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Electricity Industry Restructuring concepts & their implementation

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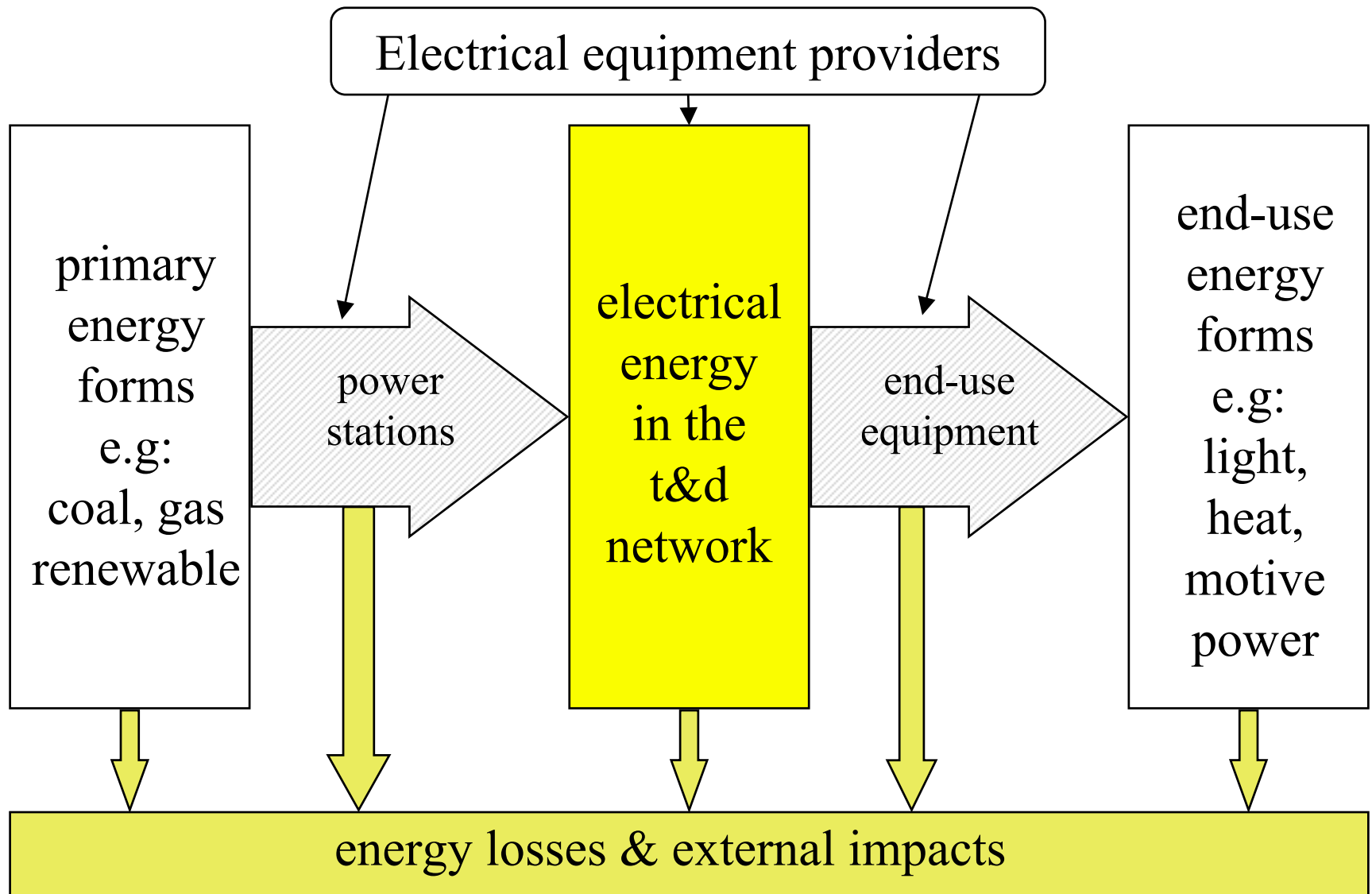
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Outline

- Characteristics of the electricity industry
- Objectives for electricity industry restructuring
- Principles of electricity industry restructuring
- Implementation of electricity industry restructuring
- Summary & conclusions

The electricity industry conversion chain

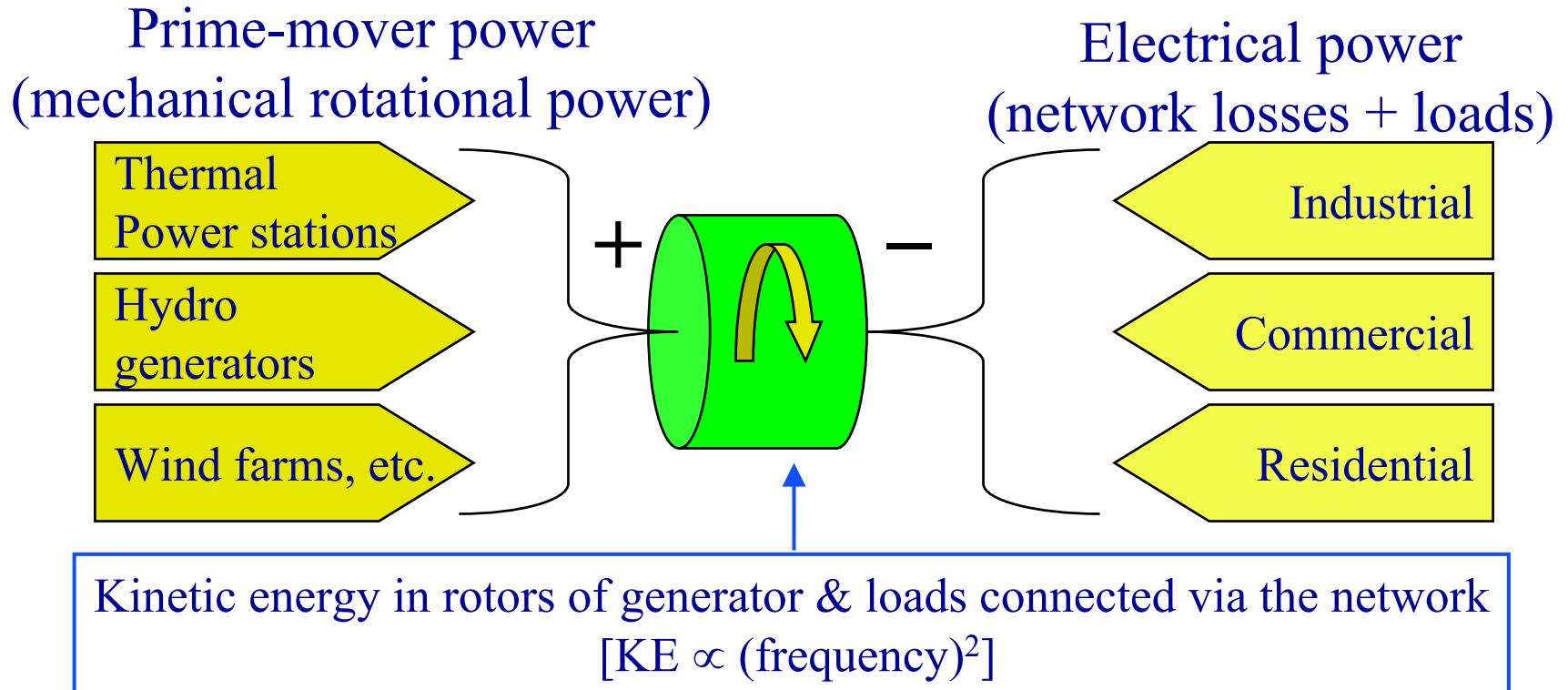


Key issues for the electricity industry

- 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 easy & cheap to use
 - Specific physical properties

- Specific properties of electrical energy:
 - No cost-effective storage of electrical energy
 - Instantaneous flow of energy from all generators to all end-use equipment via network:
 - Network & end-use equipment determine generator power output
- Implications:
 - Supply & demand must balance at all times:
 - Active demand-side participation important
 - Electrical continuum - all power stations to all end-uses
 - Cannot send energy from specific power station to specific consumer: a 'pool' rather than a 'bilateral' physical process
 - *No clear separation between:*
 - *Generation, network & end-use services*
 - *Wholesale and retail markets*
 - *Competitive generation & retail, & regulated network services*

Supply-demand balance in the electricity industry



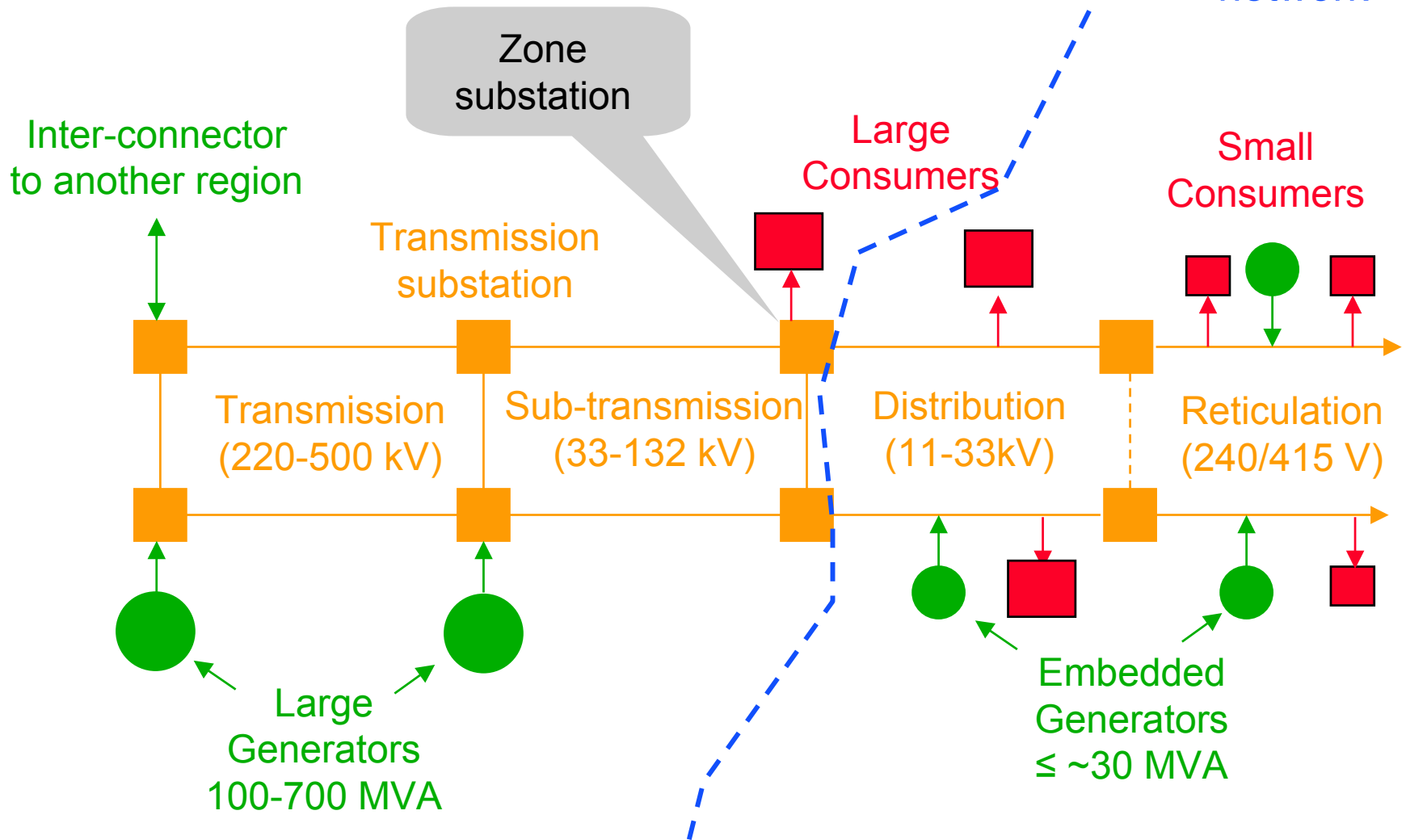
- Frequency is a measure of supply-demand balance:
 - Rate of change of KE = mechanical power - electrical power (loads & losses)
- Power flows & network availability are stochastic processes:
 - Frequency is always varying

A regional electricity network

(frequency is uniform but voltage is location-specific)

Meshed transmission network

Radial distribution network



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 (efficiency; flexibility)

Objectives for industry restructuring

- Improve economic efficiency by introducing competition & facilitating new entry, which assumes:
 - Effective markets & sound legal environment
- Enhance accountability to end-users & society through 'customer choice', which 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 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; appropriate investment
 - Environmental impacts, social expectations, etc.
 - *Arguably the most important for electricity restructuring*

Comparison of 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:
 - Consumer can't choose a power station
 - Power station can't control quality of delivered energy
- Location matters because of network losses & constraints

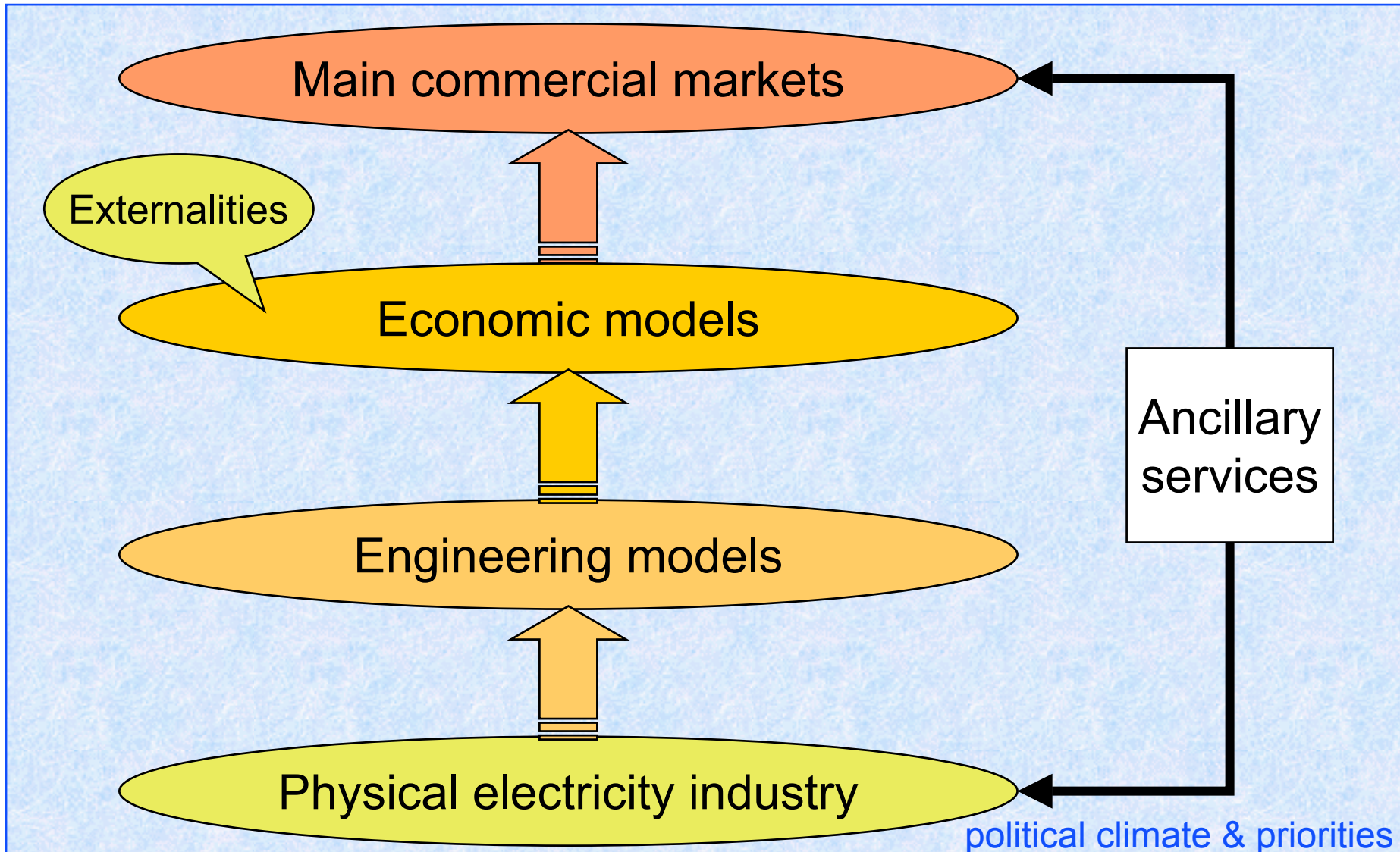
Bilateral trade does NOT work well:

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

Models of the electricity industry

- Physical reality, e.g. for electricity:
 - Instantaneous voltages, currents & power flows
- Engineering models (an electrical example):
 - Balanced 3 phase sinusoidal voltages & currents
- Main commercial models (typical examples):
 - Wholesale & retail 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:
 - Sets & implements societal objectives

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



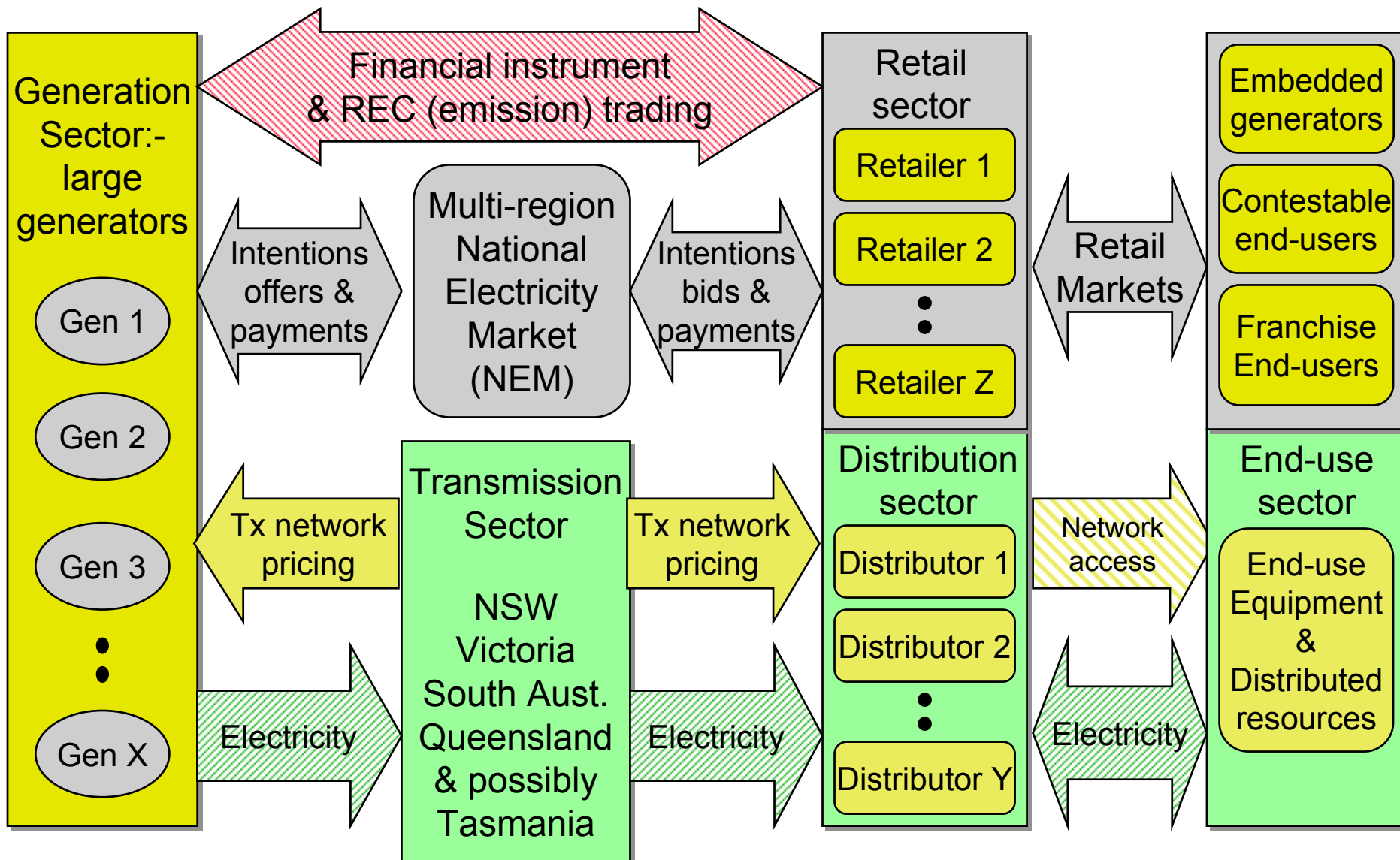
A model of electricity trading

- Spot market energy traded as a commodity:
 - Energy (that meets QOS criteria) traded during each (short) spot market interval
- Financial instruments (derivatives):
 - Related to future spot market prices:
 - Convey expectations of future spot market behaviour
 - Allow risk management
- Ancillary services:
 - To manage availability & quality of supply

Managing quality of supply

- ‘Quality of Supply’ (QOS) attributes:
 - Voltage, frequency, waveform purity, phase balance, supply availability *at each node*
- Managed by:
 - ‘Ancillary services’ (AS) in the short term:
 - Appropriate resources under automatic control
 - Projections of future supply-demand balance
 - Investments in new resources as required
- Via appropriate commercial arrangements

Electricity industry structure in SE Australia



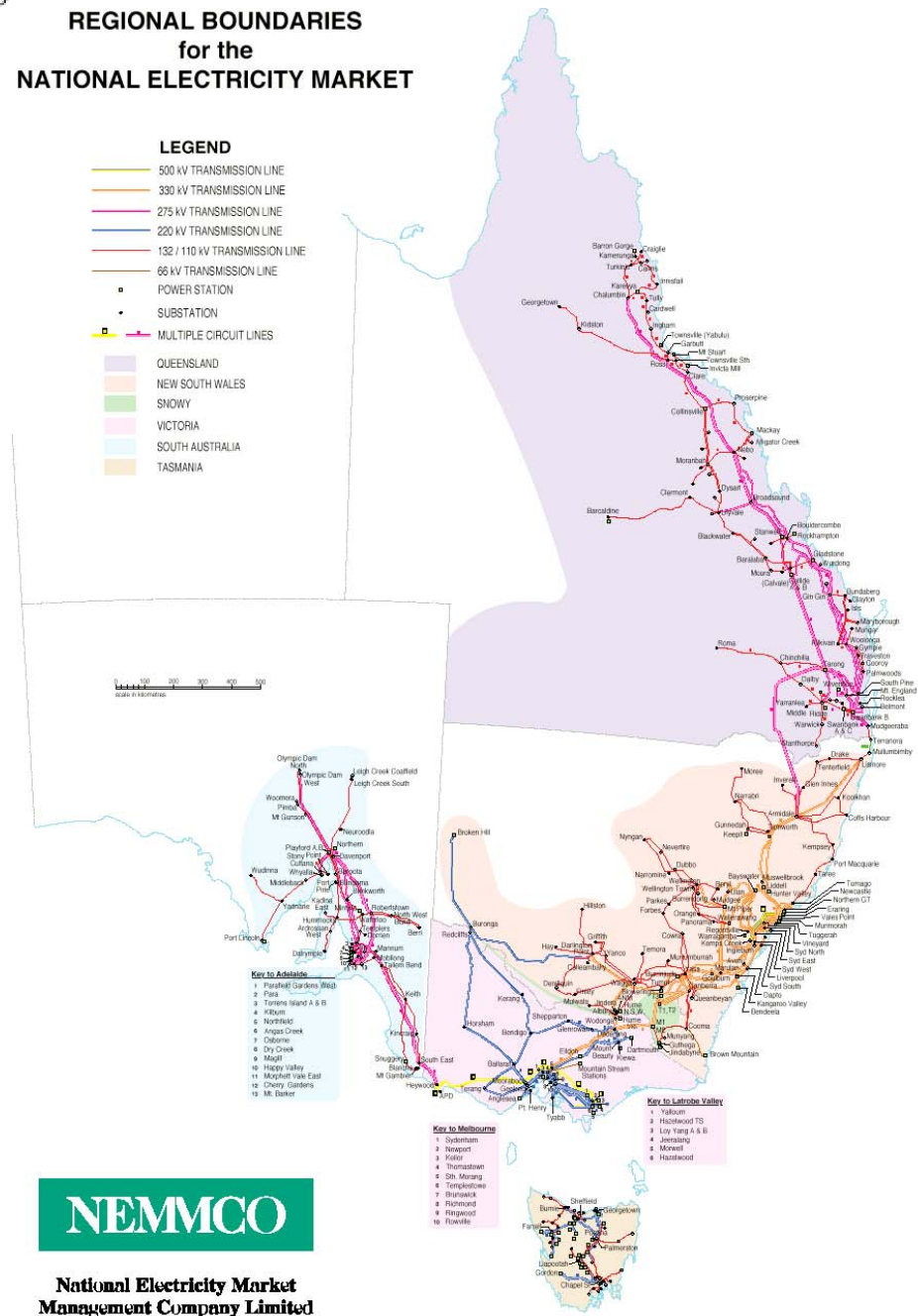
REGIONAL BOUNDARIES for the NATIONAL ELECTRICITY MARKET

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 are not always on state borders (e.g. two regions in NSW)

For efficiency reasons, retail markets should have the same boundaries

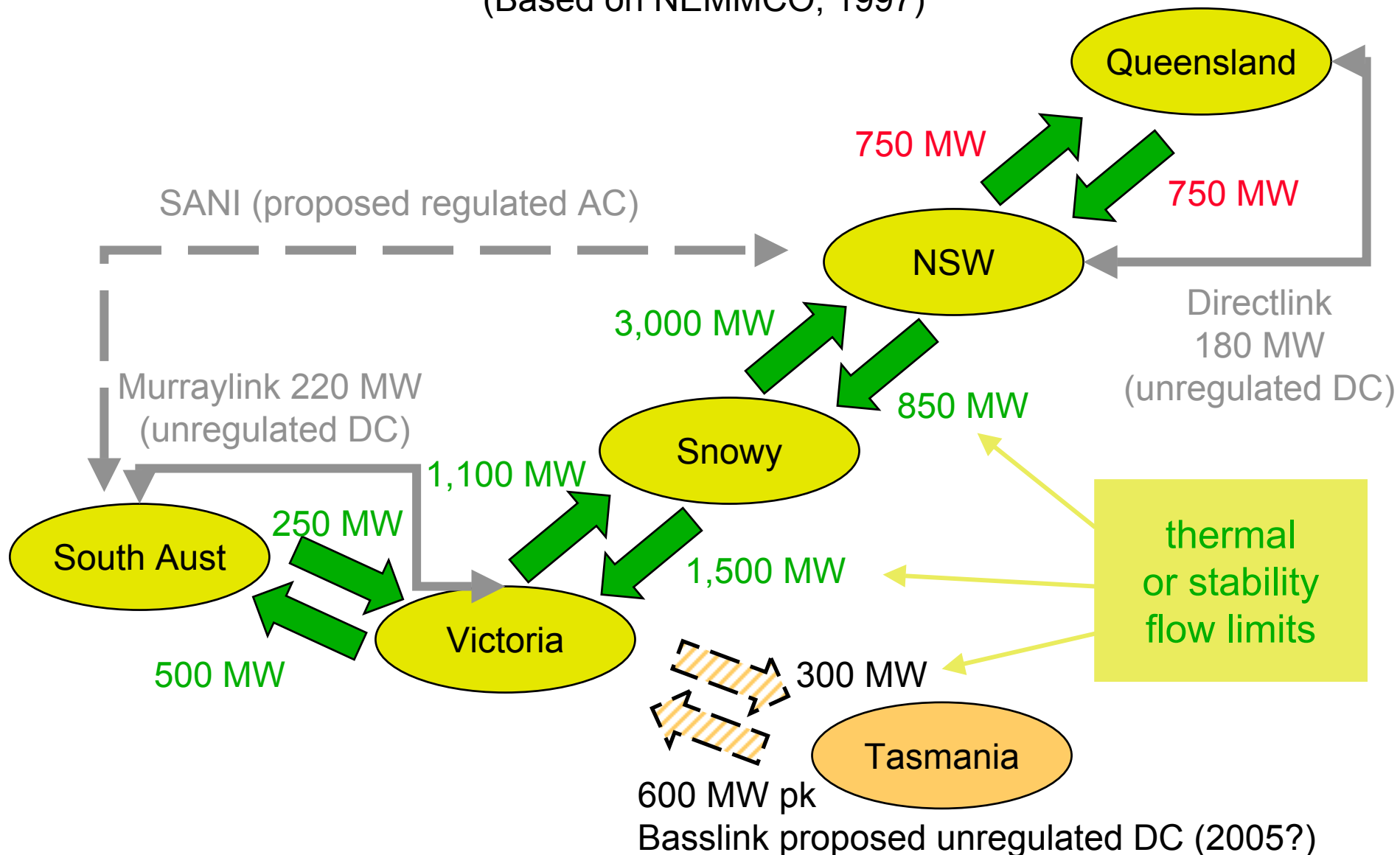


Region boundaries & inter-connectors

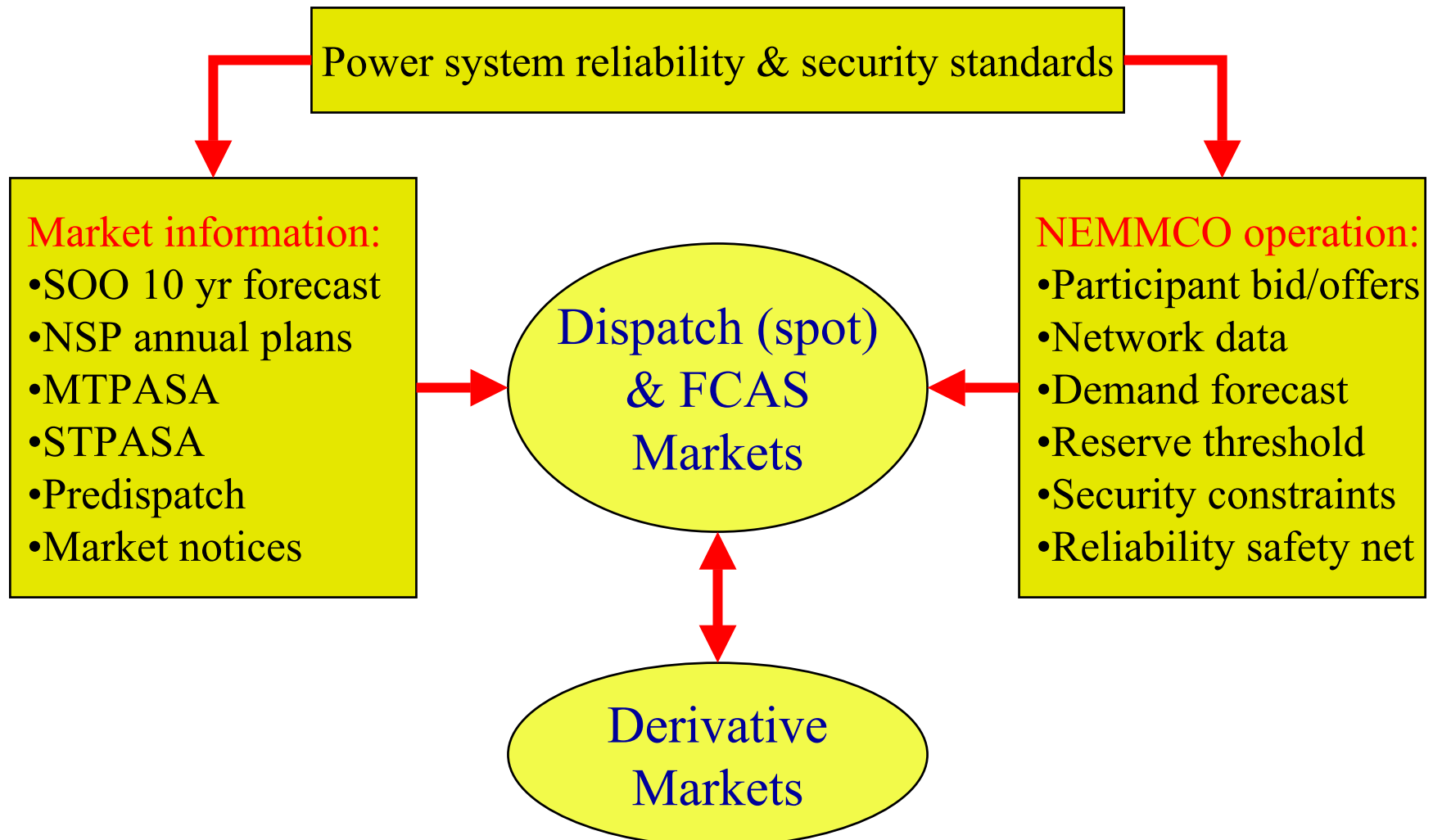
- Regions boundaries selected so that:
 - Transmission constraints are rare within a region
 - Frequently-occurring constraints are placed on region boundaries
- Region boundaries to be reset as required:
 - Whenever a constraint occurs > 50 hours/year
- An unregulated inter-connector is allowed if:
 - dispatchable so that it can bid like a generator:
 - ‘Directlink’ the first (operating since July 2000):
 - 180 MW DC link between NSW & Queensland regions

NEM regional spot market model

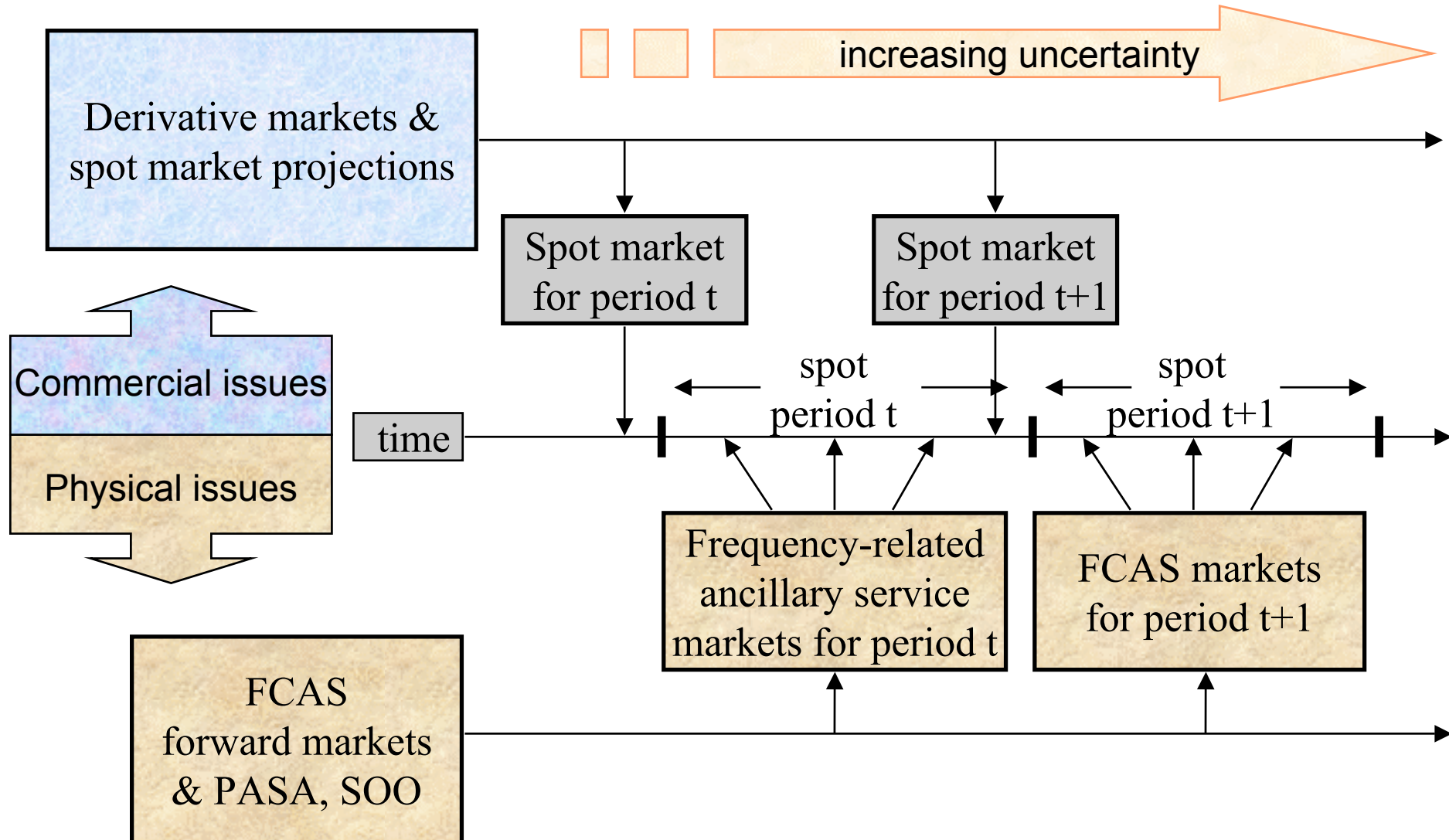
(Based on NEMMCO, 1997)



NEM processes for managing supply-demand balance

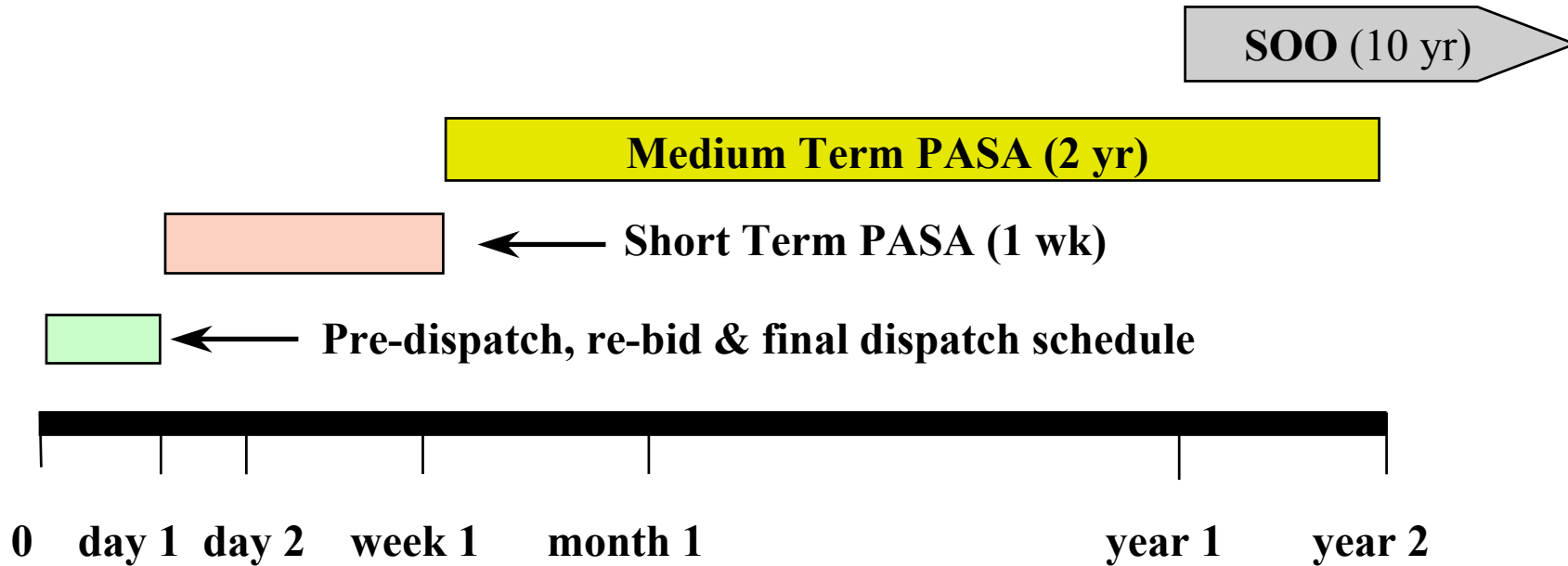


Managing supply-demand balance in NEM



Dispatch, Pre-dispatch, PASA & SOO

(source: NEMMCO)



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

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

(source: NEMMCO)



Financial instrument (derivative) trading in support of NEM

- Trading in swap & cap contracts:
 - Bilateral trading
 - Over-the-counter instruments
 - Exchange-traded CFDs (swaps)
- Inter-regional hedges:
 - Specialised form of financial instrument:
 - to manage regional price difference risks
 - funded by interconnector settlement residues
 - NEMMCO inter-regional settlement residue auctions:
 - Commenced in 1999

Key derivative markets

- Forward contracts (futures)
 - Expected spot price for a defined load shape & period (eg flat annual demand)
 - Either OTC or exchange traded
- Call options
- Renewable energy certificates
 - Available to qualifying generators
 - Increasing to 9,500 GWH pa at 2010 then constant to 2020 (*under review*)

Practical implementation of electricity trading

- Wholesale spot & forward market:
 - Large generators, retailers, large consumers
 - Some representation of networks in markets
- Consistent retail spot & forward market:
 - Retailers, consumers, embedded generators
- Ancillary services (wholesale & retail):
 - Hybrid engineering & commercial arrangements
- Network services not represented in market:
 - Regulated access regime, administered network pricing, limited competition in some aspects

Metering and communication

- Metering:
 - Interval metering desirable for all participants:
 - Record 30 minute energy, quality & availability
 - Provide data read-out for participant
 - Profiling not an adequate option
- Communication:
 - Broadcast 30 minute energy prices to all participants
 - Read metering data at appropriate intervals

Legal & regulatory basis for the restructured electricity industry

Trade Practices Act & other federal legislation

National Electricity Law

National Electricity Code

National Electricity Market
Design & Regulation

Jurisdiction-specific laws

Retail Electricity Market
Design & Regulation

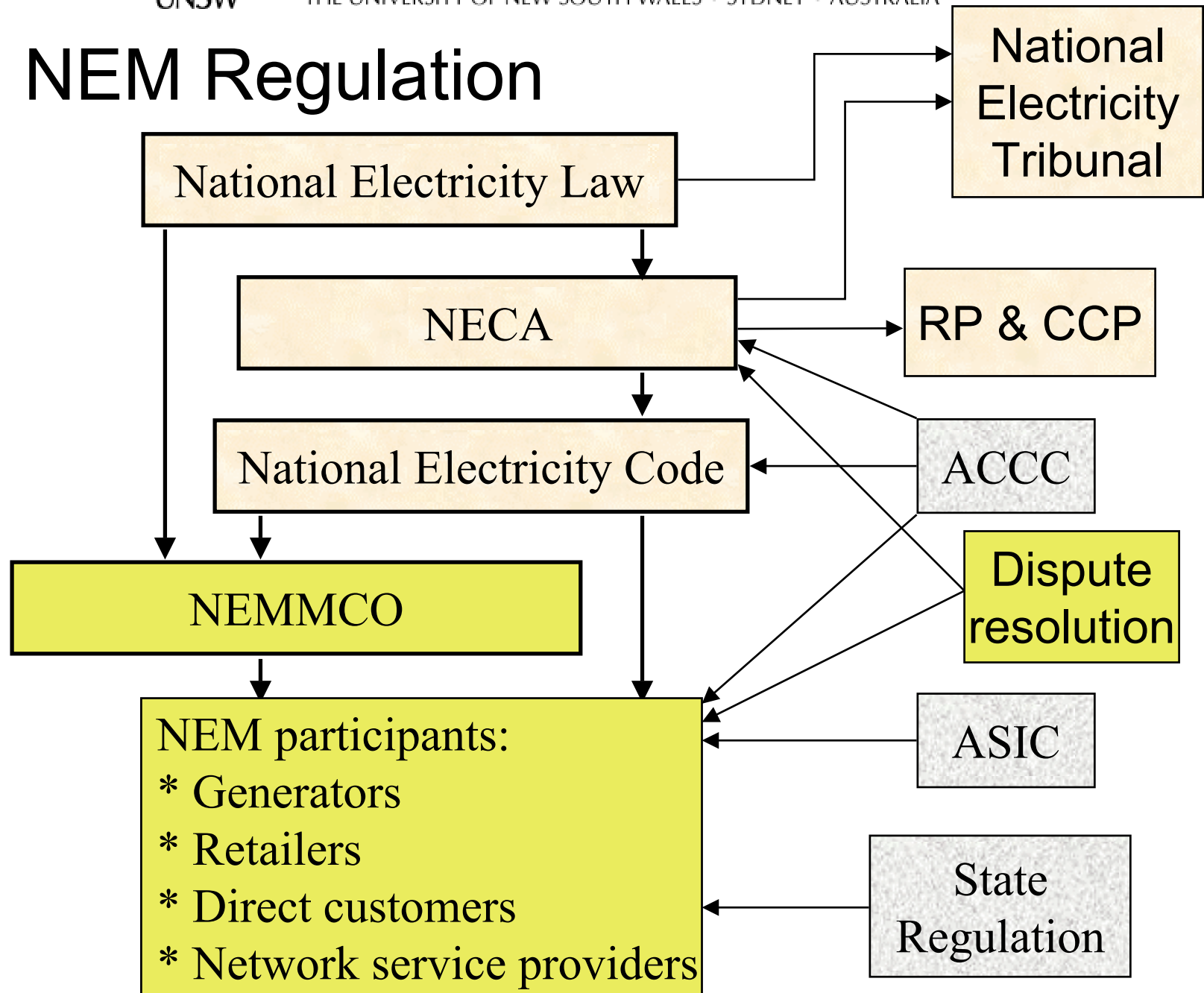
Network Technical Regulation

Network
Economic Regulation

Supply Authority
Restructuring

Environmental
externalities

NEM Regulation



COAG Response to Parer Review

(Ministerial Council on Energy Communique, 1/8/03)

- Recommends the establishment of:
 - A single energy market governance body
 - A new national legislative framework
 - Two new statutory commissions from 1/7/04:
(electricity (& later gas) wholesale market & transmission)
 - Australian Energy Market Commission (AEMC):
 - Rule making & market development, replacing NECA
 - Australian Energy Regulator (AER)
 - Wholesale market & transmission regulation &
possibly distribution & retail; partly taking over ACCC role
- Undertake comprehensive transmission review & consider national planning function

COAG Response to Parer Review, ctd

(Ministerial Council on Energy Communique, 1/8/03)

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


Ministerial Council on Energy program summary (12/03)

Denotes stakeholder consultation

MCE denotes MCE decision point

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

Ministerial Council on Energy program summary (12/03)

Projects	Q4/03	Q1/04	Q2/04	Q3/04	Q4/04	2005
3. Electricity Transmission [Qld]						
<i>Transmission Regulatory Reform</i> 	MCE endorse policy framework	Commission study on regional boundaries. Commence agreed code changes	MCE consider boundary report. Remove market biases	Implement new regulatory test and transmission availability incentives	Implement new transmission pricing	
<i>National Transmission Planning</i>	NEMMCO commence scoping ANTS.	MCE finalise new planning process	First ANTS produced	Implement last resort power		
4. User Participation [Tas]						
<ul style="list-style-type: none"> ○ Demand side response ○ Interval metering ○ Full Retail Contestability 	SCO develop issues paper	SCO prepare draft report	MCE approve user policy	Implementation commences		
5. Gas Market Development [NT]						
<i>MCMPR Upstream Issues</i>	Advice requested from MCMPR	MCMPR review unproduced areas for 3 rd party access		MCE respond to MCMPR review		
<i>PC Gas Access Review</i>	PC issue draft report		PC issue final report	SCO draft response to report	MCE respond to PC review	
6. Program Coordination [C'wlth]						
<i>Market Consultation</i>	MCE endorse consultation plan	Market consultation (as above)	Consultation continues, as appropriate			

Denotes stakeholder consultation

MCE denotes MCE decision point

Conclusions

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