APPENDIX 1 - SIMULATION PROCESS AND ASSUMPTIONS

The Simulation Process

BENCHMARKING

The market simulation and analysis in this project was separated into a number of steps, the first of which is a comprehensive benchmarking exercise, establishing the basic parameters against which the market development will be built. This stage is particularly important as failure to properly establish a realistic starting point will result in a potentially incorrect final assessment of market signals for new investment over time.

The benchmarking exercise consisted of developing a complete data set that, closely replicates the performance of the actual market from a given period. This is done in a number of steps.

The first step basically establishes that when the model is provided with the information on which actual market dispatch was made that it reproduces the original outcome. This is done by providing the model with a complete set of offer, cost, performance and availability information for each generator in the NEM, actual interconnector limits for all of the notional interconnectors and the actual NEM demand for each period.

Over a number of stages this fully described dataset is resolved into mathematically equivalent variable arrangements designed to accurately represent what actually happened but are applicable to future market development. The first mathematical approximation is to replace the actual interconnector limits by the complex set of limit equations which are representative of the complete set used in actual NEM dispatch. The next is to establish suitable forced and maintenance outage parameters to replicate the actual generator and transmission line performance. The third and most challenging stage is to develop a set of costs, contractual arrangements and other instruments to attempt to replicate the behavioural drivers of the generators in the NEM. The validity of each of these mathematical approximations is tested against:

- the volume weighted regional price and regional price duration curves (PDC)[3];
- the flow duration curves (FDC)[4] for each of the inter-regional flow paths; and
- the typical generator performance (number of starts, service factor, capacity factor and available capacity factor).

FORECASTING

The dataset prepared and verified in the benchmarking process was then used to develop a ten year price and dispatch forecast for the NEM including Tasmania. The inclusion of Tasmania adds

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[3] The Price Duration Curve is produced by a statistical analysis of the relative frequency of regional reference node prices.

[4] A Flow Duration Curve is calculated in the same manner as a price duration curve, however it is based on the frequency of power flow in either direction for a specific interconnector path.

significantly to the complexity of modelling assumptions as it presents not only an as yet undefined set of potential generator behaviours, but also a significant and complex water resource management issue.

Once the benchmark studies have been satisfactorily completed the forecasting process commences. Key to this analysis is the interpretation of new entry conditions. The model used by the Planning Council has the ability to automatically assess investment opportunities, provided it is supplied with a comprehensive representation of new entrant cost and performance parameters.

As previously discussed, the Planning Council has considered the new entrant cost parameters as developed for ESCOSA and by ACIL Economics for NEMMCO and created a set of appropriate new entry generators for each region of the market. The physical cost of energy production is not, of course, the only consideration for the development of new capacity. There is a complex interrelationship between the physical cost of implementation and the management of wholesale market risks mitigated through the contract market. So that the Planning Council analysis may better incorporate at least part of this interrelationship external advice has been sought and constitutes a significant part of this assessment.

The PLEXOS model develops a relatively coarse assessment of the likely price duration curve that would be produced in each year given fixed input assumptions. By integrating the area defined by the Y axis and the PDC above the SRMC value it is possible to calculate the potential revenue a generator could make if it is to operate continuously for all regional prices above that level. This represents a significant but unavoidable approximation. It assumes that each generator can operate such that it receives all of the prices above that level which then ignores forced outages and maintenance un-availability. It also assumes that the new entrant is able to be fully dispatched as soon as prices reach that level and can then be fully de-committed for all prices below that level which ignores the physical start up / shut down performance of the machines. The model can then roughly assesses the potential revenue available above the marginal operation cost of each of the proposed new entrants and compare this to its total cost requirements. The new entrant which has the largest positive margin over their total cost is selected. If this comparison shows that none of the new entrants available at this node can potentially access sufficient revenue to cover their total cost then no new entrants are added. If a new entrant is successful then the price duration curve is modified, representing the market price change that a new entrant would probably produce and the process is repeated.

Assumptions

The simulation of revenue streams, in Australia's National Electricity Market, primarily relies upon developing a view of the forward wholesale price in the NEM over the study period. Price forecasting of this nature is highly dependent on a large number of detailed assumptions as to the technical and commercial behaviour of market participants and the transmission network. A wide range of assumptions need to be made and minor variations in any assumption can have a significant impact on the final price outcome. The establishment and testing of these modelling assumptions, prior to the commencement of the analysis, is time consuming.

The following is a brief summary of the key assumptions used in the modelling.

- Only gas fired new generators considered;

- 385 MW CCGT units in NSW, QLD and VIC;
- 240 MW CCGT units in SA;
- 160 MW OCGT units in all States;

The assumptions used in the Planning Council modelling were consistent with those presented in the 2005 NEMMCO ANTS with the following exceptions:

- Maintenance rates were re-optimised to include a major outage consistent with the operational performance of the generators in the NEM over the full period of its operation;
- Some fuel cost escalators were applied to some sub regions where intense development interest occurred. This reflected the potential increase in transport costs as a result of significant increases in particularly peak demand.

APPENDIX 2 - NEW INVESTMENT HISTORY IN THE NEM

To understand the incentives on participants to explore new investments in the NEM, the Planning Council has first sought to understand of the investment history of the market by examining the increases in capacity that have occurred in contrast to other parameters, such as demand growth, wholesale market price and reserve margin in each region.

Demand Growth

Demand growth in all regions since the start of the NEM has been significant. The growth of actual demand from year to year is not a reliable measure in this case as it is affected by weather conditions that can vary considerably and are the dominant driver on electricity demand. Growth, therefore, has been calculated based on the medium growth 50% Probability of Exceedance (PoE) figures as published in the annual NEMMCO Statement of Opportunities (SOO).

Table 1 shows the growth in demand in each mainland region since the start of the NEM in December 1998 and the ten year forecast of future peak demands as provided in the 2005 NEMMCO SOO. It is interesting to note that, based on these figures, NSW is not anticipating experiencing its peak demand in summer until 2009-10 whereas all of the other mainland States experience their peak demand in summer.

Table 1 - 50% PoE Demand Growth

Year	SA Summer	VIC Summer	NSW Summer	QLD Summer	Year	NSW Winter
1998/99	2,512	7,584	10,220	5,928		
2005/06	3,091	9,260	13,120	8,702	2005	13,140
2014/15	3,804	11,056	16,710	12,245	2014	16,020
					2015	16,340

Additional capacity and New Generation

Since the start of the National Electricity Market, investment in new generation capacity has occurred in all regions. In South Australia and Victoria, capacity enhancements to existing units and investments in new generation appear to have coincided with, or immediately followed, periods where there has been insufficient reserves to provide the reserve margins calculated by NEMMCO as being needed to satisfy the Reliability Panel's Reserve Standard. The size of these new investments has reasonably matched the reserve deficit and resulted in a situation where the reserve margins have, until recently, been maintained.

Significant investments in high capital cost new generation technologies, suitable for high capacity factor duty have occurred in Queensland, without there being predictions of reserve margin deficits. The size, technology, location and configuration of these investments has resulted in increases in the required reserve margins and despite this Queensland has significant over capacity.

Other than the completion of a significant Co-generation plant in Sydney and some enhancement of the maximum available capacity of existing units there has been only one new generator completed in NSW.

Figure 1 – Cumulative New investment capacity by State and technology

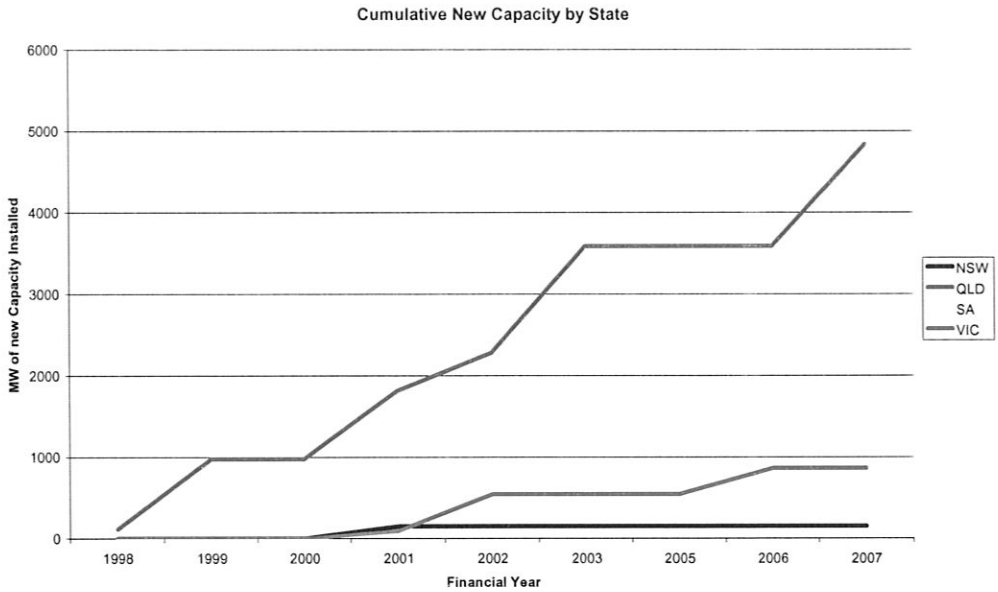

Figure 1 shows the cumulative new investment in each mainland region since the start of the NEM. Comparing the level of new investment with the growth in the 50%PoE peak demand forecast from *Table 1* shows that Queensland is the only mainland state to have installed more capacity than the growth in their 50% PoE demand.

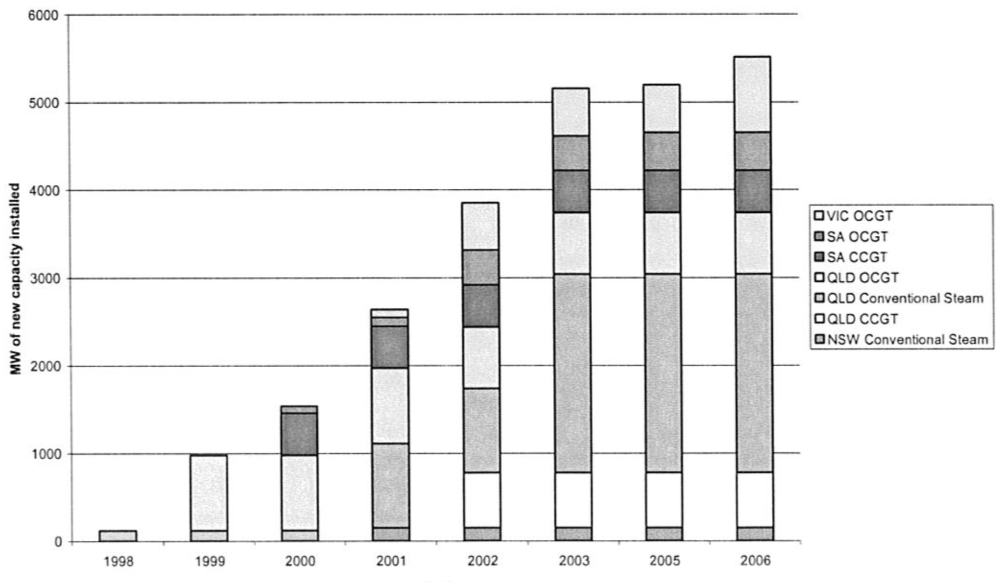

Figure 2 - New investment capacity by State and technology

Figure 2 shows the new generation investments in the National Electricity Market by generation technology since the start of the market.

The following tables categorise the new investments in the NEM but their technology year of development and installed capacity.

Table 2 Open cycle gas turbine new investments.

State	Plant Name	Commissioning Date	Total Installed Capacity (MW)
QLD	Oakey Power Station (Gas)	1999	
QLD	Roma Power Station (Gas)	1999	75
QLD	Mount Stuart Power Station (Gas)	1999	304
QLD	Yabulu (Townsville) Gas Turbine (Initially OCGT converted to CCGT)	1999, 2002 ('add on' 83MW ST)	242
SA	Ladbroke Grove Power Station (Gas)	2000	80
VIC	Bairnsdale Power Station (Gas)	2001	92
SA	Lonsdale Power Station (Reciprocating Diesels)	2001	20
VIC	Valley Power Station (Gas)	2002	300
VIC	Somerton Power Station (Gas)	2002	150
SA	Quarantine Power Station (Gas)	2002	96
SA	Hallet Power Station (Gas / Diesel)	2002	200
SA	Angaston Power Station (Reciprocating Diesels)	2005	40
VIC	Laverton North Power Station (Gas)	2006	320
QLD	Wambo Braemar Power Ventures Pty Ltd (Gas)	Summer 2006/07 (expected)	500

Table 3 Conventional steam cycle new investments.

State	Plant Name	Commissioning Date	Total Installed Capacity (MW)
QLD	Callide A Power Station (refurbishment of existing coal units)	1998 (recom)	120

State	Plant Name	Commissioning Date	Total Installed Capacity (MW)
QLD	Callide C Power Station (Coal)	2001	840
NSW	Redbank Power Station (Coal)	2001	150
QLD	Tarong North Power Station (Coal)	2003	450
QLD	Millmerran Power Station (Coal)	2003	852
QLD	Kogan Creek Power Station (Coal)	2007 (expected)	750

Table 4 Combined cycle new investments.

State	Plant Name	Commissioning Date	Total Installed Capacity (MW)
QLD	Yabulu (Townsville) Gas Turbine (Gas) (Initially OCGT converted to CCGT)	1999, 2002 ('add on' 83MW ST)	242
SA	Pelican Point Power Station (Gas)	2000	478
QLD	Swanbank E Power Station (Gas)	2002	385

The generating technology chosen for the new entrants and their fuel sources has been different for each state in the NEM. The majority of the new capacity built in NSW and Queensland has been high efficiency conventional coal fired steam cycle generation suitable for base load duty, or high efficiency combined cycle gas turbine technology, suitable for base to intermediate duty. Investments in the southern states has been predominantly gas fuelled gas turbine technology of a more peaking nature.

Investment in new capacity in Queensland appears to have been driven by the signals other than the short term reserve margin signals as was the experience in the southern States. Investment in new capacity in each state has been offset by growth in demand **Error! Reference source not found.** provides a summary of the new investment by region and the load growth. **Error! Reference source not found.** also summarised the reserve margins as calculated and published by NEMMCO in the Statement of Opportunities. (got to get them first)

The comparison between the growth in 50% PoE demand predictions and the installation of new capacity is best shown graphically. Figure 3 represents the level of new investment with respect to the growth on the 50% PoE Demand and clearly shows that investments in new capacity for all states other than Queensland has not kept pace with growth in demand. It must be remembered that states, such as NSW, entered the market with significant over capacity so while the level of investment has not kept pace with demand growth there is still adequate capacity available at this time. Significant investments in new capacity in Queensland have far outstripped demand growth while those in South Australia have largely matched demand growth. It shows however that the market should be heading towards a period of significant investment in new generation capacity providing that the appropriate market signals are present to encourage such investment.

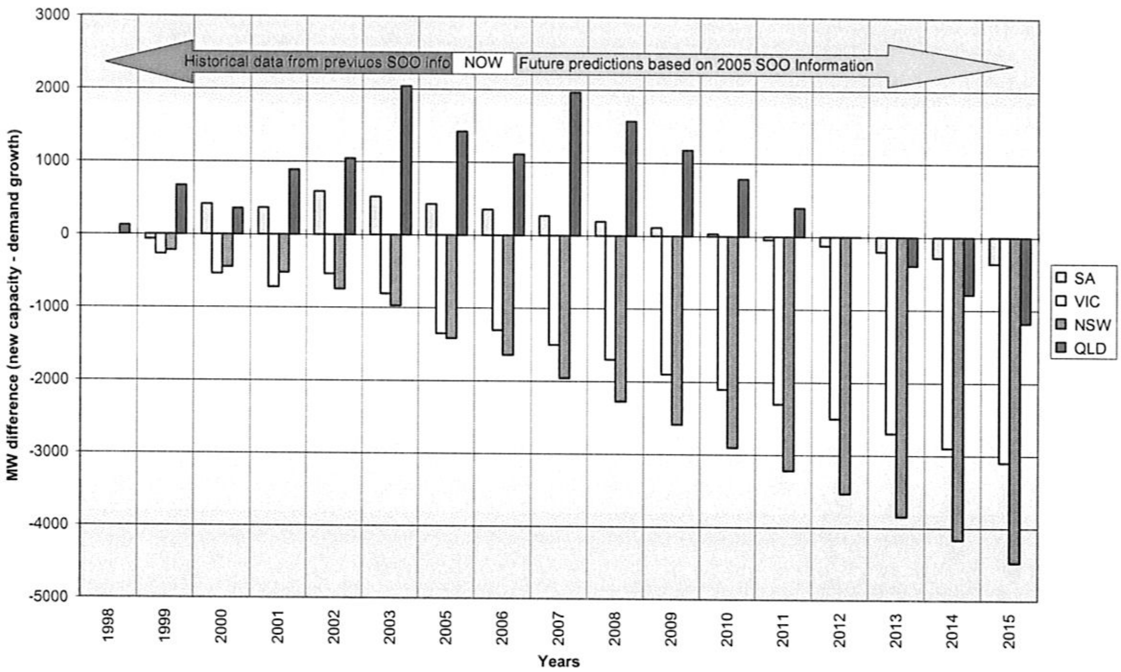

Figure 3 - Capacity Additions over Demand Growth

What is apparent is that the oversupply situation that existed at the start of the market is now gone and all of the mainland states are approaching a point where new capacity is needed. This raises the question therefore as to whether the current market settings will deliver the required levels of new investment needed to maintain reserve margins and arrest the declining ratio of capacity to demand.

I would welcome the opportunity to discuss any of the matters raised above with you or your staff.

Yours sincerely

David Swift
CHIEF EXECUTIVE