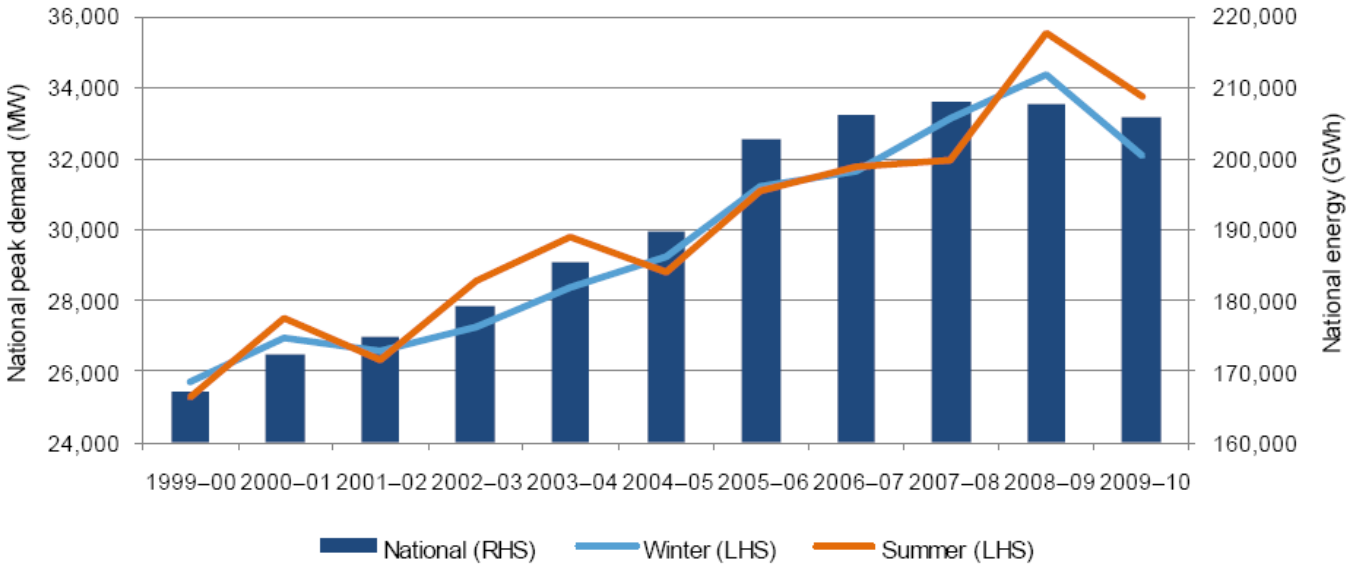
THE UNIVERSITY OF QUEENSLAND
AUSTRALIA

Modelling the broader deployment of demand side management onto the Australian National Electricity Market

By
Liam Wagner
Craig Froome
John Foster

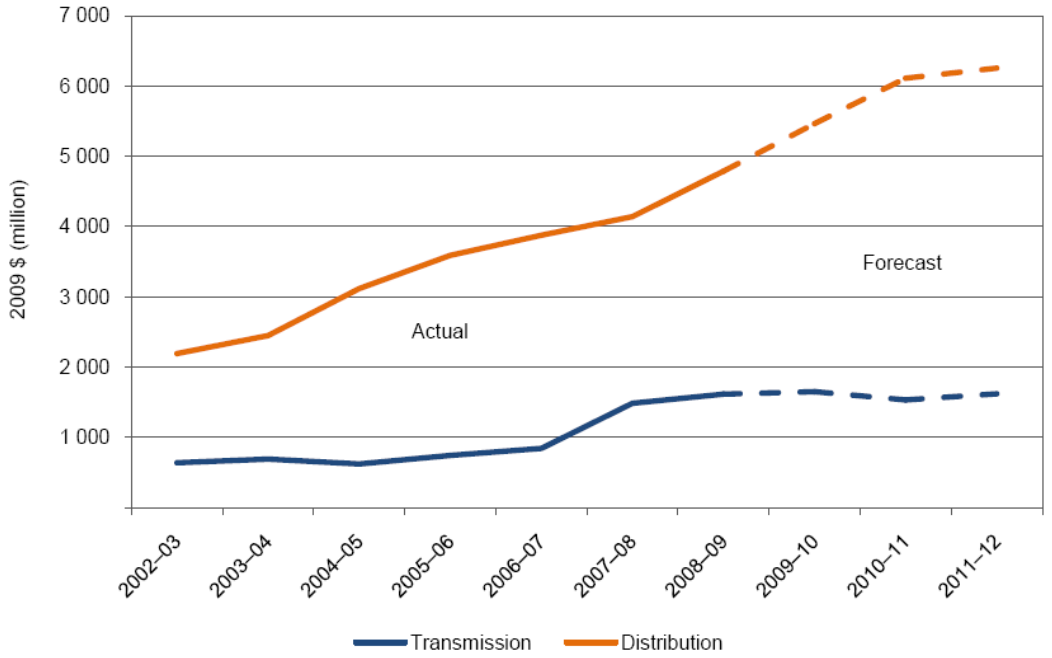
Demand Side Participation

- Australia's National Electricity Market has barely any DSM
- Demand Side Participation has been shown before in other studies to
  - Reduce potential Capex expenditure on transmission
  - Reduce volatility in spot markets
  - Potentially reducing emissions

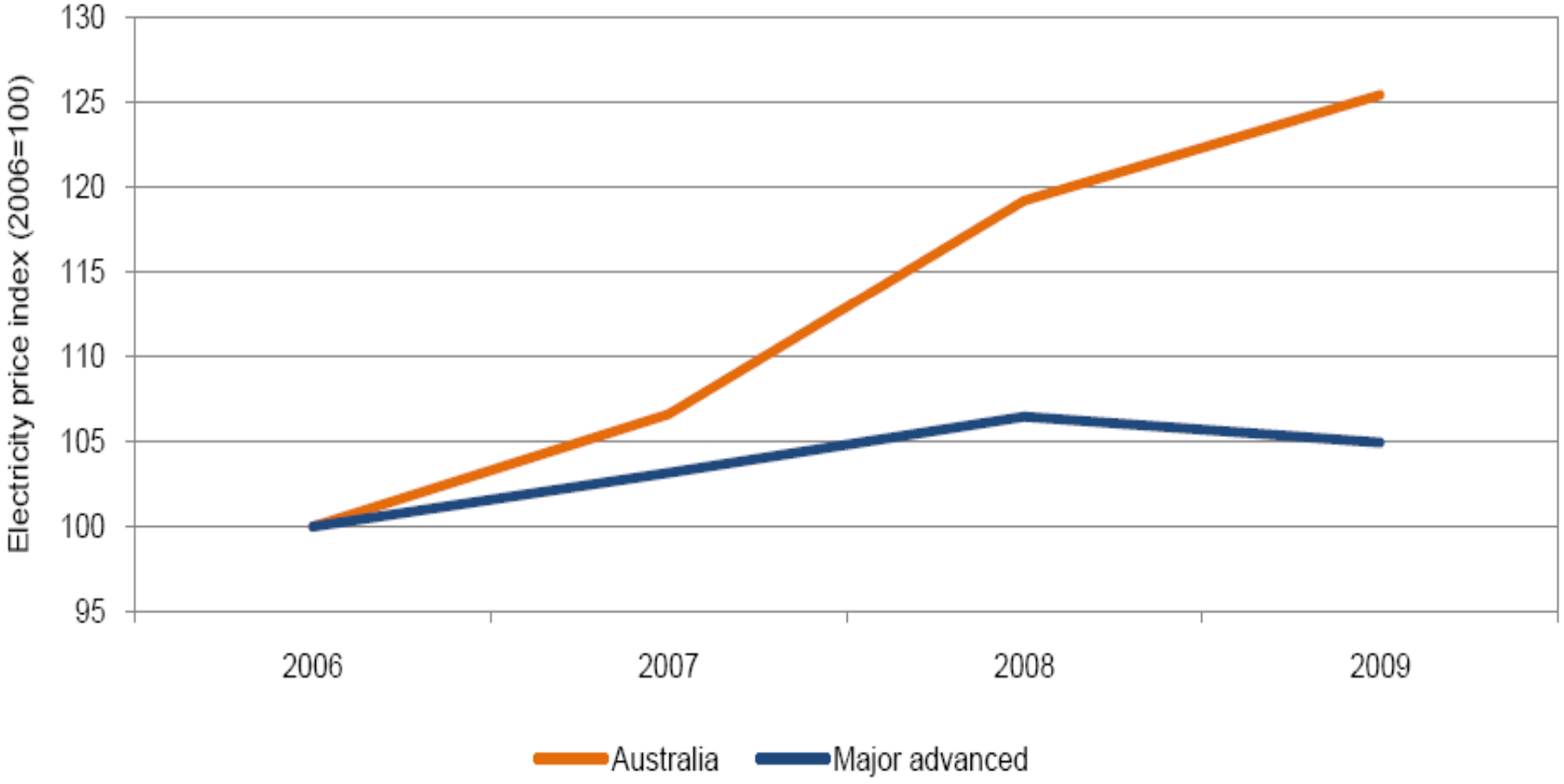


•Peak Demand Has been Growing
By record levels
•2008-2009 Peak in QLD grew 8%

Investment in Transmission and Distribution Infrastructure is rapidly growing



Real electricity prices in Australia and the seven major advanced economies, 2006 to 2009, index in US dollars



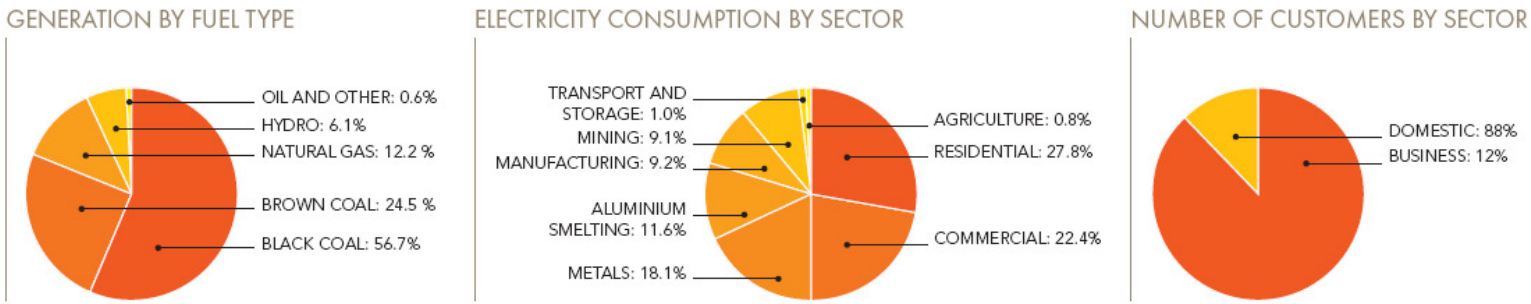
Source: IEA 2009, OECD 2010.

The ~45 GW supply-side covers all of eastern Australia:

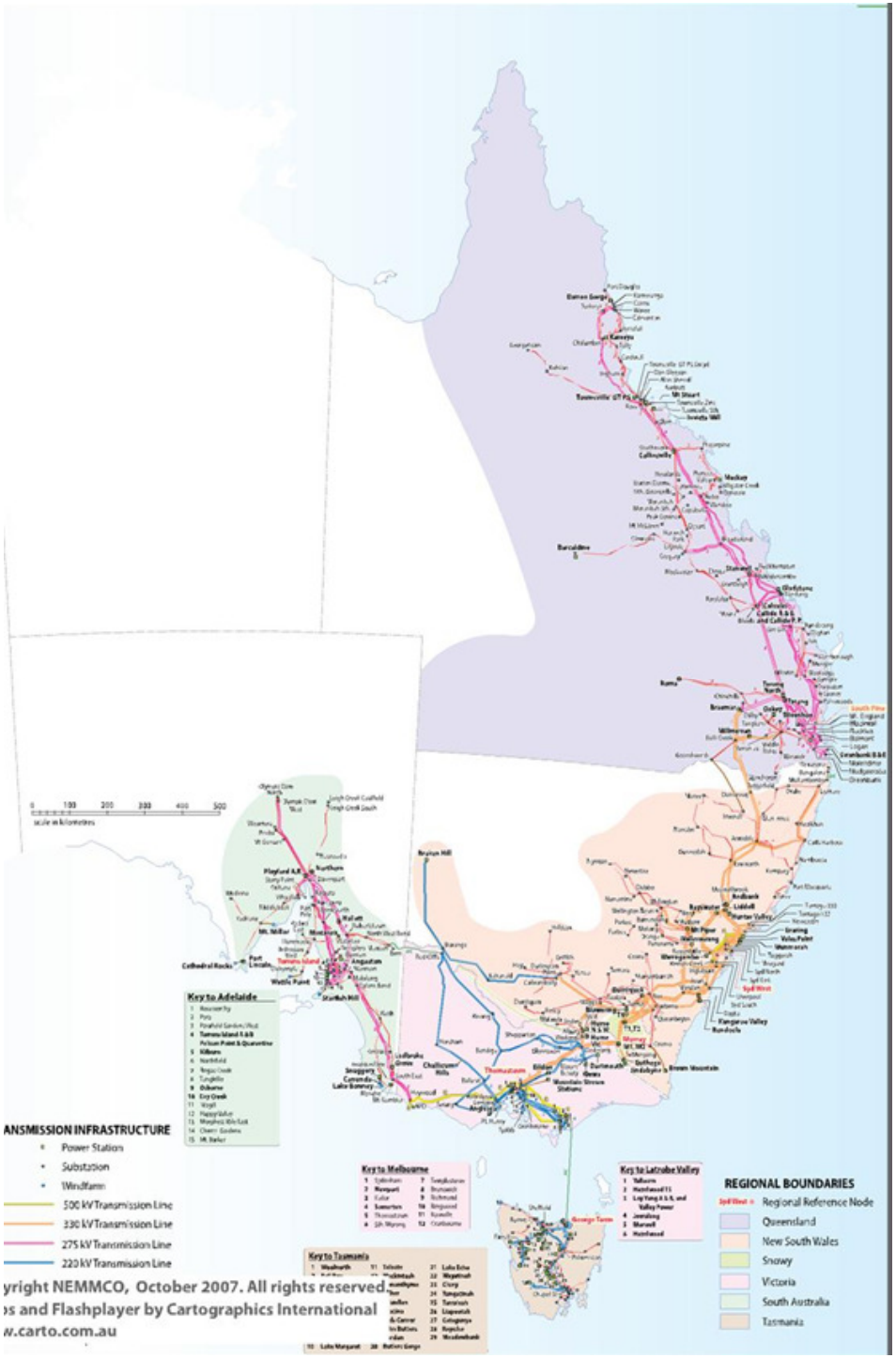
- Queensland ~14,000MW
- New South Wales ~13,000MW
- Snowy Mountains 3,700MW
- Victoria 8,600MW
- South Australia 4,000MW
- Tasmania 2,500MW

The demand-side:

- Aggregate demand (simultaneous) 32,000MW
- Aggregate energy 205,000GWh
- CO2 emissions at approx 180Mt, about 35% of the national total

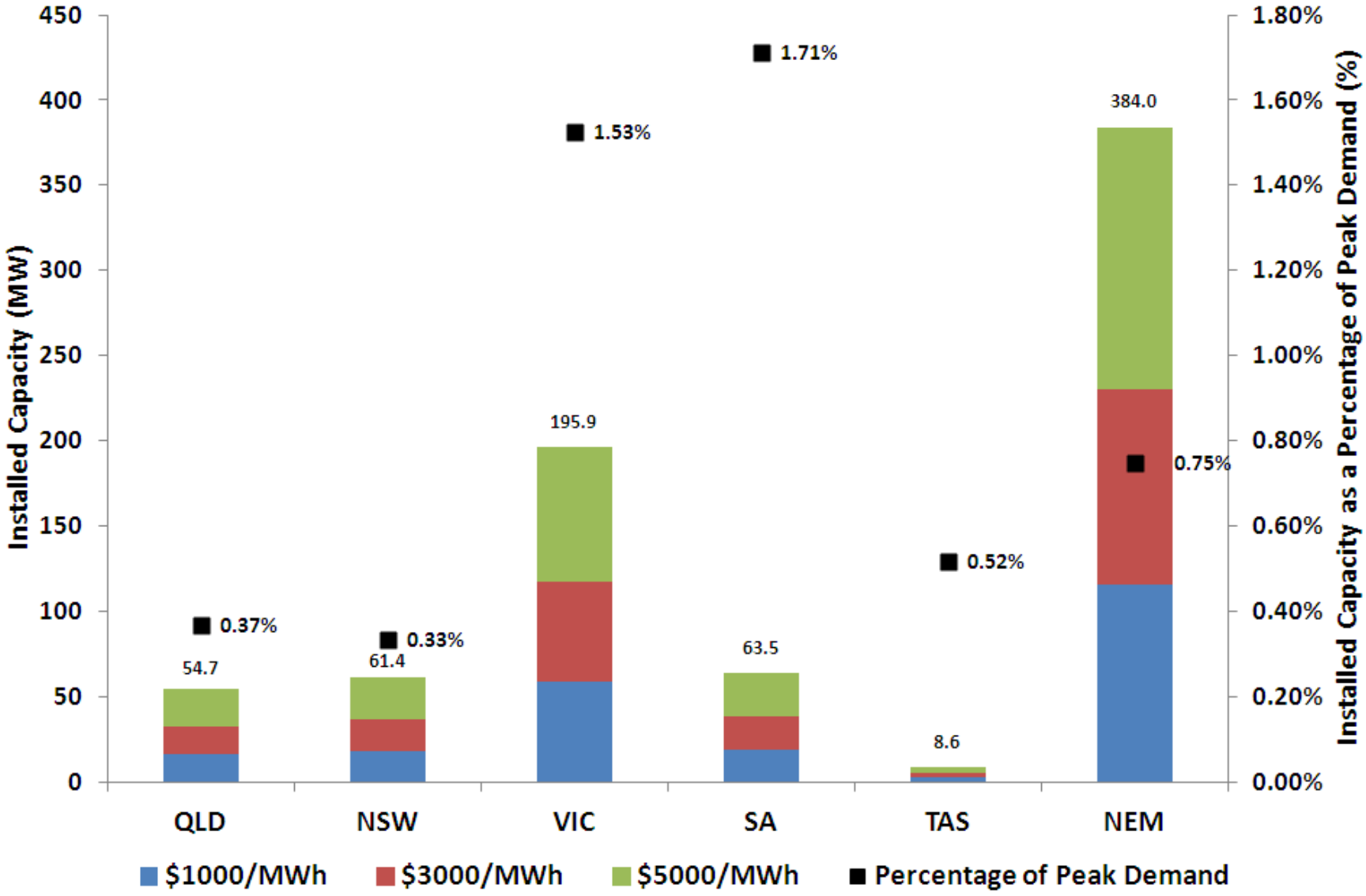


Source: An Introduction to Australia's National Electricity Market, July 2009
Australian Energy Market Operator (AEMO)



Source: NEMMCO Statement of Opportunities 2007

Current Deployment of DSP in the



Regulatory Review of DSP

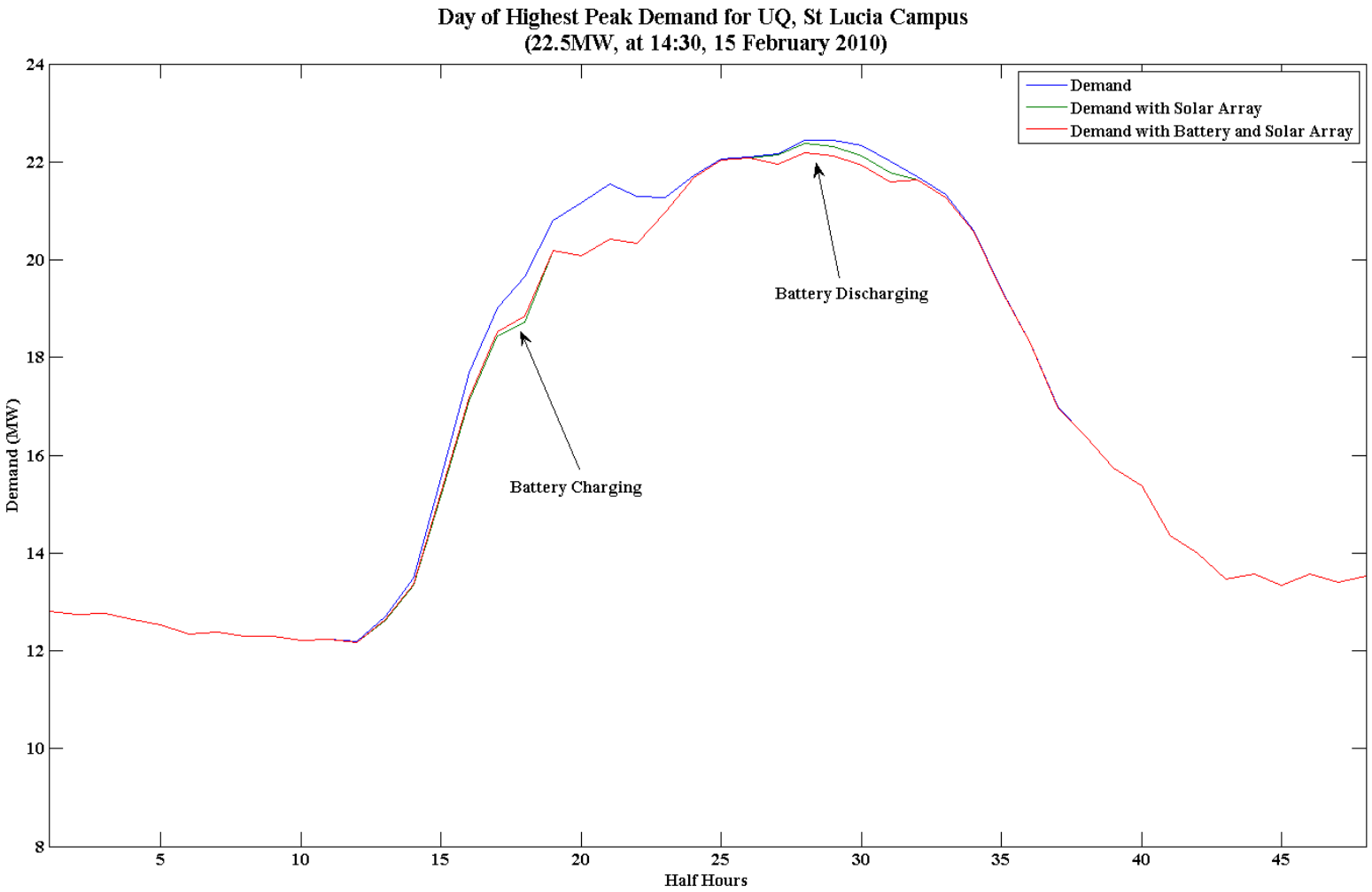
- Australian Energy Market Commission has reviewed DSP in the NEM 3 times
- Final review which may bare some fruit has identified three market features which can contribute the promotion of DSP:
  - Peak shifting
  - Electricity conservation
  - Fuel switching
  - Distributed Generation
  - Energy Efficiency
- Market and Regulatory frameworks will be more of a challenge

Large Scale Solar with Storage

- University of Queensland 1.22MW
- 1.211MW Solar PV
- 8.5 kW Concentrating Photovoltaic

- 400kWh of Storage (Zinc-Bromine)

Example of Peak Shaving



Australia's Carbon Abatement Scheme

Passed House of Representatives yesterday!

Will pass the Senate Tomorrow and Promulgated in another 30 days

- Price on carbon emissions will initially take the form of a Tax
  - $23 July 2012
  - $24.15 July 2013
  - $25.40 July 2014
- From July 2015 a Cap and Trade scheme will be introduced
- Monthly Auctions of Credits
- $50 Penalty price (Post 2015)
- 50% Cap on the importation of international credits
- Initial commitment to a minimum 5% cut in emissions
- Assistance to stationary energy production for 5 years
  - Only brown coal generators will receive assistance under this scheme.

Modelling

In this initial modelling we consider the first target year in the carbon pollution reduction scheme of 2020. The following three policy frameworks were modelled as follows:

- **Business-As-Usual (BAU) case with CPRS -5%:** The CPRS is introduced in combination with the renewable energy target to reach an overall reduction of emissions by 5% below 2000 levels. The price of emissions permits reaches approximately ~$40 t/$CO_2$ in 2020.
- **CPRS -5% and 5% of Peak Demand as Installed DSP:** Roughly ~2600MW of Installed Capacity
- **CPRS -5% and 10% Peak Demand as Installed DSP:** Roughly ~5200MW of installed Capacity

Demand Side Participation

- The roll out of DSP could have a significant effect on the NEM
- Deployment of rapid start/ramp up plant could significantly reduce extreme price spikes (especially at peak time)
- Recent study on Distributed generation suggests a reduction in volatility and average prices

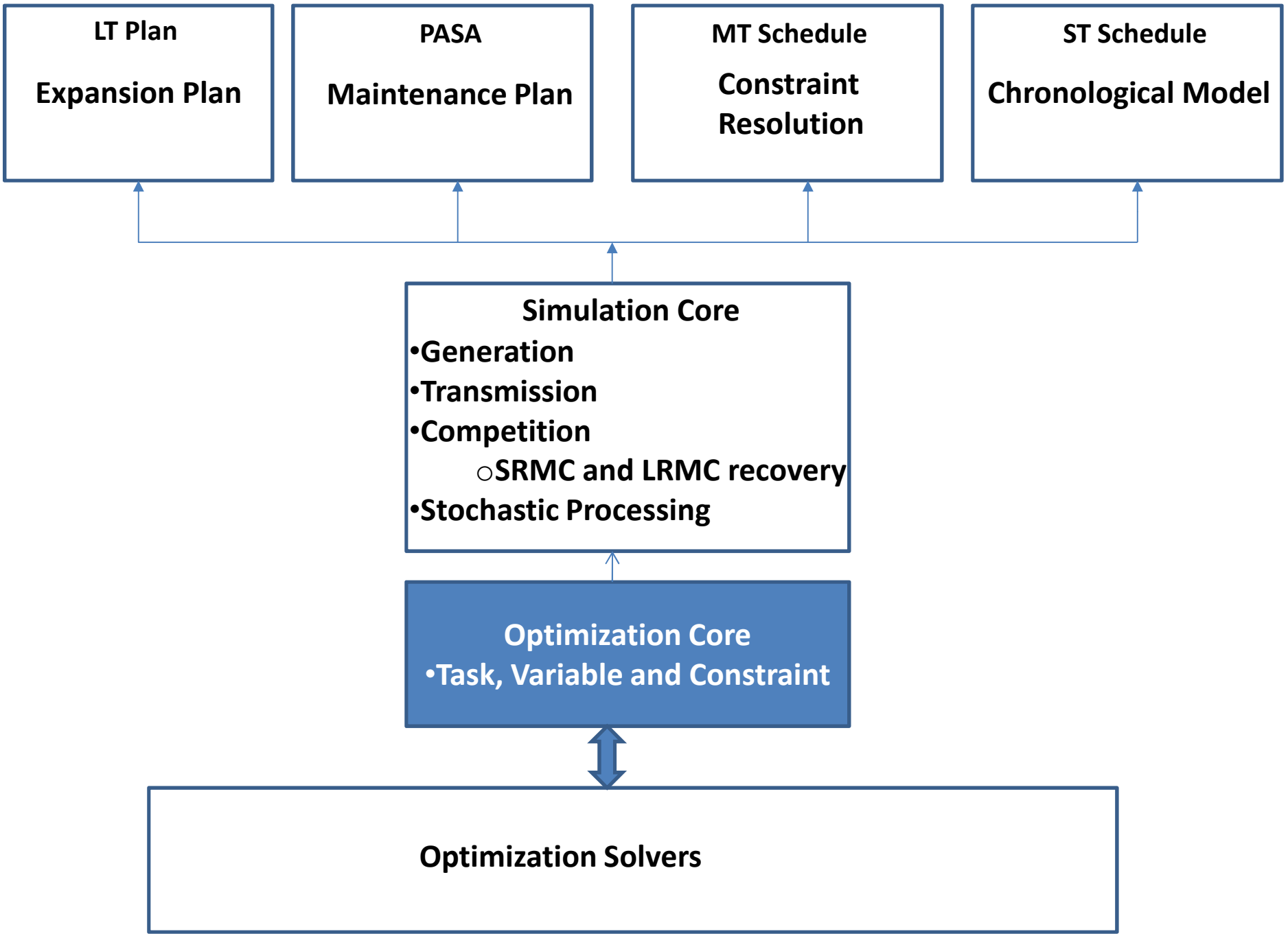
DSP Technology Types

Variety of Embedded and Distributed Generation options available to

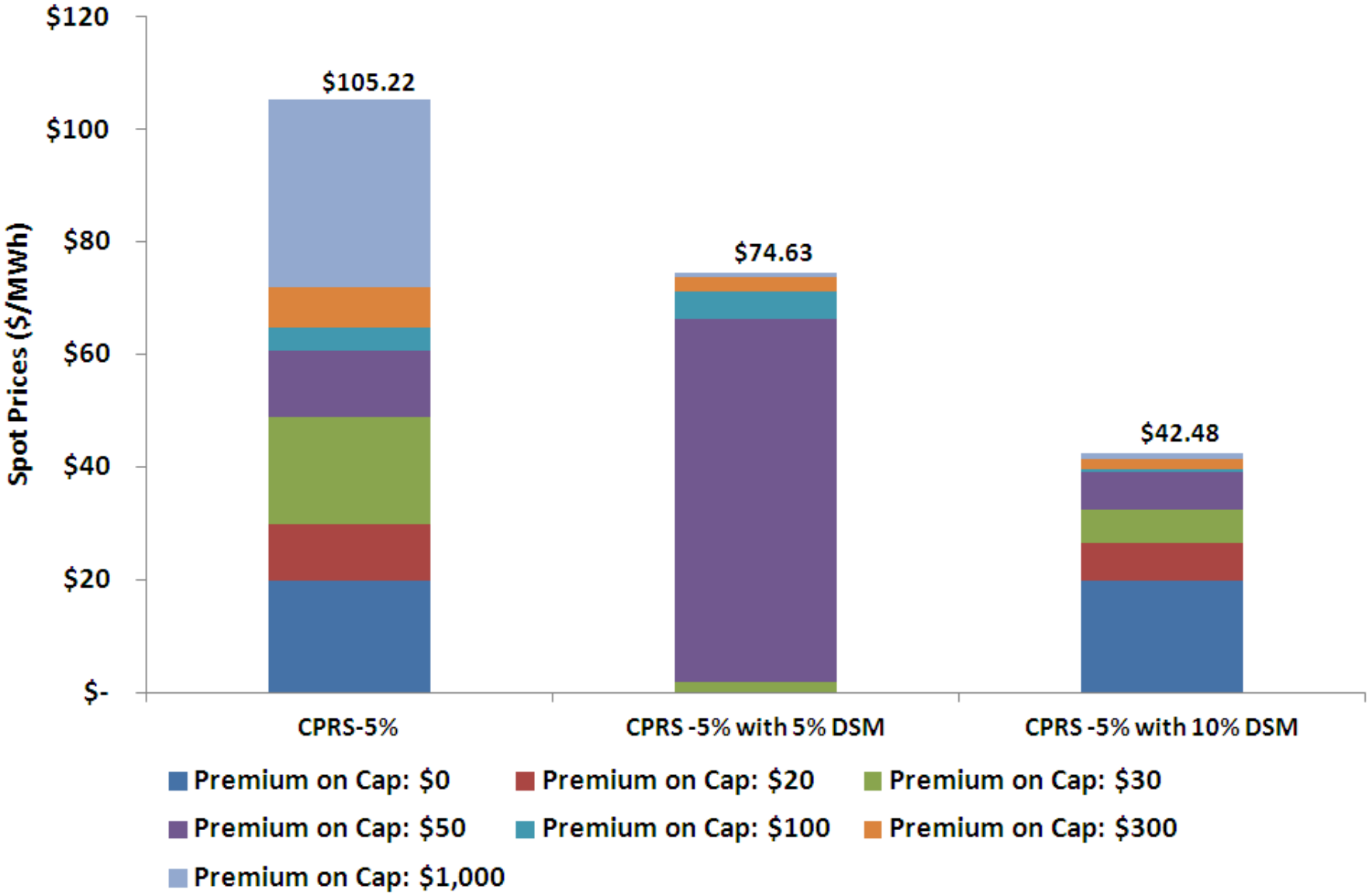
- Gas combined cycle w. CHP 30 MW
- Gas microturbine w. CHP 60 kW
- Gas reciprocating engine 5 MW, 500 kW and 5 kW
- Gas reciprocating engine w. CHP 1 MW and 500 kW
- Biomass steam w. CHP 30 MW
- Diesel engine 500 kW
- Wind turbine 10 kW and 1kW
- Biogas/landfill gas reciprocating engine 500 kW
- Gas fuel cell w. CHP 2 kW
- Gas microturbine w. CCHP 60 kW
- Gas reciprocating engine w. CCHP 5 MW and 500 kW
- Battery Storage 500kW to 1MW
- Solar PV 40 kW and 1MW

Plexos Simulates

- Optimal dispatch of generators across the NEM.
- Optimal bid stack formulation for each station for Short Run and Long Run Marginal Cost (SRMC and LRMC) recovery.
- Merit order of dispatch formulated based on bid stack.
- Physical operating characteristics of each generating unit
- Portfolio optimisation and emissions profiles
- Transmission and Interconnector flows.


LT Plan
Expansion Plan
PASA
Maintenance Plan
MT Schedule
Constraint Resolution
ST Schedule
Chronological Model
Simulation Core
•Generation
•Transmission
•Competition
○SRMC and LRMC recovery
•Stochastic Processing
Optimization Core
•Task, Variable and Constraint
Optimization Solvers

Results


$120
$100
$80
$60
$40
$20
$-
Spot Prices ($/MWh)
$105.22
$74.63
$42.48
CPRS-5%
CPRS -5% with 5% DSM
CPRS -5% with 10% DSM
Premium on Cap: $0
Premium on Cap: $20
Premium on Cap: $30
Premium on Cap: $50
Premium on Cap: $100
Premium on Cap: $300
Premium on Cap: $1,000

Results

- Significant reduction in volatility with increasing deployment of DSP
- Deferral of network infrastructure is relatively minor with only 5% installed DSM
  - Mainly in Queensland and Victoria
  - However this will require more modelling
- DSP at 10% however may reduce transmission capex by 2020

Conclusion

- Demand Side Participation and Management is by no means new
- Australia lags greatly behind in efforts to deploy smart grids and DSP
- 10% while ambitious is certainly a target Australia should consider
- Contribution of DSP to the NEM should be recognised by some incentive structures for participants.
  - But will mostly be exhibited by reductions in retail commercial/industrial and consumer tariff prices
- Smart grids with greater consumer demand agility and peak shaving is the best way to ensure that we don't continue to replicate recent retail price rises