TransGrid's Submission to the
Australian Competition & Consumer Commission

Revised Transmission Capital Investment Program 2004-2009

Attachment 6A

ROAM Consulting Report – Probabilistic Assessment of Generation Developments for NSW

November 2004

ATTACHMENT 6A

ROAM Consulting®

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Report (Trg00008) to

TransGrid

NATIONAL ELECTRICITY MARKET FORECASTING

Probabilistic Assessment of Generation Developments for New South Wales

16 November 2004

EXECUTIVE SUMMARY

The future supply/demand balance in each region and adjoining regions are key drivers that will determine the potential development of generation within the National Electricity Market (NEM). Load growth and the range of possible generation developments across the NEM may require network augmentations including reinforcement within the New South Wales system, reinforcement of interconnectors and development of new interconnectors.

The future generation development pattern in the NEM is unknown and hence it is necessary to assess the need for network developments against a set of backgrounds that represent the more probable likely future developments.

The average annual demand in New South Wales is about 8,500 MW and the all time peak demand is around 12,838MW. New South Wales is heavily interconnected with other regions of the NEM, with combined imports from north and south up to 4,000MW and combined exports up to 1,500MW. The development of new generation in New South Wales therefore needs to be considered within the context of the entire NEM.

To assess the most probable generation development scenarios anticipated within the NEM during the next decade, ROAM Consulting (ROAM) has developed expansion plans for the NEM over a long term horizon, covering the period up to 25 years ahead, for a range of credible input assumptions.

This was performed using ROAM's Integrated Resource Planning Model together with ROAM's 2-4-C dispatch methodology to accurately establish the likely operating patterns for up to 25,000 separate development scenarios in the next 25 years.

A wide range of scenarios was studied to identify the most likely outcomes for the NEM. Five scenarios were selected as the most probable cases representing the range of potential generation development scenarios within the NEM over the next decade. These scenarios and their associated probabilities are as follows:

- Low Black Coal Fuel Price with 20% probability;
- Medium Black Coal fuel Price with 25% probability;
- High Black Coal Fuel Price with 10% probability;

- Carbon Tax with 25% probability, and

- Carbon Tax and High Gas Price with 20% probability.

The impact of each of the above scenarios, on the New South Wales transmission system will be different, requiring different investments in the various parts of the network.

Each of the five scenarios contains a combination of at least two plant types to be built in the years to 2011/12, which is within the period that TransGrid will have to actively consider in the revenue reset period which extends up to June 2009. The outcomes are summarised in the following table.

Probability of Development of Various Plant Types (MW)

Scenario	Probability	2009/10	2010/11	2011/12
1	20%	1,400 Black	600 OCGT	1,400 Black
2	25%	1,200 OCGT	700 Black	1,400 Black
3	10%	1,200 OCGT	700 Brown	1,400 Brown
4	25%	1,200 OCGT	1,200 OCGT	600 CCGT
5	20%	1,200 OCGT	700 Black	1,200 OCGT

Consideration of the probabilities of each of the scenarios, and the associated likely pattern of generation developments, shows that there is a 20% probability of at least 700MW of black coal plant being commissioned by 2009/10. There is a 65% probability of at least 700MW of black coal plant being commissioned by 2010/11. There is a 40% probability of at least 2100MW of black coal plant being commissioned by 2011/12.

TransGrid will need to consider the potential impact of these additional levels of base load generating capacity on the grid, since existing black coal generation will also be operating at high levels by that time. All mothballed plants, including four Liddell units and two Munmorah units, are assumed in the modeling to be in service. The larger the amount of new black coal-fired generating capacity, the more likely that the power will come from further away and that some additional power would be transported from Queensland over the QNI interconnector.

There is an 80% probability of at least 1200MW of new OCGT capacity in the NEM by 2009/10. There is a 45% probability of at least 2400MW of new OCGT capacity in the NEM by 2011/12. The locations of the OCGTs could be distributed widely around the NEM, but would be likely to be at locations with close proximity to gas pipelines. This could be in Victoria, South Australia, NSW or Queensland.

The probability of CCGT developments is relatively low, with a 25% probability of 600MW of new CCGT capacity being developed by 2011/12. The location of such base load CCGT capacity would be dependent on access to a dedicated gas resource. Origin Energy is one private party that has foreshadowed the development of CCGT capacity in Victoria and/or Southern Queensland in the next several years.

The probability of brown coal developments is also quite low, with a 10% probability of at least 700MW by 2010/11.

The IRP studies have demonstrated that there is a relatively high degree of uncertainty as to the location and type of new generating capacity to be built in the NEM in the next 10 years. Since New South Wales is central to the NEM, with the potential for large bidirectional transfers on both the QNI and Snowy to NSW interconnectors, it is prudent to plan for this uncertainty.

The magnitude of new entry generation could also be significantly higher than assessed in the IRP model, given the competitive forces applying in the generation sector of the NEM.

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The future supply/demand balance in each region and adjoining regions are key drivers that will determine the potential development of generation within the National Electricity Market (NEM). Load growth and the range of possible generation developments across the NEM may require network augmentations including reinforcement within the New South Wales system, reinforcement of interconnectors and development of new interconnectors.

The future generation development pattern in the NEM is unknown and hence it is necessary to assess the need for network developments against a set of backgrounds that represent the probable future developments.

TransGrid wishes to identify credible market development scenarios that could occur over the next 10-year period, and could have significant impacts on the New South Wales transmission system. Furthermore, TransGrid are seeking the probabilities of each of these scenarios proceeding.

The average annual demand in New South Wales is about 8,500 MW and the all time peak demand is around 12,838MW. New South Wales is heavily interconnected with other regions of the NEM, with combined imports from north and south up to 4,000MW and combined exports up to 1,500MW. The development of new generation in New South Wales therefore needs to be considered within the context of the entire NEM.

To assess the most probable generation development scenarios anticipated within the NEM during the next decade, ROAM Consulting (ROAM) has developed expansion plans for the NEM over a long term horizon, covering the period up to 25 years ahead, for a range of credible input assumptions.

This has been performed using ROAM's Integrated Resource Planning (IRP) model together with ROAM's 2-4-C dispatch methodology to accurately establish the likely operating patterns for up to 25,000 separate development scenarios in the next 25 years.

This paper sets out details of the modelling as well as forecasts of the likely generation developments and associated probabilities that could influence the projected New South Wales electricity network, and therefore the potential need for transmission augmentations and interconnection developments in this State.

2) HISTORICAL NEM GENERATION DEVELOPMENT

A summary of generation capacity changes in the six years since the start of the NEM is shown in Table 2.1 below. Generating capacity has varied in size, location and technology. The major development types have been black coal, open cycle gas turbines (OCGT) and combined cycle gas turbines (CCGT). The main drivers for new plant have been the availability of fuel resources and the locations of perceived and actual shortfalls in generating capacity.

The uneven development of generation across the NEM demonstrates the degree of uncertainty associated with forecasting generation development. Substantial renewable capacity has also been developed, especially wind and biomass. This renewable capacity has been netted off the load, consistent with National Electricity Market Management Corporation (NEMMCO) forecasts, and is therefore not included in this discussion.

Table 2.1 – Committed New Plants Since Start of NEM

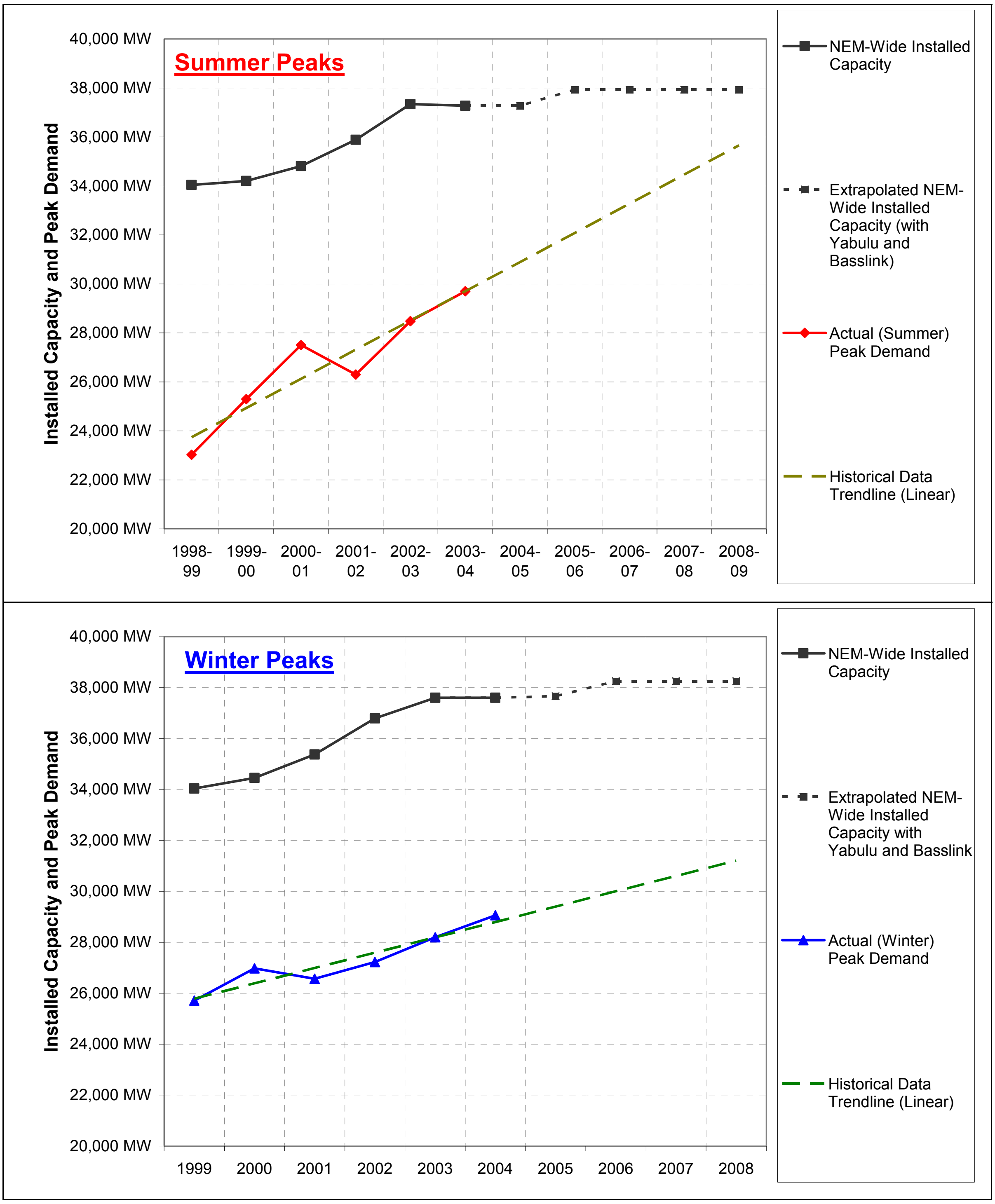
Year	New Plant	Location	Size (MW)	Type	Total (Location)
98-99	Mt Stuart	QLD	288	Oil	512MW *(QLD)*
	Roma	QLD	74	Gas	
	Yabulu	QLD	150	Oil	
	Total in the NEM				*512MW*
99-00	Ladbroke G	SA	92	Gas	92MW *(SA)*
	Oakey	QLD	320	Gas	320MW *(QLD)*
	Total in the NEM				*412*
00-01	Bairnsdale #1	VIC	43	Gas	43MW *(VIC)*
	Callide C	QLD	840	Black Coal	840MW *(QLD)*
	Pelican Point	SA	490	Gas	490MW *(SA)*
	Redbank	NSW	150	Black Coal	150MW *(NSW)*
	Total in the NEM				1,523MW
01-02	Bairnsdale #2	VIC	43	Gas	536MW *(VIC)*
	Hallett	SA	185	Gas	283MW *(SA)*
	Millmerran	QLD	860	Black Coal	1,245MW *(QLD)*
	Quarantine	SA	98	Gas	
	Somerton	VIC	157	Gas	
	Swanbank E	QLD	385	Gas	
	Valley Power	VIC	336	Gas	
	Total in the NEM				*2,064MW*
02-03	Tarong North	QLD	450	Black Coal	450MW *(QLD)*
	Total in the NEM				*450MW*
03-04	-	-	-	-	-
Total in the NEM by 2003/04					***4,961MW***
04-05	Yabulu	QLD	70	Gas	70MW *(QLD)* *70MW (NEM)*
05-06	Basslink	-	-	-	-
06-07	-	-	-	-	-
07-08	Kogan Creek	QLD	750	Black Coal	750MW *(QLD)*
	Total in the NEM				*750MW*
Total in the NEM by 2007/08					***5,781MW***

Table 2.2 – Retirements Since Start of NEM

Year	New Plant	Location	Size (MW)	Type	Total (Location)
98-99	-	-	-	-	-
99-00	Middle Ridge	QLD	44	Oil	44MW *(QLD)*
	Total in the NEM				*44MW*
00-01	-	-	-	-	-
01-02	Callide A	QLD	120	Black Coal	120MW (QLD)
	Total in the NEM				*120MW*
02-03	Swanbank A	QLD	408	Black Coal	408MW *(QLD)*
	Total in the NEM				*408MW*
03-04	-	-	-	-	-
Total in the NEM by 2003/04					***572MW***
04-05	-	-	-	-	-
05-06	-	-	-	-	-
06-07	-	-	-	-	-
07-08	-	-	-	-	-
Total in the NEM by 2007/08					***572MW***

New generation developed since the NEM has not been sufficient to maintain the margin between generation and system demand. The following graphs show, on a whole of NEM basis, the trend in supply and demand from market inception for winter and summer peak conditions. The closure of the gap between supply and demand is an indication of the need for several new major developments in the next 10 years.

Figure 2.1 – NEM wide reserve (existing five regions)



Considering the existing five regions of the NEM, one or more of these regions need to build the necessary new generating capacity to meet market requirements in future years. As it is not certain which regions of the NEM will take what part and in what proportion, more than one scenario needs to be assessed. Each scenario, however, will have different probabilities of proceeding according to many variables including market conditions and the regulatory framework.

3) INTEGRATED RESOURCE PLANNING

3.1) DESCRIPTION

The production cost information from ROAM's 2-4-C dispatch methodology[1] has been combined with Capital and fixed Operation and Maintenance costs for each individual scenario to compute an optimum development plan for the NEM[2].

Since coal and gas are the available fuels to power major new plants in the NEM for the 25-year period ahead, in this assessment the allowable new generator types are:

- Black coal generators in New South Wales or Queensland of nominal 700MW unit capacity;
- Brown coal generators in Victoria or South Australia of 700MW unit capacity;
- OCGTs in all states of nominal 600MW capacity, and

[1] 2-4-C has been developed to incorporate the following key features which ensure the package delivers rigorously-developed forecasts: A fully time-sequential LP-based optimization to mimic the operation of the National Electricity Market Dispatch Engine (NEMDE); Comprehensive Monte-Carlo based unit forced outage modelling, coupled with comprehensive maintenance outage scheduling. 2-4-C has been used in consultation with NEMMCO over the last year to establish revised minimum reserve levels for the NEM.

[2] The IRP model has included Tasmania as self sufficient in energy terms. Basslink transfers are energy neutral, but Basslink supplies up to 600MW of peak capacity to the mainland.

- CCGTs in all states of nominal 600MW capacity.

The choice of unit sizes for the four plant types has been chosen by considering the existing unit sizes in the NEM. New South Wales has standardised on 660MW units for almost 20 years, and is progressively upgrading these to 700MW. A 750MW unit is being built in Queensland. No new brown coal plants have been built in Victoria for more than 10 years, but some units are being upgraded from 500MW to 530MW and it is quite likely that new brown coal generators would be larger than the existing units to gain further efficiencies and economies of scale.

Open cycle and combined cycle units have been divided into 600MW blocks, which could represent various combinations of unit sizes, such as 2x300MW, 3x200MW, 4x150MW and so forth. The 600MW plants do not have to be in one location, or even in one region.

Consideration of all combinations of the above four generator types resulted in about 25,000 separate scenario-years to be simulated. The 25-year study period is necessary to evaluate the optimum development plan over the 10-year period from 2005/06, to allow for any residual effects at the end of the 10-year period.

The IRP is consistent with the choices that market participants would be expected to make, given a comprehensive knowledge of load forecasts and generation costs, and resulting operating patterns, for the various generation technologies.

Following the completion of the production costing studies, a base case has been calculated and a range of sensitivities to the underlying assumptions have been prepared. This has been carried out by varying the assumed plant costs such as Capital, Fuel and Operation and Maintenance, as well as other market factors including change in Weighted Average Cost of Capital (WACC), over their likely ranges.

Changes resulting from introduction of emissions caps, emission trading and new major remote gas resources, requiring take or pay arrangements, were also allowed for as sensitivities. This has assisted in considering the likely effects of such events on generation development and on the associated probability of occurrence.

3.2) Input Assumptions

3.2.1) NEM Supply and Demand

The key aspects considered in developing and modelling the scenarios included:

- The latest supply and demand forecasts from the Statement of Opportunities (SOO) 2004, published by NEMMCO. The estimated load growth and energy beyond the 10-year period of the SOO forecast has been based on an annual growth rate equivalent to the geometric average of the growth in the 10-year SOO forecast;

- The recent changes to the Minimum Reserve Levels for the regions of the NEM as described in the 2004 SOO. This is accounted for in estimating the likely minimum quantum of generation that is developed in New South Wales and adjoining regions over the next 10 years, and

- The fuel supply situation including the availability of coal and gas within the NEM.

Present NEM rules require sufficient capacity in a region to meet the Medium Demand with 10% Probability of Exceedence (Medium 10% poe) forecast peak load plus reserve margin. However, reserve can be accessed from neighbouring regions provided spare generating capacity exists and interconnector capacity is sufficient. The present minimum reserve margin is equivalent to 850MW of reserve above the 10% poe forecast for the NEM.

Some NEM regions are forecast to begin to run out of capacity to provide the minimum reliability standard by about 2007/08. The growing gap between demand (plus reserve) and available capacity needs to be supplied by new generation sources. The 2% renewable energy supply has already been factored into these forecasts as a reduction in demand, so major new developments are expected to be the primary means of filling the gap.

According to the SOO 2004, the total need for new generation across the NEM is approximately 7,300MW by 2013/14. This is in addition to all committed plant identified in the SOO 2004, including the 750MW Kogan Creek project in South West Queensland.

NEMMCO forecasts show that the split in new generation across the mainland states, with present interconnection capacities and present minimum reserve levels, would be made up of approximately 1,300MW in Queensland, 2,800MW in New South Wales and 3,200MW in combined Victoria/South Australia.

The NEM projections are made on a region by region basis but considering the overall capability of the existing interconnections between the regions. They are therefore only one scenario of how the aggregate shortfall could be split between regions and do not take account of plant type.

For the IRP modelling, no plant retirements have been assumed for the duration of the study. This is justifiable, since the timing of any retirements is uncertain, and retirements would further increase the need for new capacity.

3.2.2) Parameters of Projected New Entry Plant

A base set of assumptions was used in the modelling as the initial step for projected new NEM capacity. Information provided by ACIL Tasman[3] , which was used by NEMMCO in studies for the SOO, was used in developing the base assumptions shown in Table 3.1. These assumptions, then, were subsequently varied in order to examine a broader range of possible scenarios within the NEM.

[3] SRMC and LRMC of Generators in the NEM, A Report to the IRPC and NEMMCO, April 2003, ACIL Tasman

Table 3.1– Assumptions for Projected New NEM Plants

Plant Type	Black Coal	Brown Coal	CCGT	OCGT
Nominal Capacity (MW)	700	700	600	600
Life Cycle (Years)	30	30	30	30
Heat Rate - S.O. (GJ/MWh)	9.60	10.50	7.20	12.00
Fuel Cost ($/GJ)	0.69	0.30	3.00	4.50
Variable O&M Cost ($/MWh)	1.00	1.00	2.00	5.00
Fixed O&M Cost (M$/Year)	24M	30M	9M	5M
Capital Cost ($/kW)	1,100	1,600	900	500
WACC[4]	10%	10%	10%	10%

When using 2-4-C, dispatch patterns for the majority of NEM plants were assumed to be based on their Short Run Marginal Costs (SRMC). However, CCGTs were set to run at more than 50% capacity factor, by assuming a take or pay gas supply arrangement during peak load periods (6:00 to 22:00 weekdays and 17:00 to 22:00 weekends), reverting to SRMC prices outside these periods.

4) SCENARIO DEVELOPMENT

A substantial number of sensitivities (greater than thirty) was evaluated in the IRP modelling by systematically adjusting the parameters in Table 3.1. The five particular scenarios, to which probabilities have been ascribed, were therefore derived from a wider range of sensitivities to the effects of credible variations in:

- Fuel prices for black coal, brown coal and gas-fired plants;

[4] Real, Pre-Tax

- Capital costs of each type of generating plant, and

- The effect of emissions limitations through carbon taxes or licencing restrictions.

While the long term development plan can be sensitive to small changes in the input assumptions, the majority of these sensitivities were found not to affect the next ten years significantly.

The following figure depicts the Base-Case outcomes of the IRP modelling, with the assumptions shown in Table 3.1.

Figure 4.1- Base-Case Existing and New Plant Installed (MW)

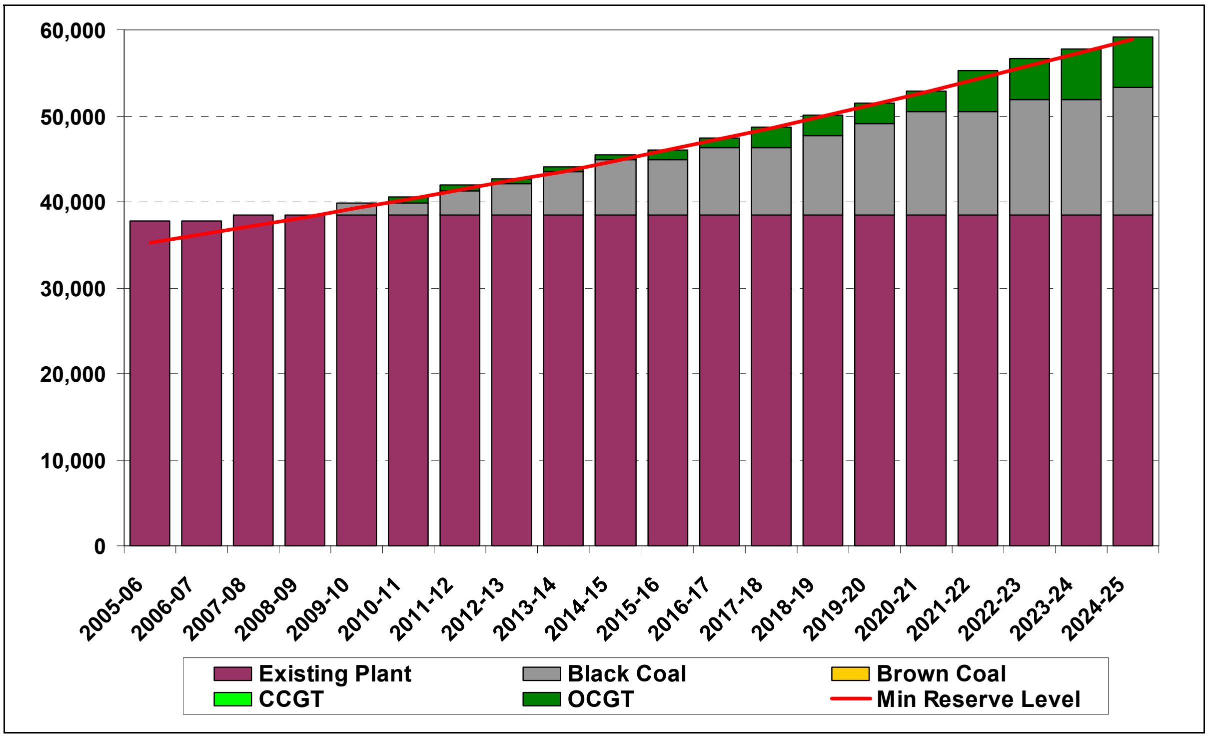


Figure 4.1 shows that the least cost generation planning outcome for the NEM would be a combination of black coal-fired plants together with OCGTs.

The major changes that could influence this trend, and result in displacement of black coal-fired generators and/or OCGTs, would be:

- A significant increase in costs associated with black coal-fired plants and/or OCGTs, and
- Lack of transmission capacity to distribute the generation to major load centres.

Fuel prices for black or brown coal are not likely to reduce over the years. A minimum of about $0.7/GJ, for black coal, and $0.3/GJ, for brown coal, is a base assumption for this study. These prices are referred to as 'low coal prices' when grouping the scenarios to be analysed.

Under different market circumstances, black coal fuel prices would vary. The study has shown that an increase of around 20% in fuel price for this type of coal, with other assumptions as for Table 3.1, would encourage more OCGTs to be built in the NEM over the next 20 years. That would displace some new black coal-fired units and bring in more OCGTs.

However, with a black coal fuel price of about $0.90/GJ or more, there would be benefits in constructing brown coal-fired plants. If black coal prices of more than $1.00/GJ are considered, brown coal-fired units would become the base load units with the lowest long run marginal costs (LRMC).

Significant discounts in fuel price and/or capital cost would be needed for CCGT plants to be selected. Reductions of around 30% in fuel cost would provide the necessary conditions for CCGT plants to become the dominant new base load plants in the NEM during the next 20 years, replacing mainly black coal-fired plants. However, such a scenario seems unlikely.

With higher costs of capital for coal-fired plants, there would again be opportunities for gas-fired plants to be built. Changes in market regulations, including environmental permitting costs and more stringent emission standards, would impact capital costs for coal-fired plants noticeably.

If market charges such as a $10/t of CO_2 carbon tax are applied, the effect would be similar to an increase of around 80% in capital costs for coal-fired plants. This would provide greater opportunities for CCGTs and OCGTs to compete.

4.1) Most likely Scenarios and Associated Probabilities

The five scenarios identified in Table 4.1 have been developed from a wide range of sensitivity cases and represent the range of potential generation development scenarios anticipated within the NEM over the next decade.

Table 4.1– Most Likely Scenarios within the NEM for the next 10 years

Scenario	Description	Assigned Probability
1	Low Black Coal Fuel Price	20%
2	Medium Black Coal fuel Price	25%
3	High Black Coal Fuel Price	10%
4	Carbon Tax	25%
5	Carbon Tax and High Gas Price	20%

These selected scenarios assist in identifying the most probable changes in the NEM that could influence the New South Wales transmission system within the next decade. The estimation of the associated probabilities is described in Section 4.1.6.

4.1.1) Low Black Coal Fuel Price

This scenario includes all assumptions specified in Table 3.1. A black coal price of around $0.70/GJ was assumed to be the low price for this type of fuel. This provides opportunities for black coal-fired plants to be constructed, particularly in Queensland, as well as commissioning of a number of OCGTs in different regions of the NEM during the years up until 2014/15.

4.1.2) Medium Black Coal Fuel Price

This scenario assumes an increase of around 30% to 40% in black coal price above that shown in Table 3.1, or a price in the range of up to $1.00/GJ. The remainder of the assumptions are the same as Table 3.1. A black coal price of up to $1.00/GJ would provide opportunities for black coal-fired plants in New South Wales as well as Queensland to be commissioned. This scenario also includes OCGTs to be built in during the next few years.

4.1.3) High Black Coal Fuel Price

This scenario assumes an increase of more than 50% in the black coal price to more than $1.00/GJ, which would provide opportunities for other types of plant, including brown coal-fired generators in Victoria.

The core assumption here is that black coal-fired plants would not be readily licenced in Queensland and New South Wales, leading to prime domestic thermal coal sites in those states remaining undeveloped. In conjunction with limitations on licencing black coal plant, it is assumed that emissions reductions for new brown coal-fired plants would be achievable in the lifetime of this plant. This assumption is consistent with a scenario of successful development of IDGCC[5] generation with potential for future CO_2 sequestration of brown coal emissions. This scenario contains a number of OCGTs within the NEM as well as a small proportion of black coal-fired plants.

4.1.4) Carbon Tax

This scenario applies a Carbon Tax on all developments which forces both black and brown coal-fired plants to be significantly more expensive. An approximate $10/t CO_2 penalty was assumed for the carbon tax. This gives a higher proportion of OCGT plants together with an increase in the number of CCGTs in later years.

4.1.5) Carbon Tax and High Gas Price

This scenario is similar to Scenario 4, but with a higher fuel price for CCGT plants, consistent with limited availability of gas in the quantities needed to fuel CCGTs. An assumed price of $4.50/GJ was adopted for the fuel price for this type of plant, the same as OCGTs. This would reduce the number of forecast CCGTs in the next decade, giving greater opportunities to black coal-fired plants, regardless of the carbon tax penalty.

4.1.6) Associated Probabilities

Scenarios 1 and 2 are the outcome of currently available technology applied in the Australian electricity market, resulting in new black coal-fired plants (super critical and ultra super critical coal-fired plants) predominating in the NEM. The most recent plant developments in the NEM and shown in Table 2.1, demonstrate that, while most NEM regions have no easy access to gas, there is ready access to fuel for black coal-fired developments to progress in the future.

[5] Integrated Drying Gasification Combined Cycle

Queensland and New South Wales black coal deposits with their low-cost sources of fuel are the probable locations for these kinds of developments, given the imminent shortfalls in both capacity (ie peaking plant) and energy (ie base load plant), as demonstrated in Figure 2.1. However, restrictions on black coal developments, including a carbon tax, could impact this type of investment.

Equal weighting has been given to the probability of carbon taxes and no carbon taxes in reference to decision making in the next 5 to 10 years. The carbon tax scenarios 4 and 5 combined are therefore expected to have the same probability as scenarios 1 and 2 combined, which are assumed not to include carbon taxes.

Scenarios 2 and 4 are considered the most practical and economic cases, given the present state of generation technology and costs, and the existing transmission grid capability between regions. Hence these are assigned the highest probabilities of the five scenarios.

Scenario 1 has been given a 20% probability, as power stations similar to Kogan Creek could be built in Queensland if there is significant opportunity to trade the power interstate.

Scenario 5 is again a relatively likely case within the NEM during the next decade. This scenario includes the lowest amount of new base-load plant and would require existing coal-fired generators, including New South Wales coal-fired plants, to run at the highest levels. Black coal fired-plants are still likely to be commissioned in this scenario, and if any reductions in gas fuel prices arise in the future, some of the OCGTs in this scenario could be converted to CCGTs.

The likely new gas pipeline developments and a number of announced possible developments of new gas-fired plants, to be undertaken by the private sector, give a slightly higher probability to Scenario 4 relative to Scenario 5.

Development of brown coal-fired power stations is considered to have the lowest probability in the next decade. This results in assigning the lowest probability to Scenario 3. New technology, such as IDGCC, is possible for development and application to on brown coal-fired plants. However, there is a low probability that such technology will become fully commercial in the Australian market during the next decade.

4.2) ESTIMATED QUANTUM AND TYPE OF NEW GENERATION IN THE NEM IN NEXT 10 YEARS

The following tables indicate the capacity of each generator type, resulting from application of the assumptions for the five scenarios listed above to the IRP model. These results, together with the NEM aggregated existing plants and Minimum Reserve Level, are illustrated in Figures 4.1 to 4.5. Again, the results for the next 10 years are shown here and the 20-year outlook for each of these scenarios is depicted in Appendix A.

Total NEM new entry capacity could exceed these levels, due to local minimum reserve levels and market opportunities.

Table 4.2– Required Plant Types within the NEM for the next 10 years (Low Black Coal Fuel Price) –MW

Plant Type	Black Coal	Brown Coal	OCGT	CCGT
2005/06	-	-	-	-
2006/07	-	-	-	-
2007/08	-	-	-	-
2008/09	-	-	-	-
2009/10	1,400	-	-	-
2010/11	1,400	-	600	-
2011/12	2,800	-	600	-
2012/13	3,500	-	600	-
2013/14	4,900	-	600	-
2014/15	6,300	-	600	-

Table 4.3– Required Plants within the NEM for the next 10 years (Medium Black Coal Fuel Price) –MW

Plant Type	Black Coal	Brown	OCGT	CCGT
2005/06	-	-	-	-
2006/07	-	-	-	-
2007/08	-	-	-	-
2008/09	-	-	-	-
2009/10	-	-	1,200	-
2010/11	700	-	1,200	-
2011/12	2,100	-	1,200	-
2012/13	2,800	-	1,200	-
2013/14	2,800	-	2,400	-
2014/15	3,500	700	2,400	-

Table 4.4– Required Plants within the NEM for the next 10 years (High Black Coal Fuel Price) –MW

Plant Type	Black Coal	Brown	OCGT	CCGT
2005/06	-	-	-	-
2006/07	-	-	-	-
2007/08	-	-	-	-
2008/09	-	-	-	-
2009/10	-	-	1,200	-
2010/11	-	700	1,200	-
2011/12	-	2,100	1,200	-
2012/13	700	2,100	1,200	-
2013/14	700	2,100	2,400	-
2014/15	700	3,500	2,400	-

Table 4.5– Required Plants within the NEM for the next 10 years (Carbon Tax) –MW

Plant Type	Black Coal	Brown	OCGT	CCGT
2005/06	-	-	-	-
2006/07	-	-	-	-
2007/08	-	-	-	-
2008/09	-	-	-	-
2009/10	-	-	1,200	-
2010/11	-	-	2,400	-
2011/12	-	-	2,400	600
2012/13	-	-	2,400	1,800
2013/14	-	-	3,600	1,800
2014/15	-	-	3,600	3,000

Table 4.6– Required Plants within the NEM for the next 10 years (Carbon Tax and High Gas Price)–MW

Plant Type	Black Coal	Brown	OCGT	CCGT
2005/06	-	-	-	-
2006/07	-	-	-	-
2007/08	-	-	-	-
2008/09	-	-	-	-
2009/10	-	-	1,200	-
2010/11	700	-	1,200	-
2011/12	700	-	2,400	-
2012/13	700	-	3,600	-
2013/14	1,400	-	3,600	-
2014/15	2,800	-	3,600	-

Figure 4.2- Low Black Coal Fuel Price Scenario (MW)

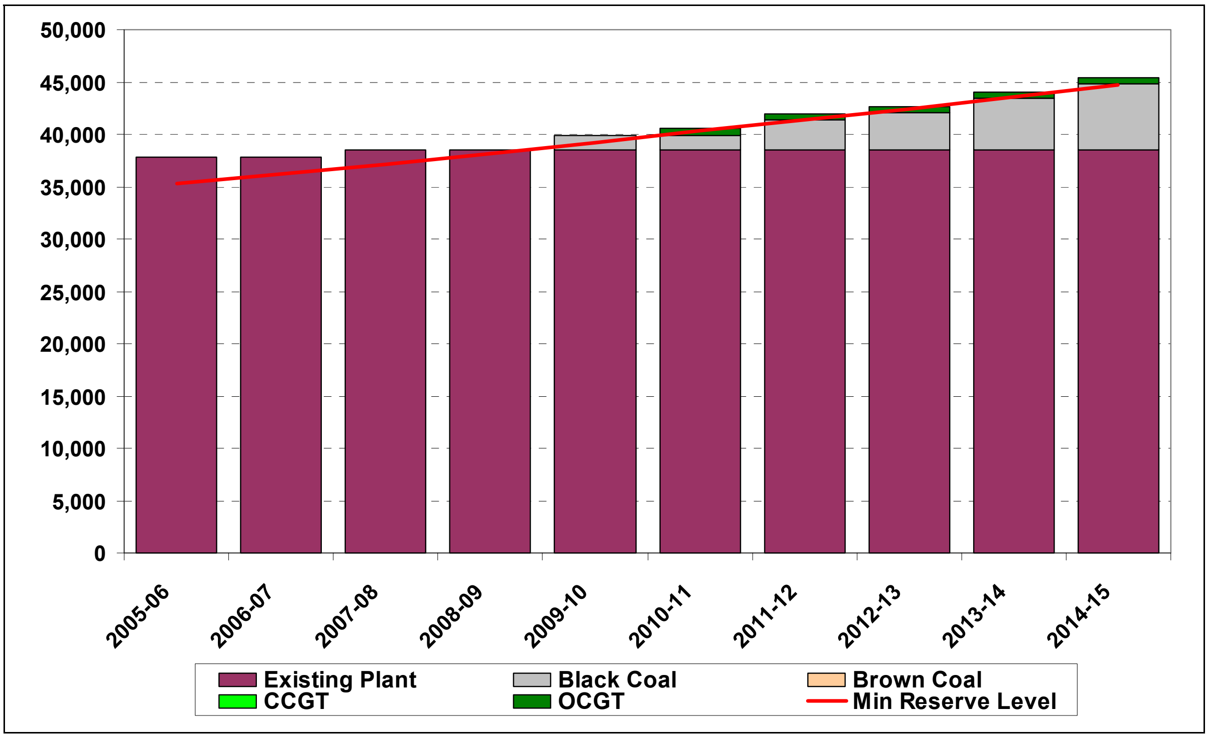


Figure 4.3- Medium Black Coal Fuel Price Scenario (MW)

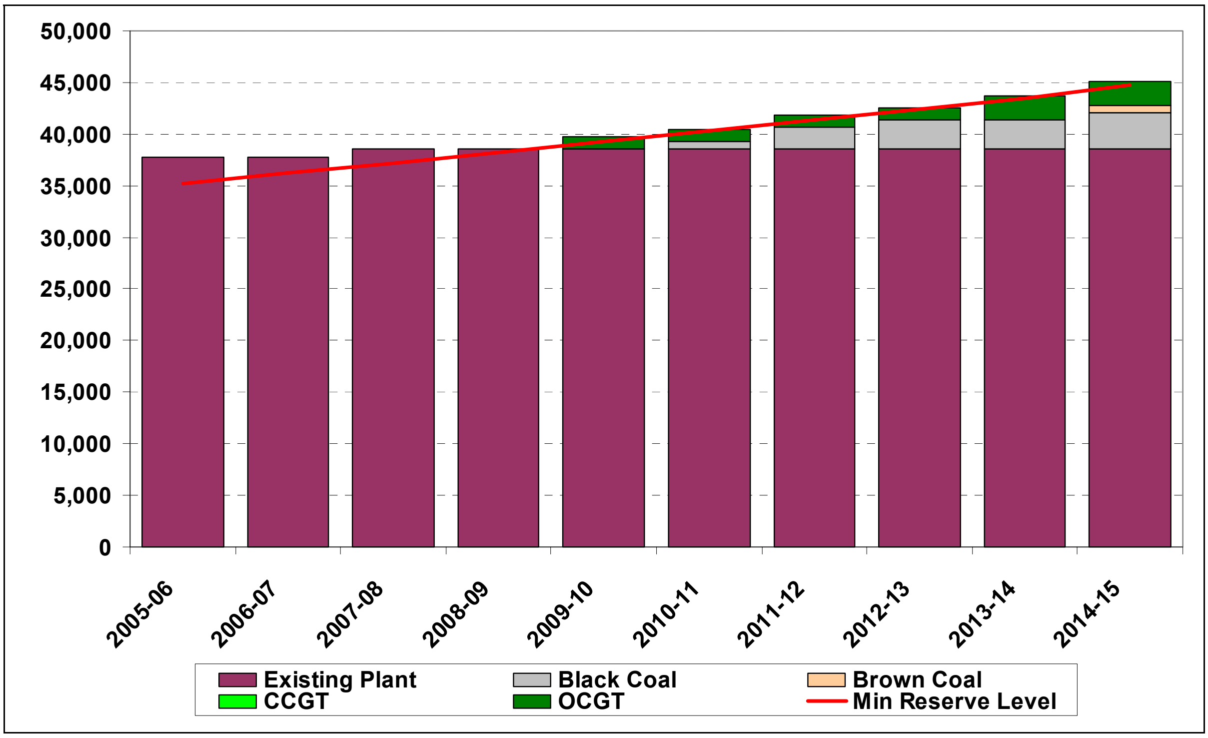


Figure 4.4- High Black Coal Fuel Price Scenario (MW)

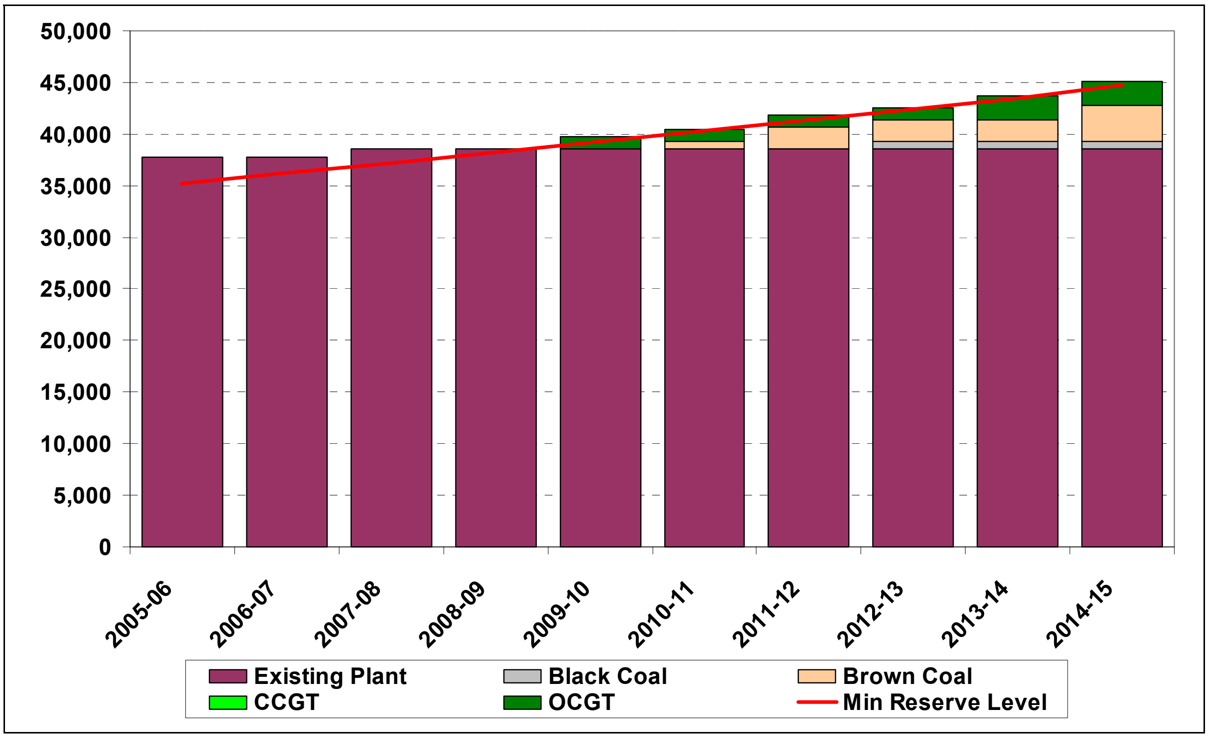


Figure 4.5- Carbon Tax Scenario (MW)

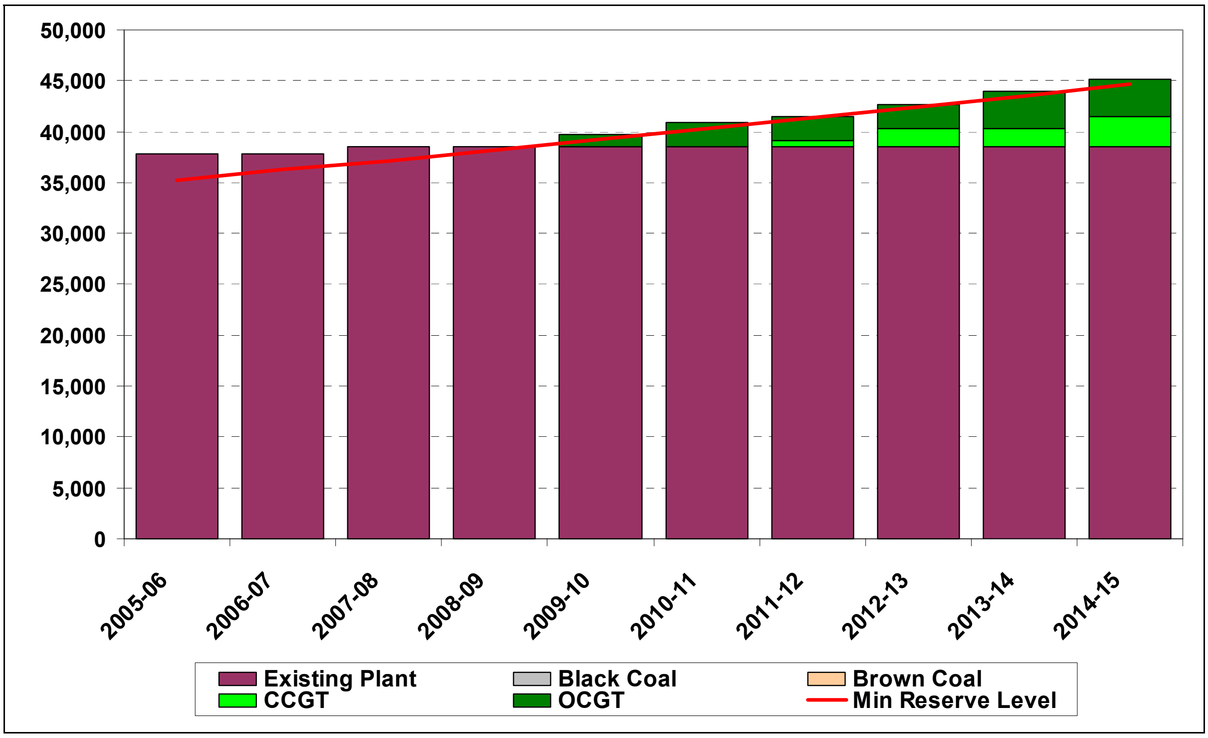
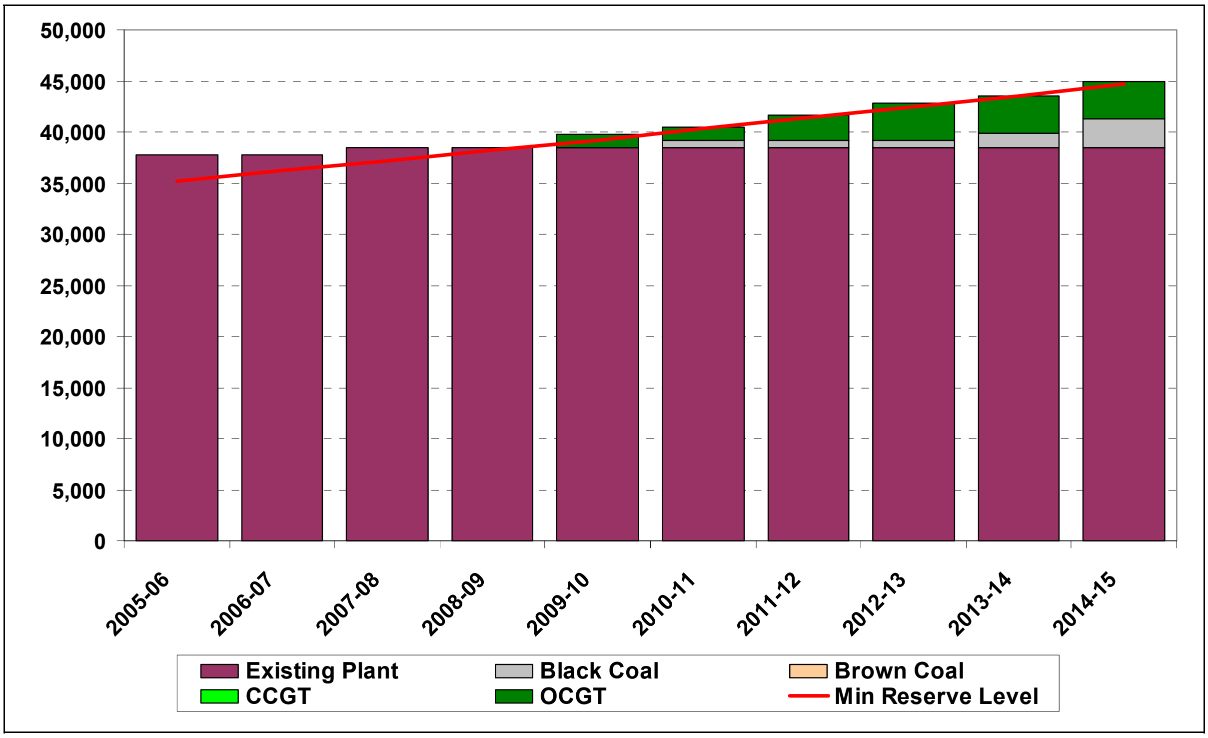


Figure 4.6- Carbon Tax and High Gas Price Scenario (MW)



4.3) Impact on New South Wales Power System

Having forecast the quantum and timing of new generation of each type that would provide the preferred development path for the NEM, for several sets of key input assumptions, the next step is to identify the likely locations of the plants and the possible effects on New South Wales transmission system.

4.3.1) Black coal-fired Development

Black coal plants in Scenarios 1, 2 and 5 are likely to be developed in close proximity to the available resources. This includes the lowest cost resources in locations such as Hunter Valley in New South Wales or in the Surat Basin in Queensland.

Scenario 1, with major coal developments in Queensland, would likely require major augmentations on interconnectors between Queensland and New South Wales (QNI) in the southerly direction, while Scenario 2 would require more attention to the transmission system within New South Wales.

The transmission development plans for New South Wales would be similar for either of these locations, since the main load centres in the State (and Victoria/South Australia) are south of these generating centres and would make use of the same TransGrid lines. There is a much lower probability that black coal-fired developments would occur within 10 years in southern or south western areas of New South Wales rather than in the northern and north western parts of the State, or in Queensland.

4.3.2) Brown Coal-fired Development

Brown coal plants in Scenario 3 are likely to be in Victoria or South Australia, either of which would have similar influence on New South Wales transmission development.

Brown coal-fired plants have substantially higher capital costs, lower fuel costs and higher specific CO_2 emissions than black coal-fired plants.

The probability of development of brown coal plants has significant implications for transmission development in New South Wales, since, if development of brown coal is precluded by capital costs, or environmental limitations, additional transfer of power from New South Wales or Queensland generators will be needed through the New South Wales grid to supply Victoria and South Australia.

4.3.3) CCGT Development

For CCGT plants to be built on a significant scale (Scenario 4), the economics of CCGTs dictates that the plant would operate at a capacity factor in the range of around 50% to 70% per annum. Below this capacity factor range, the additional efficiency of CCGTs relative to OCGTs would be less likely to offset the additional capital cost, and consequently OCGTs would be chosen.

CCGT plants would likely be constructed at locations in the network with low gas transport costs. This is likely to be closer to major gas fields, rather than near the major load points in New South Wales. Major potential gas fields are in Bass Strait and Central Australia. Other possible gas pipeline expansions, such as PNG, would provide opportunities for the gas-plant to be built in Queensland.

4.3.4) OCGT Developments

OCGT plants generally have a much lower amount of operating time than other types of plants. Higher gas costs can be tolerated for short periods when pool prices are high.

Provided gas pipeline capacity is available, generators are more likely to be located in close proximity to major load centres. OCGT plants are also likely to have backup supplies of liquid fuel. Construction of new OCGTs is feasible in any region of the NEM.

4.4) Cumulative Probabilities of Different Developments

The previous section has described the outcomes of the IRP study including the development of five different scenarios which, together, have a high probability of containing the likely outcomes for the NEM, in terms of the quantum and type of new generation.

Each of the five scenarios contains a combination of at least two plant types to be built in the next 7 years to 2011/12, which is within the period that TransGrid will have to actively consider in the revenue reset period which extends up to June 2009. The outcomes are summarised in Table 4.7.

Table 4.7–Probability of Development of Various Plant Types (MW)

Scenario	Probability	2009/10	2010/11	2011/12
1	20%	1,400 Black	600 OCGT	1,400 Black
2	25%	1,200 OCGT	700 Black	1,400 Black
3	10%	1,200 OCGT	700 Brown	1,400 Brown
4	25%	1,200 OCGT	1,200 OCGT	600 CCGT
5	20%	1,200 OCGT	700 Black	1,200 OCGT

Consideration of the probabilities of each of the scenarios, and the associated likely pattern of generation developments, shows that there is a 20% probability of at least 700MW of black coal plant being commissioned by 2009/10. There is a 65% probability of at least 700MW of black coal plant being commissioned by 2010/11. There is a 40% probability of at least 2100MW of black coal plant being commissioned by 2011/12.

TransGrid will need to consider the potential impact of these additional levels of base load generating capacity on the grid, since existing black coal generation will also be operating at high levels by that time. All mothballed plants, including four Liddell units and two Munmorah units, are assumed in the modeling to be in service. The larger the amount of new black coal fired generating capacity, the more likely that the power will come from further away and that some additional power would be transported from Queensland over the QNI interconnector.

There is an 80% probability of at least 1200MW of new OCGT capacity in the NEM by 2009/10. There is a 45% probability of at least 2400MW of new OCGT capacity in the NEM by 2011/12. The locations of the OCGTs could be distributed widely around the NEM, but would be likely to be at locations with close proximity to gas pipelines. This could be in Victoria, South Australia, New South Wales or Queensland.

The probability of CCGT developments is relatively low, with a 25% probability of 600MW of new CCGT capacity being developed by 2011/12. The location of such base load CCGT capacity would be dependent on access to a dedicated gas resource. Origin Energy is one private party that has foreshadowed the development of CCGT capacity in Victoria and/or Southern Queensland in the next several years.

The probability of brown coal developments is also quite low, with a 10% probability of at least 700MW by 2010/11.

5) SUMMARY AND CONCLUSIONS

TransGrid has sought to identify a range of credible market development scenarios that could occur over the next 10-year period, and could have significant impacts on the New South Wales transmission system. Furthermore, TransGrid have sought the relative probabilities of each of these scenarios proceeding.

Since New South Wales is heavily interconnected with other regions of the NEM with combined imports from north and south up to 4,000MW and combined exports up to 1,500MW, the development of new generation in this region needs to be considered within the context of the entire NEM.

To assess the most probable scenarios within the NEM during the next decade, ROAM has carried out this study by assessing the optimum development plans for the NEM over a long term horizon, covering the period 25 years ahead.

This was performed using ROAM's Integrated Resource Planning Model together with ROAM's 2-4-C dispatch methodology to accurately establish the likely operating patterns for up to 25,000 separate development scenarios in the next 25 years.

A wide range of scenarios was studied to identify the most likely outcomes for the NEM. Five scenarios were selected as the most probable cases representing the range of potential generation development scenarios within the NEM over the next decade. These scenarios and their associated probabilities are as follows:

- Low Black Coal Fuel Price with 20% probability;
- Medium Black Coal fuel Price with 25% probability;
- High Black Coal Fuel Price with 10% probability;
- Carbon Tax with 25% probability, and
- Carbon Tax and High Gas Price with 20% probability.

The impact of each of the above scenarios, on the New South Wales transmission system will be different, requiring different investments in the various parts of the network.

Consideration of the probabilities of each of the scenarios, and the associated likely pattern of generation developments, shows that there is a 20% probability of at least 700MW of black coal plant being commissioned by 2009/10. There is a 65% probability of at least 700MW of black coal plant being commissioned by 2010/11. There is a 40% probability of at least 2100MW of black coal plant being commissioned by 2011/12.

TransGrid will need to consider the potential impact of these additional levels of base load generating capacity on the grid, since existing black coal generation will also be operating at high levels by that time. All mothballed plants, including four Liddell units and two Munmorah units, are assumed in the modeling to be in service. The larger the amount of new black coal fired generating capacity, the more likely that the power will come from further away and that some additional power would be transported from Queensland over the QNI interconnector.

There is an 80% probability of at least 1200MW of new OCGT capacity in the NEM by 2009/10. There is a 45% probability of at least 2400MW of new OCGT capacity in the NEM by 2011/12. The locations of the OCGTs could be distributed widely around the NEM, but would be likely to be at locations with close proximity to gas pipelines. This could be in Victoria, South Australia, NSW or Queensland.

The probability of CCGT developments is relatively low, with a 25% probability of 600MW of new CCGT capacity being developed by 2011/12. The location of such base load CCGT capacity would be dependent on access to a dedicated gas resource. Origin Energy is one private party that has foreshadowed the development of CCGT capacity in Victoria and/or Southern Queensland in the next several years.

The probability of brown coal developments is also quite low, with a 10% probability of at least 700MW by 2010/11.

The IRP studies have demonstrated that there is a relatively high degree of uncertainty as to the location and type of new generating capacity to be built in the NEM in the next 10 years. Since New South Wales is central to the NEM, with the potential for large bidirectional transfers on both the QNI and Snowy to NSW interconnectors, it is prudent to plan for this uncertainty.

The magnitude of new entry generation could also be significantly higher than assessed in the IRP model, given the competitive forces applying in the generation sector of the NEM.

6) Appendix- 20-year Outlook For the Most Likely Scenarios

Figure A.1- Low Black Coal Price Scenario (MW)

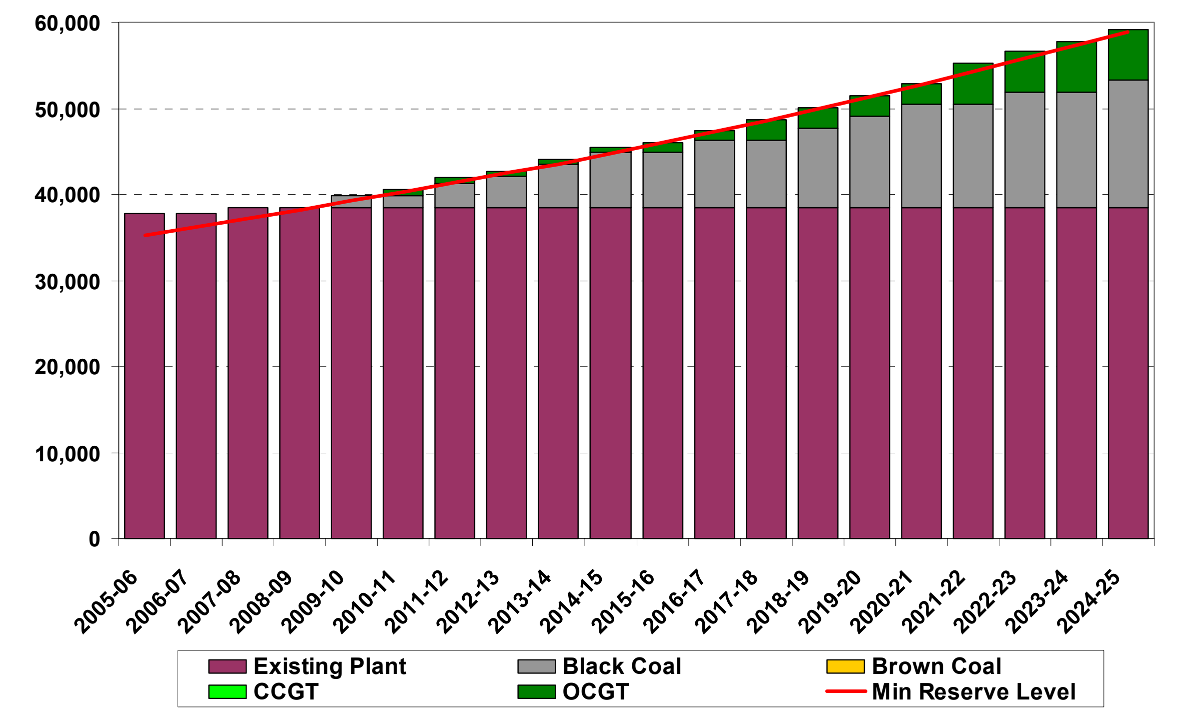


Figure A.2- Medium Black Coal Price Scenario (MW)

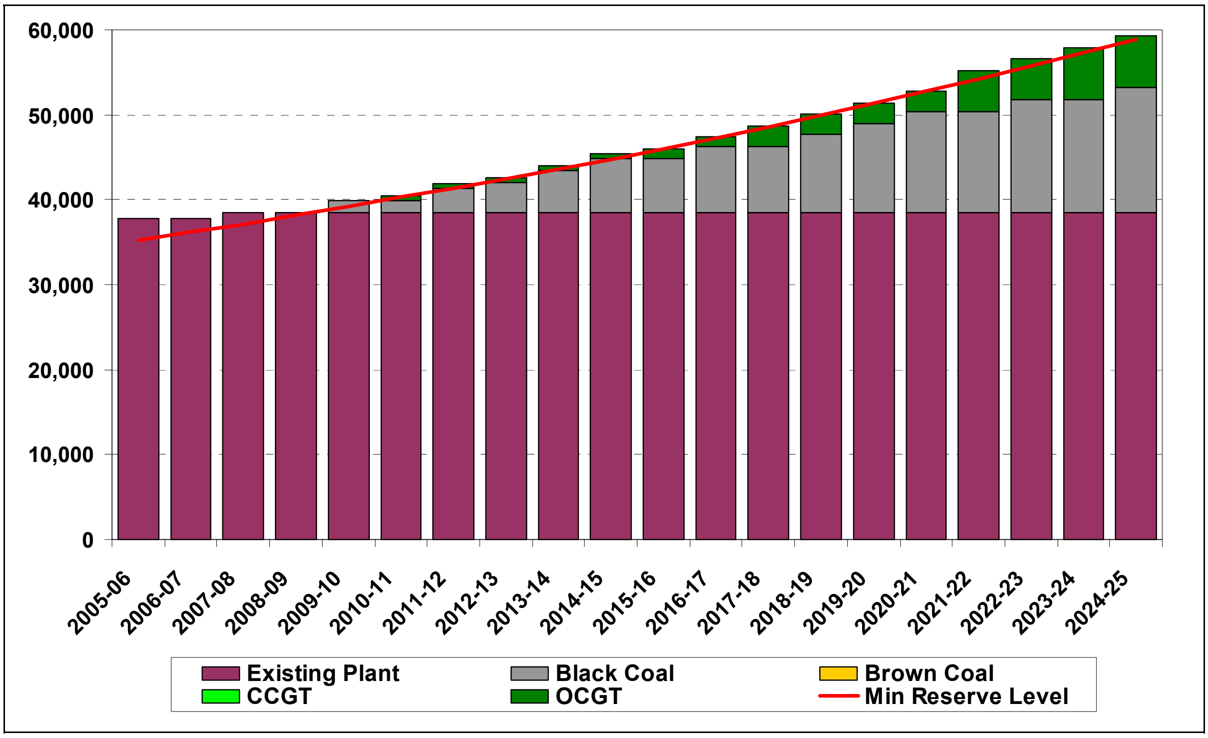


Figure A.3- High Black Coal Price Scenario (MW)

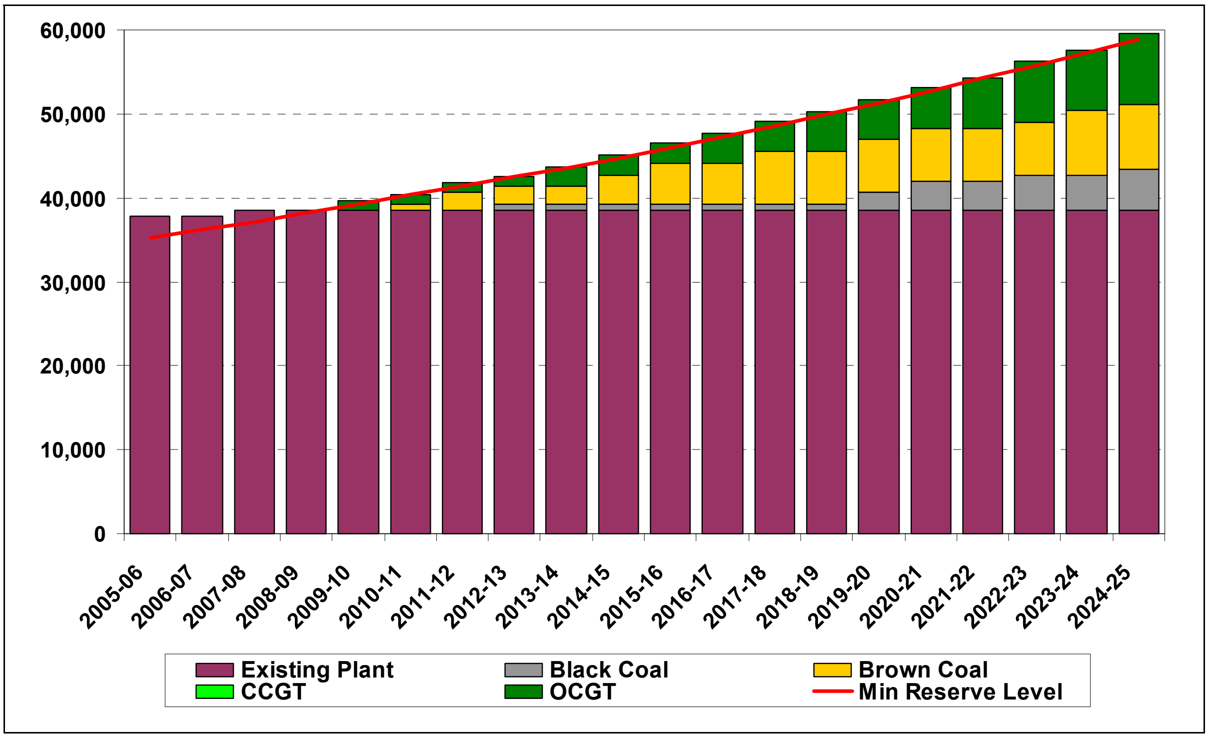


Figure A.4- Carbon Tax Scenario (MW)

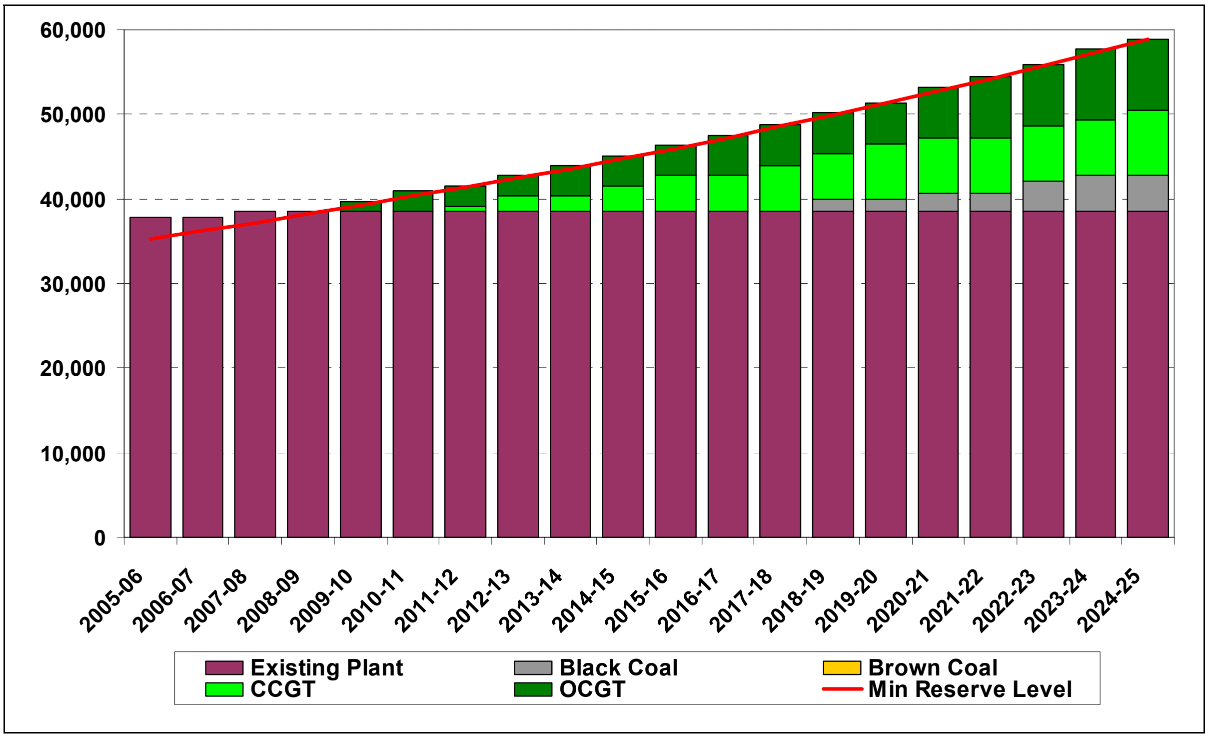


Figure A.5- Carbon Tax and High Gas Price Scenario (MW)