Greenhouse Gas Abatement Programme
Bluewaters Project

April 2008

Griffin Power Pty Ltd and Griffin Power 2 Pty Ltd

GREENHOUSE GAS ABATEMENT PROGRAMME BLUEWATERS PROJECT

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1. Introduction

This document presents the Greenhouse Gas Abatement Programme to support the operation of Griffin Power Pty Ltd’s and Griffin Power 2 Pty Ltd’s (Griffin’s) Bluewaters Project, presently comprising two 208 MW (nett) coal-fired units (Phase I and II) at the northern end of the Coolangatta Industrial Estate immediately adjacent to the Griffin Coal Mining Company.

2. Background

2.1 Project Overview

Griffin Power Pty Ltd and Griffin Power 2 Pty Ltd (Griffin) are constructing and intend to operate two 208 MW (nett) phases of the Bluewaters coal-fired power station (Bluewaters Phase I and Phase II).

The Bluewaters Project is located at the northern end of the Coolangatta Industrial Estate immediately adjacent to the Griffin Coal Mining Company (Griffin Coal) Ewington I mine development and approximately 4 km north-east of Collie (Figure 1).

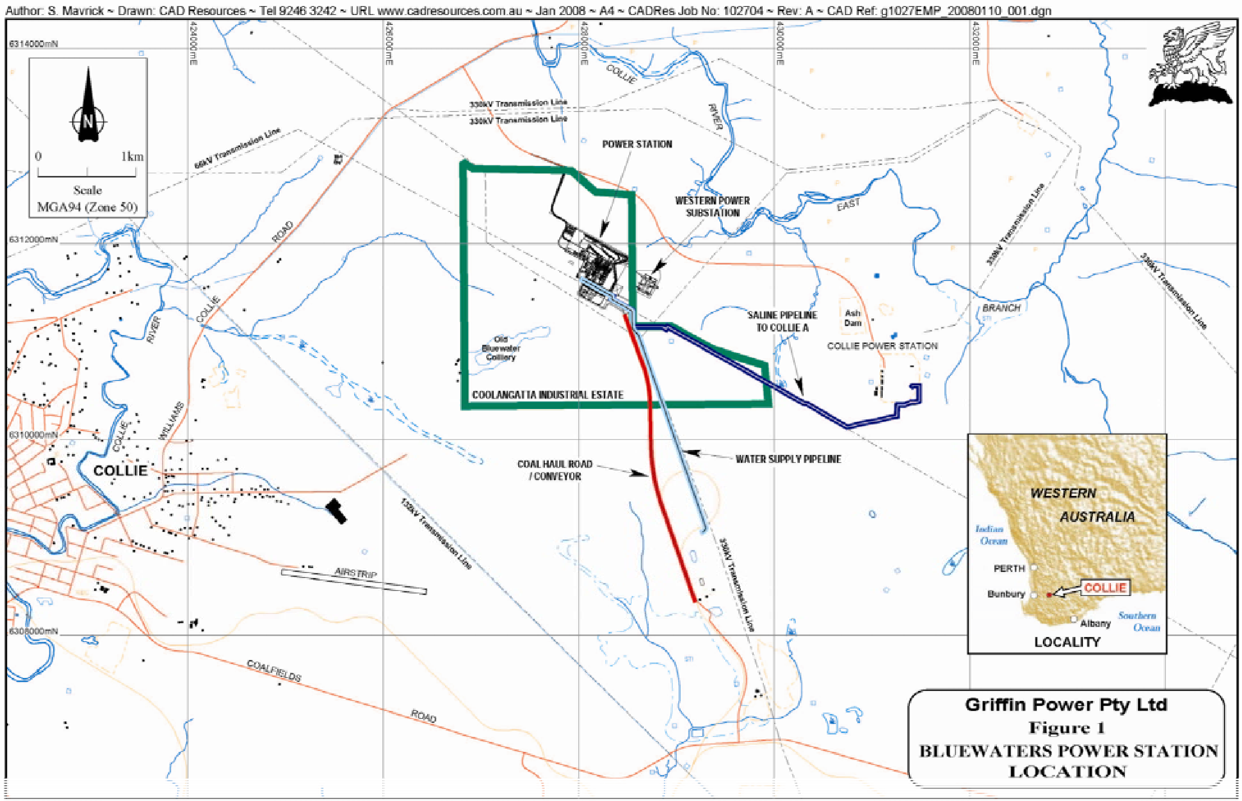


Figure 1: Bluewaters Project Location

The Bluewaters Project will provide electricity to the South West Interconnected System (SWIS) grid and/or will supply electricity direct to private customers.

The Bluewaters Project is a sub-critical coal fired power station that will operate 24 hours per day, 365 days per year. The primary source of fuel for the Bluewaters Project will be coal from Griffin Coal's Ewington I and II mines. The amount of coal input per year will vary from year to year, based on:

- The availability of the plant (see Section 3.2.1.4); and
- The calorific (energy value) of the coal being supplied to the power station.

It is estimated that the operation of each 208 MW unit requires the input of on average approximately 850,000 tonnes of coal making the total coal supply requirement for both units 1.7 million tonnes on average per annum. This coal input has been based on a plant availability of 92% which is believed to be the likely average annual availability of the plant over its life. However in any specific year, the plant could require a coal input of more or less than this, depending on the variables above. As such whilst the average greenhouse emissions per year have been calculated based on an average availability of 92%, it is possible that during any given year the availability may increase or decrease and therefore the greenhouse emissions for that year will be greater or less than the average annual emissions that have been calculated. However over the 30 year life of the plant the total emissions are expected to be consistent with an average availability factor of 92%. This is further explained in Section 3.2.1.4.

The Bluewaters Project was subject to a formal level of assessment, set at a Public Environmental Review (PER) under Part IV of the Environmental Protection Act 1986. The Bluewaters I PER was released for public review in May 2004 (Griffin 2004), with Ministerial approval granted in August 2005 (Statement 685) (Minister for the Environment 2005).

The Bluewaters II PER was released for public review in January 2005 (Griffin 2005), with Ministerial approval granted in May 2006 (Statement 724) (Minister for the Environment 2006).

2.2 Objectives of Greenhouse Gas Abatement Programme

This Greenhouse Gas Abatement Programme (GHGAP) has been prepared to fulfil Condition 6-2 of Ministerial Statements 685 and 724 that relate to the Bluewaters Project, which requires Griffin to prepare a Greenhouse Gas Abatement Programme (GHGAP) to the requirements of the Minister for the Environment on the advice of the Environmental Protection Authority within six months of the commencement of construction, and to implement that plan.

The GHGAP must:

- *Ensure that the plant is operated in a manner which achieves reductions in GHG emissions as far as practicable;*
- *Provide for ongoing GHG emissions reductions over time;*
- *Ensure that through the use of best practice (as defined in the EPA guidance statement No. 55), the total net GHG emissions per unit of product from the projects are minimised; and*
- *Manage GHG emissions in accordance with the Framework Convention on Climate Change 1992, and consistent with the National Greenhouse Strategy.*

2.3 Scope of Greenhouse Gas Abatement Programme

The scope of the GHG Management Abatement Program is reflected in Condition 6-2 of Ministerial Statements 685 and 724, which require the GHGAP to include:

1. *Calculation of the GHG emissions associated with the Bluewaters Project, as advised by the EPA according to the requirements of the Minimizing Greenhouse Gas Emissions, Guidance for the Assessment of Environmental Factors, No.12 guidance statement published by the EPA;*
2. *Specific measures to minimise the total net GHG emissions and the GHG emission per unit of product associated with the proposal using a combination of "no regrets" and "beyond no regrets" measures;*
3. *The implementation and ongoing review of GHG offset strategies with such offsets to remain in place for the life of the proposal;*

4. *Estimation of the GHG efficiency of the project (per unit of product and or other agreed performance indicators) and comparison with the efficiencies of other comparable projects producing a similar product both within Australia and overseas;*

5. *Implementation of thermal efficiency design and operating goals consistent with the Australian Greenhouse Office Technical Efficiency guidelines in design and operational management;*

6. *Actions for the monitoring, regular auditing and annual reporting of GHG emissions and emission reduction strategies;*

7. *Defining a target set by the proponent for the progressive reduction of total GHG emissions and /or GHG emissions per unit of product and as a percentage of total emissions over time, and annual reporting of progress made in achieving this target. Consideration should be given to the use of renewable energy sources such as solar, wind or hydro power;*

8. *A program to achieve reductions in GHG emissions, consistent with target referred to in (7) above;*

    - *Entry, whether on a project specific basis, company wide arrangement or within an industrial grouping, as appropriate, into the Commonwealth Government's Greenhouse Challenge Plus, voluntary co-operative agreement program. .*

9. *Review of practices and available technology;*

10. *Continuous improvement approach so that advances in technology and potential operational improvements of plant performance are adopted where practicable; and*

11. *Research relating to options for geo-sequestration of carbon dioxide emissions.*

2.4 Project Status

Construction of the Bluewaters Phase I plant commenced in November 2006. Construction of the Bluewaters Phase II plant commenced in October 2007**.**

3. GHG Emissions Inventory

3.1 Background

The Greenhouse Gas Emission Inventory for the Bluewaters Project was estimated using relevant factors and methodologies based on the expected operations for each year of the life of the project.

As described in EPA Guidance Statement for Minimising Greenhouse Gas Emissions (No. 12 October 2002), this Greenhouse Gas Abatement Programme contains:

- An estimate of the gross emissions of greenhouse gases that are likely to be emitted from the proposed project for each year of its operation in absolute and in carbon dioxide equivalent figures (CO_2-e), calculated in accordance with the National Greenhouse Gas Inventory Committee (NGGI) and its proxy the Australian Greenhouse Office (AGO) Factors and Methods Workbook, for the full life cycle emissions associated with this project. In accordance with the NGGI and AGO Factors and Methods Workbook full life-cycle emissions for the project are characterised as Scope 1: Direct Combustion Emissions and Scope 3: Indirect Emissions associated with the mining and transport of power station fuel.

- An estimate of the greenhouse gas efficiency of the proposed project calculated in accordance with the NGGI/AGO.

- A comparison of the estimated greenhouse gas emissions and greenhouse gas efficiency of the Bluewaters project with similar technologies producing similar products.

- A comparison of the estimated greenhouse gas emissions and greenhouse gas efficiency of the Bluewaters project in the context of improvement in industry practice since 1990.

  [Any estimate (unless not relevant) for any gross removals of GHG due to carbon sequestration activities? as per 3.3(a) of Guidance Statement No. 12?]

3.2 Project Lifecycle Greenhouse Gas Emissions Inventory

3.2.1 Direct Emissions (Scope 1)

3.2.1.1 Gross Emissions

The principal greenhouse gases likely to be emitted during the operation of the Bluewaters Project are Carbon Dioxide (CO_2), Methane (CH4) and Nitrous oxide (N_2O).

It is estimated Bluewaters I and II will each emit approximately 1.54 Mt of CO_2, 15 t of CH_4, and 13 t of N_2O per year during their operational life without any additional mitigation measures, based on emission factors provided by the NGGI (2006) and as presented in Table 1.

Based on the NGGI greenhouse gas accounting methodology the quantity of emissions of greenhouse gases other than CO_2 are not statistically or materially relevant in the case of the Bluewaters project, because they represent a very small proportion of the overall greenhouse emissions from the project.

Table 1: Summary of Average Annual Emissions from Bluewaters Power Station (Per Stage) Including All Greenhouse Gases

Bluewaters Power Station (Per Stage)/annum [1]	
Bluewaters Power Station Capacity (MW)	208
Availability (%)	0.92
Production (MWh)	1,676,314
Average Efficiency of Power Station	36.40%
Power Station Fuel Input (GJ)	16,578,926
CO_2 Emissions Factor (kg CO2/GJ)	92.8
CH_4 Emissions Factor (Mg CH4/PJ)	0.9
N_2O Emissions Factor (Mg N2O/PJ)	0.8
CO_2 Emissions (t CO2)	**1,539,073**
CH_4 Emissions (t CH4)	**15**
N_2O Emissions (t N2O)	**13**
Total CO_2 Equivalents (t)	**1.54**

Notes

1) Emission factors sourced from NGGI Australian Methodology for the Estimation of Greenhouse Gas Emissions and Sinks 2005: Energy (Stationary sources) (2006).

3.2.1.2 CO_2 Equivalent Emissions

The equivalent CO_2 emissions (CO_2-e) are an appropriate measure of the total greenhouse gas emissions from direct combustion at the Bluewaters project. These equivalent emissions include the individual contributions of each absolute greenhouse gas recognised by the NGGI.

It is estimated Bluewaters I and II will each emit approximately 1.54 Mt of CO_2-e per annum during their operational life without any additional mitigation measures, based on emission factors provided by the AGO Methods and Factors Workbook[1] and the NGGI (refer to Table 1).

3.2.1.3 Commissioning Considerations

As per the Project Status, Bluewaters I is under construction and is expected to commence commissioning in August 2008, being fully operational by 1 December, 2008. If commissioning runs very smoothly, it is possible that Bluewaters I will operate at normal capacity between August and December 2008. Although it is possible that Bluewaters I may operate for less time in 2008, the above assumption has been used to ensure conservative greenhouse emissions estimates are provided. Bluewaters I will be fully operational between 2009 and 2038.

[1] 2006

Bluewaters II has commenced construction and is expected to commence commissioning in May 2009, being fully operational by 1 October, 2009. If commissioning runs very smoothly, it is possible that Bluewaters II will operate at normal capacity between May and December 2009. Again, although it is possible that Bluewaters II may operate for less time, the above assumption has been used to ensure conservative greenhouse emissions estimates are provided. Bluewaters II will be fully operational between 2010 and 2038.

3.2.1.4 Availability

The “availability” of a power station unit refers to the actual amount of time the power plant is available to produce electricity (taking into account predicted outages) and is measured as a percentage.

The availability used in calculating greenhouse emissions for the Bluewaters power station has been set at 92% per annum. This is intended as an average availability over the 30 year life of the plant and has been calculated based on the planned maintenance cycle for the plant and the predicted forced outage rate. However it is possible that during any given year the plant may operate at a availability of 100% with no planned or forced outages, and conversely in years of higher planned and forced outages may be less than 92%. As such whilst the average greenhouse emissions per year have been calculated based on an average availability of 92%, it is possible that during any given year the availability may increase or decrease and therefore the greenhouse emissions for that year will be greater or less than the average annual emissions that have been calculated. However over the 30 year life of the plant the total emissions are expected to be consistent with an average availability factor of 92%.

3.2.1.5 Direct Emissions Calculations

The estimated total direct emissions per annum for the life of Bluewaters I and Bluewaters II are presented in Tables 2, 3 and 4.

Table 2: Summary of Direct GHG Emissions from Bluewaters I Unit on Average During Each Year over 30 Years

Bluewaters I Unit Direct Average GHG Emissions Each Year[1]			
	2008	**2009**	**2010 - 2038**
Bluewaters I Power Station Capacity (MW)	208	208	208
Availability (%)	92	92	92
Production (MWh)	558,771	1,676,314	1,676,314
Average Efficiency of Power Station	36.4%	36.4%	36.4%
Power Station Fuel Input (GJ)	5,526,309	16,578,926	16,578,926
Equivalent Volume of Coal (T)	280,523	841,570	841,570
Scope 1 GHG Emissions Factor (kg CO2-e/GJ)	93.1	93.1	93.1
Direct GHG Emissions (t CO2-e)	514,499	1,543,498	1,543,498

Notes

1) Emission factors sourced from 0(a) AGO Factors and Methods Workbook (2006) Full Fuel Cycle Emission Factor (Kg CO2 -e/GJ) (b) AGO Factors and Methods Workbook (2006) Coal Combustion Emission Factor (Kg CO2 -e/GJ) and (c) AGO Factors and Methods Workbook (2006) Indirect Emission Factor.

Table 3: Summary of Direct GHG Emissions from Bluewaters II Unit on Average During Each Year over 30 Years

Bluewaters II Unit Direct Average GHG Emissions Each Year[1]			
	2008	**2009**	**2010 - 2038**
Bluewaters II Power Station Capacity (MW)	0	208	208
Availability (%)	0	92	92
Production (MWh)	0	838,157	1,676,314
Average Efficiency of Power Station	0	36.4%	36.4%
Power Station Fuel Input (GJ)	0	8,289,463	16,578,926
Equivalent Volume of Coal (T)	0	420,785	841,570
Scope 1 GHG Emissions Factor (kg CO2-e/GJ)	0	93.1	93.1
Direct GHG Emissions (t CO2-e)	0	771,749	1,543,498

Notes

1) Emission factors sourced from (a) AGO Factors and Methods Workbook (2006) Full Fuel Cycle Emission Factor (Kg CO2 -e/GJ) (b) AGO Factors and Methods Workbook (2006) Coal Combustion Emission Factor (Kg CO2 -e/GJ) and (c) AGO Factors and Methods Workbook (2006) Indirect Emission Factor.

Table 4: Summary of Direct Cumulative GHG Emissions from Bluewaters I and II Units on Average During Each Year over 30 Years

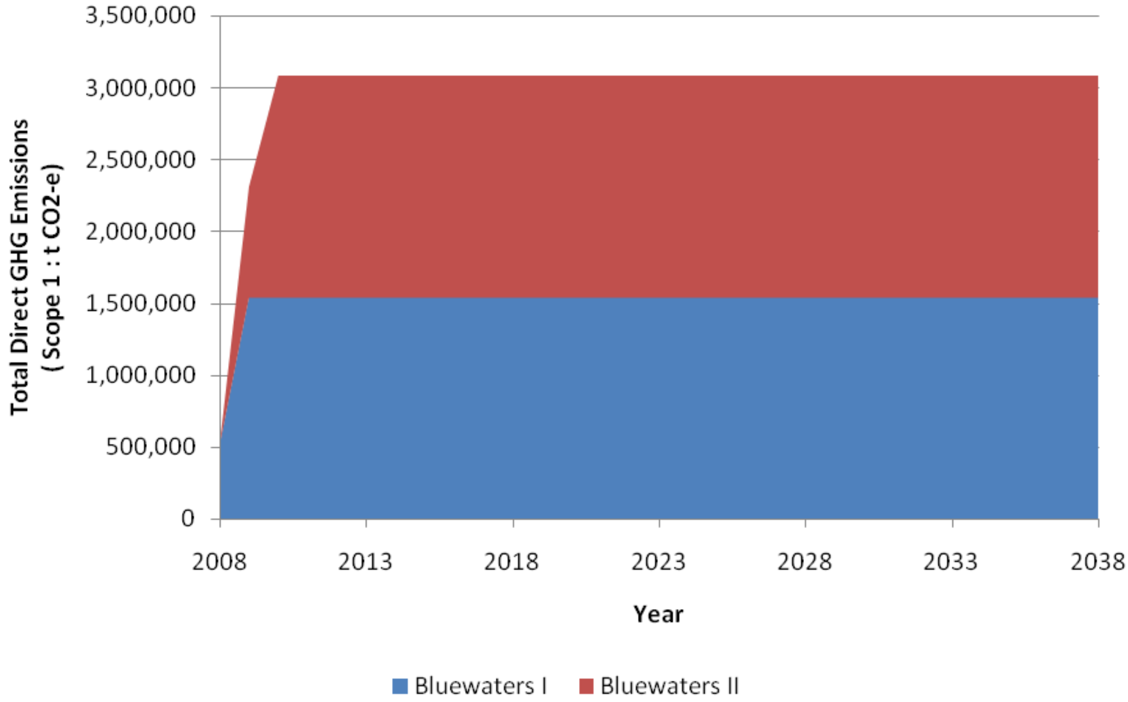
Bluewaters I and II Units Direct Average GHG Emissions Each Year[1]			
	2008	**2009**	**2010 - 2038**
Bluewaters I and II Power Stations Capacity (MW)	208	416	416
Production (MWh)	558,771	2,514,470	3,352,627
Power Stations Fuel Input (GJ)	5,526,309	24,868,389	33,157,851
Equivalent Volume of Coal (T)	280,523	1,262,355	1,683,140
Total Direct GHG Emissions (t CO2-e)	514,499	2,315,247	3,086,996

Notes

1) Emission factors sourced from (a) AGO Factors and Methods Workbook (2006) Full Fuel Cycle Emission Factor (Kg CO2 -e/GJ) (b) AGO Factors and Methods Workbook (2006) Coal Combustion Emission Factor (Kg CO2 -e/GJ) and (c) AGO Factors and Methods Workbook (2006) Indirect Emission Factor.

The total direct GHG emissions from Bluewaters I and II over each year of plant operation for 30 years are shown in Figure 2.

Figure 2 : Total Direct GHG Emissions Bluewaters I and II



3.2.2 Indirect Emissions (Scope 3)

In accordance with EPA Guidance Statement No. 12 full lifecycle emissions for the Bluewaters project have been estimated. In the context of this project, these lifecycle emissions are characterised by Scope 3: Indirect Emissions associated with the extraction and transport of power station fuel, which are additional to the Scope 1 Direct emissions provided above. Lifecycle emissions are embodied in the full fuel cycle emission factor derived from the AGO Factors and Methods workbook.

Bluewaters I and II will each be indirectly responsible for the Scope 3 emissions of approximately 18 kt of CO_2-e per year during their operational life without any additional mitigation measures, based on emission factors provided by the Australian Greenhouse Office (December 2006) and as presented in Table 5.

Table 5: Summary of Scope 3 Average Annual Emissions from Bluewaters Power Station (Per Stage)

Bluewaters Power Station (Per Stage)/annum[1]	
Bluewaters Power Station Capacity (MW)	208
Availability (%)	92
Production (MWh)	1,676,314
Average Efficiency of Power Station	36.40%
Power Station Fuel Input (GJ)	16,578,926
Equivalent Volume of Coal (T)	841,570
Indirect GHG Emissions – extraction and transport of coal (t CO2-e)	18,237

Notes

1) Emission factors sourced from (a) AGO Factors and Methods Workbook (2006) Full Fuel Cycle Emission Factor (Kg CO2 -e/GJ) (b) AGO Factors and Methods Workbook (2006) Coal Combustion Emission Factor (Kg CO2 -e/GJ) and (c) AGO Factors and Methods Workbook (2006) Indirect Emission Factor.

Based on the commissioning and operating schedule outlined in the Project Status, Bluewaters I will operate for 1 month of normal full operation in (Dec 2008) and 1 equivalent full operation month during commissioning (Aug – Nov 2008) during 2008 and will be fully operational between 2009 and 2038. Bluewaters II will operate for 2 months of normal full operation (Nov and Dec 2009) and 1 equivalent full operation month during commissioning (July – Oct 2009) in 2009 and be fully operational between 2010 and 2038.

The total indirect emissions per annum for the life of Bluewaters I and Bluewaters II are presented in Tables 6, 7 and 8 below.

Table 6: Summary of Average Annual Scope 3 GHG Emissions from Bluewaters I Unit During Each Year of Life over 30 Years

Bluewaters I Unit Indirect Average Emissions Each Year[1]			
	2008	**2009**	**2010 - 2038**
Bluewaters I Power Station Capacity (MW)	208	208	208
Availability (%)	92	92	92
Production (MWh)	558,771	1,676,314	1,676,314
Average Efficiency of Power Station	36.4%	36.4%	36.4%
Power Station Fuel Input (GJ)	5,526,309	16,578,926	16,578,926
Equivalent Volume of Coal (T)	280,523	841,570	841,570
Scope 3 GHG Emissions Factor (kg CO2-e/GJ)	1.1	1.1	1.1
Indirect GHG Emissions (t CO2-e)	6,079	18,237	18,237

Notes

1) Emission factors sourced from (a) AGO Factors and Methods Workbook (2006) Full Fuel Cycle Emission Factor (Kg CO2 -e/GJ) (b) AGO Factors and Methods Workbook (2006) Coal Combustion Emission Factor (Kg CO2 -e/GJ) and (c) AGO Factors and Methods Workbook (2006) Indirect Emission Factor.

Table 7: Summary of Average Annual Scope 3 GHG Emissions from Bluewaters II Unit During Each Year of Life over 30 Years

Bluewaters II Unit Indirect Average Emissions Each Year[1]			
	2008	**2009**	**2010 – 2038**
Bluewaters II Power Station Capacity (MW)	0	208	208
Availability (%)	0	92	92
Production (MWh)	0	838,157	1,676,314
Average Efficiency of Power Station	0	36.4%	36.4%
Power Station Fuel Input (GJ)	0	8,289,463	16,578,926
Equivalent Volume of Coal (T)	0	420,785	841,570
Scope 3 GHG Emissions Factor (kg CO2-e/GJ)	0	1.1	1.1
Indirect GHG Emissions (t CO2-e)	0	9,118	18,237

Notes

1) Emission factors sourced from (a) AGO Factors and Methods Workbook (2006) Full Fuel Cycle Emission Factor (Kg CO2 -e/GJ) (b) AGO Factors and Methods Workbook (2006) Coal Combustion Emission Factor (Kg CO2 -e/GJ) and (c) AGO Factors and Methods Workbook (2006) Indirect Emission Factor.

Table 8: Summary of Average Annual Scope 3 Cumulative GHG Emissions from Bluewaters I and II Units During Each Year of Life over 30 Years

Bluewaters I and II Units Average Indirect Emissions Each Year[1]			
	2008	**2009**	**2010 – 2038**
Bluewaters I and II Power Stations Capacity (MW)	208	416	416
Production (MWh)	558,771	2,514,470	3,352,627
Power Stations Fuel Input (GJ)	5,526,309	24,868,389	33,157,851
Equivalent Volume of Coal (T)	280,523	1,262,355	1,683,140
Total Indirect GHG Emissions (t CO2-e)	6,079	27,355	36,474

Notes

1) Emission factors sourced from (a) AGO Factors and Methods Workbook (2006) Full Fuel Cycle Emission Factor (Kg CO2 -e/GJ) (b) AGO Factors and Methods Workbook (2006) Coal Combustion Emission Factor (Kg CO2 -e/GJ) and (c) AGO Factors and Methods Workbook (2006) Indirect Emission Factor.

The total indirect GHG emissions from Bluewaters I and II over each year of plant operation for 30 years are shown in Figure 3.

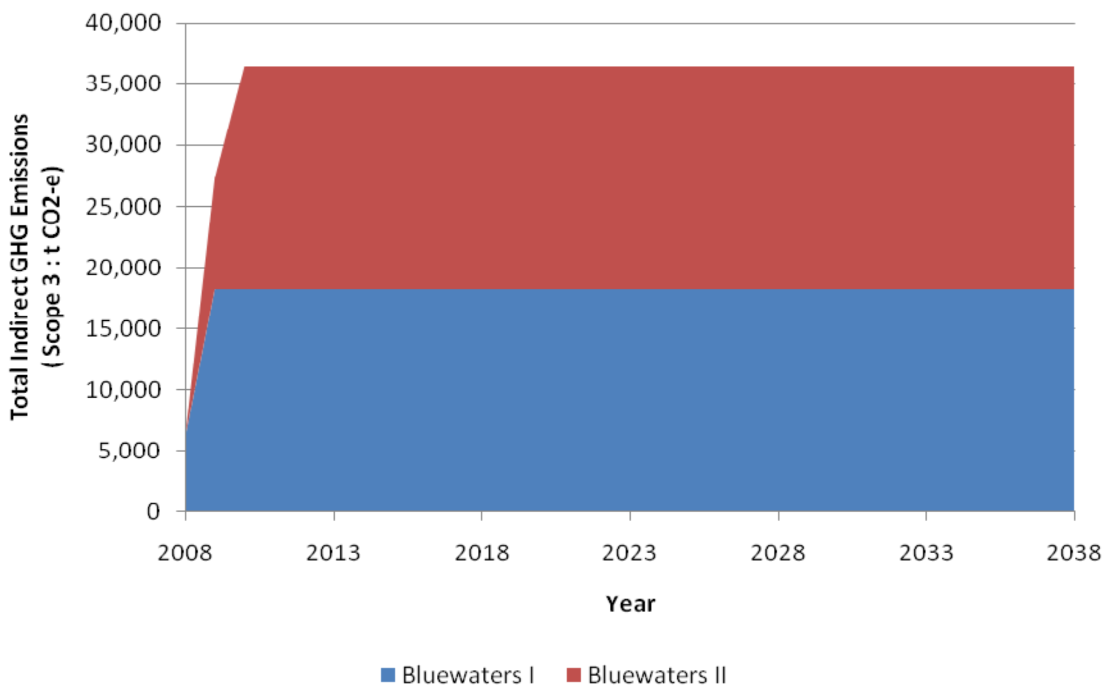


Figure 3: Summary of Total Indirect GHG Emissions Each Year from Bluewaters I and II

3.2.3 Total Equivalent Lifecycle Emissions

The total equivalent lifecycle emissions for the Bluewaters project are estimated to be approximately 3.12 Mt of CO_2-e per year during the operational life without any additional mitigation measures, based on emission factors provided by the Australian Greenhouse Office (December 2006) and as presented in Table 9.

Table 9: Summary of Total Direct and Indirect Average GHG Emissions from Bluewaters I and II Units During Each Year over 30 Years

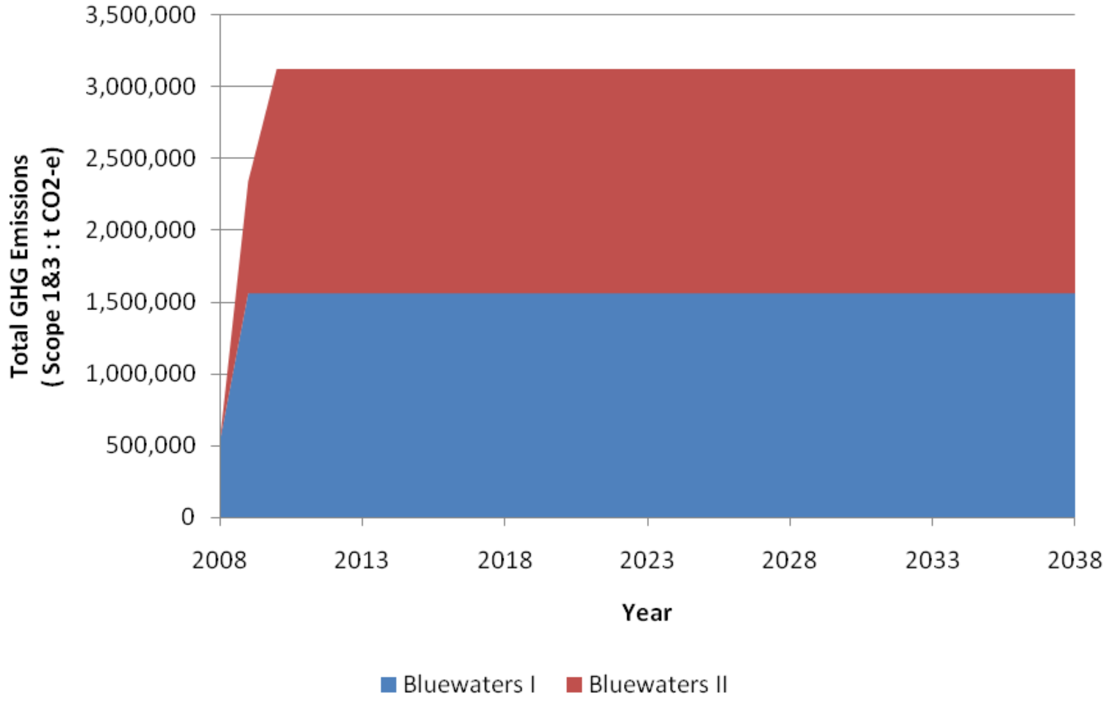
Bluewaters I and II Units Total Direct and Indirect Average GHG Emissions Each Year [1]			
	2008	**2009**	**2010 – 2038**
Bluewaters I and II Power Stations Capacity (MW)	208	416	416
Production (MWh)	558,771	2,514,470	3,352,627
Power Stations Fuel Input (GJ)	5,526,309	24,868,389	33,157,851
Scope 1 Direct Emissions (t CO_2-e)	514,499	2,315,247	3,086,996
Scope 3 Indirect Emissions (t CO_2-e)	6,079	27,355	36,474
Total CO_2 Equivalent GHG Emissions (t CO_2-e)	520,578	2,342,602	3,123,470

Notes

1) Emission factors sourced from (a) AGO Factors and Methods Workbook (2006) Full Fuel Cycle Emission Factor (Kg CO2 -e/GJ) (b) AGO Factors and Methods Workbook (2006) Coal Combustion Emission Factor (Kg CO2 -e/GJ) and (c) AGO Factors and Methods Workbook (2006) Indirect Emission Factor.

The total indirect and direct GHG emissions from Bluewaters I and II over each year of plant operation for 30 years are shown in Figure 4.

Figure 4: Summary of Total Equivalent GHG Emissions Each Year from Bluewaters I and II



3.3 Greenhouse Gas Intensity of Project

In the context of the Bluewaters project the greenhouse gas intensity of the project is calculated as the direct equivalent greenhouse gas emissions (1,543,498 t CO_2-e) divided by the sent out electricity (1,676,314 MWh). The carbon intensity of power generated by Bluewaters I and Bluewaters II has been calculated at 921 kg CO_2-e/MWh sent out.

3.4 Comparison with Similar Technologies

The intensity figure allows comparison with other large scale energy producers from within the same region to determine relative efficiencies of other power plants.

Table 10 presents the carbon intensity ratios of other coal fired power generation facilities that form part of the SWIS. The carbon intensity ratio of the Bluewaters Project plant compares favourably with the other power stations from the same region.

Table 10: Comparison of Power Stations GHG Emission Intensity per MW/h Produced

Power Stations	Intensity Ratio (kg CO2/Mwh)	Greenhouse Emissions (t CO2e/annum)
SWIS	900[1]	11,979,000[1]
Muja A and B	1,205[2]	1,302,243[1]
Muja C and D	1,030[2]	5,319,332[1]
Collie A	950[2]	2,334,150[1]
Bluewaters I	920	1,305,798,
Bluewaters II	920	1,305,798

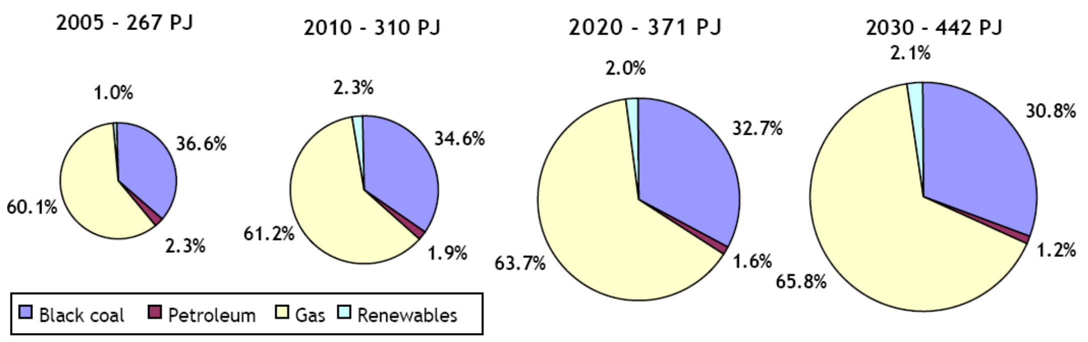
Notes

1. Western Power 2005 Annual Report
2. KM 2002, Collie Power Station Strategic Environmental Review

3.5 Statement of Continual Improvement of Industry

The West Australian electricity generation industry has demonstrated a continual improvement in overall greenhouse intensity which will be supported by the Bluewaters project.

ABARE modelling has shown that while black coal will gradually reduce its overall percentage contribution to WA electricity generation, it will increase in absolute terms between 2005 and 2030.



Source: Next Energy (2006) Supply side options for WA stationary energy: An assessment of alternative technologies and development support mechanisms, Final report to WA Greenhouse and Energy Taskforce 26 September 2006

Figure 5: ABARE scenario of electricity generation by fuel mix to 2030

Based on these electricity generation contribution forecasts ABARE predicts that the West Australian power industry will continue to improve its greenhouse emissions intensity.

Table 11: Comparison of Power Stations GHG Emission Intensity per MW/h Produced (predicted for 2010 onwards).

	2005	2010	2020	2030
WA Emissions Intensity (t CO_2/MWh)	0.71	0.66	0.61	0.56

Notes
Source: ABARE 2006 referenced in Next Energy (2006) Supply side options for WA stationary energy: An assessment of alternative technologies and development support mechanisms, Final report to WA Greenhouse and Energy Taskforce 26 September 2006

By being the most efficient subcritical black coal fired power station in Western Australia, Bluewaters will play a role in ensuring the continual improvement of the industry.

4. Measures to Minimise Total Net GHG Emissions

Griffin has considered and continues to consider a wide range of measures aimed at ensuring that GHG emissions generated from the project are as low as practicable, and will implement a combination of "no regrets" and "beyond no regrets" measures to minimise the total net greenhouse gas emissions from the Project. These measures include:

- The incorporation of the best practicable technology;
- Ongoing plant efficiency and performance management; and
- Adoption of corporate greenhouse reduction measures..

4.1 Adoption of Best Practicable Technology

4.1.1 Choice of Technology

Griffin's decision to build the Bluewaters coal fired power station was based on the proximity and reliability of a coal supply from Griffin Coal mining activities in the area.

The use of gas for the project is not considered to be currently viable as the foreseeable transport and reliability of gas was considered insufficient and the cost not commercially viable.

Reasons for selecting coal:

- Coal is cheaper than gas at the proposed location and the extraction of coal is already environmentally approved.
- Existing and approved mines can readily sup ply the coal requirement, with no additional developments required;
- Bluewaters will contribute to the sustainability of Collie as a population centre and economy within the SW
- Bluewaters will have the maximum possible security of fuel supply being close to the mouth of the primary mine and close to several other mines in the area;
- Use of state of the art sub-critical coal technology for Bluewaters results in lower air and greenhouse gas emissions when compared with older power stations in the area; and
- Bluewaters will contribute to the sustainability of Collie as a population centre and economy within the South West;
- A mix of coal and gas generation capacity is required to preserve a minimum level of supply security; and

Reasons for not selecting gas:

- There is currently no supply of gas in Collie. The provision of gas would require the installation of new infrastructure, which is not economically viable for Griffin;
- The existing Dampier to Bunbury Natural Gas pipeline is currently operating at maximum capacity and supply cannot be guaranteed in the short to medium term;
- The source of gas is distant and so supply is dependent on a single very long pipeline.
- The extension of a gas supply to Collie is not practicable for power generation, given that gas fired power stations are best located closer to the major uses of the electricity produced; and
- Gas is a high value product with a range of uses, including fertilizer manufacture and as a transport fuel. Use of gas for base load power generation is questionable.

During the design process for Bluewaters, Griffin considered a number of different clean coal combustion technologies.

Clean coal technology refers to the range of coal fired generation technologies that are current state of the art, or under development, and are strongly focused on reducing pollutant discharge and increasing plant efficiency in a cost effective manner. Improving plant efficiency has benefits on two fronts, by reducing specific fuel consumption, the cost of generation is reduced, and emissions per kWh are also reduced. Emission control technologies can be applied at all stages of the coal utilisation chain.

Table 12 shows clean coal technologies currently available, and the technology chosen for the Bluewaters project.

Table 12: Clean Coal Technologies

	Process	Clean Coal Technologies	Bluewaters Technology
Coal Fuel	Combustion	Sub Critical PF	X
		Super Critical PF	
		Ultra Super Critical PF	
		Fluidised Bed Combustion (FBC)	
		Integrated Gasification Combined Cycle (IGCC)	
Emission Control	Particulate Emission Control	Electrostatic precipitator (ESP)	
		Bag Filter	X
		Venturi Scrubber	
		Cyclones	
	SO_2 Emission Control	Flue gas desulphurisation (FGD) spray dry scrubbing	N/A*
		FGD – wet limestone/gypsum	N/A*
		FGD – other wet process	N/A*
		FGD - regenerative	N/A*
		Sea water	N/A*
		Sorbent injection	N/A*
		Combined SO_x/No_x removal	N/A*
	NO_x emission control	Selective catalytic reduction (SCR)	
		Selective non-catalytic reduction (SNCR)	
		Low NO_x burners	X
		Two Stage Combustion	X
		Over fire air	X
		Flue gas recirculation	

** No additional SO_2 emission control is currently proposed for Bluewaters.*

This document was approved as adequately meeting conditions 6.1 and 7.2 of Ministerial Statements 685 and 724 on 20 March 2006 and 27 September 2006 respectively. The thermal efficiency of a coal fired power plant is defined as the ratio of energy sent out to useful energy in, and may be expressed in terms of generated thermal efficiency or sent out thermal efficiency. The Australian Greenhouse Office Technical Efficiency Guidelines[2] outline the target values of sent out thermal efficiency for the combustion of black coal. This section states that the world best plant in 1999 had a thermal efficiency of 43.6% HHV and that after adjusting to typical Australian cooling water conditions, the best practice achievable under Australian conditions becomes 41.7% HHV and is based on a supercritical plant. Best practice thermal efficiency for a < 250 MW sub critical plant is considered to be 37.7% HHV and when adjusted for Collie coal is 37.1% HHV.

The Bluewaters Project is expected to achieve an average thermal efficiency of approximately 36.4% HHV and 38.6% LHV. This is considered to be consistent with best practice for a sub critical plant the size of Bluewaters Phase I and II.

Griffin recognises that supercritical PF coal technology does surpass sub-critical technology as the leading commercially viable technology for new coal fired plants. However for units under 350 MW the efficiency advantages of the supercritical cycle cannot be realised due to

[2] Australian Greenhouse Office (January 2001) Technical Guidelines: Generator Efficiency Standards, Version 1.2 Commonwealth of Australia.

the effects of scale. The minimum supercritical PF unit size currently commercially available and supported by manufacturers is 350 MW, and this does not match the requirements of the SWIS.

Coal based units, due to the high capital costs associated with construction, are ideally suited to a base load operation (i.e. availability in excess of 85%). Due to the small size of the SWIS in terms of overnight load, power station unit sizes of greater than or equal to 250 MW will generally be turned down overnight as the electricity system cannot cope with the loss of a major unit overnight. This has a significant impact on the economic viability of a power station and also the maximum size of the power station.

Manufacturers (eg: Mitsui, Siemens) of supercritical coal fired power stations (higher efficiency coal units) have advised Griffin that it is not economical to build units with supercritical technology at a unit size of less than 350 MW. Connecting a 400 MW power station unit to the SWIS that would be turned down to approximately 250 MW almost every night would significantly reduce its efficiency. At levels below 75% operating capacity, significant reductions in efficiency occur, with adverse consequences for fuel consumption and emissions per kwh.

Griffin has therefore selected the most advanced 200 MW coal fired unit that is ideally sized for the SWIS. This achieves a high operational efficiency (it is the most efficient for the size of conventional coal fired power station unit sizes and will be operated at maximal efficiency load all of the time). This, therefore, offers the best GHG intensity for generation requirements.

Griffin will keep abreast of ongoing technology improvements that may occur so that they can be implemented should they be commercially viable. Griffin will develop a plan and program to keep abreast of ongoing technology improvements, further GHG reduction measures and the means by which these improvements and measures will be evaluated and potentially implemented. In addition this plan will identify the processes Griffin will use to keep itself informed of best practice and evaluating this against its own operations.

4.2 Ongoing Plant Efficiency and Performance Management

As detailed above, Griffin has selected the most advanced 208 MW coal fired unit that is ideally sized for the SWIS which achieves a high operational efficiency (most efficient available technology for the size of conventional coal fired power station unit sizes) and therefore offers the best GHG intensity for generation requirements. The high efficiency of the units results in more energy produced by the unit per tonne of coal fired, and therefore less GHGs emitted to produce the energy required.

To ensure that the efficiency of the Bluewaters Project is maintained at optimal levels Griffin is currently developing an Operation and Maintenance Services Agreement with key performance indicators (KPIs) that the contractor will be obliged to meet. KPIs will be developed for the following;

- Plant Availability;

- Maintenance Effectiveness;
- Continuous Improvements;
- Plant Efficiencies; and
- Safety and Environmental Performance.

The boiler/turbine combination has already been optimised with feed water heaters. As part of plant commissioning, turbine gland leakage will be reduced. In addition to optimising standard operational practices, Griffin is also investigating opportunities to improve efficiency beyond the manufacturer's specifications. These include:

- Boiler tuning - improving combustion control to optimise the boiler mix of fuel to air to reduce waste and energy; and
- Low excess air operation to minimise the amount of hot air sent up the boiler chimney stack.

It is estimated that the maximum efficiency improvements to sub-critical coal fired power plants that could be realised through these measures is around 2.9%. This level of improvement is usually associated with older plant. Lower levels of improvement are anticipated for the Bluewaters project because new plant is being installed. Other opportunities are also being investigated by Griffin to reduce total greenhouse gas emissions:

- Washing coal can reduce its ash content by 4-5% and produce a more consistent quality. Besides stable boiler operation, this increases the life of components and improves the performance of electrostatic precipitators. This leads to overall stable plant operations, improved plant availability and improved thermal efficiency.
- Fly ash from coal-fired power stations can be utilised by other industries, replacing the need to mine or obtain raw materials from other sources. For example, a 10% reduction in overall coal-related greenhouse gas emissions could be obtained if more fly ash were used in the production of cement. Fly ash can also be used in road construction. Griffin is investigating potential markets for flyash which, if economically feasible, could be used to help reduce GHG production in these industries.

At this stage, it is not possible to quantify the reductions that will be achieved from the above initiatives.

Further GHG reduction measures may be investigated and implemented throughout the life of the Project and these will be reported annually. This will be potentially be done through the Greenhouse Challenge.

4.3 Adoption of Corporate Greenhouse Reduction Measures and Offsets

Griffin has considered and continues to consider a wide range of measures aimed at ensuring that GHG emissions generated from the project (and other projects within Griffin's portfolio) are reduced as far as practicable. These measures include.

1. A Corporate Greenhouse Gas Emissions Reduction Target for Griffin Energy of a 2.5% reduction in average GHG emissions per unit of energy produced by the Griffin Energy generation portfolio over the life of the Bluewaters projects Phase I and II. This target will include:

    a. A Renewable Energy Target, aimed at ensuring that Griffin Energy's total energy generation portfolio consists of at least 5% renewable generation sources.

    b. 265,000 t CO2-e sequestered via bio-sequestration.

2. Participation in national emissions trading scheme (ETS). This will include, subject to Scheme requirements, providing offsets to reduce GHG Emissions from the Bluewaters Project.

The reduction measures are described below.

4.3.1 Renewable Energy Target

Griffin Energy has a corporate target that its Energy Generation Portfolio consists of at least 5% renewable generation sources.

Griffin is currently the joint venture owner of an existing wind farm (described below) and is currently considering (and will continue to consider) additional renewable projects into the future.

Emu Downs Wind Farm

Griffin Energy is part of a joint venture with Stanwell Corporation which developed the 80 MW wind farm located at Emu Downs, 200 km north of Perth, (near Cervantes) on the mid west coast of Western Australia.

The project was formally approved by the joint venture in July 2005 and is now operational. Western Australia's state energy provider Synergy is the main purchaser of the electricity generated.

It is estimated that during its life the portion of the Emu Downs wind farm owned by Griffin will prevent the emissions of 2.2 million tonnes of Co2-e being generated by the SWIS (based on the assumption that the wind farm will replace generation from coal and gas fired power stations represented by the current average GHG emissions intensity of the SWIS[3]).

The wind farm is unlikely to be eligible to generate offsets under a future national ETS,[4] so therefore it has not been included as a direct offset for the Bluewaters Project in this Greenhouse Gas-Abatement Programme. However it is a positive step being taken by Griffin Energy towards reducing the overall GHG emissions and thus the average greenhouse gas intensity of energy generated by the Griffin portfolio.

Future Renewable Projects

Griffin is currently considering (and will continue to consider) additional renewable projects into the future to ensure its corporate renewable energy target is met.

4.3.2 Bio-sequestration

Griffin is committed to tree planting on agricultural properties and in mine rehabilitation areas.

Griffin owns numerous rural agricultural properties throughout Western Australia (through W R Carpenter Agriculture a related company). Currently Griffin has approximately 2,127 ha of tagasaste (*Chamaecytisus prolisser*) growing on three properties, estimated to hold 160,000 tonnes of CO_2. The accounting methodology used by Griffin and its consultants to estimate carbon storage in tagasaste is based on internal sampling studies. Griffin will continue to work on refining the methodology.

Whilst the tagastaste is a relatively short lived plant (approximately 15 – 20 years life) Griffin is prepared to ensure that an equivalent amount of tagastaste plantings is always in existence (via. an ongoing program of managing healthy tagasaste, including replanting of stands that have become moribund), ensuring that the carbon stock within the tagastaste plantings is always maintained at 160,000 tonnes of CO_2.

Griffin also has approximately 263 ha of native and exotic tree species growing on mine rehabilitation land that meets Kyoto eligibility criteria for carbon sequestration.

The rehabilitation plantings are expected to sequester 105,000 tonnes of CO_2 based on NCAS Full CAM 3.10[5], if the trees were allowed to mature to full size. Griffin is prepared to commit to retaining this stored CO_2 indefinitely.

The carbon sequestration expected via the above initiatives is illustrated in Table 13 below.

Table 13: Biosequestration Summary

[3] The estimate for total avoided emissions equals windfarm output multiplied by the full fuel cycle emissions factor for SWIS electricity consumed (0.936 kg CO2-e/kWh) as per the Commonwealth Factors and Methods Workbook (December 2006) over the period covered by the power purchase agreement. Note that this is an upper estimate based on the current emissions factor, which is most likely to reduce over time as the WA electricity intensity drops.

[4] For example, refer *Possible Design for a National Greenhouse Gas Emissions Trading Scheme - A Discussion Paper* prepared by the National Emissions Trading Taskforce, August 2006, Page 73.

[5] NCAS FullCAM 3.10 against the methodology as outlined in *"The contribution of mid to low rainfall forestry and agroforestry to greenhouse and natural resource management outcomes"*, (AGO 2003) combined with the work of John Bartle of CALM, Australia's lead authority on sequestration and the mallee tree.

Source	t CO2-e
Est. sequestration - Tagasate Plantations	160,000
Est. sequestration - Mine Rehabilitation	105,000
TOTAL sequestration	265,000

Griffin intends that the above 265,000 t of CO2-e sequestered by the above initiatives will be utilised as offsets to meet compliance obligations associated with the project under the national ETS to be implemented in 2010 (see section 4.2.3).

4.3.3 Emissions Trading Scheme and Offset Strategies

A national ETS is currently being developed in Australia and likely to be implemented by 2010. Griffin is supportive of an ETS with widest possible coverage for all emitters and sinks.

The Federal Government has stated that it will utilise the ETS to set emissions caps for total GHG emissions in Australia.

It is expected that there will be a firm emissions ‘cap’ which limits total GHG emissions from the power generation sector, and GHG emissions associated with power generation will need to be counter-balanced by the sourcing and surrender of eligible GHG emissions permits or offsets. These permits and offsets will have to be procured at the market price for carbon. Failure to do so will attract a potentially significant financial penalty per tonne of any shortfall.

Griffin will ensure strategies are in place to meet any offset requirements for the Bluewaters Power Station under the ETS and will undertake periodic reviews through the life of the project to review the above offset strategies and to identify opportunities to further reduce GHG emissions over time.

4.4 Investigations and Research

Griffin will keep up to date with practices and advances in technology to reduce GHG emissions. The following section outlines specific investigations and research which Griffin is currently part of or will undertake.

Some of the potential reduction options such as geosequestration are not currently feasible as they have yet to be developed to a commercial viability or they are still in the research phase. However as greater focus is placed on the issue of GHG emissions and climate change, it becomes increasingly likely that the utilisation of these technologies will become more commercially viable. Where practicable, Griffin will support other research and development projects through CCSD and coal 21.

4.4.1 Geosequestration

Geosequestration is the process of capture, transport, injection and storage of CO2 in underground formations for the primary purpose of mitigating greenhouse gas emissions. The applications for geosequestration extend to industries with point source emissions such as processing, electricity generation, petroleum and coal industries.

The Australian Government has been developing a national regulatory framework for geosequestration activities and the West Australian government has been actively involved in this process, while involving other State stakeholders (www.doir.wa.gov.au). Geosequestration is recognised as a favourable GHG abatement option in the West Australian Greenhouse Gas Strategy.

A potential geosequestration storage area for CO2 from the Bluewaters power stations is the Perth Basin which extends from the Murchison in the North to the south coast and out to sea. The significant offshore component of the Perth basin means the likelihood exists that a suitable geosequestration site may only be available offshore. It has been estimated that the minimum cost for the capture of flue gases from power stations is approximately $US20 per tonne rising to approximately $US70 per tonne depending on the extraction process. This equates to an annual operating cost in the range $US30 to $US105 million per year for a plant the size of the Bluewaters Project. When this is added to the cost of developing and delivering the gas to a suitable geosequestration location, it can be seen that currently the cost is prohibitive. Griffin will however continue to investigate and monitor the potential for geosequestration.

4.4.2 Investigation of Available Technologies

Griffin plans to keep abreast of technology advances which reduce greenhouse gas emissions by research and development projects, so that they can be implemented should they become commercially viable. Griffin will continue to contribute financial support to the Cooperative Research Centre (CRC) for Coal in Sustainable Development for further investigation into clean coal technologies and will be periodically updated as these technologies become more advanced. Investigations being undertaken by CRC include the following technologies.

Co-Firing Coal/Biomass

Coal biomass co-firing is a technology used by several Australian Power Stations to reduce emissions. Research seeks to optimise the implementation of coal biomass firing for industry purposes. A pilot scale plant has been established to study the combustion characteristics of coal and biomass blends.

Gasification

Research is being carried out to provide the necessary technical information to understand the development status of, and reduce the risks of the implementation of advanced high efficiency power generation technologies based on coal gasification.

Oxyfuel Combustion

Traditionally boilers use air for combustion, as a consequence the N2, from the air dilutes the CO2 concentration in the flue gas. This results in costly CO2 recovery using scrubbers. An alternative is to reduce the N2 concentration by using oxygen for firing instead of air. The research aims at understanding the science and technology of oxyfuel combustion with a focus on providing a sequestration ready CO2 product stream.

Pressurised Fluidised Bed Combustion

This technology utilises combined gas turbine and steam turbine cycles to increase the efficiency of electricity production from coal. Research is currently focused on coal performance and developing a combustion predictor for commercial scale plants.

4.5 Application of “Best Practice” Consistent with EPA Guidance Statement 55

EPA Guidance Statement 55 (2003) *“Implementing Best Practice in proposals submitted to the Environmental Impact Assessment process”* states:

“The EPA’s approach to the application of ‘best practice’ in the environmental impact assessment of new proposals or significant expansions of existing projects is:

1. *A proposal should not cause an exceedence of any recognised environmental protection standards (for instance National Environmental Protection Measures, hazard and risk guidelines, standards in Environmental Protection Policies etc.). For new sources or significant extensions to existing sources that come to the EPA for assessment, issues of cost will not be considered where pollution reduction or other environmental management measures are needed in order to comply with recognised environmental standards.*
2. *Where a proposal complies with environmental protection standards, best practicable measures for prevention or minimisation of adverse environmental impacts and encouragement of practices beneficial to the environment would be sought in line with the:*
   - *statutory requirement under the EP Act for the EPA to use its best endeavours to protect the environment and to prevent, control and abate pollution;*
   - *encouragement of eco-efficient practices and technologies;*
   - *encouragement of implementation of the waste hierarchy; and,*
   - *encouragement of continuous improvement in environmental performance.*
3. *With regard to discharges, the EPA makes a distinction between common pollutants (sometimes called criteria pollutants), such as sulphur dioxide and nitrous oxides, and hazardous pollutants, such as asbestos, dioxins, PCBs, beryllium, cadmium and mercury. The thrust of this Guidance Statement is that:*
   - a) *All relevant environmental quality standards must be met.*
   - b) *Common pollutants should be controlled by proponents adopting Best Practicable Measures (BPM) to protect the environment.*
   - c) *Hazardous pollutants (like dioxins) should be controlled to the Maximum Extent Achievable (MEA), which involves the most stringent measures available. For a small number of very hazardous and toxic pollutants, costs are not taken into account.*
   - d) *There is a responsibility for proponents not only to minimise adverse impacts, but also to consider improving the environment through rehabilitation and offsets where practicable. The EPA will always encourage proponents to achieve best practice. In general, a proposal which embraces best practice, meets appropriate standards and EPA objectives would be recommended for approval.”*

Guidance Statement 55 goes on to state:

“The achievement of best practice will be greatly facilitated if a proponent has an environmental management system in place, particularly if it is consistent with an international standard such as ISO 14001. Where appropriate, the proponent should demonstrate that an environmental management system is in place and includes the following elements:

- a) *An environmental policy and corporate commitment to it;*

b) Mechanisms and processes to ensure:

i. planning to meet environmental requirements;

ii. implementation and operation of actions to meet environmental requirements; and

iii. measurement and evaluation of environmental performance

c) Review and improvement of environmental outcomes."

Griffin will ensure that through the use of best practice (as defined in EPA Guidance Statement No.55), the total net greenhouse gas emissions and/or greenhouse gas emissions per unit of product from the project are minimised utilising the following strategies:

- Ensuring that Bluewaters I and II does not cause an exceedence of any recognised environmental protection standards for Greenhouse Gas Emissions in particular any commitments made under the Greenhouse Challenge Plus, National Greenhouse and Energy Reporting Act or future ETS (see Sections 4.3.3 and 5.3.1).

- Utilising best practicable measures for prevention or minimisation of adverse environmental impacts and practices beneficial to the environment including:

  - Development of this Greenhouse Gas Abatement Program in compliance with condition 6.2 of Ministerial Statements 685 and 724 issued under Part IV of the *Environmental Protection Act, 1986.*

  - Use of eco-efficient practices and technologies (see Sections 4.1, 4.2 and 4.3); and

  - Continuous improvement in environmental performance and ongoing consideration of methods to reduce Greenhouse Gas Emissions (see Sections 4.1, 4.2, 4.3 and 4.4).

- Ensuring the Bluewaters Phase I and II Plant has an Environmental Management System consistent with ISO 14001 in place and that it includes the following elements:

  a) An environmental policy and corporate commitment;

  b) Mechanisms and processes to ensure:

  i. planning to meet environmental requirements;

  ii. implementation and operation of actions to meet environmental requirements; and

  iii. measurement and evaluation of environmental performance

  c) review and improvement of environmental outcomes."

  This is consistent with Commitment 1 of Ministerial Statements 685 and 724 which requires Griffin to "Develop and implement an Environmental Management System for the proposal which meets AS/NZS ISO 14001:1996". Griffin has submitted evidence of compliance with this commitment to the DEC.GHG Emissions Monitoring, Auditing and Reporting Program

4.6 GHG Emissions Monitoring

Griffin will establish a GHG emissions monitoring program that will be used to monitor progress towards the achievement of targets nominated in this Greenhouse Gas Abatement Program. This plan will be in line with Griffin's requirements under:

- The Greenhouse Challenge Plus;
- National Greenhouse and Energy Reporting Act, 2007; and
- Any future national ETS legislation which may be enacted.

See Section 5.3 below.

4.7 Auditing

Griffin will develop an internal audit program and in addition will provide annual compliance reports to the DEC in accordance with the nominated conditions in the Ministerial Statement 685 and 724.

The proposed audit program will include the following:

- Annual internal audits for conformity with this plan to ensure compliance with all applicable legislation and all actions (i.e. proposed monitoring, management and mitigation measures) outlined in the plan. In addition the audits will assess the progress of proposed mitigation measures and or investigations (for GHG reduction); and
- Five yearly external audits to ensure that all the Plan's objectives and commitments are met.

4.8 Reporting

4.8.1 Commonwealth Reporting

Greenhouse Challenge Plus

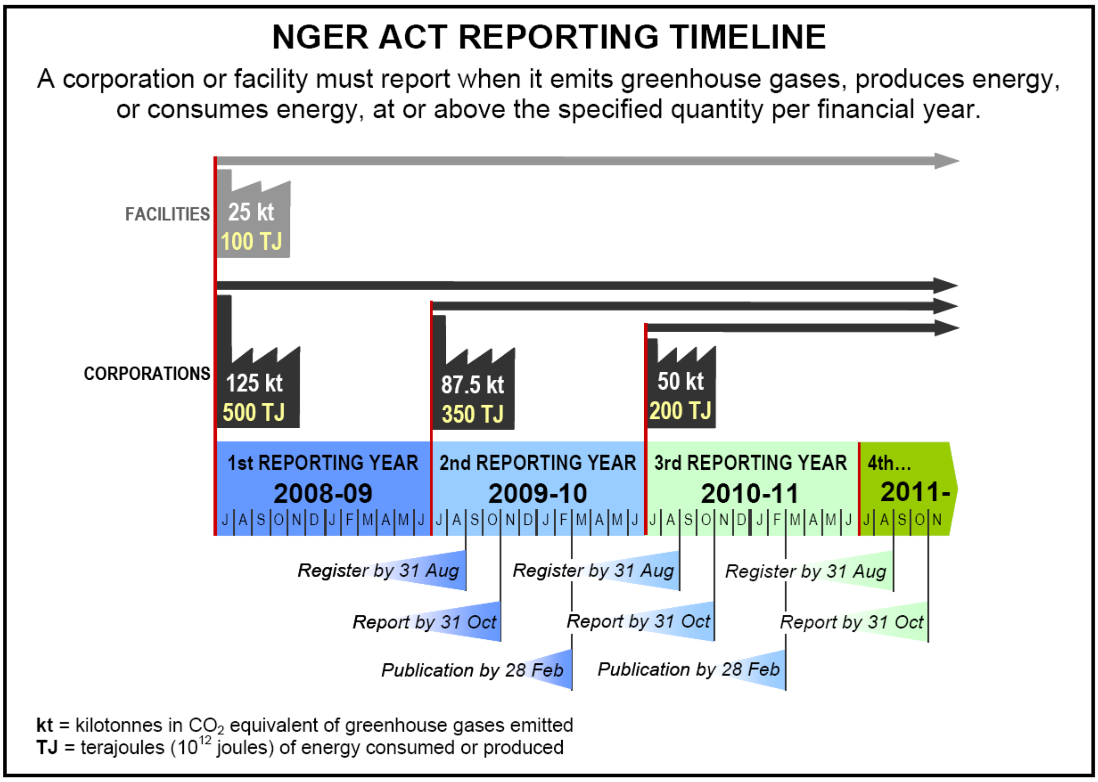
Griffin Power Pty Ltd and Griffin Power 2 Pty Ltd will join the Commonwealth Greenhouse Challenge Plus prior to the commencement of commercial operations. Membership is achieved by entering into a confidential written agreement with the Australian Government which includes:

- An inventory of all greenhouse gas emissions;
- An action plan that identifies abatement opportunities;

- Greenhouse Performance Indicators (GPI) to measure emission intensity;
- A commitment to report annually on progress against the above, including a Public Statement; and
- A commitment to participate in independent verification as required.

National Greenhouse and Energy Reporting Act

Griffin is required to report its Scope 1 and Scope 2 GHG emissions under the National Greenhouse and Energy Reporting Act 2007 (NGER Act), which establishes a national framework for Australian corporations to report greenhouse gas emissions, reductions, removals and offsets, and energy consumption and production, from 1 July 2008. The reporting timetable is illustrated in Figure 6 below.



Source: AGO

Figure 6: Timetable for Reporting under the NGER Act

4.8.2 State Reporting

A summary of monitoring and management measures undertaken as part of this plan will be provided to the DEC in the annual compliance report required by the nominated conditions in Ministerial Statements 685 and 724.

Additional details, modifications, actions, and notes of meetings conducted with government agencies relative to this EMP will be incorporated into or appended to this document.

4.8.3 Reporting Responsibility

Griffin will require the operator of Bluewaters I and II to report data and information to meet all statutory greenhouse reporting requirements including (but not limited to) the requirements listed above.

5. Consistency with UNFCCC and National Greenhouse Strategy

5.1 The United Nations Framework Convention on Climate Change

The United Nations Framework Convention on Climate Change (UNFCCC) sets an overall framework for intergovernmental efforts to tackle the challenge posed by climate change. It recognizes that the climate system is a shared resource for which stability can be affected by industrial and other emissions of carbon dioxide and other greenhouse gases. The Convention enjoys near universal membership, with 192 countries having ratified it.

Under the Convention, governments:

- Gather and share information on greenhouse gas emissions, national policies and best practices;
- Launch national strategies to address greenhouse gas emissions and adapt to expected impacts, including the provision of financial and technological support to developing countries;
- Cooperate in preparing for adaptation to the impacts of climate change.

Ratifying Governments are also required to report the progress and implementation of policies and measures to the Secretariat of the UNFCCC, and to provide an inventory of greenhouse gas emissions.

In 1992 Australia became a party to the UNFCCC and undertook a number of commitments in accordance with its provisions, including:

- Submitting a national inventory of emissions and removals of greenhouse gases;
- Implementing national programs to mitigate climate change and adapt to its impacts;
- Strengthening scientific and technical research and systematic observation related to the climate system, and promoting the development and diffusion of relevant technologies;
- Promoting education programs and public awareness about climate change and its likely effects; and
- Periodically submitting comprehensive National Communications (ie reports) on activities to implement commitments under the Convention.

Griffin will support Australia’s commitments under the UNFCCC by:

- Adopting best practicable measures in minimising and mitigating GHG emissions from the Bluewaters Project;
- Reporting its GHG emissions in a manner that it can be incorporated into the National Greenhouse Gas Inventory (NGGI) and Australia's National Communications;
- Complying with Commonwealth GHG emissions reduction policies and programmes enacted to meet UNFCCC commitments; and
- Supporting the development and commercialisation of low emissions electricity generation technologies as outlined in Section 5.

5.2 National Greenhouse Strategy

The National Greenhouse Strategy (NGS), formulated in 1998, provides the present strategic framework for advancing Australia's domestic greenhouse response. With the recent change of Commonwealth Government, it is very likely that this strategy will be revised in due course.

The new Government's comprehensive plan to tackle climate change is understood to include[6]:

- Immediately ratifying the Kyoto Protocol;
- Establishing a national ETS by 2010 to put a price on carbon and cut emissions;
- Committing $500 million to the development of clean coal and low emission technologies through the National Clean Coal Initiative;
- Encouraging the development of a strong vibrant Australian clean energy industry with a $15m Clean Energy Export Strategy and a $20m Clean Energy Innovation Centre, and an energy innovation fund to encourage development and deployment of technologies within Australia;
- Supporting the Clean Energy Plan by providing a Renewable Energy Fund to encourage renewable energy technology, and a Clean Business Fund to help business deliver energy efficiency coupled with productivity and innovation;
- Establishing a $50 million Australian Solar Institute and a $50 million geothermal initiative;
- Establishing a $500 million Green Car Challenge to help develop a cleaner Australian car fleet;
- Committing to a 20% by 2020 Renewable Energy Target by increasing the Mandatory Renewable Energy Target;
- Introducing practical measures to improve household energy efficiency including generous rebates for solar power and hot water systems, Green Loans for families to

[6] As per advice from the Department of Climate Change.

undertake practical water and energy savings measures, and rebates to encourage landlords to insulate rental properties ;

- Assisting schools and communities to take practical action by increasing funding for making all schools solar, boosting the Solar Cities program, establishing a one-stop Green Shop website for access to efficiency programs, and establishing a 10-star appliance rating system.

The NGS is directed toward the achievement of three overarching goals:

- Fostering knowledge and understanding of greenhouse issues;
- Limiting greenhouse gas emissions; and
- Laying the foundations for adaptation for climate change.

It provides a broad menu of actions some of which will be implemented by governments acting individually, some by joint intergovernmental initiatives and some through partnerships between government, various stakeholders and the community. All governments will participate in arrangements designed to facilitate implementation, monitoring and reporting of outcomes, as well as the review and ongoing development of Australia's NGS.

Measures under the NCS are grouped in the three main areas above.

Fostering knowledge and understanding of greenhouse issues

- Profiling Australia's greenhouse gas emissions.
- Understanding and c communicating climate change and its impacts.

Limiting greenhouse gas emissions

- Partnerships for greenhouse action: governments, industry and the community.
- Efficient and sustainable energy use and supply.
- Efficient transport and sustainable urban planning.
- Greenhouse sinks and sustainable land management.
- Greenhouse best practice in industrial processes and waste management.

Laying the foundations for adaptation for climate change

- Adaptation to climate change.

(Source: NGS 1998 – Department of Climate Change)

Griffin will support the NGS by:

- Reporting its GHG emissions in a manner that supports national greenhouse reporting imperatives;

- Complying with Commonwealth and State GHG emissions reduction policies and programmes enacted under the NGS, including Greenhouse Challenge Plus;

- Supporting the development of renewable energy generation through direct investment in wind farm development and other sources of renewable energy;

- Supporting the expansion and management of greenhouse sinks by direct participation in carbon sequestration initiatives; and

- Supporting the development and commercialisation of low emissions electricity generation technologies as outlined in Section 5.

.

6. Stakeholder Consultation

Griffin is committed to carrying out comprehensive and open consultation with the community through its public relations programs and initiatives. Griffin will maintain an open consultation program throughout the Project's operations and maintenance. To date the following organisations have been consulted:

- Environmental Protection Authority (EPA Service Unit);
- Local Collie Shire Council;
- Bunbury Wellington Economic Alliance;
- Conservation Council of WA;
- Department of Environment and Conservation
- Department of Industry and Resources (DoIR);
- South West Environment Centre;
- Collie Conservation Group;
- Wellington National Park Community Advisory Group;
- Department of Aboriginal Affairs (DIA); and
- Department of Water
- Collie Basin Planning and Management Group

Consultation will continue during operations as required, including the ongoing maintenance of a complaints register, community updates through Griffin's bulletins and newsletters and communications activities that may be undertaken by the Operator, Transfield Worley Power Services (TWPS).

7. Review and Revision

Griffin will undertake annual reviews and revisions of the Greenhouse Gas Management plan pursuant to the annual report and findings of the annual internal audits to assess its suitability, adequacy and effectiveness in meeting the plan's objectives.

APPENDIX A: *Consideration of Alternatives: Greenhouse Gas and Air Emissions Reduction Technology, January 2006*

Griffin Power Pty Ltd

Bluewaters I Power Station

Consideration of Alternatives
Greenhouse Gas and Air Emissions Reduction Technology

January 2006

Document No: Revision: 0

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1. INTRODUCTION

Griffin Power Pty Ltd (Griffin) proposes to construct and operate a 200 MW coal fired power station (Bluewaters I). The Bluewaters Project is located at the northern end of the proposed Coolangatta Industrial Estate immediately adjacent to the Griffin Coal Mining Company (Griffin Coal) Ewington I mine development and approximately 4 km north-east of Collie (refer to Figure 1).

The aim of the Bluewaters Project is to produce electricity to supply to the South West Interconnected System (SWIS) grid and/or to supply electricity direct to private customers, including those in the proposed Coolangatta Industrial Estate.

Bluewaters will be a subcritical coal fired power station that will operate 24 hours per day, 365 days per year. The primary supply of coal will be Griffin Coal's Ewington I mine which is currently in development. Operation at full capacity would require an estimated 800,000 tonnes of coal a year. All water requirements for the development will be sourced from mine dewatering activities at the nearby Ewington I mine.

The Bluewaters I Project was subject to a formal level of assessment set at a Public Environmental Review (PER) under Part IV of the *Environmental Protection Act*. The PER was released for public review in May 2004 (Griffin 2004), with Ministerial approval in August 2005 (Statement 00685) (Minister for Environment, 2005). The Ministerial approval is subject to the preparation and implementation of a range of commitments and measures to manage all relevant environmental factors.

1.1 Purpose

This Document has been developed in accordance with Ministerial Statement No. 685 for the Bluewaters Project to demonstrate compliance with the following ministerial conditions.

- MC 6.1: Demonstrate that the plant has been designed to achieve reductions in greenhouse gas emissions as far as practicable; and
- MC 7.1: Demonstrate that the plant has been designed to ensure that best available, practicable and efficient technologies are to be used to minimise total air

emissions from the power station to meet emission limits consistent with current industry standards and ambient air quality standards.

For the purposes of this assessment Griffin have used the definition of best practicable measures as outlined in EPA Guidance Statement 55 *"Implementing Best Practice Proposals Submitted for Environmental Impact Assessment Process*" (December 2003), and being defined as the following:-.

> ***"Best Practicable Measures*** *incorporate technology and environmental management procedures which are practicable having regard to, among other things, local conditions and circumstances (including costs), and to the current state of technical knowledge, including the availability of reliable, proven technology"*

2. Coal or gas

Griffin's decision to build the Bluewaters coal fired power station was based on the proximity and reliability of a coal supply from Griffin Coal mining activities in the area. The use of gas for the project is not considered to be currently viable as the foreseeable reliability of gas was considered insufficient and the cost not commercially viable. The decision to use coal is outlined below.

Reasons for selecting coal:

- Existing and approved mines can readily supply the coal requirement, with no additional developments required;
- Bluewaters will contribute to the sustainability of Collie, especially once Muja A & B power stations are decommissioned;
- Bluewaters will have the maximum possible security of fuel supply being close to the mouth of the primary mine and close to several other mines in the area;
- Use of state of the art coal technology in Bluewater result in lower air and greenhouse gas emissions when compared with older power stations in the area; and
- Coal is cheaper than gas at the proposed location and the extraction of coal already environmentally approved.

Reasons for not selecting gas:

- There is currently no supply of gas in Collie. The provision of gas would require the installation of new infrastructure, which is not economically viable for Griffin.
- The existing Dampier to Bunbury Natural Gas pipeline is currently operating at maximum capacity and supply cannot be guaranteed in the short to medium term.

- The source of gas is distant and so supply is dependent on a single very long pipeline. A mix of coal and gas generation capacity is arguably required to preserve a minimum level of supply security.
- The extension of a gas supply to Collie is not practicable for power generation, given that gas fired power stations are best located closer to the major uses of the electricity produced
- Gas is a high value product with a range of uses, including fertilizer manufacture and as a transport fuel. Use for base load power generation is questionable.

3. Clean Coal Technology

During the design process for Bluewaters, Griffin considered a number of different clean coal combustion technologies which are outlined in detail in the following sections. The proposed Bluewaters coal fired power station represented the best compromise between environmental factors, energy efficiency, economics, reliability of technology for a plant of this size and the requirements of potential customers.

Clean coal technology refers to the range of coal fired generation technologies that are current state of the art, or under development, and are strongly focused on reducing pollutant discharge and increasing plant efficiency in a cost effective manner. Improving plant efficiency has benefits on two fronts, by reducing specific fuel consumption, the cost of generation is reduced, and emissions per kWh are also reduced. Emission control technologies can be applied at all stages of the coal utilisation chain. Use of state of the art coal technology results in Bluewaters having a higher thermal efficiency and would result in less CO_2 emissions per GJ of energy produced when compared with similar older coal fired units. Table 1 shows clean coal technologies currently available.

Table 1: Clean Coal Technologies

<table>
<tr><th></th><th>Process</th><th>Clean Coal Technologies</th><th>Bluewaters Technology</th></tr>
<tr><td rowspan="5">Coal Fuel</td><td rowspan="5">Combustion</td><td>Sub Critical PF</td><td>X</td></tr>
<tr><td>Super Critical PF</td><td></td></tr>
<tr><td>Ultra Super Critical PF</td><td></td></tr>
<tr><td>Fluidised Bed Combustion (FBC)</td><td></td></tr>
<tr><td>Integrated Gasification Combined Cycle (IGCC)</td><td></td></tr>
<tr><td rowspan="9">Emission Control</td><td rowspan="4">Particulate Emission Control</td><td>Electrostatic precipitator (ESP)</td><td></td></tr>
<tr><td>Bag Filter</td><td>X</td></tr>
<tr><td>Venturi Scrubber</td><td></td></tr>
<tr><td>Cyclones</td><td></td></tr>
<tr><td rowspan="5">SO_2 Emission Control</td><td>Flue gas desulphurisation (FGD) spray dry scrubbing</td><td>N/A*</td></tr>
<tr><td>FGD – wet limestone/gypsum</td><td>N/A*</td></tr>
<tr><td>FGD – other wet process</td><td>N/A*</td></tr>
<tr><td>FGD - regenerative</td><td>N/A*</td></tr>
<tr><td>Sea water</td><td>N/A*</td></tr>
</table>

Process		Clean Coal Technologies	Bluewaters Technology
		Sorbent injection	N/A*
		Combined SO_x/No_x removal	N/A*
	NOx emission control	Selective catalytic reduction (SCR)	
		Selective non-catalytic reduction (SNCR)	
		Low NO_x burners	X
		Two Stage Combustion	X
		Over fire air	X
		Flue gas recirculation	

*No SO_2 emission control is proposed for Bluewaters – see Section 0 for explanation.

4. Combustion Technology

The alternative combustion technologies considered by Griffin for use at Bluewaters are described in the following Sections.

4.1 Subcritical Pulverised Fuel

The predominant coal combustion technology used world wide is subcritical pulverised fuel, which is well proven technology and has been successfully used for over 40 years. The technology is capable of supporting large, reliable and low cost units of up to 1400 MW. The coal is ground (pulverised) to a fine powder which is then blown with part of the combustion air into the boiler plant through a series of burner nozzles. Secondary and tertiary air may also be added.

Combustion takes place at temperatures from 1300 -1700°C, depending largely on coal rank. Steam is generated, driving a steam turbine and which is coupled to an electricity generator. The steam cycle is limited to subcritical conditions (below 221 bar), boiler design and operation is simplified, but overall efficiency is limited to around 35 - 37% (net generation and Higher Heating Value (HHV)[7]). Achievable availability of the subcritical units is around 90 %.

4.2 SuperCritical Pulverised Fuel

Supercritical[8] boilers (above 221 bar) were built in the US in the 1950's and 1960's and developed a reputation for high efficiency but low reliability. Development of these units continued in Europe and Asia such that by the 1990's supercritical technology provided the bulk of new generation capacity. Steam conditions have increased well into the supercritical range, reaching over 300 bar / 600°C and achieving HHV efficiencies of around 42%.

[7] **Higher Heating Value** is defined as the amount of energy released when a fuel is burned completely in a steady-flow process and the products are returned to the state of the reactants. The heating value is dependent on the phase of water/steam in the combustion products. If H2O is in liquid form, heating value is called HHV (higher Heating Value). When H2O is in vapor form, heating value is called LHV (Lower Heating Value).

[8] **Supercritical** is a thermodynamic expression describing the state of a substance where there is no clear distinction between the liquid and the gaseous phase

Supercritical power plants are well proven technology which can achieve a reasonable availability, with typical average availability being around 85%.

However, the size of the Western Australian South West Interconnected System (SWIS) is too small too accommodate commercially available supercritical units. The largest and most efficient supercritical coal fired boilers in operation is 1300 MW. Suppliers do not offer units of a size range (200 – 300 MW) suitable for the SWIS. The minimum size readily available is 350 MW and the cost of these smaller units suffers from diseconomies of scale.

At less than 350 MW, the efficiency advantages of the supercritical cycle cannot be realised due to the effects of scale such as high blade tip losses in the HP turbines. This was borne out in the proposals submitted to the recent power procurement process in Western Australia. The efficiency of a small supercritical unit offered in one proposal was publicly stated to be no greater than the alternative subcritical proposal.

The minimum unit size currently commercially available is a fatal limitation for the application of supercritical plant in the SWIS. Further unit sizes need to be in the range 500 – 1300 MW to overcome the increased expense of the required materials.

The 200 MW unit size proposed for the Bluewaters Powerstation is ideal for the SWIS but is not within the typically commercially supported size range for supercritical technology and therefore there is no commercial or technical basis to use a supercritical unit.

4.3 Ultra-supercritical pulverised fuel

The upper end of supercritical technology is the units referred to as ultra supercritical. A few ultra super critical units are in operation with efficiencies of up to 42.8% HHV and are considered leading edge technology. Availabilities of these units are expected to be around 85 % in time. However this technology is not yet commercially proven. This was the principle reason for not considering an ultra-supercritical unit for Bluewaters. In addition, the minimum practicable unit size is larger than the minimum size of supercritical units hence the technology is also unsuitable for the SWIS.

4.4 Fluidised Bed Combustion (FBC)

Fluidised bed combustion (FBC) is a method of burning coal in a bed of heated particles suspended in a gas flow. At sufficient rates the bed acts as a fluid resulting in the rapid mixing of particles. Coal is added to the bed and continuous mixing encourages complete combustion, at a lower temperature than pulverised fuel combustion.

The principle benefits of FBC are its ability to use wide varieties of poor quality fuel, but with good combustion and environmental performance. FBC allows the use of cheaper, low-grade fuel, and finds application in the disposal of waste materials. Efficiencies are normally around 32 % HHV. FBC technology offers environmental benefits in that the removal of SO_2 (90 – 95 %) and NO_x (below 100 ppm) which takes place within the combustion process without the need for additional post combustion clean up.

FBC is generally divided into two categories, depending on the fluidising velocity adopted. Circulating fluidised bed combustion is considered to be more suited to power generation than bubbling FBC units. The largest Circulating FBC units have been built by Foster Wheeler and Alstom, with two 350 MW units currently operating in Florida. It is understood that both the vendors are experiencing difficulties with the larger units. The technology cannot be considered commercially proven at this time, the coal at Collie does not warrant the use of FBC and there is no greenhouse gas intensity advantage over subcritical pulverised fuel.

4.5 Pressurised Fluidised Bed Combustion (PFBC)

The development of PFBC technology in the 1980's was driven by the need to reduce acid gas (SO_x and NO_x) emissions together with the understanding that direct use of high temperature combustion gases to drive the turbine offered a useful efficiency gain. However, direct use of the hot combustion gases in a gas turbine needs to address two important issues which include the following;

- The gases must be delivered at elevated pressure; and
- Solid and gaseous contaminants must be reduced to acceptable levels for admission to the gas turbine.

The PFBC is a relatively compact pressure vessel that holds coal particles in suspension in a rising gas stream. Downstream of the combustor, the hot gas cleanup plant conditions the combustion gases to remove particulates and other contaminants. A more rugged gas turbine than standard is used to accommodate the residual contaminant level of the hot combustion gases.

The use of steam and gas turbines in a combined cycle enables higher overall efficiencies to be achieved than a steam only cycle with comparable steam conditions. PFBC units have shown HHV efficiencies of around 40%, however this has been based on limited testing.

The advances in waste gas cleanup have to some extent eroded the advantages of PFBC technology.
This technology is still in the proving stage and gas turbine design and gas cleanup are important issues which need further advances in technology to make it commercially viable. Further there are understood to be no proven plants of commercial size.

4.6 Integrated Gasification Combined Cycle

The distinctive feature of the IGCC is the integration of three well established processes; pressurised gasification, gas refining and combined cycle electricity generation. When coal is brought into contact with steam and oxygen, thermochemical reactions produce a fuel gas, largely carbon monoxide and hydrogen, which when combusted can be used to power gas turbines.

Standard refinery treatment processes are used for gas clean up. Because the gas stream is at high pressure and undiluted by combustion air, the volume of gas to be treated is small when compared with flue gas discharges of conventional pulverised coal fired plants. Therefore, pollutant discharge levels approaching those of natural gas utilisation are potentially achievable.

Demonstration plants currently in operation have an HHV efficiency level of about 45%, with recent advances in gas turbine technologies these systems are now capable of reaching above 50%. Plant availability of 80% to 85% is reported for the limited experience to date. IGCC technology is still at the demonstration phase with estimates of total plant capacity varying. IGCC is considered to be as efficient as subcritical and supercritical units but with lower emissions. Before being considered commercially viable IGCC must overcome higher costs, poor reliability and unproven flexibility compared with rival technology.

4.7 Appropriate Combusition Technology for Bluewaters

Griffin determined that appropriate technology for the proposed 200 MW Bluewaters power station is subcritical pulverised fuel. A comparison of the different combustion technologies carried out by Griffin is shown in Table 2.

Table 2: Comparison of Combustion Technologies

Combustion Technology	HHV Efficiency	Suitability of Technology	Plant Availability
Subcritical PF	35-37%	Currently the most utilised technology.	90%
Supercritical PF	42%	Manufactures do not commercially support units under 350 MW	85-90%
Ultra-supercritical PF	42.8%	Still in the development phase.	unproven
Fluidised Bed Combustion (FBC)	32%	Technology still experiencing problems at commercial stage	unproven
Pressurised Fluidised Bed Combustion (PFBC)	40%	This technology is still in the proving stage and gas turbine design and gas cleanup are important issues which need further advances in technology to make it commercially viable	unproven
Integrated Gasification Combined Cycle (IGCC)	41% up to 50%	IGCC technology is still at the demonstration phase with estimates of total plant capacity varying. Before being considered commercially viable IGCC must overcome higher costs, poor reliability and unproven flexibility compared with rival technology.	80-85%

Griffin recognises that supercritical PF coal technology does surpass subcritical technology as the leading commercially viable technology for new coal fired plants. However for units under

350 MW the efficiency advantages of the supercritical cycle cannot be realised due to the effects of scale such as high blade tip losses in the high pressure turbines. The minimum unit size currently commercially available and is supported by manufacturers is 350 MW, this therefore is a fatal limitation for the use of a supercritical unit in the SWIS. With coal based units, due to the high capital costs associated with construction, they are ideally suited to a base load operation (ie: capacity factors in excess of 85%). Due to small size of the West Australian electricity network in terms of overnight load, power station unit sizes of greater than or equal to 250 MW will generally be turned down overnight as the electricity system cannot cope with the loss of a major unit overnight. This has a significant impact on the economic viability of a power station and also the maximum size of the power station.

Manufacturers (eg: Mitsui, Siemens) of supercritical coal fired power stations (higher efficiency coal units) have advised Griffin that it is not economical to build units with supercritical technology at a unit
size of less than 350 MW. It would be extremely expensive to try and connect a 400 MW power station unit to the South West Interconnected Network and it would be turned down to approximately 250 MW almost every night.

Griffin has selected the most advanced 200 MW coal fired unit which seems to be ideally sized for the South West Interconnected System and provides a high efficiency (most efficient for the size of conventional coal fired power station unit sizes).

Other combustion methods outlined in Section 4 are not at this stage considered to be commercially viable. Most of these technologies are still at the development stage and have yet to demonstrate the high reliability at reasonable costs that would be required to proceed to commercial application.

4.8 Greenhouse GAS rEDUCTION mEASURES

Griffin is committed to ensuring that it keeps abreast of technology advances which reduce greenhouse gas emissions by Research and Development projects. In addition Griffin has in the past and will continue to contribute financial support to the Cooperative Research Centre (CRC) for Coal in Sustainable Development for further investigation into clean coal technologies. Investigations being undertaken by CRC is grouped into three themes and includes

- **Informing Strategic Decisions**: Research is designed to inform strategic decisions that will enable the opportunities and threats from technology developments to be identified and managed
- **Understanding Coal Performance:** Research is focusing on the behaviour of Australian Coals if they were to be used in modern gasifiers (IGCC), oxyfuel plants, FBC and low temperature blast furnaces. There are also programs which are assessing the co-firing of coal with Biomass in electricity generation and with plastics in iron-making.
- **Improved Environmental Performance;** Research programs are to develop methodologies designed to assess power station emissions in a comprehensive and accurate manner, and to enable emissions to be minimised. Research is also carried out to address the management and utilisation of wastes from coal-fired power stations.

Griffin have also committed to participating in the AGO Greenhouse Challenge Plus. As part of the program Griffin will be required to;

- Prepare an energy inventory of all relevant greenhouse gas emissions;
- Develop key performance indicators to measure emission intensity;
- Annually report emissions inventory, significant abatement actions and updated KPI data;
- Provide public annual statements that detail the above mentioned activities; and
- Accept the organisation may be selected to be independently verified.

The Griffin Group is involved in number of positive initiatives have the potential to generate Greenhouse Offsets. Some examples are outlined below.

Emu Downs Wind Farm

Emu Downs Wind Farm project is joint venture between Griffin Energy and Stanwell. The project was formally approved by the joint venture in July 2005 and will cost $180 million, with construction expected to take 16 months.

Wind energy is an environmentally sustainable source of electricity. It produces no waste products and displaces the emission of greenhouse gases that would otherwise be released into the atmosphere from non-renewable electricity generation. In line with Griffin's commitment to sustainability, an extensive feasibility study was undertaken to investigate impacts of the development proposal. This study included investigations into impacts on aesthetics, noise, wildlife and impacts on the local community. The project was found to have very low impacts when management measures are taken into account and all required development approvals were granted. The windfarm will result in savings of approximately 120,000 T of greenhouse gas emissions per year, when compared with the SWIS.

Collie River East Branch Diversion Project

The trial diversion of the East Collie River is a project in place to combat salinity levels in the Wellington Dam near the township of Collie in the South West of Western Australia. The trial is a partnership between the Griffin Group, Harvey Water and the Western Australian and Federal Governments. It is aimed a diverting the first winter flush of the Collie River, which is generally saline, to a storage location, so that it does not cause salt contamination of the Wellington Dam. Griffin Coal have made available a disused mine void to store the diverted water.

During the trial, monitoring will be conducted to determine salinity reductions achieved and effectiveness of the mine void for water storage. If expectations are met, this initiative will restore the Wellington Dam back to potable water standards. The restoration of Wellington Dam (which has an average recharge of 90 to 100 GL/annum is equal to offsetting the greenhouse gases required for powering a 45 to 50 MW new Desalination Project load which would produce an equivalent amount of water). The trial is intended to run for at least 2005 and 2006.

Tree Planting

Griffin is committed to a tree planting on agricultural properties and in mine rehabilitation areas. The Griffin Group owns numerous rural agricultural properties throughout Western Australia (through W R Carpenter Agriculture a subsidiary), on which it is feasible to plant various species of trees for sequestration. The tree planting program and its potential for significant sequestration of greenhouse gases is currently being reviewed.

5. Air Emission Controls

Modern coal-fired power stations emit three major air pollutants of interest, particulates, nitrogen oxides (NO_x) and sulphur oxides (SO_x). Griffin carried out air emissions modelling using TAPM to determine the likely impacts of the proposed Bluewaters Power Station on air quality. Results of the modelling assisted Griffin in determining the most appropriate emission control equipment for Bluewaters, Sections 5.1 - 5.4 details emission control equipment considered by Griffin.

5.1 Particulates

Air emissions modeling for Bluewaters shows that the regional PM_{10} levels (highest 24-hour concentration of 106 µg m^{-3}) are well above the NEPM standard (50 µg m^{-3}) for as far as 6 km from Muja power station, but are well below the standard near Collie and Bluewaters stations. The higher concentrations are not affected by additional emissions from the Bluewaters sources and highest concentrations at the Collie Township are less than half of the NEPM standard.

Emission particulate control equipment considered by Griffin for use in the Bluewaters Power Station is detailed in the sections below.

5.1.1 Electrostatic Precipitators

This technology is well established, with only minor improvements expected from further developments.

Flue gas is passed through a strong electric field, which charges dust particles and they are attracted to oppositely charged collecting (parallel) plates. The plates are regularly rapped to knock of the accumulated dust, which falls into collection hoppers. Total collecting performance is improved by having a number of precipitator zones in series, although this enhanced performance is then achieved at the expense of space requirements and cost.

Wet precipitators are occasionally used where the inlet gas temperature is close to the gas dew point, although this is not normal for standard designs for coal fired plants. In these systems the plates are water washed to remove the accumulated particles.

Advantages	Collect particles to less than 0.1 micron
	Remove either liquid or solid particles with high efficiencies
	Particulates can be removed in the same state as they arrive at the precipitator (either wet or dry)
	Extremely low pressure losses
	Operate at ambient temperatures up to 750°C
	Handle vacuum or pressure conditions
	Relatively low maintenance costs
Disadvantages	High capital costs
	Large Space requirements
	Lower performance with high resistivity ash

5.1.2 Fabric Filters

This technology is also well established. Dust collecting performance is generally better than for an equivalent electrostatic precipitator, particularly for the smaller particle sizes.

Dust laden gases are passed through the semi porous medium of woven or felted cloth making up the individual filter bags. This material retains the dust particles and allows the clean gases to pass through. The efficiency of this type of filter is very high, but is subjected to temperature and chemical composition limits in particular water vapour content.

Where flue gas temperatures are higher (such as may be experienced in coal-fired power stations), bags can be made of ceramic materials to avoid damage from the higher temperature environment.

The bags must be cleaned frequently, and this is achieved by either of the following three methods. The cleaning system is initiated by a control system, on a periodic or pressure drop-related basis;

- Reverse air – air is successively reversed through a section of the filter, and the dust drops into the filter below
- Pulse Jet – A short sharp pulse of air is directed onto the top of the open bag, which briefly expands the bag thus breaking away any dust cake. The dust falls into the hopper below.
- Vibration – Bags are periodically vibrated to dislodge the caked dust.

Advantages	High efficiency for sub micron sized dust
	Produces dry product
	Lower cost than ESP
Disadvantages	High pressure drop
	Bags damaged at high temperature
	Dew point problems at low temperatures
	High maintenance costs

5.1.3 Venturi Scrubbers

In the most widely used venturi scrubber, water is injected into the flue gas stream at the venturi throat to form droplets. Fly ash particles impact with the droplets forming a wet by-product which then generally requires disposal. Wet scrubbing for particulate removal depends on particle size distribution. The system efficiency is reduced as the particle size decreases. The process can also have a high energy consumption due to the use of sorbent slurry pumps and fans. The forceful contact resulting from the droplet dispersal (spray tower), contraction of the gas stream (venturi) or counter current flow (collision), removes some of the particles

5.1.4 Cyclones

In the past, industrial plant operators tended to fit mainly cyclones. More recently, fabric filters have increased their market share in industry in the various processing fields. Cyclones are robust technologies that can deal with the cyclic operation and load changes, which is quite common in these types of plants. However, their efficiency is moderate when compared with ESP or fabric filtration. A cyclone is a cylindrical vessel, usually with a conical bottom. The flue gas enters the vessel tangentially and sets up a rotary motion whirling in a circular or conical path. The particles are 'thrown' against the walls by the centrifugal force of the flue gas motion where they impinge and eventually settle into hoppers

5.1.5 Particulate Control at Bluewaters

Scrubbers and cyclones were largely abandoned by the power industry due to unsatisfactory performance following the introduction of pulverised fuel. They were not considered when choosing the particulate emission controls for Bluewaters.

General experience in Australia has led to a general preference for fabric filters. The low sulphur content of Australian coals results in high ash resistivity that reduces the performance of electrostatic precipitators. Fabric filters are not affected by dust resistivity and are the control measure of choice in all New South Wales coal fired power stations.

There have been significant advances made by the manufacturers of electrostatic precipitators but the performance of fabric filters was considered to be more predictable leading to the choice of fabric filters for Bluewaters.

5.2 Nitrogen Oxides

NO_x emissions in the Collie region are dominated by those from the Muja power station (six times larger than those of Collie or the proposed Bluewaters power station). Consequently, the largest concentrations of NO_2 in Collie are associated with Muja, however the highest hourly and annual averaged concentrations predicted by TAPM are below the NEPM standard.

Section 5.2.7 details NO_x emission control equipment considered by Griffin for use in the Bluewaters Power Station.

5.2.1 Selective Catalytic Reduction (SCR)

Vaporised ammonia is injected into the flue gas stream at about 300 – 400°C and the gases are passed over a catalyst unit (usually based on oxides of titanium, vanadium and tungsten arranged in a flat plate or honeycombed configuration) The NO_x is reduced by the ammonia to molecular nitrogen. This system normally achieves 89 – 90% NO_x reduction. Commercial use of this system is restricted to lower sulphur coals only,

5.2.2 Selective Non-Catalytic Reduction (SNCR)

In the SNCR process an amine based chemical reagent (normally ammonia or urea) is injected in aqueous or gaseous form into the flue gas at 900:1, 100°C, reducing the NO_x to molecular nitrogen. This is system can achieve NO_x reductions of 40-50% depending on the reagent type and the operating conditions. SNCR is a simpler and cheaper system than SCR, but it effectiveness is considerably less. The SNCR system can also produce nitrous Oxide (N_2O, a greenhouse gas).

5.2.3 Low NO_X Burners

Most installations now incorporate as “best available technology” low NO_x burners. Such burners normally achieve NO_x reductions of up to 60% compared with other burners.

Low NO_x burners are designed to control fuel and air mixing at each burner in order to create larger and more branched flames. Peak flame temperature is thereby reduced, and results in less NO_x formation. The improved flame structure also reduces the amount of oxygen available in the hottest part of the flame thus improving burner efficiency. Combustion, reduction and burnout are achieved in three stages within a conventional low NO_x burner. In the initial stage, combustion occurs in a fuel rich, oxygen deficient zone where the NO_x are formed. A reducing atmosphere follows where hydrocarbons are formed which react with the already formed NO_x. In the third stage internal air staging completes the combustion but may result in additional NO_x formation. This however can be minimised by completing the combustion in an air lean environment.

Low NO_x burners can be combined with other primary measures such as overfire air, reburning or flue gas recirculation. Plant experience shows that the combination of low NO_x burners with other primary measures is achieving up to 74% NO_x removal efficiency.

5.2.4 Two Stage Combustion

Staged supply of fuel and combustion air creates three distinct combustion zones, operating in fuel lean, fuel rich and fuel lean conditions respectively. In the first zone coal is fired with excess air, producing NO_x from both the fuel bound and combustion air nitrogen. In the second zone, above the primary zone, a secondary fuel is injected to create a fuel rich region, which reduces NO_x formed in the primary zone to nitrogen. Finally the remainder combustion air is injected above the reburn zone to complete the combustion. In general 23-30% of the total heat input can be supplied as reburn fuel. Reburn can achieve up to 70% NO_x reduction.

However this method of NO_x reduction is still at the preliminary commercial stage after only recently completed various stages of demonstration.

5.2.5 Over Fire Air

70 – 90% of the combustion air is supplied to the burners (as primary air) and the remainder to furnace at a level above the burners (as secondary or over-fire air). Initial combustion therefore produces a relatively low temperature, oxygen deficient, fuel rich zone near the burner which helps to reduce the formation of fuel NO_x. A relatively low temperature secondary combustion zone then limits the formation of thermal NO_x. The location of the injection ports and the mixing of over fire air with the main stream of gases are critical to achieving efficient combustion.

5.2.6 Flue Gas Recirculation

Recirculation of 20 – 30% of the Flue Gas usually at 300 – 400°C, back to the furnace or to the burners decreases the flame temperature and oxygen concentration and thus helps to reduce the formation of thermal NO_x. In coal fired units NO_x reduction is generally less than 20% due to the relatively low contribution of thermal NO_x in the total NO_x produced.

5.2.7 NOX control at Bluewaters

Low NO_x burners and staged combustion were selected to be used in the Bluewaters plant because they represented the balance between the NO_x reduction capabilities, the availability of the technology and also economic factors. The package of NOx emission controls chosen includes low NOx Burners, staged combustion and over fire air. These controls achieve a NOx reduction of approximately 60% and results in approximately 3050 tpa of NOx emissions which meets the required NEPM standard.

Table 3 shows a comparison of the different NO_x control technology considered by Griffin.

Table 3: Comparison of NOx Control Technology

NOx Control Technology	NO_x reduction capabilities	Availability of Technology
Selective catalytic reduction (SCR)	80 – 90%	Commercially available for low sulphur coals
Selective non-catalytic reduction (SNCR)	40 – 50%	Commercially available however can also produce Nitrous Oxide (a greenhouse gas).
Low NO_x burners	60%	Represents the most widely used technology
Two Stage Combustion	70%	Relatively new technology and recently completed the demonstration stage
Over fire air	70 – 90%	Relatively new technology
Flue gas recirculation	20%	Not commercially applied in Australia to date.

5.3 Sulphur Oxides

Griffin under took air emissions modeling, the following findings arise from an examination of the highest SO_2 concentrations over a 12-month period for four emissions scenarios.

- Scenario 1 (proposed 200 MW Bluewaters I power station in isolation) produced *hourly-averaged* concentrations below the NEPM standard at all times.
- Scenario 2 (proposed 2 x 200 MW Bluewaters I + II power station in isolation), produced *hourly-averaged* concentrations below the NEPM standard on all days except one.
- For scenario 3 (sources Muja A, B, C and D, Collie, Collie expansion (identical to Collie), Worsley and Bluewaters I), there were exceedances of the NEPM standard for hourly-averaged concentrations on 27 days, associated with both Collie and Muja power stations.
- For scenario 4 (scenario 3 sources plus Bluewaters II), there were also 27 exceedance days. Comparison with scenario 5 (sources Muja A, B, C and D, Collie, Collie expansion, and Worsley) shows that the proposed sources do not lead to any additional exceedance days.

In summary, the TAPM modelling showed that emissions from both the proposed Bluewaters power stations do not lead to an increase in the number of days on which the NEPM standard for hourly-averaged SO_2 is exceeded. This is under a scenario that includes the existing Muja, Collie and Worsley power stations plus an expansion of the Collie station. For all scenarios, NEPM standards were not exceeded at Collie township for any of the averaging periods.

Desulphurisation and sulphur reduction technologies considered by Griffin for use at Bluewaters are detailed in Sections 5.3.1 – 5.3.7.

5.3.1 Flue gas desulphurisation (FGD) spray dry scrubbing

The spray dry process uses concentrated calcium hydroxide slurry injected into the flue gas to react with and remove acidic compounds such as SO_2, SO_3 and HCl. It is one of the most developed and widely used processes and can achieve 85 – 90 % SO_2 removal with moderately high sulphur fuels. The operating costs are among the highest of FGD technology due to the cost of lime and by product disposal.

Advantages	Low capital costs compared with other FGD processes
	Proven Technology
Disadvantages	Expensive to operate
	Requires land for installation
	Produces a by product which has to be disposed of.

5.3.2 FGD – wet limestone/gypsum

A wet slurry of limestone is sprayed into the scrubber tower, after gas has been cooled in the heat exchanger. Limestone is converted to calcium sulphate (gypsum) during its passage through the tower. Limestone slurry is partially re-circulated to improve collecting efficiency (approx 98%).

Advantages	Proven Technology
Disadvantages	Produces large quantities of waste water
	Requires area for storage of solids
	Additional Waste Stream

5.3.3 FGD – Wet Ammonia

The wet Ammonia FGD process has undergone significant developments in the last few years. Flue gas is passed through an aqueous solution of ammonia producing ammonium sulphate as a by product that can be used as fertiliser. SO_x removal is reported to be potentially 95%. Although this technology has been used since the 1950's, there appears to be only one 350 MW oil fired until still in-service using ammonia scrubbing.

Advantages	Produces ammonium sulphate, which can be used as a fertiliser
Disadvantages	Economics are better for High sulphur coal
	Plant expensive

5.3.4 FGD - regenerative

Sodium carbonate/hydroxide is used in an absorber tower, producing saleable end products of sulphur and sulphuric acid. Regenerable FGD technologies find marginal applications throughout the world. The attractiveness of these types of process is hindered by high operation and maintenance costs

Advantages	Does not require the consumption of large quantities of sorbent
	Does not produce large quantities of solid waste
	Relatively low operating cost
Disadvantages	Expensive to install

5.3.5 Sea water

Where seawater cooling is used, the natural alkalinity of the sea water can be used for FGD. A portion of the sea water taken from the Cooling Water discharge from the steam turbine condenser is sprayed into an absorber tower. The seawater absorbs the SO_2 in the flue gas as it drops to the bottom of the tower. The resulting sulphite solution is then mixed with the CW discharge from the condenser and flows into a large, open reaction pond. Compressed air is introduced into this pond, which oxidises the sulphite to sulphate. The resulting solution is then discharged to sea. The flue gas then requires reheating to enable discharge from the stack, and this is achieved either by adding an additional heater after the FGD tower, or using a portion of the original flue gas as a bypass. Suppliers claim efficiencies of 99%.

Advantages	Requires no solid absorbent or other reagent (apart from seawater)
	No by product to dispose of
	Relatively low energy consumption
Disadvantages	Limited to coastal sites
	Heavy metals and chlorides may be present in waste water
	Uses 0.7 -1.0% of power generated

5.3.6 Sorbent injection

The simplest technology is furnace sorbent injection where a dry sorbent is injected into the upper part of the furnace to react with SO_2 in the flue gas. The finely grained sorbent is distributed quickly and evenly over the entire cross section in the upper part of the furnace in a location where the temperature range is 750 – 1250oC. Commercially available limestone ($CaCO_3$) or hydrated lime (Ca $(OH)_2$) is used as sorbent. While the flue gas flows through a connective pass (where the temp remains above 7500°C) the sorbent reacts with SO_2 and O_2 to form $CaS0_4$. Removal efficiencies are around 70%.

Advantages	Cheap to install
Disadvantages	Produces large quantity of waste material
	Un-reacted sorbent and reaction products cannot be collected separately from fly ash

5.3.7 Combined SOx/NOx removal

A combined NO_x/SO_x system using regenerable copper oxide absorbent is under development in the USA. The copper oxide is converted to copper sulphate and also acts as a catalyst for the reduction of NOx to nitrogen using ammonia. The sorbent is regenerated using methane and the SO_2 liberated is processed to give elemental sulphur or sulphuric acid. Tests on the 1 MW scale have shown desulphurisation of >98%. However this system is not yet commercially available.

5.3.8 SOx Control at Bluewaters

Griffin undertook a review of desulphurisation technologies currently being used based on environmental, social, cost, reliability of technology and efficiency factors. Essentially any benefits of utilising FGD technology is offset by environmental, social and cost implications. The implementation of FGD technologies discussed in Section 5.3 is likely to result in the following additional environmental impacts;

- Additional demand on existing water sources through additional water demand for FGD technology (approximately 15 – 34 GL per year
- Requirement for lime and the secondary impacts associated with lime quarrying and manufacture;
- Additional energy supply of which would overall reduce plant efficiencies;
- Increases the capital cost of project;
- Requirement for additional land area for installation; and
- Generation of large quantities of waste water which has to be disposed of or stored.
- Emissions of carbon dioxide would be increased by 5% due to gases released in the process. The desulphurisation process could result in an additional 60,000tpa of CO_2 -e to be emitted from Bluewaters.

For Bluewaters it was concluded that there is no net environmental benefit to be derived through the application of desulphurisation. Additionally modelling of SO_2 showed that the NEPM standard was not exceeded at Collie township for any of the averaging periods. The final decision not to use FGD is upheld in the Appeal Conveners Report for Bluewaters I where it was stated " *that it noted that the proposal is not predicted in it's self to lead to increases in ambient concentrations at Collie and other nearby receptors. On this basis it is considered appropriate that the development of emission limits for both the Bluewaters proposal and other existing and proposed power generation and industrial facilities within the Collie region occur as part of a strategic air quality management framework* "rather than using European Union directive limits. The Minister for Environment upheld this decision in her appeal decision and did not require FGD to be fitted to Bluewaters I.

5.4 Carbon Monoxide, MErcury, Pah and Fluoride

Air emissions modeling showed that concentrations of carbon monoxide were well below the NEPM 8-hourly-averaged concentration standard, while annual averaged concentrations of mercury and PAH were orders of magnitude smaller than WHO guidelines for the protection of human health. 24-hourly-averaged fluoride concentrations were below the ANZEC goals for vegetation relating to general land use. Griffin does not propose to include any emission controls for these substances as they are well within recognised standards. The levels of these emissions were accepted in EPA Bulletin 1160 and in Ministerial Statement 685.

c) References

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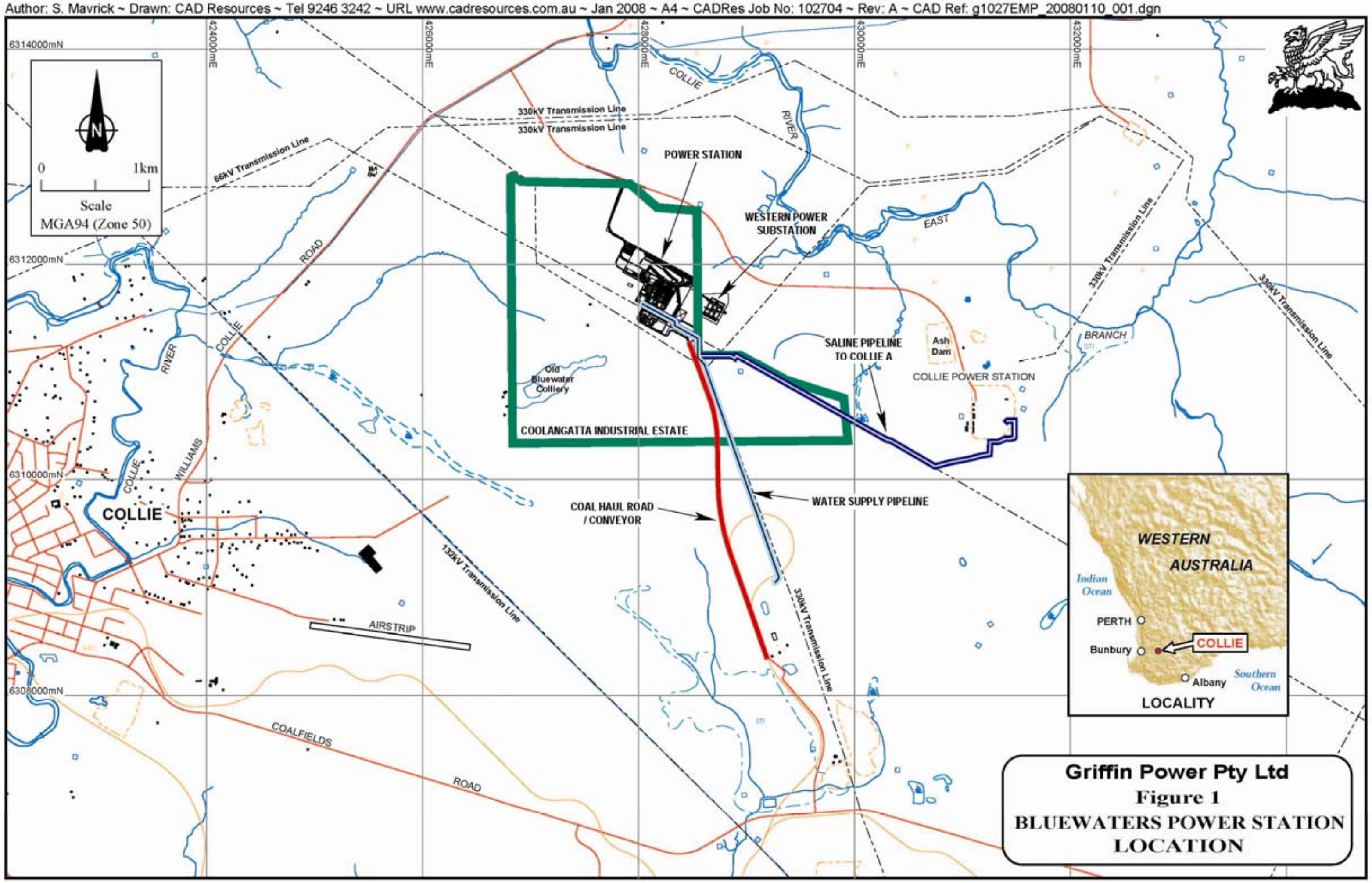

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Figure 1

BLUEWATERS POWER STATION LOCATION