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 (Rail) 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 AE Rail 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 greenhouse gases 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 various human activities. The development and operation of the Project (Rail) has the potential to contribute to the greenhouse effect through emissions produced by various activities throughout the construction and operation of the Project (Rail). A GHG impact assessment for the Project (Rail) has been undertaken within Volume 4 Appendix AE, 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 (if any), farming, etc
- Definition of the GHG and 100 year Global Warming Potentials relevant to the Project (Rail)
- 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 an 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 (Rail) activities during the construction and operation phases

For a list of exclusions and assumptions used in the GHG assessment refer Volume 4 Appendix AE.

The greenhouse gases 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, measured as tonnes of CO2 equivalent (t/CO_2-e).

Table 8-1 Greenhouse Gases and 100 Year Global Warming Potential

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
Sulfur hexafluoride (SF_6)	23,900

Source: NGA Factors, July 2012

8.2 Description of Environmental Values

The GHG emissions for the Project (Rail) were calculated based on estimated energy usage during construction and operations. The total Scope 1 emissions over the life of the Project (Rail) are estimated to be approximately 57,647 t/CO_2-e for:

- Construction at 311 kt/CO_2-e
- Operation at 57,335 kt/CO_2-e

The emissions are attributed to:

- Diesel consumption for coal haulage accounting for 99.5 per cent of emissions
- Vegetation clearing 0.3 per cent and diesel consumption (during construction) accounting for 0.2 per cent

The average annual Scope 1 emissions over the life of the Project (Rail) were estimated to be approximately 614 kt/CO_2-e per annum.

Electricity is not proposed to be used during construction and therefore Scope 2 emissions are zero. Details with regard to the future proposed electrification of the rail track were not proposed at the time of the assessment and therefore Scope 2 during operations emissions are also zero. If electrification of the rail track occurs in the future then the emissions and associated impacts will be assessed at this time.

As per International Standard and the Greenhouse Gas Protocol, the accumulative impact of greenhouse gases resulting from the Project is expressed in terms of CO2-e. Through this calculation, the greenhouse gas potential of relevant gases (CO_2, CH_4, N_20) has been taken into account.

The majority of greenhouse gas emissions produced by Project (Rail) is through the combustion of diesel. The greenhouse gas potential for minor components as a result of this combustion is quite high, hence this is converted to t/CO2-e which is the relevant international standard for greenhouse gas reporting. Individual gases are not reported separately as these figures provide limited value. The greenhouse gas inventory is provided in Table 8-2.

Table 8-2 Greenhouse Gas Inventory over 90 Year Project Life

Emissions Source	Quantity	Units	Scope 1 Emission Factor#	Scope 2 Emission Factor	Units	Scope 1 Emissions	Scope 2 Emissions	Total Emissions	Proportion of Total Inventory
	Total		t CO_2-e / units	t CO_2-e / units		(t CO_2-e)	(t CO_2-e)	(t CO_2-e)	%
Diesel - construction	50,000	kL	2.683	0.000	kL	134,135	0	134,135	0.2%
Vegetation removal - construction	48,037*	Tonnes of carbon (t/C)	3.670	0.000	t/C	176,297	0	176,297	0.3%
Wastewater treatment - construction	3,667	Person years (p)	0.248	0.000	p	909	0	909	0.0%
Diesel - operation	21,250,000	kL	2.698	0.000	kL	57,335,475	0	57,335,475	99.5%
Project Life GHG Emissions						**57,646,816**	**0**	**57,646,816**	**100.0%**

Note:

NGA Factors (DCCEE, 2012a)

* The total tonnes of carbon for each vegetation type is estimated as:

- *Corymbia citriodora* on duplex – woodland soil (13,6985 t/C)
- Mixed species environmental planting on clay – brigalow and gidgee soils (2,310 t/C)
- Pasture grasslands (32,029 t/C)

8.3 Potential Impacts and Mitigation Measures

8.3.1 Greenhouse Gas Impacts During Construction

8.3.1.1 Potential Impact

The GHG emissions generated during the construction of the Project (Rail) will result from emissions generated during vegetation removal, wastewater treatment, transport, manufacturing and construction of building materials and energy usage. These GHG emissions will be relatively low, produced over a short time period and are therefore unlikely to contribute significantly to Queensland's overall GHG emissions.

8.3.1.2 Management and Mitigation

Adverse impacts of GHG emissions arising from the construction of the Project (Rail) have been addressed according to the hierarchy of avoidance, mitigation and offsetting of adverse impacts, implemented where possible through the planning and design process and the development of ongoing standard practices.

Reduction and Avoidance

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

- Implementation of vehicle operating guidelines to encourage correct and efficient operation of vehicles
- The implementation of a traffic management plan that:
  - Reduces the number of vehicles and/or trips required for transport
  - Uses buses for transportation of large numbers of personnel to minimise number of vehicles operating
- Implementation of a wider fuel management strategy which encourages use of more efficient plants and vehicles, planning, logistics, driver education and maintenance
- Efficient management of procurement and product supply
- Reduction on 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
- Use of teleconferencing and video conferencing to reduce travel to and from offices and associated gaseous emissions from fuel combustion
- GHG emissions and energy consumption will be measured in accordance with current legislative requirements
- Fuel consumption, energy use and GHG emissions will form part of reporting requirements to Adani senior management

- GHG emissions and energy consumption will be reported to relevant authorities in accordance with current legislative requirements
- A GHG emissions inventory has been established and assessed for the Project (Rail) EIS (Volume 4 Appendix AE Rail Greenhouse Gas Emissions Report). A more comprehensive GHG emissions inventory will be developed prior to construction that provides greater detail on construction emissions
- The next step will be to set achievable and realistic reduction targets and identify and investigate potential reduction opportunities to realise these targets. A site specific marginal abatement cost curve for identified reduction opportunities will be developed to assist Adani to prioritise these opportunities and be useful in determining what particular opportunities can be employed to reach a specific carbon reduction goal

Activities such as vegetation clearing will be restricted to the required footprint only through the implementation of the EMP which will identify clearing limits. The concept design also re-uses excavated spoil material onsite as fill for the train line embankment, thereby reducing transport distances and heavy vehicle trips to an offsite disposal area. While fuel usage is a necessary requirement for construction of the Project (Rail), so far as to reduce GHG emissions the following measures will be implemented as far as practicable:

- Utilisation of buses for transport of construction personnel to minimise the number of vehicles operating
- Use of charter flights
- Procurement of generators which use biodiesel or natural gas (where possible)

Mitigation

Biodiesel blends (diesel that has a percentage of the fuel replaced with biodiesel) may reduce greenhouse gas emissions due to fuel consumption. However, this is dependent on a number of factors including the origin of the biodiesel feedstock. When sourced from appropriate feedstocks, the reduction in emissions is approximately equivalent to the percentage of biodiesel in the blend (for example diesel with 20 per cent biodiesel will reduce greenhouse gas emissions by approximately 20 per cent). Calculations to determine the reduction in greenhouse gas emissions when using biodiesel should consider the entire life cycle of the fuel. Opportunities for the use of biodiesel will be further examined and used where possible on the Project (Rail).

SBR, a private rail operator in Victoria currently run their AC locomotives on B20 biodiesel, enabling savings of carbon emissions through daily operations. Biodiesel is currently not commonly utilised throughout the Australia train industry, however with successful application in the private sector, this consideration may become more feasible with time.

The application of technical efficiencies in construction plant and equipment will also provide more efficiency. These options will be further investigated, including any new technologies available, expected benefits, potential risks and costs.

The EMP will include a GHG Emissions Management Sub Plan that will outline the strategies, objectives and mitigation measures required to measure, report and identify energy efficiency opportunities. A GHG emissions inventory has been established and assessed for the Project (Rail) construction. Through the EMP, appropriate management will be integrated into all construction

activities and processes and GHG emissions will be monitored. Through assessment and review, the Project (Rail) will seek continuous improvement in compliance and emissions reduction.

Energy Efficiency and Management

Given that energy is the largest source of GHG emissions, 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. Fortescue Minerals Ltd have undertaken detailed energy analysis of their freight trains, identifying activities and operations which are fuel intensive in order to identify opportunities where fuel efficiency could be improved. An understanding of energy uses and corresponding fuel consumption would help Adani identify further opportunities where reduction in sources is most feasible and effective
- Site offices and accommodation buildings will be designed and constructed so as to include energy and water efficient equipment
- Implementation of a Construction 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
- The EMP will set out appropriate management and encourage integration of key activities and processes so as to effectively monitor GHG emissions

Offset Measures

The feasibility of generating carbon offsets for the construction of the Project (Rail) 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.

Offsetting additional GHG emissions through the purchase of carbon offsets generated in Australia or overseas will be considered when assessing the Project (Rail) liability under the carbon pricing mechanism.

8.3.2 Greenhouse Gas Impacts During Operation

8.3.2.1 Potential Impact

The GHG emissions generated during the operation of the Project (Rail) include fugitive emissions (coal dust) and direct emission sources such as diesel usage. These GHG emissions will contribute to Queensland and Australia's overall GHG emissions over an extended period of time.

The average annual Scope 1 emissions over the life of the Project (Rail) were estimated to be approximately 641 kt CO_2-e per annum, approximately 0.5 per cent of Queensland's 2009 greenhouse gas emissions and approximately 0.1 per cent of Australia's 2009 greenhouse gas emissions (DCCEE, 2011b).

8.3.2.2 Management and Mitigation

The management of adverse impacts arising from the operation of the Project (Rail) has been addressed according to the hierarchy of avoidance; mitigation and offsetting of adverse impacts.

Avoidance

A reduction in the quantity of fuel consumed will be achievable through ongoing optimisation of operational activities and logistics, thereby reducing the number of vehicles and/or trips required.

The Australasian Railway Association (2010) identifies a number of options which will lead to a reduction in fuel consumption of the train sets, including:

- Use of newer locomotives, or old locomotives with new engines to improve operational efficiency.
- Fitting electronically controlled pneumatic (ECP) braking to locomotives and wagons, enabling all wagons to brake simultaneously, reducing fuel consumption. There have been extensive Australia trials on the benefits of this technology to reduce overall fuel consumption, with overall savings of around 4-11% in some trials.
- Improving the aerodynamics of locomotives and wagons.
- Use of anti-idling engine management software to balance energy demand and fuel consumption. Similar technologies such as automatic engine stop start (AESS) systems, which shuts down the engine if it has been idling for more than 10 minutes have been successfully adopted for freight train transportation in Western Australia.

Adani will investigate the applicability of these options in regards to a wider fuel management strategy applying technical efficiencies in train operations and more efficiency in operations.

Mitigation

A number of mitigation techniques will be implemented throughout the operational phase of the Project (Rail).

Renewable sources of electricity will be investigated for maintenance facilities.

The application of technical efficiencies in construction plant and equipment will also provide opportunities for greater efficiency; expected benefits, potential risks and costs will be further investigated.

Commitments to energy management will be developed as part of a detailed energy efficiency assessment. Monitoring and implementation of energy efficient improvements are also required under the *Energy Efficiency Opportunities Act 2006* (EEO Act). Regular energy audits and reviews of railway operations will identify possible energy efficiency improvement opportunities which will be implemented to progressively improve operations and subsequent energy efficiency.

The Australasian Railway Association (2010) identifies a number of options for mitigating the impacts of fuel use associated with rail freight, which vary in their current level of technical capacity, development and cost. They include:

- Utilising liquid natural gas or compressed natural gas in place of diesel.
- The use of hybrid locomotives with rechargeable energy storage systems (RESS). Regenerative braking charges the RESS, which is then used to supplement the diesel engine.
- The use of biodiesel blends, which have been tested in Australia with limited success. Opportunities for the use of biodiesel will be further examined and used where possible during the operation of the Project (Rail).

It also identifies potential energy efficiency opportunities for the rail freight, including:

- Use of engine management systems to determine the optimal power output for the task. Fortescue Minerals Ltd have undertaken detailed energy analysis of their freight trains, identifying activities and operations which are fuel intensive in order to identify opportunities where fuel efficiency could be improved. An understanding of energy uses and corresponding fuel consumption would help Adani identify further opportunities where reduction in sources is most feasible and effective.
- Use of consist management systems to optimally distribute the load between locomotives in multiple locomotive consists.

Scope 1 and 2 emissions from the rail operations will be measured (or estimated) and reported in accordance with the technical guidelines under the *National Greenhouse and Energy Reporting Act 2007*. Monitoring and reporting is also mandatory under the EEO Act. In order to fulfil the monitoring and implementation requirements of the EEO Act, regular improvements in transport operations energy efficiency will be reviewed and undertaken. The legislative measuring and reporting requirements will be used to assist in the identification of greenhouse gas reduction opportunities and track performance throughout the rail operations.

An Operational EMP will outline strategies, objectives and mitigation measures required to measure, report and identify energy efficiency opportunities. Through the EMP, appropriate management will be integrated into all activities and processes and GHG emissions will be monitored. This will allow for continuous improvement in compliance and emissions reduction. Continuous review of the EMP will also identify opportunities to improve workforce awareness of energy efficiency through training and education.

Offset Measures

The feasibility of generating carbon offsets at the Project (Rail) site (or elsewhere) in accordance with the Carbon Farming Initiative will be investigated during project planning and will include legislative and development approval requirements in assessing whether the potential carbon offset projects comply with the additional requirements of the Carbon Farming Initiative.

The Project (Rail) is likely to exceed the threshold for a liable entity under the *Clean Energy Act 2011*. Therefore, a legislative price on the Scope 1 greenhouse gas emissions from the Project (Rail) is likely to apply. Offsetting additional greenhouse gas emissions through the purchase of accredited carbon offsets generated in Australia or overseas will be considered to reduce the impacts of the Project (Rail).

8.4 Summary of Greenhouse Gas Assessment

The Project (Rail) construction and operation will result in the generation of GHG emissions. Management and mitigation of any potential impacts on the surrounding environment will be implemented through a hierarchy of avoidance, mitigation and offsets throughout the life of the Project (Rail).

Through efficient and appropriate management of the Project (Rail) construction and operations, emissions can be reduced. Recognising opportunities to make significant energy consuming equipment more efficient, including the application of technical efficiencies in plant and equipment as and once available, would provide improved efficiency.

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