TransGrid

TransGrid's Submission to the
Australian Competition & Consumer Commission

Revised Transmission Capital

Investment Program 2004-2009

Attachment 6E

Development and Application of a Set of Backgrounds Forming the Basis for the Future High Voltage Network Augmentation Program

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ATTACHMENT 6E

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DEVELOPMENT AND APPLICATION OF A SET OF BACKGROUNDS FORMING THE BASIS FOR THE FUTURE HIGH VOLTAGE NETWORK AUGMENTATION PROGRAM

DISCUSSION PAPER

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DEVELOPMENT AND APPLICATION OF A SET OF BACKGROUNDS FORMING THE BASIS FOR THE FUTURE HIGH VOLTAGE NETWORK AUGMENTATION PROGRAM

1. INTRODUCTION

This discussion paper sets out the process for developing load and generation “Backgrounds” and their application in deriving a probabilistic-based network reinforcement program with respect to TransGrid’s submission to the ACCC for a forward capex budget.

In developing the initial submission to the ACCC in 2003 a probabilistic-based approach was also applied. In this case the load and generation development “Backgrounds” (then called scenarios) were based on the report by ROAM Consulting “Scenario Planning and Modelling Study for 2003 Onwards” dated 12th April 2003. This report identified 16 basic scenarios of load, generation development and interconnector usage.

The ROAM scenarios were as follows:

Scenario	Load forecast		Generation development				Energy policy	
	Growth	POE %	Coal	Gas	North	South	Yes	No
1	Low	90	✓		✓		✓	
2	Low	90	✓		✓			✓
3	Low	90		✓		✓	✓	
4	Low	90		✓		✓		✓
5	Medium	50	✓		✓		✓	
6	Medium	50	✓		✓			✓
7	Medium	50		✓		✓	✓	
8	Medium	50		✓		✓		✓
9	Medium + 1000	50	✓		✓		✓	
10	Medium + 1000	50	✓		✓			✓
11	Medium + 1000	50		✓		✓	✓	
12	Medium + 1000	50		✓		✓		✓
13	High	10	✓		✓		✓	
14	High	10	✓		✓			✓
15	High	10		✓		✓	✓	
16	High	10		✓		✓		✓

The energy policy refers to the implementation of the NSW Greenhouse benchmark scheme
poe: probability of exceedance

The medium + 1000 MW load scenario covered two situations:

- High growth - 50% probability of exceedance (poe)
- Medium growth - 10% poe

The Medium growth with 1000 MW was defined as five 200 MW increments commencing in 2003/4.

There have been a number of market-related changes in the intervening period that impact on these scenarios:

- The Kogan Ck Power Station development has been announced and is now treated as committed in the 2004 Statement of Opportunities (SOO), according to NEMMCO's guidelines.

- The reserve plant margins in NSW and Queensland have been modified as follows:

	Queensland	**NSW**
2003	450	700
2004	610	-290
Change MW	+160	-990

- Load forecasts in each State have been updated.

- The Annual Interconnector Review has been published in the 2004 SOO.

The development of a coal-fired power station in Queensland attracted a certain probability in the ROAM work, appearing explicitly in scenarios 6 and 10, and hence the probabilities of other scenarios now need to be adjusted.

The change in reserve plant levels implies a change in the future generator developments that may be needed to meet the required supply reliability.

The Annual Interconnector Review has been conducted partly by the IRPC. The IRPC provided a consultation document in late 2003 that proposed a number of scenarios for the analysis of the need for interconnector reinforcement. A set of generator cost data, interconnector capability and other data was put in the public domain and forms a basis for future market modelling work. NEMMCO has used this data to identify a potential stream of market entry and reliability entry generation under a few market scenarios and these results have been published in the SOO.

These issues indicate a need to revise the ROAM-based scenarios.

2. NETWORK DEVELOPMENT DRIVERS

Load growth within NSW and across the NEM, generation development in response to the load growth and isolated load and generation developments are the major influences on the future adequacy of the power transfer capability of the network. These are therefore the major drivers for network augmentation or alternative non-network solutions. A number of other drivers may be important in isolated cases.

The following main development drivers arise with respect to the subsystems and substations forming localised supply systems, the NSW main system (500/330/220 kV system) and interconnectors with adjoining states:

Driver	**Area of Influence**		
	Localised Supply Requirements	**NSW Main System**	**Interconnectors**
Local load growth	x		
Load growth in NSW		x	x
Load growth in adjoining regions			x
Reliability criteria with DNSP's / Loads	x		
Generation development in NSW	x	x	x
Generation development in adjoining states or regions			x
Interconnector utilisation		x	
Generator retirement	x	x	x
Generator dispatch patterns		x	
Losses	x	x	x
Operation of MNSP's	x	x	x
Code technical requirements	x	x	x
Revised environmental constraints	x	x	
Network asset issues / refurbishment	x	x	

Load growth

Load growth within NSW may impact on localised supply requirements, the overall main system and interconnector loadings. Localised load growth is particularly import in assessing transformer capacity requirements and the need for subsystem developments.

Major load developments may require reactive power support, new substation development or new line development.

The load growth in adjoining NEM regions will affect the spare power / energy available for transfer over the interconnectors. Increased NSW load implies higher levels of import over the interconnectors and lower load growth implies increased export.

Load growth is defined by the high, medium and low economic growth forecasts set out in the 2004 APR and 2004 SOO.

Reliability Criteria with DNSPs / Loads

The establishment of an appropriate reliability criteria for a customer (as a matter of joint agreement) has a direct relationship with the need for and timing of a network reinforcement and may also affect the choice of augmentation option.

The value to be assigned to unserved load may also be critical.

Generation Development

Generation development includes plant upgrading as well as the development of new power stations.

Increased MW loading on existing generators may result in higher transmission loadings and may imply a reduced reactive power capability from the unit. There may also be increased reactive power losses in the system. Hence there may be a need for works within the transmission system such as the need for increased reactive power support.

Plant retirements can lead to higher loading on sections of the network. This may imply the need for reactive power support, substation augmentation or line developments.

The operation of embedded generation can be important for local system conditions.

The supply / demand balance in each region of the NEM affects the utilisation of the NSW main system and interconnectors.

The level of generator development is dependent on many factors that would be expected to include forecast pool prices, region reliability levels and reserve plant margins.

Relatively small renewable generation developments are generally not expected to have widespread impacts on the need for transmission system development remote from the site. They generally require local works to enable connection.

Generator Dispatch

The main NSW system has been planned on the basis of traditional dispatches of the generators. Variations to the traditional patters due to changing bid behaviour on the part of the local and inter-regional generators may lead to higher network loading and hence the need for network development.

Losses

The overall MW and energy transmission losses in lines, transformers, shunt plant etc impact on the cost of plant (includes conductor size). It is possible that line losses may lead to a need for network reinforcement.

TransGrid's network augmentation plans may also be impacted by marginal loss factors applied in the NEM.

Operation of MNSP's

The operation of MNSP's in response to market forces may impact on network loading and hence the need for network augmentation.

Code Technical Requirements

The Code technical requirements form a basis for transmission system requirements. Changes to the Code requirements will affect the need for transmission augmentation and the extent of the augmentation.

One example is the operating time requirements for primary protection that may lead to significant network augmentation. Another less well-known situation occurs with the time requirement for local backup protection. Relatively short times could require a redesign of switchyards.

Revised Environmental Constraints

Environmental constraints may change with time and TransGrid may need to respond with capital works. This issue includes

- Losses in the network leading to greenhouse gas emissions
- Noise impacts as the land surrounding substations is developed.
- Visual impact of lines and substations as developing areas encroach near to TransGrid lines and substations.

Network Asset Issues / Refurbishment

Major refurbishment works must be coordinated with future network development plans to achieve the optimum level of investment.

Other Drivers

TransGrid has other minor projects that will need to be developed – these include line rating monitors, disturbance recording, emergency control systems etc. The drivers for these projects could be the need to delay or minimise the need for network augmentation, improved system modelling aimed at improving system security (which itself may lead to a change in the capital works program) etc.

3. EXPECTED VALUES OF DRIVERS

The main drivers are load growth and generation development. There are no known generation retirements that are likely to significantly affect the network in NSW.

3.1 Load Growth

The load forecast and its basis are presented in the APR and SOO. The forecast is developed in terms of economic growth: high, medium and low.

These have been established to have the following probabilities (these are draft estimates at this stage):

Economic Growth	Probability
High	10%
Medium	70%
Medium and 400 MW industrial development in two increments from 2007/8	10%
Low	10%

The allocation of high, low and medium forecasts follows from the analysis of economic scenarios (to be provided).

In the ROAM work allowance was made for a 1000 MW industrial load development in five increments. Since then the Austeel project and other smaller projects have not been pursued.

There remains the possibility of development of one or more major industrial loads over the review period. These have been excluded from the TransGrid load forecast. Examples are the fourth potline at Tomago (about 400 MW) following from the present expansion by about 170 MW or expansion of the smelter at Kurri (of the order of 300 MW). These load developments have been regularly reviewed by the smelter owners.

A notional 400 MW load increment has been assumed. It is assumed that is developed in two increments from 2007/8 (ie in the last two years of the review period) and is located at the Tomago 330 kV busbar. A 10% probability has been allowed for this scenario.

The low, medium and high load growth is assumed to be applied consistently to each State load forecast.

3.2 Generation Development

The SOO sets out the existing generator capability and prospective developments. The supply / demand balance provides an indication of potential future shortfalls and hence the need for future generator / interconnection development.

The summer generation capability in NSW is shown below, only the progressive changes in output are indicated, there being only one thermal plant upgrade in 2005/6 and no changes, apart from Snowy units, thereafter.

	2004/5	2005/6	2006/7	2007/8	2008/9	2009/10	2010/11	2011/12	2012/13
Bayswater	2800								
Eraring	2640								
Liddell	2030	2040							
Mt Piper	1320								
Munmorah	600								
Redbank	148								
Vales Pt	1320								
Wallerawang	1000								
Total thermal	11858	11868							
Blowering	80								
Hume	0								
Hunter V GT	51								
Shoalhaven	240								
Snowy	3676	3694	3779	3846	3896				

It is intended that the above capabilities would be applied in this network review.

In the SOO in some cases allowance is made for down-rating of the power station output due to limitations on cooling water temperatures. This applies to Eraring and Vales Pt. However for transmission planning only the maximum capability as shown above is significant.

The Bayswater capability above differs from the SOO. The SOO indicates that the capability is 2640 MW. However Macquarie Generation is understood to be moving to 2800 MW although there may be restrictions on hot days due to lake water temperature restrictions.

In the SOO NEMMCO also refers to the following announced or advanced Projects

2 x 150 MW OCGT – Wagga
400 MW – Tallawarra
Up to 800 MW OCGT to CCGT at Tomago
200 MW solar tower – Buronga

These GT developments are included as alternatives below. The solar tower would only be assessed if it were to become a firm proposal.

Based on connection inquiries there are also a number of prospective windfarm developments in NSW.

4. GENERATION SITING BACKGROUNDS

Market modelling and reviews of prospective generator entry to the market do not directly provide siting probabilities.

The following are the most likely siting scenarios that are expected to apply over the time-frame of interest. This draws on the NSW Statement of System Opportunities 2002 (SOSO), connection inquiries and local planning knowledge[1]:

Area	Coal	GT	Renewables
North and west of the state	Hunter Valley Gunnedah - Narrabri Ulan Mt Piper Unit upgrading	Tomago Eraring Munmorah	Lismore area (sugar mills)
South of the state	Oaklands	Pt Kembla Tallawarra Tomerong Marulan Goulburn area Wagga	Wind – range of sites in the Marulan to Goulburn area

It is assumed that no significant generation development will be feasible in the Sydney basin due to environmental restrictions that would result in preference for more remote sites.

The coal sites cover large geographic areas and the power stations could be developed anywhere in the broad area which would lead to a range of transmission costs. The sites closest to the transmission system within the coal area will be assumed to be the preferred site from the point of view of this planning exercise.

Standard generator unit ratings will be assumed, ie coal: 500 MW to 700 MW, gas turbine: 150 MW to 200 MW.

4.1 Coal Stations

The vast NSW western and northern black coal reserves could enable power station development at many sites. A two unit power station development in any area is assumed. Other considerations including water supply and proximity to the transmission system imply a focus on the following sites:

Ulan

This site has been identified for several decades and has been the subject of recent detailed analysis. The power station site is assumed to be near to the original coal-fired power station.

[1] For example note the ECNSW 30 year plan of 1989.

A connection application for a two unit 500 MW power station has recently been addressed. The unit rating could range up to 700 MW.

Hunter Valley

The Hunter Valley power station is assumed directly connected to the Bayswater switchyards. It represents the Foybrook or Mt Arthur sites that were assessed in the 1980's and 1990's.

Gunnedah - Narrabri

This station could be located in the Gunnedah – Narrabri area. Gunnedah is closest to the NSW main system and is assumed for this study. The station is relatively close to Queensland.

Mt Piper

There is scope for the addition of two 660 MW units at Mt Piper with minimal infrastructure developments.

Oaklands

The Oaklands coal is of lower quality than northern coal but higher calorific value than brown coal. Oaklands could provide Victoria with an energy source.

It is considered to be of lower probability than northern coal developments.

Unit Upgrading

Ten of the 660 MW units are capable of 700 MW output or more, with a relatively low capital investment. This upgrading has been undertaken at Bayswater and it is assumed the other six units will follow with the following order:

Bayswater: 2004/5 as above – by 40 MW per unit – total 160 MW
Mt Piper – total 80 MW
Eraring – total 160 MW

Liddell refurbishment (4 x 15 MW) is scheduled to be completed for summer 2004/5 as noted above.

It is assumed that plant upgrading would proceed before the development of new coal plant.

4.2 Renewables

Renewables may require connection to the 330 kV or 132 kV system. Due to the low capacity factor and transient nature of the generation it is assumed that no deep network augmentations would be required.

Based on the state of connection inquiries the following two wind farms will be assumed, independent of the scenarios:

Crookwell II 120 MW: 2005/6

Taralga 100 MW: 2006/7

The sugar mill generators are relatively small but will affect the timing of reinforcement on the far north coast system.

4.3 Gas Turbines

Tomago and Eraring are the subject of connection inquiries. Munmorah provides another option.

There are a number of possible southern sites:

Pt Kembla - associated with the steel mill (225 MW CCGT)
Tallawarra – a publicly announced project
Tomerong – the subject of recent inquiries
Marulan – from past knowledge
Goulburn area – from past knowledge and inquiries
Wagga - from a connection application

Their viability depends on gas pricing.

They will be assumed to each have the capability for 300 MW of GT's except for Tallawarra which will be assumed to have 600 MW capability.

4.4 Siting Probabilities

The following probabilities have been assigned:

Coal		**GT (300 MW)**		**Renewables**	
Site	**Prob %**		**Prob %**	**Site**	**Prob %**
Unit upgrading	100	Tomago	10	Lismore area	100
		Eraring	10	(sugar mills)	
Ulan	30	Munmorah	10	Crookwell	100
Mt Piper	20	Pt Kembla	10	Taralga	100
Gunnedah	20	Tallawarra #1	10		
Bayswater	20	Tallawarra #2	10		
Oaklands	10	Tomerong	10		
		Marulan	10		
		Goulburn area	10		
		Wagga	10		

5. OVERALL PROCESS

The overall process starting with the development of the backgrounds through to the inclusion in the capital budget is shown in Figure 1.

Probabilities are assigned at the following steps:

- Demand backgrounds
- Generation planning
- Selection of the types of generator
- Selection of the location of power stations.

Localised supply augmentations tend to be governed principally by load growth so a simpler process for these developments is envisaged.

The development of the generation / interconnection backgrounds is covered in Section 6. The following are the main subsequent steps and expected documentation.

Select types of generation

Market-entry plant will be identified as coal or gas-fired depending on the market premium.

Reliability-entry plant will be gas-fired except where the total installation in NSW rises above 600 MW where coal-fired generation will then be assumed, recognising that there will be gas supply limitations.

Select location of power stations

For any proposed coal or gas-fired development the full range of above options will be considered, each one creating a separate “Background”.

Each “Background will be documented”.

Develop system models

Standard system models of the local area, the NSW main system or the four state interconnected system (as appropriate) will be modified to include the generation and load scenarios.

The models will cover a range of generation / interconnector dispatch to identify the worst case conditions and highly probable conditions.

The conditions will be documented.

System adequacy analysis

The system models covering critical conditions will be assessed with respect to the following aspects, as appropriate:

- Short circuit duty - compared to plant rating.

- Line and transformer loading - compared to thermal rating
- Voltage control capability – to assess power transfer capability
- Transient stability – to assess power transfer capability

The analysis will be restricted to critical years in the load forecast.

The analysis will be summarised in a document addressing each system limitation.

Develop Options for Reinforcement

The options available to address a system requirement will be developed from planning knowledge. Only the more practical options will be considered and these will be documented.

A broad scope of works will be developed to enable the options to be costed.

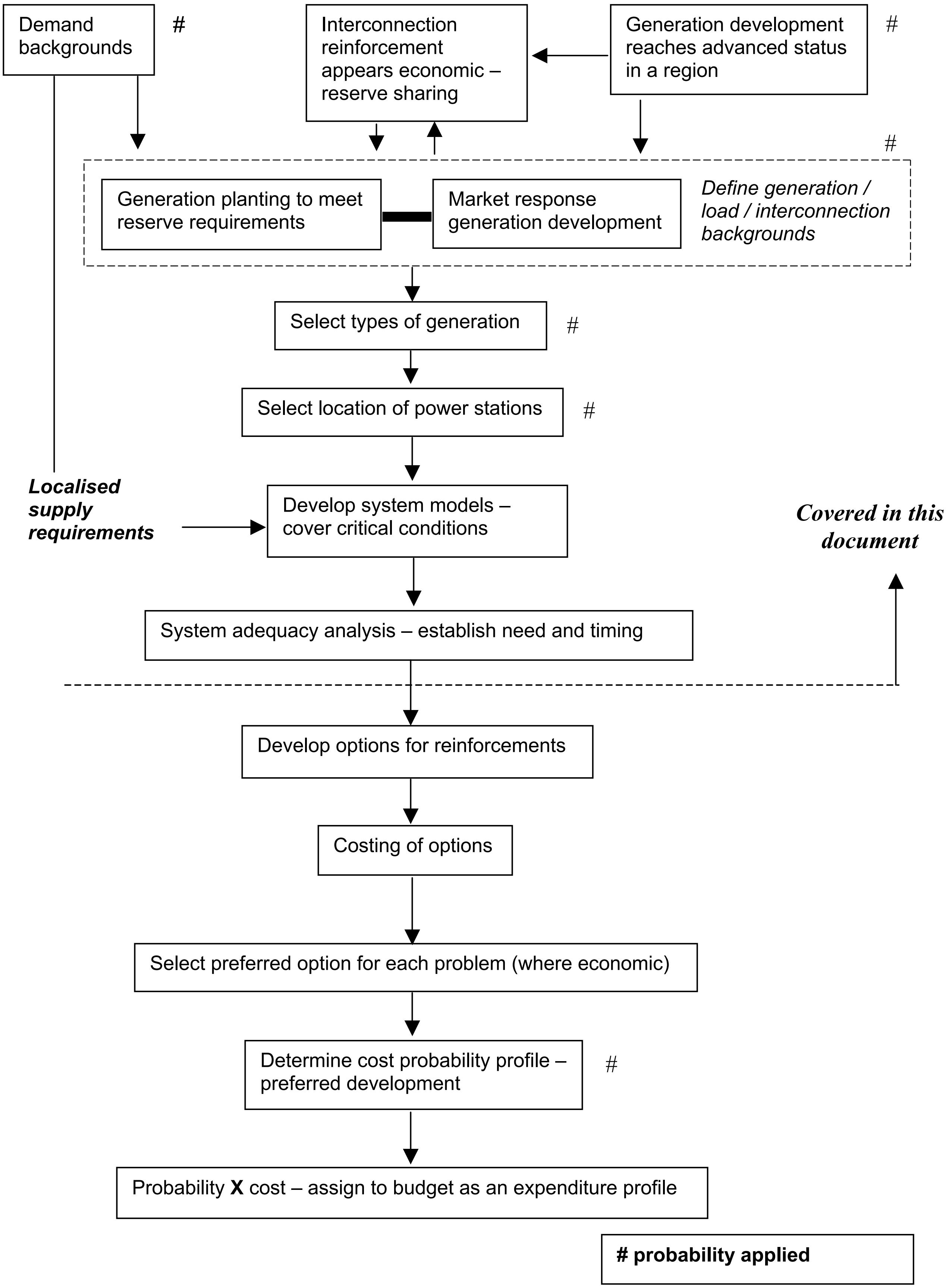

Figure 1 – Overall Process

6. GENERATION / INTERCONNECTOR BACKGROUNDS

The development of the load/generation/ interconnector scenarios would ideally follow the process shown in Figure 2. The data is based on the AIR data developed by the IRPC.

The AIR considered three situations:

- A base case using the published fuel and plant costs;
- An increased gas scenario, assuming coal costs will escalate; and
- The implementation of all advanced projects.

These will be applied in this review with the following probabilities:

Situation	Probability %
Base case	50
Increased gas	30
Advanced projects	20

There are a number of issues with this approach that may not be overcome in the time available and hence the abbreviated approach (set out in Section 7), based on published information, will be followed in parallel. The issues with the detailed approach include:

- Bidding behaviour – a bidding process based on historical data was developed as part of the AIR. This requires considerable adjustment and iterations when applied for future years. The outcomes of historical bidding are known to differ from the outcomes of SRMC and LRMC bidding.
- Considerable iterative work is required to identify possible interconnector developments as opposed to development of generation plant in a region. In the time available it is not expected that this work would be sufficiently robust.

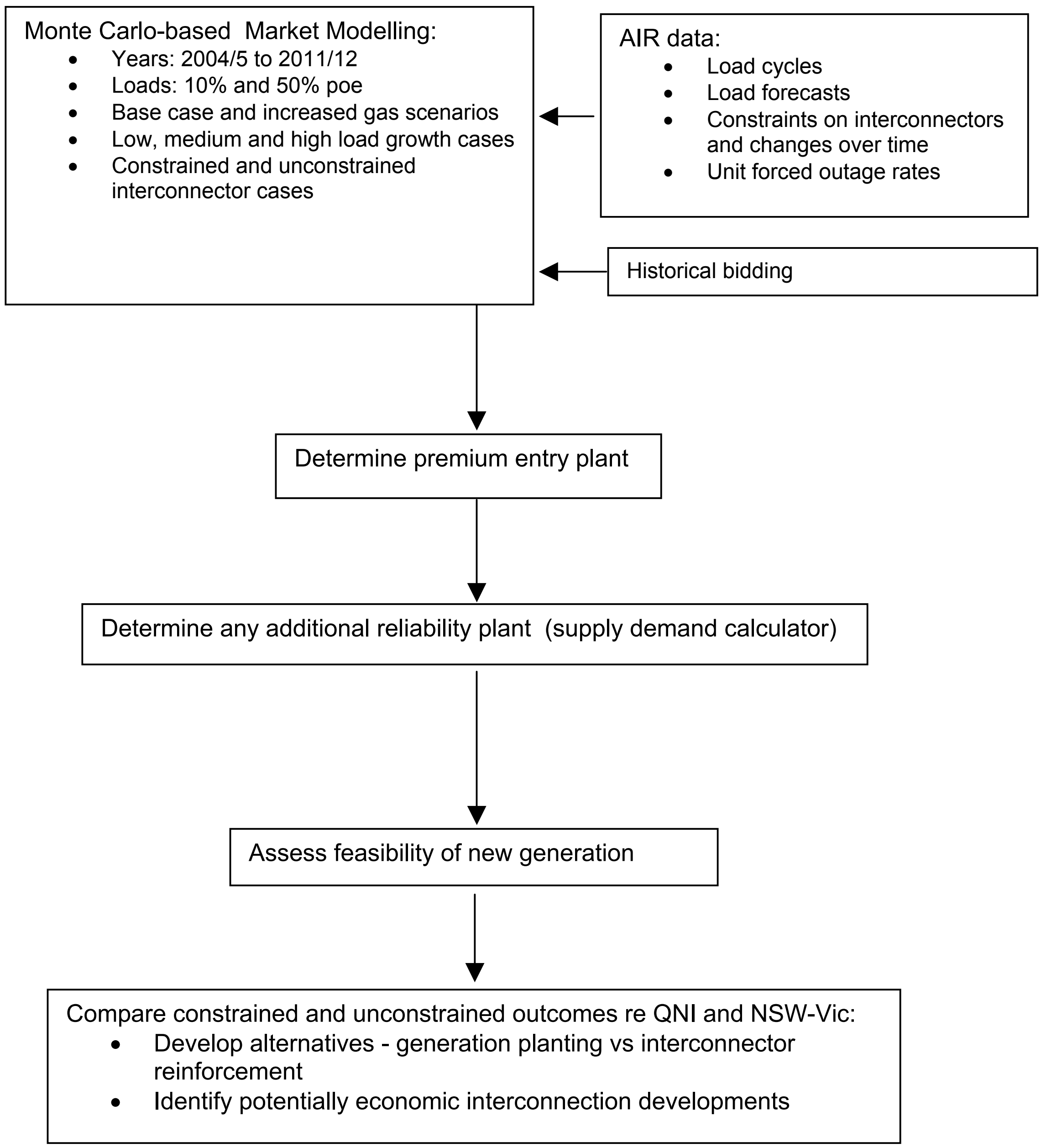

Figure 2: Identification of Generation / Interconnector Backgrounds

7. ABBREVIATED PROCESS – GENERATION / INTERCONNECTOR BACKGROUNDS

The abbreviated process of Figure 3 is proposed as a means of identifying the generation / interconnector "Backgrounds". It is based on the AIR outcomes published in Chapter 11 of the SOO 2004.

The AIR determined market and reliability entry plant for medium growth to 2013/14.

The AIR applied the load forecasts of the 2003 SOO and assumed certain generation was committed or advanced. The AIR has applied the recently revised reserve plant margins.

The following amendments to the advanced plant now apply:

> Kogan Creek – now regarded as committed
> Redbank 2 – now unlikely to proceed

The following steps would be applied:

Load forecast adjustments

The differences between the SOO 2003 load forecast for medium growth in each region would be compared to the SOO 2004 forecast for each of medium, low and high economic growths. Differences in demands indicate a need to increment (or decrement) the level of generation entry. It will be assumed that the market entry plant is unchanged and only the reliability plant changed, to minimise market simulation requirements.

Generation entry adjustments

The amendments to the advanced plant details will be used to adjust the market entry plant.

Interconnector Upgrades

The AIR identified the four highest priority interconnection developments under the medium economic growth scenario. The AIR also provides an indication of the likely capacity upgrade that may be required by the market.

It will be assumed that these interconnector capacity upgrades will all proceed for the medium growth backgrounds with lead times appropriate to the development.

The lead times are:

> Substation development predominantly with minor line works only: lead time 3 years.
>
> New line development: lead time 6 years.

The new line work for any interconnector is likely to involve long-distance high voltage transmission lines such as from south west NSW to near Melbourne or from northern NSW into southern Queensland. The lead time for the new line work includes consideration of the need to carry out a regulatory assessment and environmental impact assessment.

Where the lead time for a new line would preclude the development of the interconnector until the longer term it will be assumed that a lower capacity upgrade would proceed, where the works can be ensured to be broadly compatible with the works that would be required for the larger scale interconnection development.

The AIR also indicated the potential advancement or deferral of works governed by the low and high growth scenarios as follows (the shortest advancement and longest deferral times have been assumed where a range has been given in the AIR to provide the lowest capital expenditures):

High growth:

	Years of advancement
Queensland	3
NSW	2
Victoria	2
SA	2

Low growth:

	Years of deferral
Queensland	9
NSW	2
Victoria	3
SA	2

These values will be applied in this review.

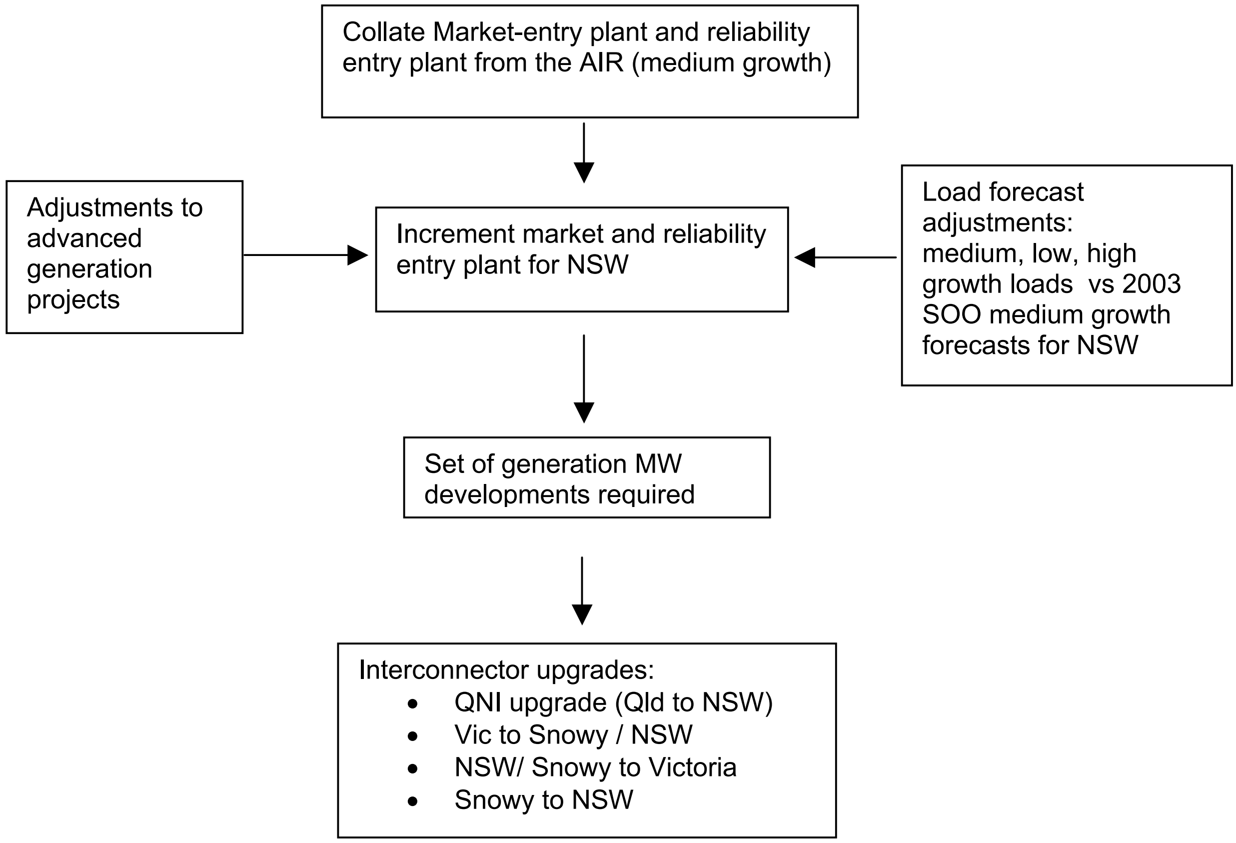

Figure 3 - Abbreviated process for generation / interconnector backgrounds

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