AECOM

Bayswater B Power Station

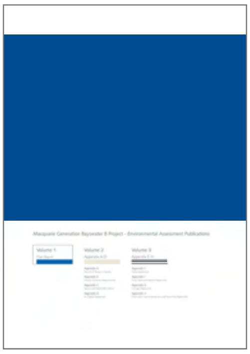
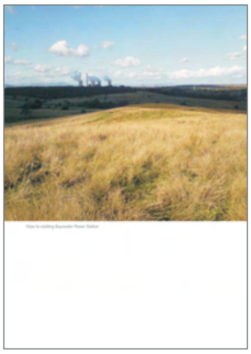
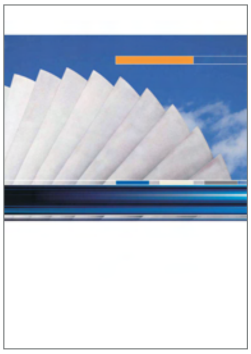
Environmental Assessment

September 2009

MAIN REPORT

Prepared for Macquarie Generation

Prepared by AECOM

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Certification

	Submission of Environmental Assessment (EA) prepared under the Environmental Planning and Assessment Act 1979 Section 75F	
EA prepared by		
Name	Ruth Baker	Michael England
Qualifications	Master of Arts (Archaeology) Principal Environmental Consultant	Bachelor of Arts (Regional and Urban Planning) Senior Principal National Practice Leader Environmental Planning
	AECOM	AECOM
Address	Level 5, 828 Pacific Highway Gordon NSW 2072	Level 5, 828 Pacific Highway Gordon NSW 2072
in respect of	Proposed Bayswater B Power Station Project	
Project application	MP 09_0118	
Applicant name	Macquarie Generation	
Applicant address	34 Griffiths Road. Lambton, NSW 2299	
Land to be developed lot no., DP/MPS, vol/fol etc Proposed project	The proposed project is to be carried out on land identified in Section 4.4 of this EA	
Environmental Assessment	an Environmental Assessment (EA) is attached	
Certification	I certify that I have prepared the contents of this Environmental Assessment and to the best of my knowledge it is true in all material particulars and does not, by its presentation or omission of information, materially mislead.	
	Ruth Baker Signature Name: Ruth Baker Date 23/9/09	Michael J England Signature Name: Michael England Date 23/9/09

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Acronyms

ACC	Air cooled condensers
AEMO	Australian Energy Market Operator
AHIMS	Aboriginal Heritage Information Management Systems
ALARP	As Low As Reasonably Practicable range
ARCU	Antiene Rail Coal Unloader
CCGT	Combined Cycle Gas Turbine (Gas Fired Option)
CCS	Carbon capture and storage
CEEC	Critically Endangered Ecological Community
CEMP	Construction Environmental Management Plan
CO	Carbon monoxide
CO_2	Carbon dioxide
CPRS	Carbon Pollution Reduction Scheme
CSG	Coal Seam Gas
DA	Development Application
DECC	Department of Environment and Climate Change (now DECCW)
DECCW	Department of Environment and Climate Change and Water
DEWHA	Commonwealth Department of Environment Water Heritage and the Arts
DG	Dangerous Goods
DGRs	Director General's Requirements
DoP	Department of Planning
DPI	Department of Primary Industries – now Department of Industry and Investment
DWE	Department of Water and Energy
EA	Environmental Assessment
EARs	Environmental Assessment Requirements
EC	Electrical conductivity
EEC	Endangered ecological community

EP&A Act	*Environmental Planning & Assessment Act 1979*
EPBC Act	Environment Protection and Biodiversity Conservation Act 1999
EPI	Environmental Planning Instruments
EPL	Environment Protection Licence
ESC Act	*Energy Services Corporations Act 1995*
GBMWHA	Greater Blue Mountains World Heritage Area
GDP	Gross Domestic Product
GFC	Global Financial Crisis
GGAS	Greenhouse Gas Reduction Scheme (NSW)
GHG	Greenhouse Gas
GSP	Gross State Product
HP	High pressure
HRSG	Heat Recovery Steam Generator
HRRWSP	Hunter Regulated River Water Sharing Plan
ICCRs	Interim Community Consultation Requirements for Applicants
IGCC	Integrated Coal Gasification Combined Cycle
IP	Intermediate pressure
LEP	Local Environmental Plan
LGA	Local Government Area
LP	Low pressure
LPG	Liquefied Petroleum Gas
MRET	Commonwealth Mandatory Renewable Energy Target
MSS	Mine Subsidence Board
NEM	National Electricity Market
NEMMCO	from 1 July 2009 known as the AEMO National Electricity Market Management Company
NES	National Environmental Significance
NGER	National Greenhouse and Energy Reporting
NO_x	Nitrous oxide

OCGT	Open Cycle Gas Turbine
NP	National Park
NP&W Act	*National Parks and Wildlife Act 1974*
PCCC	Post Combustion Carbon Capture
PEA	Preliminary Environmental Assessment
PFM	Planning Focus Meeting
PHA	Preliminary Hazard Analysis
POEO Act	*Protection of the Environment Operations Act 1997*
QHGP	Queensland Hunter Gas Pipeline
REP	Regional Environmental Plan
RET	Renewable Energy Target
SEPP	State Environmental Planning Policy
SOC	State Owned Corporation
SoC	Statement of Commitments
SOO	Statement of Opportunities
SWMP	Soil and Water Management Plan
TSC Act	*Threatened Species Conservation Act 1995*
USC	Ultra Supercritical (pulverised coal fired option)
VOC	Volatile organic compound
WARR Act	*Waste Avoidance and Resource Recovery Act*
WM Act	*Water Management Act 2000*

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Executive Summary

Introduction

Macquarie Generation (MacGen) is seeking Concept Plan Approval for activities to construct and operate a power station capable of generating 2000 MW of electricity, on land within its ownership adjacent to the existing Bayswater Power Station in the Upper Hunter region. The proposed project is known as “Bayswater B”. Approval for Bayswater B is being sought for two fuel alternatives:

- Gas Fired Combined Cycle Gas Turbine (CCGT) Plant
- Pulverised Coal Fired Ultra Supercritical (USC) Thermal Plant

The proposed Bayswater B Project has been declared by the Minister for Planning (the Minister) as a Major Project under the *Environmental Planning and Assessment Act 1979 (EP&A Act),* which requires assessment under Part 3A of the *EP&A Act*. The Minister has authorised the submission of a Concept Plan for the project under Part 3A. Furthermore, the proposed project is a Critical Infrastructure Project as per the criteria declared by the Minister on 26 February 2008.

AECOM has been engaged by MacGen to prepare this Environmental Assessment (EA) to assess potential impacts associated with the proposed Bayswater B Project. This EA has been prepared in accordance with the provisions of Part 3A of the *EP&A Act* and the *Environmental Planning and Assessment Regulation 2000* (EP&A Regulation), together with the Environmental Assessment Requirements (EARs) issued by the Director-General of the Department of Planning in July 2009.

The Project

The proposed Bayswater B Project would include construction and operation of the following:

- A power station, either gas fired consisting of five 400 MW CCGT units, or coal fired consisting of two 1000 MW USC units
- An access road and water pipeline between the project site and the existing Bayswater Power Station
- A 500kV transmission switchyard, connecting to the existing dual 500kV transmission lines which pass the proposed Bayswater B site
- For the gas fired option, a natural gas spur pipeline linking into the approved Queensland to Hunter Gas Pipeline, approximately 18 km north east of the project site
- For the coal fired option, a coal conveyor connecting into MacGen’s existing Antiene Rail Coal Unloader and existing conveyor, as well as an ash conveyor and an ash haulage route to an ash disposal site proximate to the project site
- Some additional infrastructure such as water treatment systems.

Statutory Planning

The proposed power station footprint would be located within the Singleton Local Government Area (LGA), to which the Singleton Local Environment Plan (LEP) 1996 would apply, while auxiliary infrastructure such as roads, conveyors and/or pipelines would be located within the Muswellbrook LGA, to which the Muswellbrook LEP 2009 would apply. The project components within Singleton LGA are located on land zoned as Rural 1(a), while the components within Muswellbrook LGA are located on land zoned as SP2 Infrastructure as well as on land zoned as RU1 Primary Production. The proposed project is permissible with consent in all of the above zones.

The Minister for Planning has declared the proposal to be a major project under Part 3A of the NSW *Environmental Planning and Assessment Act 1979 (EP&A Act)* as it meets the criteria of a Major Project under State Environmental Planning Policy (Major Projects) 2005 (SEPP 2005).

The assessment process has identified the relevant local, regional, State and Commonwealth legislative requirements for the proposed Bayswater B Project. An assessment of the relevant matters of consideration was undertaken in this EA and concluded that the project is compliant with the requirements of the Singleton and Muswellbrook LEPs and other relevant State and Commonwealth requirements.

There are two approvals required for the proposed project, being:

- Concept approval under section 3A of the EP&A Act
- Environment Protection Licence (EPL) under the *Protection of the Environment (Operations) Act 1997* (POEO Act)

Consultation

The EA has been prepared in accordance with EARs issued by the Director General as required by Clause 75F of the *EP&A Act*. Consultation has been undertaken with relevant authorities and community stakeholders including the following:

- NSW Department of Planning (DoP)
- NSW Department of Environment, Climate Change and Water (DECCW) (previously the Department of Environment and Climate Change and the Department of Water and Energy)
- Singleton Shire Council
- Muswellbrook Shire Council
- Commonwealth Department of Environment Water Heritage and the Arts (DEWHA)
- Commonwealth Department of Climate Change (DCC)
- NSW Mine Subsidence Board
- NSW Department of Primary Industries
- Macquarie Generation Community Consultative Committee
- Muswellbrook Council Environment Committee
- Muswellbrook Shire Council Commerce, Industry and Tourism Committee

- Hunter Central Rivers Catchment Management Authority
- Hunter Business Chamber
- Aboriginal community
- Landowners along the potential pipeline route.

AECOM and MacGen have consulted with the above stakeholders via meetings and letters. A site visit has also been undertaken as part of Aboriginal community consultation. The Proponent would undertake further consultation with stakeholders during the course of the approval process.

Prioritisation of Issues

The preliminary environmental assessment undertaken for the project identified and prioritised environmental issues associated with the project on the basis of the potential severity of environmental effects and the likely consequences of those potential effects if unmanaged. The assessment of environmental issues in this EA was based on that prioritisation as follows:

- High priority issues: Air quality, Greenhouse gas emissions
- Medium priority issues: Flora and fauna (including EPBC matters), Water
- Low priority issues: Transport and traffic, Social and economic, Cultural heritage, Soils and stability, Noise and vibration, Visual impact.

Air Quality

An Air Quality Impact Assessment was undertaken to assess potential impacts of the Project on the local, regional and interregional air quality environment.

The existing environment in the Upper Hunter Valley was assessed in terms of existing air quality and aspects influencing or influenced by air quality. The study found that there was little significant variability in the climate and local meteorological factors that influence plume dispersion. Statistical analyses for the variability in wind field distributions and air quality impacts were combined to select two typical years and one atypical year for the dispersion modelling.

Dispersion modelling was performed along with a stack height sensitivity analysis to optimise plume dispersion and minimise predicted ground-level concentrations. For the coal fired option, a stack height of 300 metres was found to be preferable to optimise plume dispersion and minimise ground-level concentrations of sulfur dioxide (SO_2).

The assessment of SO_2 emissions has been based on predicted ground-level concentrations of SO_2 for various coal sulfur contents. Further investigation was carried out to quantify the probability of any additional exceedances due to the operation of the proposed Bayswater B Project in combination with the existing Bayswater and Liddell Power Stations.

For the assessment of nitrogen dioxide (NO_2), the rate of conversion of oxides of nitrogen emitted from the proposed Bayswater B Project to NO_2 has been calculated.

In regard to air quality impacts associated with emissions from the proposed Project, the air quality impact assessment has found that the either fuel option (coal or gas) would cause a relatively minor change to ambient air quality. The most important air pollutant for the gas fired option is NO_2. Ground-level concentrations of NO_2 can be managed and minimised with the proposed use of low emissions technology. The most important air pollutant for the coal fired option is SO_2. Ground-level concentrations of sulfur dioxide can be managed and minimised with the use of low sulfur coal. The specific outcomes of the assessment are detailed below for each air pollutant:

Predictions for gas fired option:

- No exceedances for NO_2, carbon monoxide or any air toxics
- Dust a small proportion of background levels.

Predictions for coal fired option:

- SO_2
  - Stochastic modelling predicted one additional exceedence based on an atypical weather data year
  - No exceedences predicted for 24-hour or annual average criteria.
- Hydrogen fluoride:
  - 24-hour average criterion for specialised vegetation exceeded at all receptor locations. This was based on a worst case assumption of HF emissions. In addition, such short term impacts are unlikely to affect the cultivation of specialised vegetation. 30-day and 90-day averages are more relevant.
  - No exceedences of 7-day average criteria for specialised vegetation at any sensitive receptor locations
  - No exceedences of 30- or 90-day average criteria for specialised vegetation at any relevant receptors, or of average criteria for general land use at other receptors.
- No exceedances for NO_2, carbon monoxide, any air toxics or metals and metalloids
- Dust a small proportion of background levels.

Greenhouse Gases

A Greenhouse Gas Assessment was undertaken to determine the greenhouse gases (GHG) produced as a result of the proposed expansion. Direct and indirect GHG emissions associated with the proposed Project were calculated for operation and construction.

The assessment calculated GHG emissions in tonnes of carbon dioxide equivalent (t CO_2-e) for the total construction period of each fuel option as follows:

- Gas fired option: 286,600 t CO_2-e
- Coal fired option: 712,800 t CO_2-e.

The assessment calculated GHG emissions in tonnes of carbon dioxide equivalent per annum (t CO_2-e p.a.) for each year of the operations phase for each fuel option as follows:

- Gas fired option: 5,918,600 t CO_2-e p.a.
- Coal fired option: 12,428,200 t CO_2-e p.a.

Predicted emissions intensity of the Project was assessed using GGAS methodology and compared to current NSW averages for the activity as per **Table ES1.**

Table ES1: Emissions Intensity Benchmarking of Bayswater B against NSW Average

GGAS Emissions Intensity Item	GHG Emissions Intensity (t CO_2-e/MWh)
NSW Pool Co-efficient (2009)	0.967
Bayswater B Coal fired option	0.840
Bayswater B Gas fired option	0.398

Predicted GHG emissions from operation of the proposed Project were compared against estimated total annual national emissions in the possible years of operations commencing and ceasing as per **Table ES2**.

Table ES2: Comparison of Bayswater B Predicted Operations Emissions against Total National Emissions

Bayswater B Project Option	% of Total Annual National Emissions in that year	
	Start of Operations (2015)	End of Operations (2044)
Coal fired option	2.02%	1.28%
Gas fired option	0.96%	0.61%

Flora and Fauna

The flora and fauna assessment found that the proposed Bayswater B project site has been subject to human activity for a number of years and the majority of the site is pasture. The bulk of land surrounding the site has been previously cleared and disturbed, although stands of native vegetation adjoin the western boundary.

The assessment indicated that while the majority of the remnant vegetation within the project site would be retained, construction of the proposed Project would result in the removal of small areas of native vegetation, mainly for linear auxiliary infrastructure, as follows:

- Coal fired option – approximately 7.3 ha comprising Central Hunter Box – Ironbark Woodland and Central Hunter Ironbark – Spotted Gum – Grey Box Forest.
- Gas fired option – approximately 14.4 ha comprising Central Hunter Box – Ironbark Woodland, Central Hunter Ironbark – Spotted Gum – Grey Box Forest and Hunter Valley River Oak Forest.

If unmitigated, construction of the project has potential to impact on riparian and aquatic fauna habitats as a result of increased runoff and sedimentation during construction. Increased traffic during this phase of both projects also has potential to negatively impact fauna. Potential operational impacts include noise, lighting and traffic disturbance to fauna species. Potential impacts of the coal fired option also include settlement of dust emissions.

Assessment of the project against Part 3A of the *EP&A Act* 'Improve or Maintain Principles' determined that significant impacts to threatened species in the locality are unlikely, provided that measures are implemented to mitigate unavoidable impacts and offset remaining impacts (if required). Management measures would include additional surveys for orchid and frog species in a more appropriate season; measures to protect vegetation communities, threatened fauna species, aquatic and riparian habitats; and measures to avoid off site or downstream impacts.

EPBC Matters

Under the *EPBC Act 1999*, there are a number of Matters of National Environmental Significance (NES) requiring consideration as part of any development project. If an action would, or is likely to have a significant impact on a Matter of NES, approval is required from the Commonwealth Minister for Environment, Heritage and the Arts.

On the basis of the EPBC matters assessment, the Bayswater B Project is not anticipated to result in significant impacts on Matters of NES. Specifically:

- There would be no impacts on World Heritage properties, National Heritage places or wetlands of international importance
- There are no impacts to threatened flora species, threatened ecological communities or listed migratory species.
- There may be some impacts to threatened fauna but these are believed to be minor and manageable via specification of development footprint location and construction techniques to minimise impacts. This needs to be confirmed via a more detailed survey during the appropriate season but is not anticipated to constitute a significant impact.

With the implementation of the recommended mitigation and management actions, it is believed that no significant impacts on Matters of NES would result from the proposed project. Notwithstanding this, a referral has been prepared and will be submitted to DEWHA.

Surface Water

The surface water assessment showed that the water required for construction and operation of Bayswater B (both options) is within MacGen's existing licensed water entitlements. Therefore, no additional water would need to be obtained from the Hunter River or other sources as a result of the project and no other water users would be affected.

The assessment demonstrated that Project construction and operation activities would not impact downstream off-site waterways and in particular would not result in water pollution or have a negative impact on downstream sensitive wetlands or estuaries or water users.

Implementation of appropriate management measures including a Soil and Water Management Plan (as part of the Construction Environmental Management Plan and the Operations Environmental Management Plan) would ensure that any potential impacts would be minimised.

Groundwater

The groundwater assessment indicated that potential adverse impacts to the groundwater regime during project construction (as a result of excavations and installation of piles) are not anticipated to be significant due to the limited extent of subsurface work required.

Potential impacts to groundwater during the operations phase of the proposed Project include those as a result of accidental spills, which would be minimised via appropriate storage and work procedures. For the coal fired option, potential impacts from ash disposal in an open-cut mine void would be assessed during the detailed design phase once coal source, plant design and ash disposal site are confirmed. Any impacts would be minimised via appropriate management procedures as detailed in an Ash Disposal Plan.

Traffic and Transport

The traffic impact assessment identified that the Project site would be accessed via the New England Highway and the existing access road to the Bayswater Power Station, with construction of a new road to connect to the project site. The assessment concluded that the Project would result in significant traffic during the construction stage due to a peak construction workforce of around 950 for the coal fired option and around 800 for the gas fired option, together with heavy vehicles delivering construction supplies to site. However, on the basis of a cumulative traffic assessment it is not anticipated that the capacity of the road network would be compromised.

To minimise the impact on the local traffic within Singleton and Muswellbrook during construction, protocols would be put in place as part of the Traffic Management Plan for the site which may include restricting traffic movements during peak hours and school bus hours. A Construction Traffic Management Plan would also be prepared to minimise the construction traffic impact on Muswellbrook and Singleton as well as other regional town centres. Observance of mitigation measures would ensure safety within the nearby town centres as well as minimal impact on the adjacent road network.

Minimal traffic impact is anticipated during the operations stage due to the smaller operational workforce and few heavy vehicle movements. As such no specific traffic mitigation measures are required during operations.

Social and Economic

The social and economic impact assessment showed that the proposed Bayswater B project would have social and economic benefits as well as costs.

The primary benefit of the project would be the securing of additional base load power to support the predicted State demand within the next ten years, supplying adequate electricity to domestic users, businesses and industry. In addition, the project would provide a broad array of social and economic benefits including:

- Direct employment for a construction workforce of up to 950 people and operational workforce of up to 160 people
- Indirect employment during the construction phase, resulting from increased demand for goods and services
- Significant capital investment during the construction phase
- Benefits to the local and regional economies as a result of the above.

The assessment identified that the bulk of potential adverse impacts on the local region would be during construction of the Project and would include pressures on local infrastructure and services. Provided that the social and economic assessment is reviewed at the detailed design phase and that a Construction Environmental Management Plan is prepared detailing appropriate mitigation measures, all social and economic impacts can be managed. Specific management measures would include proper planning and management of the construction workers camp, traffic and rehabilitation. Importantly, stakeholder engagement would include further consultation with the Muswellbrook and Singleton Councils to manage impacts on each LGA.

The remaining impacts would be those that are beneficial to the locality, region and State.

Cultural Heritage

The aim of the heritage assessment was to identify the Aboriginal and non Aboriginal archaeological values as well as potential areas of archaeology and constraints associated with construction of the proposed Bayswater B Project.

As a result of initial Aboriginal stakeholder consultation, ten community groups registered their interest in being consulted regarding the proposed project. Consultation is ongoing.

No non Aboriginal heritage items were identified within the project area. Two highly significant Aboriginal heritage sites were identified, along with 45 Aboriginal sites of moderate significance. Areas of Aboriginal archaeological deposit were also identified. Construction of the proposed Project has potential to impact on these sites. Management commitments to minimise impacts on Aboriginal heritage values in the project area include:

- Fencing and avoidance of highly significant Aboriginal sites
- Collection of the contents of Aboriginal sites impacted by the development and relocation to the closest area within the same landform, conducted by the Aboriginal community working with an archaeologist, prior to commencement of construction.
- Test excavation of significant potential archaeological deposit to accurately clarify the extent of archaeological deposit and to identify appropriate areas of concentrated archaeological material suitable for archaeological salvage excavation
- Salvage excavation of locations of significant deposit or features as identified through test excavations, with the involvement of the Aboriginal community.

Land Capability and Soils

The assessment of land capability indicated that potential issues at the site which may impact or be impacted upon by the project include:

- Structural degradation hazard including low load bearing capacity, which can be managed via measures such as foundation design
- Erosion hazard and erodibility, which can be managed by adequate erosion and soil conservation measures along with sedimentation controls
- Existing soil salinity, which can be managed by treatment of soils if required, as well as avoiding soil tillage and maintaining vegetation cover
- Soil acidity potentially resulting in increased erosion potential, loss of vegetative cover and toxicity effects. Each of these issues can be managed individually
- Localised poor drainage, which can be managed via appropriate drainage control measures
- Hardsetting surfaces potentially resulting in excess overland flows, which can be managed by appropriate soil and stormwater management, in addition to ripping of compacted areas if required.

The assessment concluded that appropriate site management measures, including those detailed above, would avoid adverse impacts on land capability. Management measures would include preparation of a Soil and Water Management Plan to be implemented during both the construction and operation phases of the Project. In addition, implementation of a Rehabilitation Management Plan following construction would ensure that there would be no residual impacts to soils or land capability.

Noise and Vibration

The noise and vibration assessment identified that the nearest residence is 8.5 km from the project site. The assessment for both construction and operation indicated compliance with relevant acoustic requirements and negligible vibration impacts.

There is a low potential for noise impacts during the construction of the proposed development. The primary noise sources during construction would include large civil construction equipment noise sources. The construction activities would take place predominantly during recommended standard working hours. Construction activities would not result in any predicted exceedance of the criteria for noise or vibration at nearby sensitive residential locations during the daytime, evening and night-time periods

Potential noise impacts during the operation of the proposed development would include operation of plant and loading / unloading activities. If the coal fired option were selected, coal would be required to be brought to the site via the existing Antiene Rail Loop. Potential noise impacts associated with additional trains utilising the Antiene Rail Loop have previously been assessed and appropriate mitigations recommended.

It is recommended that the proponent prepares a Construction Noise Management Plan and an Operational Noise Management Plan which would each outline noise mitigation measures, noise monitoring and management procedures to be implemented to minimise noise impacts during the relevant phase of the project. Each plan may also include management practices to minimise potential noise impacts at sensitive receivers during the relevant phase.

The noise and vibration impact assessment has found that all predicted operational noise and vibration levels for the both the coal and gas fired options under neutral and adverse weather conditions comply with the site specific operational noise criteria at all nearby residential receivers during the daytime, evening and night-time periods.

Visual

The visual assessment has shown that the proposed Project would have a very minor visual impact in the local region and that visual amenity would be consistent with existing facilities in the local area. As such no mitigation measures would be required.

The construction site and building works within the development footprint would not be visible to any permanent receptors. The only potential visual impact from construction would be caused by traffic movements and deliveries to the construction site.

In the operation phase, the proposed Bayswater B project would not be visible from permanent receptors in the west or southwest. The analysis shows that for the coal fired option the stack would be visible from receptors to the south and northeast. However, the stack section visible is not believed to be visually intrusive and would not create a new industrial dominance within the visual landscape. No other elements of the Bayswater B site would be visible from these receptors. The stack for the gas fired option would not be visible from any of the permanent receptors.

The site would be visible to transient receptors on the New England Highway but would be viewed within the context of an agglomeration of large scale facilities dominated by the existing Bayswater and Liddell Power Stations.

Given the low level of visual impacts predicted, no specific mitigation and management measures are required.

Hazard and Risk

The hazard and risk assessment included a Preliminary Hazard Assessment (PHA) and a plume rise analysis. The PHA was undertaken to assess the potential off-site risks associated with the storage and use of dangerous good within the project area. This involved identification of potential hazards, assessment of consequences and analyses of frequency and risk for hazards with potential off site impact. Mitigation and safety measures were identified in respect of hazards that have the potential to impact off site areas, in order to minimise any risks to the environment and adjacent land uses.

The PHA identified that three theoretical incidents (if unmitigated) have the potential to impact off site areas with severity levels exceeding the criteria published in the Hazardous Industry Planning Advisory Paper (HIPAP) No. 4 – Risk Criteria for Land Use Safety Planning and Multi Level Risk Assessment:

- Chlorine cylinder connection failure leading to chlorine release
- Gas pipeline incident leading to gas leak as a result of external interference (i.e. excavation impact) – for the gas fired option only.
- Ammonia release from pipework, flanges or fittings

The risk analysis of chlorine release incidents identified that at the project site boundary the risk of fatality would not exceed 5 chances per million per year (5 pmpy) and the risk of injury would also be less than 5 pmpy. These estimated risks are below the selected risk criteria. The risk of fatality adjacent to the gas pipeline would not exceed 3 pmpy, while the risk of injury resulting from ammonia release would not exceed 0.39 pmpy, both of which are also below the selected risk criteria.

The results of the PHA showed that potential risks related to the Project would result in a Project classification of 'potentially hazardous' and that mitigation measures would ensure that risks remain as low as reasonably practicable.

A plume rise analysis was conducted to assess the potential impact on aviation safety from the proposed Project as a result of flue exhaust plumes. This assessment is required by the Civil Aviation Safety Authority (CASA) for facilities with exhaust plumes that meet certain height and velocity criteria. Results of the plume rise analysis demonstrated that for both proposed options (coal and gas) stack plumes would exceed the relevant criteria. On the basis of these findings, the proponent would be required to apply to CASA for an "Operational Assessment of a Proposed Plume Rise" in order to determine whether the plume should be classified as a 'hazardous object' under the Civil Aviation Safety Regulations.

Waste

The waste assessment reviewed anticipated waste streams from the proposed project. The approach for management of wastes likely to be generated during the construction and operation phases was discussed with reference to waste avoidance, reuse, on-site management, transport and disposal.

The majority of waste generation is likely to be during the construction phase, predominantly generated from civil works activities associated with the construction and preparation of the power station, transmission infrastructure, roads and water pipeline, as well as the coal conveyor and ash haulage route and/or gas pipeline as applicable. During the construction period it is estimated that there would be waste generation of some 50 tonnes (t) per month on average (600 t /year). This would result in total construction period waste of approximately 2700 t for the coal fired option, or 1900 t for the gas fired option.

Waste generated during the operations phase of works would predominantly be general solid waste, as well as various wastewater which would for the most part be recycled. If the coal fired option is selected, fly ash and bottom ash would be generated as by-products of the coal combustion process. During normal operation of the proposed Power Station, it is estimated that waste volumes would be approximately as follows:

- General solid waste – 50 tonnes p.a.
- Sewage waste – 10 mega litres (ML) p.a.
- Chemical wastewater – 110 ML p.a. for the gas option (to be recycled for use at the existing Bayswater Power Station) or 146 ML p.a. for the coal fired option (to be recycled for use at the Project site)
- Coal ash (coal fired option only) – 1.6 million tonnes p.a.

Ash from the coal fired option is likely to be disposed of in an open cut mine void in the vicinity of the project site. This would be managed to minimise potential residual impacts on groundwater. Potential impacts and management measures regarding ash disposal would require further review and investigation during the detailed design phase of the Project. At that stage the mine void to be used for disposal would be identified, allowing site-specific impact assessment and management measures.

Waste management procedures would be developed as part of the Construction Environmental Management Plan and Operations Environmental Management Plan for the Project, which would ensure that waste is appropriately handled, stored and reused, recycled or disposed. Wastes would be appropriately managed and reused or recycled where possible. As such, no significant residual impacts are anticipated as a result of waste generated by the Project.

Residual Risk

A residual risk analysis was undertaken to assess the residual risk of the project following the implementation of safeguards and mitigation measures. Residual environmental risk was assessed on the basis of the significance of environmental effects of the proposed project and the ability to confidently manage those effects to minimise harm to the environment.

The residual risk analysis indicates that the proposed project presents an overall low to medium risk in relation to each of the identified environmental issues, provided that the recommended mitigation, management and monitoring measures are implemented.

Cumulative Impacts

Cumulative impacts have been considered in relation to each of the environmental issues identified in this EA with respect to impacts associated with the proposed project, in addition to impacts associated with other projects in the region. The mitigations proposed for each issue relevant to Bayswater B have been targeted at amelioration of potential impacts associated with each individual risk and to minimise the overall cumulative impacts of the development.

The cumulative impact of the combined developments in the region has the potential to exacerbate the use of infrastructure and service resources within Muswellbrook and Singleton. Mitigation measures to address these potential impacts would be addressed in the detailed design stage of the proposed Bayswater B project and would include consultation with Council, DoP and other relevant Government Authorities to create a coordinated approach to impact management and ensure all issues are resolved.

The potential impacts for each of the environmental factors were considered to be acceptable provided the prescribed mitigation measures and safeguards are implemented. As the identified impacts are able to be adequately controlled through mitigation and best practice management, it is considered that there would be no adverse cumulative impacts expected from the Project.

Statement of Commitment

The Statement of Commitments (SoC) describes measures for environmental mitigation, management and monitoring which would be undertaken as part of the proposed project during detailed design, construction and operational activities, to ensure that the potential impacts identified in this EA are appropriately managed. The SoC prepared in respect of the proposed project has been compiled on an issues basis and is informed by the environmental risk analysis and impact assessment undertaken as part of this EA. The SoC has been written in a format which can be incorporated into the project approval issued to act as the conditions of that approval.

Project Justification

Justification of the proposed project has been provided with regard to site location, biophysical, economic and social considerations together with the principles of Ecologically Sustainable Development (ESD) as it relates to the Project. The assessment of the proposed Project undertaken in this EA has integrated these considerations and principles. The consequences of not proceeding have also been reviewed.

The preliminary design of the Project and the assessment of potential impacts presented in this EA show that the Project is able to be constructed and operated in the proposed location in a manner which is compatible with existing and future land uses. The proposed Bayswater B project is also considered to be consistent with the principles of ESD.

The assessment of potential impacts on the biophysical environment conducted as part of this EA concluded that the implementation of a range of environmental safeguards and measures as recommended throughout this EA would mitigate potential impacts, and that the proposal would not have a significant adverse impact on the biophysical environment. The proposal is therefore justifiable taking into account potential impacts on the biophysical environment.

The EA has assessed economic considerations and potential economic impacts associated with the proposed Project. Bayswater B would be a significant contributor to the local, regional and State economies. Bayswater B would provide local direct and indirect employment opportunities as well as increasing demand for local goods and services during both the construction and operation phases of the project. The Bayswater B Power Station would also help to secure an adequate supply of electricity for NSW, which would support continued growth in the local, regional and State economies. Given the anticipated economic benefits, the proposed Bayswater B Project is considered to be justifiable from an economic perspective.

The assessments presented in this EA regarding social impacts indicate that provided appropriate mitigation and management measures as outlined in the Statement of Commitments are implemented, the proposed Project would have a minimal and acceptable impact on social and related issues. The proposed Project is therefore justifiable taking into account potential social impacts.

The main consequence of not proceeding with the proposed Project would be that NSW would have a base load electricity shortfall by around 2015/16. If the Project does not proceed and existing generators were required to increase their output close to maximum capacity, this is likely to result in negative impacts on supply reliability due to added strain on already aging plant. As such, without the development of a new power station in NSW such as Bayswater B, there would be insufficient electricity to provide the demand of industrial, business and domestic energy consumers in NSW. This may also constrain the development of new and existing industries and businesses due to limitations on energy available for operation.

Undertaking the Project in the manner proposed is justifiable taking into consideration potential impacts on the biophysical, economic and socio-cultural environments. Additionally, the proposal accords with the principles of ESD and is in the public interest. Consideration of the proposal against a wide range of criteria demonstrates that the project is environmentally sustainable and justifiable.

Conclusion

In summary the project would involve construction and operation of a 2000 MW power station, either coal or gas fired, in the Upper Hunter region. The potential environmental impact of the project which has been assessed as having highest priority is air quality – the air quality impact assessment has found that the proposed project would cause a relatively minor change to ambient air quality.

Provided that the recommended mitigation, management and monitoring measures are implemented, the proposed project presents an overall low to medium risk in relation to each of the identified environmental issues. Furthermore, it is considered that there would be no adverse cumulative impacts expected from the Project.

The project is considered justifiable on biophysical, economic and social grounds, and is considered to be consistent with the principles of ESD.

1.0 Introduction

1.1 Background

Macquarie Generation (MacGen) owns and operates Liddell and Bayswater Power Stations between Singleton and Muswellbrook in the Upper Hunter Valley.

In May 2007, the Premier of NSW announced the establishment of an *Inquiry into Electricity Supply* within the State (Owen Inquiry) to be undertaken into generating needs in New South Wales. The terms of reference for the inquiry included:

- *Review the need and timing for new baseload generation that maintains both security of supply and competitively priced electricity.*
- *Examine the baseload options available to efficiently meet any emerging generation needs.*
- *Review the timing and feasibility of technologies and/or measures available both nationally and internationally that reduce greenhouse gas emissions.*
- *Determine the conditions needed to ensure investment in any emerging generation, consistent with maintaining the State's AAA credit rating.*

Following a lengthy process of consultation the Owen Inquiry made a number of findings relating to the need, timing and technology for additional electricity generation capacity in NSW.

A review of the Owen Inquiry recommendations based on the NEMMCO 2008 Statement of Opportunities has shown that the findings still stand with the exception that the timing for commissioning of the next baseload generator is now between 2014 to 2016, rather than 2013 to 2014. This was based on a revision of the predicted growth in energy demand.

More up to date predictions in 2009 from TransGrid have led to a refinement of the "2014-2016" date as the date by when additional baseload power would be needed. However, this early 2009 forecast was based on predictions undertaken during the Global Financial Crisis and so to 2008 forecast may be more realistic (refer **Chapter 2** – Strategic Justification).

The Owen Inquiry concluded baseload energy needs can be met by coal fired and/or gas fired generation as other technologies can only contribute on a relatively small scale or are unlikely to mature until 2020 at the earliest.

MacGen is acting as the Proponent for the application for Concept Approval for a new power station within the Bayswater-Liddell power generation complex to provide up to an additional 2000 MW of generating capacity, on land within its ownership adjacent to the existing Bayswater Power Station (the proposed "Bayswater B" project).

MacGen is seeking Concept Approval for the Bayswater B project as either coal or gas fired technology. As such, this Environmental Assessment (EA) presents an impact assessment for both fuel technology options.

Should Concept Approval be given, subsequent further planning processes would be undertaken by the proponent as part of the final design, construction and operation of the Bayswater B project.

1.2 Overview of the Project

1.2.1 Site Location

The existing Bayswater Power Station site comprises approximately 3km^2 of land and is located within the Muswellbrook Local Government Area (LGA) in NSW. Plashett Dam, which is used as part of the existing power station operations, is located within the Singleton local government area (LGA).

The proposed Project Site is located to the west of the existing Bayswater Power Station, adjacent to Plashett Dam, on land owned by MacGen approximately 25km north west of Singleton and some 10km south of Muswellbrook. The project site is located within the Singleton LGA and associated infrastructure for the site would lie within Muswellbrook LGA. The location of the site is shown in **Figure 1-1** and **1-2.**

1.2.2 Coal Fired Technology

Of the various alternate coal fired technologies that minimise greenhouse gas emissions, only ultra supercritical pulverised fuel coal fired generation would be capable of being operational by 2014/16. It has a carbon intensity lower than current coal fired plant in NSW and would displace less efficient and more carbon intensive coal fired generation, thereby reducing the average carbon intensity in the NSW region of the National Electricity Market (NEM). Carbon capture and storage (CCS) is the major enabling technology to limit carbon dioxide emissions produced through the combustion of fossil fuels although application on the scale of a baseload power station is just entering the pilot plant stage. Although CCS is unlikely to be available within the timeframe required for new baseload generation plant to be operational in NSW, such plant would be made 'carbon capture ready'.

1.2.3 Gas Fired Technology

Gas fired generation for the Bayswater B site is envisaged as increasingly viable following the development approval of the Queensland to Hunter Gas Pipeline (QHGP) and eventual access to the Narrabri and Queensland coal seam gas reserves. The relative higher thermal efficiency and lower carbon intensity of coal seam gas represent a significant advantage in displacing less efficient and carbon intensive generation. This flows through to potentially greater reductions in average carbon intensity in the NSW region of the NEM. Natural gas used as the fuel for power generation in a Combined Cycle Gas Turbine (CCGT) plant would emit carbon dioxide (CO_2) albeit at lower rates than for coal fired plant. As noted above, despite the likely unavailability of CCS within the timeframe required for new baseload generation plant in NSW, such plant would be made "carbon capture ready".

1.3 The Proponent

MacGen is a State Owned Corporation (SOC) that owns and operates Bayswater and Liddell Power Stations between Singleton and Muswellbrook in the Upper Hunter Valley, NSW. MacGen operates under the *Energy Services Corporations Act* (1995) and the *State Owned Corporations Act* (1989) and was established on 1 March 1996.

MacGen aims to be an industry leader in the provision of safe, reliable and cost effective electricity for NSW. MacGen is focussed on maintaining a leading, profitable and successful business, an ethical and responsible approach to governance, stringent environmental management, efficient use of resources and sound relationships with neighbours and stakeholders.

MacGen believes in the operation of a successful commercial business that supplies reliable and safe products at a competitive cost and in an environmentally responsible manner.

1.4 Environmental Assessment Approach

The *Environmental Planning & Assessment Act 1979* (EP&A Act) and the *EP&A Regulation 2000* provide a framework for environmental planning in NSW. Part 3A of the *EP&A Act* establishes the processes and matters for consideration by the approval authority when determining the impact of major projects and whether such projects should be approved.

1.4.1 Major Projects

The proposed project falls within the definition of 'major development' (formerly state significant development) under Schedule 1, clause 24 of *State Environmental Planning Policy 2005 (Major Projects)* (SEPP 2005), being works for the purpose of an electricity generation facility with a capital investment of more than $30 million. The proposal, which has a preliminary estimated value in excess of $2 billion, is therefore eligible for declaration as a major project under Part 3A of the *EP&A Act* with the Minister being the decision making authority. The Minister declared the Bayswater B Power Station a Major Project on 19 June 2009 (**Appendix A**)

1.4.2 Critical Infrastructure

On 26 February 2008, under section 75C of the *EP&A Act,* the Minister for Planning declared certain power generating facilities to be critical infrastructure projects. The Minister's declaration relates to development for the purpose of a facility for the generation of electricity that has a capacity to generate at least 250MW and that is the subject of an application for approval under Part 3A of the *EP&A Act* which is lodged before 1 January 2013. Accordingly, the proposed Bayswater B project is a declared 'critical infrastructure' project.

1.4.3 Concept Approval

A 'concept approval' under section 75O of the *EP&A Act* is being sought for the proposed project to allow for further details and environmental assessment to be undertaken once greater certainty of the project is assured. The Minister authorised the submission of a concept plan in June 2009 (refer Appendix A). In this respect, in accordance with section 75M, an outline of the proposed power generating project is provided in this EA.

1.5 Environmental Assessment Process

1.5.1 Preliminary Environmental Assessment Report

The Preliminary Environmental Assessment (PEA) Report (dated June 2009) formed the basis of environmental assessment for the proposed concept works, as required under Part 3A of the *EP&A Act*, and provided the Minister for Planning with an outline of information and background environmental data on the site and the proposed concept plan. This allowed the key environmental issues of significance and the level of environmental assessment required for the application to be established.

The PEA identified the following environmental issues as having a medium to high priority as summarised below:

- Air Quality – potential impacts on air quality including stack emissions and particulate emissions during construction and operation
- Greenhouse Gases – potential greenhouse gas (GHG) emissions during construction (temporary) and operation
- Water – ability to demonstrate water supply and ensure a zero discharge site during operations
- Flora and Fauna – potential direct and indirect impacts on threatened species and ecological habitat during construction and operation.

These impacts, as well as mitigation measures and other environmental issues, are described further in **Chapters 9** to **24** of this EA.

Other environmental issues were identified in the PEA, however, the potential impacts associated with these were expected to be minimal or minor. These issues are also discussed in the EA. Appropriate mitigation measures and environmental safeguards are also identified across the Statement of Commitments (SoC) (**Chapter 25**) provide for the minimisation and proper management of potential impacts.

1.5.2 Planning Focus Meeting

A Planning Focus Meeting (PFM) was held on the 19th of June 2009 and was attended by relevant regulatory authorities. The PFM discussed issues to be included in the Environmental Assessment Requirements, by referring to a copy of the PEA. The PFM also helped outline the assessment and approvals process to be undertaken for the progression of the concept. This consultation process provided opportunity for key regulatory authorities to establish the requirements for the form and content of the EA. These requirements are outlined in **Chapter 7** of this EA.

1.5.3 Director-General's Environmental Assessment Requirements

Section 75F of the *EP&A Act* requires an EA to be prepared in accordance with the requirements of the Director-General of the Department of Planning (DoP). A request for these requirements was made in June 2009.

The Director-General's Environmental Assessment Requirements (EARs) were issued on 6 July 2009 following the PFM, a copy of which is enclosed as **Appendix B** to this EA.

1.5.4 Stakeholder Consultation

During the preparation of this EA, key stakeholders consulted included community representatives and interest groups as well as key government agencies. Throughout the preparation of the EA, these stakeholders have been kept informed of the progress of the project and matters raised by stakeholders have been addressed in the EA.

Further details on consultation are discussed in **Chapter 7**.

1.5.5 EA Exhibition

The *EP&A Act* requires that the EA be placed on exhibition for public review for a period of not less than 30 days.

1.6 Purpose of this Report

This EA has been prepared by AECOM on behalf of MacGen, the Proponent for this Concept Application.

This EA has been prepared pursuant to the requirements listed in the EARs and following consultation with relevant statutory and other agencies.

The purpose of this report is to:

- Explain the nature of the activities which could occur as part of the proposed Bayswater B concept (including construction, production, post development and final rehabilitation activities)

- Assess the potential environmental impacts of these activities on the physical, social and economic environment
- Identify mitigation measures to be implemented during construction and operation of the project.

The outcomes and recommendations contained within this EA would be incorporated into the future commissioning and operation of the proposed Project. This would ensure a consistent level of environmental management and monitoring would be undertaken across the site.

1.7 Structure of this Report

This EA has been divided into two volumes, as detailed below. **Volume 1** should be read with reference to **Volumes 2 and 3 (Appendices)**.

- Volume 1: Environmental Assessment, including the sections described below:
  - **Chapter 1 Introduction** – provides an overview of the project and the planning and approvals process.
  - **Chapter 2 Strategic Justification** – describes the predicted energy demands and the need for the project as a means to enhance security of electricity supply within NSW.
  - **Chapter 3 Alternatives Considered** – provides information on the alternatives considered for the project.
  - **Chapter 4 Site and Context** – provides an overview of the project location and legal description of the land affected by the proposal.
  - **Chapter 5 Project Description**– provides an overview of the proposed activities in relation to both potential technologies.
  - **Chapter 6 Statutory Planning** – addresses Local, State and Commonwealth Statutory requirements relevant to the project and details the planning and approval framework under which the project is being assessed.
  - **Chapter 7 Consultation** – provides details of stakeholder and agency consultation undertaken as further detailed in **Appendix C**.
  - **Chapter 8 Issues Prioritisation** – provides a prioritisation of the issues identified, based on a risk assessment matrix.
  - **Chapter 9 Air Quality** – this section provides an overview of the potential impacts on air quality from the proposed project, and summarises the findings of the Air Quality Impact Assessment undertaken for the proposal, provided in **Appendix D**.
  - **Chapter 10 Greenhouse Gas Emissions** – this section assesses the GHG emissions relating to the project.
  - **Chapter 11 Surface Water** – this section addresses potential impacts to surface water quality and management and treatment of produced water.
  - **Chapter 12 Land Capability** – this section addresses potential impacts to land capability including geology and soils and the potential for sedimentation and erosion.

- **Chapter 13 Groundwater Assessment** – this section addresses potential impacts to groundwater.
- **Chapter 14 Noise** – this section provides an assessment of potential noise and vibration impacts from the proposed project and summarises the findings of the Noise and Vibration Assessment undertaken in respect of the project, provided in **Appendix E**.
- **Chapter 15 Flora and Fauna** – this section addresses potential ecological impacts and constraints. Potential impacts to habitat values and threatened and endangered species are also addressed. The Ecology Assessment is provided in **Appendix F**.
- **Chapter 16 EPBC Matters** – this section addresses potential impacts on Matters of National Environmental Significance under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) drawing on the flora and fauna assessment.
- **Chapter 17 Heritage** – this section provides an assessment of potential impacts on Indigenous and non-Indigenous heritage that may be affected by the project. The Heritage Assessment is provided in **Appendix G.**
- **Chapter 18 Local Social and Economic Assessment** – this section addresses the social and economic environments affected by the project and provides an assessment of potential impacts.
- **Chapter 19 Visual Assessment** – this section provides an assessment of the potential impacts on visual amenity that may result from the proposal. A viewshed analysis has been undertaken to demonstrate visibility.
- **Chapter 20 Hazard and Risk** – this section summarises the Preliminary Hazard Analysis (PHA) undertaken in respect of the project to assess potential hazardous impacts to surrounding land uses. The Preliminary Hazard Assessment is provided in **Appendix H**.
- **Chapter 21 Traffic and Transport** – this section provides an assessment of traffic, transport and access arrangements for the project.
- **Chapter 22 Waste** – this section addresses the likely types of waste generated by various components of the project and identifies management measures to be implemented.
- **Chapter 23 Cumulative Impacts** – this section provides an overview of known existing and proposed developments and land uses that may result in similar impacts to this proposal, and discusses the likely implications of cumulative impacts with this project.
- **Chapter 24 Environmental Management** – provides information on construction and operational environmental management plans for the project.
- **Chapter 25 Statement of Commitments** – provides a draft SoC for the project.
- **Chapter 26 Residual Risk Analysis** – this section provides an assessment of residual risks of the project following the implementation of mitigation measures and environmental safeguards proposed in this EA.
- **Chapter 27 Project Justification** – this section addresses the justification for the project including the strategic context, and consideration of biophysical, economic and socio-cultural issues.

- **Chapter 28 Conclusion** – provides a concluding statement for the project.
- **Chapter 29 References** – provides a list of references utilised throughout this EA.

- Volumes 2 and 3: Appendices containing technical reports and other relevant information referred to throughout this EA.

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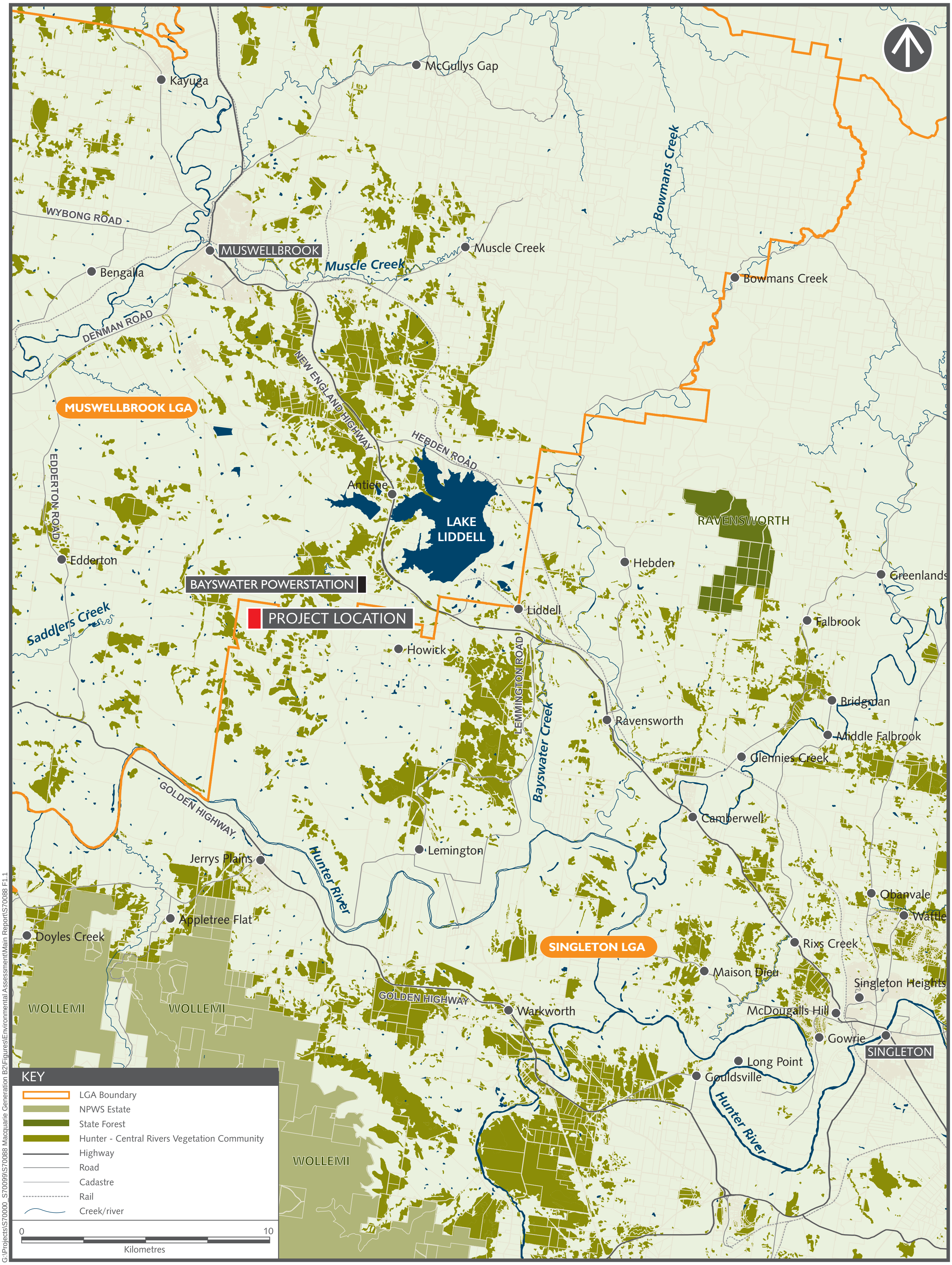

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AECOM

SITE LOCATION

Environmental Assessment

Bayswater B Power Station

Figure 1.1

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AECOM

SITE CONTEXT

Environmental Assessment

Bayswater B Power Station

Figure 1.2

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2.0 Strategic Justification

This Chapter provides the Strategic Justification for the project and addresses the requirements of the Director-General as follows:

Strategic Planning and Justification – the EA must:

Include a strategic assessment of the need, scale, scope and location for the project in relation to predicted electricity demand, transmission constraints and the strategic direction of the region and the State in relation to electricity supply, demand and electricity generation technologies;

Include an analysis of site suitability with respect to potential land use conflicts with existing and future land uses (including existing and approved rural-residential development and mineral reserves) taking into account local and strategic landuse objectives.

2.1 Project Demand

2.1.1 Introduction

In order to illustrate the strategic justification with reference to this project, it is important to outline the meaning of certain terminology underpinning the electricity market. In operating a bulk electricity supply system (where all generators are electrically interconnected with all loads) it is necessary to consider two parameters:

- Demand; and
- Energy.

Demand

Demand is a measure of the instantaneous aggregate load represented by all consumers (which must be supplied by all generators acting collectively) and is expressed in megawatts (MW) or gigawatts (GW).

“Generated” means the total amount of power generated at the source (ie the power station). “Sent out” is a term used to describe the power leaving the power station after internal power needs are supplied.

The sent out energy is subject to losses within the transmission network. This is merely a factor of transporting power through the networks at distances. The power that eventually reaches the consumers, is then referred to as “delivered”.

Demand varies constantly as it is affected by a number of factors including weather, time of day, seasons and weekends. Maximum demand is the highest load which occurs in a period of interest and governs the total capacity of generating plant which must be installed and available for that period.

The instantaneous reliable maximum continuous output (expressed in MW) of a generator is referred to as its “capability” which may differ from its “capacity”, a property which is usually synonymous with its nameplate rating. Nameplate ratings are usually expressed in relation to relevant local or other standardised conditions.

Capability is the criterion which determines the ability of a set of generators to meet a projected maximum demand in a period of interest. If at the time of a high system load insufficient capability is available to meet that load, load shedding is necessary and some consumers would experience a temporary loss of supply or “blackout”.

Energy

When viewed from the supply perspective, the term “energy” is a measure of all the instantaneous outputs of a set of generators summed over a period of time (eg. hour, day, year) and is expressed in megawatt hours (MWh) or gigawatt hours (GWh). For example 2000 MW supplied continuously for 3 hours is energy of 6000 MWh or 6 GWh.

Peaking plant generators (eg. open cycle combustion turbines) do not supply large quantities of energy because whilst they are inexpensive to install, they are characteristically expensive to operate as a result of their need to burn costly fuels sometimes at poor thermal efficiencies. Intermittent generators (eg. wind turbines) are expensive to install but can produce very low cost energy. As they have highly variable and thus unreliable capabilities (energy storage systems which could ameliorate this problem are not yet available) they are not regarded as suitable for the continuous supply of fixed quantities of energy.

Base load generators supply the majority of the energy in interconnected power systems. They are characteristically more costly to install but exhibit high availabilities, constant and reliable capabilities, reasonable thermal efficiencies and, ability to burn low cost fuels. Traditionally in NSW they are the coal fired plants. The development of large and higher efficiency oil or gas fired combined cycle technology over the last decade or so would see this class of plant sharing this role in the future.

When a power system becomes energy constrained the addition of new base load plant is required. Inspection of the load projections and the energy which can be produced by existing generators allows a determination of the year in which an energy supply shortfall would occur if no new plant is installed.

2.1.2 Baseload Power Generation

Over the last few years, a process of review and recommendation has been undertaken with respect to energy demand and the appropriate response. In May 2007, the NSW Premier established the Inquiry into Electricity Supply to be undertaken by Professor Anthony D Owen of the School of Economics and Finance in the Curtin Business School in Canberra (the “Owen Inquiry”. Refer Section 1.1 for the Terms of Reference of the Inquiry). The findings of the Owen Inquiry were reported in September 2007.

A key finding of that inquiry was;

“With a risk-averse approach, New South Wales needs to be in a position where new baseload generation can be operational by 2013-14 if necessary, in order to avoid potential energy shortfalls.”

The Owen Inquiry noted that the bulk of the NSW electricity generation capacity was constructed during the 1970s and 1980s. MacGen’s Liddell Power Station was developed in 1971-73 and the Bayswater Power Station was commissioned in 1985-6. No new major baseload power generating facilities have been constructed in NSW since 1993. Existing generation, including inter-state energy transfers, have continued to meet demand in NSW. Owen identified the maximum base load power generation capacity in NSW (from coal, gas and hydro power generating facilities) as 85,100 GWh per year and with growth in electricity demand as forecasted, there is anticipated to be a shortfall in available energy within the next decade – by 2013-14.

These projections have been revised since 2007, and this is discussed in further detail below.

2.1.3 NSW Electrical Energy Consumption

Each year the NSW Transmission Network Service Provider Transgrid produces forecasts of demand and energy growth (on a medium or "baseline" scenario basis) for the NSW Region (defined to include the ACT) which are published in its Annual Planning Review (APR).

The Australian Electricity Market Operator (AEMO) also produces annual demand and energy forecasts for the National Electricity Market (NEM). The TransGrid baseline forecasts for NSW are adopted by AEMO who also develop high and low scenario forecasts. TransGrid's and AEMO's baseline forecasts for NSW are therefore identical.

Native energy is defined by TransGrid as "the sum of net energy output of Scheduled generators located within the Region plus net interconnector energy flows into the Region plus energy output from Semi Scheduled and Non Scheduled generators within the Region". Given zero net interconnector energy flows, it corresponds with the "sent out energy" of all the generators in NSW. Only very low levels of net interconnector energy flows are predicted to occur for NSW in the foreseeable future.

The growth of electrical energy use in NSW is very dependent upon certain growth rates forecast for the economy. Consequently it is prudent to consider the inputs supporting energy projections. The TransGrid 2009 APR projections were based on historical data which includes:

- demand and energy;
- population;
- gross state product (GSP);
- electricity and gas prices;
- interest rates;
- Consumer Price Index (CPI); and
- Weather.

Their process then uses forecasts of each (except the first) to produce forecasts for demand and energy.

At the time of preparing the 2009 forecasts (several months ago), energy consumptions were projected by TransGrid to be significantly lower than had been forecast in the 2008 APR as a consequence of concerns about the impact of the Global Financial Crisis (GFC).

However, economic projections for 2009 onwards are now expected to be higher as a result of Australia's resilience to the effects of the GFC. This in turn assumes a higher expectation for energy growth than were assumed in early 2009 (which reflected the GFC influences).

A good illustration of this is the movement is interest rate projections. This shows how projections have changed since the start of the GFC. In constructing its forecasts TransGrid utilised data prepared for them by accounting firm KPMG. For the 2009 forecast, KPMG advocated the use of a variable home loan interest rate profile (a model input) at low levels up to and through the year 2011-2012.

Most financial system commentators are already saying that these rates would start to increase before the end of this calendar year (2009) as Australia avoids the worst of the GFC. This illustrates then how model inputs for the growth projections are already, within the space of some months, potentially under-forecasting. As noted above, interest rates are one of the inherent components of energy growth projections and so these projections too are believed to be now an under-projection.

Native energy growth (baseline) projections together with "generated" energy (baseline) forecasts using TransGrid's 2009 APR are shown in **Table 2.1**. For comparison purposes TransGrid's 2008 APR baseline Native and "generated" energy forecasts have been included.

Table 2-1: NSW Energy Growth Projections Scenarios

Year	08/09	09/10	10/11	11/12	12/13	13/14	14/15	15/16	16/17	17/18	18/19
	GWh										
TransGrid 2009 APR Native energy	75,680	75,470	76,030	76,510	77,920	78,350	79,590	**81,720**	**83,250**	84,670	86,100
Transgrid 2009 APR Generated energy	80,430	79,860	80,470	81,140	82,630	83,190	84,600	86,910	88,610	90,260	91,850
Transgrid 2008 APR Native energy	79,790	80,440	80,700	81,270	82,430	83,190	83,820	85,130	85,650	86,580	Not avail.
Transgrid 2008 APR Generated energy	81,750	83,180	83,830	85,700	86,960	87,930	89,910	92,080	93,690	94,680	Not avail.

As noted above, it is believed that the 2008 projections represent a more realistic forecast given that the 2009 projections were heavily influenced by the GFC, which can now be illustrated to have resulted in under-forecasting (such as interest rates).

It is noted that all these forecasts include provision for:

- Current proposals for introduction of a national Carbon Pollution Reduction Scheme (CPRS)
- NSW generation resulting from the introduction of the expanded Renewable Energy Target (RET)
- The effect of demand management measures to improve end use efficiency and uptake in new renewable energy sources in NSW.

It should also be noted that the above growth scenarios in **Table 2.1**, like Owen, do not take into account the potential for new major industrial demand, merely projected domestic and existing incremental growth over the next decade.

2.1.4 NSW Electrical Energy Supply

In NSW during 2008-2009 “generated” energy production was 80,430 GWh (actual data) and is made up of the following components:

- Unscheduled existing renewable and embedded generation accounting for - 1.5% (1,200 GWh)
- Semi scheduled large wind of 0% (0 GWh). Will contribute from 2009/10 onwards
- Interstate net imports of 7% (5,900 GWh)
- NSW Region component of Snowy (Tumut generation) at 2% (1,900 GWh)
- Non State Owned Corporation (SOC) scheduled generation of 3% (2,600 GWhr)
- SOC coal fired generation of 86% (68,800 GWh).

When considering the energy supply resources required to meet the revised growth projections, there are a variety of issues that need to be considered:

- The contribution from NSW’s share of Snowy output is projected to decline marginally from the past long term contribution due to the effect of additional environmental flows.
- The net contribution to NSW’s energy needs from Victoria is projected to remain negative as energy supply in Victoria, South Australia and Tasmania is likely to become tighter by 2014/15.
- Energy supply to NSW from Queensland has progressively declined over the past three years and there is no reason to expect that trend would reverse.
- The Non SOC NSW generator at Tallawarra CCGT will make a contribution of about 2,300GWh, or 3% of total energy supply in 2009/10.
- The balance of supply is to be made by the SOC coal fired power stations that by 2015/16 will be generating at historically high levels since commissioning in the early 1970s. All the SOC generators, by 2015/16, will be generating at record sustained levels of production.

In relation to this last point, from the late 1940’s up to the early to mid 1970’s the international power plant industry underwent major and rapid change. In Australia generator sizes were scaled up from approximately 30 MW to 500 MW in a period of 20 years or so.

While technology advanced and greater efficiencies were achieved, overall there was a trend towards plants which required greater maintenance, were generally less tolerant to exposure to “off design” conditions. In addition, because of the use of tighter design margins they frequently demonstrated accelerated life expenditure rates compared to previous plant designs.

Great difficulties were experienced both in Australia and abroad in achieving nameplate ratings, heat rates (efficiencies) and availabilities during this period. In addition, ageing plants need increasing time out of service for repairs which directly and adversely impacts on availabilities. Reduced availability means reduced energy production.

In order to meet an energy "generated" load of say 92,000 GWh (which based on the 2008 projections would occur in 2015/16), the NSW system would have to produce as follows:

- Existing renewable, embedded and semi scheduled, 4% or 5,200 GWh
- Interstate net imports – virtually nil (Imports from Queensland similar to exports to Victoria/South Australia/Tasmania and New South Wales component of the Snowy (Tumut generation) of 2% (2,000 GWh)
- Non SOC scheduled generation of 5% (4,600 GWh)
- Coal Fired SOCs of 89% (80,400 GWh).

Based on this, the existing SOC coal fired generators would be required to sustain a 17% increased output (an extra 10,000 GWh per year) above 2008/09 levels. Given that the oldest of these plants would by then be 45 years old this has implications for maintaining supply reliability. The introduction of additional base load capacity by about 2015/16 would mitigate this risk to NSW supplies, and support the need for additional baseload power thereafter.

This timeframe is critical to the choice of technology. The *Owen Inquiry* highlighted the timeframe requirements (including planning approvals, detailed design processes, contracting periods, mobilisation, construction and commissioning). The timeframe to commission plant greatly restricts the types of fuels and technologies that can be considered as viable to be operational within the 5-7year timeframe required for plant to be operational.

2.1.5 Summary

A series of factors are influencing the present situation that underpins the need for the Bayswater B project:

- 2007: The Owen Inquiry identifies an electricity shortfall by 2013/14;
- 2008: TransGrid (utilised by NEMMCO (now AEMO) revises the projections and identifies a shortfall in 2014-16;
- Early 2009: The growth projections are revised downwards to take account of the GFC;
- Later 2009: Projections begin to be revised as the effects of the GFC become more known and understood. A key illustration of this is the movement of interest rates against what was forecast.

On this basis, the 2008 projections are seen as being a more realistic forecast.

Based on the 2008 projections, the energy projection of 92,000GWhr required in 2015/16 could be met but would be contingent on the existing power stations generating at their full capability. As noted above, by this time, some plants would be up to 45 years old and so the reliability of achieving full capability may not be maintained on an ongoing basis.

As such, the power shortfall is projected to occur in 2016/17. This is based on the point in time when energy growth would exceed 92,000GWhr. As noted above, the 92,000GWhr could be met in 2015/16 but only if current power capability can be sustained. If reliability of supply is to be maintained, the shortfall (or the need to support reliability) could occur as soon as 2015/16.

As noted above, the timeframe required to develop and construct a baseload power station can be 6-10 years. If this Concept Application is approved, it can be assumed that the sale of land would occur within 2010 and then potentially detailed design and final approvals throughout later 2010 and 2011.

The construction timeframe for a coal fired power station is anticipated to be 5 years, or 3 years for a gas fired power station. This would mean that if coal becomes the preferred technology, the earliest that the power station might become operational is approximately 2016.

As such, this project represents a baseload power project that could be operational within the timeframe required to support the projected shortfall and support reliability of supply.

2.1.6 Renewable Energy Targets and Demand Management

The Commonwealth Mandatory Renewable Energy Target (MRET) scheme was introduced in 2001. Following this in 2006, the NSW Government initiated the development of a State-based scheme to supplement the MRET scheme. That NSW State-based scheme is now intended to be absorbed into the Commonwealth's more recently developed expanded RET requiring 20% of energy to come from renewable sources by 2020.

Sector efficiency and initiatives have been driven by a variety of sources including the NSW Greenhouse Plan and the Greenhouse Gas Reduction Scheme (GGAS), pending implementation of the CPRS and the *National Greenhouse and Energy Reporting Act 2007*.

- **Greenhouse Gas Reduction Scheme (GGAS**) was introduced in 2003. It provides benchmarks for all NSW electricity retailers and other voluntary parties (including MacGen to abate a portion of their GHG emissions. The GGAS Scheme is to be terminated when the CPRS commences.
- **NSW Greenhouse Plan (2005):** The *NSW Greenhouse Plan* is soon to be superseded by the *NSW Climate Change Action Plan* due later this year. Currently the Greenhouse Plan remains a key document in the NSW response to GHG and outlines a number of measures to reduce GHG emissions through abatement measures.
- **National Greenhouse and Energy Reporting Act 2007:** This Commonwealth Act brought into force a single reporting framework for reporting GHG. It is aimed at providing a consistency of accurate information to understand the current levels of GHG being generated and to inform both the Commonwealth CPRS as well as State based policy initiatives to reduce GHG emissions.
- **Carbon Pollution Reduction Scheme** is intended to be implemented through proposed Commonwealth legislation and would focus on market based carbon pricing and trading processes.

End-user demand management has been managed primarily through electricity retailers under the *NSW Code of Practice (2004)*. Demand Management strategies include measures to reduce peak level electricity demand, reduction in electrical energy consumption through increases in efficiency (e.g. compact fluorescent light bulbs, BASIX requirements), alternate reticulated energy sources (such as natural gas) and renewable energy sources.

The MRET and the expanded RET would see renewable energy production increase. At this stage the increase is not predicted to be sufficient to fulfil the need for increase base load generation in NSW within the timeframe before a shortfall occurs. *Commonwealth Parliamentary Research Paper* (Needham, 2008) notes that the technology for the continuous and reliable generation of electricity from some renewable generation sources is already available but it predicts that it is unlikely to be economic before about 2040.

The proposed Bayswater B project does not replace the need for the continued development of renewable energy sources nor does it undermine the need for government policy to regulate and reduce GHG emissions. It is intended that the proposed Bayswater B project would be undertaken within this context. The project would be subject to both Commonwealth reporting legislation and the CPRS when commenced and would similarly be subject to NSW Government initiatives and policy requirements.

The design of this project has taken GHG emissions and their reduction into account – both in the design of the power generation plant (to reduce GHG emissions) and in making the project carbon capture ready (discussed further in **Chapters 4** and **10** of this EA).

2.1.7 Primary Project Objectives

On this basis, the primary project objectives are to:

- Develop a project that will help to meet base load power generation demand
- Develop a financially viable project complying with all government environmental requirements
- Develop a project that can be constructed and become operational within the timeframe required
- Develop a project which can complete in the NEM.

2.2 Project Needs

2.2.1 Scale

MacGen is seeking approval to develop a 2000 MW (nominal) base load power plant. The unit configurations of the proposal are:

- Gas fired 5 x 400 MW (nom.); or
- Coal fired 2 x 1000 MW (nom.)

The operating capacity of 2000 MW was chosen on the basis of:

- The generation of enough energy to support baseload generation requirements and allow for some future demand growth (refer to **Section 2.1** above)
- The largest gas turbines provide the best thermal efficiencies while ultra critical steam conditions are only available in large steam turbine unit sizes
- The large generating unit capacities have been selected to obtain economy of scale advantages leading to lowest capital costs. History shows that each doubling of unit size can produce an approximate 15% reduction in capital cost on a per MW basis.

For the reasons indicated above it is prudent to seek Approval for the Bayswater B site for 2000 MW of generating capability thus providing NSW with a means by which additional base load capacity can be installed to meet the emerging shortfall in supply capacity in NSW and satisfy the economic growth of the State.

Secondary Project Objective

Building on the primary objectives of meeting base load demand, a secondary project objective is to develop a project that will be of sufficient scale to allow for best thermal efficiency and best efficiency in capital cost.

2.2.2 Scope

The scope of work determined for the gas and coal fired technologies has been identified on the basis of the need to increase base load power generation within a defined timeframe and the scale of the project is summarised in the table below.

Table 2-2: Summary Project Scope

Gas Fired Components	Coal Fired Components
5 x 400 MW Combined Cycle Gas Turbine Units	2 x 1000 MW Ultra Super Critical Coal Fired Units
Access road	Access road
Raw water supply pipeline	Raw water supply pipeline
Switchyard	Switchyard
Gas supply pipeline and use of gas trunk main for gas supplies	Use of Antiene Rail Loop for coal deliveries and coal conveyor
500kV transmission connections to the adjacent, existing 500kV transmission lines	500kV transmission connections to the adjacent, existing 500kV transmission lines
	Ash conveyor and haulage road

The scope of the project has also been established in the context of the project location and the availability of existing infrastructure and resources and is discussed in **Section 2.2.3**.

Secondary Project Objective

A further secondary objective in designing the scope of the project is to:

- Support the primary objectives
- Maximise the use of existing infrastructure to reduce potential constraints and impacts from the project.

2.2.3 Location

The proposed Bayswater B project offers a range of commercial and practical benefits including:

- Remote location with no significant residential impact
- Site size sufficient to accommodate future expansion and the retrofitting of post combustion carbon capture plant
- Access to fuel supplies (coal via the MacGen Antiene Rail Unloader and access to the approved Queensland to Newcastle Gas Pipeline)
- Adjacent to rail transport infrastructure
- Proximity to existing transmission infrastructure
- Access to water supplies
- Co-located with existing power generation infrastructure.

The issue of site suitability is discussed further below in relation to potential land use conflicts. The site location is also discussed further in **Chapter 3 Alternatives**.

Secondary Project Objective

Following from the previous secondary objectives, additional secondary objectives in locating the project are to:

- Optimise access to fuel sources (both coal and gas)
- Minimise potential impacts on residents and sensitive environmental areas
- Maximise use of existing infrastructure to reduce potential constraints and impacts from the project.

2.3 Transmission Requirements

A key feature of the site is the close proximity of existing infrastructure which includes an existing 500kV transmission line. This line runs immediately north of the Project site, which affords the opportunity to connect directly with this existing service infrastructure. It is expected that the transmission system from the Upper Hunter Valley towards the Newcastle area will be augmented to cater for total generation at the full load capacity of Liddell, Bayswater and the proposed Bayswater B project together with the peak import capacity from Queensland.

TransGrid, the Transmission Network Service Provider (TNSP) for NSW, owns and operates the high voltage electricity transmission system within NSW. As the TNSP, it is responsible for planning and developing that system to deliver the requirements of customers within the state in a timely manner and to facilitate operation of the National Electricity Market (NEM).

To meet the continually growing demand for electricity, there will be opportunities both for new generation in the Sydney Basin and demand side response actions. However, most of the new electricity will continue to be sourced from areas to the north, west and south of Sydney, from electricity derived from gas, wind or coal. As a consequence of the ongoing electricity demand growth, the NSW network needs:

- To transmit increased power flow from local or interstate generation to these major load centres;
- To allow the connection of necessary new generation capacity; and
- To have sufficient capacity to support the required power system performance parameters for reliability and security.

It was accepted in the mid to late 1970s that the installed 330kV transmission network would be inadequate to deliver the longer term NSW high voltage electricity supply needs, particularly with projected electricity demand growth in Sydney, Newcastle and Wollongong. In the mid 2000s increasing customer demand in this major load centre approached the capacity of the main NSW 330kV electricity delivery system.

Consistent with its charter, TransGrid has for many years developed the concept of a high capacity 500kV ring system linking the Sydney, Newcastle and Wollongong load centres with major generating centres located in the Central Coast, Western coalfields and Hunter Valley to address the future electricity delivery requirements of customers in the main load areas. TransGrid's network solution to assist in meeting the future customer demand growth for electricity in the Sydney, Newcastle and Wollongong area, which is subject to justification of need (the Regulatory Test) oversighted by the Australian Energy Regulator (AER), is proposed to be delivered by the progressive development of the 500kV transmission ring system.

Part of this system is already in place and further development upgrades are presently underway with the next phase scheduled for completion before 2013. The timing and sequencing of additional projects which will complete the overall upgrade are variable and are yet to be committed, but are anticipated to occur over the period 2013 to 2017, when future generation timings and locations are known.

2.4 Strategic Directions

2.4.1 Electricity Supply

Priority P2 of The NSW State Plan (2006, updated 2008) identifies continued and sustained capital expenditure on public infrastructure including roads, railways, power, water supply and ports. The Plan states *"The Government needs to ensure we have the right infrastructure at the right place at the right time."* The plan commits to maintain an average annual growth rate in Government capital expenditure of 4.6% nominal over the decade to 2015-16.

The NSW Government State Plan objectives also discuss increasing the reliability of the electricity generation. *Priority E2 (a): Electricity supply reliability is considered a basic service and critical to the quality of life of residents and the State's business competitiveness*. The plan identifies a target of electricity reliability for NSW of 99.98% by 2016.

This equates with the 2008 Statement of Opportunities (SOO) prepared by the National Electricity Market Management Company (NEMMCO, from 1 July 2009 known as the AEMO) which stated that *"The power system is considered reliable if, over the long-term, at least 99.998% of consumer demand is met. The amount of energy that is not supplied to meet consumer demand in any given year is referred to as 'unserved energy'. The Reliability Standard permits an average annual level of unserved energy over the long-term that is no more than 0.002% of annual regional energy consumption."* (Part 1 p3).

The *NSW Energy Reform Strategy of March 2009* outlined the government's plans to deliver new investment in power stations to support the development of facilities to increase baseload power generation. Following the *Energy Reform Strategy*, the Minister for Finance and Minister for Infrastructure on 2 July 2009 announced the lodgement of planning applications for new baseload power stations in NSW (including the proposed Bayswater B project):

> *"With the prospect of carbon pollution pricing, gas will become an increasingly attractive fuel source for future base-load generation. The Rees Government is preparing for the next generation of baseload power stations using more environmentally friendly gas-fired technology. Mr Tripodi said the 2007 Owen Inquiry determined NSW needed to be ready for new sources of baseload electricity by the middle of the next decade.*
>
> *As we transition towards a low carbon economy, the Government is creating a platform to secure our energy needs and look after the environment.*
>
> *Whichever fuel source is ultimately used by the developer these new stations will use the cleanest, greenest commercially-available and viable technology which will lead to a reduction in the intensity of greenhouse gas emissions."*

Secondary Project Objective

Building on the previous objectives, this project seeks to support the NSW government in baseload electricity supply and reliability, using the best commercially available and viable low carbon technology.

2.4.2 Electricity Demand

The population of NSW is steadily growing. In 2008, the population was recorded as being just under 7 million people. This represented a growth from the previous year of 1.1% and an increase on averages over the previous five years of 0.9% per year.

The *NSW State Infrastructure Strategy* (Dept of Treasury 2008) identified population growth as one of the key drivers in delivering better and more sustainable infrastructure services. It notes that the NSW population is predicted to grow to 7.6 million by 2018 and that *"The growing spread of the population is fuelling greater infrastructure demand in coastal and new urban areas, in particular for expanded transport, health, education and police services."*

It references infrastructure required to support development (i.e. infrastructure to support large scale demand based industry). In addition, the *Hunter Regional Delivery Update 2008* (which forms part of the NSW State Plan and its update documents) states its continued commitment to *"increase electricity capacity and cater for future growth".*

Secondary Project Objective

Building on the previous objectives, this project seeks to:

- provide additional base load power in the context of ongoing government initiatives with respect to population and economic growth and future development needs.

2.4.3 Generation Technologies

Priority E2(b) of the *NSW State Plan* addresses Renewable Energy consumption and the role the government would like it to play in the State's future. The Government recognises that *"a long term strategy and development of a robust industry will be essential if renewable energy is to have a significant future role in reducing greenhouse gas emissions"*. The plan seeks to achieve a target consistent with the proposed Commonwealth expanded RET of 20 per cent renewable energy supply by 2020. This priority is closely linked to *Priority E3: Cleaner air and progress on greenhouse gas reductions.*

As noted above, the base load power deficiency is predicted to occur within the next decade and hence the timeframe is a key issue in providing additional capability to meet needs. The *Owen Inquiry* findings (as commissioned by the NSW government and based on 2007 energy consumption forecasts) in relation to generation technologies stated that:

- *Most of NSW extra baseload energy needs are likely to be met by coal-fired and/or gas-fired generation as other technologies can only contribute on a relatively small scale or will not mature until 2020 at the earliest.*
- *New renewable energy generation sources, mainly wind and biomass, are expected to supply some 1,375GWh in 2013-14 and about 1,600 GWh by 2016-17.*
- *Technologies with minimal carbon emissions, such as Solar Thermal and Geothermal Hot Rock could offer much as baseload generation in the future, but not for stations that are to be operational within the next ten years.*
- *Nuclear is not an option due to the NSW Government's policy position. In addition, establishing a nuclear energy regulatory framework and planning, building and commissioning a nuclear power plant in Australia is expected to take at least 10 years.*

TransGrid's 2009 forecast now expects new renewable energy generation sources in NSW to provide around 3,700GWh per year by 2015/16.

The *NSW Energy Reform Strategy* of March 2009 further discussed the power generation technology issue. It noted that while black and brown coal dominated the market, the use of lower emission sources is increasing. It also noted that *"the share of renewable generation has increased since the introduction of the MRET and the share of gas-fired generation capacity has also grown particularly, with the NSW Government's GGAS"*. Finally, it noted that renewable fuels and gas are anticipated to increase their share of total generation capacity with the introduction of the national CPRS, and that *"coal-fired generators are expected to continue to play a crucial role in both the NEM and in NSW."*

Despite the timeframe and technology requirements, these still need to be viewed within the context of the *NSW State Plan* and broader environmental policies. Priority E3 of the *NSW State Plan* is *Cleaner air and progress on greenhouse gas reductions*. The target for Priority E3(a) is to *Meet national air quality goals as identified in the National Environment Protection Measure for Ambient Air Quality.* The target for Priority E3(b) is *a return to year 2000 greenhouse gas emission levels by 2025 and a 60 per cent cut in greenhouse emissions by 2050.*

2.5 Site Suitability

2.5.1 Land Use Compatibility

The site of the proposed project is on MacGen owned land and is currently grazed under lease. The proposed project is permissible in all land use zones under the provisions of the Singleton and Muswellbrook Local Environmental Plans (LEP) or via the Infrastructure State Environmental Planning Policy (SEPP), as discussed in **Chapter 6 Statutory Planning**.

Consultation with the Mine Subsidence Board (MSS) and the Department of Primary Industries (DPI – now Dept of Industry and Investment (DII)) has revealed that the Greta Coal Measures extend through this area and that the proposed power station footprint interacts with the measures. There are currently no mining leases covering the area, however there is an exploration licence that covers this land. The licence was granted in mid-2007 and lapses in 2010.

The location of the power station is adjacent to the south western edge of the exploration licence area (known as Savoy Hill) and so is not anticipated to represent a significant impact to exploration activities on the part of the lease holder Dellworth Pty Ltd.

In addition, the power station is located on the southern extremity of the Greta Coal Measure which in that location is a poor quality resource, and so is not believed to represent a significant impact or a land use incompatibility. This is discussed in further detail in **Section 6.1.2** and illustrated on **Figure 6-2**.

2.5.2 Strategic Land Use Objectives

The State Infrastructure Strategy 2006-07 to 2016-17 identifies that the Hunter Region is forecast to increase in population by over 8% within the next decade. The Plan also identifies, in line with this population projection, the need for new dwellings, many in new residential areas. It also identifies key health and education upgrade projects within the Hunter region (including Muswellbrook and Singleton).

This project does not conflict with any of the anticipated development needs or locations associated with the Hunter Region generally or projects associated with the Muswellbrook and Singleton areas.

Chapter 18 Social and Economic Assessment also includes an overview of the strategic land use objectives for the LGAs. This project is consistent with both the land use zonings and the strategic land use objectives for both Singleton and Muswellbrook.

Chapter 6 Statutory Planning of this EA includes a summary of the zone objectives with a commentary with respect to this project. This project meets all the objectives of the applicable zonings within the Muswellbrook and Singleton LGAs.

2.5.3 Infrastructure Availability

As noted above, the Project Site affords the opportunity to utilise existing infrastructure associated with the existing Bayswater facility, or infrastructure located nearby, meaning that the potential impacts of the project's infrastructure are reduced or negated. Utilisation of existing infrastructure includes:

- Use of the existing Antiene Rail Loop for the delivery of coal
- Construction of a conveyor that utilises the existing coal conveyor transfer stations and the existing corridor as it runs east-west to the north of the Bayswater B site
- Use of existing water supply, through access to existing Macquarie Generation purchased entitlements
- Use of existing water infrastructure (i.e. dams, pumps, pipes)
- Use of the existing 500 kV transmission line running immediately to the north of the site
- Proximity of approved fuel supply locations, including coal mines and the approved Queensland to Hunter Gas Pipeline (QHGP).

Secondary Project Objective

Secondary objectives with respect to site suitability are:

- Ensure land use compatibility to avoid land use conflicts with other parties or developments
- Ensure consistency with strategic land use objectives of Muswellbrook and Singleton Council in order to support local planning objectives
- Maximise access to existing infrastructure to reduce potential constraints and impacts from the project.

2.6 Conclusion

The primary goal of this project is to support the development of additional baseload power generation within the context of the projected growth of energy consumption in NSW and the capability of energy supply from existing and planned sources. The key objectives outlined above are summarised below in relation to the requirements of the EARs.

Table 2-3: Summary of Project Objectives

Project Objective	Commentary/Justification
Project Demand	
Develop a project that will help to meet base load power generation demand	The proposed power station will meet base load power generation demand
Develop a project that can be constructed and become operational within the timeframe required.	This project can be constructed and be operational by the middle of the next decade which meets the timeframe of need
Project Scale	
Develop a project that will be of sufficient scale to allow for best thermal efficiency and best efficiency in capital cost.	This project has been designed to utilise best available technology at that site. The project represents the best achievable thermal efficiency for the site

Project Objective	Commentary/Justification
Project Scope	
Support the primary objectives	The scope of the project has been developed to be able to support the primary objective above with respect to meeting energy supply needs of NSW in the coming decade
Maximise the use of existing infrastructure to reduce potential constraints and impacts from the project	This scope of the proposed project takes advantage of the nearby available infrastructure including rail loop, water storage, resources and transmission capacity
Project Location	
Optimise access to fuel supplies (both coal and gas)	Both coal and gas are resources that are either located nearby or have transport options nearby (such as the rail loop and the recently approved Queensland to Hunter Gas Pipeline)
Minimise potential impacts on residents and sensitive environments	The site is approximately 5 km from the nearest private residences, 10 km from Muswellbrook and 20 km Singleton
Maximise use of existing infrastructure to reduce potential constraints and impacts from the project	See above
Strategic Directions: **Electricity Supply**	
Support the NSW government in securing baseload electricity supply and reliability	This project supports the NSW Government's aim of securing adequate baseload power generation ahead of projected system shortages. It supports the NSW State Plan and provides support for the future direction of the State, projected population growth and future industrial development for economic growth.
Strategic Directions: **Electricity Demand**	
Provide additional base load power in the context of ongoing government initiatives with respect to population and economic growth and future development needs.	This project would not reduce or diminish the need for renewable energy sources or for government regulation and policy directives. This project would be undertaken within the context of these initiatives and growth in NSW.
Site Suitability	
Ensure land use compatibility to avoid land use conflicts with other parties or development.	The subject site and adjoining land is owned by MacGen and lies within an existing power station generation complex and its buffer lands. This project is a compatible land use with existing, permissible and known future development.
Ensure consistency with strategic land use objectives of Muswellbrook and Singleton Council in order to support local planning objectives.	This project complies with and is consistent with the zoning and strategic objectives of the Singleton and Muswellbrook LGAs.

Project Objective	Commentary/Justification
Maximise access to existing infrastructure to reduce potential constraints and impacts from the project	The site and its location take advantage of the proximity of existing infrastructure and resources.

The alternatives for the Bayswater B Project are assessed in **Chapter 3** which also provides a summary justification for the selection of the preferred project.

Chapter 27 of this EA also provides a discussion of the justification of the project on the grounds of ecological sustainability.

3.0 Alternatives Considered

This Chapter provides the Alternatives Considered for the project and addresses the requirements of the Director-General's EARs as follows:

***Strategic Planning and Justification** – the EA must:*

Describe alternatives considered for the project including project location, fuel source, generation technology (i.e. integrated coal gasification, combined cycle as well as other low carbon emission power generating technologies), water use and waste disposal and provide justification for the preferred project demonstrating its benefits at a local and strategic scale and how it achieves project objectives compared to the alternatives considered.

3.1 Overview

In accordance with the EARs, this section provides information on alternatives including:

- Project location
- Fuel sources
- Generation technologies
- Water use
- Waste disposal.

Water use, waste disposal and GHG issues are discussed in relation to impact assessment in **Chapters 11, 22** and **10** respectively. The information provided here identifies the alternatives assessed in order to define the proposed project for either gas or coal fired generation.

3.2 Project Location

3.2.1 Selection Criteria

The key selection criteria for the project location was to:

- Optimise access to fuel sources
- Minimise potential impacts on residents and sensitive environments
- Maximise use of existing infrastructure to reduce potential constraints and impacts from the project.

3.2.2 Options

Preliminary designs for both coal and gas fired technologies have been developed, taking into consideration the location of the Project footprint and infrastructure.

No alternate locations were reviewed for the power station given the suitability of the location within MacGen owned land that met all the selection criteria as outlined in **Section 3.2.1** above. The locations of various elements of the project were then assessed further.

Alternate Location of the Power Station Footprint

The footprint of the power station was originally further to the east. This allowed adequate space for laydown areas for construction (for concrete batching plant, storage areas and stockpiles etc) which would be constrained by the topography on the western side of the site. While that location was preferable from a construction management perspective, the footprint in this location had the potential to directly impact on Saltwater Creek. The footprint was subsequently moved to avoid the creek lines completely and provide a 50m buffer but with the consequence of a reduced area for construction laydown.

Alternate Location of Switchyard and Associated Infrastructure

The switch yard has similarly been moved to a location that is clear of the creek lines and in an area devoid of vegetation in order to reduce the environmental effects of its construction. The preferred location provides a beneficial environmental outcome together with a consistent and viable engineering outcome.

Similarly, the associated infrastructure for the site (raw water supply line and access road) were originally sited based on the shortest distance between two points. The access road and raw water pipeline have also been moved to best utilise areas of cleared land to minimise impacts on vegetation where possible. In addition, the gas pipeline has been sited to take advantage of rail and road easements as much as possible so as to avoid potential impacts to vegetation.

As detailed design is undertaken, it would include consideration of this assessment, and any further surveys, in order to locate infrastructure (including the gas pipeline if the gas fired option is chosen) as far as possible, in a manner that avoids impacts. If impacts cannot be avoided, the residual impacts can be quantified on the basis of the detailed design and offset development adopted.

3.2.3 Selected Option

The Project Site was the only viable option considered for the construction and operation of the proposed Bayswater B project. This was because:

- The site is on MacGen owned land
- It lies within the Bayswater-Liddell power generation complex and so affords opportunities to utilise existing infrastructure and water entitlements
- If a coal fired technology becomes the preferred approach, it lies within an area convenient for coal sources and transport
- If a gas fired technology becomes the preferred approach, it lies within easy reach of the approved QHGP which passes the site to the north east
- Being within the Bayswater-Liddell power generation complex, the site is consistent with the primary uses of this area and avoids the need to introduce a large generation facility to a new area
- The site is well located away from sensitive receptors, including environmental areas and community areas/residents
- The topography of the site assists in screening the proposed facility from long distance view points
- The site affords ready access from the New England Highway, avoiding the need for road upgrades or additional traffic on rural road networks.

As such it meets all the selection criteria for the location of the project.

3.3 Fuel Source

3.3.1 Selection Criteria

Electricity can be generated by renewable means such as solar, wind, biomass, but only in relatively small quantities due to the very low energy intensity. Renewable generation is not able to meet the reliability or cost demanded by society for bulk electricity at this stage and for the immediate future. Whilst renewable generation has a supply augmentation role, it is not presently feasible for base load generation.

Electricity is a transformed form of energy. The challenge is to generate large quantities of electricity economically and in an environmentally appropriate manner to meet society's demand, 24 hours a day, 365 days a year for electrical energy.

The key selection criteria with regards to fuel source were:

- Ability to generate large quantities of electricity economically to meet demand
- Ability to generate electricity in a sustainable and secure manner.

3.3.2 Options

The provision of electrical energy is based on transforming a fuel source of energy into electrical energy or in the case of solar directly into electrical energy. Solar and wind contain, by their very nature, extremely low levels of energy and require optimal resource sites to generate electricity in an inherently intermittent manner. The following table illustrates the typical comparative levels of energy intensity for different fuel sources that could be used to generate electricity. The comparative energy densities of both wind and solar have not been included as the values are low.

Table 3-1: Considered Options

Fuel	Energy Density MJ/kg
Water at 100m head	0.001
Begasse (~ 50% water)	10
Wood (~ 30% water)	15
Brown Coal (Lignite, ~ 60% water)	16
Domestic Coal	24
LPG	34
Diesel	48
Natural Gas	53
Hydrogen	120
Nuclear fission (U_{235})	90,000,000
Nuclear fusion	300,000,000

Consideration of the above table illustrates practical constraints in selecting a fuel source for generating base load electricity. In considering the necessary fuel security required to generate base load energy at the proposed Bayswater B site, considerable physical, resource, economic and legislative constraints exist.

3.3.3 Selected Options

Natural gas and coal were selected as the two fuel source options. The actual source of the fuels remains open as it would be subject to competitive tender and contract negotiations. The key factor however is the availability of those fuel sources to the site.

This Project would require approximately 6.2 million tonnes per year of coal dependent on the specific energy vale of the coal, which could vary the final volume required.. The Bayswater B site lies within an area rich in coal. In addition, the site has access to coal transport infrastructure (i.e. the Antiene Rail Loop), which would provide access to other coal rich regions such as those further to the north and west within NSW.

A gas fired power station would need around 112 Petajoules (PJ) per annum of gas as fuel.

A strategic-level review of gas supply was undertaken given that the potential fuel sources are not as immediate or obvious as coal reserves. The review identified that natural gas reserves in Queensland and NSW are substantial, in particular Coal Seam Gas (CSG).

Figure 3-1 illustrates the CSG reserves in “Eastern Australia” (i.e. Queensland and NSW) as at the end of June 2009. This shows that Queensland dominates in CSG reserves. Commercial production from the Sydney Basin has now occurred, but the most significant, accessible resources appear to be located in the Gunnedah Basin. The two key operators in this basin, Santos and Eastern Star Gas have current exploration programs. Eastern Star Gas, for example, is undertaking pilot plant production and has stated it anticipates reaching 1300 PJ of 2P reserves for the Narrabri CSG Project by year-end and has previously indicated a contingent resource in excess of 6000 PJ. Santos has indicated its estimate of resource for the licence areas operated by itself and those operated by ESG represent a resource potential exceeding 50,000 PJ.

Upstream requirements to produce gas for Bayswater B would not be different to other projects, so existing operations and development plans for Eastern Australian gas supplies would be suitable (i.e. no special upstream developments would be needed in order to supply Bayswater B). In addition, the volume of gas required would be substantial, making Bayswater B foundation gas customer for the developers of gas reserves, as well as enabling economies of scale to be tapped into for gas transmission. This makes gas supply a viable option for the Bayswater B project.

A gas pipeline from Queensland to the Hunter (QHGP) was recently approved which will run to the north east of the Bayswater B site and so would provide ready access to identified gas reserves. The approved capacity of the pipeline is less than would be required for the Bayswater B project. An increase to capacity is (in engineering terms) feasible and viable. It would require the placement of above ground compressors at certain points along the pipeline route. It would also require a modification to the current consent if gas were the selected option, and the Queensland to Hunter pipeline was utilised.

Overall, the strategic review of fuel sources concluded that there were no overarching factors to inhibit the production, transport and use of gas or coal for the proposed Bayswater B project. The price of gas is however not known with any accuracy at this time

3.4 Generation Technologies

3.4.1 Selection Criteria

A range of alternative generation technologies were reviewed by MacGen to determine their ability to achieve base load power capacity within the timeframe needed. These included:

- Geothermal
- Hydro
- Solar
- Wind
- Nuclear
- Gas fired
- Coal fired.

The key selection criteria for the generation technology were:

- The ability to meet base load power requirements in a manner also meeting efficiency of scale (i.e. 2000 MW)
- Ability to be fully operational by the middle of the next decade
- Ability to demonstrate best achievable practice within the context of the geography particularly in relation to GHG emissions
- Ability to generate secure supply of electricity with minimal downtimes
- Ability to be developed within a defined spatial project area and utilising existing infrastructure
- Cost efficiency within the context of operational requirements.

3.4.2 Options

Geothermal

Hot rock technology has major disadvantages including:

- The technology is difficult to implement at a large scale
- Usually found in remote locations (e.g. north eastern South Australia) and so would also require new transmission networks
- Given the remote location there would be high transmission losses over the long network distances
- Can result in costly electricity

This technology was not considered viable for a base load business case within the required timeframe.

Hydro-electricity

Hydro-electricity has long had a place in the Australian electricity supply system but was not considered as:

- It would require the development of a new dam site
- Appropriate sites (in terms of water availability in locations which have access to load centres and transmission networks) are difficult to find, especially for base load capacity
- The cost to build is likely to be economically prohibitive.

Solar

Solar technology is quite mature but there are difficulties to overcome including:

- Technology is not available for baseload generation, because commercially available storage technology would not be available within the next decade
- Large land areas required - 400 times that of equivalent fossil fuel sites
- High cost to install (approximately three to five times that of a coal fired plant)
- Operating costs can be relatively high as for example, constant dust removal is necessary to keep capability and conversion efficiency high
- Back up storage or reserve generation plant needed to compensate during the night and in poor solar conditions.

Wind

Wind energy technology is quite mature, however it was not considered to be appropriate because:

- NSW is positioned in the sub tropical high pressure region of the globe which is in general characterised by low annual average winds. It is the presence of sufficiently high average wind that enables the effective deployment of wind farms. Wind generation in NSW has been confined to a number of ridge lines where the topographical feature generates adequate annual average wind resources. The large wind generators under development in NSW are located in the extreme south west of the state close to the South Australian border where prevailing South West winds provide an adequate wind resource.
- Best locations are usually remote and high transmission costs and losses are incurred
- Large areas would be required to generate an amount equivalent to base load coal or gas fired technology (similar to solar energy)
- The best annual capacity factors vary between 15% and 40% (depending on location) compared to 90% with fossil plant
- High costs of installation – two to four times more costly than fossil fuel plants
- It is not suited to base load operation and reserve plant or energy storage is needed
- Technology is not available for baseload generation, particularly because commercially available technology would not be available within the next decade.

Nuclear

Despite the availability of mature technology and clear cost advantages, Government policy and the absence of a legislative and regulatory framework precludes consideration of nuclear plants.

Open Cycle Gas Turbine (OCGT)

OCGT is the best practice technology for peak load operation. An OCGT power station provides the necessary rapid start up capability to generate electricity at full load within minutes and hence is ideal to meet peak electricity demand.

Combined Cycle Gas Turbine (CCGT)

This technology utilises the hot exhaust gases from the gas turbines by ducting them into separate Heat Recovery Steam Generator (HRSG) units to produce steam. The steam is then used to turn the blades of a steam turbine which is hard coupled to a generator to produce additional electricity. The steam exhausted by the steam turbine is then condensed back into water for reuse in the steam cycle.

The CCGT configuration allows more efficient utilisation of the available heat energy through the use of energy from the hot exhaust gases from the gas turbines, giving improved thermal efficiency.

CCGT power stations are suited to intermediate or base load operation, but are not suitable for peak load operation as they have a comparatively slower start up time to full output of up to some four hours. This technology has therefore been considered as an option for the proposed Bayswater B project together with Carbon Capture and Storage (CCS) ready design.

Integrated Coal Gasification Combined Cycle (IGCC)

This technology has been under development for the past 50 years and is not yet commercially viable. The benefit of the IGCC process is reduced GHG emissions and near total pollutant capture. Considerable development is being undertaken overseas but the technology remains at the demonstration stage. While the full timing required to move IGCC to commercial viability is uncertain, the technology is not sufficiently advanced to enable full scale commercial operation within the timeframe required.

While carbon capture technologies have been used in other industries since the 1970s, their application on the scale of a base load power plant is only just entering the pilot stage. The application of this technology, when fully developed, is likely to be part of IGCC technology but is not yet, in any case, proven or commercially viable at the scale required. It is unlikely to be developed at utility scale for incorporation into base load plants until beyond 2020, which is outside the timeframe required for additional base load power supply in NSW.

Other Clean Coal Technologies

These technologies include Oxy firing to capture CO_2 for sequestration. They are at an early (demonstration) stage of development and are not yet commercially viable. Consequently, they are not sufficiently advanced to enable full scale operation within the required timeframe.

Pulverised Coal Fired Ultra Supercritical Thermal

Ultra supercritical thermal plant is commercially viable and offers high thermal efficiency and lower GHG emission over current coal fired plant in NSW.

Of the various coal fired generation technologies, Pulverised Coal Fired Ultra Supercritical Thermal plant would be capable of being operational within the identified timeframes required for additional base load power supply in NSW. This technology has therefore been considered as an option for the proposed Bayswater B project together with CCS ready design.

3.4.3 Selected Options

Gas Fired Technology

The base load requirements identified by the Owen Inquiry and the NEMMCO Statement of Opportunities (2008) are driving this project. As such, gas fired CCGT is the best available gas technology to meet base load requirements.

MacGen has adopted the F Class Gas Turbine technology to maximise plant thermal efficiency and minimise GHG emissions. This technology is based on five gas turbine units with exhaust gases being emitted from five wake free stacks. To increase the efficiency of electricity generation, gas turbines incorporating heat recovery steam generators and steam turbines are proposed.

Coal Fired Technology

MacGen has adopted the Pulverised Coal Fired Ultra Supercritical Thermal technology to maximise plant thermal efficiency and minimise GHG emissions.

3.5 Water Use

3.5.1 Selection Criteria

The key selection criteria with regards to water use were:

- The ability to maximise operational efficiency with minimum water usage
- The ability to reduce GHG emissions
- The ability to use water sustainably and to levels that would not impact other water users
- The ability to manage water in a sustainable and environmentally beneficial manner.

3.5.2 Options

Steam exhausting from the steam turbine (in either gas fired or coal fired plants) must be condensed. This requires the rejection of heat from the steam to the atmosphere via cooling plant.

Coal Fired Technology Water Use

Cooling system options were considered at the pre-feasibility stage of which four are outlined in **Table 3-2** below.

Table 3-2: Cooling System Options

Option	System Description
Wet Natural Draft Cooling System	The main cooling mechanism of the Wet Natural Draft Cooling System is through evaporation of the cooling water, which removes latent heat from the steam leaving the cooling tower. This option is similar to the cooling system currently utilised at the Bayswater Power Station. Large pumps circulate the cooling water between the cooling tower and tubed condenser. This solution provides high thermal efficiency, high make up water usage, lowest operational cost and high capital cost.
Wet Mechanical Draft Cooling System	This option is similar to the Wet Natural Cooling System option, except that the air is forced mechanically through the cooling tower by fans. The cooling towers are smaller due to better air flow and heat transfer. This solution provides the highest thermal efficiency, high make up water usage, lowest capital cost and higher operations cost.
Dry Air Cooled Condenser (Preferred Option)	Air cooled condensers (ACC) use direct heat transfer to the atmosphere to cool and condense the steam exhausted from the steam turbine. No circulating water system is required nor a tubed condenser, as the steam is ducted directly to the large fin-fan heat exchanger. This solution has lowest thermal efficiency, no evaporative losses requiring make up water, high capital cost and moderate operations cost.
Dry Cooling System with Spray Cooling	Heat transfer by dry cooled systems depends on ambient dry bulb temperatures. During periods of high ambient temperatures, the inability of dry cooling systems to dissipate sufficient heat may result in limitations on plant output and reduced efficiency. To counter this effect, water sprays can be used to cool the incoming air and on the external surfaces of the heat exchanger elements to provide cooling by evaporation. Similar performance to above but with improvements in performance on hot days.

The performance of wet cooling over dry cooling is governed by the prevailing site wet or dry bulb temperature at a given moment. The effectiveness of the cooling plant in transferring heat efficiently is better for wet cooling as the wet bulb temperature is below that of the dry bulb temperature. As such, there is a significant improvement in thermal efficiency and reduction in greenhouse efficiency by adopting wet cooling. That is, 40.5% for wet cooling compared with 38.9% for dry cooling on a sent out basis at reference conditions. This translates into a 4% reduction in GHG emissions.

Water cooling however would require a total water usage of approximately 22 GL/yr. The advantage with dry cooling is the comparatively lower water consumption of around 2.5 GL/yr.

This option of wet cooling was not adopted as additional water for wet cooling is required.

Gas Fired Technology Water Use

Following from the coal fired assessment, two condensing system options for the steam turbine exhaust have been considered; ACC with cooling water sprays (Option 1) and wet mechanical draft cooling towers (Option 2). Generally water availability is the main factor in selecting the condensing system. If water availability is limited, air cooled condensers with water sprays to ameliorate high temperature performance are used.

As with coal fired technology, the effectiveness of the cooling plant in transferring heat efficiently is better for wet cooling as the wet bulb temperature is below that of the dry bulb temperature. As such, there is an improvement in thermal efficiency and reduction in greenhouse efficiency by adopting wet cooling for gas fired generation. That is, 50.7% for wet cooling compared with 50.0% for dry cooling on a sent out basis. This translates into a 1.4% reduction in GHG emissions.

Water cooling however would require a total of approximately 12 GL/yr. The advantage with dry cooling is the comparatively lower water consumption of some 1.7 GL/yr.

This option of wet cooling was not adopted as additional water is required for wet cooling.

Gas turbines suffer performance degradation during hot periods and so systems for cooling the air intake system are often installed.

The most common system is an evaporative type cooler, where the inlet air stream comes in contact with water falling/flowing down the cooler elements and is cooled by evaporation of the water. Water can also be sprayed into the air stream.

Evaporative systems are a low capital cost option and perform best in hot dry climates as they increase density by reducing the air temperature. This is also achieved by the additional water load from evaporated water vapour.

Evaporative systems consume water which is discharged with the exhaust, however in reviewing available plant combinations, economic and performance comparisons indicate the use of evaporative cooling to control turbine gas inlet temperature is cost effective.

3.5.3 Selected Options

The availability of water for plant cooling improves plant thermal efficiency. The highest thermal efficiency, lowest greenhouse emissions and lowest capital cost are achieved by employing wet cooling.

Dry cooling uses less than 10% of the water used by a wet cooled plant but at a cost of lower thermal efficiency, higher greenhouse emissions and higher capital cost. As discussed above, a wide range of cooling options have been investigated in order to quantify the conflicting requirements relating to greenhouse gas emissions, water usage and plant capital cost.

Wet cooling would improve thermal efficiency and reduce GHG emissions for both the coal fired and gas fired options. However, the option of wet cooling was not adopted for either fuel option for the project due to the additional water requirements needed for that option.

Sufficient water resource exists within MacGen’s existing water purchases to meet the water demand sufficient for the proposed Bayswater B project to be dry cooled. As such, dry cooling has been selected for both the coal and gas fired options.

3.6 Waste Disposal

3.6.1 Selection Criteria

The primary waste generated by coal fired technology is:

- Large ash particles which fall to the bottom of the furnaces (bottom ash) where they are collected in the furnace ash hopper.
- Fine ash particles (fly ash), over 99% of which are removed from boiler flue gases before release to the atmosphere. Fabric filters are installed for this purpose

It is anticipated that the Bayswater B project (if coal fired) would result in approximately 1.5 million tonnes per year of ash to be reused or disposed. The sections below describe the possible uses and disposal options for the fly ash and bottom ash.

The key selection criteria with regards to coal ash waste disposal was:

- Ability to transfer the ash waste to a nearby location in an efficient manner while minimising the amount of storage space required.

3.6.2 Options

Re-use of Fly Ash and Bottom Ash

There are several potential uses for fly ash and bottom ash in landscaping and the construction industry including for cement manufacture and building materials and for road works. The existing Bayswater and Liddell Power Stations re-use approximately 4.33% of fly ash. This level of reuse is commensurate with demand in the market place. Reuse options are actively pursued by MacGen as a more positive outcome to disposal. Ash is however a low cost commodity and the location of the Bayswater site means a high rate of transport costs that outweigh the cost of the product. Other power stations (such as Eraring Energy's power station) have greater opportunity to reuse ash by-product given closer proximity to the demand source and ultimate market.

During construction of the proposed Bayswater B project, fly ash from the existing Bayswater site would be used for construction materials (i.e. concrete) where feasible and bottom ash for road base. This affords the project an opportunity to temporarily reduce the amount of ash being disposed from Bayswater and also reduces the raw materials needing to be sourced by the project for construction.

Once operational, the Bayswater B facility would have limited opportunity to reuse fly and bottom ash, given the limited opportunity and remote location compared with other power stations.

The Proponent would, however, review on a regular basis, the options and opportunities for the beneficial re-use of fly and bottom ash within local markets in order to reduce the dependence on direct disposal (as discussed below).

Disposal of Fly Ash and Bottom Ash

Fly ash is removed from the fabric filters, dampened down with a small quantity of low quality (and otherwise unusable) water before being conveyed (as conditioned ash) by a conveyor to a nearby mine void disposal point. The bottom ash and mill pyrites rejects would be collected and trucked using dedicated haul roads to the same void used for fly ash disposal and primarily used for in void road base.

In general, disposal options for fly ash are restricted to sequential placement in open areas (such as dams or open cut mines) with sequential rehabilitation, or placement within mine voids.

The preference is to place the ash within a mine void within a short distance of the site. It would also negate the need to construct a new ash dam of sufficient capacity to take fly ash of that volume for the life of the Bayswater B Power Station.

Conditioned ash and dense phase placement require less space (i.e. capacity of receiving disposal area) given that the ash is conditioned with less water than Lean Phase disposal. If the disposal site is within a suitable distance, the fly ash could be disposed by a conveyor rather than by road. The conditioning of the fly ash and method of placement is discussed in further detail in **Chapter 22 Waste**.

Bottom ash comprises approximately 10% of the ash product (i.e. 150,000 tonnes per year). Bottom ash is dewatered and similarly trucked daily to nearby mine voids for permanent disposal under topsoil.

Waste Disposal for Gas Fired Technology

No ash is generated as a result of the combustion process and so no alternatives needed to be addressed for the gas fired technology. A discussion and assessment of general waste management for this technology is provided in **Chapter 22** of this EA.

3.6.3 Selected Option

The final selection in terms of ash management is to convey fly ash and truck bottom ash to a disposal location proximate to the site. The final location however has not yet been determined. This would need to be subject to further assessment and negotiation with landowners if the coal fired option is selected.

3.7 Configuration

3.7.1 Selection Criteria

The key selection criteria in the configuration of the plant were:

- Retention of high thermal efficiency and lower GHG emissions
- Minimisation of other emissions (including sulphur and particulates).

3.7.2 Options

For the CCGT gas fired option, the key considerations were:

- The best technology for the Bayswater B site was selected as being F class technology.
- Further improvement in F Class thermal efficiency was considered through the use of wet cooling. This option was not adopted as additional water for wet cooling is required.

For USC thermal coal fired option the key considerations were:

- Further significant improvement in USC coal fired thermal efficiency was considered through the use of wet cooling. This option was not adopted as additional water for wet cooling is required.
- Increased thermal efficiency for USC Dry Cooled was considered. It was found that a small improvement in thermal efficiency was possible but thermodynamic limitations are an absolute constraint. This option was not adopted due to the excessive capital cost of attaining a small improvement in thermal efficiency.

3.7.3 Selected Options

Gas Fired

The gas fired plant proposed is based on the use of two thermodynamic cycles (Rankine and Brayton) and is referred to as a combined cycle plant. It is characterised by a higher thermal efficiency, lower capital cost and higher fuel cost on an energy basis. It has a better greenhouse gas emission performance than the coal fired alternative but electricity production costs are higher.

Each unit of the gas fired plant alternative is based on the use of a gas turbine of approximately 270 MW capacity and a steam turbine of approximately 130 MW. Unfired triple pressure reheat HRSGs are proposed to achieve the highest thermal efficiency attainable for this class of plant.

Coal Fired

The 1000 MW coal fired units are based on the use of ultra supercritical steam conditions (main steam 285 bar and 600^{o}C with reheat steam 620^{o}C) to achieve world's best practice thermal efficiency (corrected to the site conditions) for this class of plant. Most importantly, both these configurations are regarded as fully mature technologies so that the likelihood of support by commercial investors and debt providers is maximised.

3.8 Air Emissions

3.8.1 Selection Criteria

The key selection criteria regarding air emissions was:

- The ability to minimise emissions to air without compromising other technological aspects (such as thermal efficiency, which would have a flow on impact to greenhouse gas emissions).

3.8.2 Options

The key options assessed for the control of air emissions were:

- The height and design of the stack was designed to reduce ground level concentrations of pollutants to acceptable levels
- Deploying low NO_x burner technology in both fuel options
- Fabric Filter technology, being the best available technology for particulate control with reference to Australian coals.

Options assessed in relation to greenhouse reduction, carbon capture and storage are discussed in full in **Chapter 10 Greenhouse Gas Assessment**.

3.8.3 Selected Options

Employing table mills for the coal pulverising plant has an advantage in that a percentage of the pyritic sulphur mineral content in the coal is rejected and disposed of with the boiler ash and not burnt. The effect of not burning all the pyritic sulphur content of the coal is to reduce the sulphur oxides emissions.

The dispersion of flue gas containing sulphur dioxide would be ducted to a single tall, wake free stack configured with two flues.

3.9 The "Do Nothing" Option

The "do nothing" option (ie not building the Bayswater B power station) would potentially have a number of consequences. This could include an electricity shortfall and/or reduced reliability of electricity supply in NSW from 2015/16.

This could secondarily impact on the NSW Government's ability to deliver its strategic objectives as laid out in the State Plan and the State Infrastructure Strategy to support population growth and economic development.

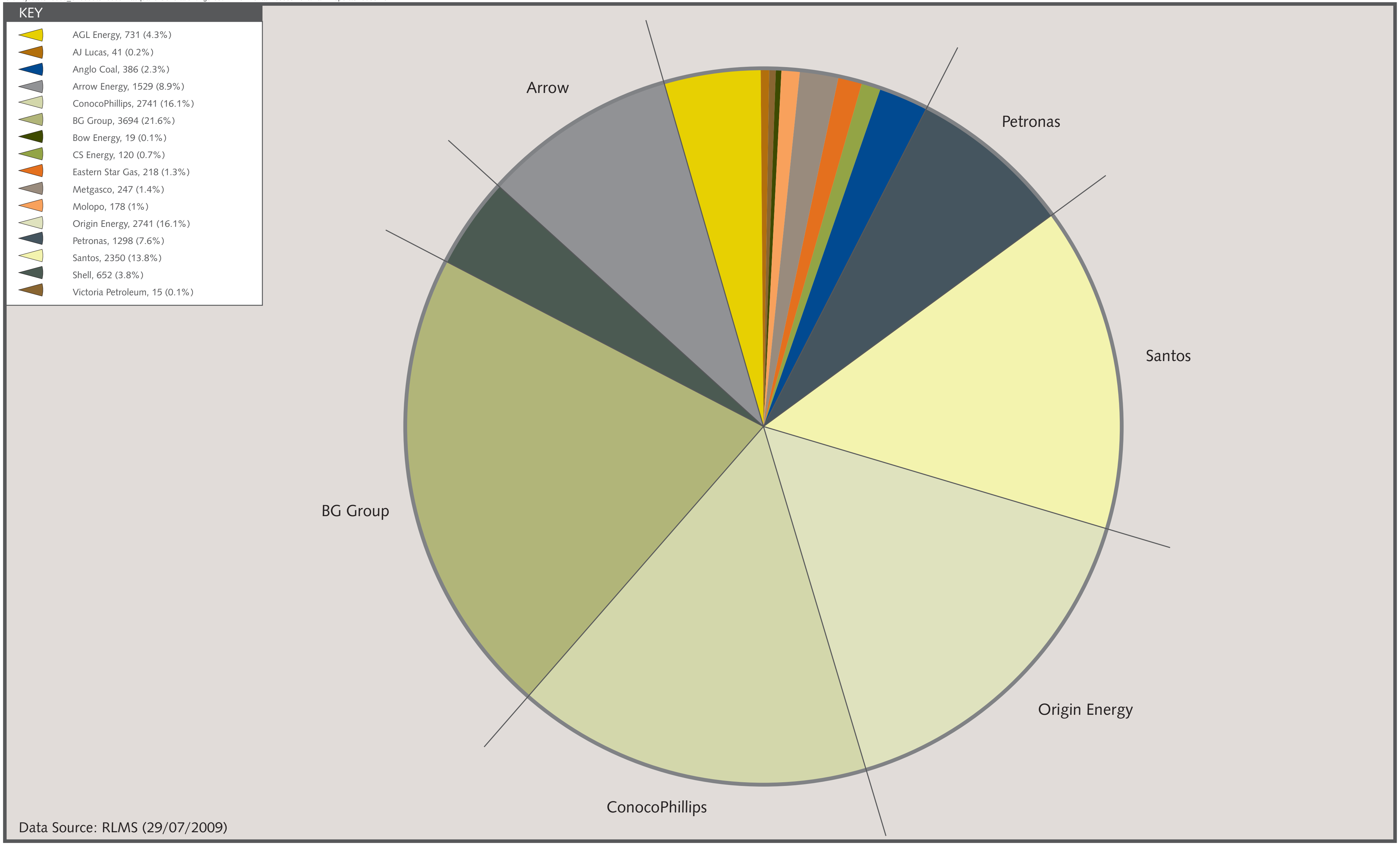
The consequences of the "do nothing" option, are discussed in detail in **Chapter 2** (Strategic Justification) and **Chapter 27** (Project Justification).

3.10 Conclusion

A summary of the proposed project is outlined below in relation to the preferred options.

Table 3-3: Summary Preferred Alternatives

Preferred Option	Justification
Project site	The project site is justified in that it is co-located with other power generation facilities, it is centred within buffer lands (separating it from sensitive receptors) and affords the opportunity to utilise existing infrastructure.
Generation Technology	The generation technology is justified on the basis that those chosen have the ability to meet base load power requirements. The F Class Gas Turbine technology has been chosen for the gas fired option to maximise plant thermal efficiency and minimise GHG emissions. To increase the efficiency of electricity generation, the gas turbines are proposed to incorporate heat recovery steam generators and steam turbines. Pulverised Coal Fired Ultra Supercritical Thermal technology has been chosen for the coal fired option to maximise plant thermal efficiency and minimise GHG emissions.
Configuration	The configurations are justified because they are focussed on a higher thermal efficiency, lower emissions, and proven, mature technology that can be implemented on the appropriate scale.
Fuel Source	The fuel source is justified because both coal and gas can support the base load power generation needs and both fuel types are feasible in terms of accessibility and security.
Air Emissions	The air emission abatement is justified because it has been designed to abate to appropriate standards to achieve license criteria and be protective of the environment.
Water Use	The selected option for water use is justified in that it allows for a design based on water use that does not require additional water supplies.
Waste Management	The selected option of disposal in a mine void is justified in that it is an appropriate methodology for the disposal of the product and can be managed accordingly, and assists in the rehabilitation of the mine void. while reviewing re-use options on an ongoing basis



Data Source: RLMS (29/07/2009)

AECOM

EASTERN AUSTRALIA 2P COAL SEAM GAS RESERVES

Environmental Assessment

Bayswater B Power Station

Figure 3.1

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