Centre for Energy and Environmental Markets

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Network services

Fundamentals of the Australian Competitive Electricity Industry

17-19 August 2005

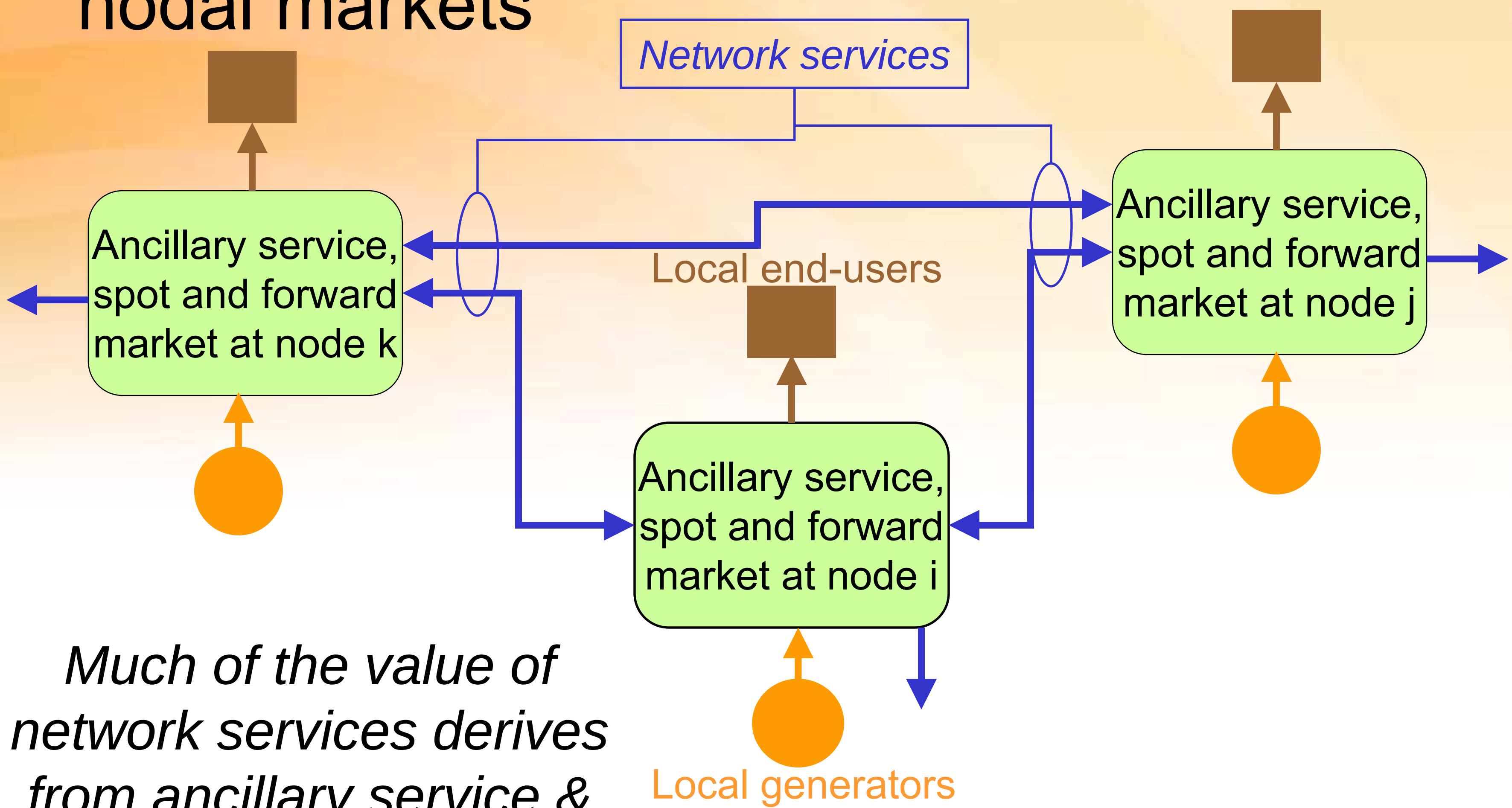
Outline

- Ideal - nodal market at each connection point:
  - Ancillary services, spot energy, future risk
  - Network arbitrage versus local resources
  - Active demand-side participation
- Impractical near term, uncertain long term:
  - Complexity, market power, uncertainty
- Practical approaches depend on context:
  - Regional markets & negotiation frameworks
  - Network service, pricing & investment protocols:
    - To allow distributed resources to compete

Ideal: competitive electricity industry modeled by nodal markets

- Based on a market at each node:
  - Local generators & end-users
  - Flows to & from the network
  - Nodal ancillary service, spot & forward markets
  - Nodal spot prices set by simultaneous auction
- Network flows determined to maximise the benefits of trade (network-based arbitrage):
  - To exploit diversity in resource availability
  - Subject to network losses & flow constraints

Network arbitrage between nodal markets



Much of the value of network services derives from ancillary service & investment timescales

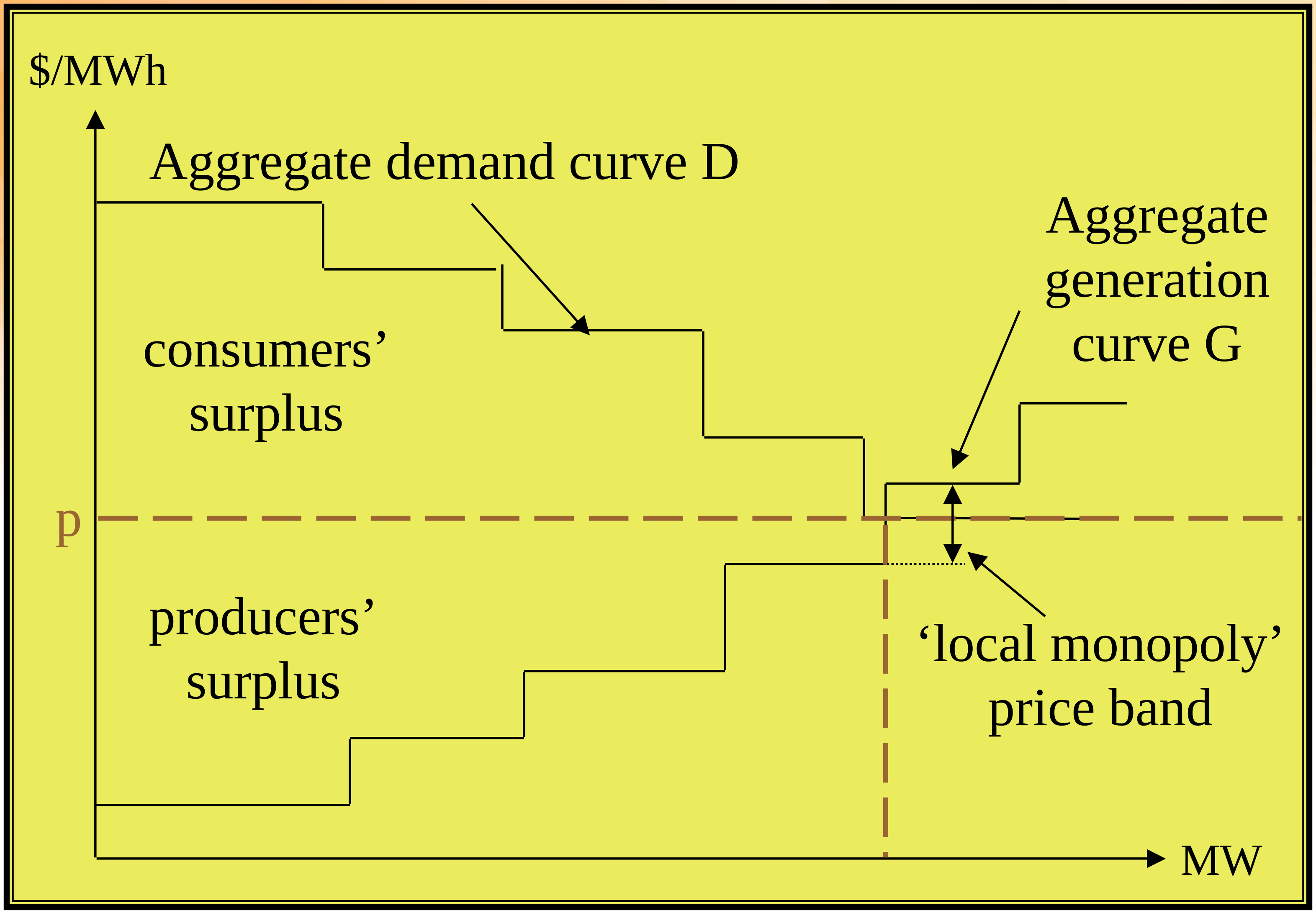
A definition of network services in an ideal competitive electricity industry

- Arbitrage between nodal markets
  - in ancillary services, spot energy & future risk
- Subject to:
  - Availability of network elements
  - Energy losses in network components
  - Maximum ratings of network elements
  - Operating limits imposed for system security:
    - Influenced by the characteristics of generators, loads & network elements as well as the system operating state
    - Matters of judgement rather than objectively set

Solving nodal spot markets that include a network model

- Single node assumption (or strong network):
  - All sellers & buyers at one location
- Two node model:
  - Sellers at one node, buyers at the other:
    - Constrained line but no losses
    - Unconstrained line with line losses
    - Competing options to relieve a network flow constraint
- Three and five node models:
  - Interaction between lines in a meshed network

Single node spot market

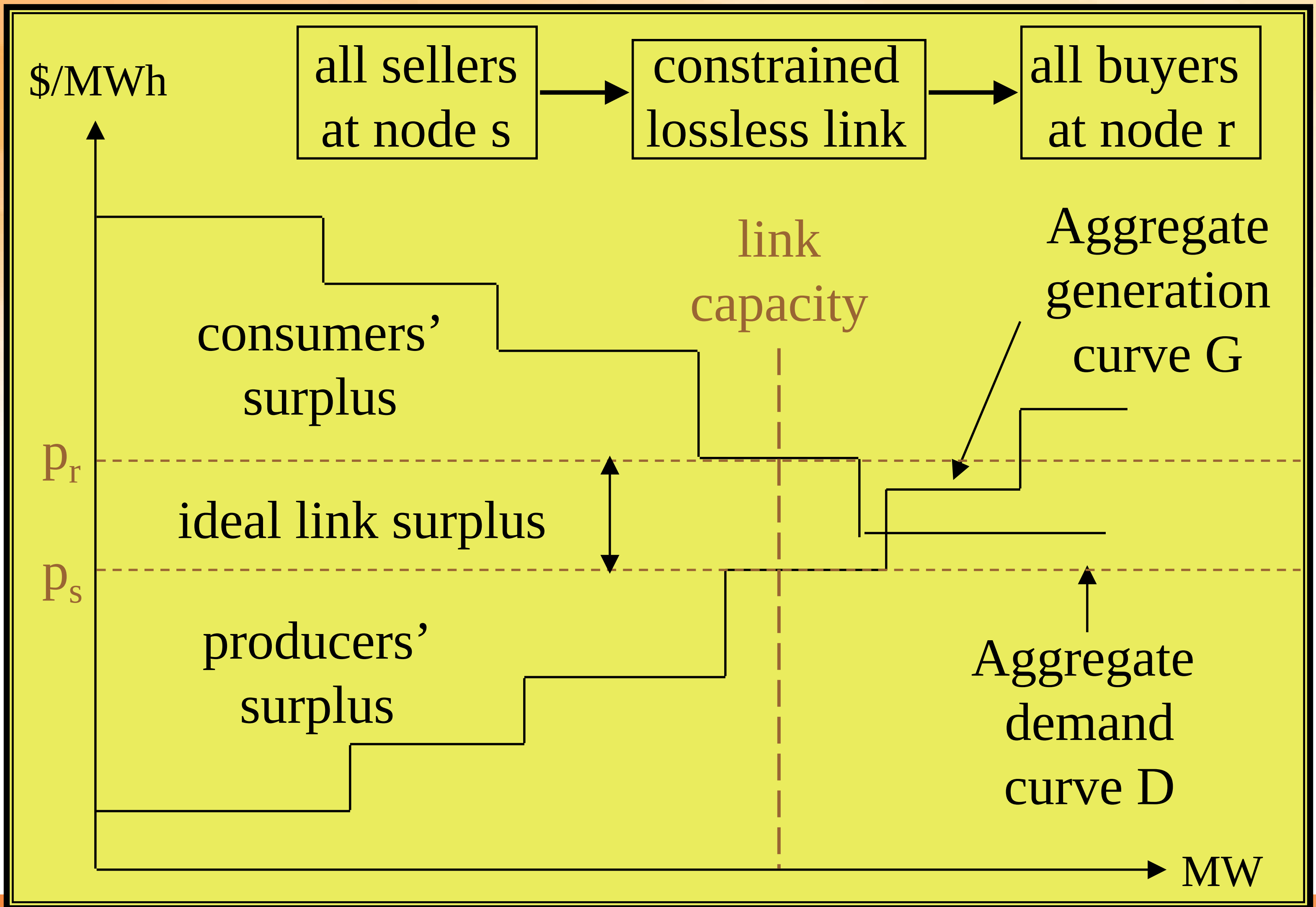


one marginal price 'p'

Issues illustrated by one node example
(all participants at one location or strong network)

- Buyers & sellers see the same nodal price
- No revenue to network operator:
  – No network-based arbitrage
- The marginal buyer or seller may have a 'local monopoly':
  – The ability to set price within a limited band
  – More likely with fewer participants

Two-node spot market with

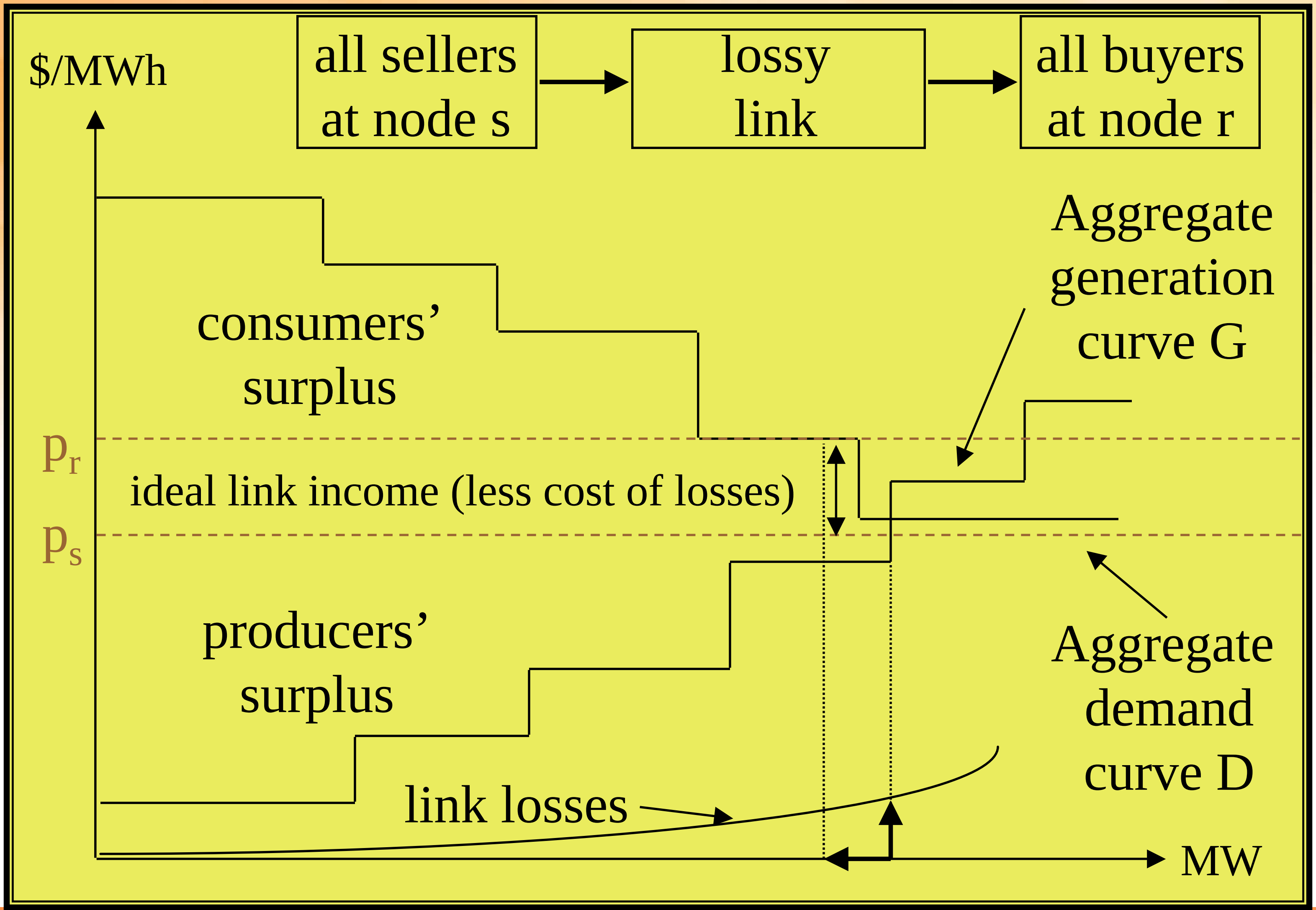


two marginal prices p_r & p_s

Issues illustrated by 2 node example: constrained, lossless link

- Nodal prices are set to constrain flow to link capacity (quantity rationing):
  - $p_r > p_s$ (always true for radial case)
  - link outage causes market collapse
- Link owner has a perverse incentive:
  - to constrain link capacity (but not to zero)
- Sellers & buyers may capture some of ideal link surplus due to 'local monopoly':
  - Local market power greater if link constrained

Two-node spot market with unconstrained lossy link



related nodal prices p_r & p_s

Issues illustrated by 2 node example: unconstrained, lossy link

- Unconstrained, lossy link between all sellers & all buyers
- Link operator buys at sending end, sells at receiving end, increasing link flow until:
  - cost of next increment of flow = its sale value:

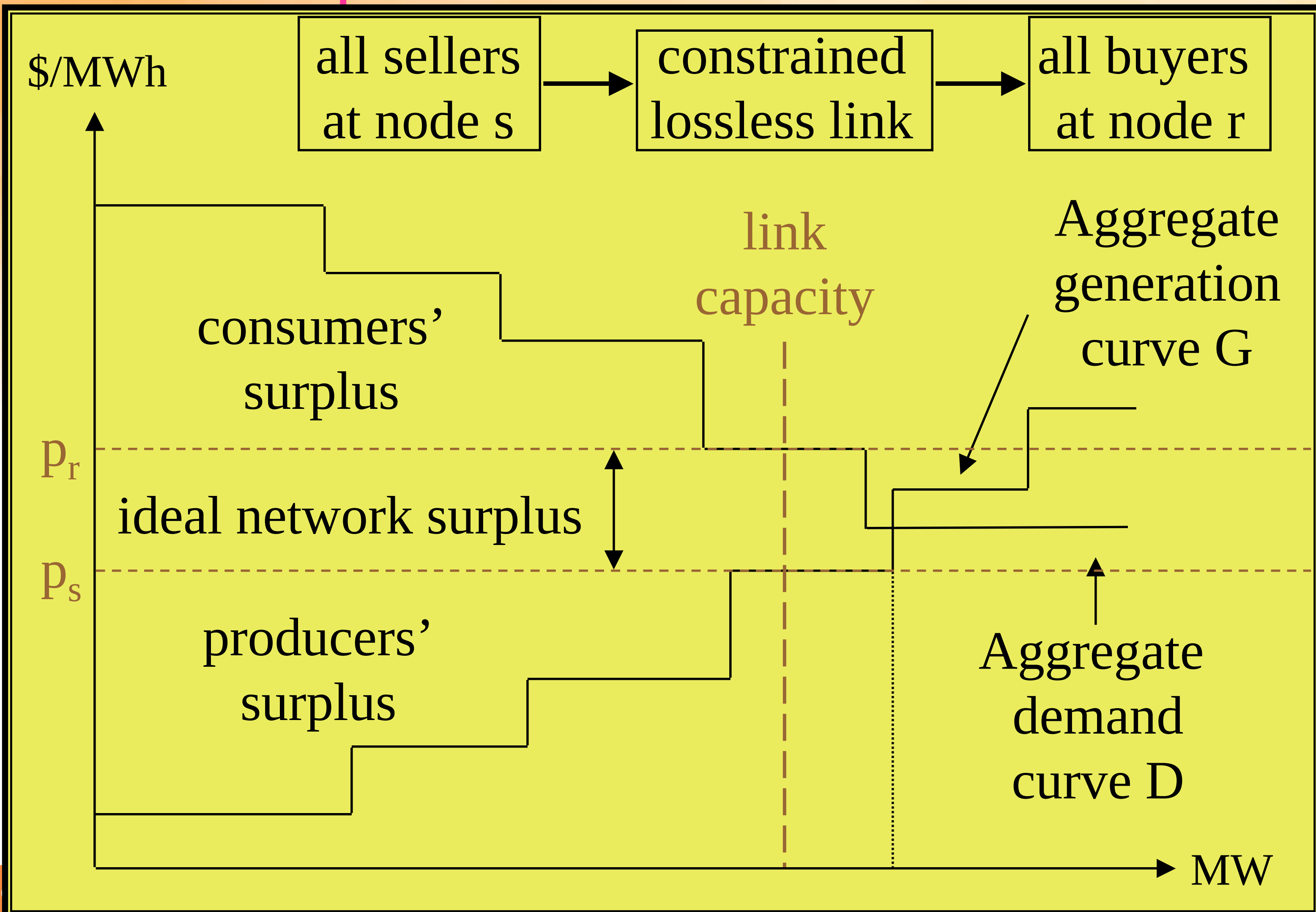
    i.e. $p_s(\Delta X+\Delta L) = p_r \, \Delta X$ [ΔX = sale, ΔL = loss]

    hence: $p_r = (1+ \Delta L/ \Delta X) \, p_s$
- Thus nodal prices are related by the incremental loss of an unconstrained link

Relieving network flow constraints

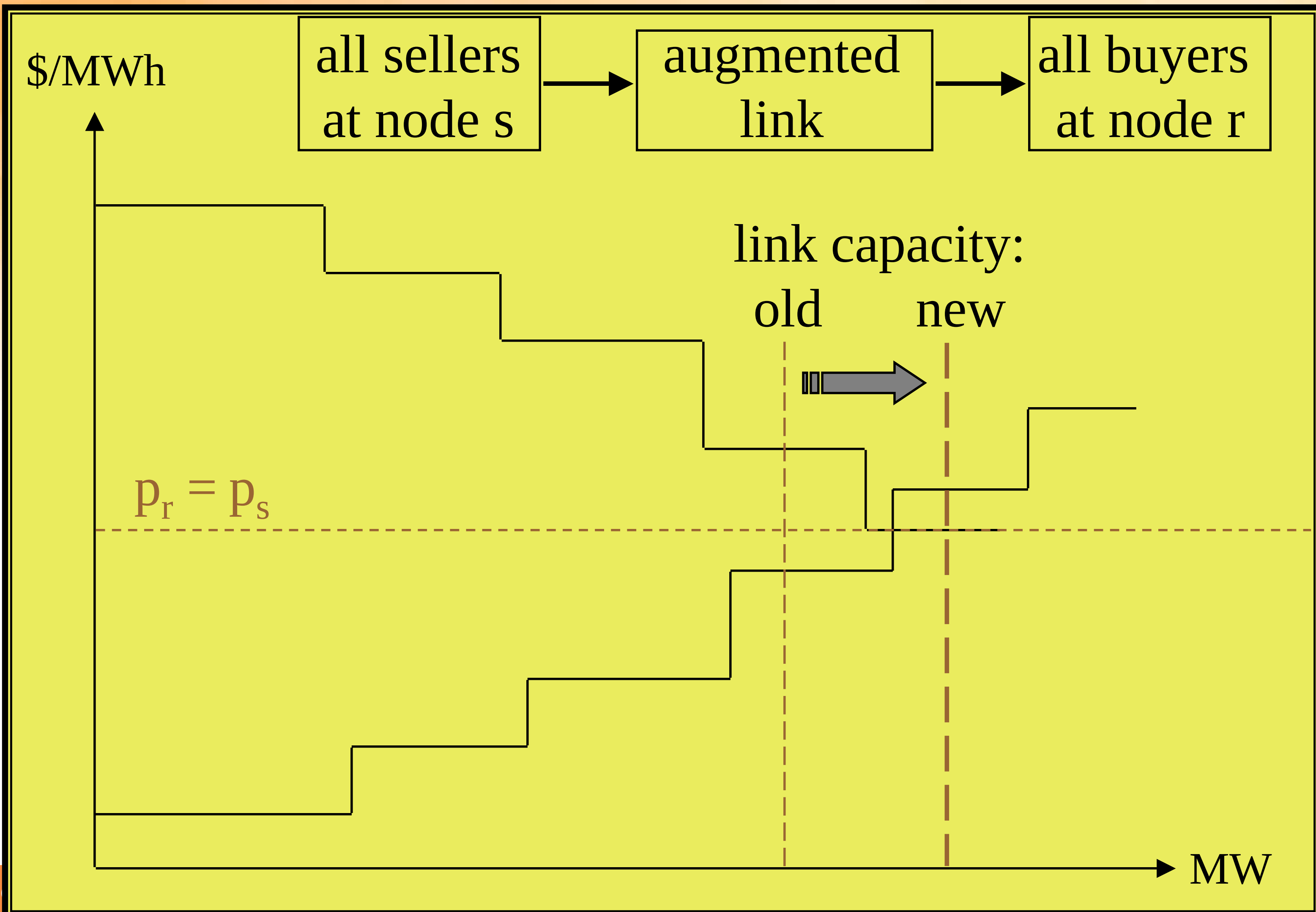
- Link flow constraints can be alleviated by:
  - investment in additional link capacity
  - investment in distributed resources:
    - Appropriately located generation, storage or load
  - relaxation of QOS criteria
- Investment underwritten by forward markets:
  - generator: sell CFD or call option at node ‘r’
  - load: buy CFD or CO at node ‘s’
  - link: buy CFD/CO at node ‘s’ and
    sell CFD/CO at node ‘r’

Relieving network flow constraints: Situation prior to resolution of constraint



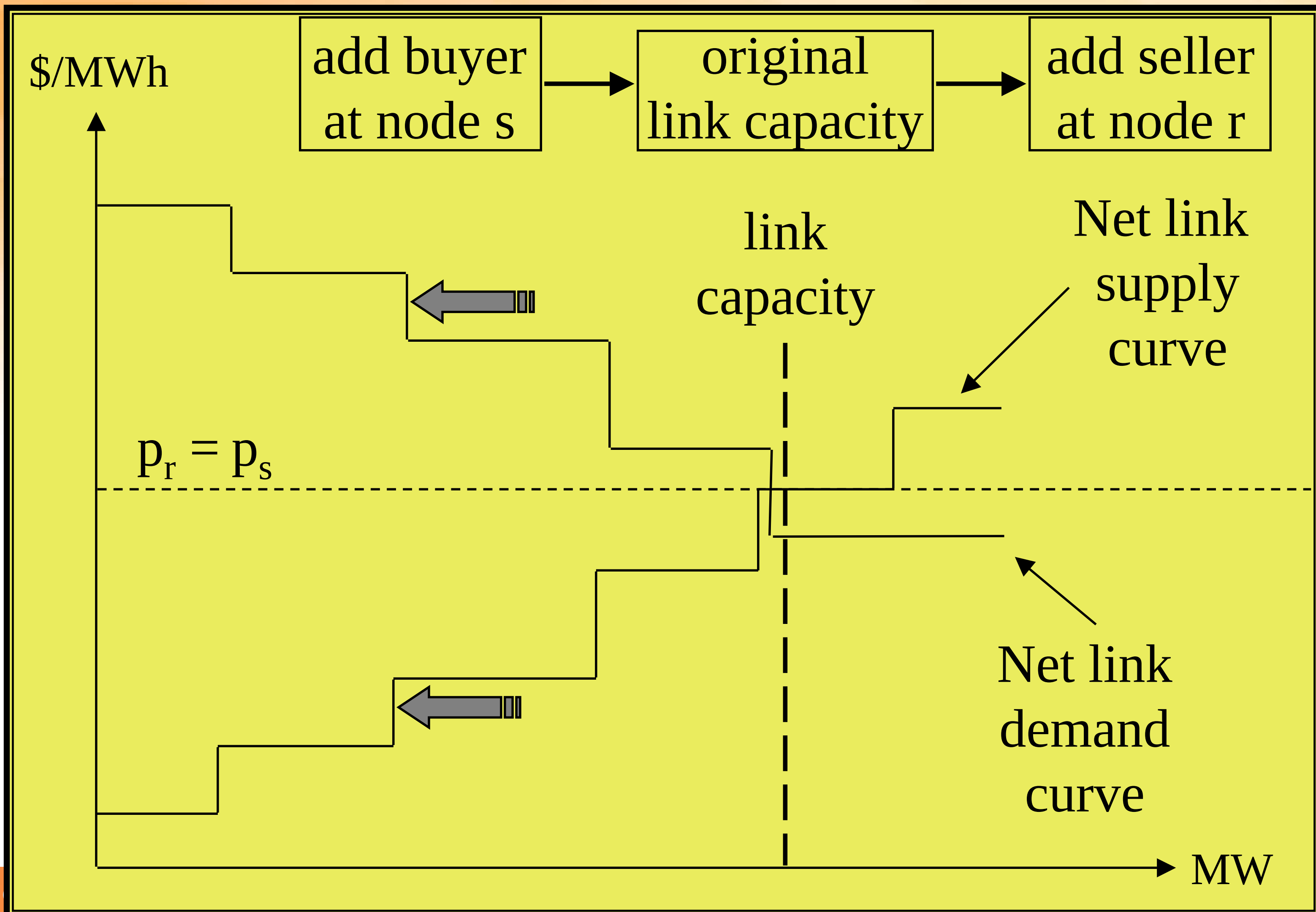
two marginal prices p_r & p_s some network surplus

Relieving network flow constraints: Option 1 - augment link capacity



one marginal price $p_r = p_s$, no network surplus

Relieving network flow constraints: Option 2 - add distributed resources



one marginal price $p_r = p_s$, no network surplus

Limits to the effectiveness of nodal markets

- For a given network, more nodal markets:
  - Mean fewer participants in each nodal market:
    - Local participants & network owners gain market power
    - Ancillary services, spot energy & risk harder to price
  - Require a more accurate network model
  - *There is a lower limit to the level of network detail that nodal markets can resolve*
- Regional markets provide one option:
  - Place major flow constraints on region boundaries:
    - Models of “notional interconnectors” then required
  - Resolve intra-regional network flow constraints by negotiation under regulatory supervision

NEC treatment of network losses & capital costs

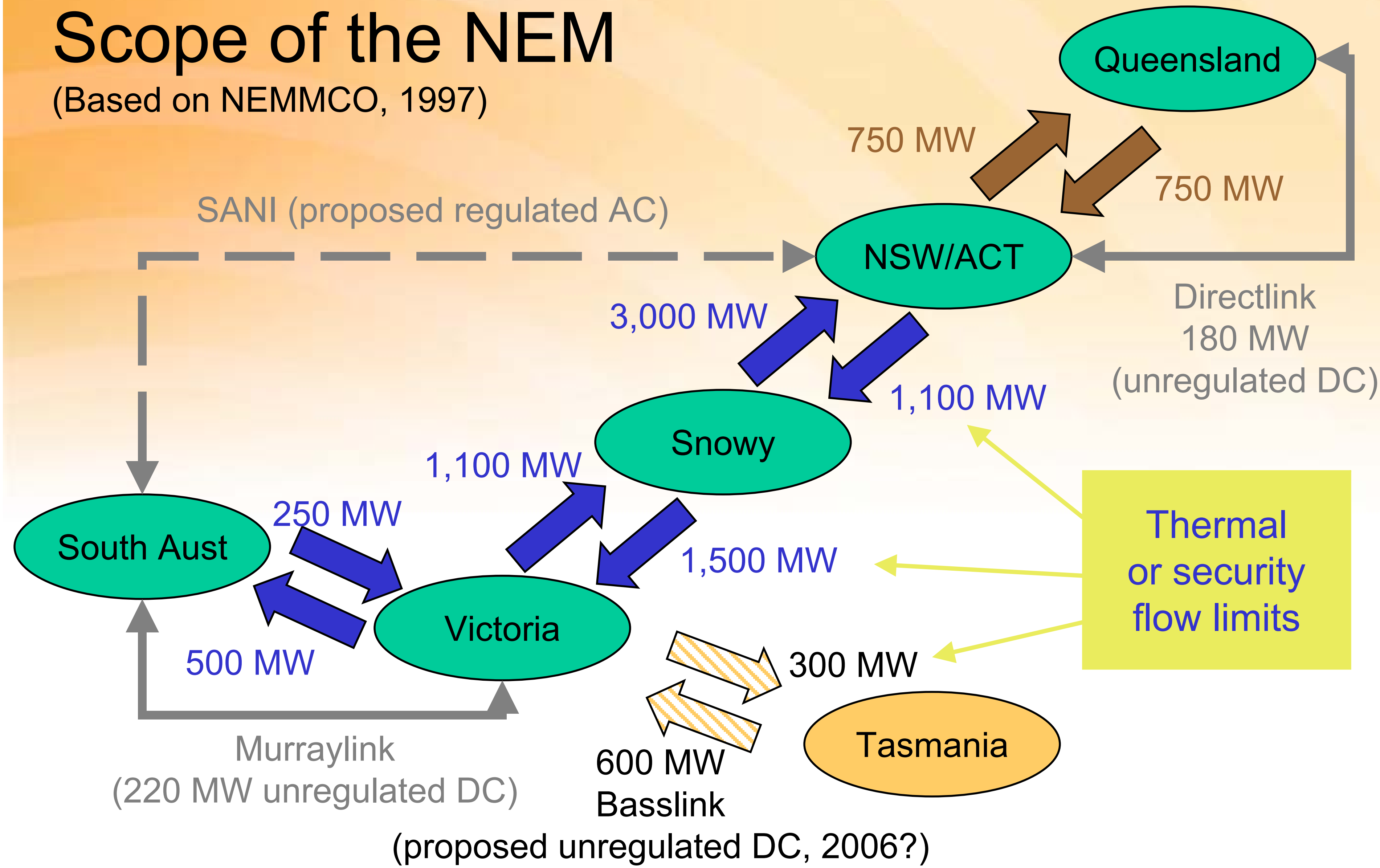
- NEC contains NEM rules & access regime:
  - Both address network issues
- National Electricity Market trading rules:
  - Notional regulated interconnectors & associated settlement residue auctions
  - Market network service provider (unregulated intercon)
  - Intra-regional network loss factors & constraints
- Network access and pricing:
  - Revenue cap for regulated network service providers

NEC treatment of network flow constraints

- NEMMCO documents inter- & intra- regional flow constraints:
  - these are inputs to the dispatch process
- Significant transmission constraints appearing 50 hours per year or more:
  - To be placed on market region boundaries:
    - where it is practical to reset the boundaries to do so

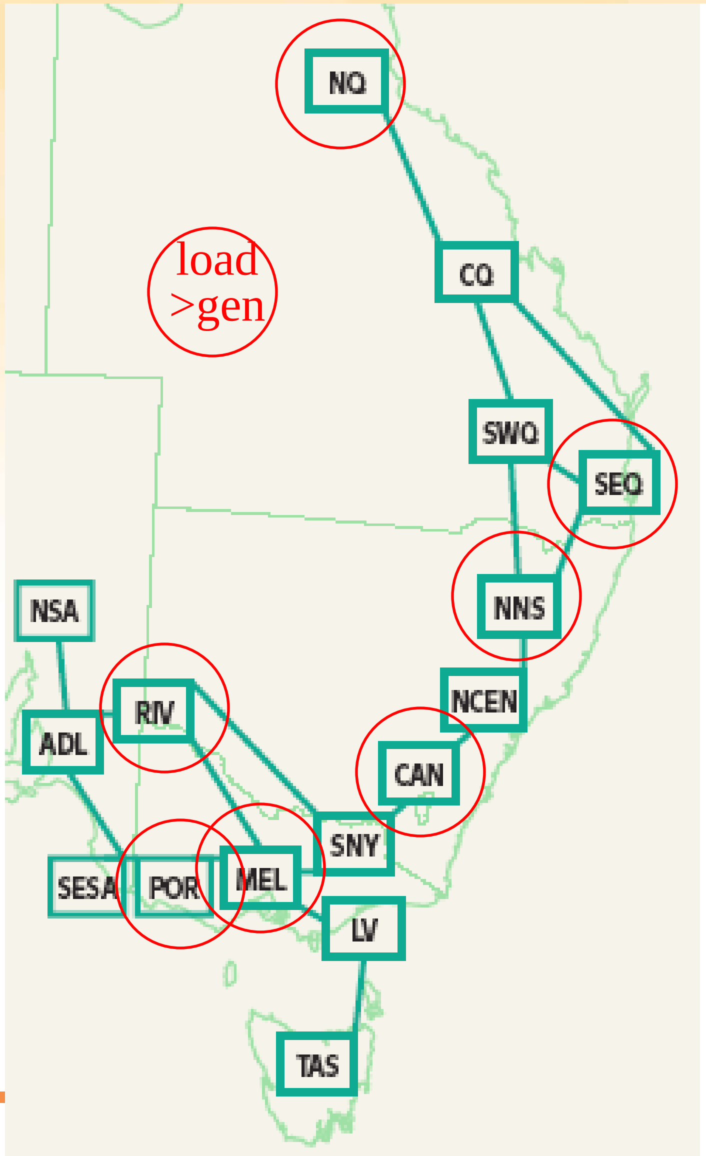
Scope of the NEM

(Based on NEMMCO, 1997)



16 region NEM model
(NEMMCO SOO, 2004)

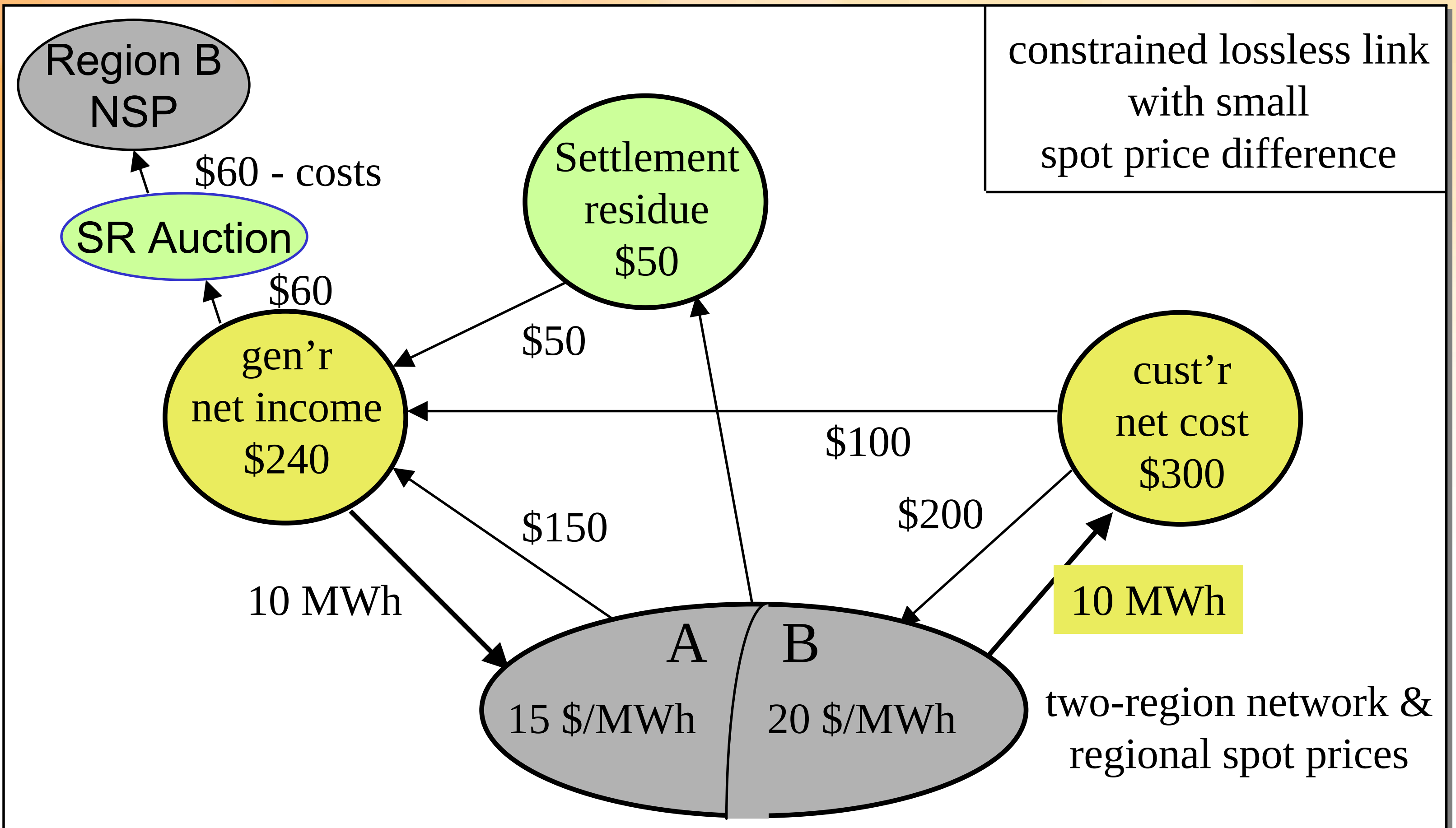
Node	Pk Ld (MW)	Gen Cap (MW)	Net Gen (MW)
NQ	1250	800	- 450
CQ	1900	4150	2250
SWQ	200	2150	1950
SEQ	4350	1450	- 2900
NNS	800	150	- 650
NCEN	10000	11650	1650
CAN	800	300	- 500
SNY	800	3900	3100
MEL	5750	800	- 4950
LV	900	7000	6100
POR	650	0	- 650
SESA	100	150	50
RIV	500	50	- 450
ADE	2100	2250	150
NSA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



Inter-regional hedges for regulated interconnectors

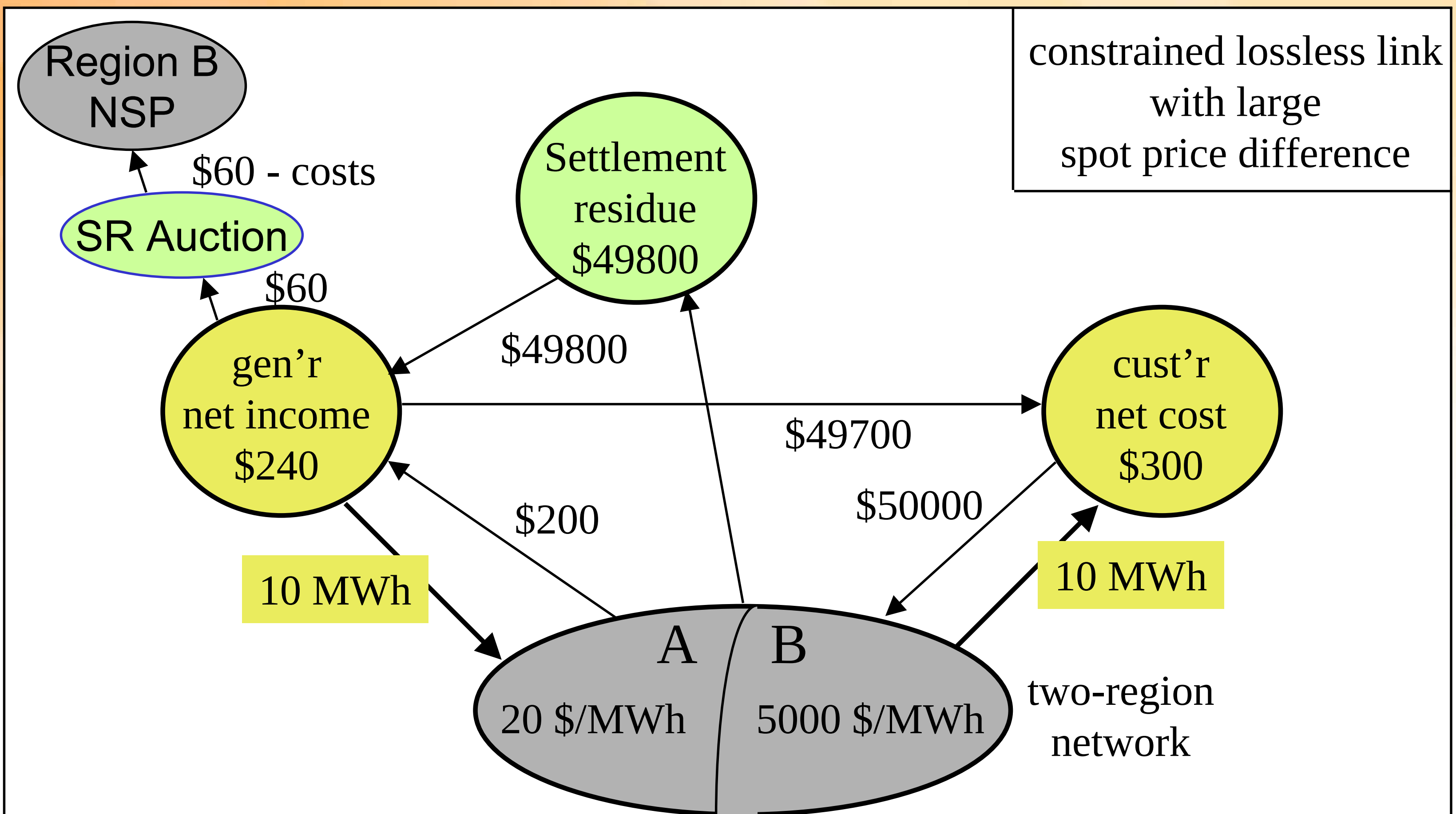
- A hedge against differences between regional spot prices for one direction of flow
- Based on interconnector settlement residue:
  - Difference in regional reference prices multiplied by interconnector power flow
    - for each spot market interval
- 3-monthly auctions of settlement residue
  - first offered for South Australia interconnector
- Incomplete hedge:
  - doesn't cover interconnector losses or outages

Inter-regional hedge example #1



Generator sells a 10 MWh hedge contract on region B price to customer at $30 MWh & buys a directed 10 MWh hedge (B-A) from NEMMCO SR auction at cost of 6 $/MWh (expected spot price difference between regions)

Inter-regional hedge example #2



Generator sells a 10 MWh hedge contract on region B price to customer at $30 MWh & buys a directed 10 MWh hedge (B-A) from NEMMCO SR auction at cost of 6 $/MWh (expected spot price difference between regions)

NEC Treatment of Transmission & Distribution Pricing (Chapter 6)

- Principles for network pricing:
  - Promote competition in the provision of services
  - Be transparent & non-discriminatory
  - Seek similar outcomes to a competitive market
- ACCC Regulatory test for T&D augmentation:
  - Reliability:
    - Minimises cost of meeting an objective reliability criterion
  - Market benefit:
    - Maximises NPV of market benefit having regard to alternative projects & market scenarios

Transgrid's interpretation of allowable market benefits (QNI preliminary assessment, 03/04)

Allowable Market Benefits	Description of Benefit
Production Efficiency Benefits	Reduction in fuel consumption of higher-priced sources Reduction in transmission losses Reduction in ancillary services
Capital Efficiency Benefits	Deferral of generation plant that would be required to maintain reliability reserve margins Deferral of generation plant that could be expected to enter the market in response to sustained high pool prices Reduction in capital costs Reduction in O&M costs Deferral of other transmission investments
Consumer Efficiency Benefits	Reduction in voluntary Demand Side Participation Reduction in involuntary load shedding

Transmission pricing
(existing arrangements; under review)

- Allowed annual revenue (AAR) for network
  - Set by regulator (ACCC), based on:
    - ‘Optimal deprival’ value of the network assets:
      - How would each asset be replaced today if it disappeared?
        - » Considering network & distributed resource options
      - Existing assets and audited five-year expansion plan
    - Allowed rate of return:
      - Depends on the assessed risk of the business
  - Five year reset, (CPI-X) annual adjustment:
    - Pressure to control costs between assessments
    - Incentive to further reduce costs, because profits are retained at least until the next assessment

Transmission pricing within regions
(existing arrangements; under review)

- Recovering AAR from network users
  - Based on assessed use of the network
  - Network elements considered individually:
    - Overall network AAR is assigned to individual elements in proportion to their optimised replacement cost
  - Each network element allocated to a category:
    1. Serve particular network users (*entry or exit*)
    2. Provide a *common service* to all network users
    3. Shared by market customers in an identifiable way:
       - these costs to be allocated in an 'equitable' fashion
       - At present using "Cost Reflective Network Pricing"

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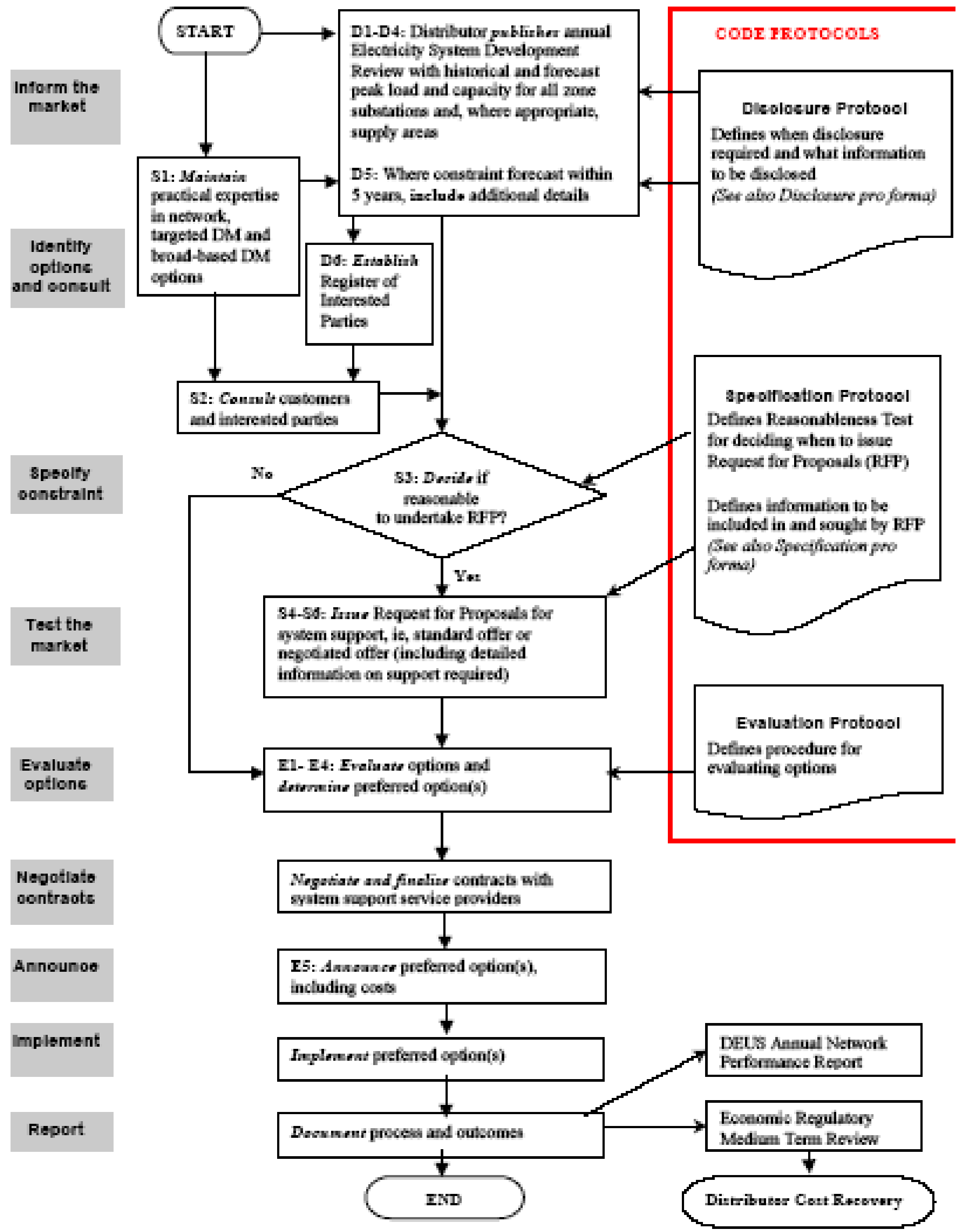
NSW Demand Management Code of Practice for Distributors (May 2004)



Distributor investment considering distributed resources

(NSW Demand Management Code of Practice, 2004)

Inform the market via annual plan

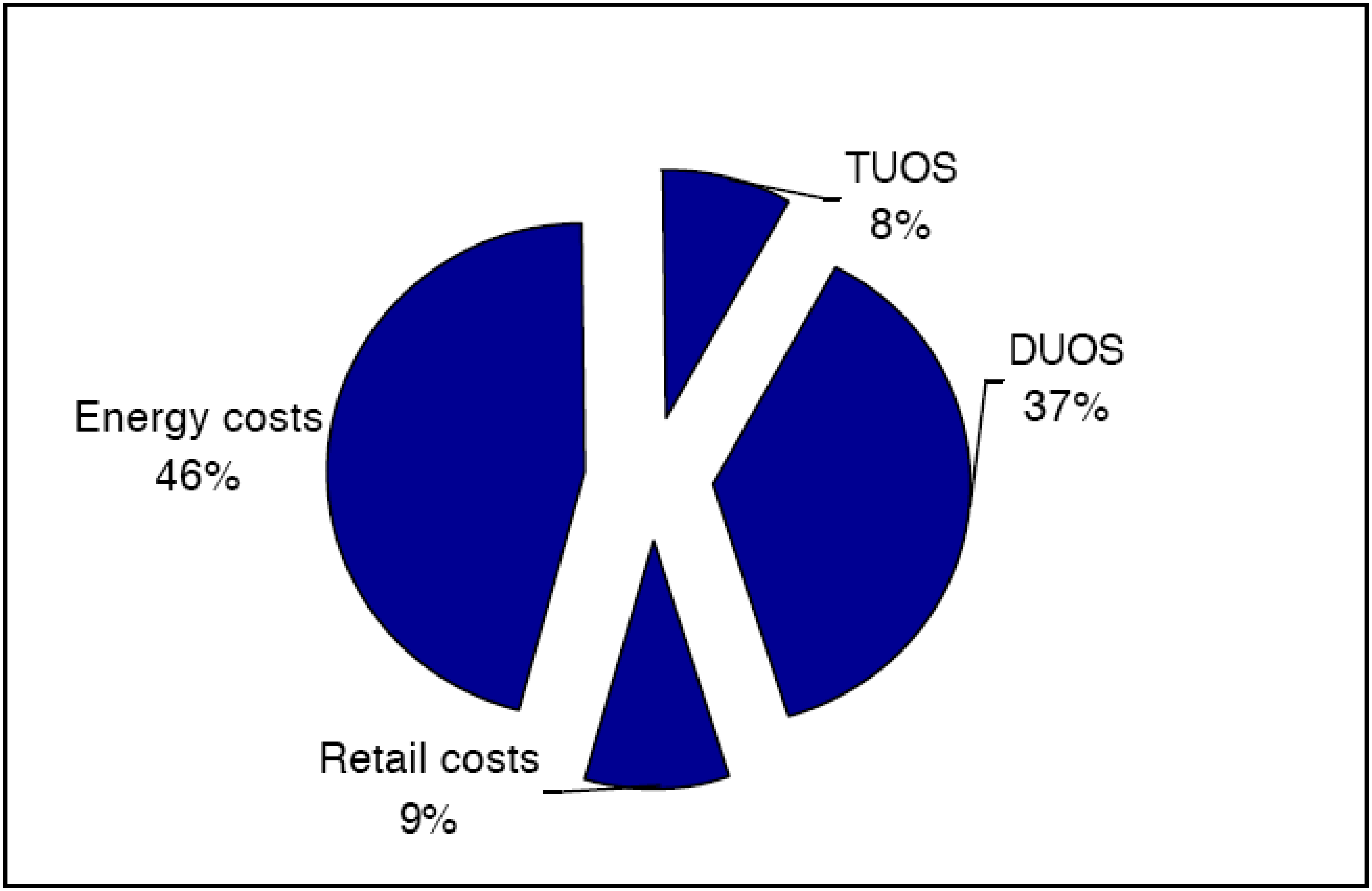
Specify constraints, test the market & evaluate options

DR Offer(s) cheaper:
Negotiate contract(s) with DR providers
(revert to network option if negotiation fails)

Network option cheaper:
Proceed with preferred network option

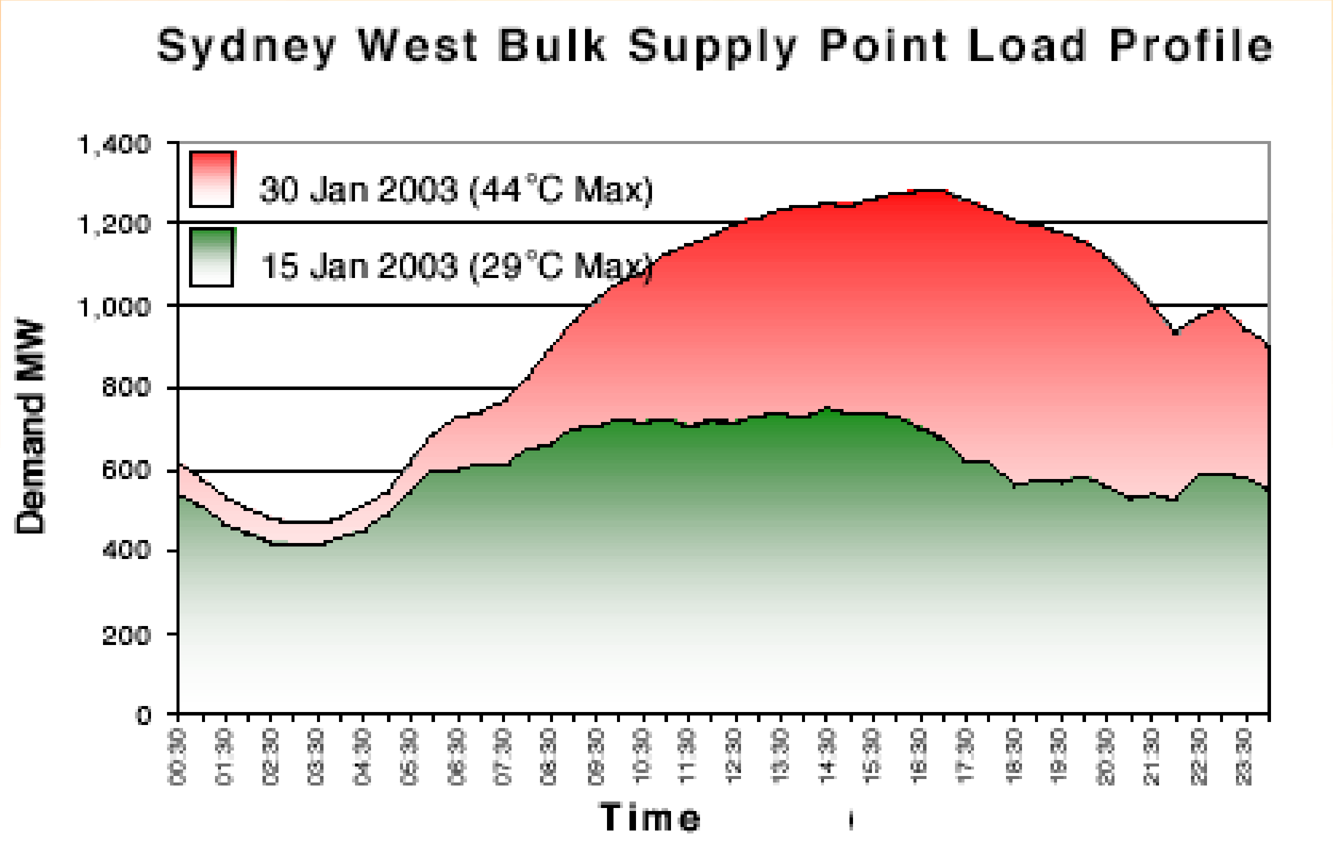
Report outcomes & update plans

Typical NSW residential electricity bill



Residential & commercial air conditioning is the key driver for peak demand growth

(IE Submission, IPART DNSP Review, 2003)

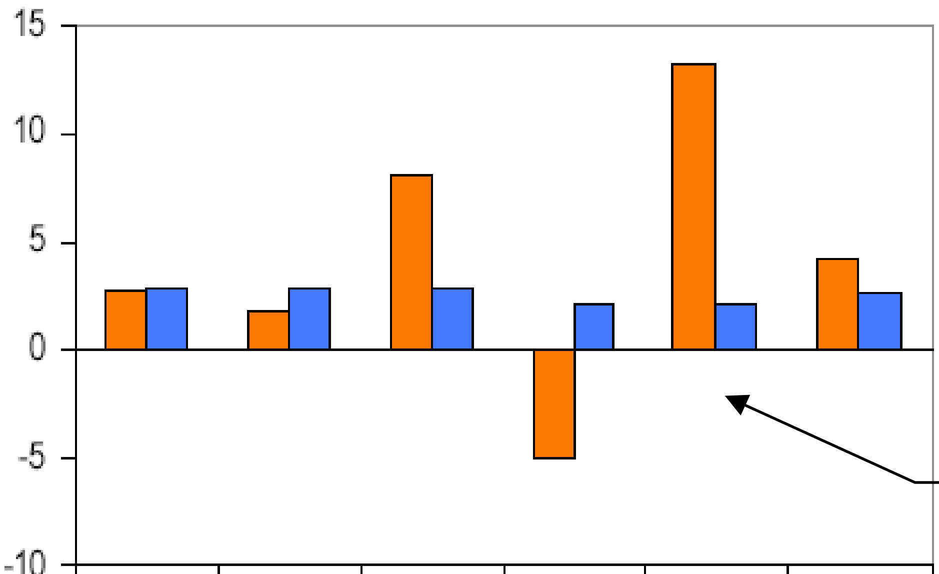


EnergyAustralia summer peak

Summer peak actual vs forecast

1999 - 2003

Annual Growth (%)



	1999	2000	2001	2002	2003	Avg
Actual	2.8	1.7	8.1	-5	13.3	4.2
1998 Forecast	3	3	3	2	2	2.6

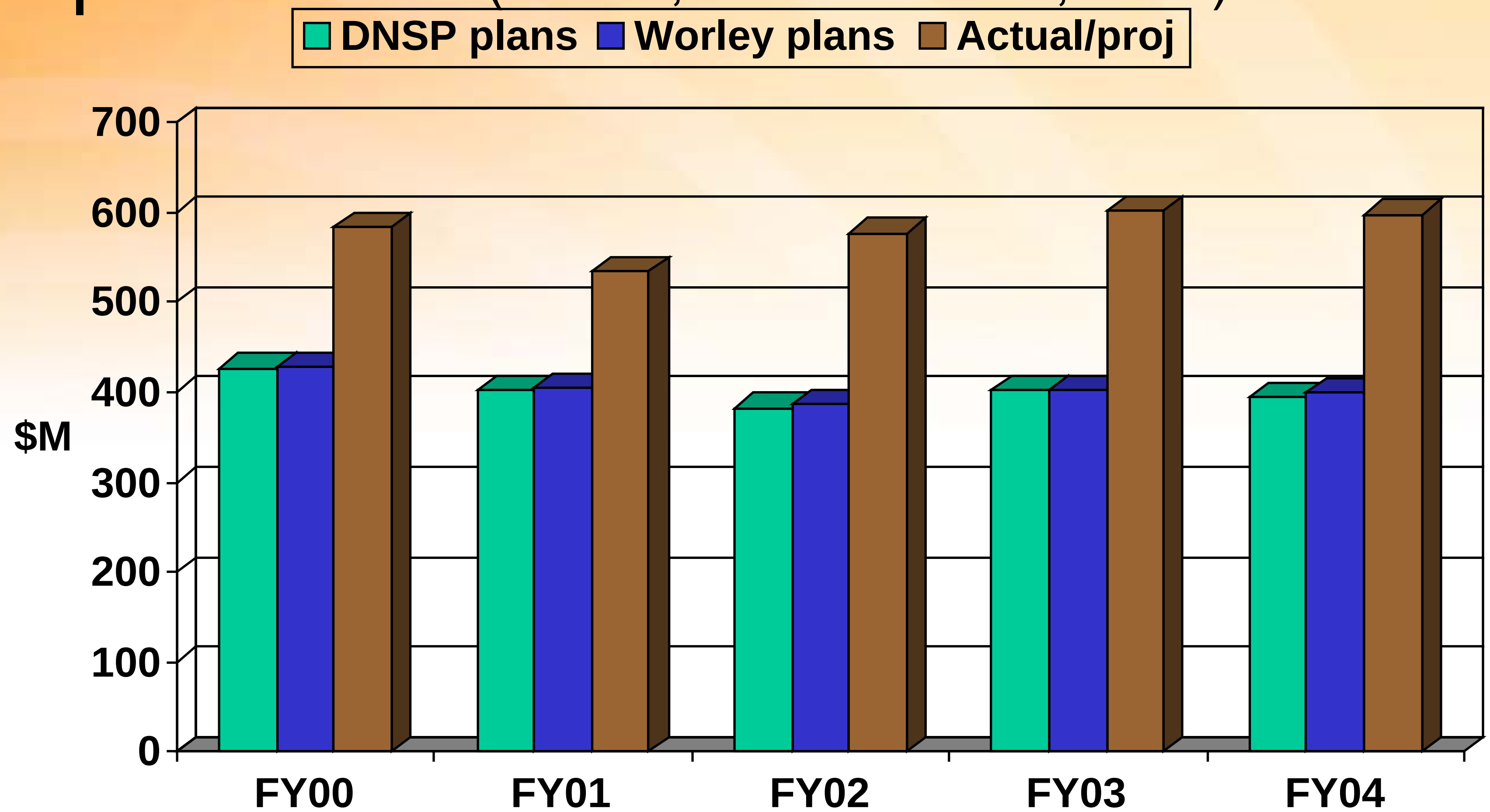
Summer of Year

Actual summer demand growth

- EnergyAustralia moving to summer peaking
- Shape of summer demand de-rates existing capacity.

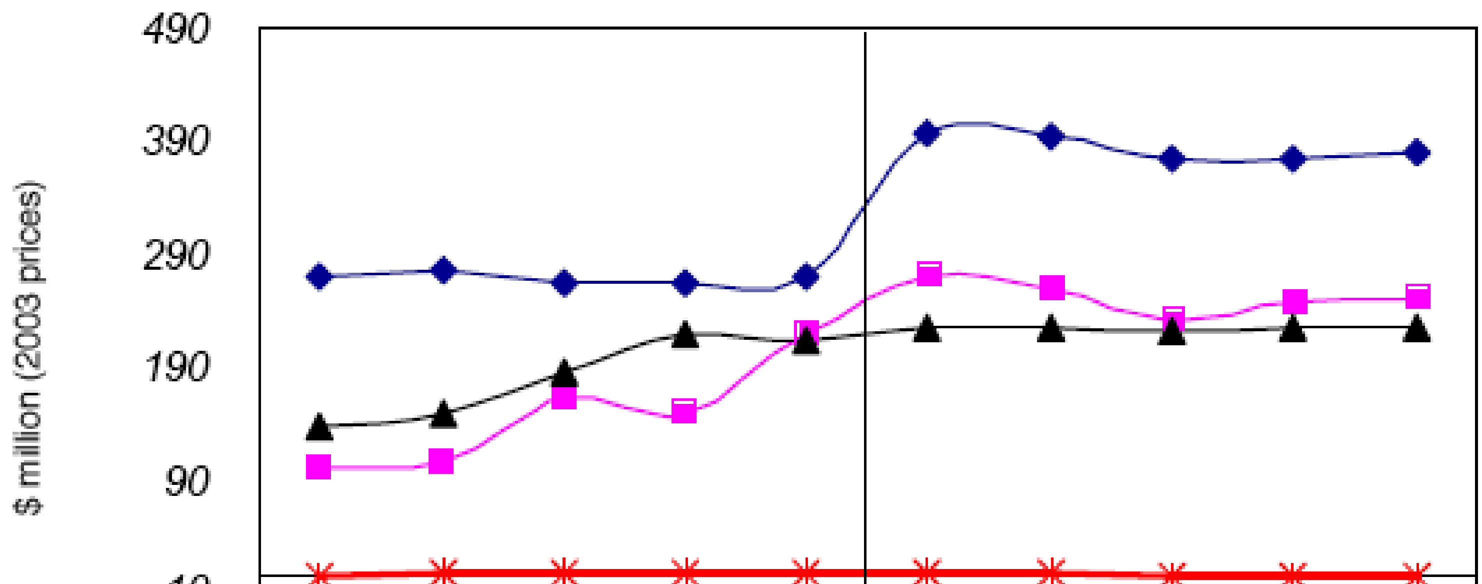
Uncertain weather-driven needle peak demand

Actual & projected DNSP capital expenditures (IPART, DNSP Review, 2003)



Capital expenditure greater than expected due to unanticipated growth in demand

NSW distributor actual & forecast



	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Energy Australia	271	275	264	263	270	398	394	374	375	379
Integral Energy	101	106	162	148	218	270	257	230	248	249
Country Energy	138	148	185	218	213	225	224	222	224	224
Australian Inland	3	3	4	3	5	3	3	3	2	2

Conclusions

- Network services:
  - Vital to an electricity industry but hard to separate from generation & demand-side services
- Network services in a restructured industry:
  - HV transmission services can be:
    - Modelled in an electricity market
    - Made partly competitive
  - Sub-transmission & distribution:
    - Regulated at present, likely to remain so
    - Can be partly contested by distributed resources