

Maximising Sustainability in a Coal-fired Power Station

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1 INTRODUCTION

The Coolimba Power Project (CPP) is proposed for development near Eneabba, approximately 270 km north of Perth, Western Australia (WA). The CPP will comprise a 440 MW coal-fired power station and is being developed to provide additional power-generating capacity for WA's South West Interconnected System (SWIS). Electricity generated at the power station will be transmitted through the SWIS network to markets in WA's South West and Mid West regions.

The proponent for the CPP is Coolimba Power Pty Ltd, a wholly owned subsidiary of Aviva Corporation Limited. Aviva is an integrated energy company listed on the Australian Stock Exchange and Botswana Stock Exchange. The company has a portfolio of energy assets including the Central West Coal Project near Eneabba (which will provide coal to the CPP) and the Mmamantswe Project in Botswana.

One of the challenges facing the development of the CPP is how to maximise sustainability in a coal-fired power station, particularly in the context of an increasing focus on global warming. This paper outlines the process and technology options being explored by Coolimba to reduce emissions and maximise the sustainability of the CPP.

2 PROJECT SETTING AND OBJECTIVES

The Project Area occurs within the northern Perth Basin and on the Eneabba Plain. The climate is dry warm Mediterranean with an average annual rainfall of approximately 505 mm (Bureau of Meteorology, 2007).

The Eneabba Plain is very sandy with small longitudinal ridges occurring in places, and small lakes and swamps in low-lying areas (Beard, 1990). The Lake Logue-Lake Indoon wetland system is located to the northwest of the Project Area. The area is characterised by Kwongan vegetation, with a fairly uniform scrub heath assemblage containing patches of melaleuca thicket, with scattered trees and woodlands (Hopkins and Hnatiuk, 1981). Kwongan vegetation is known to have high biodiversity values and to support endemic species. However, much of the area proposed for development has previously been cleared for farming.

The CPP is proposed for development primarily on cleared farmland approximately 18 km southwest of Eneabba and 25 km from the coast. In addition to farming, the Eneabba region supports mineral sands mining with the area containing around 70% of the world's mineral sands deposits. The Mid West's iron ore industry is also developing rapidly and there is a strong local requirement in this region to service other industries.

The importance of developing both energy and industry in the Mid West region is widely recognised. One of the recommendations of the Mid West Regional Minerals Study conducted by the WA Department of Industry and Resources (DoIR) is to enact policies to stimulate development of large power stations in the Mid West region (DoIR, 2000). Further, a study on energy for minerals development in the South West Coast Region of WA has recommended the development of a northern Perth Basin coal mine as a source of energy supply to facilitate iron ore processing initiatives (DoIR, 2004).

Development of the CPP will assist in meeting the power demands of the Mid West region and the demand for energy in the SWIS, which continues to grow at approximately 120 MW each year. In addition, establishing a power station in the Mid West will greatly reduce the energy losses experienced when transmitting power over large distances from the State's South West to Mid West region (which are currently estimated by the WA Energy Industry to be up to 12%). In reducing the transmission losses, the volume of

greenhouse gas emissions produced per usable electricity units is also reduced. In addition, increased power generation in the Mid West will assist in meeting the State Government's "Fuel Diversity Policy" and could provide the transmission capacity to support additional renewable energy projects, such as wind projects, in the region.

3 ENVIRONMENTAL ASSESSMENT PROCESS

Coolimba's proposal to develop the CPP is currently undergoing formal EIA, at the level of Public Environmental Review (PER) under Part IV of the WA *Environmental Protection Act* 1986. In addition, the proposal is considered to be a "controlled action" under the Australian Commonwealth *Environment Protection and Biodiversity Conservation Act* 1999. The controlling provisions are listed threatened species and communities. The environmental assessment is being conducted in accordance with the "Agreement between the Commonwealth of Australia and Western Australia under Section 45 of the EPBC Act Relating to the Environmental Impact Assessment (the Bilateral Agreement) and in conformance with the Cooperative Arrangements to the Bilateral". This means that the Commonwealth has accredited the WA environmental impact assessment process and that the PER will satisfy the requirements of both the State and Commonwealth EIA systems, rather than producing separate documents for each system.

In preparing the PER for the CPP, Coolimba is required to consider a range of legislation, regulations policies, guidelines and other documents relating to environmental protection and management. These include the *Environmental Protection Act* 1986, which was amended in 2003 to include the following principles:

- The precautionary principle.
- The principle of intergenerational equity.
- The principle of the conservation of biological diversity and ecological integrity.
- Principles relating to improved valuation, pricing and incentive mechanisms.
- The principle of waste minimisation.

These principles are discussed in a series of position statements and guidance statements developed by the WA Environmental Protection Authority (EPA) to elucidate the EPA's views on matters of environmental importance and to provide an avenue for the Authority to inform the public about environmental values and its vision for the future. Of particular relevance to this paper is Position Statement No. 6, "Towards Sustainability" (EPA, 2004a). This position statement discusses the concept of sustainability in relation to the State Government's State Sustainability Strategy (Government of Western Australia, 2003), global issues and local issues for a number of sectors. The statement also provides a provisional checklist of questions to be addressed during the impact assessment of proposals. These questions cover a range of topics including the use of non-renewable resources, water and energy efficiency, pollution prevention and the waste hierarchy, rehabilitation, biodiversity and ecological footprints, as well as environmental, social and economic benefits. EPA Position Statement No. 7, "Principles of Environmental Protection" is also of particular relevance as it provides the public and other key stakeholders with a summary of the key aspects that the EPA considers to be important in guiding its decisions and provision of advice to Government on matters of environmental protection (EPA, 2004b).

4 KEY SUSTAINABILITY CONSIDERATIONS

Coolimba is currently developing the design of the CPP and is exploring ways to maximise sustainability of the Project. The power station will incorporate new generation design features into a conventional Rankine cycle technology. The term "Rankine cycle" describes a closed loop thermodynamic cycle that uses a recirculating fluid (water/steam) that has energy added in the form of heat, and energy extracted in the form of electricity from the expansion of steam and heat rejection to a waste heat sink (PB Power *pers com.*). In incorporating sustainability considerations into the project design, Coolimba is addressing the following factors:

- Carbon capture and sequestration.

- Energy efficiency.
- Efficiency in water utilisation.
- Minimising sulphur dioxide and other emissions.
- Development of a greenhouse gas abatement strategy.
- The possible need for environmental offsets.

These factors are discussed below.

Carbon Capture and Sequestration

The key difference between the proposed CPP and “traditional” coal-fired power stations is that the CPP will be designed to be “carbon capture ready”. This means that it will be developed in such a way that it can be easily converted to a plant that is capable of capturing carbon from its air emissions at some future point.

The power station design will be sufficiently flexible to allow conversion to either a post-combustion capture plant or a pre-combustion or “oxygen firing” plant. The CPP will be the first commercial scale “carbon capture ready” boilers used in Australia and will be ready to be converted to be carbon capture once an economic signal from a carbon trading system gives the financial support and sequestration sites are proven to be available and technically sound. The required design modifications of the proposed plant to be carbon capture ready will include making provision for the necessary space for ducting, piping and additional plant associated with the carbon capture technology.

Australia’s leading carbon capture and storage research group CO2CRC (Cooperative Research Centre for Greenhouse Gas Technologies) will assess the potential for storing carbon dioxide emissions in the deep subsurface near Eneabba in the northern Perth Basin. Preliminary work completed by CO2CRC has identified the northern Perth Basin as being prospective for sequestration and storage of carbon dioxide. This study complements the CPP, which proposes carbon capture and sequestration.

Energy Efficiency

To improve the power station cycle efficiency for the CPP, a number of technologies will be used to reduce the quantity of emissions per kWh. These technologies are:

- Feed water heating, which comprises preheating of boiler feed water increasing energy efficiency.
- Superheating steam, where steam is superheated to increase heat transfer efficiency.
- Reheating steam from the high pressure turbine exhaust, where waste heat from the turbine exhaust is reused to heat the incoming steam to the turbine increasing energy efficiency.
- Lowering the condenser pressure, where the turbine exhaust steam is captured and cooled by condensation and recycled back to the boiler feed water increasing energy and water efficiency.

Efficiency in Water Utilisation

The power station units will be of sub-critical pressure design and will be predominantly self sufficient with regard to water supply from the associated mine dewatering activity. This will involve an appropriate use of conventional water and air cooled condensers so as to minimise water consumption. Sub-critical pressure design refers to where the power station units operate at optimal pressure and temperature in order to minimise overall energy use.

Minimising Sulphur and Other Emissions

Desulphurisation will be employed for the CPP using Circulating Fluidised Bed Combustion with limestone addition. In a Circulating Fluidised Bed Combustion boiler, desulphurisation can be undertaken within the boiler, thereby eliminating the need for post combustion clean up. Limestone is added to the furnace, with the lime reacting with the SO₂ to form sulfates which become part of the ash.

Ash will be collected from the CPP boiler flue gas and boiler bottom as fly-ash and bottom-ash, respectively. The fly-ash will be collected in bag filters or in electrostatic precipitator hoppers, whilst the bottom-ash will be collected in water-filled hoppers. It is proposed that the fly ash and bottom ash be transported to the Central West Coal Project mine void for disposal. This method of disposal is currently under investigation, but disposal of fly ash and bottom ash to landfill is a common disposal method.

Greenhouse Gas Abatement

Coolimba is developing a greenhouse gas abatement strategy considering available technologies and options to reduce and offset the quantity of greenhouse gases released to the atmosphere. Those technologies include carbon capture and sequestration, and increased plant efficiency to reduce the volume of carbon dioxide released to the atmosphere. Options include environmental offsets and carbon trading.

Environmental Offsets

Coolimba's approach for the CPP is to endeavour to firstly either prevent or minimise environmental impacts through project design or environmental management. In accordance with the EPA's Guidance Statement No. 19 Environmental Offsets (EPA, 2007), Coolimba will consider environmental offsets to counterbalance an adverse environmental impact, to achieve 'no net environmental loss' or aspirationally a 'net environmental benefit' when all other project design and management measures have been implemented and/or exhausted.

Environmental offsets will be considered within the greenhouse gas abatement strategy to offset the quantity of greenhouse gases released to the atmosphere. Broad categories for offsets to be considered for the CPP include bio-sequestration, energy efficiency, renewable energy, greenhouse gas avoidance, capture and destruction projects.

5 CONCLUSION

One of Coolimba's key project objectives is to deliver a power station that is ready to be converted to use carbon capture technologies when future carbon trading schemes provide an appropriate trigger. This project objective is one of the key concepts driving the selection of plant design and technologies.

The CPP has been presented as a case study to maximise sustainability considerations of a coal-fired power station through the following factors integrated into the project design:

- Carbon capture and sequestration.
- Energy efficiency.
- Efficiency in water utilisation.
- Minimising sulphur dioxide and other emissions.
- Development of a greenhouse gas abatement strategy.
- The possible need for environmental offsets.

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7 REFERENCES

- Beard, J.S. (1990) *Plant Life of Western Australia*. Kangaroo Press Pty Ltd. Kenthurst, NSW.
- Bureau of Meteorology (2007) <http://www.bom.gov.au/> Accessed 5 November 2007.
- Department of Industry and Resources (2000) *Mid West Regional Minerals Study*. Perth, Western Australia. June 2000.

- Department of Industry and Resources (2004) *Energy for Minerals Development in the South West Coast Region of Western Australia*. Study report prepared by Sleeman Consulting and GBRM. December 2004.
- Environmental Protection Authority (2004a) *Towards Sustainability*. Position Statement No. 6. Environmental Protection Authority, Perth, Western Australia. August 2004.
- Environmental Protection Authority (2004b) *Principles of Environmental Protection*. Position Statement No. 7. Environmental Protection Authority, Perth, Western Australia. August 2004.
- Environmental Protection Authority (2007) *Guidance for the Assessment of Environmental Factors. Environmental Offsets*. Draft Guidance Statement No. 19. June 2007.
- Government of Western Australia (2003) *Hope for the Future: The Western Australian State Sustainability Strategy*. Department of the Premier and Cabinet, Perth, Western Australia.
- Hopkins, A.J.M. and Hnatiuk, R.J. (1981) *An Ecological Survey of the Kwongan South of Eneabba, Western Australia*. Wildlife Research Bulletin Number 9. Western Australian Wildlife Research Centre, Department of Fisheries and Wildlife, Perth, Western Australia.