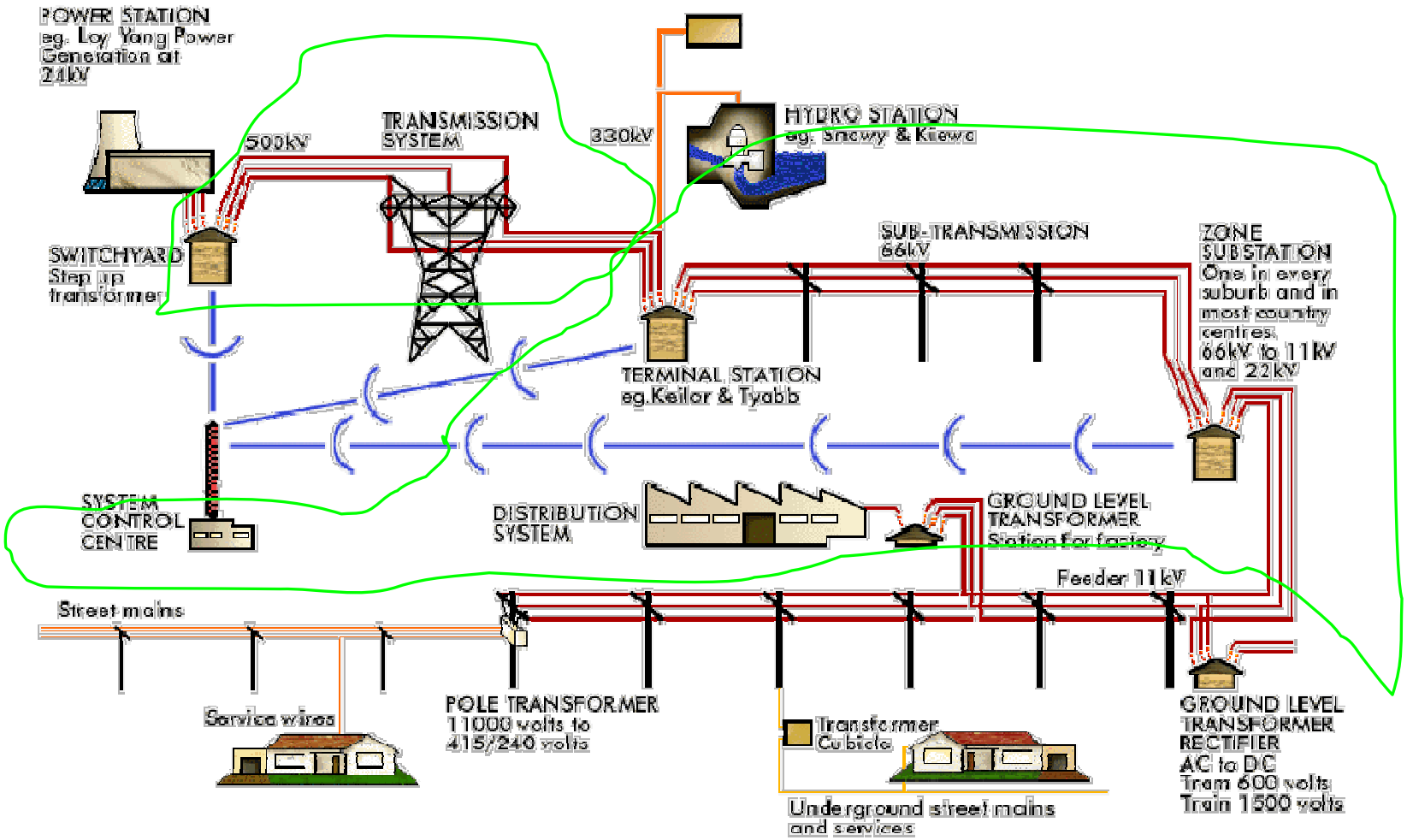
Gas & Other Fuel Markets

Renewable Energy Market

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

Disaggregation of power sectors:
generation, transmission, distribution, and consumption/retail

Power system security procedures, rules and compliances in Code chapter 4

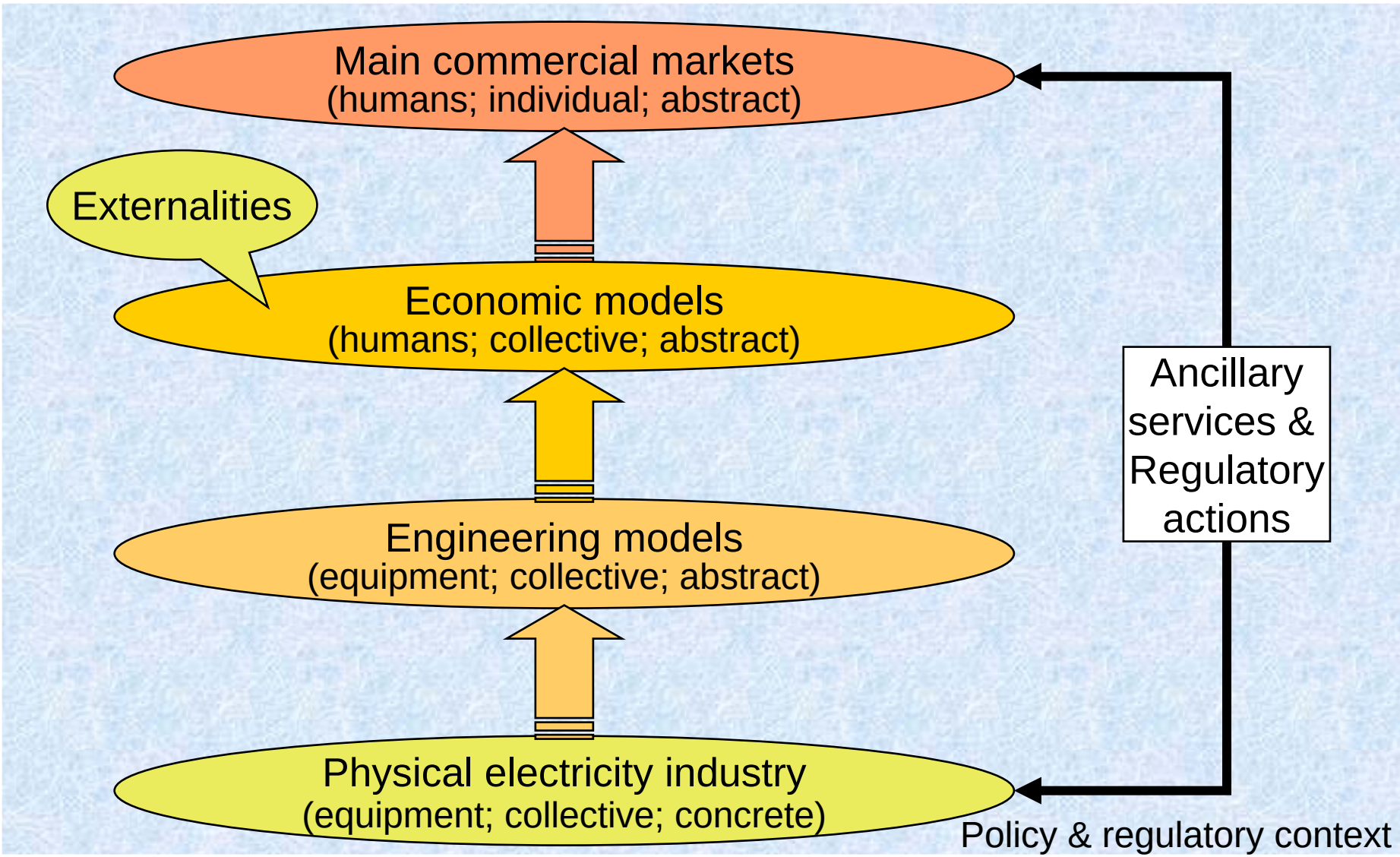


Source: Loy Yang Power Management Ltd: www.loyyangpower.com.au/site/main.html

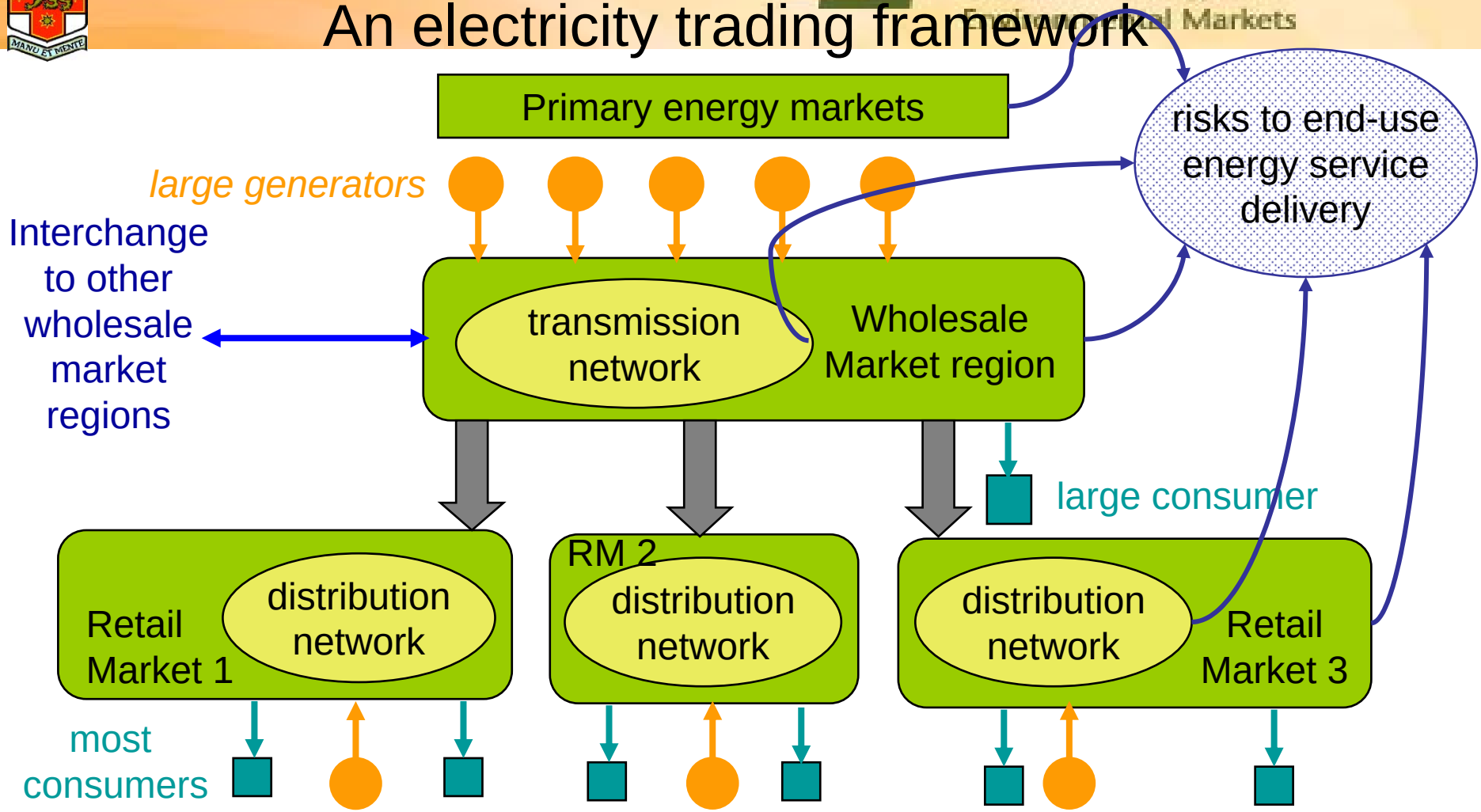
Models of the electricity industry

- Physical reality, e.g. for electricity:
  - Instantaneous voltages, currents & power flows
- Engineering models (a typical example):
  - Balanced 3 phase sinusoidal voltages & currents
- Main commercial models (typical examples):
  - Spot & forward markets; network access regime:
    - *Designed to elicit economically efficient behaviour*
- Ancillary services to manage mismatches:
  - Between main commercial models & physical reality
- Policy & regulatory framework for the industry:
  - Societal objectives & behavioural norms

Trading in electricity: an abstraction from reality



An electricity trading framework



- *Small consumers, embedded generators & storage should be supported by energy service advisers*

- *Wholesale & retail market designs should be compatible*
  - *Both should include network models*

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

Electricity market models

- Gross pool (eg NEM):
  - Temporal & location risk managed collectively:
    - Ancillary services, spot market, PASA, SOO
- Net pool (eg UK NETA):
  - Long term & location risk managed bilaterally
    - Network not modelled in trading arrangements
  - Short-term operational risk managed collectively:
    - System operator given only one day's notice of bilateral trades

Some insights from electricity pricing theory #1: temporal issues in pricing

- A single owner of an electricity industry:
  - Could maximise industry benefits of trade (IBOT):
    - if *all* supply costs *& all demand side benefits* were known
- Optimal prices in a decentralised industry:
  - Those prices that achieve the same IBOT:
    - The incremental cost *or loss of benefit* of delivering an additional unit of energy *at a particular location*
  - Standard SRMC definition if no inter-temporal links
  - Otherwise prices that reflect future decision options:
    - Based on best available model of future price behaviour, *including impacts of a specific decision on future prices*

Some insights from electricity pricing theory #2: spatial issues in pricing

- A single owner of an electricity industry:
  - Could maximise IBOT taking into account:
    - Network losses & flow constraints
    - Security: probability & consequence of outages
- Optimal prices in a decentralised industry:
  - Location-dependent avoidable spot prices:
    - Local supply/demand balance
    - Network arbitrage subject to losses & flow constraints
  - Location-dependent derivative prices reflecting:
    - Plausible future patterns of generation & demand
    - Plausible future network losses & flow constraints
    - Effects of future decision options

Single owner (engineering optimisation problem)

- Given:
  - An inventory of existing & potential future generation, network & demand side electrical equipment:
  - Technical parameters, operating & capital costs, industry benefits, operating constraints
  - Uncertainties in performance, costs & benefits
  - Ability to control all generation, network & end-use equipment
- Calculate a strategy to maximise IBOT:
  - Solve a stochastic non-linear dynamic optimisation problem for operating & investment decisions in generation, network and demand side equipment

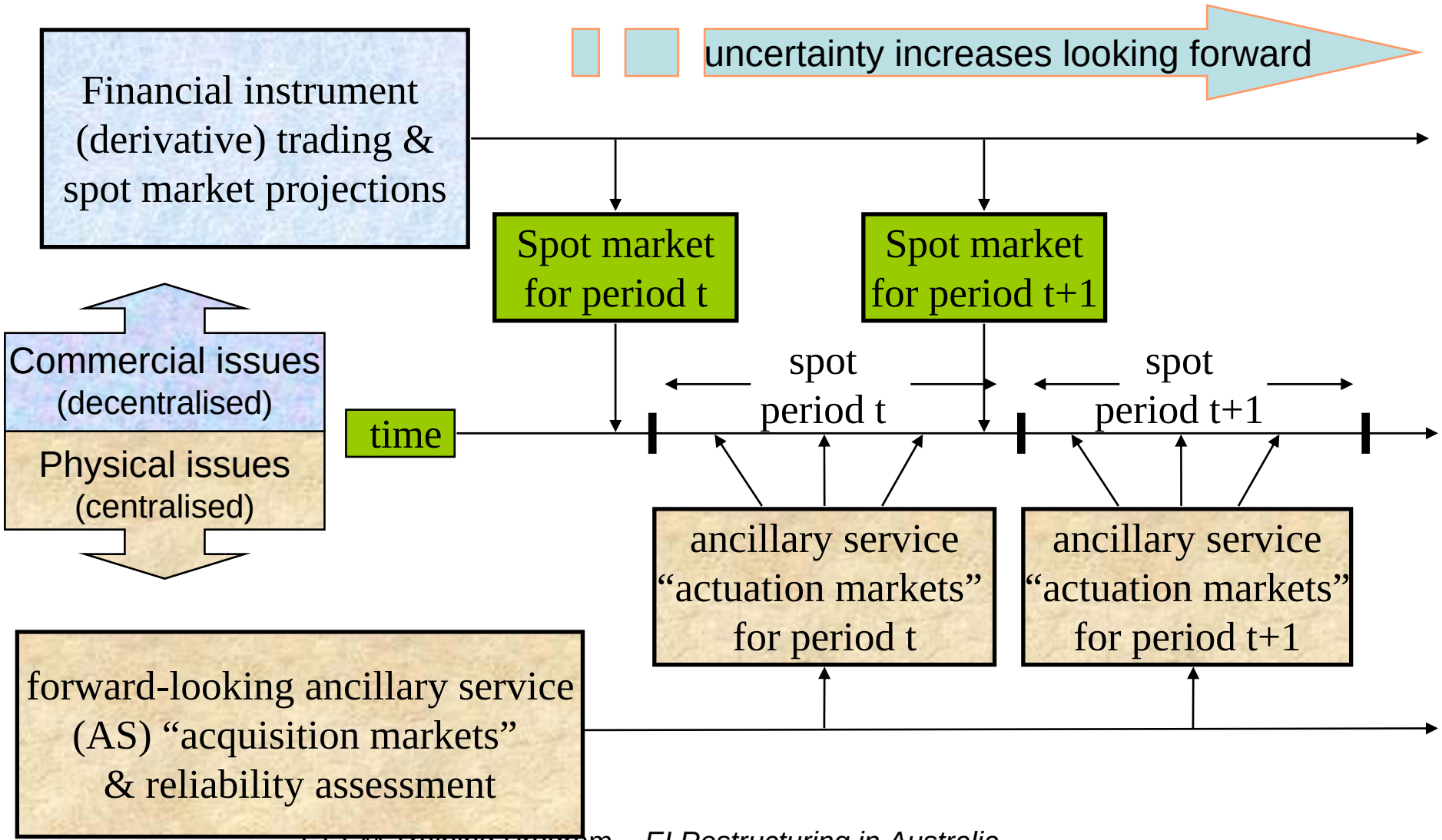
Decentralised industry (economic optimisation problem)

- Locational energy spot market:
  - Energy (that meets QOS criteria) traded at spot price in successive short spot market intervals
- Locational derivative markets:
  - Related to future spot price expectations:
    - Predict aspects of future spot market behaviour
    - Permit reallocation of risks
- Ancillary services:
  - Resources that maintain quality of supply
- Regulatory monitoring of strategic behaviour

Challenges for a restructured industry

- Consistency between centralised & decentralised processes:
  - *Centralised:* most ancillary services; industry operation; industry design & regulation
  - *Decentralised:* some ancillary services; spot & forward markets
- Sound interface between centralised & decentralised processes:
  - Clear accountabilities & “hand-overs”
- Active involvement of informed end-users

Timeline for electricity trading



Uncertainty & risk in electricity trading

Time scale	Issues	Mechanisms
< 30 minutes	• Demand fluctuations • Contingencies	• Ancillary services
30 minutes to several days	• Demand uncertainty • Inter-temporal links, eg • Unit commitment	• Ex-ante spot market • Short term forward market

Weeks to years - *operation*	• Inter-temporal links, eg
	  • Retail tariff setting
	  • Hydro scheduling
		• Long term forward market

Weeks to years Š *investment*	• Optimal investment decisions	• Long term forward market • Policy framework

Ideal spot market trading of electricity

- Specify quality of supply (QOS) criteria:
  - Assume QOS maintained by Ancillary Services
- Use shortest spot market interval consistent with commercial decision making, e.g:
  - Half-hour trading intervals
- Specify locations at which trading occurs:
  - Use multiple locations to partly incorporate network losses & flow constraints
- Active generator & end-user participation:
  - Symmetrical bidding & market clearing price
    - Demand & supply side options fully equivalent

Practical implementation of electricity trading

- Wholesale spot & forward market:
  - Large generators, retailers, large consumers
  - Some representation of networks in markets
- Retail spot & forward market (temporary?):
  - Retailers, consumers, embedded generators
- Ancillary services (wholesale & retail):
  - Hybrid engineering & commercial arrangements
- Residual network services:
  - Regulated access regime, administered network pricing, limited competition in some aspects

Metering and communication

- Metering:
  - Interval metering essential for all participants:
    - Record 30 minute energy, quality & availability
    - Provide data read-out for participant
  - Profiling not an adequate option
- Communication:
  - 30-minute energy prices sent to all participants
  - Feeder power flows monitored continuously
  - Participant 30-minute energy collected at appropriate intervals for billing purposes

Evolution of competition policy in Australia

- Development of COAG process in late 80's
  - Formal interface between federal & state gov'ts may foster rational policy development
- National Competition Policy,1993 Hilmer Report:
  - Facilitate competition where effective & pro-competitive regulation where not
  - Treat public & private firms equally
  - Apply universal & uniform market rules of conduct
    - Specific codes only if shown to be in the public interest
  - Develop access regimes for essential facilities

Evolution of competition policy in Australia: Competition Reform Act, 1995

- Amended Trade Practices Act, encompassed Prices Surveillance Act
- Established Australian Competition & Consumer Commission (ACCC):
  - Neutral, economy-wide, open process
  - Decisions may be appealed to Aust.Comp'n Tribunal
- Implements the principles of competition policy
- Assumes public interest is in economic efficiency subject to other specified social objectives

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

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

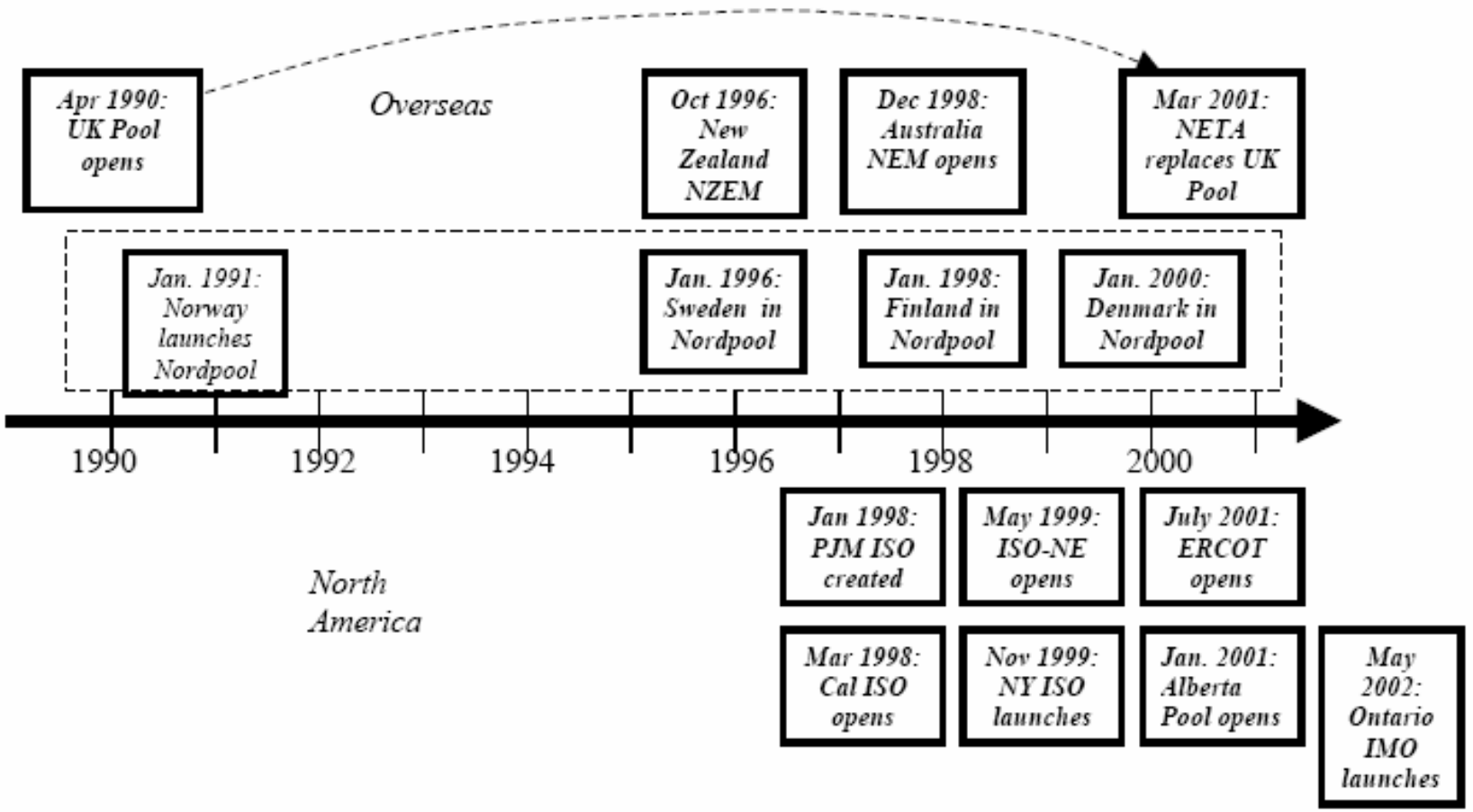
May 4, 1997, NEM stage 1, NSW, VIC, ACT, SA

Dec 13, 1998, NEM commenced operation

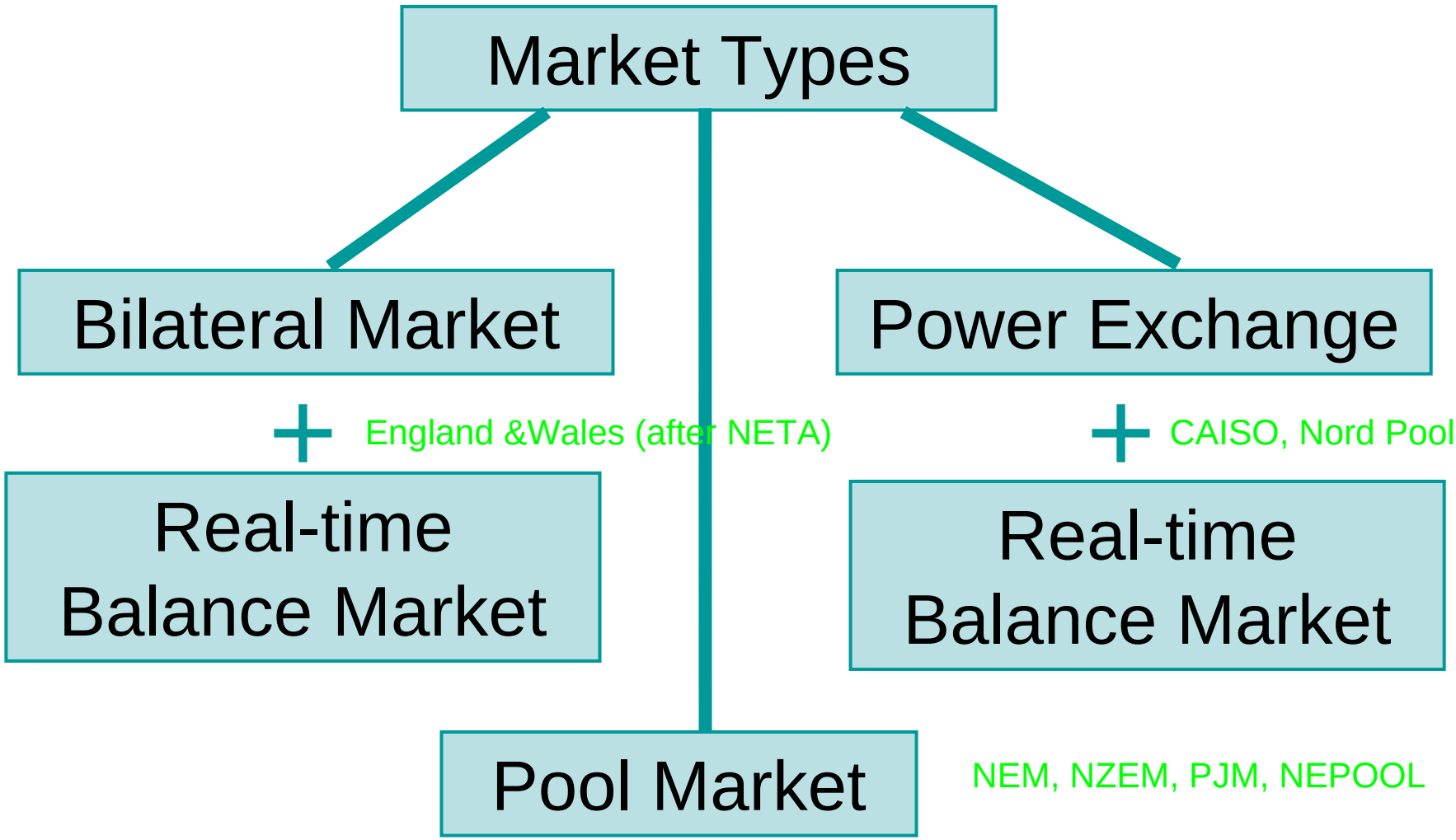
Jan 18, 1998, QLD connected to NEM1

Some international restructuring efforts

(Public Utilities Commission of Texas, *Comparison of Market Designs*, 2004)

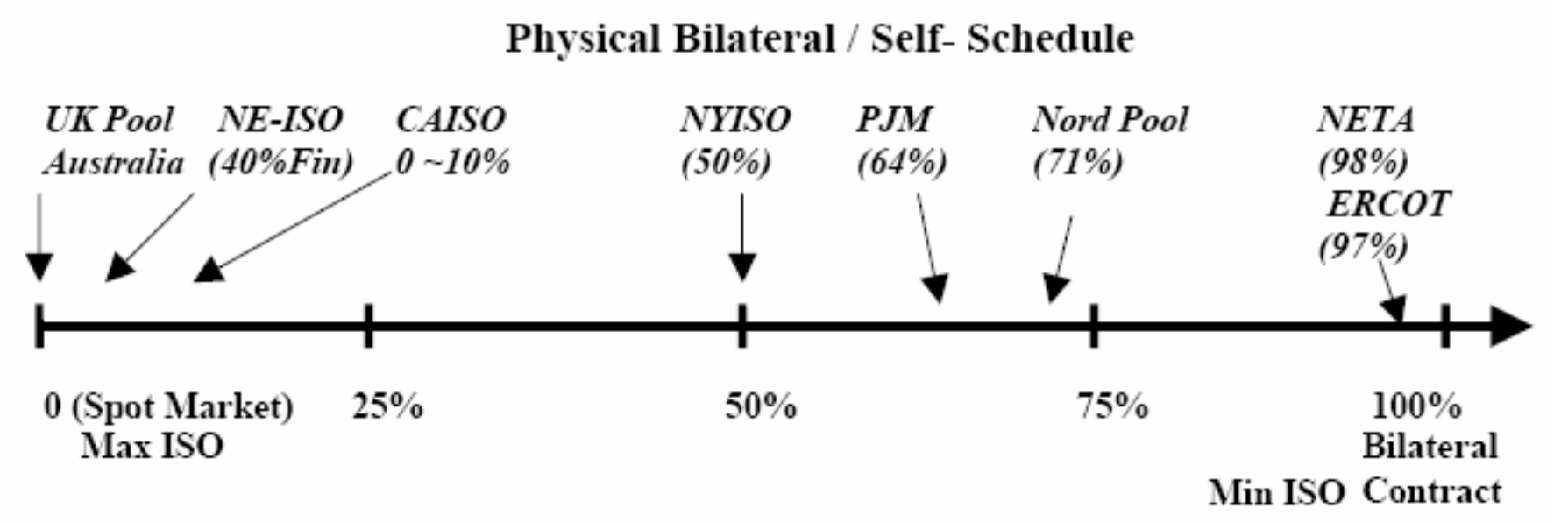


Some different market approaches



The role of bilateral trading is a key difference

(Public Utilities Commission of Texas, *Comparison of Market Designs*, 2004)

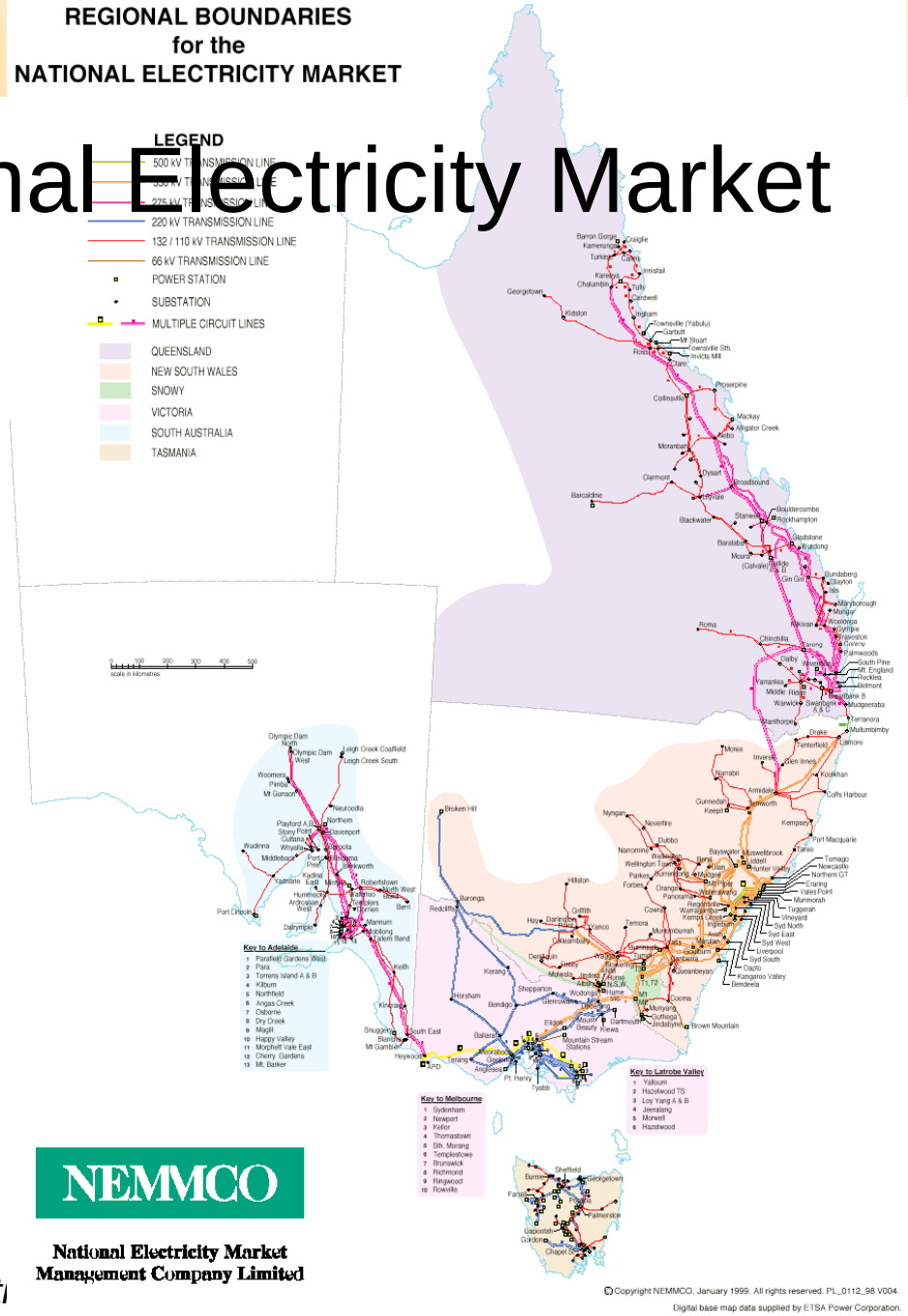


Structure & ownership issues

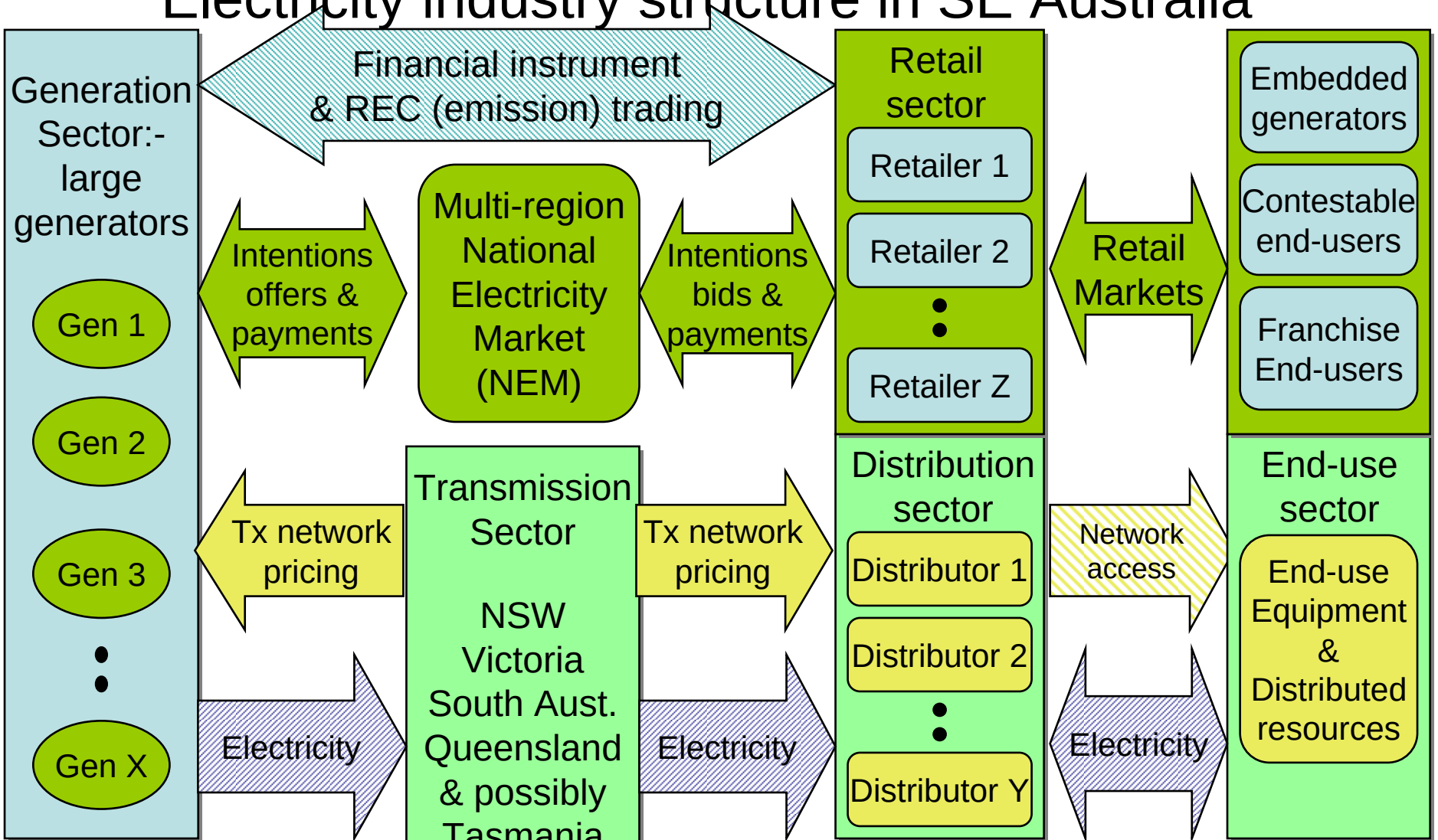
- Structure:
  - All stages in energy conversion chain matter:
    - Primary energy, generation, network services, end-use
    - Shared accountability for continuous energy flow
  - Retailers play an ambiguous role:
    - Don’t participate in energy conversion chain - may be redundant
  - Will number + structure of participants drive competition
- Ownership:
  - Public owners can in principle consider many issues in assessing the public good:
    - But subject to capture by interest groups
  - Private owners focus on shareholder outcomes
    - The public good may not be achieved

The Australian National Electricity Market

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



Electricity industry structure in SE Australia



Market regulation in Australian EI

- Federal regulation
  - General market regulation wrt electricity as market commodity and networks as monopoly assets
    => TPA administered by ACCC – authorises NEC, access undertakings, regulation of transmission (eventually), abuse of market power
  - NEM regulation set out in NEC –administered by NECA
  - NEM operation administered by NEMMCO
  - National Electricity Tribunal, ASIC roles
- State regulation
  - Retail electricity markets
  - Distribution Network Service Providers
  - NECA and NEMMCO influence (via States membership)

Assessing restructuring

- Economic
  - Efficiency
  - Effective competition
- Security
  - Timely + adequate investment
  - Appropriate choices for the longer term
- Societal
  - Provision of this essential public good
  - Reduced environmental impacts

An assessment of progress to date

- Too soon to draw definitive conclusions + continuing restructuring + reform efforts underway…

- Some success, however also notable failures to date
  - Price spikes
  - Security
  - Environmental impacts

Some price crises

(IEA, 2002)

Table 7

Markets Experiencing Electricity "Price Crises"

Juris-diction	Cause of Price Crisis	Duration	Government Response	Outcomes
Canada (Alberta)	High fuel prices, high electricity prices in neighbouring markets.	1/2001 – 3/2001	High retail price cap, rebates.	Market prices much lower than cap. New capacity entering market.
New Zealand	Tight energy supply due to low rainfall and concerns about availability of thermal fuels.	4/2001 – 7/2001	Government campaign for electricity savings.	6-10% savings in demand. Steps to improve market transparency, demand response and financial markets.
Australia (South Australia)	Tight capacity due to rapid growth.	1/2002 – 3/2002	Let market respond (but delayed retail liberalisation).	New capacity appeared quickly in response to high prices.
Nord Pool (Norway)	Tight energy supply due to low rainfall/cold winter.	12/2002 – 3/2003	Let market respond.	Large imports, significant demand response.
Canada (Ontario)	Demand growth, delay in capacity investment.	7/2002 – 7/2003	Low retail price cap, rebates. Government investment in peaking plant.	Wholesale prices high, no new private investment announced.
New Zealand	Tight energy supply due to low rainfall and concerns about availa-bility of thermal fuels.	4/2003 – 6/2003	Demand reduction, commission to acquire generating capacity for dry years.	Crisis averted through savings and increased rainfall.

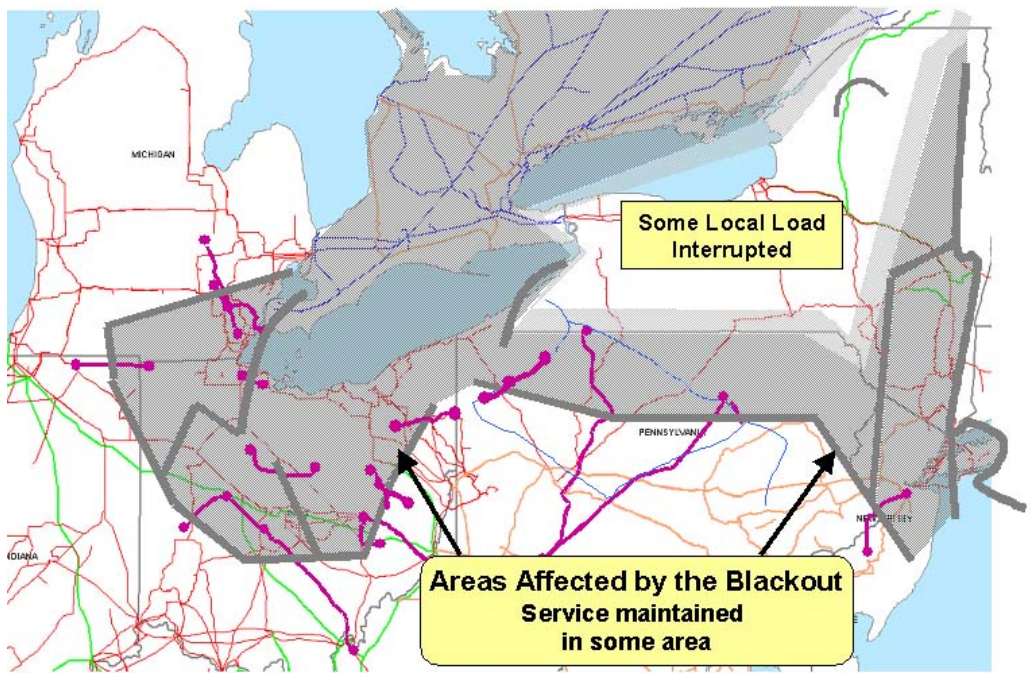
Some blackouts

- The North America Blackout of 14/8/03 (www.spectrum.ieee.org/webonly/special/aug03/black.html)
  - DOE studies had predicted trouble since ‘98:
    - Inadequate regional oversight & control
  - Operators unable to stop problem escalating :
    - Midwest ISO had less authority than PJM & New England counterparts
    - Human errors & loss of institutional capacity

North American blackout - affected areas

(T Mount, Cornell University, 2004)

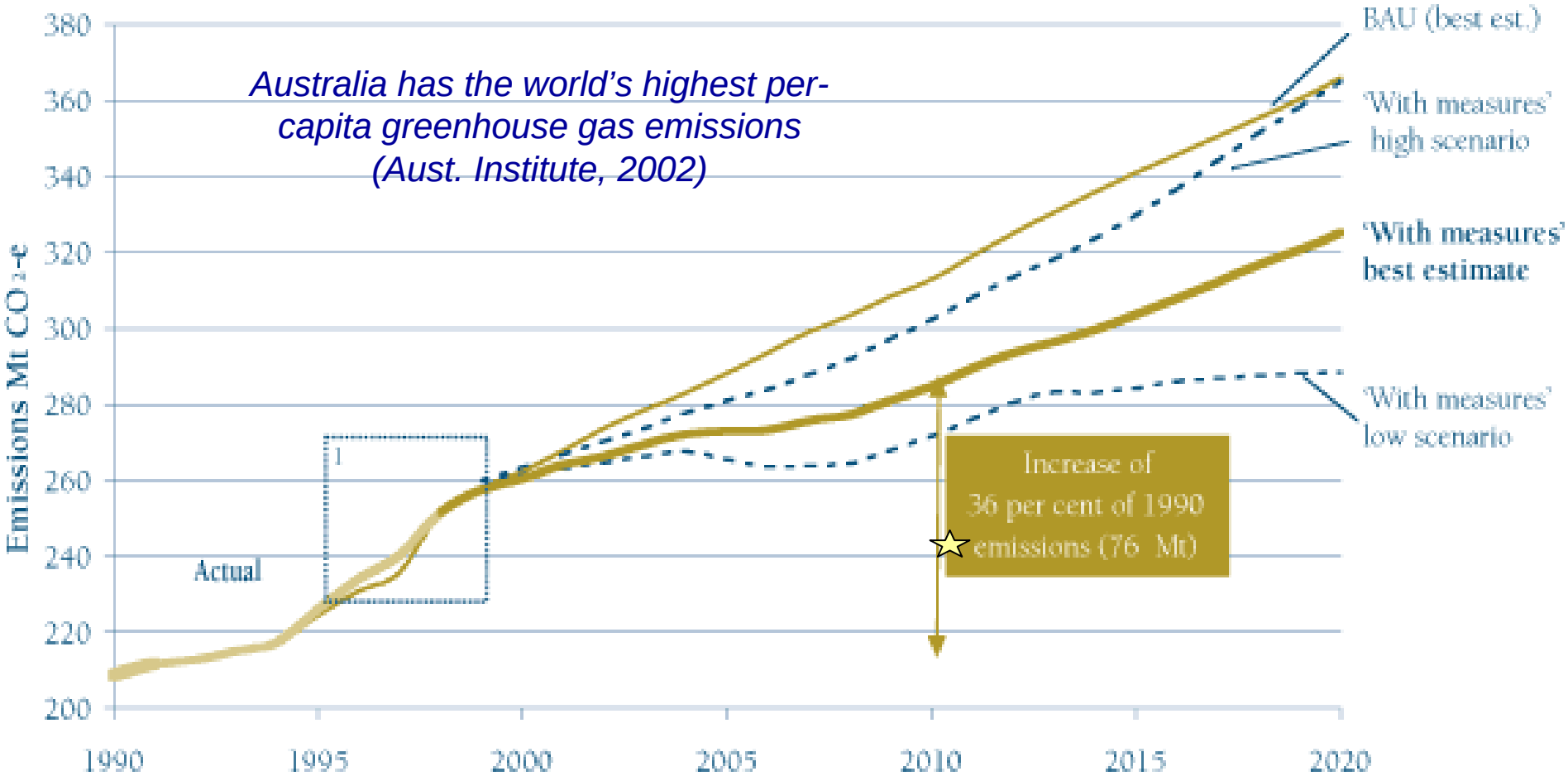
When the cascade was over at 4:13pm, over 50 million people in the northeastern USA and the province of Ontario had no power.



Some looming environmental concerns

Projected emissions from Aust. Stationary Energy sector, 1990-2020

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



Source: Australian Greenhouse Office (2002)

Conclusions on electricity industry restructuring

- A “designer” process:
  - Industry-specific laws, codes, markets
  - A “social experiment” with risks & ethical issues
- Mix of technical, economic & policy issues:
  - Physical behaviour continuous & cooperative
  - Commercial behaviour individual & competitive
- Restructuring is still a learning situation:
  - No complete successes, some disastrous failures, difficult to return to monopoly industry
  - Must solve commercial, technical & institutional challenges (each aspect must function well)

To find out more…

Relevant UNSW Work

- Incorporating network effects in a competitive electricity industry, in *Electricity Pricing and Technology,* 1996.
- Observations on the Workshop for Markets in Electricity - Economics and Technology, Stanford University, August 2000
- The design of efficient markets for ancillary services, Proceedings of the 34th Hawaii International Conference on Systems Sciences, Maui, 3-6 January 2001.
- A services model of the electricity industry with particular attention to network services, 2002
- The evolving National Electricity Market - an Assessment, in *Power Progress: An Audit of Australia's Electricity Reform Experiment,* 2004.
- *Wind energy and the National Electricity Market with particular reference to South Australia,* Australian Greenhouse Office, 2003
- *National Wind Power Study,* Australian Greenhouse Office, 2003

- See www.ceem.unsw.edu.au and www.ergo.ee.unsw.edu.au for papers and presentations

Australian Govt. & NEM web sites

- Australian Competition and Consumer Commission (ACCC): http://www.accc.gov.au/
- National Electricity Code Administrator (NECA): http://www.neca.com.au/
- National Electricity Market Management Company (NEMMCO): http://www.nemmco.com.au/
- Department of Industry, Tourism & Resources: http://www.ditr.gov.au/
- Australian Greenhouse Office (AGO): http://www.greenhouse.gov.au/
- COAG energy market reform process: http://www.mce.gov.au/

State-based regulators

- Independent Pricing and Regulatory Tribunal of NSW (IPART): http://www.ipart.nsw.gov.au/
- Essential Services Commission, Victoria: http://www.esc.vic.gov.au/
- Queensland Competition Authority: http://www.qca.org.au/
- Essential Services Commission of South Australia: http://www.escosa.sa.gov.au/
- Office of the Tasmanian Energy Regulator: http://www.energyregulator.tas.gov.au/
- Office of Energy, Western Australia: http://www.energy.wa.gov.au/
- Northern Territory Utilities Commission: http://www.nt.gov.au/oiuc/

Other relevant Australian sites #1

- Department of Energy, Utilities & Sustainability, NSW: http://www.deus.nsw.gov.au/
- Energy & Water Industry Ombudsman NSW: http://www.eionsw.com.au/
- Environment Protection Authority of NSW: http://www.epa.nsw.gov.au/
- Sustainable Energy Development Authority of NSW: http://www.seda.nsw.gov.au/
- NSW Market Implementation Group: http://www.treasury.nsw.gov.au/mig.htm/
- Victorian Government Treasury: http://www.vic.gov.au/treasury/html/
- Sustainable Energy Authority of Victoria: http://www.seav.vic.gov.au/

Other relevant Australian sites #2

- Energy Supply Association of Australia: http://www.esaa.com.au/
  - With links to member sites
- Australian Natural Gas Industry: http://www.gas.asn.au/
  - With links to member sites
- Sustainable Energy Business Council of Australia: http://www.bcse.org.au/
- Sydney Futures Exchange: http://www.sfe.com.au/
- Transgrid: http://www.tg.nsw.gov.au/
- Transenergie Australia (DirectLink, MurrayLink): http://www.transenergie.com.au/

International web sites

- US Federal Energy Regulatory Commission: http://www.ferc.fed.us/
- North American Reliability Council: www.nerc.com
- California Public Utilities Commission: http://www.cpuc.ca.gov/
- PJM Electricity Pool: http://www.pjm.com/
- European electricity industry: http://unipede.eurelec.org
- UK Office of Gas & Electricity Markets: http://www.ofgem.gov.uk/ofgem/
- New Zealand Electricity industry Inquiry (2000): http://www.electricityinquiry.gov.nz/
- Intergovernmental Panel on Climate Change (IPCC): http://www.ipcc.ch/