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REPORT (TRG00010) TO

NATIONAL ELECTRICITY MARKET FORECASTING

Scenarios for Revenue Reset Application: 2009-10 to 2013-14

20 February 2008

EXECUTIVE SUMMARY

To assist TransGrid in identifying the likely areas of network development over the next Revenue Reset period from 2009/10 to 2013/14, potential generation development paths for the region of New South Wales over the next ten years have been assessed through the application of a scenario analysis methodology.

This analysis was completed in February 2008. All inputs to the modelling were developed from publicly available information. ROAM recognises that information may have been released since this time, which may reduce or increase the likelihood of projects assessed in this report. The release of subsequent announcements, reports, and government policy, such as the decision to lease existing electricity generators to private operators, may impact upon the underlying assumptions used in this report.

The methodology is based on the identification of four separate 'theme sets' defining the direction of the energy sector in the region of New South Wales. These theme sets relate to:

- Market demand for grid supplied electricity in NSW;
- The availability of water to both thermal wet cooled and hydroelectric plant in the NSW, Queensland, Snowy, Victoria and Tasmanian regions;
- Potential for increased interconnector capability between Queensland, Snowy and NSW regions, and;
- Influences on new generation projects stemming from the imposition of a more rigorous greenhouse gas abatement policy and including the potential for increased availability of gas in NSW.

The generation developments that have been assessed cover a mix of thermal gas and coal fired plant, wind generation and other renewable technologies including biomass. The level of new entrant generation required to support the growth in demand even in low load growth and increased interconnection scenarios is considerable. A reasonable mix of technologies is therefore necessary in order to provide a reliable and secure supply network.

The increased uptake of wind generation in New South Wales is not expected to have a significant effect on the overall level required of the various technologies of scheduled generation. The intermittency of wind dictates that only a small proportion of the total capacity provided by these stations should be allowed for in minimum reserve margin calculations[1]. Therefore, even if a high proportion of all announced wind projects proceeds (say 1300MW) there would still be considerable need for other coal, open cycle gas and combined cycle gas plant to sustain load growth.

ROAM has incorporated the latest information from the 2007 TransGrid Annual Planning Report and the 2007 NEMMCO Statement of Opportunities (and subsequent update) documents in this analysis.

[1] Minimum reserve margin calculations by NEMMCO set the lowest level of installed capacity in each region of the NEM to meet the reliability standards set by AEMC's Reliability Panel.

The following table summarises the themes, which were developed and studied in this scenario analysis:

Table A – List of Themes Studied

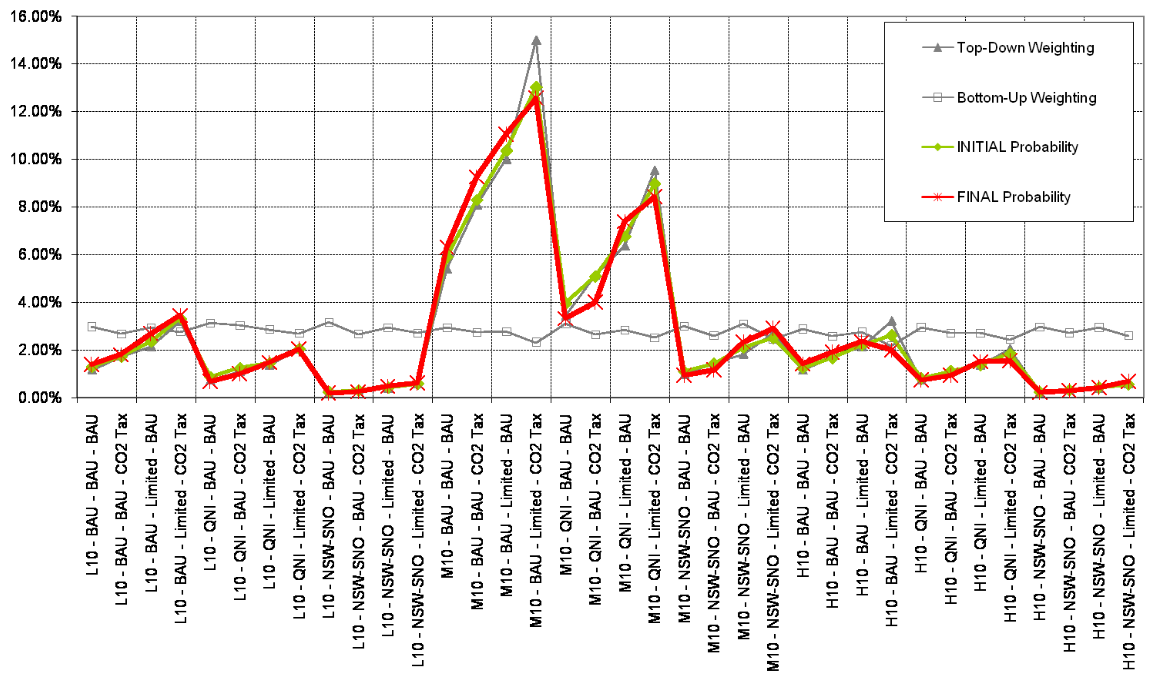
1. Load Growth		2. Inter-Regional Trade	
Theme	**Description**	**Theme**	**Description**
L10[1]	Low economic growth with 10% probability of exceedance demand.	BAU	Inter-regional trading levels maintained at current levels.
M10	Medium economic growth with 10% probability of exceedance demand.	QNI	Queensland – New South Wales Interconnector (QNI) upgrade increases bi-directional transfer capability by nominally 500MW. New South Wales - Snowy Interconnector remains at current levels.
H10	High economic growth with 10% probability of exceedance demand.	NSW-SNOWY	New South Wales - Snowy Interconnector upgrade increases bi-directional transfer capability by nominally 500MW. Queensland – New South Wales Interconnector (QNI) remains at current levels.
3. Water Availability		**4. Greenhouse Policy**	
Theme	**Description**	**Theme**	**Description**
BAU	No water restrictions in place, following a return to satisfactory levels for major hydro and thermal station water storages across the Eastern States.	BAU	Current State and Federal greenhouse policies are maintained consistent with present arrangements. Coal projects are in the minority but remain economically favourable.
LIMITED	Persistent water restrictions / low rainfall restrict output from Snowy Hydro, Victorian and Tasmanian hydro-electric capacity and NSW/QLD wet cooled thermal generating plant. Peak generation capability of wet cooled thermal plant is maintained at current maxima.	CO_2 Tax	Significant change in greenhouse policy, with the introduction of a nominally \$35.00/t CO_2-e tax/trading scheme. New coal projects highly unlikely. Additional gas supplies made available. Increased incentive for renewable technologies.

Using the combination of these four theme sets, thirty six discrete development scenarios were constructed encompassing a range of widely differing market development paths. The relative likelihood of each of these development paths was assessed using a probabilistic methodology, which takes a ‘Top-down’ theme-based approach and a ‘Bottom-up’ individual project-based approach and combines the two strategies, through a process of moderation.

[1] Reliability standards in the National Electricity Market (NEM) are based on ensuring that installed generating capacity in each region is sufficient to meet 1 in 10 year peak demands, which are here referred to as L10, M10 or H10, depending on the respective economic growth scenario.

The following chart summarises the relative probabilities determined for each of those thirty six scenarios (final probabilities marked in red):

Figure A – Final Scenario Probabilities



The outcome of the scenario analysis as seen in the chart above is a set of thirty six scenarios which have corresponding generating plant installation programmes matching the projected state peak demand and at least meeting the NSW minimum reserve margin. The probability that has been determined for each of these scenarios varies significantly. Nevertheless it may be important for TransGrid to address each of the scenarios in order to provide a reliable view of the variability of future generating patterns.

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1 INTRODUCTION

In support of its next regulated revenue application covering the period 2009-10 to 2013-14, TransGrid has requested ROAM Consulting (ROAM) to provide an analysis of prospective generation development scenarios. The future generation development pattern in the NEM and in NSW specifically is subject to market forces resulting from competitors' assessments of a wide range of factors including forecast future electricity prices, meeting NEMMCO's minimum reserve margins, and expectations of electricity growth rates. Hence it is appropriate to assess the need for network developments against a set of backgrounds that represent the more probable likely future generation developments.

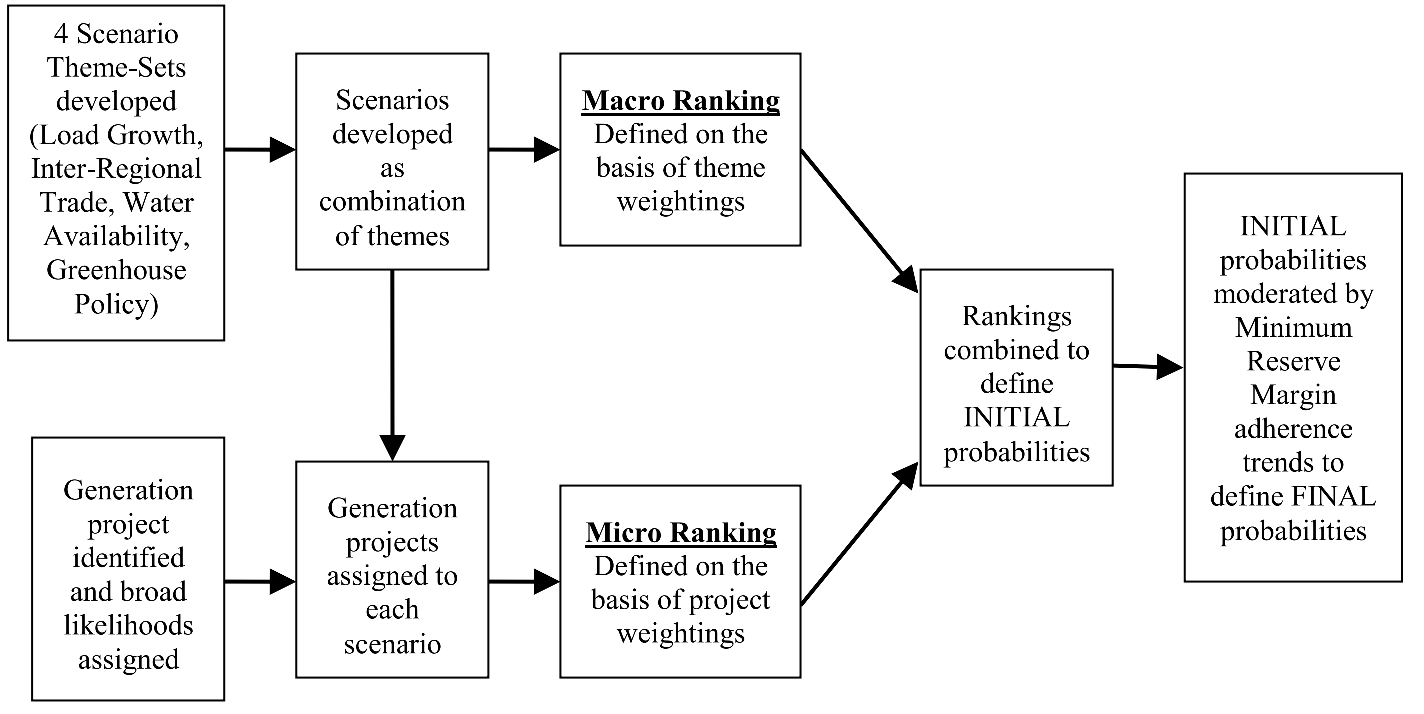
The scenario analysis conducted relates primarily to assisting TransGrid in identifying the need for load driven transmission augmentations associated with various generation development, interconnector capacity and load forecast assumptions. Generator connection assets are not addressed by this methodology.

2 SCENARIO ANALYSIS METHODOLOGY

The methodology used in this assessment has been designed to deliver a forward-looking view of a number of plausible market development scenarios, specifically focusing on the New South Wales region.

The approach is summarised in the diagram below:

Figure 2.1 – Methodology for identifying market development scenarios



Specific comments are made with respect to each of the steps identified above:

Step 1) Scenario Theme Sets Identified

The following theme sets were used in the study:

1) Three themes within the Load Growth scenario theme set:

- **Low, Medium** and **High** load growth. The three theme set limbs relate to economic growth levels, each considering 10% poe demand. ROAM has considered only the 10% poe demands as the NEM reliability standards require TNSPs to plant the system in order to meet one in ten year peak demands.

2) Three themes within the Inter-Regional Trading theme set:

- **Business as Usual, QNI Upgrade,** and **Snowy-NSW Upgrade**. The upgrade scenarios incorporate a potential upgrade of 500MW on the respective interconnector. Both the QNI interconnector and the Snowy-NSW interconnector are the subject of ongoing assessments that could result in an augmentation decision, as discussed in the TransGrid APR 2007. The 2007 NEMMCO SOO also identifies these particular interconnector augmentations worthy of further investigation. 500MW has been considered as a realistic upgrade path for both alternatives which would support significant changes in power flows and be feasible within the next revenue reset period.

3) Two themes within the Water Availability theme set:

- **Business as Usual** and **Limited Water Availability**. The limited water scenario reduces the annual energy capability of the Snowy Hydro, Victorian and Tasmanian hydro-electric stations and the QLD and NSW wet-cooled thermal stations, however only Snowy Hydro capacity is anticipated to reduce at times of peak loads. The limited water scenario would therefore provide reduced support to NSW at times of peak demand, owing to the need to conserve water to meet uncertain future conditions.

4) Two themes within the Greenhouse Policy theme set:

- **Business as Usual** and **CO_2 Tax**. The CO_2 Tax theme set foreshadows the introduction of a nominally \$35.00/t CO_2-e carbon tax (or equivalent carbon trading scheme) *within the period of the revenue reset*. The Business as Usual theme reflects the present situation whereby a variety of schemes have been introduced to curb emissions but without an umbrella price for **CO_2** mitigation.

Other developments consisting of high impact, but low probability events, for example the development of major geothermal power stations, have not been considered within the report. These exceptional scenarios would result in a substantial shift in generation patterns requiring separate treatment by the regulator, and are therefore not within the scope of the Revenue Reset Scenario Analysis. The timing of such developments is also likely to be beyond the current regulatory reset period.

The defined theme sets and themes are discussed in detail in Section 3 of this report.

Step 2) Theme Probabilities and Top Down Scenario Weightings

Each of the themes has been assigned a relative probability of proceeding. The probabilities associated with each are listed below:

Table 2.1 – Initial Scenario Probabilities			
1. Load Growth		**2. Inter-Regional Trade**	
Theme		**Theme**	
L10	15%	BAU	55%
M10	70%	QNI	35%
H10	15%	NSW-SNOWY	10%
3. Water Availability		**4. Greenhouse Policy**	
Theme		**Theme**	
BAU	35%	BAU	40%
LIMITED	65%	CO_2 Tax	60%

From the themes contained within the four theme sets of Load Growth, Inter-Regional Trade, Water Availability and Greenhouse Policy, thirty six (36) discrete combinations are possible. Each of these combinations forms a 'scenario'. The relevant theme probabilities are combined to produce a 'Top-Down' Weighting for each of the thirty six scenarios using the following formula:

$$TDW = W_{Load} \times W_{Trade} \times W_{Water} \times W_{Greenhouse}$$

*where **TDW** is the Top Down Weighting, and **W** is a theme weighting.*

The Top Down Weighting for each of the scenarios was calculated to be as follows:

Table 2.2 – Top Down Weightings for each Scenario			
Scenario	**Scenario Theme Combination**	**Combination of Probabilities**	**Top-Down Weighting**
1	L10 * BAU * BAU * BAU	0.15 * 0.55 * 0.35 * 0.4	1.16%
2	L10 * BAU * BAU * CO2 Tax	0.15 * 0.55 * 0.35 * 0.6	1.73%
3	L10 * BAU * Limited * BAU	0.15 * 0.55 * 0.65 * 0.4	2.15%
4	L10 * BAU * Limited * CO2 Tax	0.15 * 0.55 * 0.65 * 0.6	3.22%
5	L10 * QNI * BAU * BAU	0.15 * 0.35 * 0.35 * 0.4	0.74%
6	L10 * QNI * BAU * CO2 Tax	0.15 * 0.35 * 0.35 * 0.6	1.10%
7	L10 * QNI * Limited * BAU	0.15 * 0.35 * 0.65 * 0.4	1.37%
8	L10 * QNI * Limited * CO2 Tax	0.15 * 0.35 * 0.65 * 0.6	2.05%
9	L10 * Snowy-NSW * BAU * BAU	0.15 * 0.1 * 0.35 * 0.4	0.21%
10	L10 * Snowy-NSW * BAU * CO2 Tax	0.15 * 0.1 * 0.35 * 0.6	0.32%
11	L10 * Snowy-NSW * Limited * BAU	0.15 * 0.1 * 0.65 * 0.4	0.39%
12	L10 * Snowy-NSW * Limited * CO2 Tax	0.15 * 0.1 * 0.65 * 0.6	0.59%
13	M10 * BAU * BAU * BAU	0.7 * 0.55 * 0.35 * 0.4	5.39%

Table 2.2 – Top Down Weightings for each Scenario			
Scenario	**Scenario Theme Combination**	**Combination of Probabilities**	**Top-Down Weighting**
14	M10 * BAU * BAU * CO2 Tax	0.7 * 0.55 * 0.35 * 0.6	8.09%
15	M10 * BAU * Limited * BAU	0.7 * 0.55 * 0.65 * 0.4	10.01%
16	M10 * BAU * Limited * CO2 Tax	0.7 * 0.55 * 0.65 * 0.6	15.02%
17	M10 * QNI * BAU * BAU	0.7 * 0.35 * 0.35 * 0.4	3.43%
18	M10 * QNI * BAU * CO2 Tax	0.7 * 0.35 * 0.35 * 0.6	5.15%
19	M10 * QNI * Limited * BAU	0.7 * 0.35 * 0.65 * 0.4	6.37%
20	M10 * QNI * Limited * CO2 Tax	0.7 * 0.35 * 0.65 * 0.6	9.56%
21	M10 * Snowy-NSW * BAU * BAU	0.7 * 0.1 * 0.35 * 0.4	0.98%
22	M10 * Snowy-NSW * BAU * CO2 Tax	0.7 * 0.1 * 0.35 * 0.6	1.47%
23	M10 * Snowy-NSW * Limited * BAU	0.7 * 0.1 * 0.65 * 0.4	1.82%
24	M10 * Snowy-NSW * Limited * CO2 Tax	0.7 * 0.1 * 0.65 * 0.6	2.73%
25	H10 * BAU * BAU * BAU	0.15 * 0.55 * 0.35 * 0.4	1.16%
26	H10 * BAU * BAU * CO2 Tax	0.15 * 0.55 * 0.35 * 0.6	1.73%
27	H10 * BAU * Limited * BAU	0.15 * 0.55 * 0.65 * 0.4	2.15%
28	H10 * BAU * Limited * CO2 Tax	0.15 * 0.55 * 0.65 * 0.6	3.22%
29	H10 * QNI * BAU * BAU	0.15 * 0.35 * 0.35 * 0.4	0.74%
30	H10 * QNI * BAU * CO2 Tax	0.15 * 0.35 * 0.35 * 0.6	1.10%
31	H10 * QNI * Limited * BAU	0.15 * 0.35 * 0.65 * 0.4	1.37%
32	H10 * QNI * Limited * CO2 Tax	0.15 * 0.35 * 0.65 * 0.6	2.05%
33	H10 * Snowy-NSW * BAU * BAU	0.15 * 0.1 * 0.35 * 0.4	0.21%
34	H10 * Snowy-NSW * BAU * CO2 Tax	0.15 * 0.1 * 0.35 * 0.6	0.32%
35	H10 * Snowy-NSW * Limited * BAU	0.15 * 0.1 * 0.65 * 0.4	0.39%
36	H10 * Snowy-NSW * Limited * CO2 Tax	0.15 * 0.1 * 0.65 * 0.6	0.59%

Therefore the scenarios with the highest Top-Down Weighting are Scenarios 15 and 16: medium load growth, with no interconnector expansion, limited water availability and either the current basket of greenhouse reduction measures or a new greenhouse policy aimed at significantly reducing greenhouse emissions, at 10.01% and 15.02% respectively.

Step 3) Potential Generation Developments identified

A total of 52 new projects of the technology types, locations and fuel types presently applicable to NSW were included in the study. These projects were based upon information already available to ROAM Consulting through published documents. All new generation options are publicly announced projects, with parameters as per the best publicly available information. Each of the projects considered appears in the Project Listing section in the Appendices (Appendix C), including details of size, plant type and location.

In order to include the potential generation developments in the scenario analysis process, it was necessary to assign rankings to each project describing its likelihood of proceeding. These rankings were converted into a numerical figure for use in the analysis process. The ranking categories chosen and corresponding numerical weightings were:

Table 2.3 – Project Rankings and Weightings

Code	Ranking	Weighting
D	Definite	**100%**
VH	Very High	**80%**
H	High	**60%**
M	Moderate	**30%**
L	Low	**10%**

Each potential project was assigned a Ranking from the table above. The selection of a ranking was based heavily upon the proportion of reported key milestones achieved by each project, including the acquisition of land, the purchase of equipment, the acquisition of approvals and licences, the achievement of power sales, the finalisation of finance and the commencement of construction. Generally, projects that had achieved more of these milestones were given a higher ranking. However, other factors were also taken into account, such as known economic drivers (or disincentives), opposition to the project (for example, from local councils), the determination of the project's proponent, and the elapsed time between announcements regarding the project.

In assigning probabilities of completion to each of the identified projects, ROAM has been mindful of the current and prospective gas supply considerations within New South Wales, advised by a consultant on gas supplies and pipeline capacities.

Step 4) Scenario 'Planting' and Bottom-Up Scenario Weightings

A manual methodology was used for 'planting' each of the thirty-six scenarios, consistent with the approach used in previous assignments of this nature for TNSPs. Each plant is also assigned a year indicating the earliest time by which it could be commissioned.

Each of the scenarios was then 'planted' to reflect the combination of themes from which the scenario was comprised. The following factors were considered when performing this task:

- The earliest possible year of entry condition was strictly enforced – projects were not allowed to be shifted to an earlier than achievable year to satisfy a supply shortfall;
- Where multiple plants of a similar type or size were able to be selected concurrently, the project with the higher 'probability' ranking was typically installed first;
- Sufficient capacity was installed to ensure that where possible, a realistic balance between supply and demand was maintained;

- Where interconnector upgrades were included in the scenario, the NSW supply portfolio tended towards a tighter supply-demand balance reflecting the greater level of imports from the expanded interconnector. Where interconnector upgrades were not included, the supply-demand balance tended to remain neutral;
- Scenarios that included the alternate greenhouse policy, introducing a significant carbon emissions trading scheme or carbon tax, also included increased incentives for the uptake of renewable technologies. These cases therefore tend towards a higher level of wind generation;
- In planting scenarios to meet the minimum reserve margin conditions, wind farms were assumed to contribute a maximum of 8% of their installed capacity at the time of a 10% POE system peak demand, in line with independently assessed figures[1], and;
- Many 'iterations' of the planting procedure were performed and cross-checks completed in order to reach a plausible planting outcome for all scenarios.

Factors affecting the location of new plant developments within New South Wales were considered through the creation of the scenarios above.

The Top-Down Weightings for each scenario generally reflect the likelihood that particular combinations of scenario themes will occur.

However, they do not address the uncertainty relating to which of the various prospective generation developments of each type will be developed under the particular theme.

For this purpose, Bottom-Up Scenario Weightings were derived as the **sum** of the weightings applicable to each of the generation projects assumed to proceed within a given scenario. The Bottom-Up Weighting was calculated as follows:

$$BUW_{Scenario\ i} = [(WP_1 + WP_2 + \ldots) / NPI_{Scenario\ i}] \,/\, \textstyle\sum_{i=1\ to\ 36}(APW_{Scenario\ i})$$

*Where **BUW** is the Bottom Up Weighting, WP_1, WP_2, etc are the individual probabilities of each of the projects **installed at any point within** scenario 'i', **NPI** is the number of plants installed throughout scenario 'i', and $APW_{Scenario\ i}$, or $[(WP_1 + WP_2 + \ldots) / NPI_{Scenario\ i}]$, is the average plant weighting of each Scenario 'i'.*

The Bottom-Up Weighting can therefore be interpreted as the average weighting of the plant selected in a scenario, compared with all of the scenarios. An example of this calculation is provided for the L10-QNI-BAU-BAU scenario, for which the Bottom-Up Scenario Weighting was calculated to be **3.1%**:

[1] The following is a quote from ESIPC's Planning Council Wind Report to ESCOSA regarding the assumed capacity factor of wind generation during the time of South Australia's regional peak demand:
"…it is prudent to leave the current Figure of between 7% and 8% for the calculation of the supply-demand balance to accommodate for this currently unquantifiable reduction at peak load until more detailed operational information is obtained."

Table 2.4 – Example Bottom-Up Weighting Calculation		
Plant installed within the scenario	**Plant Ranking**	**Plant Weighting**
Tallawarra	D	100%
Uranquinty	D	100%
Lake Munmorah	D	100%
Broadwater Sugar Mill	D	100%
Condong Sugar Mill	D	100%
Eraring Black Start Turbine	D	100%
Eraring Upgrade	VH	80%
Mt Piper Upgrade	H	60%
Snowy Plains (Berridale)	VH	80%
Harwood	H	60%
Ulan Unit 1	M	30%
Ulan Unit 2	M	30%
Sum of plant weightings (SumPW)	= (1.0+1.0+1.0+1.0+1.0+1.0+0.8+0.6+0.8+ 0.6+0.3+0.3) = **9.4**	
Number of Plants Installed (NPI)	**12**	
Average Plant Weighting in Scenario (APW)	= SumPW / NPI = **0.78**	
Bottom-Up Weighting of Scenario (BUW)	=APW / SUM (All scenario APW's) = 0.78 / 24.9 = **3.1%**	

The Bottom-Up Weighting calculation gives a *high* value where the selected plant within the scenario consists of projects primarily of high likelihood, and a *low* value where most of the selected plant is of a low likelihood. The Bottom-Up Weighting of a scenario can therefore be quite different from the Top-Down Weighting relative to the weightings of the other scenarios.

The calculated Bottom-Up Weighting for each of the 36 scenarios is shown below:

Table 2.5 – Bottom-Up Weightings for each Scenario		
Scenario	**Scenario Theme Combination**	**Bottom-Up Weighting**
1	L10 * BAU * BAU * BAU	3.0%
2	L10 * BAU * BAU * CO2 Tax	2.7%
3	L10 * BAU * Limited * BAU	2.9%
4	L10 * BAU * Limited * CO2 Tax	2.8%
5	L10 * QNI * BAU * BAU	3.1%
6	L10 * QNI * BAU * CO2 Tax	3.0%
7	L10 * QNI * Limited * BAU	2.9%

Table 2.5 – Bottom-Up Weightings for each Scenario		
Scenario	**Scenario Theme Combination**	**Bottom-Up Weighting**
8	L10 * QNI * Limited * CO2 Tax	2.7%
9	L10 * Snowy-NSW * BAU * BAU	3.2%
10	L10 * Snowy-NSW * BAU * CO2 Tax	2.7%
11	L10 * Snowy-NSW * Limited * BAU	2.9%
12	L10 * Snowy-NSW * Limited * CO2 Tax	2.7%
13	M10 * BAU * BAU * BAU	2.9%
14	M10 * BAU * BAU * CO2 Tax	2.7%
15	M10 * BAU * Limited * BAU	2.8%
16	M10 * BAU * Limited * CO2 Tax	2.3%
17	M10 * QNI * BAU * BAU	3.1%
18	M10 * QNI * BAU * CO2 Tax	2.6%
19	M10 * QNI * Limited * BAU	2.8%
20	M10 * QNI * Limited * CO2 Tax	2.5%
21	M10 * Snowy-NSW * BAU * BAU	3.0%
22	M10 * Snowy-NSW * BAU * CO2 Tax	2.6%
23	M10 * Snowy-NSW * Limited * BAU	3.1%
24	M10 * Snowy-NSW * Limited * CO2 Tax	2.5%
25	H10 * BAU * BAU * BAU	2.9%
26	H10 * BAU * BAU * CO2 Tax	2.6%
27	H10 * BAU * Limited * BAU	2.8%
28	H10 * BAU * Limited * CO2 Tax	2.2%
29	H10 * QNI * BAU * BAU	2.9%
30	H10 * QNI * BAU * CO2 Tax	2.7%
31	H10 * QNI * Limited * BAU	2.7%
32	H10 * QNI * Limited * CO2 Tax	2.4%
33	H10 * Snowy-NSW * BAU * BAU	3.0%
34	H10 * Snowy-NSW * BAU * CO2 Tax	2.7%
35	H10 * Snowy-NSW * Limited * BAU	2.9%
36	H10 * Snowy-NSW * Limited * CO2 Tax	2.6%

In this scenario analysis, it can be observed that the Bottom-Up Weightings are tightly clustered between 2.2% and 3.2%. This low degree of volatility results from the high level of new entrant plant required; due to the large amount of load growth in NSW; even in the low growth scenario, a reasonable level of both likely and unlikely plant is required in most scenarios. This tends to indicate that no scenario is either highly dominant or inconsequential from a bottom up perspective.

Step 5) Calculation of the Initial Scenario Probability

The Initial Scenario Probability is determined from the combination of the Top-Down Weighting and the Bottom-Up Weighting. It is calculated as follows:

$$ISP_{Scenario\ i} = (TDW_{Scenario\ i} * BUW_{Scenario\ i}) / \sum_{i=1\ to\ 36}(TBW_{Scenario\ i})$$

*Where **ISP** is the Initial Scenario Probability, **TDW** is the Top-Down Weighting, **BUW** is the Bottom-Up Weighting, and $TBW_{Scenario\ i}$ is the Top Bottom Weighting of Scenario 'i'(i.e. $TDW_{Scenario\ i} * BUW_{Scenario\ i}$).*

The Initial Scenario Probability for each of the thirty-six scenarios was calculated to be as follows:

Table 2.6 – Initial Scenario Probabilities for each Scenario

Scenario	Scenario Theme Combination	Initial Scenario Probability
1	L10 * BAU * BAU * BAU	1.3%
2	L10 * BAU * BAU * CO2 Tax	1.7%
3	L10 * BAU * Limited * BAU	2.4%
4	L10 * BAU * Limited * CO2 Tax	3.3%
5	L10 * QNI * BAU * BAU	0.9%
6	L10 * QNI * BAU * CO2 Tax	1.3%
7	L10 * QNI * Limited * BAU	1.5%
8	L10 * QNI * Limited * CO2 Tax	2.1%
9	L10 * Snowy-NSW * BAU * BAU	0.2%
10	L10 * Snowy-NSW * BAU * CO2 Tax	0.3%
11	L10 * Snowy-NSW * Limited * BAU	0.4%
12	L10 * Snowy-NSW * Limited * CO2 Tax	0.6%
13	M10 * BAU * BAU * BAU	5.9%
14	M10 * BAU * BAU * CO2 Tax	8.3%
15	M10 * BAU * Limited * BAU	10.4%
16	M10 * BAU * Limited * CO2 Tax	13.0%
17	M10 * QNI * BAU * BAU	4.0%
18	M10 * QNI * BAU * CO2 Tax	5.1%
19	M10 * QNI * Limited * BAU	6.8%
20	M10 * QNI * Limited * CO2 Tax	9.0%
21	M10 * Snowy-NSW * BAU * BAU	1.1%
22	M10 * Snowy-NSW * BAU * CO2 Tax	1.4%

Table 2.6 – Initial Scenario Probabilities for each Scenario

Scenario	Scenario Theme Combination	Initial Scenario Probability
23	M10 * Snowy-NSW * Limited * BAU	2.1%
24	M10 * Snowy-NSW * Limited * CO2 Tax	2.5%
25	H10 * BAU * BAU * BAU	1.2%
26	H10 * BAU * BAU * CO2 Tax	1.7%
27	H10 * BAU * Limited * BAU	2.2%
28	H10 * BAU * Limited * CO2 Tax	2.6%
29	H10 * QNI * BAU * BAU	0.8%
30	H10 * QNI * BAU * CO2 Tax	1.1%
31	H10 * QNI * Limited * BAU	1.4%
32	H10 * QNI * Limited * CO2 Tax	1.9%
33	H10 * Snowy-NSW * BAU * BAU	0.2%
34	H10 * Snowy-NSW * BAU * CO2 Tax	0.3%
35	H10 * Snowy-NSW * Limited * BAU	0.4%
36	H10 * Snowy-NSW * Limited * CO2 Tax	0.6%

The combined top down and bottom up weightings show somewhat less variability than the top down weightings, ranging from 13% down to 0.2%. This was due to the fact that the scenarios which were most probable from a top down perspective were scenarios in which the increased CO2 signal was in place. Under this theme, a large amount of low probability plant such as speculative windfarms and/or biomass projects proceed. These scenarios also typically featured a larger number of thermal units; that is, smaller gas units tended to replace large coal-fired facilities. Both of these factors cause the Bottom-up Weighting to be somewhat lower, thus affecting the Initial Scenario Probability.

Step 6) Moderation and the Final Scenario Probabilities

The *Initial Scenario Probability* calculated in Step 5 (being the product of the *Top-Down* and *Bottom-Up Weightings*) was developed for each scenario, without considering any particular market indicators. Hence, the values may not accurately reflect realistic limitations on system capacity and energy imposed either by the market in limiting oversupply or by regulatory requirements for minimum generation.

It was recognised that a reasonable level of adherence to the accepted Minimum Reserve Margin conditions is key for any future scenario. Therefore Minimum Reserve Margin is used to moderate the probabilities of the scenarios developed.

The Minimum Reserve Margin condition is defined as having sufficient plant (or firm interconnection capability, or Demand Side Management) to supply the peak 10% Probability of Exceedence demand, plus the assumed Reserve Margin. New South Wales currently has a negative minimum reserve margin. This reflects the ability of New South

Wales to rely on capacity support across interconnectors from neighbouring regions. The Minimum Reserve Level is currently -1430MW from 2007-08, reducing from -1490MW applicable for the 2006-07 summer.

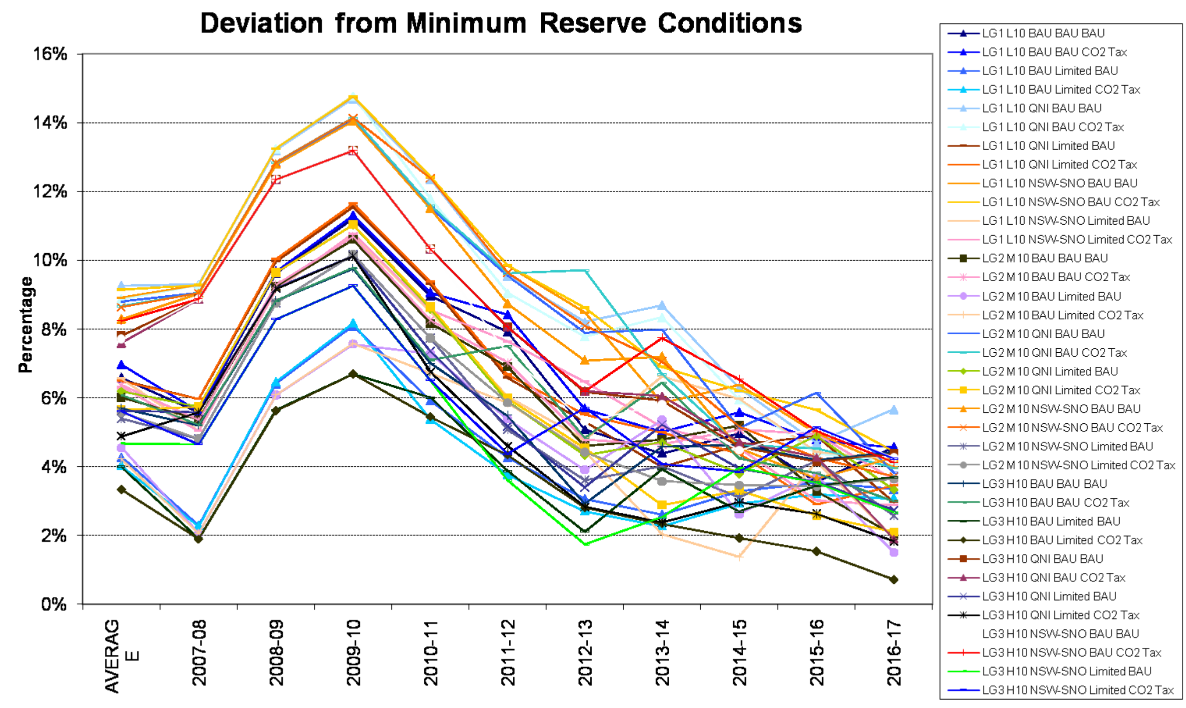
The Minimum Reserve Margin moderation factor for each scenario was calculated as the average of the factors determined for individual years:

$$MFMRM = Average\ (MFMRM_{2007/08}\ ,\ MFMRM_{2008/09}\ ,\ ..)$$

*Where **MFMRM** is the Moderating Factor for the Minimum Reserve Margin.*

The yearly and average deviation from the Minimum Reserve Margin conditions for each of the thirty six scenarios is summarised in the following figure. It should be noted that these percentages reflect the percentage by which the total available supply (via local generation or import) exceeds or falls short of the Minimum Reserve Conditions, being the sum of the relevant peak 10% POE demand and the Minimum Reserve Margin.

Figure 2.2 – Deviation from Minimum Reserve Margin Conditions – All Scenarios



As can be seen in the chart above, the scenarios maintain a level of installed capacity that varies from just 1% greater than the Minimum Reserve Margin conditions to approximately 15% greater than these minimum conditions. The lowest reserve levels are seen in 2007-08 in the high load growth scenarios where limited water impedes Snowy Hydro's ability to export into NSW at time of NSW peak demand. The greatest reserve margin is in 2009-10, in which all currently committed plant (Tallawarra, Uranquinty and Lake Munmorah peaking stations) are commissioned in low economic load growth conditions.

New South Wales has historically installed a greater level of plant than required to meet reliability standards. The analysis presented here shows a continuation of that trend, decreasing somewhat over time. ROAM considers that while the leasing of NSW's generation to private operators will likely drive margins closer (as has been in the case in other regions), this would develop over a timeframe of some years. ROAM's scenarios show the level of reserves increasing rapidly from current levels in line with the large amount of committed new entry plant, and then progressively reverting to current levels over time.

Wind generation is differentiated from thermal generators when considering reserve margins and reliability conditions. Only 8% of the maximum output of all wind generation is considered to contribute to the supply to meet the 10% POE demand (see Step 4 of Section 2). However, this wind generation will be available to produce far more than 8% of its maximum rated capacity on average, with average annual energy production equivalent to 30% to 35% of rated capacity. This large amount of wind generation will be available for use within New South Wales or export to the rest of the NEM.

Moderating the Initial Scenario Probabilities

The moderating factor discussed above is combined with the Initial Scenario Probabilities in the following way:

$$FSP_{Scenario\ i} = (ISP_{Scenario\ i} * MF_{MRM\ of\ Scenario\ i}) / \sum_{i=1\ to\ 36}(MSP_{Scenario\ i})$$

*Where **FSP** is the Final Scenario Probability, **ISP** is the Initial Scenario Probability, MF_{MRM} is the Moderating Factor for the Minimum Reserve Margin, and $MSP_{Scenario\ i}$ is the Moderated Scenario Probability of Scenario 'i'(i.e. $ISP_{Scenario\ i} * MF_{MRM\ of\ Scenario})_i$.*

The Moderating Factor weightings used are summarised in the following table. Negative values indicate a shortfall of supply, and positive values indicate an adequate level of supply. It is unacceptable for the region to be short of capacity, as this would lead to NEMMCO invoking its reserve trader powers, and hence a tendency towards undersupply is penalised more heavily than oversupply.

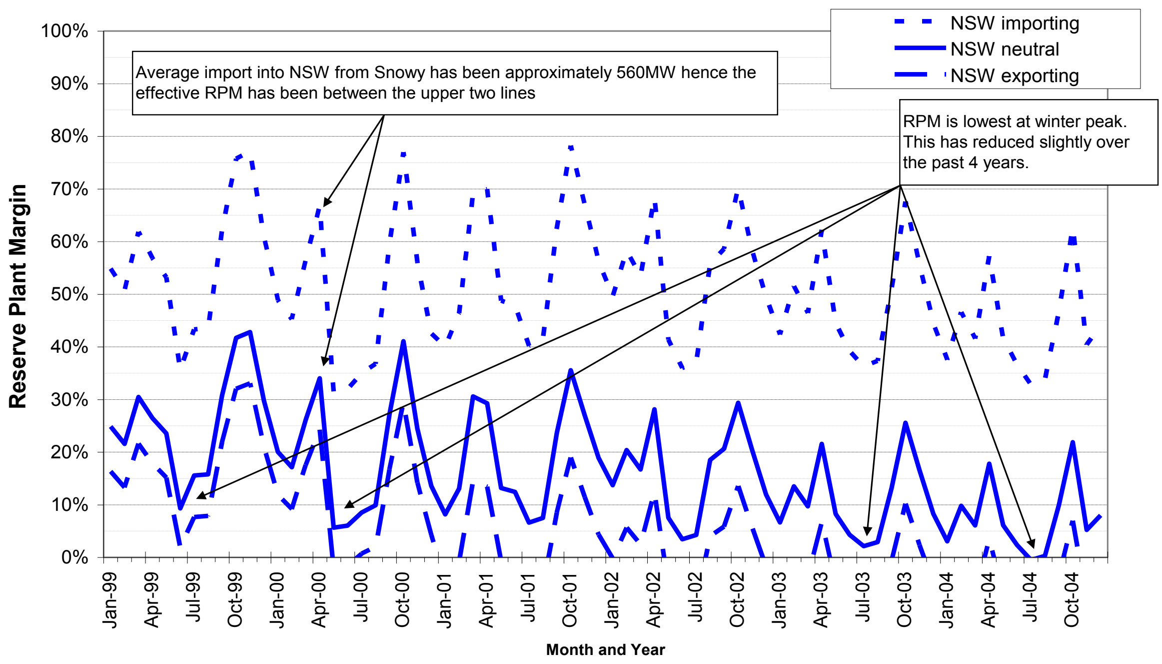
Table 2.7 – Minimum Reserve Margin Moderating Factor Weightings	
% difference from Minimum Reserve Margin Conditions	**Weighting**
-1.0%	0
0.0%	1
1.0%	1
2.0%	3
3.0%	5
4.0%	5
5.0%	5
6.0%	5
7.0%	5
8.0%	4
9.0%	3
10.0%	2
11.0%	1
12.0%	1
13.0%	1
14.0%	0

Historically, New South Wales has installed capacities well in excess of the minimum reserve margin. As Figure 2.3 below shows, reserve plant margins of approximately 30% to 50% were the norm before 2003, with the RPM slowly reducing since that time.

The NSW RPM has reduced in recent years, such that the region relies much more heavily on imports to support peak demands than in the past. However, the RPM is still likely to continue to be moderately positive, supported by the recent commitment of approximately 1300MW of peaking plant at Uranquinty and Lake Munmorah (Colongra). With the decision to lease the operation of the NSW government owned generators, it is likely that the commercial advantages of a tighter supply-demand balance will exert some pressure to reduce this margin. In this case, ROAM considers that the moderating factors attributed to the Minimum Reserve Margin should favour values consistent with the lower end of the recent past; that those scenarios which maintain a positive RPM be weighted more heavily than those which either result in an excessively high or excessively low RPM.

ROAM therefore has moderated those scenarios with a greater weighting where the RPM is between 3% and 7%. Furthermore, ROAM has treated RPM's less than 3% as less likely than those greater than 7%, as is shown in Table 2.7 above.

Figure 2.3 - Historical Reserve Plant Margin – New South Wales



Following the moderation process, the Final Scenario Probability for each of the thirty six discrete scenarios was determined to be as follows:

Table 2.8 – Final Scenario Probabilities for each Scenario		
Scenario	**Scenario Theme Combination**	**Final Scenario Probability**
1	L10 * BAU * BAU * BAU	**1.4%**
2	L10 * BAU * BAU * CO2 Tax	**1.8%**
3	L10 * BAU * Limited * BAU	**2.7%**
4	L10 * BAU * Limited * CO2 Tax	**3.5%**
5	L10 * QNI * BAU * BAU	**0.7%**
6	L10 * QNI * BAU * CO2 Tax	**1.0%**
7	L10 * QNI * Limited * BAU	**1.5%**
8	L10 * QNI * Limited * CO2 Tax	**2.0%**
9	L10 * Snowy-NSW * BAU * BAU	**0.2%**
10	L10 * Snowy-NSW * BAU * CO2 Tax	**0.3%**
11	L10 * Snowy-NSW * Limited * BAU	**0.5%**
12	L10 * Snowy-NSW * Limited * CO2 Tax	**0.6%**
13	M10 * BAU * BAU * BAU	**6.3%**
14	M10 * BAU * BAU * CO2 Tax	**9.3%**
15	M10 * BAU * Limited * BAU	**11.1%**
16	M10 * BAU * Limited * CO2 Tax	**12.6%**
17	M10 * QNI * BAU * BAU	**3.3%**
18	M10 * QNI * BAU * CO2 Tax	**4.0%**
19	M10 * QNI * Limited * BAU	**7.4%**
20	M10 * QNI * Limited * CO2 Tax	**8.4%**
21	M10 * Snowy-NSW * BAU * BAU	**1.0%**
22	M10 * Snowy-NSW * BAU * CO2 Tax	**1.2%**
23	M10 * Snowy-NSW * Limited * BAU	**2.3%**
24	M10 * Snowy-NSW * Limited * CO2 Tax	**2.9%**
25	H10 * BAU * BAU * BAU	**1.4%**
26	H10 * BAU * BAU * CO2 Tax	**1.9%**
27	H10 * BAU * Limited * BAU	**2.4%**
28	H10 * BAU * Limited * CO2 Tax	**2.0%**
29	H10 * QNI * BAU * BAU	**0.8%**
30	H10 * QNI * BAU * CO2 Tax	**0.9%**
31	H10 * QNI * Limited * BAU	**1.5%**
32	H10 * QNI * Limited * CO2 Tax	**1.6%**
33	H10 * Snowy-NSW * BAU * BAU	**0.2%**

Table 2.8 – Final Scenario Probabilities for each Scenario		
34	H10 * Snowy-NSW * BAU * CO2 Tax	**0.3%**
35	H10 * Snowy-NSW * Limited * BAU	**0.4%**
36	H10 * Snowy-NSW * Limited * CO2 Tax	**0.7%**

Step 7) Final Project Probabilities

In addition to calculating scenario probabilities, one of the outcomes of the methodology is a set of final *project* probabilities. The calculation of a final project probability is defined as follows:

$$FPP_{Project\ i} = \sum_{i=1\ to\ 36} (FSP_{Scenario\ i} * DF_{Scenario\ i})$$

*Where **FSP** is the Final Scenario Probability, and*

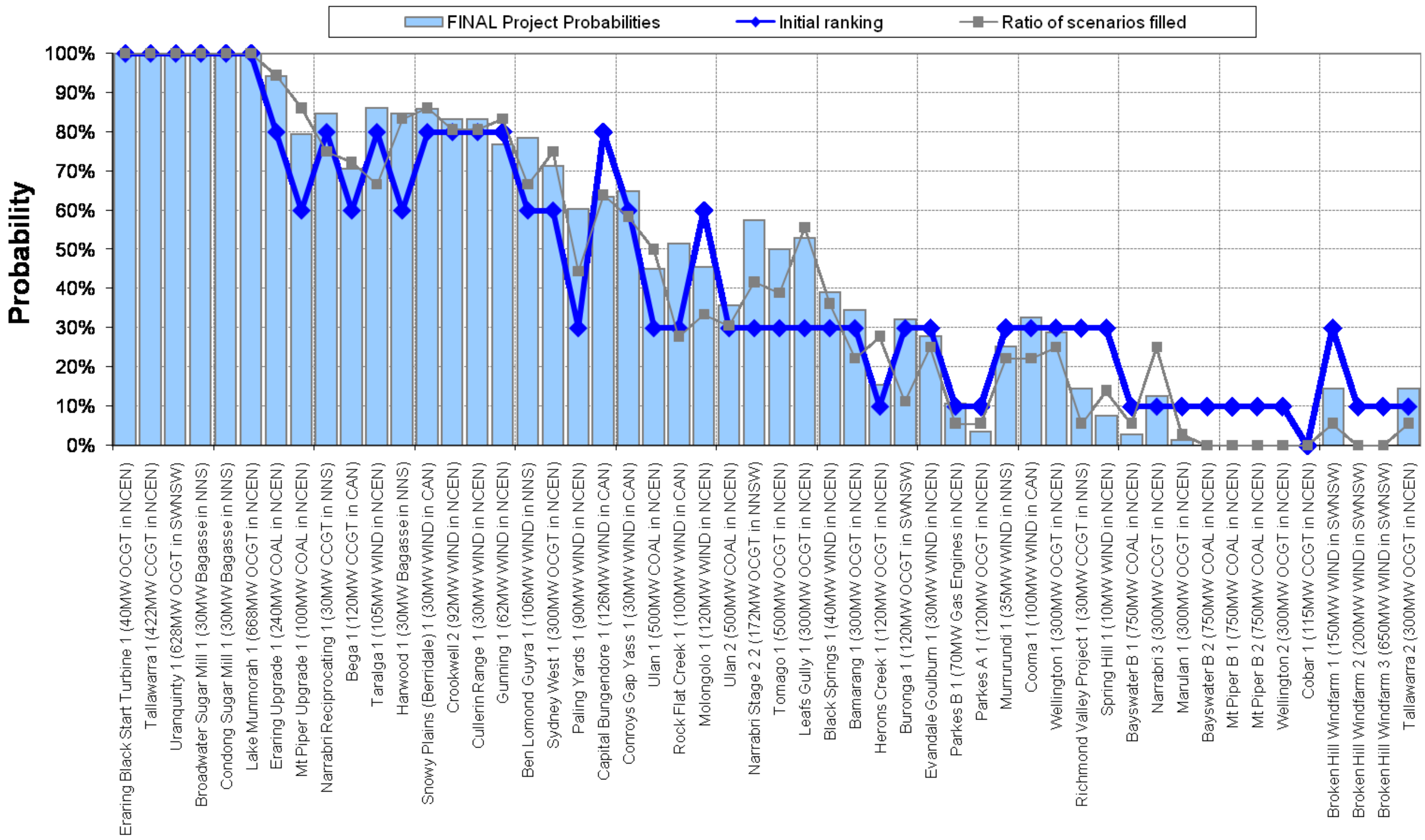
$$DF_{Scenario i} = \begin{cases} 1 \text{ if Project i is selected in Scenario } i \\ 0 \text{ if Project i is NOT selected in Scenario } i \end{cases}$$

That is, the final *project* probability is the sum of the final *scenario* probabilities of every scenario in which that project was used (installed). Therefore the initial project ranking has no effect on the final project probability other than making that project more likely to appear in scenarios if it had a higher initial ranking (and vice versa).

The final project probabilities are summarised in the following chart (aligned perpendicular to the text for readability).

The bulk of the selected projects are located in the NCEN (Central New South Wales) zone. A large proportion of the wind developments however are located within the CAN zone (Canberra and South Eastern New South Wales).

Figure 2.4 – Initial and Final Project Probabilities



3 DATA ASSUMPTIONS

3.1 Generation Requirements

ROAM has used the NIEIR load forecasts as published in the 2007 NEMMCO Statement of Opportunities (and Update) in order to determine the level of generation required for each of the load growth scenarios. The NIEIR forecasts include L10, M10 and H10 forecasts, corresponding with sustained low, medium and high economic growth. In this analysis ROAM has only considered the 10% poe load forecast by NIEIR. According to the National Electricity Rules (Version 12),

> *"A 10% probability of exceedence of* load forecast *must be adopted for the purposes of determination of* short term capacity reserve *and* medium term capacity reserve *requirements under the* power system security and reliability standards.*"*[1]

The following table shows the NIEIR generator-terminal peak demand forecasts for the relevant 10% POE case.

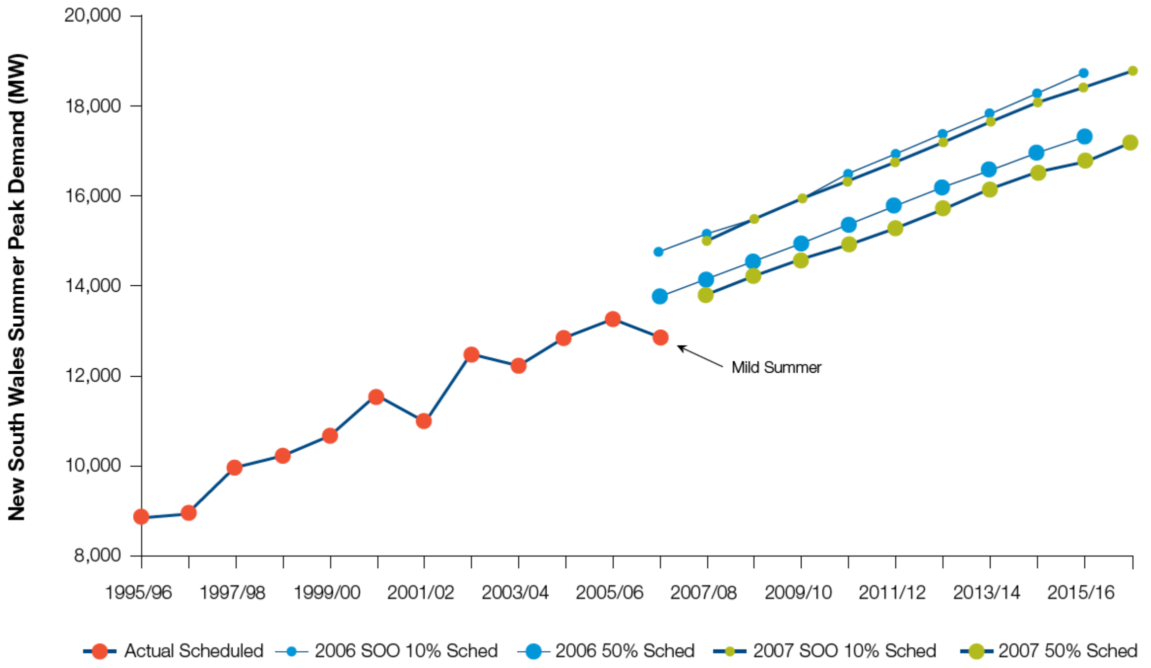
Table 3.1 – New South Wales NIEIR forecast summer Peak Demand

Load Growth Theme	06-07	07-08	08-09	09-10	10-11	11-12	12-13	13-14	14-15	15-16	15-16
L10	12,876	14,990	15,450	15,850	16,240	16,620	17,030	17,420	17,810	18,060	18,380
M10	12,876	15,020	15,500	15,930	16,350	16,760	17,220	17,670	18,110	18,420	18,800
H10	12,876	15,040	15,560	16,050	16,520	16,980	17,500	18,010	18,510	18,870	19,310

ROAM notes that there has been a reduction in the peak summer demand forecasts prepared in 2007 as compared to those prepared in 2006. Figure 3.1 below demonstrates that due to a mild summer in 2006-07, NIEIR has revised its forecast downwards marginally.

[1] National Electricity Rules (Version 12), Chapter 4, Section 4.9.1(e)

Figure 3.1 – Comparison of Actual NSW Summer Scheduled Demand with Previous and Current Projections (Medium Scenario)



In the 2007 NEMMCO Statement of Opportunities, NEMMCO has determined that the forecast level of demand side participation (DSP) for New South Wales is approximately 13MW (down from 21MW in the 2006 SOO) with another 89MW of 'non-committed' DSP. This is based upon annual surveys of NEM participants to estimate the levels of price-sensitive loads. This conclusion in the Statement of Opportunities conflicts with the 2007 TransGrid Annual Planning Report, which states that up to 130MW of load in New South Wales could be curtailed in the event of high prices as part of DSP. In either case, given the relatively small level of DSP in comparison with total NSW maximum demand, the level is considered immaterial and therefore no DSP has been considered for this forecast. Were a material amount of NSW loads to become price sensitive and curtail in the event of high prices, it could be considered that DSP loads would compete directly with the installation of peaking plant. Therefore, DSP could be considered a direct alternative to peaking plant, and may replace the installation of such a plant in these forecasts.

The following table shows the assumed current and committed installed capacity in New South Wales. These numbers are as published in the 2007 NEMMCO Statement of Opportunities.

Table 3.2 – Assumed Current Installed and Committed Capacity in New South Wales
MW As Generated

2006-07	2007-08	2008-09	2009-10	2010-11	2011-12	2012-13	2013-14	2014-15	2015-16
12,414	12,419	13,322	14,147	14,147	14,147	14,147	14,147	14,147	14,147

There are three major committed stations in New South Wales at present: Tallawarra, Uranquinty and Lake Munmorah (Colongra GT). These new projects are included in the model with a 100% probability of proceeding.

As mentioned in Step 6 of Section 2, the New South Wales minimum reserve level is currently -1430MW for the 2007-08 summer, changing from -1490MW applicable for 2006-07. Total installed generation plus maximum available imports minus forecast peak demand must therefore be greater than this to meet the minimum reserve condition. As explained in Section 3.2.1, the maximum available import for reliability purposes is 1800MW.

Comparing Tables 3.1 and 3.2, it can be seen that a significant shortfall exists in all load growth themes over the studied ten year period. As New South Wales is a primary importer of electricity, some of this generation shortfall will be provided for by neighbouring regions. From 2010-11 however, the import of 1800MW combined with currently installed and committed capacity in New South Wales falls short of demand. This shortfall must be met with new NSW generating plant, power imported via interconnection with the rest of the NEM, or other measures, for example Demand Side Management or non-scheduled generation.

3.2 Inter-Regional Trade

3.2.1 Business As Usual

For each of the Inter-Regional Trade themes, it is necessary to assume a level of import or export that is expected to be fully available at the time of New South Wales' peak summer demand. According to NEMMCO's Supply-Demand Calculator[1], under coincident Medium growth, 10% POE conditions across the NEM regions, approximately 1800MW is available for import into New South Wales on average over the next 10 years from Snowy Hydro.

Historical analysis of the last three years demonstrates that at the time of New South Wales' peak demand, significantly more capacity has been available for import. The years 2004-05 to 2006-07 saw New South Wales importing up to 3800MW at the time of the region's peak demand. This historical operation is summarised in the table below:

Table 3.3 – Historical Imports at time of Regional Peak

Financial Year	Net QLD Import[2]	Snowy Import	Total Import into NSW
2004-05	1000MW	2000MW	3000MW
2005-06	500MW	3000MW	3500MW
2006-07	800MW	3000MW	3800MW

ROAM considers that although historically the import capacity at time of system peak has been greater than that recognised by the Supply Demand Calculator, for reliability purposes

[1] This data is based upon the outcomes from the Supply-Demand Calculator supplied with NEMMCO's 2007 Statement of Opportunities.
[2] Net QLD Import includes the net import from the Queensland New South Wales Interconnector (QNI) and the Terranorra Interconnector (previously known as the Directlink MNSP).

this level of capacity sharing cannot be assumed. NEMMCO instead states that the flow into New South Wales from neighbouring regions for use in the MTPASA minimum reserve level constraints is limited to 1878MW[1]. This is purely shared from the Snowy region, as the limit on flows from Queensland is limited to zero.

ROAM therefore has assumed a total import capacity of 1800MW for the purposes of the modelling.

3.2.2 Increased Inter-regional Transfer Capacity

The NSW transmission system is currently interconnected to Queensland and Victoria by the QNI, Directlink and Snowy-NSW interconnectors.

Under the Market Rules interconnector augmentations are subject to a net market benefit test. In its 2007 Statement of Opportunities NEMMCO stated that benefits from an augmentation of the QNI interconnector were only marginally significant to pass this test although these conditions may change in the future.

Over recent years a considerable body of work has been undertaken by TransGrid, Powerlink and other interconnector proponents to determine the commercial feasibility of either augmenting existing interconnector capacity or constructing new interconnectors. ROAM Consulting considers within the regulatory period there to be the potential for bi-directional upgrading of either the QNI or NSW-Snowy interconnectors by notionally 500MW. This assessment recognises the increasing reliance of NSW on imports to meet peak electricity demand and the significant benefits from trading across interconnectors.

Two theme sets include increased capacity for inter-regional transfers. The theme sets include increased interconnection capabilities, both import and export, in the following ways:

- QNI theme set: 500MW increase in import and export with Queensland;
- Snowy-NSW theme set: 500MW increase in import and export with Snowy.

On the basis that the majority of market benefits would most likely accrue to the first interconnector augmentation it has not been considered possible for both augmentations to proceed during the regulatory period.

In considering these theme sets, it has been assumed that sufficient generation capacity is available within Queensland and the southern states for the interconnector to be utilised to its maximum import capability at times of peak demand in NSW.

The following tables show the assumed import capability for the three theme sets included in the study.

[1] Import limit of 1878MW is published in the report *Interconnector limits forecast for MTPASA*, NEMMCO.

Table 3.4 – Assumed Import Capability of New South Wales at time of Peak Demand due to Interconnector Expansion			
Theme Set	**QNI Import**	**Snowy-NSW Import**	**Total Import**
Business As Usual (BAU)	0 MW	1800 MW	1800 MW
QNI	500 MW	1800 MW	2300 MW
Snowy-NSW	0 MW	2300 MW	2300 MW

ROAM has considered the possibility of each interconnector upgrade during the regulatory period. In 2005 TransGrid and Powerlink identified that an opportunity existed for increased transfer capacity across QNI, confirmed by the 2005 ANTS. The 2007 ANTS however declared that benefits attributable to the upgrade would be marginal to justify under the AER Regulatory Test. This is primarily due to existing committed network augmentations (the Bayswater – Mount Piper – Bannaby 500kV conversion for example) between Brisbane and Sydney which reduce the benefit which may be attributed to the upgrade alone.

TransGrid and Powerlink continue to examine the possibility of an upgrade of the QNI. For the purposes of this scenario analysis, ROAM has considered one upgrade option, namely the installation of a back-to-back HVDC link, increasing transfer capacities up to 500MW bi-directionally. The effect of a smaller upgrade would be so minimal as to be inconsequential to the outcome of the scenario analysis and has therefore been ignored. A larger interconnector such as a new line between the regions is considered a remote prospect during the next regulatory period and has therefore also been disregarded.

The majority of benefits attributable to the upgrade of interconnector limits are from the deferral of new generation. With the commitment of approximately 1700MW of peaking plant in New South Wales in 2008-09 (Tallawarra and Uranquinty) and 2009-10 (Lake Munmorah), the likelihood of a QNI upgrade passing the AER Regulatory Test remains slim over the regulatory period. For these reasons, ROAM considers that a probability no greater than 35% is appropriate for the QNI upgrade theme set.

ROAM considers that the expansion of an inter-regional transmission path is likely to absorb most benefits, thereby significantly reducing the opportunity for a second expansion. The development of the Snowy – Canberra – Sydney corridor however is currently proposed as part of the 2007 TransGrid Annual Planning Report, with options mooted for new transmission lines between Bannaby / Marulan and Yass (which may include 500kV line development options). While no indication has been given that the upgrade may affect the current limitation between Snowy and NSW of approximately 3200MW, ROAM considers that some upgrade may result and a value of 500MW bidirectionally is a reasonable prospect. Given the location of the committed Uranquinty power station, on the Snowy side of the thermal constraints between Snowy and NSW, this power station's development may increase the probability of such an upgrade, possibly increasing the possibility for constraint on the flow path at time of peak demand.

ROAM considers that the probability of a 500MW bidirectional upgrade of the Snowy-NSW line section of no greater than 10% is appropriate for this exercise, particularly in light of the significantly depleted storages in the Snowy.

3.3 Water Availability Themes

An increasing concern over recent years has been the availability of cooling water to inland power stations, this issue stemming from the present prolonged drought in Australia and including the eastern seaboard, South Australia and Tasmania. Continued drought conditions may also impact upon generation capability of hydro-electric schemes most notably in the instance of Snowy Hydro. Whilst restrictions to wet cooled stations and to the output of Snowy Hydro may be unavoidable, one possible policy response by government would be to promote the construction of new dry cooled plant, either gas or coal fired.

In recognition of the importance which water plays in maintaining high levels of availability at wet cooled coal fired stations and the possibility of Snowy Hydro generation being limited by drought conditions, ROAM has considered two possibilities in relation to water restrictions.

Under the first limb present water restrictions are expected to ease with there being no limitation on either wet cooled or hydro generation.

Under the alternative limb water restrictions are anticipated to remain across the Eastern seaboard throughout the regulatory period. This would present the Snowy scheme with increasing difficulty in conserving its limited water supplies for use exclusively during high demand periods and as a consequence this limb assumes a reduction of one quarter of Snowy's generation capacity during those periods. A second effect would be for NSW and Queensland wet cooled coal fired generators to suffer reduced levels of generation during non-peak periods as water is conserved to meet peak demands. It should be noted that reductions in Victorian brown coal fired generation as a result of the drought are less likely and this has not been considered under the analysis.

The decision under the second limb to include water restrictions in regions bordering NSW has been taken based on the expectation that restrictions of sufficient duration to impact upon TransGrid's capital programme could only occur as a result of a continuation of the present prolonged dry period that would by its nature affect the whole of the NEM south of the tropics. Under these conditions it is also anticipated that wet cooled coal generation projects would convert to dry cooling and that these dry cooled projects would become more likely to eventuate as additional capacity was required to substitute for lost Snowy and off peak wet cooled coal fired generation.

As of February 2008 and despite very recent good falls in Queensland, water storage levels in all NEM regions remain at near-record lows. Lake Eucumbene, the main storage dam in the Snowy Mountains scheme, is at approximately 21% capacity, having reduced steadily in the last ten years from the 80% level. Hydro Tasmania reports current water storage levels in all storage facilities aggregate to 23% of capacity. Furthermore, the major Southern Hydro plant, Dartmouth, has storage levels at only 15% of capacity. Prolonged above average inflows over a period of years will be required to return water storage levels across the NEM to pre-drought levels.

The following table shows the potential impact upon the import capacity of New South Wales due to water restrictions. The interconnector upgrade theme sets are also included as this will affect the magnitude of the reduction:

Table 3.5 – Assumed Import Capability of New South Wales at time of Peak Demand due to Water Restrictions

Theme Set	QNI Import	Snowy-NSW Import	Total Import
No Water Restrictions (BAU) and No Interconnector Upgrade (BAU)	0 MW	1800 MW	1800 MW
No Water Restrictions (BAU) and QNI Upgrade (QNI)	500 MW	1800 MW	2300 MW
No Water Restrictions (BAU) and Snowy-NSW Upgrade (Snowy-NSW)	0 MW	2300 MW	2300 MW
Water Restrictions (Limited) and No Interconnector Upgrade (BAU)	0 MW	1350 MW	1350 MW
Water Restrictions (Limited) and QNI Upgrade (QNI)	500 MW	1350 MW	1850 MW
Water Restrictions (Limited) and Snowy-NSW Upgrade (Snowy-NSW)	0 MW	1725 MW	1725 MW

There is a high level of uncertainty in predictions as to the level of inflows which the major hydro facilities in the NEM will receive over the next several years. However, based on the assessments of weather forecasting professionals and past events of similar magnitude, it is more likely that rainfall will recover towards long term average levels, thereby easing current water restrictions than the case where the drought will continue with such low inflows. Recent flooding events in Tasmania and New South Wales, and the typical snowfalls in New South Wales and Victoria this winter tend to support this conclusion. Overall, however, the storages are so depleted that the balance of probabilities points to ongoing effects of the drought continuing.

The scenario where water restrictions are expected to ease and bear no impact on wet cooled and hydroelectric plant has been assigned a probability of 35%. A probability of 65% has been assigned to the scenario where water restrictions continue for the period of the revenue reset and impact on hydroelectric plant and off-peak wet cooled coal production.

3.4 Carbon Value Themes

ROAM Consulting considered, when undertaking this assignment, those issues related to increased availability of gas in NSW and also the impact of any significant change in greenhouse gas policy by the Federal Government. ROAM considers that these two issues are related and should be dealt with under a single Theme Set in order to capture their inter-relationship. Reasons for making this assessment are provided further below.

The following table summarises the identified new generation projects by fuel type.

Table 3.6 – Summary of New Projects by Fuel Type

Fuel Type	Projects	Total MW	% of Total MW
Gas	22	5,555	46%
Coal	8	4,340	36%
Wind	19	2,106	17%
Other	3	90	1%
Total	**50**	**12,091**	**100%**

Whilst coal is reasonably well represented at approximately 36% of total new capacity, this fuel type is dominated by a small number of very large projects the absence of any one of which would substantially reduce the percentage of new coal fired capacity. The identified gas projects are on average of a much smaller size and total gas fired capacity less exposed to single project failure, effectively increasing the relative importance of gas to future generation development in NSW as perceived by project proponents. This over representation of gas fired projects in a state with considerable low cost coal deposits and little indigenous gas is somewhat contradictory when the cost advantage of coal over gas fired generation is considered. The majority of gas fired projects are for open cycle plant which does not compete with coal fired plant due to its peaking mode of operation. However, when the difficulties of managing this type of plant stemming from linepack restrictions are considered the argument remains that gas fired plant in total appears to be the preference of project developers irrespective of economic or operational considerations.

ROAM considers there to be two possible reasons for this apparent inconsistency. Firstly, the investment market may be anticipating a significant increase within NSW of gas delivered at prices below those obtainable in the market today. The second possibility is that the investment community is currently deterred from promoting new coal fired projects due to uncertainty surrounding Federal Government policy on greenhouse gas emissions. Given the projected deterioration in the gas supply/demand balance on the eastern seaboard over the next two decades it may be unlikely that expectations of cheaper gas prices are driving gas fired investment.

ROAM considers that the anticipation by the investment community of a significant greenhouse gas policy is the major contributor to the current investment position. The Federal Labor Government has committed to a carbon emissions scheme from 2010, although it is unclear as to how carbon will be priced. Such a policy should, in the medium term, favour gas fired generation even potentially if gas prices escalate somewhat from their current levels. Other responses such as the introduction of low emissions coal technology or the commitment to nuclear stations are unlikely to be realised before the end of the next regulatory period. Furthermore, increased quantities of renewable generation are already factored into TransGrid's demand forecast although the response from this sector could be somewhat greater than that currently envisaged, especially with the committed expansion of the MRET scheme to 20% by 2020.

Based upon the above arguments ROAM considers that the issues of gas availability and emissions restrictions are related and should be dealt with within a single Theme Set. Before progressing to what market conditions the Limbs of such a Theme Set may represent it is first useful to consider the current and prospective future position of Australia's generation sector with regard to greenhouse emissions.

3.4.1 Background to Greenhouse Emissions

Under the Kyoto Agreement on Climate Change participating states have committed to limit their emissions of greenhouse gasses during the period 2008-2012 (the first reporting period). Limits apply to total national emissions of greenhouse gasses and are expressed as percentages of 1990 CO_2-e levels. For Australia the cap for the first reporting period was set at 108% of 1990 levels, this increase being in recognition of Australia's position as a leading producer of low cost coal and its preponderance of energy intensive industries. Australia has now ratified the Kyoto Agreement. Consistent with this expectation a number of policy initiatives have been introduced such as the Mandatory Renewable Energy Target scheme (MRET) designed to encourage additional generation from renewable sources. It is widely recognised that the MRET scheme in either its current form or an enhanced form will not be sufficient to produce the sustained cuts required if Australia's emissions are to be contained at a level close to the Kyoto target in the longer term. This issue is underscored by the fact that electricity consumption is forecast to continue to grow into the future, so making any target set below current levels of emissions increasingly difficult to achieve.

3.4.2 Fuel Gas Availability and Greenhouse Gas Restrictions Theme Set

Based upon the analysis provided within this section of the report ROAM considers that the Fuel Gas Availability and Greenhouse Gas Restrictions Theme Set can be described using two Limbs. One Limb represents the continuation of the current market conditions with respect to emissions policy and gas pricing and availability. Under this Limb uncertainty as to future revisions of greenhouse gas policy remains but investments in identified projects are made largely upon economic considerations.

Under the alternative Limb emission policy equivalent to a \$35/tonne CO_2-e carbon tax is introduced. A carbon cost of this magnitude will effectively abort all additional coal fired green field projects, other than ultra-low emissions coal plant with carbon capture and storage, of which no projects are likely to be available for commissioning during the regulatory period. The limb also promotes increased development of additional renewable technologies. This limb further anticipates delivery of levels of gas to NSW through pipeline developments and compression expansion, albeit at higher prices than the prevailing gas price.

While green field coal developments have been assumed to be economically unreasonable under such a greenhouse policy, brown field conversions and upgrades have not been explicitly excluded from the generation installation path. Brown field developments do not have the significant capital requirements that green field developments do, and therefore are considered possible, albeit unlikely, under this limb.

Although the introduction of an emissions trading regime has recently become a Federal government commitment, this limb has been assigned a probability of 60% for this analysis. This is in recognition of the uncertainty of the structure of such a scheme and the valuation carbon emissions will initially receive. As previously mentioned, the shortage of new coal developments and the plethora of gas fired projects demonstrate that proponents are already factoring in a carbon mitigating policy shift. Assigning a probability greater than 60% would therefore exacerbate current investment trends and exaggerate the effect of an alternate greenhouse policy.

4 DISCUSSION

ROAM Consulting has constructed thirty-six plausible scenarios for generation development in the New South Wales region for the next ten years. As a result of implementing this methodology, the relative probability with which each of the thirty-six identified development scenarios would proceed has been calculated, and the relative likelihood of each of the identified potential projects has also been calculated.

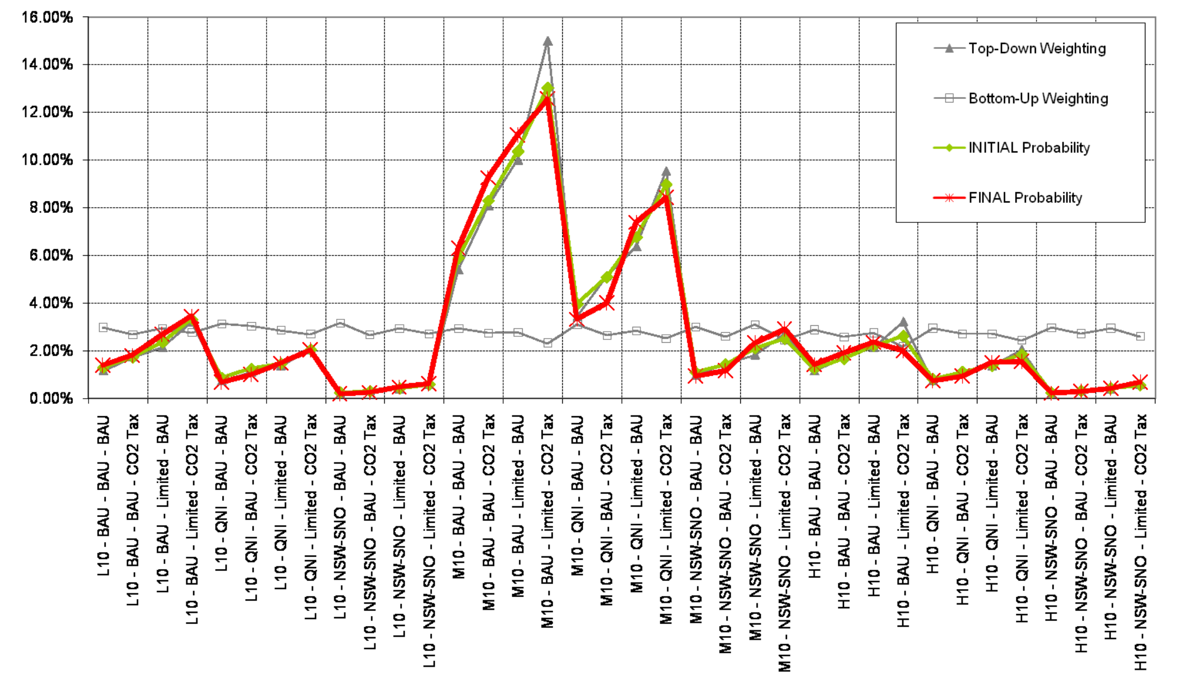
Specific mention is made here of key results. Individual commentary has also been provided with respect to each scenario (Appendix B) and each potential project (Appendix C).

4.1 Analysis of the Scenarios

The ten defined themes were combined to create thirty-six discrete scenarios capturing a variety of developmental trends. The actual outcome may (and likely will) differ from all of the scenarios with respect to the final size, timing and constitution of the projects. However the range of scenarios provided in this assessment is intended to provide a broad enough range of possibilities such that the future market development that actually evolves in New South Wales over the next ten years is not dissimilar from those proposed in this assessment.

The following chart summarises the relative probabilities determined for each of those thirty six scenarios:

Figure 4.1 – Final Scenario Probabilities



With respect to Figure 4.1, the following observations can be made:

- The M10-BAU-Limited-CO2 Tax (medium load growth, existing interconnector capacities, limited water availability, and the introduction of a significant new carbon reduction policy) scenario was determined to be the 'most likely' outcome out of the thirty-six studied scenarios, achieving a final probability rating of 12.6%. This scenario features the addition of approximately 4000MW of new gas fired plant (a mix of OCGT and CCGT technologies), and only a small amount of new coal plant, which is tempered by the retirement of the existing Munmorah coal units. Wind and other plant account for approximately another 1000MW of new capacity.

- The M10-BAU-Limited-BAU (medium load growth, existing interconnector capacities, limited water availability, and the existing carbon reduction schemes) scenario was determined to be the next most likely of the thirty-six, although 1.5% less likely than M10-BAU-Limited-CO2 Tax. Compared with the M10-BAU-Limited-CO2 Tax scenario, this scenario features significantly more coal installations and less in the way of gas and wind capacity. A total of 53% of all new installed plant is coal-fired (approximately 1340MW), while some 2350MW of new gas plant is assumed. There are also no retirements in this scenario.

- The Bottom-Up Weightings did not vary significantly across the thirty-six scenarios. Although there was a reasonable degree of variation in the planting schemes across the scenarios, and considerable difference existed in plant probabilities (from low to definite), the high level of growth in demand (even under low load growth conditions) minimised the effect of this diversity as most scenarios required some low probability plant in order to meet minimum reserve levels.

- The increased incentive for wind generation under a significant greenhouse emissions reduction policy may present challenges for the New South Wales region. Not a significantly 'windy' region, up to 1250MW of intermittent non-scheduled wind capacity may be installed over the next ten years or so. However, given that only 8% of its maximum output can be assumed available at the time of regional peak demand, significant levels of thermal plant must supplement this generation, possibly resulting in a large excess of plant at some times of the year. This however may reduce NSW current exposure to inter-regional disruptions in supply, as the region currently relies significantly on imported energy.

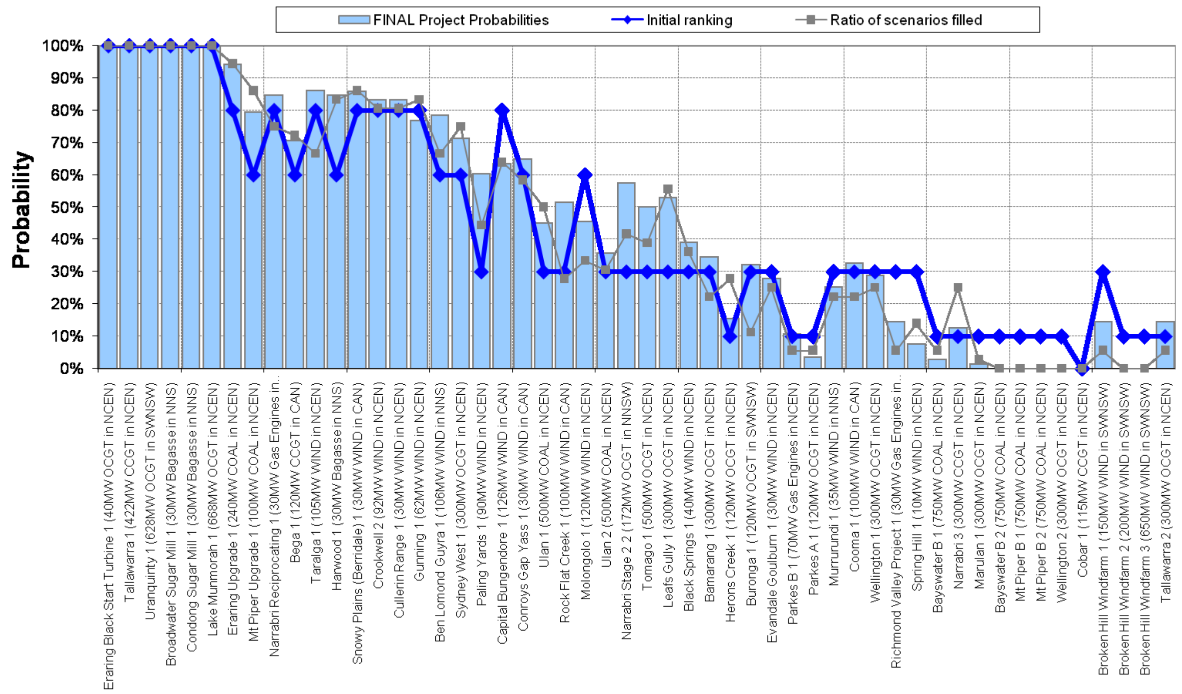
- The combination of the theme weightings was seen to have a far greater bearing on the final probability than the bottom-up (project) weightings due to low level of volatility in the bottom-up weightings. This low level of volatility was due to the large number of projects required in all scenarios.

- The Minimum Reserve Margin moderating factor had a minor influence on final probability outcomes, as the minimum reserve level was largely maintained at a consistent level. However, a degree of variation exists in later years after the installation of committed gas plant and after which coal units are assumed capable of entry.

4.2 Analysis of New Generation Projects

The Initial Ranking and Final Project Probability for each of the 52 studied new generation developments are shown in Figure 4.2.

Figure 4.2 – Project Probabilities



As a result of this study, the following projects were considered highly likely or committed (>80%).

- The Tallawarra power station is committed and thus has a probability of 100%.
- The Uranquinty power station is committed and thus has a probability of 100%.
- The Lake Munmorah power station is committed and thus has a probability of 100%.
- The Eraring Black Start Gas Turbine is installed, and has been allocated to every scenario (100%).
- TransGrid has informed ROAM that the Broadwater and Condong sugar mills are committed, and thus are assigned a probability of 100%.
- The Eraring upgrade of the four existing units at Eraring Power Station was considered likely even under an alternate greenhouse policy, as the brown field upgrade provides considerable operational cost advantages, being coal-fuelled, without the significant capital costs incurred for a green field development. This proposal was included in thirty-four of the thirty-six scenarios, with a final probability of approximately 94%.
- The Harwood bagasse project in Northern New South Wales was present in most scenarios, irrespective of the particular theme. Being a small bagasse project, following other bagasse operations in the area, the drivers for this project were considered largely independent of the theme sets. It has a final probability of approximately 85%.
- The Narrabri plant is a three stage development fuelled by local coal seam methane. The first stage is considered likely, with stages two and three pending the successful

exploitation of local CSM resources. The final probability for the first stage of this project is approximately 85%.

- Various wind developments also exceed 80%:
  - Crookwell 92MW approximately 83%;
  - Cullerin Range 30MW approximately 83%;
  - Taralga 105MW approximately 86%, and;
  - Snowy Plains 30MW approximately 86%.

The following major projects received a high likelihood of proceeding (>60%).

- The Mt Piper upgrade of the two existing units at Mt Piper Power Station, for much the same reasons as the Eraring upgrade. This proposed development proceeded in thirty-one of the thirty-six scenarios, with a final probability of approximately 79%.
- The Sydney West open cycle gas turbine is considered a low cost peaking station, however it is in some cases impeded by the significant level of peaking capacity already committed. It is however well located close by the Sydney load. The first 300MW stage has a final probability of approximately 71%. This project is considered interchangeable with the Leafs Gully project.
- The Bega CCGT project with a 71% final probability.
- Four wind projects exceed 60% final probability:
  - Gunning 62MW approximately 77%;
  - Conroys Gap 30MW approximately 65%;
  - Capital Bungendore 126MW approximately 63%; and
  - Ben Lomond 106MW approximately 78%.

The following projects received a moderate likelihood of proceeding (>30%).

- The Bamarang OCGT is hampered by the limited capacity of the Eastern Gas Pipeline, which may require expansion should this project proceed. The project is more favoured when limited water increases the need for alternate peaking generation given Snowy's reduced capacity to support NSW.
- The second stage Narrabri CSM OCGT was found to have a probability of approximately 58%, representing its reliance on the successful delivery of local coal seam methane.
- The Tomago open cycle gas turbine is a large 500MW development. It may have supply issues as it is beyond the capacity of the Moomba to Sydney Pipeline System (MSPS). It is primarily installed in high load growth scenarios, and where more gas supplies become available in the CO_2 theme.
- The Leafs Gully OCGT project may be considered similar in nature to a second stage of the Sydney West plant.
- The Buronga OCGT received a 32% project probability, but may rely on network support opportunities to some degree.
- The Ulan coal fired power station is a fairly high probability 1000MW green field project. Its two stages appear in many scenarios except for those where a new Federal greenhouse policy effectively aborts all new entry coal fired generators. It has a final probability of approximately 45% and 36% respectively for each of the two 500MW stages.
- Several wind developments also have probabilities greater than 30%:
  - Paling Yards 90MW approximately 60%;
  - Rock Flat Creek 100MW approximately 52%;
  - Molongolo 120MW approximately 46%;
  - Black Springs 40MW approximately 39%, and;
  - Cooma 100MW approximately 33%.

5 CONCLUSIONS

Potential generation development paths for the region of New South Wales over the next ten years have been assessed through the application of a scenario analysis methodology. The methodology is based on the identification of four separate 'theme sets' defining the direction of the energy sector in the region of New South Wales. These theme sets relate to:

- Three alternate load growth rates;
- Business as Usual or increased transfer capacities on the major interconnectors between New South Wales, Queensland and Snowy;
- The availability of water to wet cooled plants in Queensland and New South Wales, and the hydroelectric facilities of Snowy Hydro. Water restrictions will either ease or intensify, and;
- The level of government action on greenhouse emissions. Either a continuation of current greenhouse policies where emissions mitigation of the stationary energy is encouraged in the form of the expanded MRET and the progressive introduction of a carbon emissions signal, or the introduction of a significant emissions policy whereby carbon emissions incur significant financial penalties from 2010.

The generation developments that have been assessed cover a mix of thermal coal and gas fired plant, wind generation and other renewable technologies including biomass.

With significant forecast growth in demand over the ten year period (between 3,300MW and 5,400MW), significant amounts of new plant of all technologies will be required to ensure sufficient supply. New coal fired generation is expected only so long as greenhouse policy does not effectively abort all developments except for a minor selection of brown field unit efficiency and capacity upgrades. In this case, a significant reliance on gas for new generating plant will prevail in New South Wales, although there is potential for well over 1000MW of wind to come into the region given the right drivers. However, as wind generation is intermittent and only 8% of capacity can be relied upon to meet peak demand (with a total capacity factor of only approximately 30%), the majority of new entrant plant will be gas fired, sourced from inter-state gas and some local CSM resources.

Appendix A – Suggested Dispatch Order for Existing and New Plant

The following table has been included to give general indication of the likely dispatch ordering of the range of New South Wales plant considered in this study.

ROAM Consulting has referenced the following report in the compilation of this table:

ACIL Tasman. March 2007. *"Fuel resource, new entry and generation costs in the NEM"*. http://www.nemmco.com.au/transmission_distribution/410-0084.pdf

Ordering is shown in relation to the existing New South Wales generating plant. Note that Loss Factor effects have not been incorporated into these values. Values are reported in 2007-08 dollars.

Table A.1 – Indicative Dispatch Order for Existing and Committed NSW Plant

Station	Type	SRMC ($/MWh)
Directlink Interconnector	DC Interconnector	N/A
QNI Interconnector	AC Interconnector	N/A
Snowy-NSW Interconnector	AC Interconnector	N/A
Bayswater	Baseload coal	11.58
Redbank Power Station	Baseload coal	11.72
Liddell	Baseload coal	12.37
Vales Point B Power Station	Baseload coal	15.34
Eraring Power Station (330kV)	Baseload coal	15.78
Mt Piper Power Station	Baseload coal	16.26
Munmorah Power Station	Baseload coal	16.98
Wallerawang C Power Station	Baseload coal	17.64
Tallawarra	Combined Cycle Gas Turbine	29.55
Smithfield Energy Facility	Cogeneration Combined Cycle Gas Turbine	35.53
Hunter Valley Gas Turbine	Open Cycle Gas Turbine	299.88