Appendix D

Greenhouse Gas Assessment

Contents

1. Introduction

1.1. Project Background

TRUenergy has recently commissioned a 400MW Combined Cycle Gas Turbine (CCGT) power station at Yallah (referred herewith as Tallawarra Stage A), on the shores of Lake Illawarra, approximately 13km south of Wollongong in the Illawarra district of NSW. The power station is sited on part of the area previously occupied by the Tallawarra coal fired power station. The Tallawarra Stage A plant consists of one Alstom GT26 gas turbine and a steam turbine.

TRUenergy is proposing to construct the Tallawarra Stage B power station located adjacent to the existing Tallawarra Stage A CCGT power station. The proposed Tallawarra Stage B plant would either be another CCGT plant similar to Tallawarra Stage A or a peak load Open Cycle Gas Turbine (OCGT) plant, assumed to be made up of two E class gas turbines. The OCGT plant would operate to supply electricity at short notice during periods of peak demand or system emergency situations.

As an OCGT, the Tallawarra Stage B gas turbines would run on natural gas as the primary fuel, with distillate fuel as a back-up fuel for use during a major interruption to, or periods of, limited natural gas supply. The Tallawarra Stage A CCGT plant and Tallawarra Stage B CCGT plant would operate on natural gas fuel only.

The project comprises the following key components:

- Tallawarra Stage B power station comprising up to 2 gas turbine generators and ancillary plant;
- high voltage switchyard (extension) comprising high voltage transformers and switchgear;
- transmission line connection to the existing 132kV network;
- connecting gas pipelines, gas receiving station and gas conditioning station;
- distillate tank and unloading station;
- potable/fire water tank;
- demineralised water tank;
- electrical module; and
- emergency diesel generator.

1.2. Assessment in Accordance with Director General Requirements

The Director-General's requirements state that a greenhouse gas assessment should be undertaken for the proposed development, incorporating a quantitative model showing the tonnages of greenhouse gases produced (directly and indirectly from the development) on the basis of each unit of production (MWh). The assessment should also include total annual emissions, project lifetime, and for each fuel (natural gas and distillate). Annual emission figures are to be expressed as a percentage of the total national and state greenhouse gases produced per year over the life of the project, and should be compared against best practice emissions for gas turbine electricity generation and alternative electricity generation technologies. Emissions per unit of production figures must also compare the project with best practice open-cycle and alternative electricity generation technologies. If a greenhouse gas offset is proposed, full details of this offset(s) must be included in the Environmental Assessment and the feasibility of its application assessed.

1.3. Study Objectives

The main objectives of this report are to outline the:

- Issues associated with greenhouse gases, in general (**Section 2**);
- The government's commitment and response to the management of greenhouse gases as detailed in national and international policy. The discussion includes the proposed emissions trading scheme (ETS) which forms part of the National Carbon Pollution Reduction Scheme (**Section 3**);
- Determination of expected greenhouse gas emissions from the proposed Tallawarra power station upgrade from the technology recommended in the feasibility study conducted by SKM (**Sections 4 and 5**); and
- Identification and recommendation of greenhouse gas management and mitigation options for the project (**Section 6**).

2. Greenhouse Gas Issues

This section of the report sets out issues associated with greenhouse gases and climate change.

2.1. Climate Change

The greenhouse effect is a natural phenomenon that makes the earth 33°C warmer than it would otherwise be, and occurs due to gases found in the atmosphere known as greenhouse gases (GHG). Since the start of the Industrial Revolution (c1750-1800), the emission of greenhouse gases has risen substantially due to increased industrial and agricultural production, and the use of fossil fuels. The resulting enhancement to GHG levels has led to increased global temperatures and changes in precipitation patterns (IPCC, 2007)[1].

It is reported that the global rate of increase in the atmosphere of CO_2 concentrations over the last 200 years far exceeds the rate of the previous 20,000 years. Although Australia contributes just 1 percent of the global GHG emissions, our per capita emissions are amongst the highest in the world (AGO, 1998). Overall, the total net greenhouse gas emissions in Australia increased 2.2 percent between 1990 and 2005. Most of the increases have come from energy generation and industrial processes.

Major GHGs produced or influenced by human activities include the following:

- Carbon dioxide (CO_2);
- Methane (CH_4);
- Nitrous oxide (N_2O);
- Synthetic halocarbons;
- Sulfur hexafluoride (SF_6); and
- Other important gases.

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[1] IPCC: The Intergovernmental Panel on Climate Change (IPCC), established by the World Meteorological Organization (WMO) and the United Nations Environment Programme (UNEP) in 1988, is both an intergovernmental body and a network of the world's leading climate change scientists and experts. The role of the IPCC is to assess on a comprehensive, objective, open and transparent basis the scientific, technical and socio-economic information relevant to understanding the scientific basis of risk of human-induced climate change, its potential impacts and options for adaptation and mitigation. Review by experts and governments is an essential part of the IPCC process. The Panel does not conduct new research, monitor climate-related data or recommend policies. It is open to all member countries of WMO and UNEP.

2.2. Greenhouse Gases

2.2.1. Carbon Dioxide

Carbon dioxide is the main anthropogenic gas contributing to climate change and concentrations of this gas in the atmosphere have increased by 30 percent during the past 200 years (CSIRO, 2000). The major anthropogenic sources of CO_2 emissions are fossil fuel combustion and land clearing for agriculture.

2.2.2. Methane

Atmospheric methane concentrations have increased by 150 percent during the past 200 years (CSIRO, 2000) and although there is less methane in the atmosphere than CO_2, it is a significantly stronger greenhouse gas. The major anthropogenic sources of methane are cattle, rice growing and leakages during natural gas production, distribution and use. Presently, natural processes remove methane from the atmosphere at almost the same rate as it is being added to it. However, over the next 100 years, methane concentrations are likely to rise.

2.2.3. Nitrous Oxide

Atmospheric nitrous oxide concentrations have increased by 15 percent during the past 200 years and it can persist in the atmosphere for up to 100 years. Major sources of nitrous oxide include industrial processes, fertiliser use and other agricultural activities, including land clearing.

2.2.4. Halocarbons and Sulphur Hexafluoride

Hydrofluorocarbons (HFC) are chlorofluorocarbons (CFC) with the chlorine atom removed, and were introduced to replace CFCs in the refrigerant industry since they do not deplete ozone. However, HFCs can be over 11,000 times stronger greenhouse gases than CO_2.

HFCs, PFCs (perfluorocarbons, another CFC substitute) and sulfur hexafluoride (a gas used for electrical insulation) are powerful greenhouse gases. Technologies exist to reduce emissions of these gases to near zero over the next few decades. Thus, they represent probably the most significant, immediate opportunity to slow down the current growth of greenhouse gases entering the atmosphere.

2.2.5. Other Important Gases

The hydroxyl radical (OH) is a highly reactive agent that helps cleanse the atmosphere of pollutants such as methane. OH will also react with carbon monoxide which, although not a GHG, reduces the amount of OH in the atmosphere, thereby increasing the length of time greenhouse gases such as methane stay in the atmosphere. Carbon monoxide, hydrocarbons and oxides of nitrogen can react to form ozone, another GHG. In contrast to ozone depletion in the stratosphere, ozone in the troposphere acts as an effective GHG.

2.3. Global Warming Potential

Global warming potentials (GWPs) are used to compare the abilities of different greenhouse gases to trap heat in the atmosphere. GWPs are based on the radiative efficiency (heat-absorbing ability) and the decay rate (the amount removed from the atmosphere over a given number of years) of each gas relative to that of carbon dioxide (CO_2). The GWP provides a construct for converting emissions of various gases into a common measure, which allows climate analysts to aggregate the radiative impacts of various greenhouse gases into a uniform measure denominated in carbon or carbon dioxide equivalents.

The generally accepted authority on GWPs is the Intergovernmental Panel on Climate Change (IPCC). In 2001, the IPCC updated its estimates of GWPs for key greenhouse gases. **Table 2-1** compares the GWPs published in 1996 in the IPCCs Second Assessment Report, those published in 2001 in the IPCCs Third Assessment Report and those published in 2006 in the IPCCs Fourth Assessment Report.

- **Table 2-1: Comparison of 100-Year GWP Estimates from the IPCC's Second (1996), Third (2001) and Fourth (2006) Assessment Reports**

Greenhouse Gas	1996 IPCC GWP	2001 IPCC GWP	2006 IPCC GWP
Carbon Dioxide	1	1	1
Methane	21	23	25
Nitrous Oxide	310	296	298
HFC-23	11,700	12,000	14,800
HFC-125	2,800	3,400	3,500
HFC-134a	1,300	1,300	1,430
HFC-143a	3,800	4,300	4,470
HFC-152a	140	120	124
HFC-227ea	2,900	3,500	3,220
HFC-236fa	6,300	9,400	9,810
Perfluoromethane (CF_4)	6,500	5,700	7,390
Perfluoroethane (C_2F_6)	9,200	11,900	12,200
Sulphur Hexafluoride (SF_6)	23,900	22,200	22,800

In assessing the greenhouse impact from a collection of different gases, it is typical to report the collective impact as carbon dioxide equivalents (CO_2-e). Carbon dioxide equivalents is a metric measure used to compare the emissions from various greenhouse gases based upon their global warming potential (GWP). For example, the GWP for methane is 25 and for nitrous oxide 298. This means that emissions of 1 tonne of methane and nitrous oxide respectively is equivalent to emissions of 25 and 298 tonnes of carbon dioxide in terms of GWP.

3. Greenhouse Response

This section of the report sets out both the international and national response to greenhouse gas management.

3.1. International Response

The international response to climate change has involved the development of an international treaty designed to limit the emissions of GHG and ozone depleting substances, known as the *Kyoto Protocol to the Framework Convention on Climate Change* (UNFCCC, 1992).

The objective of the Kyoto Protocol is to reduce the GHG emissions worldwide. The Kyoto Protocol establishes provisions to limit emissions of specified greenhouse gases (GHGs) (UNEP, 1997). Signatories to the *Kyoto Protocol* would be required to reduce GHG emissions by at least five percent below 1990 levels by 2008–2012 (DEC, 2003).

It is understood that some countries will do better than expected in reducing GHG emissions, coming in under 5 percent, while others will exceed 5 percent. This means that some countries that have emissions units to 'spare' (i.e. emissions permitted to them but not 'used'). The Protocol allows countries to sell their excess emission units to other countries so that countries not meeting their commitments will be able to 'buy' compliance. This gives rise to a 'carbon market'.

The Kyoto Protocol sets a framework for the control of the emission of six greenhouse gases (GHGs). These are:

- Carbon dioxide (CO_2);
- Methane (CH_4);
- Nitrous oxide (N_2O);
- Hydrofluorocarbons (HFCs);
- Perfluorocarbons (PFCs); and
- Sulphur hexafluoride.

On 3 December 2007, the Australian Prime Minister Kevin Rudd signed the instrument of ratification of the Kyoto Protocol. As such, Australia has committed to meeting its Kyoto Protocol target, and has set a target to reduce greenhouse gas emissions by 60 percent on 2000 levels by 2050. Australia will participate actively and constructively in the negotiations working towards a post-2012 agreement which is equitable and effective. Australia's position is that any binding commitments need to encompass both developed and developing countries if we are to be successful in tackling climate change.

3.2. National Response

3.2.1. The Department of Climate Change (DCC)

The Department of Climate Change (DCC) was established on 3 December 2007 as part of the Prime Minister and Cabinet Portfolio. It followed the establishment of the Australian Greenhouse Office (AGO), part of the Department of the Environment and Heritage, to coordinate national climate change policy and drive associated programs such as the National Greenhouse Strategy (AGO, 2004).

The National Greenhouse Strategy was developed to provide the strategic framework for an effective greenhouse response and for meeting current and future international commitments (Commonwealth of Australia 1998). The Strategy was endorsed by the Commonwealth and all State and Territory governments in 1998. The three goals of the National Greenhouse Strategy are to:

1) Limit net GHG emissions, in particular to meet our international commitments;
2) Foster knowledge and understanding of greenhouse issues; and
3) Lay the foundations for adaptation to climate change.

Australia has developed methodologies consistent with the Intergovernmental Panel on Climate Change (IPCC) guidelines for preparing and reporting the National Greenhouse Gas Inventory (NGGIC, 1996).

The DCC (formerly AGO) delivers the majority of programs under the Australian Government's $1.8 billion climate change strategy. This strategy is centred on five key areas including emissions management, international engagement, strategic policy support, impacts and adaptation, and science and measurement. Major initiatives include:

- Boosting renewable energy actions and pursuing greater energy efficiency;
- Investing significant resources into greenhouse research and monitoring Australia's progress towards its Kyoto target through the National Greenhouse Gas Inventory;
- Studying the landscape of Australia through the National Carbon Accounting System;
- Encouraging the development and commercialisation of low emissions technologies;
- Encouraging industry, business and the community to use less greenhouse intensive transport; and
- Fostering sustainable land management practices.

The Australian Government is building partnerships with industry through the Greenhouse Challenge program, which provides a framework for undertaking and reporting on actions to abate emissions.

The Greenhouse Friendly initiative and Greenhouse Gas Abatement program encourage industry action to abate greenhouse emissions from a range of sectors.

In addition, the Government encourages households, communities and local councils to take action to reduce greenhouse gas emissions through its Local Greenhouse Action initiative which includes the International Cities for Climate Protection program. Action is also being pursued with the energy industry through the establishment of efficiency standards.

3.2.2. Greenhouse Challenge Program and Greenhouse Challenge Plus

The Greenhouse Challenge Program was launched in October 1995, with signatories to the program aiming to cut their emissions substantially by 2000. This is a key voluntary program, involving a partnership between Government and industry to reduce greenhouse gas emissions. There is a broad and diverse participation in the program, with over 500 signed agreements with large and medium sized organisations.

Greenhouse Challenge Plus builds on the success of the Greenhouse Challenge programme and integrates two other industry focused measures (the Generator Efficiency Standards and Greenhouse Friendly initiative). It also incorporates the changes announced in the Australian Government's 2004 Energy White Paper '*Securing Australia's Energy Future*'.

Greenhouse Challenge Plus is designed to:

- Reduce greenhouse gas emissions;
- Accelerate the uptake of energy efficiency;
- Integrate greenhouse issues into business decision-making; and
- Provide more consistent reporting of greenhouse gas emissions levels.

The Greenhouse Challenge Plus Program involves the management of greenhouse gas emissions through emissions inventory reporting and through the development and implementation of action plans to achieve cost effective abatement.

3.2.3. Greenhouse Friendly Initiative

The Australian Government's Greenhouse Friendly initiative is designed as a fresh approach to doing business. It aims to help businesses show their commitment to the environment, whilst improving their bottom line at the same time. The initiative is designed to assist businesses stand out from their competition by showing that good environmental practices make business sense.

The AGO conducted Greenhouse Friendly Consumer Research during October 2004 to determine the responsiveness of the general public towards greenhouse and Greenhouse Friendly type products and services. The research revealed that the enhanced greenhouse effect and climate change were important issues for consumers surveyed. Many people, when making certain purchasing decisions, consider the impacts of climate change. Respondents wanted to see rigorous accreditation and independent verification on products and services with reduced climate change impacts. This research therefore suggests that the interest in "green" products and services with a reduced climate change impact is quite high among consumers.

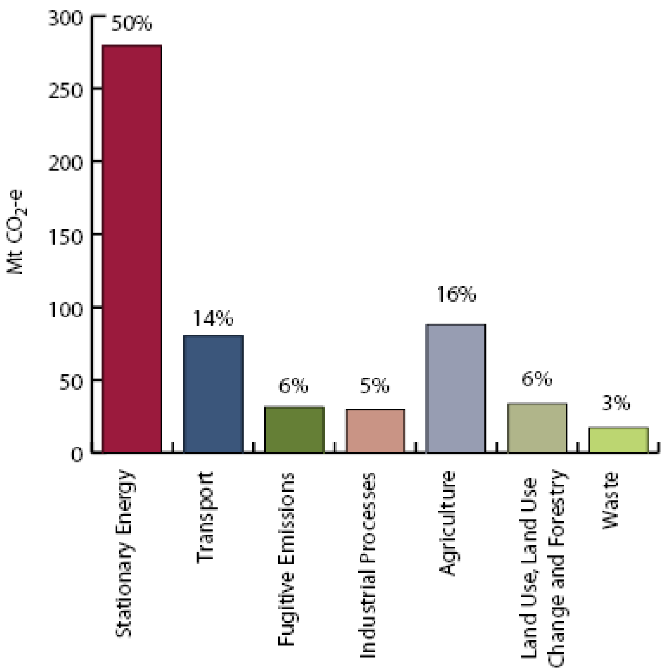
3.2.4. National Greenhouse Gas Inventory

The Australia's National Greenhouse Gas Inventory Report 2005 (AGO, 2007) has the dual purpose of providing estimates of Australia's net greenhouse gas emissions for the United Nations Framework Convention on Climate Change (UNFCCC) and of tracking Australia's progress towards its internationally agreed target of limiting emissions to 108 percent of 1990 levels over the period 2008–2012.

Australia is committed, as a party to UNFCCC, to updating and publishing annual national greenhouse gas inventories. Inventories have been produced for each year from 1990 to 2005 inclusive. The 2005 inventory is based on international guidelines established by the IPCC and Kyoto accounting provisions.

In 2005, Australia's net greenhouse gas emissions using the Kyoto accounting provisions were 559.1 million tonnes of CO2-equivalent Mt (CO2-e). The combined energy sectors were the largest source of greenhouse gas emissions comprising 69.9 percent (391.3 Mt CO2-e) of emissions (refer to **Figure 3-1**). This proportion is less than in many countries due to the relatively large contribution from agriculture (15.7 percent) and land use, land use change and forestry sectors (5.3 percent). Other relatively minor sources include emissions from industrial processes, such as from the manufacture of mineral products and emissions from waste disposal.

- **Figure 3-1: Contribution to total net CO2-e emissions by sector (Kyoto accounting), 2005 (Source: National Greenhouse Gas Inventory Report, 2007)**



- **Table 3-1: Australian Net Greenhouse Gas Emissions by Sector (Kyoto accounting), 2005 (Source: National Greenhouse Gas Inventory Report 2007)**

Sector and Subsector	Emissions (Mt)			
	CO_2	CH_4	N_2O	CO_{2-e}
All energy (combustion + fugitive)	361.1	1.3	0.01	391
Stationary energy	277.2	0.1	0.003	279.4
Transport	78.3	0.03	0.005	80.4
Fugitive emissions from fuel	5.6	1.2	0.0001	31.2
Industrial processes	23	0.003	0.0001	29.5(b)
Agriculture	NA	3.2	0.07	87.9
Land use, land use change and forestry	31.4	0.1	0.002	33.7
Waste	0.03	0.8	0.002	17

(a) Emissions are included in Industrial Processes for reasons of confidentiality
(b) HFCs, PFCs and SF_6 are not separately reported here but are included in the CO_2-e totals

3.2.5. Generator Efficiency Standards

Generator Efficiency Standards (GES) are one of the key energy measures announced in the Prime Minister's 1997 climate change statement *Safeguarding the Future: Australia's Response to Climate Change*. It aims to encourage businesses to "achieve movement towards best practice" generation performance and, as a result, reduce greenhouse emissions. It was endorsed by the Council of Australian Governments in 1998 and subsequently incorporated into the National Greenhouse Strategy. These guidelines were developed following extensive consultation with industry, electricity users and the wider community and were most recently published in December 2006.

3.2.6. National Carbon Pollution Reduction Scheme

The Carbon Pollution Reduction Scheme is designed to limit carbon pollution while minimising the impact on business and households. There are two distinct elements - the cap on carbon pollution and the ability to trade. The cap achieves the environmental outcome of reducing carbon pollution. The ability to trade ensures carbon pollution is reduced at the lowest possible cost.

Mechanics of a cap and trade Carbon Pollution Reduction Scheme:

- The Government sets a cap on the total amount of carbon pollution allowed in the economy by covered sectors;
- The Government will issue permits up to the annual cap each year;
- Industries that generate carbon pollution will need to acquire a 'permit' for every tonne of greenhouse gas that they emit;
- The quantity of carbon pollution produced by each firm will be monitored and verified;
- At the end of each year, each liable firm would need to surrender a permit for every tonne of carbon pollution the firm produced in that year;
- Firms compete in the market to purchase the number of permits that they require. Firms that value the permits most highly will be prepared to pay the most for them, either at auction, or on a secondary trading market. For some firms, it will be cheaper to reduce emissions than to buy permits; and
- As a transitional assistance measure, certain categories of firms might receive some emissions permits for free. These firms could use these permits or sell them.

The price of permits is not set by the Government- rather, it emerges from the market. If a firm can reduce carbon pollution more cheaply than the prevailing market price of permits, it will choose to reduce carbon pollution rather than buy permits. Therefore, this kind of scheme provides a strong incentive for participants to reduce their own carbon pollution. By making this business decision around whether to reduce carbon pollution or trade in permits, firms operate within the overall cap at least cost.

In this way, the scheme gives firms the flexibility to choose the most cost-effective way to meet the carbon pollution cap. At the same time, the carbon pollution market provides a greater financial incentive for firms to develop and adopt technologies to reduce emissions (Further information: www.climatechange.gov.au).

3.3. State Response

3.3.1. NSW Government Green Paper

The increasing demand for electricity has led to an increase in negative externalities created as a result of electricity production. For example, as outlined in the NSW Government Green Paper of December 2004, greenhouse gas emissions have increased by almost 50 percent in the past ten years. New South Wales is the only jurisdiction in Australia to have placed mandatory greenhouse reduction targets on its electricity retailers.

There are significant timeframes required for appropriate planning, financing and construction of new energy assets. To allow planning to commence for capacity that will meet additional demand at the end of the decade, the Government is now seeking to provide regulatory certainty for investors. The purpose of the Green Paper is to provide this certainty.

3.3.2. Greenhouse Gas Abatement Program

The Greenhouse Gas Abatement Program (GGAP) is a major NSW Government initiative to assist Australia in meeting its Kyoto Protocol target. The objective of GGAP is to reduce Australia's net greenhouse gas emissions by supporting activities that are likely to result in substantial emission reductions or substantial sink enhancements, particularly in the first commitment period under the Kyoto Protocol (2008-2012). $400 million has been allocated to this Program.

This environmental initiative is a key part of the Measures for a Better Environment package announced in May 1999, in association with the Government's taxation reforms.

GGAP targets opportunities for large-scale, cost-effective and sustained abatement across the economy. GGAP supports projects that will result in quantifiable and additional abatement not expected to occur in the absence of GGAP funding. Priority is given to projects that deliver abatement exceeding 250,000 tonnes of carbon dioxide equivalents (CO_2-e) per annum. Projects that do not meet this threshold but meet other criteria to a high degree may be selected.

In keeping with the Government's commitment to reduce greenhouse gas emissions through cost-effective actions that minimise the burden for business and the community, GGAP seeks out projects with a low cost for each tonne of emissions that is reduced or avoided. GGAP employs a competitive selection process, with two key cost-effectiveness indicators informing project selection:

- GGAP funds (dollars) per metric tonne of reasonably assured and additional CO_2-e estimated to be abated in 2008-2012; and
- Net national cost (dollars) per metric tonne of reasonably assured and additional CO_2-e estimated to be abated in 2008-2012.

Projects funded under GGAP are expected to provide complementary benefits, for example opportunities for rural and regional Australia, ecologically sustainable development, employment growth, the use of new technologies and innovative processes, and non-government investment.

3.3.3. NSW Government's Inquiry to Electricity Supply in NSW

The NSW Government's (Owen) *Inquiry to Electricity Supply in NSW* (September 2007) has established the need for additional base load electricity in NSW by the summer of 2013/14. The Inquiry concluded that "the most technologically advanced, commercially viable options currently available for the next tranche of base load generation in NSW are CCGT and Ultra-supercritical Coal (USC)".

In terms of Alternative Technology, the Inquiry considers the constraints associated with them in terms of immediate implementation as base load electricity generators in NSW. These technologies can be generally described as follows:

<u>Advanced Coal and Gas Technologies</u>

- Integrated Coal Gasification Combined Cycle (IGCC); and
- Ultra Clean Coal Combined Cycle (UCC).

<u>Renewable Energy Technologies</u>

- Hydro;
- Wind;
- Solid Biomass;
- Solar Thermal; and
- Geothermal Hot Dry Rock.

Other energy technologies identified in the Inquiry as not being suitable for base load electricity generation in NSW include ocean wave, ocean tidal, solar photo-voltaic, geothermal aquifer, biomass gasification, biogas methane, fluidised bed coal combustion, and pressurised fluidised bed coal combustion.

In terms of nuclear technology, while this is mature and has low carbon emissions, this was ruled out by the Inquiry as an alternative base load option on the basis of NSW Government policy and the absence of a nuclear energy regulatory framework in NSW.

3.4. TRUenergy Initiatives

3.4.1. TRUenergy Climate Change Strategy

Given a supportive policy framework, TRUenergy intends to reduce emissions across its portfolio by:

- capping carbon intensity with reductions commencing by 2010;
- cutting emissions intensity by one-third of 2007 levels (1.2 tonnes/MWh) by 2020;
- reducing emissions by 35 percent by 2035 on a 1990 baseline (proportional to market share);
- reducing emissions by 60 percent by 2050 on a 1990 baseline (proportional to market share); and
- committing not to build any greenfield, traditional technology, coal-fired power stations.

As TRUenergy continues to grow market share, it will take responsibility for its increased proportion of emissions across the National Electricity Market. TRUenergy will also implement programs to help consumers manage their carbon footprint through energy efficiency and the promotion of accredited GreenPower customer products.

3.4.2. Key Assumptions Underpinning TRUenergy's Climate Change Strategy

TRUenergy's Climate Change Strategy is predicated on a number of critical assumptions, including:

- a global high-level objective to prevent global warming of 2ºC or more above pre-industrial average surface temperatures;
- modelling that assumes an effective and efficient national emissions trading scheme;
- the availability of commercial scale 'clean coal' with carbon capture and storage by 2030; and
- the assumption that nuclear power will not be a part of the generation mix until a comprehensive regulatory framework to support it is in place.

The achievement of TRUenergy's Climate Change Strategy relies on the introduction of an effective national emissions trading scheme that creates an explicit, market-based price of carbon and preserves existing asset values of those most adversely affected by a carbon charge.

Australia's policy framework should also provide strong incentives for publicly funded research and development of cost effective emission reduction technologies, as well as a national mechanism to support low and zero emission technologies in their commercialisation phase to ensure they are deployed in a timely manner.

3.4.3. TRUenergy's Climate Change Strategy Actions

TRUenergy will drive its Climate Change Strategy through early action, including:

- a comprehensive program to reduce greenhouse emissions at the Yallourn power station;
- the construction of Tallawarra Stage A, Australia's most energy efficient gas-fired power station;
- the management of CLPs interests in Roaring 40s renewable energy joint venture;
- increasing customer uptake of a range of accredited GreenPower products;
- an energy efficiency focus across the whole business, from generation assets to offices to customers;
- membership of the AGO Greenhouse Challenge Plus Program to help in the identification of TRUenergy's emissions footprint and manage an action plan to reduce it; and
- annual measurement and reporting of greenhouse gas emissions and mitigation strategies.

4. Construction Greenhouse Emissions

During the construction phase, sources of greenhouse gas emissions will include the use of vehicles and equipment. Equipment that will be used during the construction phase includes:

- Excavators;
- Front end loaders
- Backhoes;
- Graders;
- Semi tipper trucks;
- Scrapers;
- Bulldozers;
- Rollers;
- Water trucks;
- Cranes; and
- Compactors.

All this equipment (and more) will consume fuel (primarily diesel) resulting in the emission of greenhouse gases.

The quantity of greenhouse gases is difficult to estimate as it is dependent on the distances travelled and work done by this equipment, which is subsequently dependent on the construction method and timetable, the location of pick-up and drop-off points and so on. Additionally, the greenhouse gases emitted during the construction phase will be short term and minimal in comparison to the operation phase.

For these reasons, the greenhouse gas emissions of the construction phase are not assessed in this report.

5. Operational Greenhouse Emissions

5.1. Greenhouse Gas Emissions from the Proposed Activity

The following activities are sources of greenhouse gas emissions associated with the operation of the Tallawarra A and B power stations:

- Natural gas extraction;
- Transportation of natural gas; and
- Combustion of natural gas at the power station.

Where Tallawarra B is configured as an OCGT plant, the extraction, transportation and combustion of diesel fuel is also relevant.

5.2. Emission Forecasting Methodology

Prediction of the greenhouse gas emissions that are likely to be associated with the project has been undertaken using the methodologies outlined in the DCC National Greenhouse Accounts (NGA) Factors, 2008. The workbook aims to provide a consistent set of emission factors, adopting the emissions categories of the international reporting framework of the World Resources Institute / World Business Council for Sustainable Development. The framework is known as *The Greenhouse Gas Protocol: A Corporate Accounting and Reporting Standard* (GHG Protocol 2006).

The NGA Factors provides three types of assessment categories –

1) <u>Scope 1</u> covers **direct emissions** from sources within the boundary of an organisation such as fuel combustion and manufacturing processes.
2) <u>Scope 2</u> covers **indirect emissions** from the consumption of **purchased electricity, steam or heat** produced by another organisation.
3) <u>Scope 3</u> includes all **other indirect emissions** that are a consequence of an organisation's activities but are not from sources owned or controlled by the organisation; that is, emissions from offsite waste disposal, emissions associated with the production of fuels, and emissions from the generation of purchased electricity. Scope 3 emissions vary on a state by state basis. NSW has the second highest Scope 3 emissions, due to the sources of natural gas located outside the state. Such emissions are outside the control of TRUenergy.

Scope 1 and 2 emissions categories are carefully defined to ensure that two or more organisations do not report the same emissions in the same scope.

Estimates of emissions from natural gas may be calculated using the following formula:

GHG Emissions (t CO2-e) = Q x EF / 1000

where:

Q is the quantity of natural gas consumed and expressed in GJ, and
EF is the relevant emission factor.
Division by 1000 converts kg to tonnes.

The following formula can be used to estimate greenhouse gas emissions from the combustion of fuels excluding natural gas:

GHG Emissions (t CO2-e) = Q x EC x EF / 1000

where:
Q is the quantity of fuel in tonnes or thousands of litres,
EC is the energy content of fuel in GJ/tonne or GJ/kL, and
EF is the relevant emission factor.
Division by 1000 converts kg to tonnes.

5.3. GHG Emission Estimates

The estimation of greenhouse gas emissions for Tallawarra B power stations has been undertaken using forecast operating capacities, plant efficiency and fuel usage. At this stage TRUenergy are unable to determine the exact operating regime of the Tallawarra Stage B configured as either a CCGT or OCGT plant. However, for the purpose of this assessment, the Stage B CCGT plant is expected to have an annual capacity in the range of 30 to 95 percent, whereas the Stage B OCGT plant would have a capacity in the range of 2 and 35 percent on an annual basis.

GHG emission estimates for the proposal have been calculated and summarised in **Table 5-1**. Provided is a summary based on full fuel cycle (i.e. Scopes 1 and 3 combined). Full emission calculations are presented in **Appendix A**.

- **Table 5-1: Full Fuel Cycle CO_2-e Emissions for Power Generation at Tallawarra B**

	CCGT 30%	CCGT 95%	OCGT 2%	OCGT 35%	Units
Generating Capacity					
-gas	402	402	320	320	MW
-distillate	-	-	342	342	
Expected Operating Hours					
-gas	2628	8322	173.4	3035.3	Hours/annum
-distillate	-	-	1.8	30.7	
Annual Emissions (total)					
-gas	492	1557	41.4	726	kt CO_2-e/year
-distillate	-	-	0.5	9.1	
Total Annual Emissions	492	1557	42	735	kt CO_2-e/year
Total Generating Capacity	1056	3345	56	981	GWh
Emissions Intensity	**465**	**465**	**750**	**750**	**tonnes CO_2-e/GWh**

It should be noted that the above stated greenhouse gas intensities are full fuel cycle (FFC) emission intensities and include both direct (Scope 1) and indirect (Scope 3) emission factors. With respect the actual emission performance of the proposed gas turbine plant only Scope 1 emissions are relevant and these are as follows:

- CCGT – 364 tonnes CO_2-e/GWh
- OCGT – 585 tonnes CO_2-e/GWh (gas fuel)

Plant emissions intensities will vary for a variety of reasons including plant type, fuel quality and ambient conditions, and as such the above stated intensities are a guide only. They are, however, considered current best practice for gas turbine plant.

It is difficult to estimate life-time greenhouse gas emissions as the operating regime may be highly variable as evidenced in **Table 5-1** and also the operating life of the power station is unknown at this stage. Assuming a 30 year lifetime, estimated GHG emissions are set out in **Table 5-2**.

- **Table 5-2 Tallawarra B Lifetime GHG Emissions**

	CCGT 30%	CCGT 95%	OCGT 2%	OCGT 35%	Units
Estimated Lifetime GHG Emissions	14.8	46.7	1.26	22.1	Mt/CO_2-e

Over a 30 year lifetime, the proposed Tallawarra Stage B CCGT power station would generate greenhouse gas emissions ranging from 14.8 to 46.7 Mt/CO_2-e, for the plant operating at average capacities ranging from 30 percent to 95 percent (refer to **Table 5-2**).

Lifetime greenhouse emissions for the proposed Tallawarra Stage B OCGT plant are estimated to be less than half the lifetime emissions of the CCGT option, ranging from 1.05 to 18.4 Mt/CO_2-e for averaging operating capacities ranging from 2 percent to 35 percent (refer to **Table 5-2**).

5.4. GHG Emission Estimates

Total greenhouse gas emissions in NSW 2005 were 158.2 million tonnes CO_2-e. Stationary energy emissions were 75.7 million tonnes CO_2-e and include fossil fuel combustion in electricity and heat production, and manufacturing and construction industries. Fugitive emissions of 14.2 million tonnes CO_2-e were emitted during the extraction and production of coal, oil and gas (DECC, 2007).

Table 5-3: State Territory and Greenhouse Gas Emissions for 2005

State	2005 Emissions (Mt CO_2-e)
New South Wales	158.2
Queensland	157
Victoria	121.9
Western Australia	66.6
South Australia	28.1
Northern Territory	13.5
Tasmania	11
ACT	1.1
Total	**557.4**

For the proposed Tallawarra Stage B OCGT power station, the greenhouse gas emissions produced will be equivalent to approximately 0.03 and 0.46 percent of NSW emissions (2005) operating at 2 and 35 percent capacity factors respectively. If the plant was to operate at 2 percent capacity this would correspond to 0.01 percent of the national emissions (2005) and if the plant was to operate at 35 percent capacity it would correspond to 0.13 percent of national emissions.

If the proposed Tallawarra Stage B CCGT power station was to operate at 30 percent capacity, the greenhouse gas emissions produced would be approximately equal to 0.31 and 0.09 percent respectively for the NSW and national emissions in 2005. Greenhouse gas emissions from the proposed Tallawarra Stage B CCGT power station operating at a 95 percent capacity factor will be equivalent to approximately 0.98 percent of the NSW emissions (2005) and 0.28 percent of the national emissions (2005). This is considered the worst case scenario, as the proposed CCGT power station will contribute higher greenhouse gas emissions on an annual basis when compared to the peak load OCGT option.

6. Greenhouse Gas Best Practice

6.1. Reducing Emissions Associated with Electricity Generation

Natural gas has the lowest carbon intensity of any fossil fuel. TRUenergy's commitment to minimising greenhouse gas emissions is demonstrated through the use of natural gas as the predominant fuel source.

In addition to the use of a low GHG emitting fuel, one of the many advantages of modern CCGT plants is their efficiency at converting fuel into electrical energy – more than 50 percent. This results in less fuel consumption and lower levels of emissions per unit of electricity generated compared to less efficient conventional fossil fuel power plants (SKM, 2006). The high electricity generation efficiency of CCGT is due to the reuse of exhaust gases.

The emission intensity associated with electricity generation is calculated by dividing the total greenhouse gas emissions from the project attributed to electricity production by the total amount of electricity produced. Emission intensities of the Tallawarra Stage B CCGT option and some emission intensities for other fossil fuel powered power stations in Australia are shown in **Table 6-1**.

- **Table 6-1 Emission Intensities for Tallawarra B (CCGT) and other Power Stations**

Power Station	Location	Fuel	Emissions Intensity (t CO_2-e/GWh)
Tallawarra B CCGT (NGA, full fuel cycle)	NSW	Natural Gas	465
NSW Black Coal Power Stations		Black Coal	950 – 1070
Bell Bay Power Station (existing thermal units and 35MW OCGT's)	Tasmania	Natural Gas	629
Wagerup CCGT (Stage 2)	Western Australia	Natural Gas	453
Worsely Cogeneration			490
Alcoa Pinjarra Cogeneration			489
Victoria Brown Coal Power Stations	Victoria	Brown Coal	1158 – 1580

As can be seen from **Table 6-1**, the benefit of the plant selection proposed for Tallawarra Stage B CCGT power station is demonstrated by the similar predicted emission intensity to other CCGT power stations around the country and a much better emission intensity than coal fired power stations in New South Wales and Victoria.

In particular when compared with similar CCGT power stations in WA where full fuel cycle (FFC) emission intensities are as low as 453 tonnes CO2-e/GWh compared with the Tallawarra B CCGT emissions intensity of 465 tonnes CO2-e/GWh, it is noted that the NSW Scope 3 emissions intensity is 14.2 kg CO2-e/GJ compared with 7.0 kg CO2-e/GJ in WA. As such where FFC = Scope 1 + Scope 3, and Scope 1 provides a true reflection of the emissions intensity of the actual installed power generating technology, it is anticipated that Scope 1 emissions from Tallawarra B as an Alstom GT26 CCGT plant i.e. 364 tonnes CO2-e/GWh would be equivalent or lower than any other CCGT plant in Australia including the WA plant referred to in **Table 6-1**.

Although renewable sources have lower emission intensities than the proposed Tallawarra Stage B CCGT plant, they do not represent feasible alternatives for various reasons. The CCGT is designed to meet base load electricity demand and therefore requires a reliable energy source. Consequently, the intermittent nature of current solar and wind energy generation technologies excludes these alternatives.

6.2. Reporting, Reviewing and Continuous Improvement Approach

In order to calculate and report greenhouse gas emissions over the lifespan of the project, TRUenergy will measure fuel consumption and obtain fuel composition from the supplier. This will allow the greenhouse gas emissions of the project to be calculated and reported in the project's Annual Environmental Report. The project's greenhouse intensity will be calculated annually, based on measurements of electricity sent-out and steam produced.

Details of the systems relevant to emissions calculations are as follows:

- Fuel Gas Metering: The gas turbine generator (GTG) will be fitted with a fuel gas flow meter to measure the flow rate of gas entering each GTG at an accuracy of 1 percent. The flow rate of gas will be corrected for temperature and pressure, which will be measured directly; and
- Electricity Metering: All sent-out electricity will be metered at the point of connection to the grid, with an accuracy of 1 percent.

The monitoring and reporting of emissions will also enable for its simple incorporation into the state and national greenhouse inventories as required in the National Greenhouse Strategy, and the emerging National Greenhouse and Energy Reporting (NGER) System.

A 'continuous improvement approach' will be adopted, with advances in technology and potential operational improvements of plant performance assessed on an annual basis and reported in the

Annual Environmental Report. The type of improvements that can be assessed annually will include:

- Appropriate maintenance of equipment to maintain or improve greenhouse efficiency;
- The use of up to date technology (with a focus on greenhouse efficiency) when sourcing components for maintenance and overhaul activities;
- Minimisation of vehicle use; and
- Minimisation of distillate fuel use.

6.3. Participation in the 'Greenhouse Challenge'

TRUenergy is a member of the Commonwealth Government's *Greenhouse Challenge Plus* program. The *Greenhouse Challenge Plus* program is designed to enable Australian companies to form working relationships with the Australian Government to improve energy efficiency and reduce greenhouse gas emissions. Building on the earlier Greenhouse Challenge program, the program establishes a single industry program. The Greenhouse Challenge Plus program is designed to:

- Reduce greenhouse gas emissions;
- Accelerate the uptake of energy efficiency;
- Integrate greenhouse issues into business decision making; and
- Provide more consistent reporting of greenhouse gas emission levels.

TRUenergy has power purchase agreements for renewable energy with two of Australia's largest wind farms, Wattle Point (91 MW each year) and Cathedral Rocks (66 MW) in South Australia. Purchasing wind power, as well as biomass and solar generated energy, assists TRUenergy in meeting its clean energy targets and demonstrates its support for the renewable energy industry.

TRUenergy also provides its customers with a choice of GreenPower accredited products. It has a 100 percent government-accredited product, TRUenergy Wind. In 2005, TRUenergy purchased 301 GWh of renewable energy from wind farms and embedded generators.

Each year TRUenergy also purchases increasing amounts of Renewable Energy Certificates to demonstrate support for the generation of renewable electricity. Each certificate is equivalent to 1 MWh of renewable energy. In 2005, TRUenergy purchased a total of 581,730 Renewable Energy Certificates.

TRUenergy's parent company, CLP, is committed to generating 5 percent of their total capacity from renewable energy sources by 2010. In October 2005, CLP acquired a 50 percent interest in Roaring

40s Renewable Energy Pty Ltd, which will provide a platform for the development of renewable energy projects (primarily wind power) in Australia and Asia.

Projects implemented in 2007 are expected to deliver annual abatements of approximately 200,000 tonnes of CO_2-e, which is the equivalent of taking around 45,000 cars off our roads.

7. Conclusions

Through the burning of natural gas (and distillate for OCGT only) to produce electricity the Tallawarra Stage B power station as a CCGT base load plant (95 percent capacity factor) will emit approximately 1,557 kilotonnes of carbon dioxide equivalents (full fuel cycle) each year of its proposed 30 year life span. This emission rate corresponds to an approximate full fuel cycle emission intensity of approximately 465 tonnes CO_2-e/GWh.

This emission intensity is low when compared to coal fired power stations around the country, which produce over 1,000 tonnes CO_2-e/GWh (full fuel cycle). It is also low when compared to other CCGT units across Australia. This relatively low emission intensity is compliant with the action contained within the National Greenhouse Strategy, which aims to lower the emission intensity associated with electricity production.

Greenhouse gas emissions from the Tallawarra B plant will be monitored throughout the operation phase of the project through the metering of fuel supplies and electricity outputs, to an accuracy of 1 %. These emissions will be reported under the National Greenhouse Inventory. A number of management measures including regular maintenance and the use of up-to-date technology will be used to create continual improvement in relation to greenhouse gas emissions.

At the current stage of design, to the best of TRUenergy’s knowledge, no ozone depleting substances will be used at the Tallawarra power station. Additionally, no ozone depleting substances will be emitted as part of the power station’s operation.

8. References

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Appendix A GHG Calculations

SCENARIO 2				
CCGT-GT26 - 95%				
Generating Capacity			402	MW
Operating Hours			8,322	hours
Annual Output			3,345,444	MWh
Heat Rate			7,104,000.0	kJ/MWh HHV
Energy per Annum			23,766,034,176,000	kJ/yr
			23,766,034	GJ/year
Emission Factor	65.5	51.3	14.2	kg CO2-e/GJ
Emissions	1,556,675,239	1,219,197,553	337,477,685	kg CO2-e/yr
	1,556,675	1,219,198	337,478	tonnes CO2-e/yr
	1,557	1,219	337	kt CO2-e/yr
Emissions Intensity	**465**	**364**	**101**	**tonnes CO2-e/GWh**
OCGT-13E2- 35%				
	Full Fuel Cycle	Scope 1	Scope 3	
Generating Capacity		Gas	320	MW
		Distillate	342	MW
Operating Hours				
-gas			3035.3	hours
-distillate			30.7	hours
Annual Output				
-gas			971,296	MWh/yr
-distillate			10,499	MWh/yr
-gas			971	GWh/yr
-distillate			10	GWh/yr
Heat Rate				
-gas			11,410,800	kJ/MWh HHV
-distillate			11,631,420	kJ/MWh HHV
Energy per Annum				
-gas			11,083,264,396,800	kJ/yr
-distillate			122,122,931,148	kJ/yr
-gas			11,083,264	GJ/year
-distillate			122,123	GJ/year
Emission Factor				
-gas	66	51.3	14.2	kg CO2-e/GJ
-distillate	74.8	69.5	5.3	kg CO2-e/GJ
Annual Emissions				
-gas	725,953,818	568,571,464	157,382,354	kg CO2-e/yr
-distillate	9,134,795	8,487,544	647,252	kg CO2-e/yr
-gas	**725,954**	**568,571**	**157,382**	**tonnes CO2-e/yr**
-distillate	**9135**	**8488**	**647**	**tonnes CO2-e/yr**
Emissions Intensity				
-gas	0.74741	0.58537	0.16203	tonnes CO2-e/MWh
-distillate	0.87003	0.80838	0.06165	tonnes CO2-e/MWh
-gas	**747.407**	**585.374**	**162.033**	**tonnes CO2-e/GWh**
-distillate	**870.030**	**808.384**	**61.647**	**tonnes CO2-e/GWh**