8. Greenhouse Gas Emissions

This section provides a summary of the greenhouse gas assessment undertaken, and the potential impacts identified, in regards to the Project (Mine) during construction and operation. The assessment was undertaken in accordance with the requirements of the Terms of Reference (ToR) and a table cross-referencing these requirements is provided in Volume 4 Appendix C ToR Cross Reference Table. A detailed greenhouse gas emissions report is included in Volume 4 Appendix T Mine Greenhouse Gas Emissions Report.

8.1. Introduction

8.1.1. Background

Greenhouse gases (GHGs) are those gases in the earth's atmosphere that trap heat, allowing the temperature of the earth to be kept at a level that is necessary to maintain life. While GHGs allow the sun's energy to enter the atmosphere, instead of letting it re-radiate back into space as infrared radiation, these gasses absorb infrared radiation and trap it in the atmosphere. This is known as the greenhouse effect.

The three main GHGs are carbon dioxide (CO_2), methane (CH_4) and nitrous oxide (N_2O). An increase in the levels of these gases in the atmosphere results in an increase in the amount of heat being trapped, leading to warming of the earth's surface. This is commonly referred to as the enhanced greenhouse effect.

GHGs are produced through many human actions, including mining activities. The development and operation of the Project (Mine) has potential to contribute to the greenhouse effect through emissions produced in the underground and open cut mining activities. A GHG impact assessment for the Project (Mine) has been undertaken within Volume 4 Appendix T, with a summary of key findings provided in the following paragraphs.

8.1.2. Methodology

Methodology employed for the GHG assessment included:

- A review of relevant regulatory framework, guidelines and standards
- An analysis of the emissions from surrounding activities, such as industry, farming, etc.
- Definition of the GHG and 100 year Global Warming Potentials relevant to the Project (Mine)
- Separation of emissions into Scope 1 and Scope 2 emissions, which are defined as:
  - Scope 1 emissions, which are greenhouse gas emissions that are released into the atmosphere as a direct result of any activity or series of activities.
  - Scope 2 emissions, which, in relation to an activity or series of activities, are greenhouse gas emissions that are released into the atmosphere as a direct result of the generation of electricity, heating, cooling or steam that is consumed during the course of carrying out the activity or series of activities.

- Collection of data and estimation of potential emissions from key Project (Mine) activities during the construction and operation stages

For a list of exclusions and assumptions used in the GHG assessment refer Volume 4 Appendix T Greenhouse Gas Emissions Report.

The GHGs considered in this assessment are listed in Table 8-1. The global warming potential for each GHG has also been outlined, which provides a relative measure of how much heat a GHG traps in the atmosphere.

Table 8-1 Greenhouse Gases and 100 year Global Warming Potentials

Greenhouse Gas	Global Warming Potential (t/CO_2-e)
Carbon dioxide (CO_2)	1
Methane (CH_4)	21
Nitrous oxide (N_2O)	310
Hydrofluorocarbons (HFCs)	140 – 11,700
Perfluorocarbons (PFCs)	6,500 – 9,200
Sulphur hexafluoride (SF_6)	23,900

Source: NGA Factors, July 2012

8.2. Description of Environmental Values

The emissions for the Project (Mine) have been estimated to be:

- Approximately 2,286 kilotonnes CO_2-e per annum for Scope 1 and 2 emissions, with Scope 1 at 782 kilotonnes CO_2-e per annum and Scope 2 at 1,504 kilotonnes CO_2-e per annum, based on average annual emissions.
- Approximately 206 million tonnes CO_2-e for the 90 year life of the Project (Mine) (refer to Appendix A of Volume 4 Appendix T Greenhouse Gas Emissions Report for calculations)

Electricity usage has been identified as the largest emission source (66 per cent of total emissions), with diesel consumption as the next largest (30 per cent of total emissions).

The TOR provide that estimates may be made with reference to the National Greenhouse Accounts (NGA) Factors and supplemented by other sources where practicable and appropriate. It is considered appropriate for fugitive methane arising from the open cut aspects of the Project (Mine) to be calculated using emission factors adopted from the ACARP Guidelines for Implementation of NGER Method 2 or 3 for Open Cut Coal Mine Fugitive GHG Emissions Reporting, as, based on the measured average gas content of results available, open cut mining will be carried out within low gas zones.

The average annual Scope 1 and Scope 2 emissions from the Project (Mine) are estimated to be approximately 2 per cent of Queensland's 2009 GHG emissions and approximately 0.6 per cent of Australia's 2009 GHG emissions (DCCEE, 2011c).

An inventory of the Scope 1 and Scope 2 greenhouse emissions is provided in Table 8-2.

Table 8-2 Average Annual Greenhouse Gas Inventory

Emissions Source	Quantity		Scope 1 Emission Factor	Scope 2 Emission Factor	Units	Scope 1 Emissions	Scope 2 Emissions	Total Emissions	Proportion of Total Inventory
	Total	Units	t CO_2-e / units	t CO_2-e / units		(t CO_2-e)	(t CO_2-e)	(t CO_2-e)	%
Electricity - imported from the grid	1,708,735	MWh/a	0.000	0.88	MWh	0	1,503,687	1,503,687	65.8
Diesel - stationary energy purposes	255,179	kL/a	2.683	0.00	kL	684,569	0	684,569	30
Explosives - ANFO	52,668	t/a	0.170	0.00	t	8,954	0	8,954	0.4
Explosives - Emulsion	3,564	t/a	0.170	0.00	t	606	0	606	0.0
Wastewater handling	2,868	p	0.248	0.00	t	711	0	711	0.0
Fugitive methane - open cut mine	46,666,667	t ROM /a	0.00023	0.00	t	10,733	0	10,733	0.5
Fugitive methane - underground mine	8,888,889	t ROM /a	0.002	0.00	t	13,996	0	13,996	0.6
Vegetation removal	16,982	t C/a	3.670	0.00	t C	62,322	0	62,322	2.7
Average Annual GHG Emissions						**781,891**	**1,503,687**	**2,285,578**	**100.0**

8.3. Potential Impacts and Mitigation Measures

8.3.1. Overview

It is recognised that the construction and operation of the Project (Mine) will result in the generation of GHG emissions. Accordingly, Adani is committed to managing and mitigating potential impacts to industry, infrastructure, the environment and humans. The following paragraphs outline the abatement measures to be implemented on site and at the corporate level to avoid, mitigate and offset the GHG emissions.

8.3.2. Construction Phase

8.3.2.1. Potential Greenhouse Gas Impacts

The construction of the Project (Mine) has potential to generate GHG emissions through activities required to establish the Project (Mine) such as vegetation clearing, waste production, transport of materials and staff, and construction of infrastructure and mine access. During the construction stage, the GHG emissions will be relatively low and produced over a short time period and are therefore unlikely to contribute significantly to Queensland's overall GHG emissions.

8.3.2.2. Mitigation Measures

Management of adverse impacts from the construction of the Project (Mine) has been addressed on the basis of the hierarchy of avoidance, mitigation and offsetting of adverse impacts.

An Environmental Management Plan (EMP) (refer to Volume 2 Section 13 Environmental Management Plan) has been developed and will be implemented during construction. This EMP includes commitments aimed to avoid and reduce GHG emissions and reduce energy consumption and costs for the construction of the Project (Mine), including:

- Implementation of vehicle operating guidelines to encourage correct and efficient operation of vehicles
- The development of a traffic management plan that:
  - Serves to reduce the number of vehicles and/or trips required for transport
  - Prescribes buses for transportation of large numbers of personnel to minimise number of vehicles operating
- Implementation of a wider fuel management strategy which encourages the use of more efficient plant and vehicles, planning, logistics, driver education and maintenance
- Efficient management of procurement and product supply
- Reduction of the amount of waste disposed to landfill and reuse of waste on site to reduce emissions associated with transport of waste
- Use of teleconferencing and video conferencing to reduce travel to and from offices to reduce emissions associated with transported
- A GHG emissions inventory has been established and assessed in this report. A more comprehensive GHG emissions inventory will be developed prior to construction that provides

greater detail on anticipated construction emissions and hence opportunities for emissions reductions.

- Establishing achievable and realistic reduction targets and identifying and investigating potential reduction opportunities to realise these targets. A site specific marginal abatement cost curve will be developed to assist Adani to prioritise identified reduction opportunities and to determine which particular opportunities can be employed to reach a specific carbon reduction goal.

The following additional measures will be implemented to reduce fuel usage as far as practicable:

- Procurement of generators which use biodiesel or natural gas
- Optimisation of construction activities and logistics

Mitigation of Impacts

Substitution of diesel with biodiesel would deliver significant GHG mitigation during construction. Emissions reductions would be achieved through the proportional amount of the biomass feedstock used in Biodiesel blends. Therefore, the use of biodiesel may reduce GHG emissions through fuel consumption. However, this is dependent on a number of factors including the origin of the biodiesel feedstock and suitability to plant and equipment. The most feasible options for biodiesel purchase, reliability of supply and suitability of use will be investigated.

Energy Efficiency and Management

Appropriate mitigation measures will be implemented to reduce energy use as far as practicable through the following:

- Identification of the significant energy consuming equipment and recognising opportunities where technical efficiencies in plant and equipment can be applied
- Implementation of an EMP which establishes the baseline water, materials and energy use objectives and targets with the aim of introducing resources and emissions reductions targets through the construction phase

Offset Measures

The feasibility of generating carbon offsets during the construction of the Project (Mine) site in accordance with the Carbon Farming Initiative will be investigated during project planning. The feasibility study would need to consider legislative and development approval requirements in assessing whether the potential carbon offset projects comply with the additional requirements of the Carbon Farming Initiative. These options for carbon offsets will be investigated as part of rehabilitation planning.

The purchase of carbon offsets generated in Australia or overseas will also be considered in managing potential carbon liability under the Federal carbon pricing mechanism.

8.3.2.3. Monitoring and Reporting

The legislative measuring and reporting requirements assist in the identification of GHG reduction opportunities and track performance throughout the mining operations. The following monitoring and reporting commitments will be implemented during the construction of the Project (Mine):

- Fuel consumption and energy consumption will be measured and monitored
- GHG emissions will be calculated and reported in accordance with legislative requirements

- Fuel consumption, energy use and GHG emissions will form part of the key environmental performance indicators reported to Adani senior management

The liable entity for reporting under relevant legislation will be determined prior to the commencement of the construction phase.

8.3.3. Operation Phase

8.3.3.1. Potential Greenhouse Gas Impacts

The average annual Scope 1 and Scope 2 emissions from the Project (Mine) operating are estimated to be approximately 2,285,578 t CO_2-e per annum, without mitigation. Purchase of electricity from the grid is calculated to be the largest contributor to the Project (Mine) GHG inventory, followed by diesel consumption. The emissions from the Project (Mine) will contribute to Queensland's overall GHG emissions over an extended period of time.

The following sections identify opportunities to plan, avoid, mitigate or managing GHG emissions from the Project (Mine) operation.

8.3.3.2. Planning and Avoidance

The EMP (refer to Volume 2 Chapter 13 EMP) has been developed for implementation during the operation of the Project (Mine). The aim of the following commitments is to avoid and reduce emissions, energy costs and energy consumption to improve its operational efficiency and business productivity:

- A detailed energy efficiency assessment will be conducted for the Project (Mine). The assessment will identify initiatives, technologies and processes to ensure energy efficiency opportunities are integrated into operations.
- A detailed review of assumptions and calculations in regards to fugitive emissions and quantities will be undertaken prior to the operation of the Project (Mine). This will ensure accuracy in reporting requirements under relevant legislation, and to assist in establishing benchmarking and reduction targets.
- A fuel management strategy will be developed prior to the commencement of operations which will incorporate Project (Mine) planning, logistics, driver education and maintenance.
- Vehicle operating guidelines will be prepared and prescribed to encourage correct and efficient operation, thus potentially reducing fuel usage and minimising maintenance requirements.
- Opportunities for the use of biodiesel may be further examined and used where possible on the Project (Mine). Adani will investigate the opportunity to purchase biodiesel generators, where fuel availability and equipment supply is available.
- The procurement strategy will consider fuel efficiency, including:
  - Appropriate sizing, maintenance and selection of equipment
  - A packaging reduction program aiming to reduce the number of loads required for delivery, hence potentially less fuel consumption
  - Placement of delivered materials would also be strategically considered in order to reduce double handling, and hence the additional fuel usage

  - Consider the energy efficient ratings of equipment prior to purchase and mandating minimum ratings
  - Use of natural gas powered generators where possible to reduce emissions
- The use of continuous conveyor based mining systems will be considered to haul waste from the mine excavation to the out of pit dumps, this would result in reduced haul truck operations and hence diesel usage.
- For the mine infrastructure and village, Adani will investigate the opportunity to include a component of electricity purchases from renewable sources, and investigate the opportunity to use onsite renewables such as photovoltaics.
- The feasibility of generating carbon offsets at the Project site in accordance with the Carbon Farming Initiative will be investigated.
- The purchase of carbon offsets will be considered in managing potential carbon liability under the Federal carbon pricing mechanism
- Establishing achievable and realistic reduction targets identifying and investigating potential reduction opportunities to realise these targets. A site specific marginal abatement cost curve will be developed to assist Adani to prioritise identified reduction opportunities and to determine which particular opportunities can be employed to reach a specific carbon reduction goal.

8.3.3.3. Mitigation Measures

The management of adverse impacts arising from the Project (Mine) has been addressed according to the hierarchy of avoidance; mitigation and offsetting of adverse impacts. Impacts of the Project (Mine) on GHG emissions have been avoided or minimised where possible through the planning and design process.

While consumption of fuel is a necessary requirement of the Project (Mine), and accounts for approximately 30 per cent of the GHG emissions from the Project (Mine), in order to reduce potential emissions, the following measures will be undertaken:

- Optimisation of operational activities and logistics
- Utilisation of buses for transport of large numbers of construction personnel to minimise number of vehicles operating
- Implementation of vehicle operating guidelines to encourage correct and efficient operation of vehicles
- Reduction in the amount of waste disposed to landfill and reuse of waste on site as much as possible, which will subsequently reduce the amount of vehicle movements and therefore fuel usage.
- Reduction in the amount of waste disposed to landfill will reduce the amount of transportation requirements and fuel usage.
- Reuse and recycling of as much waste as possible onsite will be considered to minimise vehicle movements.
- Use of teleconferencing and video conferencing to reduce travel to and from offices and associated gaseous emissions resulting from fuel combustion

Approximately 66 per cent of GHG emissions result from the consumption of electricity during mining operations. Although this is an essential requirement for the operation, there are a number of ways to make energy use for equipment more efficient, including regular monitoring of the electrical load of the draglines and undertaking regular calibration checks on significant energy consuming equipment, including the draglines.

Substitution of diesel with biodiesel would deliver significant GHG mitigation during construction and operation. Emissions reductions would be achieved through the proportional amount of the biomass feedstock used in biodiesel blends. Therefore, the use of biodiesel may reduce GHG emissions through fuel consumption. However, this is dependent on a number of factors including the origin of the biodiesel feedstock and suitability to plant and equipment. The most feasible options for biodiesel purchase, reliability of supply and suitability of use will be investigated.

Energy Efficiency and Management

Through efficient and appropriate management of the operations, emissions generated as a result of electricity consumption can be reduced. The following measures will be implemented to reduce energy use as far as practicable:

- Identification of the significant energy consuming equipment and recognising opportunities where technical efficiencies in plant and equipment can be applied
- For site ancillary facilities and the mine village, Adani will include where viable, a component of electricity purchases from renewable sources and also use onsite renewables such as photovoltaics
- Site offices and Mine village will be designed and constructed so as to include energy and water efficient equipment
- Investigation into opportunities for cogeneration of electricity from available feed sources such as methane and waste oils.
- Implementation of an Energy and Emissions Plan which will outline control, management, measurement, reporting and research requirements for the operational and decommissioning phases of the Project (Mine). Through the plan, appropriate management will be integrated into all activities and processes. Through assessment and review, the Project (Mine) will seek continuous improvement in compliance, energy efficiency and emissions reduction.
- Regular calibration checks will be conducted on significant energy consuming equipment, including the draglines.

Technology Review

The application of technical efficiencies in plant and equipment as, and once available, will provide more efficiency in operations. Due to the 90 year operational life of the Project (Mine), regular equipment replacement will be subject to an appropriate business case review. An appropriate business case will identify equipment options to be considered, including any new technologies available, expected benefits, potential risks and costs.

In order to fulfil the monitoring and implementation requirements of the *Energy Efficiency Opportunities Act 2006*, regular improvements in mining operations energy efficiency will be required.

Offset Measures

The feasibility of generating carbon offsets at the Project (Mine) site (or elsewhere) in accordance with the Carbon Farming Initiative will be investigated during project planning. The feasibility study would need to consider legislative and development approval requirements in assessing whether the potential carbon offset projects comply with the additional requirements of the Carbon Farming Initiative. These options for carbon offsets will be investigated as part of rehabilitation planning.

The Project (Mine) is likely to exceed the threshold for participation in the Federal carbon pricing mechanism under the *Clean Energy Act 2011*. Therefore, a legislative price on the Scope 1 GHG emissions from the Project (Mine) is likely to apply, as is an increase in pricing of Scope 2 and Scope 3 emissions. The purchase of carbon offsets generated in Australia or overseas will be considered in managing liability under the Federal carbon pricing mechanism.

8.3.3.4. Monitoring and Reporting

Scope 1 and 2 emissions from the mining operations will be required to be measured (or estimated) and reported as per the requirements of the *National Greenhouse and Energy Reporting Act 2007* (NGERs). The technical guidelines for NGERs outline the methods used for measuring and reporting Scope 1 and Scope 2 GHG emissions. Measuring and monitoring Scope 1 emissions will be required as part of the carbon pricing mechanism and monitoring and reporting will also be mandatory under the *Energy Efficiency Opportunities Act 2006.*

The legislative measuring and reporting requirements may be used to assist in the identification of GHG reduction opportunities and track performance throughout the mining operations. Accordingly, Adani will implement the following monitoring and reporting commitments during the operation of the Project (Mine):

- Fuel consumption and energy use will be measured and monitored
- GHG emissions and energy consumption will be calculated and reported
- Regular energy audits and reviews of operations will be conducted to identify possible energy efficiency improvement opportunities
- Fuel consumption, energy use and GHG emissions will form part of the key environmental performance indicators reported to Adani senior management

The liable entity for reporting under relevant legislation will be determined prior to the commencement of operations.

8.4. Summary

A number of GHG mitigation and management measures have been identified as part of the GHG assessment (refer to Volume 4 Appendix T), while other measures are being considered by Adani for future implementation. These measures along with avoiding emissions where possible will reduce the total GHG emissions resulting from the Project (Mine).

The feasibility of mitigating GHG emissions from fugitive emissions, electricity consumption and diesel consumption will be investigated during Project (Mine) planning. Management and mitigation of any potential impacts of the Project (Mine) in regard to contributing to the generation of GHG will be implemented through a hierarchy of avoidance, mitigation and offsets throughout the life of the Project (Mine).

This page intentionally left blank