CEEM Specialised Training Program
EI Restructuring in Australia

Design of the NEM

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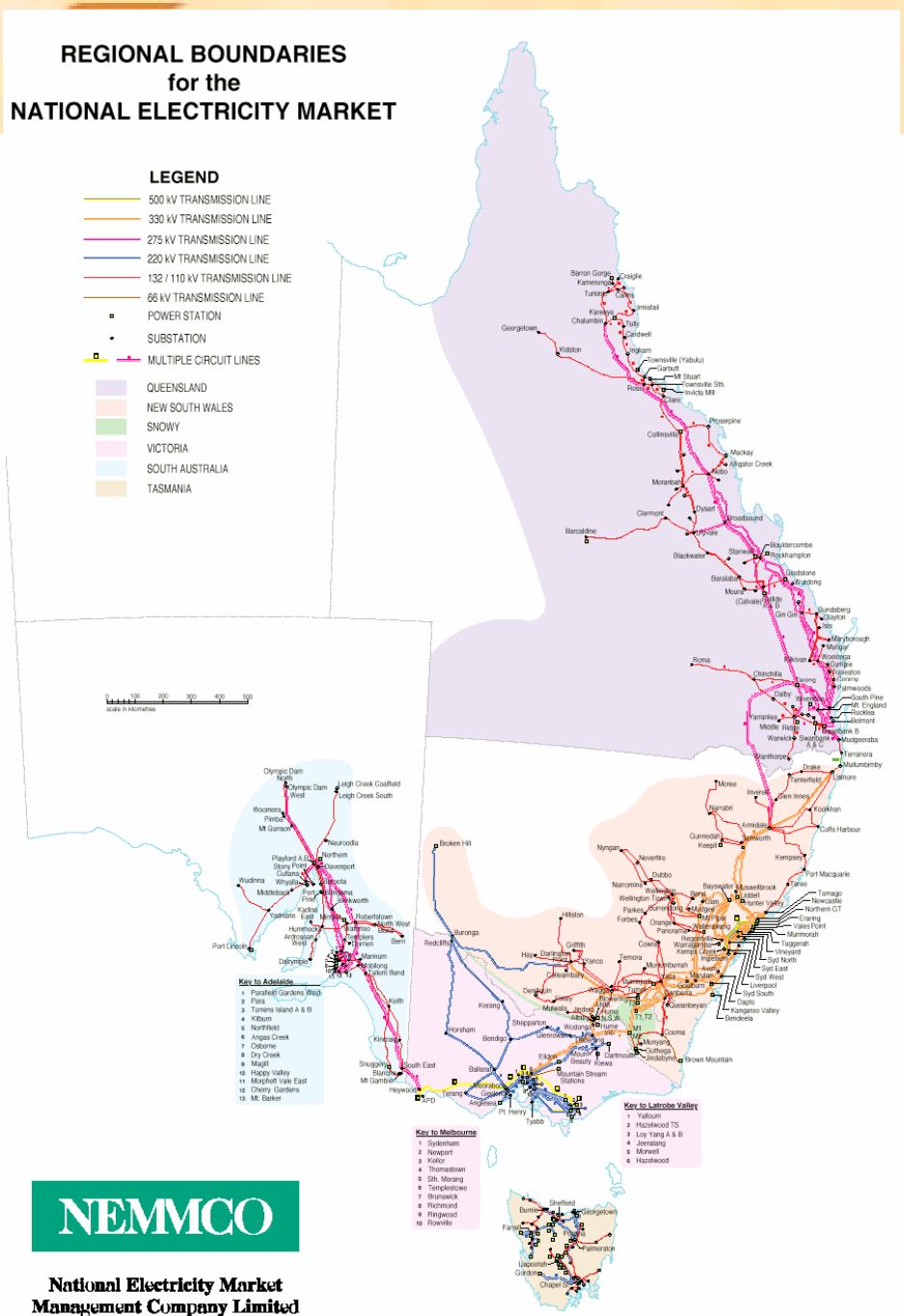
Scope of the NEM

- 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)



Key NEM features

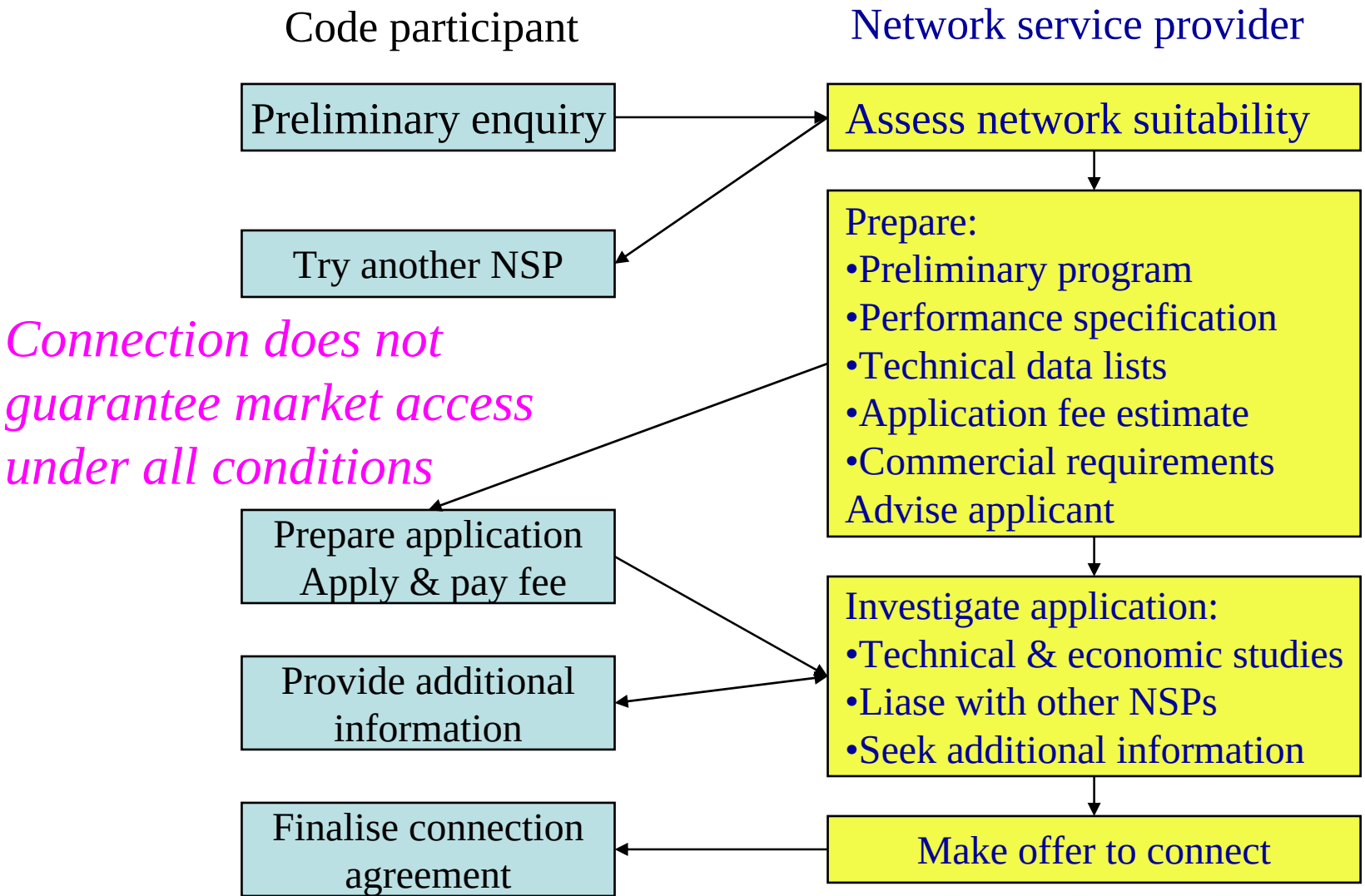
- NEM covers all participating states:
  - A multi-region pool with intra-regional loss factors
  - Ancillary services, spot market & projections
  - Auctions of inter-regional settlement residues
  - Operated by NEMMCO (owned by states)
- Compulsory participants in NEM:
  - All dispatchable generators & links > 30 MW
  - Network service providers & retailers
- Contestable consumers may buy from NEM

NEC categories of generators

- Either market, non-market or exempt
  - Market implies sell to NEM
    - Can then also sell ancillary services
  - Non-market or exempt: *sell to local retailer*
- Either scheduled or non scheduled:
  - Scheduled implies centrally dispatched:
    - Must then participate in the NEM processes of bidding, pre-dispatch & PASA
    - Default category for generation projects > 30 MW
    - Not appropriate for “intermittent” generation, eg wind

NEC Grid connection process

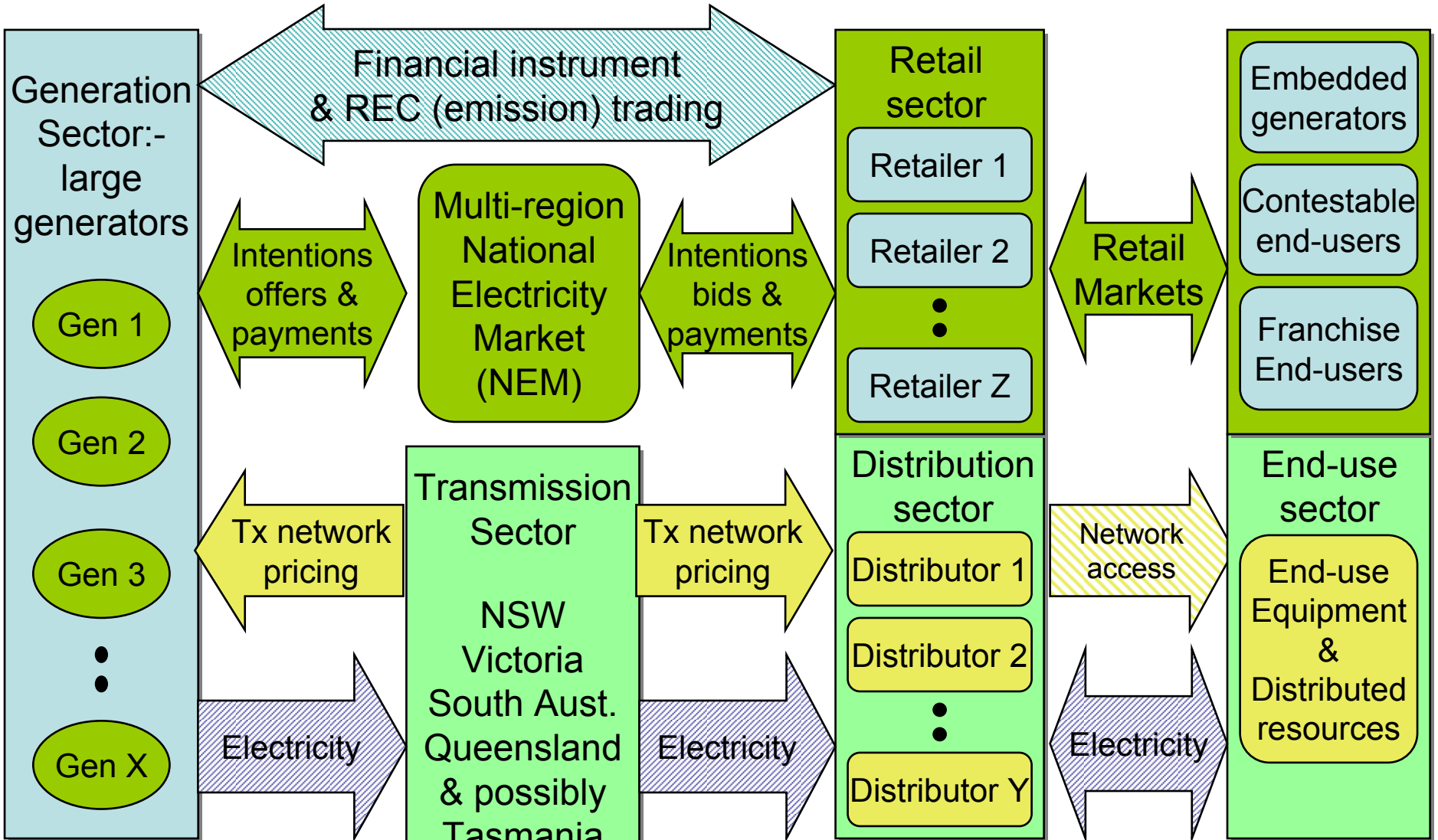
(NEC, Chapter 5, p 9)



National Electricity Code (NEC) connection requirements for generators

- Reactive power & voltage control capability
- Quality of electricity injected into network
- Protection requirements
- Remote control arrangements
- Excitation system requirements
- Loading rates
- Ride-through to avoid cascading outages:
  - Loss of largest generator; 175ms network fault

Electricity industry structure in SE Australia

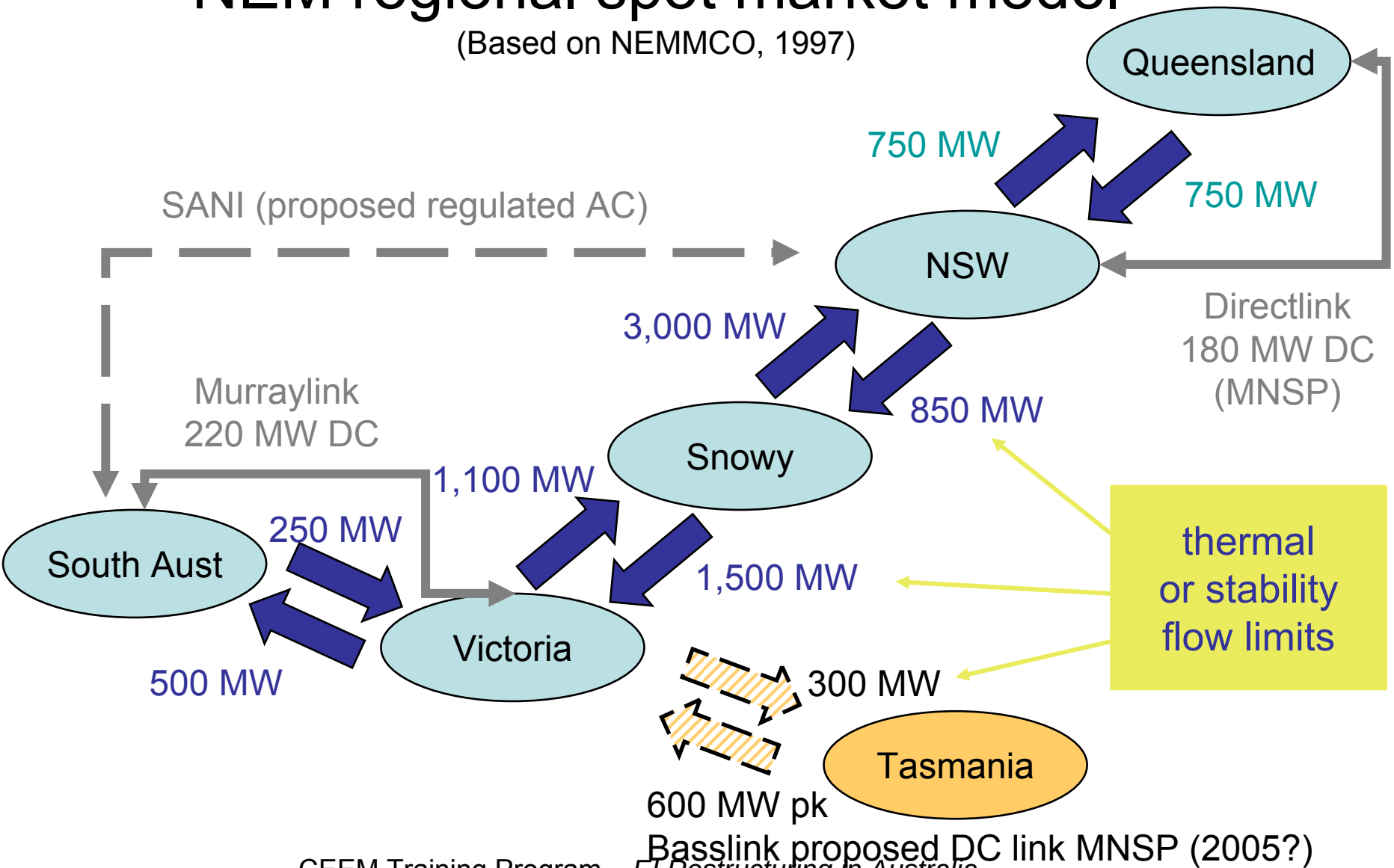


Region boundaries & inter-connectors

- 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)



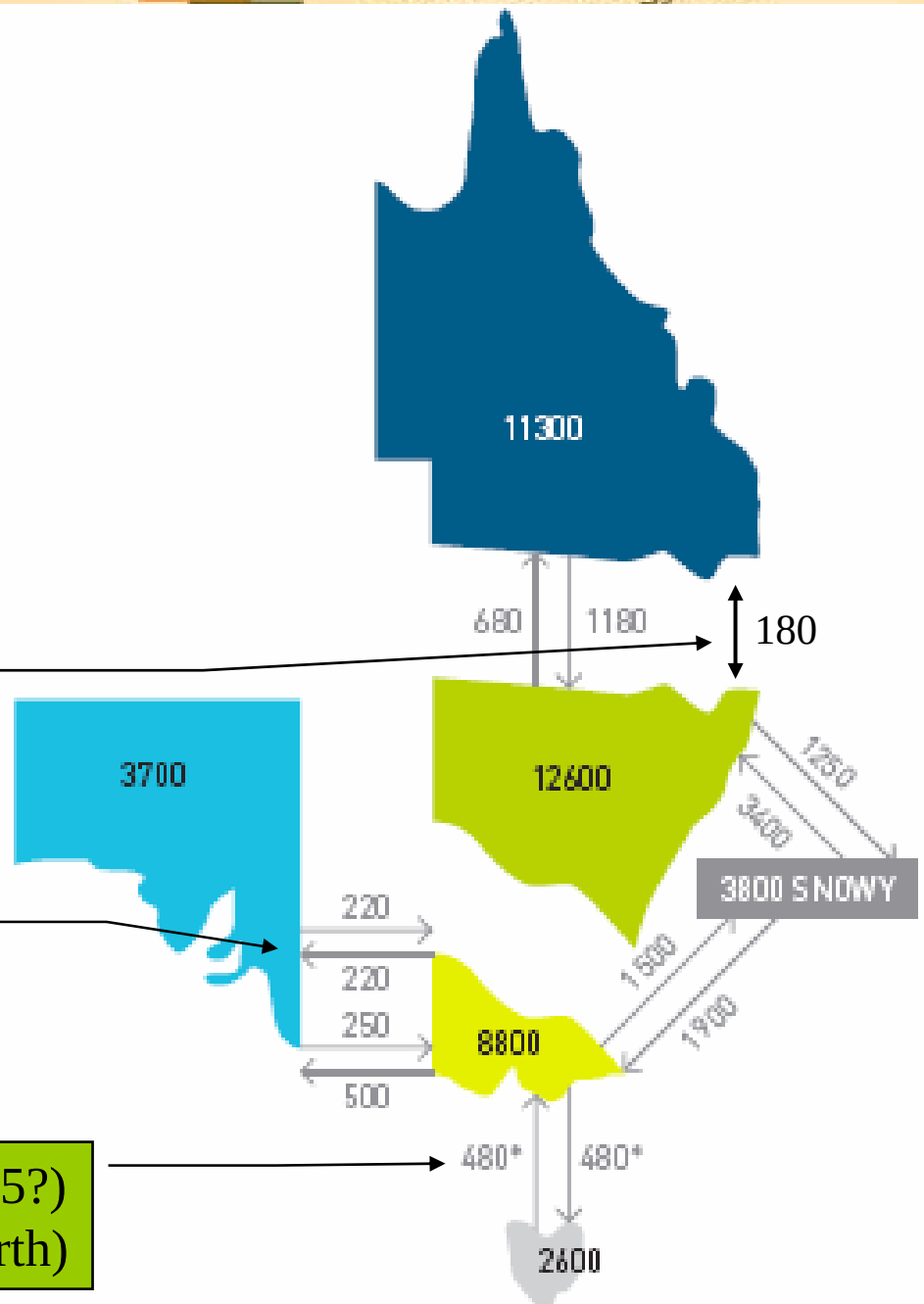
NEM market regions

(Securing Australia's Energy Future, 2004)

Directlink DC link, currently MNSP

Murraylink DC link, now regulated, formerly MNSP

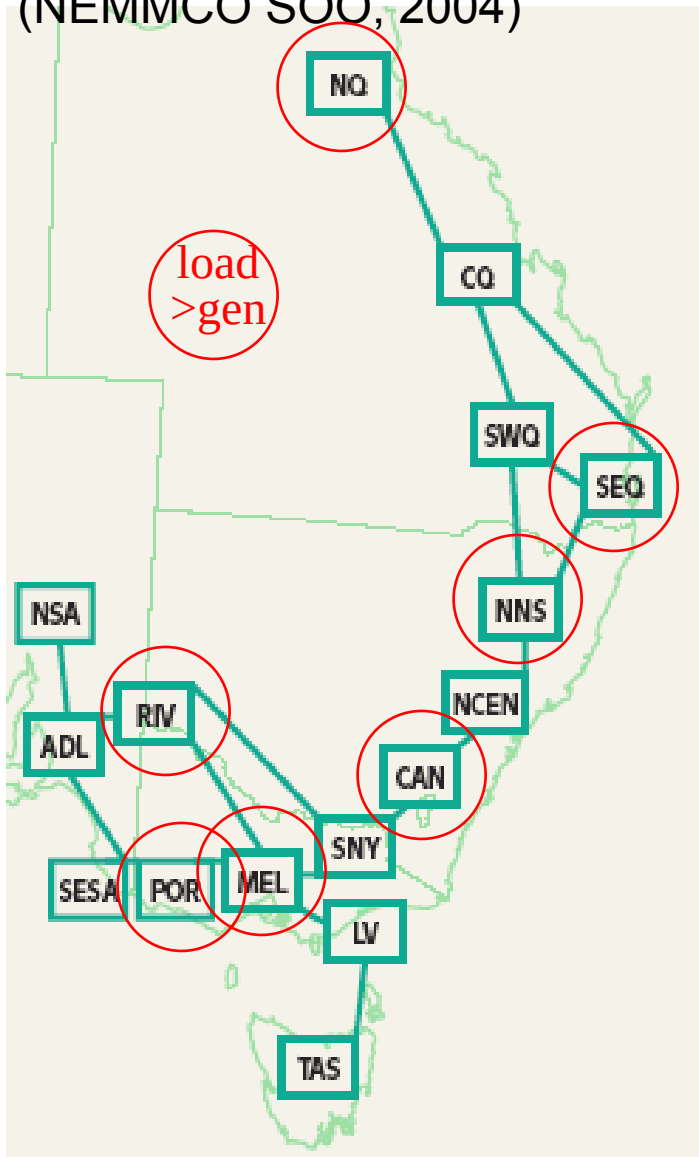
Basslink DC link MNSP (2005?) 600MW short term rating (north)



Node	Pk Ld (MW)	Gen Cap (MW)	Net Gen (MW)
NQ	1250	800	- 450
CQ	1900	4150	2250
SWQ	200	2150	1950
SEQ	4350	1450	- 2900
NNS	800	150	- 650
NCEN	10000	11650	1650
CAN	800	300	- 500
SNY	800	3900	3100
MEL	5750	800	- 4950
LV	900	7000	6100
POR	650	0	- 650
SESA	100	150	50
RIV	500	50	- 450
ADE	2100	2250	150
NSA	200	1100	900
TAS	1500	2500	1000

16 region NEM model

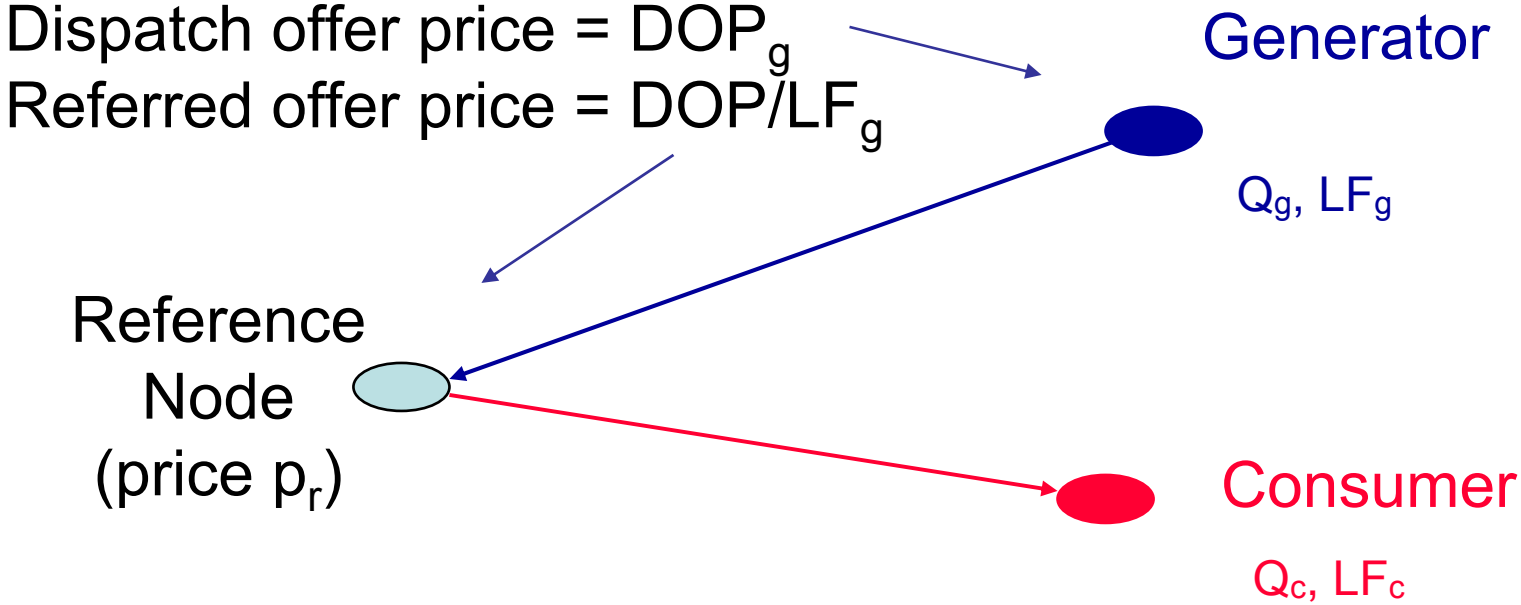
(NEMMCO SOO, 2004)



Modelling regulated interconnectors & intra-region location

- Regulated interconnector between 2 regions
  - Modelled by a linearised marginal loss function:
    - A ‘dynamic’ network loss factor that depends on flow
    - Flow limits (security or thermal criteria)
- Locational effects within regions
  - Modelled by ‘static’ network loss factors (LFs)
    - Annual average of estimated half-hour marginal losses for each generator node & group of consumer nodes
  - Intra-regional constraints not modelled but a ‘constrained-on’ generator cannot set price

Effect of intra-regional network loss factors on spot market outcomes



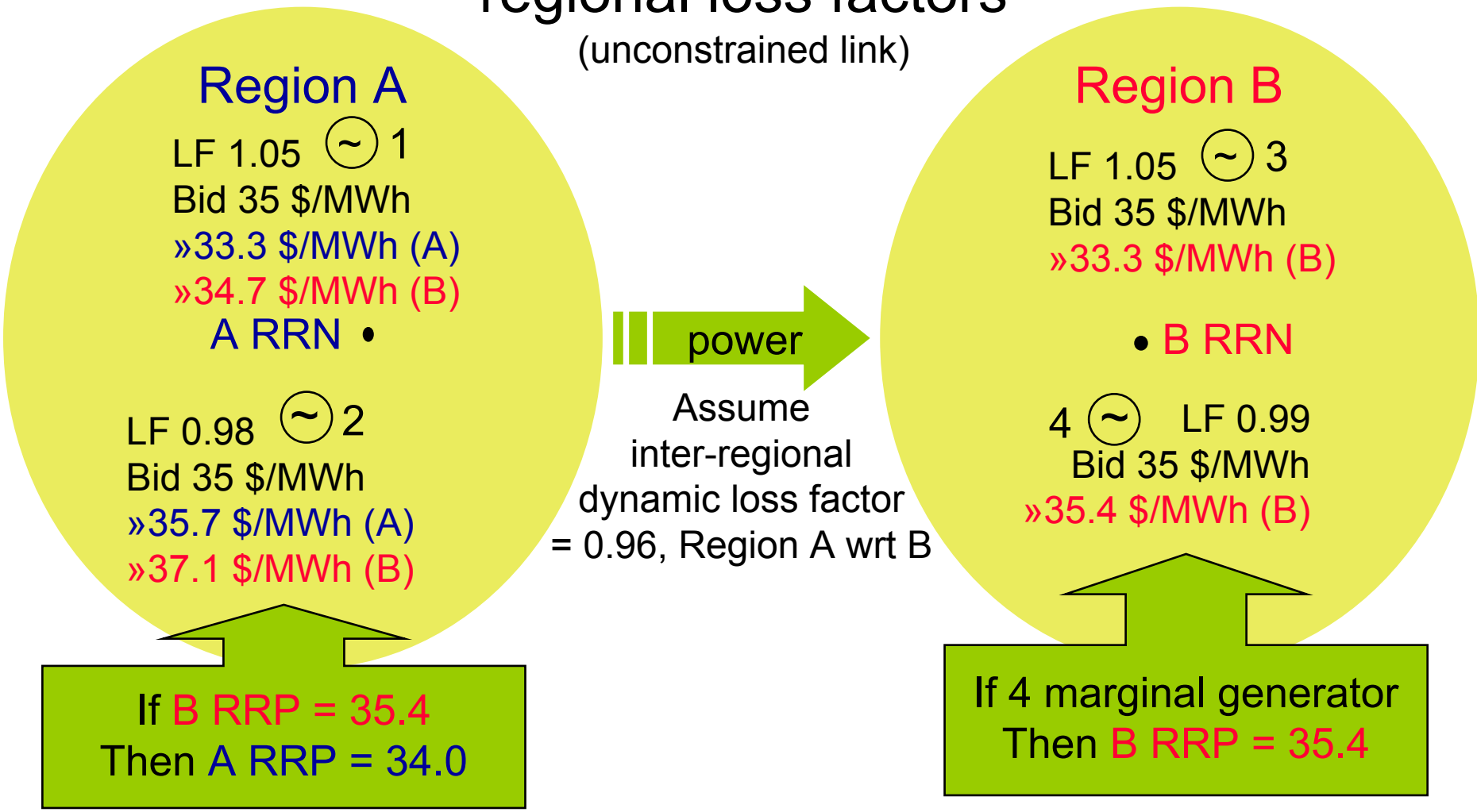
Generator produces Q_g & is paid $p_r \times LF_g \times Q_g$

Consumer consumes Q_c & pays $p_r \times LF_c \times Q_c$

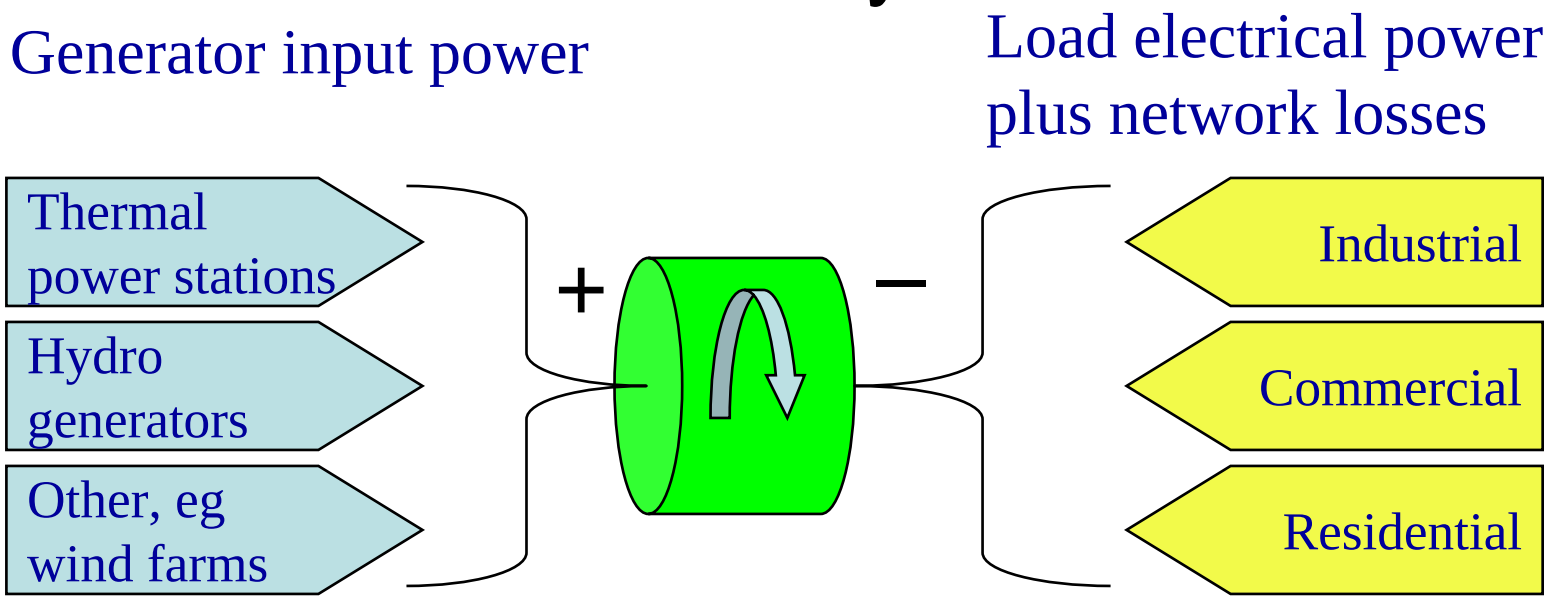
Net income is given to network service provider(s)

Combining dynamic inter- regional & static intra-regional loss factors

(unconstrained link)

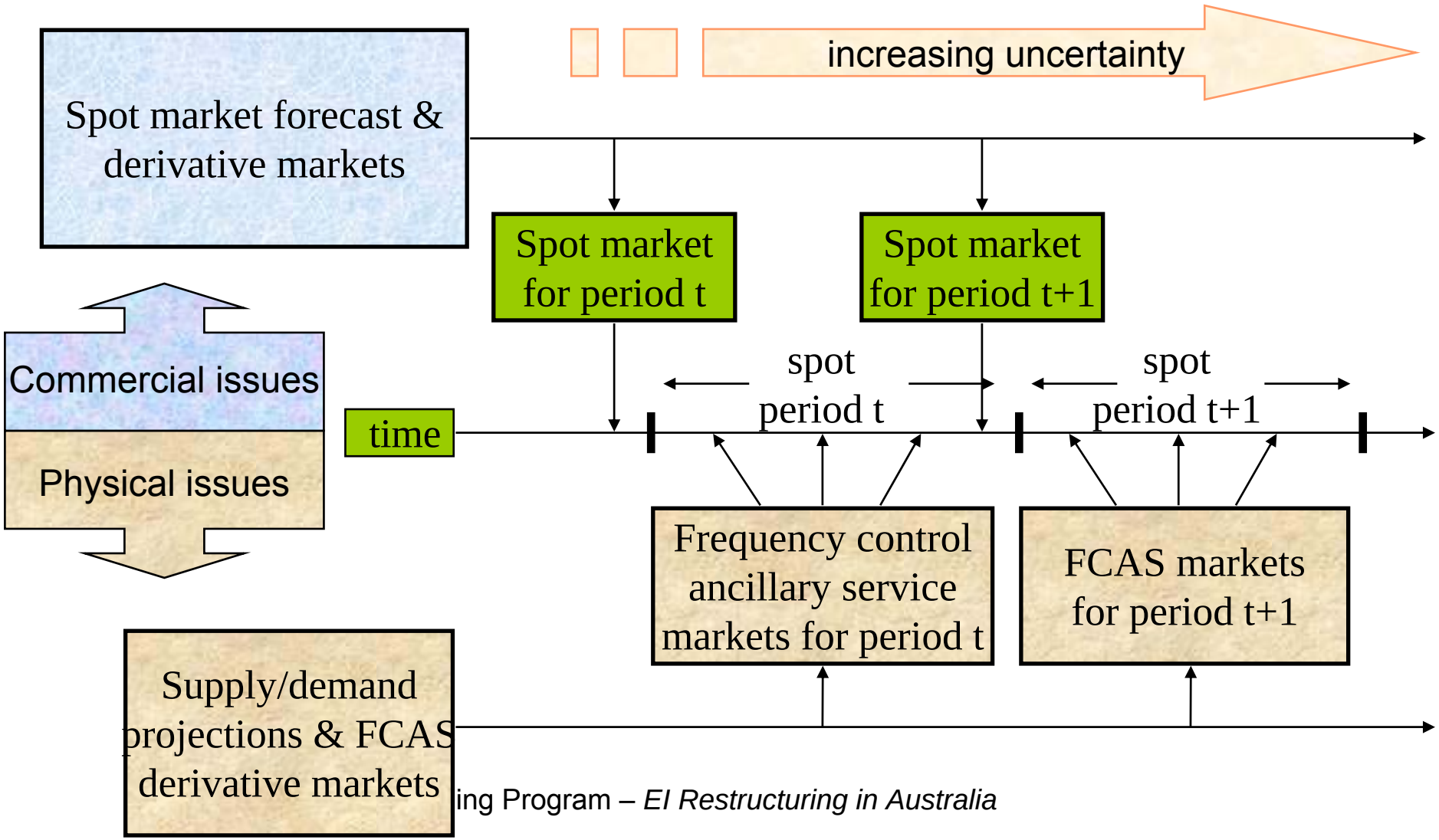


Supply-demand balance in the electricity industry

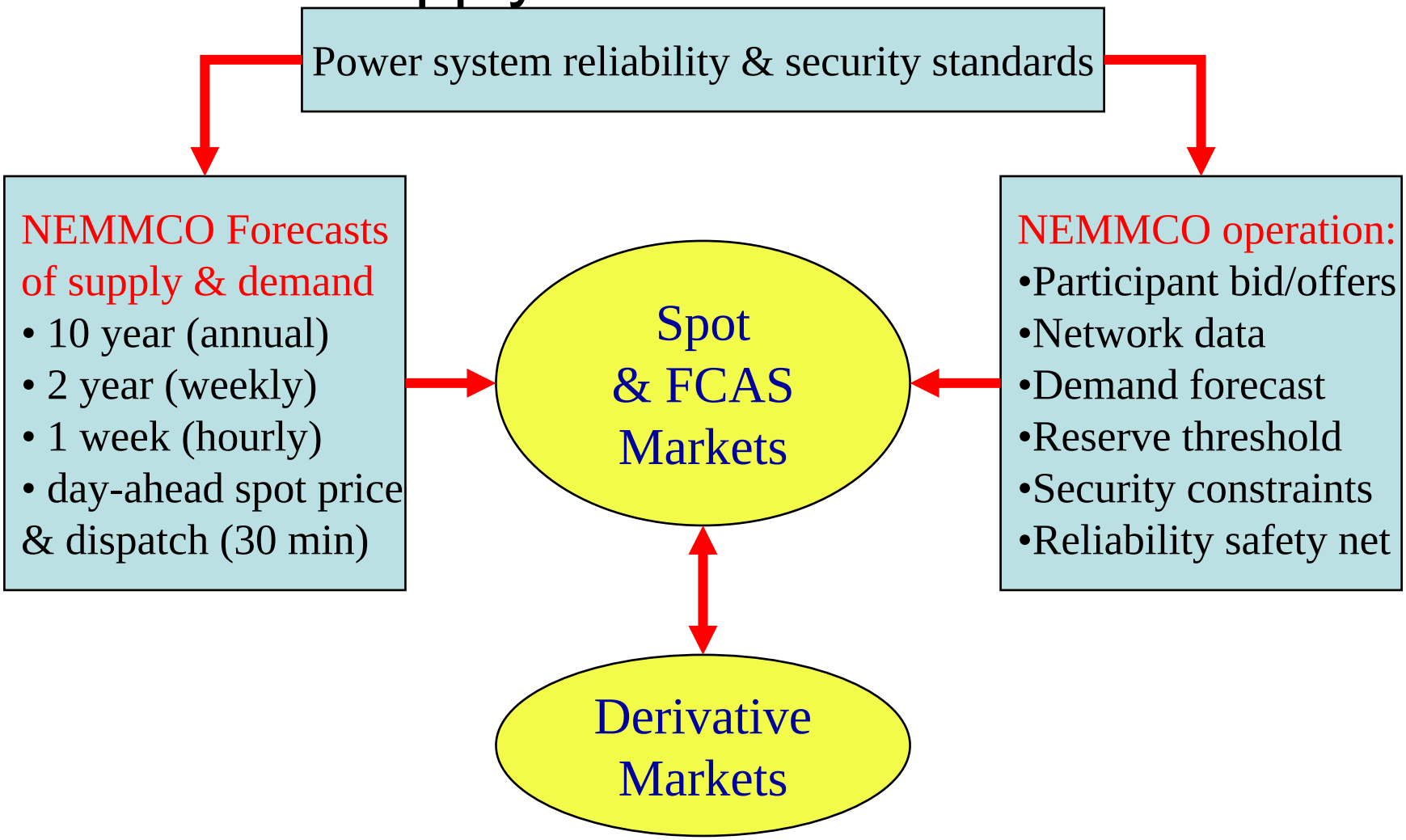


- Frequency is a measure of supply-demand balance:
  - always varying due to fluctuations in power flows

Managing supply-demand balance in Australian NEM

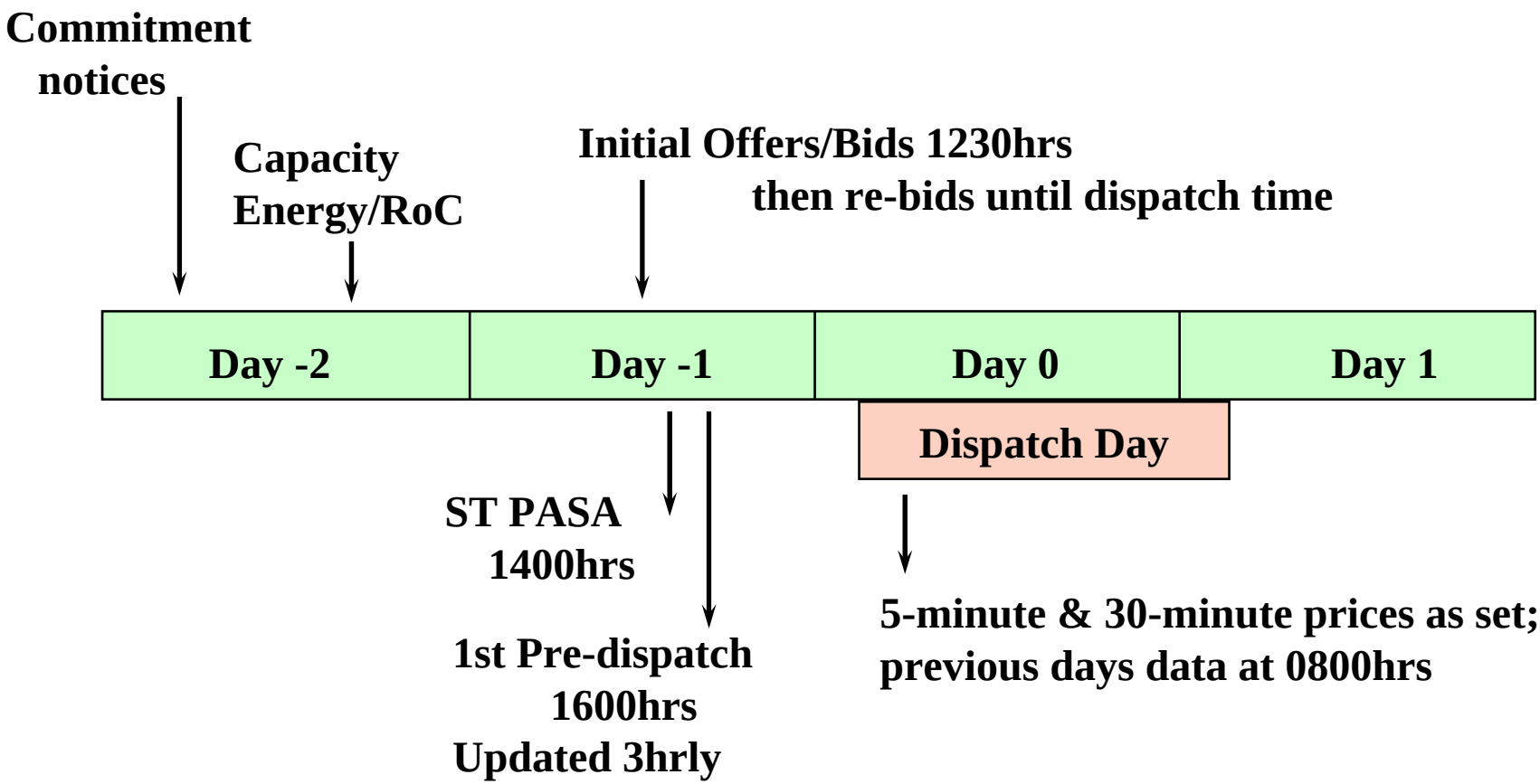


NEMMCO processes for managing supply-demand balance



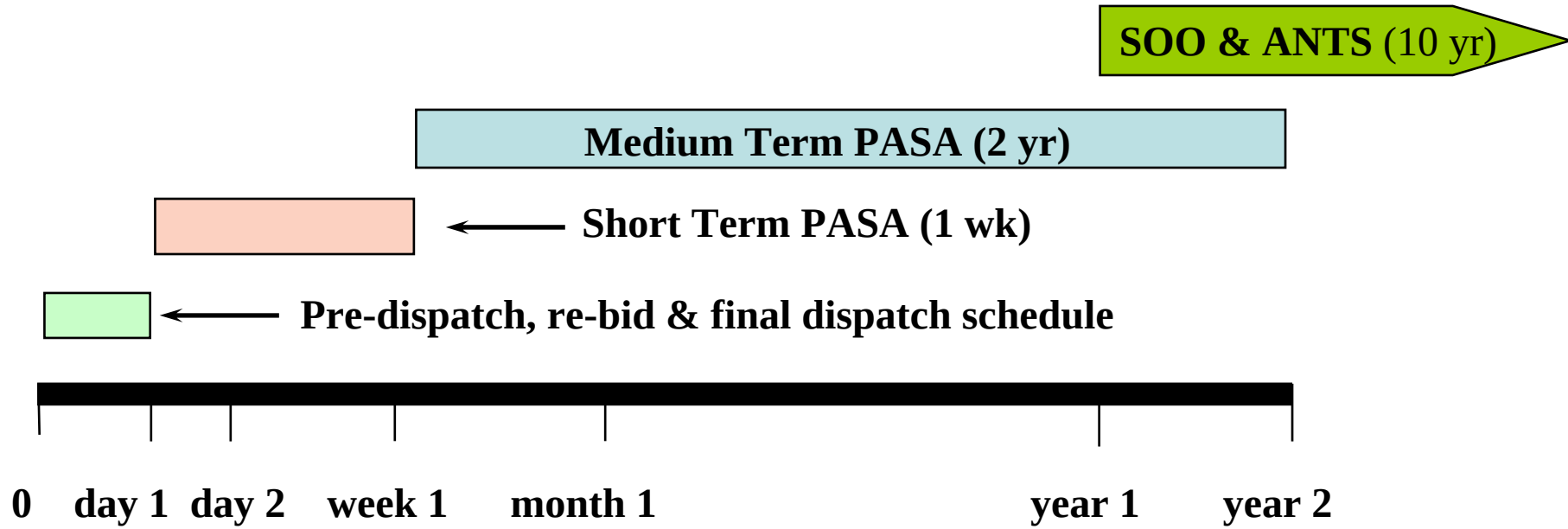
Bidding & dispatch

(source: NEMMCO)



Dispatch, Pre-dispatch, PASA, SOO & ANTS

(source: NEMMCO)

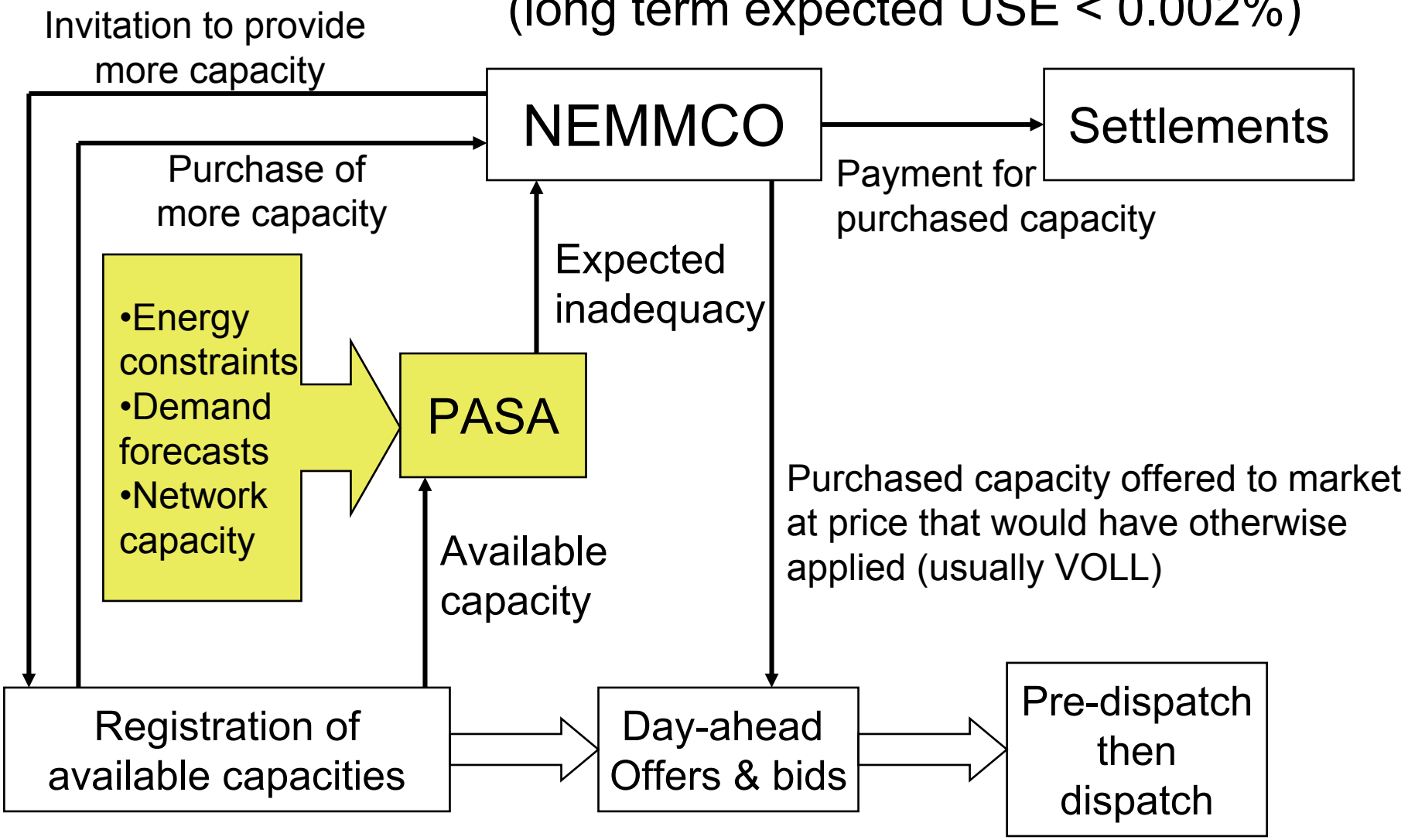


Statement of Opportunities (SOO) & Annual National Transmission Statement (ANTS) are intended to inform generation, demand & network investment decisions (10 year horizon, yearly update)

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

PASA & reserve contracts

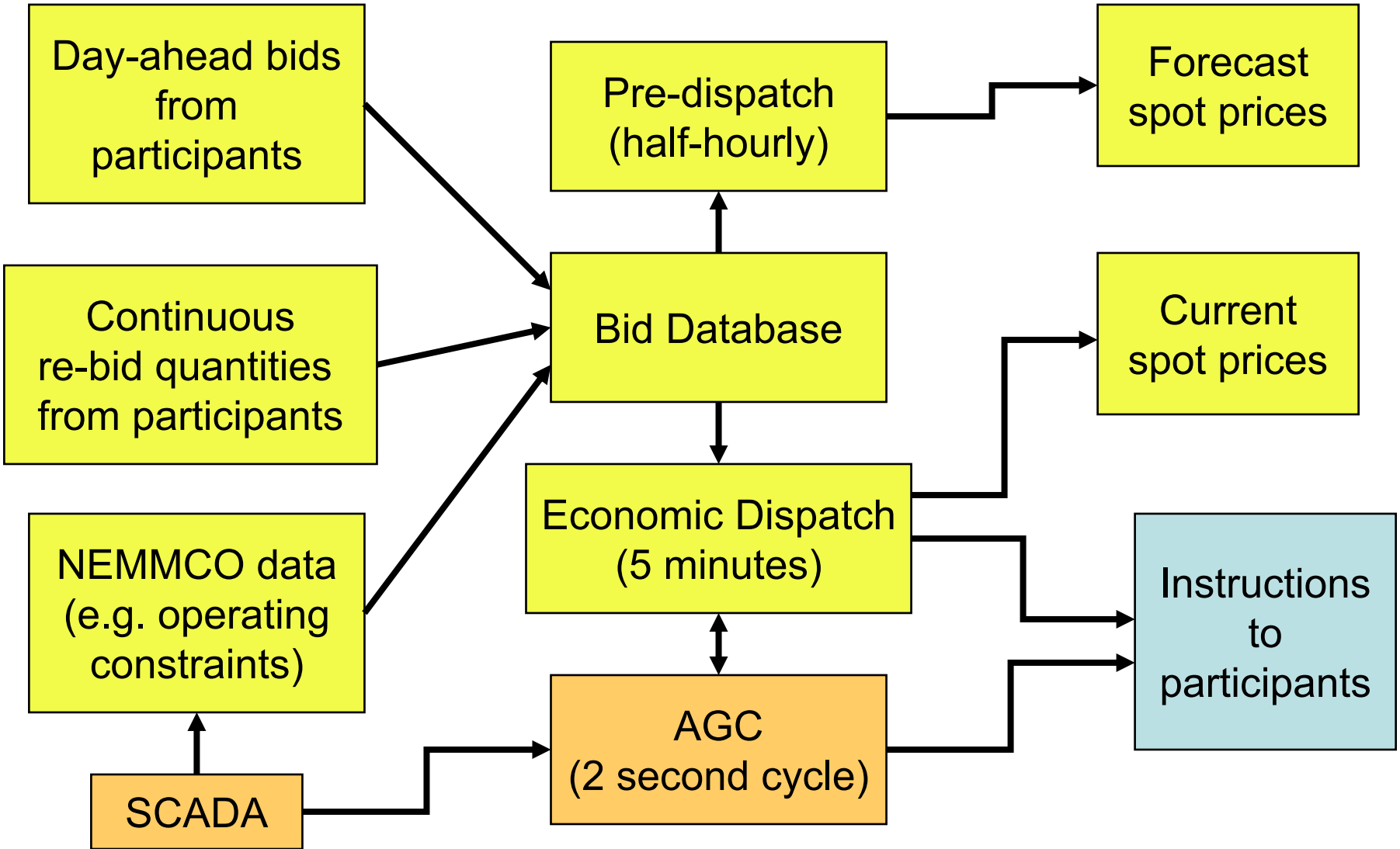
(long term expected USE < 0.002%)



Spot market offers & bids

- Generators, retailers & consumers:
  - Price-quantity curve (sell/buy) for each half hour:
    - ≤ 10 daily prices, quantities changeable until dispatch
  - Demand forecasts 'bid in' at $10000/MWH (VoLL)
- Dispatchable links between regions:
  - Flow offer curve based on price difference
- Bids & offers ranked to give dispatch stack:
  - Considering loss factors & inter-tie constraints
  - 5 minute prices set by economic dispatch:
    - Half-hourly averages are calculated in 'real time'

NEM Pre-dispatch, Dispatch & AGC



Financial instrument 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

Relationship between wholesale gas & electricity markets

- Market design simpler for gas than electricity:
  - Gas macro-molecular; electricity sub-molecular
  - Flows on pipelines individually controllable but not on transmission lines
  - Intermediate storage in “linepack”, not in electrical networks
- Gas network linepack is a shared resource:
  - Gas market design should be a “pool” not physical bilateral trading if linepack constraining:
    - It does when gas is used for electricity generation

Gas wholesale trading in Australia

- Victoria (~8 hours linepac):
  - Pool market & some bilateral physical trading
  - Pool market does not set sub-day prices
  - are derivative markets adequate?
- Other states (several days linepack)
  - Bilateral physical trading
- Status of gas wholesale trading:
  - inadequate to support use for peak electricity generation