ENVIRONMENTAL IMPACT STATEMENT

RED HILL
MINING LEASE

Section 12
Greenhouse Gases

Section 12 Greenhouse Gases

12.1 Description of Environmental Values

12.1.1 Introduction

BHP Billiton Mitsubishi Alliance (BMA), through its joint venture manager, BM Alliance Coal Operations Pty Ltd, proposes to convert the existing Red Hill Mining Lease Application (MLA) 70421 to enable the continuation of existing mining operations associated with the Goonyella Riverside and Broadmeadow (GRB) mine complex. Specifically, the mining lease conversion will allow for:

- An extension of three longwall panels (14, 15 and 16) of the existing Broadmeadow underground mine (BRM).
- A future incremental expansion option of the existing Goonyella Riverside Mine (GRM).
- A future Red Hill Mine (RHM) underground expansion option located to the east of the GRM.

The three project elements described above are collectively referred to as 'the project'.

The greenhouse gas (GHG) assessment of the project has considered the following:

- annual global and national GHG emissions;
- international and national policy in regards to GHG emissions;
- direct and indirect sources of GHG emissions from the development and operation of the mine; and
- proposed GHG reduction measures.

The GHG assessment has considered emissions from the following existing and proposed operations:

- Existing operations:
  - GRM; and
  - BRM.
- Proposed operations:
  - mining within mining lease (ML) 1763 and MLA70421 associated with the RHM;
  - mining within MLA70421 associated with the Broadmeadow extension; and
  - transport of the RHM remote workforce.

12.1.2 Background to Greenhouse Gases and Climate Change

Climate change refers to long-term fluctuations in temperature, precipitation, wind and other elements of the Earth's climate system. The Earth naturally absorbs and reflects incoming solar radiation and emits longer wavelength terrestrial radiation back into space. A portion of this terrestrial radiation is absorbed by gases (known as greenhouse gases) in the atmosphere. Changes in the atmospheric concentrations of these greenhouse gases can alter the balance of energy transfer between the atmosphere, space, land, and oceans (Trenberth 1992). Water vapour is the principal greenhouse gas in the atmosphere. Other gases which contribute to the 'greenhouse effect' include (but are not limited to):

- carbon dioxide (CO_2);
- ozone (O_3);
- methane (CH_4);
- nitrous oxide (N_2O); and
- chlorofluorocarbons (CFC).

Each greenhouse gas absorbs one or more wavelengths of terrestrial radiation. The way in which the greenhouse gases are distributed throughout the atmosphere has played a role in the establishment of the current and past temperature profile of the atmosphere and will play a role in the future as well. Alterations in the concentration of a greenhouse gas (either due to anthropogenic activities or natural phenomena) will ultimately have an influence on the temperature profile of the atmosphere. This in turn affects the surface temperature of the earth.

The Intergovernmental Panel on Climate Change (IPCC) was established in 1988 to provide an objective source of information regarding climate change. IPCC summarised the findings of *The Fourth Assessment Report in Climate Change 2007: Synthesis Report* (IPCC 2007). The key findings include:

- 'Warming of the climate system is unequivocal as evident from observations of increases in global average air and ocean temperatures, widespread melting of snow and ice and rising global average sea level.
- Global atmospheric concentrations of CO_2, CH_4 and N_2O have increased markedly as a result of human activities since 1750 and now far exceed pre-industrial values.
- Global GHG emissions due to human activities have grown since pre-industrial times with an increase of 70 per cent between 1970 and 2004.
- The global atmospheric concentration of CO_2 increased from a pre-industrial value of about 280 parts per million (ppm) to 379 ppm in 2005. Global increases in CO_2 concentrations are due primarily to fossil fuel use, with land-use change providing another significant but smaller contribution.
- The global atmospheric concentration of CH_4 has increased from a pre-industrial value of 715 parts per billion (ppb) to 1,732 ppb in early 1990s and was 1,774 ppb in 2005. It is very likely that the observed increase in CH4 concentration is predominantly due to agriculture and fossil fuel use.
- The global atmospheric N_2O concentration increased from a pre-industrial estimate of about 270 ppb to 319 ppb in 2005. The increase in N_2O concentration is primarily due to agriculture.
- Most of the observed increase in global average temperatures since the mid-20th century is very likely due to the observed increase in anthropogenic GHG concentrations.
- Continued GHG emissions at or above current levels would cause further warming and induce many changes in the global climate system during the 21st century that would very likely be larger than those observed during the 20th century' (IPCC 2007).

Note that an assessment of climate change related impacts on the project is provided in **Section 4.10.1.**

12.1.3 Legislative Framework

12.1.3.1 International Policy

The Kyoto Protocol to the United Nations Framework Convention on Climate Change was signed in 1997 and entered into force in 2005. Australia ratified the Kyoto Protocol in December 2007. The protocol aims to limit GHG emissions of countries that ratified the protocol by setting individual mandatory GHG emission targets in relation to those countries' 1990 GHG emissions. The Kyoto Protocol sets out three flexibility mechanisms to allow GHG targets to be met:

- The Clean Development Mechanism;
- Joint Implementation; and
- International Emissions Trading.

The definitions of the three mechanisms are complex but effectively allow GHG reductions to be made at the point where the marginal cost of that reduction is lowest. Essentially, a key application of the mechanisms is that an industrialised country sponsoring a GHG reduction project in a developing country can claim that reduction towards its Kyoto Protocol target and those GHG reductions can be traded.

12.1.3.2 Australia's Climate Change Policy

Australia's climate change policy is managed by the Department of the Environment. Australia's Sixth National Communication on Climate Change (DCCEE 2013) describes the Australian Governments' approach to climate change which is based on a broad three pillar strategy: reducing Australia's emissions, adapting to unavoidable climate change and helping to shape a global solution (DCCEE 2010).

12.1.3.3 Clean Energy Act 2011

The *Clean Energy Act 2011* introduced a national carbon pricing scheme to reduce carbon emissions, increase the use of clean energy and achieve Australia's GHG reduction target of five per cent below 2000 emissions by 2020.

The carbon price commenced on 1 July 2012. Entities are liable if they operate facilities that exceed the threshold of 25,000 tonnes for covered 'scope 1' emissions, or if they supply or use natural gas. Liable entities are required to pay a fixed price per tonne of CO_2 equivalent (CO_2-e).

However, the Government will seek to abolish the carbon tax from 1 July 2014.

12.1.3.4 National Greenhouse and Energy Reporting Act 2007

The *National Greenhouse and Energy Reporting Act 2007* (NGER Act) and related regulations establish the legislative framework for a national greenhouse and energy reporting system in Australia.

The objectives are set out in the NGER Act and include:

- informing government policy formulation and the Australian public;
- meeting Australia's international reporting obligations;
- assisting Commonwealth, State and Territory government programs and activities;
- underpinning the introduction of an emissions trading scheme in the future; and
- avoiding duplication of similar reporting requirements in the states and territories.

A controlling corporation must register under the NGER Act by 31 August, and make its first annual report by 31 October, following the financial year in which it meets any one of the following thresholds:

- total GHG emissions from its controlled facilities are 50 kilotonnes CO_2-e or higher;
- total energy production or consumption of the facilities is 200 terajoules or more; or
- any single facility emits ≥ 25 kilotonnes CO_2-e, or produces or consumes at least 100 terajoules of energy.

It is anticipated that the project, during its construction as well as its subsequent operation, will be under the operational control of BM Alliance Coal Operations, which is registered as a controlling corporation under the NGER Act. The project's annual consumption and production of energy, and emissions of GHG, will be included in the BM Alliance Coal Operations annual NGER report.

12.1.3.5 Energy Efficiency Opportunities

The Energy Efficiency Opportunities Act 2006 (EEO Act) requires large energy users (over 0.5 petajoules of energy consumption per annum) to participate in a program to encourage on-going improvements in energy efficiency. Businesses are required to identify, evaluate and report publicly on cost effective energy savings opportunities.

The EEO Act is designed to achieve:

- improved identification and uptake of cost-effective energy efficiency opportunities (EEOs);
- improved productivity and reduced GHG emissions; and
- greater scrutiny of energy use by large energy consumers.

Obligations under the EEO Act align with those under the NGER Act. The project will be incorporated in the Assessment and Reporting Schedule for BMA's second EEO Act assessment cycle (July 2014 - June 2019).

12.1.3.6 State Policy and Initiatives

Mineral Resources Act

The *Mineral Resources Act 1993* (MR Act) places some restrictions on the use of IMG produced from a (non-hydrocarbon) coal mining lease and BMA will ensure compliance with these requirements.

Under a mining lease, incidental mine gas can either be:

- applied to a beneficial use on site (e.g. power generation) for mining under the mining lease; or

- transfer the gas to the holder of an overlapping petroleum lease.

Other potential uses, including collecting and piping the gas from the mining lease for any use, and generating electricity on the mining lease for sale to the grid, are not allowed unless the mining lease holder also holds a petroleum lease.

The MR Act also only allows flaring of incidental mine gas in the event that it is not commercially or technically feasible to reuse the gas for a beneficial mining use or to use the gas under a petroleum lease that the mining lease holder might be able to obtain.

BMA's Carbon Management Plan

BMA's Carbon Management Plan aims to develop an approach to the management of GHG emissions that:

- cost effectively reduces the impact of carbon penalties;
- ensures compliance with regulatory and corporate requirements; and
- delivers on expectations of stakeholders in relation to carbon management.

The plan responds to the following key aspects:

- BMA's GHG emissions are forecast to grow, driven mainly by the company's growth plans and the inclusion in those plans of emission intensive underground mines such as the proposed project.
- Carbon pricing is a material new cost to BMA, one effect of which is to strengthen incentives to improve productivity and reduce costs within existing planning and operating parameters. Note that the Government will seek to abolish the carbon tax from 1 July 2014.
- Fugitive emissions are a distinctive aspect of coal mining and represent BMA's biggest source of carbon uncertainties, risks and opportunities.

BMA's approach to managing these aspects includes the following themes and key activities:

- Reducing BMA's carbon intensity through increased productivity provides the best prospects for sustained abatement, as it is compatible with the company's mining performance improvement agenda and growth aspirations. BMA maintains a pipeline of carbon abatement activities, which quantifies the GHG reduction benefits of existing and planned business improvement programs and identifies potential new projects for study (for example through the carrying out of EEO assessments).
- Fugitive emissions warrant particular attention. This includes evaluating the potential to use and/or sell methane drained during the development and operation of BMA's 'gassier' coal deposits such as those associated with the project. Depending on the outcomes of these assessments, the beneficial utilisation of waste mine gas might present significant opportunities for BMA in seeking to abate emissions and defray carbon penalties.

12.1.4 Inventory Methodology

12.1.4.1 Accounting and Reporting Principles

The GHG emissions inventory for the project is based on the accounting and reporting principles detailed within the *Greenhouse Gas Protocol* (World Business Council 2004). The protocol was first established in 1998 to develop internationally accepted accounting and reporting standards for GHG emissions from companies. The main principles are as follows:

- Relevance: the inventory must contain the information that both internal and external users need during decision making.
- Completeness: all relevant emissions sources within the inventory boundary need to be accounted for so that a comprehensive and meaningful inventory is complied.
- Consistency: the consistent application of accounting approaches, inventory boundary and calculation methodologies are essential to producing comparable GHG emissions over time.
- Transparency: information needs to be archived in a way that enables reviewers and verifiers to attest to its credibility. All parameters, values and methodologies used are to be accessible and presented within the inventory.
- Accuracy: data should be sufficiently precise to enable intended users to make decisions with reasonable assurance that the reported information is credible.

12.1.4.2 Inventory Organisational Boundaries

For the purpose of establishing a preliminary greenhouse gas inventory, the organisational boundary of the project was defined as the:

- RHM and associated infrastructure; and
- the new Red Hill coal handling and preparation plant (CHPP) located adjacent to the Riverside CHPP.

12.1.4.3 Inventory Operational Boundaries

The Coordinator-General's Terms of Reference for the project specifies that both direct and indirect emissions from the project should be assessed. The Greenhouse Gas Protocol defines direct and indirect emissions through the concept of emission Scopes.

Scope 1: Direct GHG emissions. Direct GHG emissions occur from sources that are owned or controlled by a company. For example:

- emissions from combustion in owned or controlled boilers, furnaces or vehicles;
- emissions from on site power generators; and/or
- incidental mine gas (IMG).

Scope 2: Electricity indirect GHG emissions. This accounts for GHG emissions from the generation of purchased electricity consumed by the company. Purchased electricity is defined as electricity that is purchased or otherwise brought into the organisational boundary of the company. Scope 2 emissions physically occur at the facility where electricity is generated but the emissions are allocated to the organisation that owns or controls the plant or equipment where the electricity is consumed. Scope 2 emissions also capture the importing of energy (such as chilled water or steam) into a site.

Scope 3: Other Indirect GHG emissions. This is an optional reporting class that accounts for all other indirect GHG emissions resulting from a company's activities, which occur from sources not owned or controlled by the company. Examples include extraction and production of purchased materials;

transportation of product by contractors; use of sold products and services; and employee business travel and commuting. Scope 3 emissions are not routinely reported by companies as the emissions are difficult to estimate accurately, the company does not have control of the emissions sources and these emissions are reported by other companies as their Scope 1 emissions.

12.1.4.4 Calculation Approach

The GHG emission inventory for the project is based on the methodology detailed in the Greenhouse Gas Protocol (the protocol) (World Business Council 2004) and the relevant emission factors in the National Greenhouse Accounts (NGA) Factors (DCCEE 2011).

A spreadsheet model has been specifically developed for the project and uses the data sources and emission factors detailed below in order to calculate project emissions for every year of construction and operation, according to the protocol and using methodology detailed in the NGA Factors.

There are several GHGs including CO_2, CH_4, and N_2O; however, to simplify inventory accounting, a single unit of measurement, the carbon dioxide equivalent (CO_2-e) is used. This accounts for the various global warming potentials of non-CO_2 gases as specified by DCCEE (2011). The global warming potential is a measure of the amount of infrared radiation captured by a gas in comparison to an equivalent mass of CO_2, over a fixed lifetime. GHG emission inventories developed for the project are expressed as mass of CO_2-e released, following this convention.

12.1.4.5 Emission Factors

The National Greenhouse Accounts Factors (DCCEE 2011) provides emission factors for a variety of activities. Those that have been used for this assessment are summarised in **Table 12-1**.

Table 12-1 Emission Factors (DCCEE 2011)

Category	Units	Emission Factor			Reference
		CO_2	CH_4	N_2O	(DCCEE 2011)
Scope 1 Emissions					
Consumption of diesel (stationary energy)	kg CO_2-e/kL	2,671	3.9	7.7	**Table 3** (stationary energy)
Consumption of diesel (general transport)	kg CO_2-e/kL	2,671	7.7	19.3	**Table 4** (general transport)
Consumption of kerosene	kg CO_2-e/kL	2,536	0.37	25.8	**Table 4** (aircraft)
Combustion of coal mine waste gas	kg CO_2-e/m^3	1.95	0.19	0.001	Table 2
Fugitive emissions from open-cut mining[2]	kg CO_2-e/ROM t		17		**Table 7** (Queensland)
Scope 2 Emissions					
Consumption of electricity[1]	kg CO_2-e/kWh	0.88	-	-	**Table 5** (Queensland)

Category	Units	Emission Factor			Reference
		CO_2	CH_4	N_2O	(DCCEE 2011)
Scope 3 Emissions					
Combustion of bituminous coal[1]	kg CO_2-e/t	2,700	0.6	6.0	Table 1

Note 1: This factor reduced to 0.82 from July 2012 as a result of amendments to the NGER Measurement Determination (see *National Greenhouse and Energy Reporting (Measurement) Amendment Determination 2013 (No.1)*.

Note 2: The Australian Government has announced that it will apply, from July 2017, an increase in the global warming potential of methane from 21 to 25, which would result in an increase in the Post-mining emissions factor to 17, and the open-cut fugitive emissions factor to 20 kg CO_2-e/ROM t.

12.1.4.6 Materiality

Materiality is a concept used in accounting and auditing to minimise time spent verifying amounts and figures that do not impact a company's accounts or inventory in a material way. The exact materiality threshold that is used in GHG emissions accounting and auditing is subjective and dependant on the context of the site and the features of the inventory. Depending on the context, the materiality threshold can be expressed as a percentage of a company's total inventory, a specific amount of GHG emissions, or a combination of both.

All emissions that emanate from within the boundary are included in the inventory unless emissions are excluded on materiality grounds. Information is considered to be material if, by its inclusion or exclusion it can be seen to influence any decisions or actions taken by users. A material discrepancy is an error (for example, from an oversight, omission or miscalculation) that results in a reported quantity or statement being significantly different to the true value or meaning.

Particular emissions are assumed to be immaterial if likely to account for less than five per cent of the overall emissions profile. The following emissions are not included in the inventory for this project on the basis of materiality:

Consumption of unleaded petroleum (ULP) or liquefied petroleum gas (LPG) in site vehicles. Most site vehicles run on diesel fuel, which is included in the inventory. Only smaller vehicles such as cars belonging to site personnel will consume unleaded fuel and are typically immaterial.

The inventory does not consider emissions or sequestration arising from land use, land use change and forestry, such as rehabilitation and clearing. These are very small surface areas that are not highly forested, so the GHG emissions from land clearing or sequestration from forestry are considered to be immaterial.

12.1.4.7 Aggregation

For completeness the assessment of GHG emissions associated with the project is considered both in isolation and in combination with current GHG emission sources from the GRB mine complex.

12.1.5 Existing Greenhouse Gas Emission Sources

This section outlines the project-specific information that was used in the assessment of the emission of GHG associated with approved mining activities.

12.1.5.1 Goonyella Riverside Open-cut Mine

The GRM is a resource comprising of approximately 750 million tonnes of run-of-mine (ROM) coal with an estimated mine life of more than 55 years. While it continues to be financially viable, the use of open-cut mining techniques will in general be preferable to underground mining. The three main sources of Scope 1 and Scope 2 emissions of GHG are:

- fugitive emissions of IMG;
- diesel consumption; and
- electricity usage.

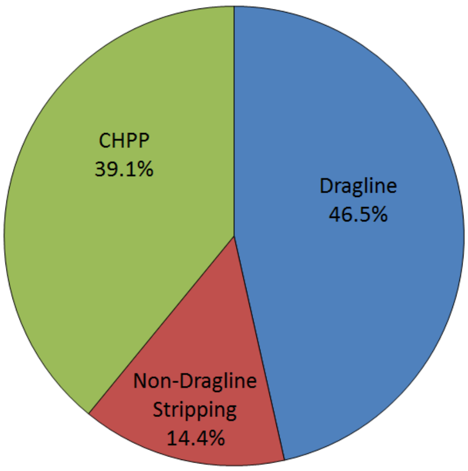
Relevant data for GRM is summarised in **Table 12-2** for the life of mine and includes the minimum, maximum year and average years. A breakdown of electricity and fuel usage for the life of the mine by activity is presented in **Figure 12-1**.

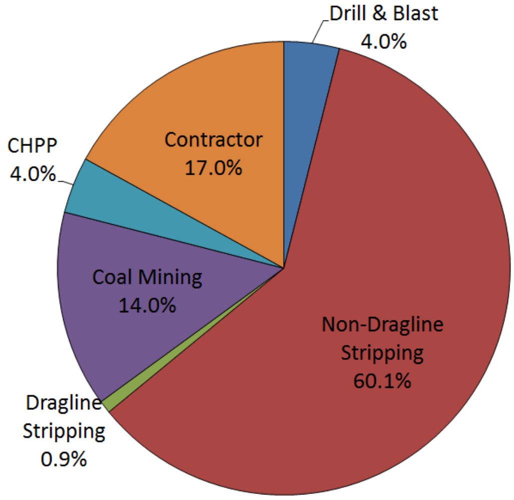
Table 12-2 GRM Information for the Life of Mine, Minimum, Maximum and Average Years

Category	Units	Value (life of mine)	Minimum	Maximum	Average
ROM Coal Mined	megatonnes	750	5.6	22.5	13.2
Electricity Demand	MWh	9,258,502	111,631	213,856	162,429
Diesel Usage	ML	6,800	24.8	167.9	119.3

Note: MWh – megawatt hours; ML – megalitres.

Figure 12-1 Breakdown of Electricity (left) and Diesel Fuel (right) Usage for GRM (life of mine)





Presented in **Table 12-3** is the information from GRM for FY2009, FY2010, FY2011 and FY2012 (based on NGERS reporting) highlighting the average rate of fugitive emissions of 0.017 tonnes of CO_2-e per ROM tonne of coal produced in accordance with the emission factor reported in **Table 12-1**.

Table 12-3 Fugitive Emission Rates for Goonyella Riverside Open-cut Mine

NGERS Reporting Year	Total Emissions (t CO_2-e)	ROM tonnes	t CO_2-e per ROM tonne
2009	232,494	13,676,106	0.017
2010	243,354	14.314,955	0.017
2011	222,300	13,076,465	0.017
2012	186,889	10,993,488	0.017

Based on the emission factors presented in **Section 12.1.4.5**, the estimated mass of GHG emissions associated with GRM is summarised in **Table 12-2** and presented in **Figure 12-2**.

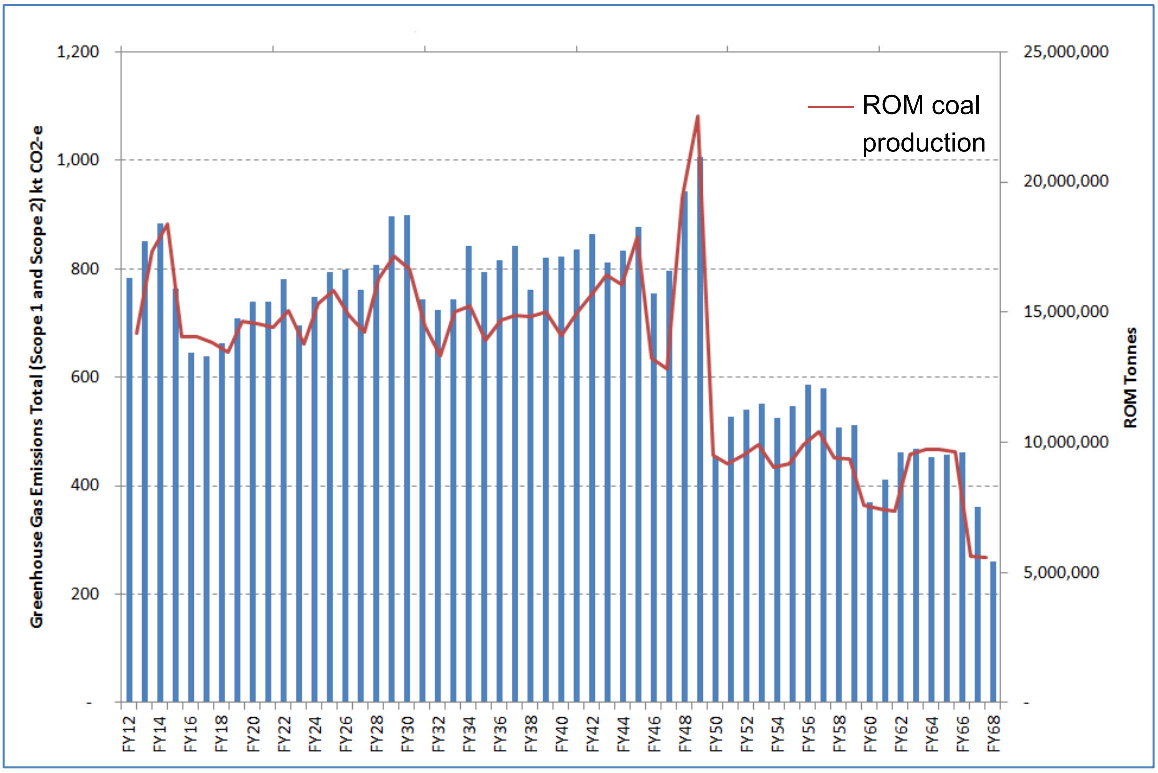
The results highlight the combustion of diesel fuel (46.7 per cent) followed by the release of fugitive emissions of IMG (32.5 per cent) as the leading sources of GHG emissions. The consumption of electricity purchased from the Queensland grid accounts for an estimated 20.8 per cent of the life of mine total GHG Scope 1 and Scope 2 emissions.

The annual variation in the total mass of GHG emissions (**Figure 12-2**) highlights the relative consistency in annual rate of emissions of GHG to approximately FY 2050. The reduction in activities in relation to open-cut mining after FY 2050 is associated with a corresponding reduction in emissions.

Table 12-4 GRM Scope 1 and Scope 2 Greenhouse Gas Emissions (kilotonnes CO_2-e)

Scope	Activity	CO_2	CH_4	N_2O	Total (life of mine)	Min Year	Max Year	Av Year
1	Diesel Usage	18,163	52	131	18,346	67	453	322
	Fugitive Emissions	-	12,756	-	12,756	95	383	224
2	Electricity Usage	8,147	-	-	8,147	98	188	143
Total Scope 1		18,163	12,808	131	31,102	162	824	546
Total Scope 2		8,147	-	-	8,147	98	188	143
Total Scope 1 and Scope 2		26,310	12,808	131	39,249	260	1,006	689

Figure 12-2 Annual Distribution of the Total Scope 1 and Scope 2 Emissions (over the life of mine) and ROM Coal Production at GRM



12.1.5.2 Broadmeadow Underground Mine

The BRM is a resource comprising of approximately 138 million tonnes of ROM coal with an estimated life of mine of approximately 20 years.

The three main sources of Scope 1 and Scope 2 emissions of GHG associated with BRM include:

- fugitive emissions of IMG including ventilation of methane during underground mining;
- diesel consumption; and
- electricity usage.

Based on information presented in **Table 12-5**, the average rate of emissions of GHG from the BRM during FY2009, FY2010 and FY2011 (based on NGERS reporting but not including energy use) was 0.0737 tonnes of CO_2-e per ROM tonne of coal produced.

Table 12-5 Fugitive Emission Rates for Broadmeadow Underground Mine

NGERS Reporting Year	Total Emissions ($t CO_2$-e)	ROM tonnes	$t CO_2$-e per ROM tonne
2009	235,706	4,470,225	0.0527
2010	198,413	3,836,427	0.0517
2011	170,083	1,459,222	0.1166

In calculating GHG emissions associated with the mining of coal from BRM, a conservative approach has been adopted whereby the following assumptions have been applied:

- Emissions per ROM tonne of coal as estimated from the FY2009 and FY2010 is representative of emissions throughout the life of BRM.
- Due to the low volume of IMG associated with BRM, pre-drainage will not be required and all waste mine gas produced during and after mining will be vented directly to the atmosphere.

Based on the emission factors presented in **Section 12.1.4.5** and the estimated life of mine ROM tonnes (**Table 12-6**), the release of GHG due to mining of BRM is approximately 11,511 kilotonnes CO_2-e (life of mine) (**Table 12-7**). There is potential for this level to increase in the future as the Australian Government intends to adopt a higher methane GWP (from 21 to 25) starting in July 2017. Results of the analysis highlights the significant contribution that fugitive emissions (88.4 per cent) contribute to the mine's GHG profile. Electricity and diesel fuel consumption account for 7.7 per cent and 3.9 per cent respectively. A time series of the total Scope 1 and Scope 2 GHG emissions is presented in **Figure 12-3**.

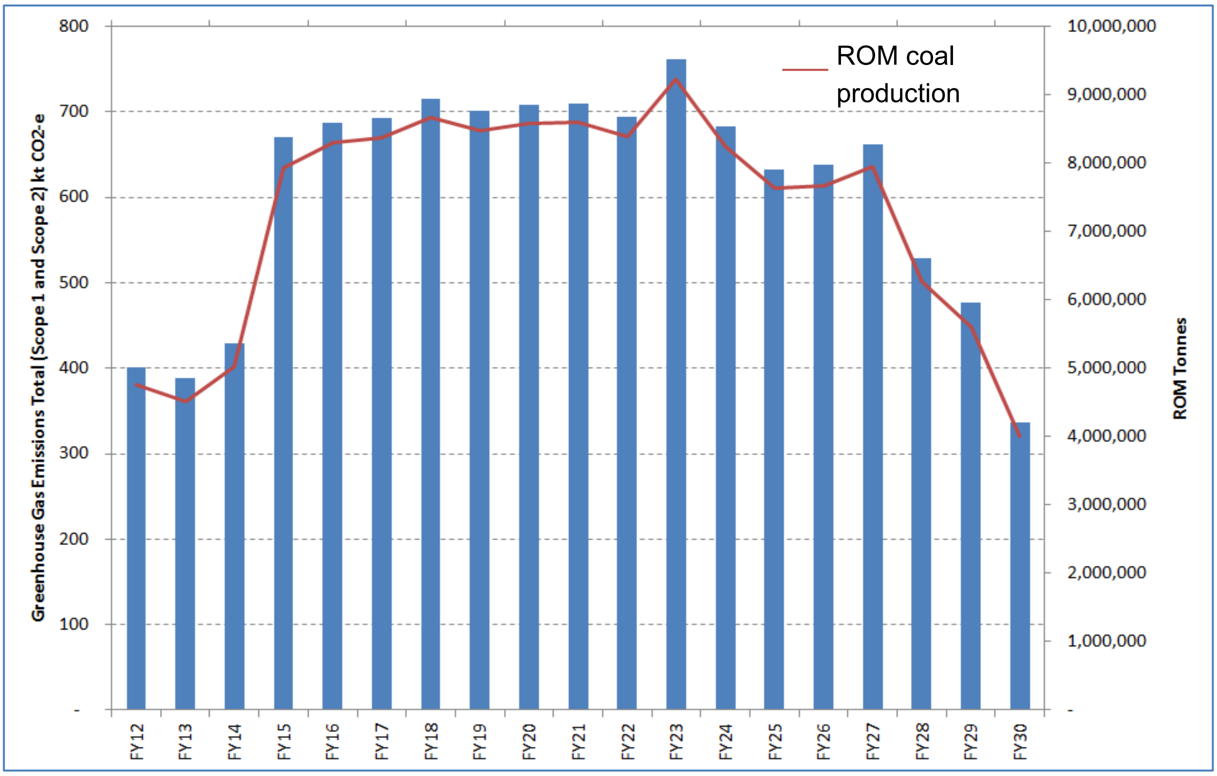
Table 12-6 Broadmeadow Underground Mine Information

Category	Units	Value (life of mine)	Minimum	Maximum	Average
ROM Coal Mined	megatonnes	138	4.0	9.2	7.2
Electricity Usage	MWh	1,003,562	31,199	68,001	52,819
Diesel Usage	ML	165	5.0	10.7	8.7

Table 12-7 Scope 1 and Scope 2 Greenhouse Gas Emissions (kilotonnes CO_2-e) for BRM

Scope	Activity	CO_2	CH_4	N_2O	Total	Min	Max	Av
1	Diesel Usage	442	1	3	447	14	29	24
	Fugitive	-	10,181	-	10,181	295	680	536
2	Electricity Usage	883	-	-	883	27	60	46
Total Scope 1		442	10,182	3	10,628	309	709	559
Total Scope 2		883	-	-	883	27	60	46
Total Scope 1 and Scope 2		1,325	10,182	3	11,511	336	761	606

Figure 12-3 Annual Distribution of the Total Scope 1 and Scope 2 Emissions (over the life of mine) and ROM Coal Production at BRM



12.1.6 Summary of Greenhouse Gas Emissions from the GRB Mine Complex

Presented in **Table 12-8** is a summary of GHG emissions from existing emission sources, namely GRM and BRM.

Included in **Table 12-8** is an estimate of the voluntary reporting Scope 3 emissions associated with the consumption of 17.5 million tonnes per annum (mtpa) of product coal by end users. Although the transport and material handling of product coal during transport to end users will also be associated with the release of Scope 3 emissions, relative to the mass of GHG emissions released during combustion of the product by the end user, these Scope 3 emissions are considered to be immaterial and have not been explicitly estimated.

Table 12-8 Summary of Greenhouse Gas Emissions (kilotonnes CO_2-e) from the GRB Mine Complex

Scope	Total (life of mine)	Minimum Year	Maximum Year	Average Year
Total Scope 1	41,730	471	1,533	1,105
Total Scope 2	9,031	126	248	189
Total Scope 1 and Scope 2	50,760	596	1,768	1,294
Total Scope 3 (17.5 mtpa)[1]	2,699,834	47,366	47,366	47,366

Note 1: These factors will be reduced from July 2012 as a result of amendments to the NGER Measurement Determination (see *National Greenhouse and Energy Reporting (Measurement) Amendment Determination 2012 (No.)–Consultation Draft).*

12.1.7 Future Greenhouse Gas Emission Sources

12.1.7.1 Broadmeadow Underground Mine Extension

The extension of two BRM long wall panels into MLA70421 forms part of the project, which will increase the ROM tonnages that are extracted from BRM by an additional 1.4 million or about 1.1 per cent. Based on the estimates of GHG emissions associated with BRM (**Section 12.1.5.2**), the increase in the life of mine mass of GHG emissions is estimated to be about 1.1 per cent of 11,511 kilotonnes CO_2-e or an additional 127 kilotonnes CO_2-e. Due to the low volumes of IMG there is little to no pre- and/or goaf drainage required. A conservative methodology has been adopted assuming all IMG is vented directly to the atmosphere.

12.1.7.2 Red Hill Mine

Sources, Volumes and Composition of Incidental Mine Gas

The emission of IMG associated with underground mining will be from the following potential sources:

- pre-drainage of coal measures prior to underground mining;
- ventilation of methane during underground mining; and
- post-drainage of IMG from the goaf after underground mining.

It is noted however, that not all of the methane is released during extraction of coal with on-going releases of methane associated with the handling, processing and stockpiling of coal.

There is an estimated life of mine total pool of IMG of 180 petajoules that will need to be managed in association with the mining of the RHM. Based on a total ROM production of 234 million ROM tonnes this suggests a gas to production ratio of 0.77 petajoules of IMG per ROM tonne of coal.

Of this 180 petajoules, an estimated 150 petajoules is associated with the pre-drainage of IMG with the objective of achieving the methane content of not more than three cubic metres per ROM tonne prior to mining.

During mining and within the confines of the underground mine it is anticipated that a life of mine total of 20 petajoules of IMG will be released. This release is associated with a reduction in IMG content of the coal from approximately three cubic metres per ROM tonne to about one cubic metre per ROM tonne. IMG released within the confines of the mine will form part of the ventilation air methane (VAM) exhaust gas.

Based on available information, the methane content of the pre-drainage gas for the RHM is expected to range from 90 to 100 per cent while the assumed methane content of the goaf gas is 30 to 85 per cent. Regulatory requirements limit the methane content of VAM exhaust gas to less than one per cent methane.

For the purposes of the GHG assessment, it is assumed that 80 per cent of the IMG is captured with 20 per cent of the total pool vented directly to the atmosphere. The project base case conservatively assumes that all captured IMG is flared. Other options for the mitigation of GHG emissions for the captured gas component of the IMG pool are considered in isolation in **Section 12.2.2** though in practice a combination of mitigation options may be implemented. It is also noted that flaring will occur as part of any future IMG management strategy.

Greenhouse Gas Emissions

Thus, Scope 1 and Scope 2 emission sources associated with the mining of coal associated with the project that have been explicitly accounted for include:

- the consumption of diesel fuel;
- the consumption of electricity;
- release of IMG associated with underground mining:
  - pre-drainage, VAM and goaf gases;
- flaring of IMG;
- the production of electricity (mitigation option); and
- fuels consumed in the transportation of the workforce.

A summary of RHM data used to estimate emissions of GHG associated with the project is presented in **Table 12-9.**

Table 12-9 Red Hill Mine Greenhouse Gas Emission Information

Category	Units	Value (life of mine)	Minimum	Maximum	Average
ROM Coal Mined	Megatonnes	234	0.51	15.5	3.5
Electricity Usage	MWh	1,452,982	5,060	82,784	38,836
Diesel Usage	ML	160	0.7	9.8	3.7
Remote Workforce	Flights[1]	19,916	312	988	650
Aviation Fuel[2]	ML	59.7	0.9	3.0	2.0

Note 1: Estimated number of return flights between Brisbane and Moranbah.

Note 2: Based on Dash 8-400 aircraft fuel consumption of 3,000 litres for a return trip between Brisbane and Moranbah.

Based on the information presented in **Table 12-9** and the emission factors presented in **Section 12.1.4.5,** the emissions of GHG associated with the consumption of electricity is estimated to be 1,279 kilotonnes of CO_2-e over the life of mine.

Using a conversion of 26.3 cubic metres per gigajoule, the 20 per cent of the IMG (which is conservatively assumed to be 100 per cent methane) that is vented directly to the environment corresponds to a life of mine total of 36 petajoules or 946.8 million cubic metres of methane. This is equivalent to a release of a total of 676 kilotonnes of methane. Based on a global warming potential of 21 times that of CO_2, the total life of mine emissions of GHG that are released as fugitive emissions during mining is about 14,196 kilotonnes of CO_2-e.

As noted previously, the project assumes a worst case scenario that all captured IMG (80 per cent of 180 petajoules) is flared. Based on the emission factors (DCCEE 2011) GHG emissions associated with the flaring of IMG during the life of mine is estimated to be 8,155 kilotonnes of CO_2-e.

Finally, with respect to GHG emissions generated in association with the transport of the remote workforce is estimated to be a total of 153 kilotonnes of CO_2-e over the life of mine.

A summary of Scope 1 and Scope 2 GHG emissions presented in **Table 12–12** suggests that activities associated with RHM will lead to a life of mine release of 24,214 kilotonnes of CO_2-e.

A breakdown of GHG emissions as a percentage of the total Scope 1 and Scope 2 emissions over life of mine is illustrated in **Figure 12-4**. Annual distribution of GHG emissions of the total Scope 1 and Scope 2 emissions over life of mine is illustrated in **Figure 12-5**.

Mine Methane Management

Exploration drilling has identified mining areas where IMG levels in the initial target mining seam, and the overlying and underlying seams, will likely need to be drained to enable the safe and efficient operation of the underground mine. Additional exploration drilling and IMG drainage planning is currently being undertaken to further characterise these gas levels and expected IMG drainage requirements. However, it is expected that the project will require construction of surface and subsurface infrastructure to drain and manage the safe and efficient mining impacts of IMG. An IMG hazard management strategy is being developed to reduce the associated risks, and it will likely include combinations of the following techniques:

- pre-drainage of coal measures prior to underground mining from surface or from underground (pre-drainage methane);
- dilution of methane through mine ventilation during underground mining, known as VAM; and
- post-drainage of goaf after underground mining (goaf methane).

These IMG management techniques are further discussed in **Appendix Q**.

Exploration permits for petroleum exist adjacent to, or overlap some of the project's mining tenements. BMA will engage with the exploration permit holders in relation to the ownership and management of IMG as required in accordance with the applicable legislation.

As noted in **Section 12.2.2**, the IMG generated from pre-drainage and post-drainage extraction works will be distributed at well head pressure to local or remote flare units where it is not commercially or technically feasible to use or dispose of it beneficially in accordance with the legislation. VAM will be vented to the atmosphere.

Table 12-10 Summary of Scope 1 and Scope 2 Greenhouse Gas Emissions for Red Hill Mine (kilotonnes of CO_2-e)

Scope	Activity	CO_2	CH_4	N_2O	Total	Min	Max	Av
1	Diesel Usage	427	1	3	431	2	26	11
	Fugitive – 20% vented	-	14,196	-	14,196	34	1,035	234
	Fugitive – 80% flared	7,430	720	4	8,155	20	595	134
	Remote Workforce	151	0	2	153	2	8	5
2	Electricity Usage	1,279	-	-	1,279	4	83	23
Total Scope 1		8,008	14,917	9	22,936	58	1,661	384
Total Scope 2		1,279	-	-	1,279	4	83	23
Total Scope 1 and Scope 2		9,287	14,917	9	24,214	62	1,744	407

Figure 12-4 Breakdown of Greenhouse Gas Emissions as a Percentage of the Total of the Scope 1 and Scope 2 Emissions (life of mine) for RHM

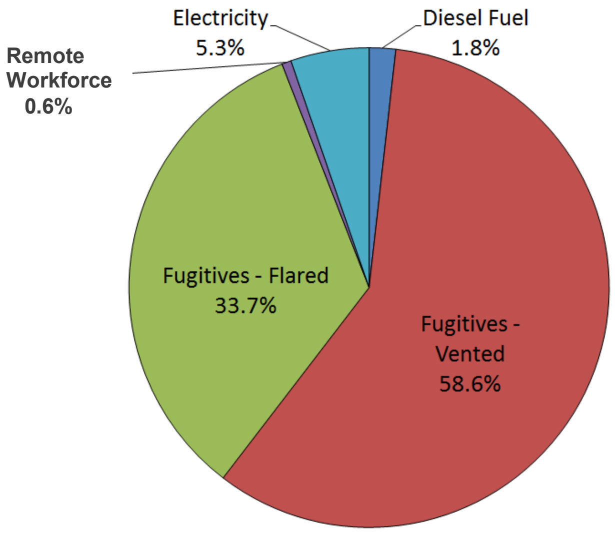
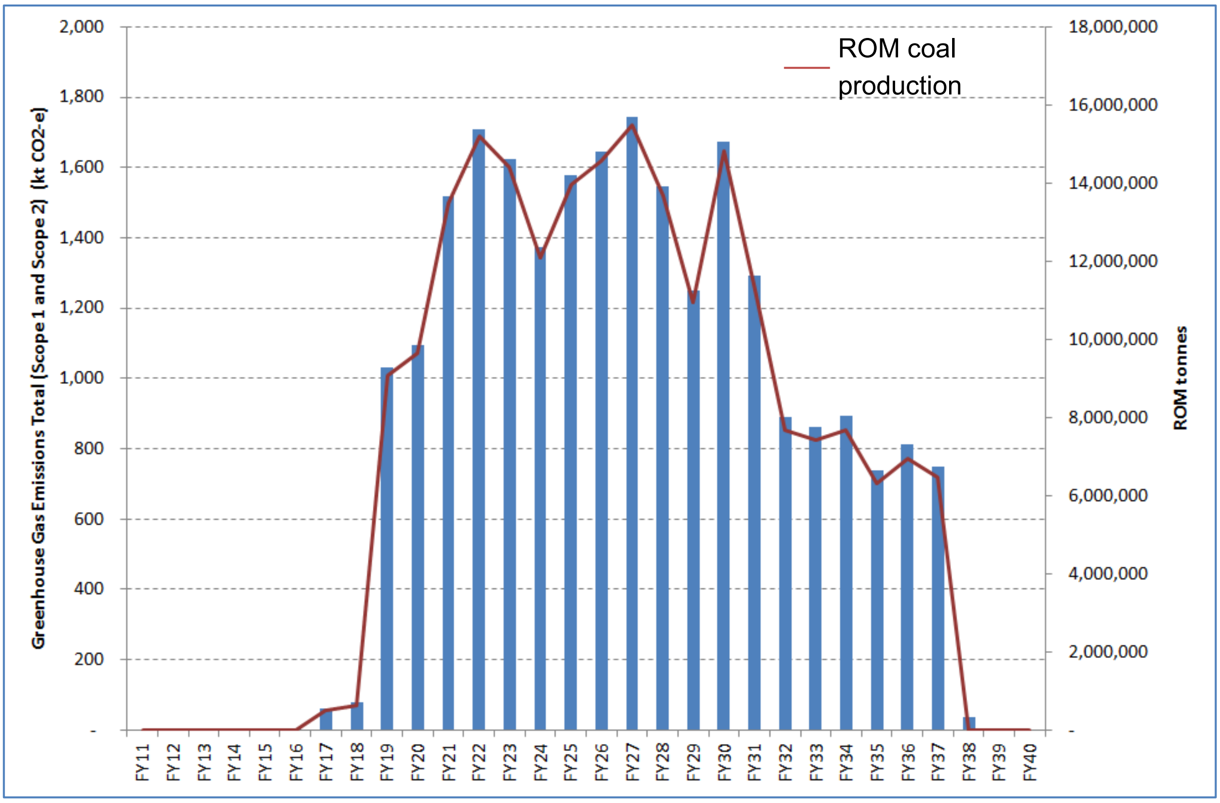


Figure 12-5 Annual Distribution of the Total Scope 1 and Scope 2 Emissions (life of mine) and ROM Coal Production for RHM



12.1.8 Emissions Summary

Results of the analysis suggest that the project will result in an increase in GHG emissions of about 50.8 per cent above that from the GRB mine complex. This increase in GHG emissions is primarily due to the release of fugitive emissions associated with the venting and flaring of IMG from RHM (**Table 12-11**).

Included in the table for completeness are the estimated Scope 3 GHG emissions due to the combustion of the product coal by the end user.

Table 12-11 Summary of Scope 1 and Scope 2 Life of Mine Greenhouse Gas Emissions (kilotonnes CO2-e) for Project-Related and Existing Emission Sources

Category	Existing		Project		Current Approvals	GRB Mine Complex and the Project
	GRM	BRM	Broadmeadow Extension[1]	RHM		
Total Scope 1	31,102	10,628	117	22,936	41,730	64,782
Total Scope 2	8,147	883	10	1,279	9,030	10,319
Total Scope 1 and Scope 2	39,249	11,511	127	24,214	50,761	72,102
Total Scope 3	-	-	-	-	2,699,834[2]	4,763,616[3]

Note 1: Values presented are for that portion of BRM that is proposed to extend into MLA70421.
Note 2: Based on an annual production of approximately 18 mtpa of product coal from the GRB mine complex.
Note 3: Based on an annual production of 32 mtpa of product coal from the GRB mine complex and the project.

12.1.9 Performance Measures

The performance of the GHG emissions efficiency is measured as emissions intensity, as defined by the Greenhouse Gas Protocol. Emissions intensity is defined as tonnes CO_2-e/tonne product coal, based on total Scope 1 and Scope 2 emissions. The project's GHG performance intensity varies from 0.113 tonnes of CO_2-e/tonne ROM to 0.128 tonnes of CO_2-e/tonne ROM throughout the life of mine, which is comparable to that of BRM for FY2011 noting that IMG from BRM is vented directly to the atmosphere whereas 80 per cent of the IMG from RHM is assumed to be flared.

12.2 Potential Impacts and Mitigation Measures

12.2.1 Comparison to National Emissions

The 2009 National Greenhouse Gas Inventory is the latest available national account of Australia's GHG emissions (DCCEE 2009). The National Greenhouse Gas Inventory has been prepared in accordance with the Revised 1996 and 2006 IPCC Guidelines for National Greenhouse Gas Inventories. The IPCC guidance defines six sectors for reporting GHG emissions:

- energy (including coal mining);
- industrial processes;
- solvent and other product use;
- agriculture;
- land use, land use change and forestry; and
- waste.

Australia's net GHG emissions across all sectors (excluding land use change and forestry) totalled 545.8 megatonnes of CO_2-e in 2009, with the energy sector being the largest emitter at 417.4 megatonnes CO_2-e. Emissions from coal-mining sources are captured under the energy category of the IPCC methodology. Approximately 39.7 megatonnes of energy sector emissions were attributable to fugitive emissions, representing seven per cent of national emissions. Australia's total emissions are just over one per cent of the global anthropogenic emissions of 49.0 gigatonnes CO_2-e, based on IPCC inventory data for 2004.

Table 12-12 shows total annual Scope 1 and Scope 2 emissions as a percentage of Australian total and energy sector emissions taken from the National Greenhouse Gas Inventory 2009. This has been calculated for the average GHG emissions from the project for the base case (flaring of IMG), mitigation option 1 (onsite power generation) and mitigation option 2 (sale of captured IMG for sale to a third party).

Table 12-12 Comparison of Australian and Project GHG Emissions, Scope 1 and Scope 2

Project (RHM and Broadmeadow Extension)	Average (kt CO_2-e)	Australian Energy Sector Total	Australian Total
Base Case	413	0.10%	0.08%
Option 1	390	0.09%	0.07%
Option 2	279	0.07%	0.05%

12.2.2 Beneficial Reuse of Gas

As noted in **Section 12.1.7.2**, the project base case assumes that all captured IMG from RHM (either pre-drainage and/or goaf) is flared. However, the project is reviewing other options that seek to beneficially use the IMG where it is technically and commercially feasible to do so, including:

1. Use for mining under the mining lease including on site power generation;
2. Transport or storage within the area of the mining lease to allow it to be used beneficially for mining under the mining lease; and/or
3. Use or disposal for a purpose other than mining, including third party gas off-take arrangements for use off site, in accordance with the applicable legislation.

The implication with respect to GHG emissions for each of these three options will be explored in this section. A detailed comparison of the two most likely options (one and three) with the base case is discussed in **Section 12.2.2.4**.

It is noted, however, that the proposed mitigation options are conceptual at this stage and considerable further investigations are required to determine feasibility of these options. In the event that none of these options prove feasible, the gas will be flared in accordance with Section 318CO of the MR Act.

12.2.2.1 Option 1 – On Site Power Generation

For the scenario that captured gas is used for on site power generation, the primary benefit from a GHG perspective is the reduction in emissions associated with purchasing of electricity from the Queensland power grid.

For this assessment, the energy of the captured gas (in gigajoules) is converted kilowatt hours (kWh) on an annual basis using the conversion factor: 1 gigajoule = 277.80 kWh. A GHG 'credit' against

Scope 2 emissions (**Section 12.1.5.1, Section 12.1.5.2, Section 12.1.7.1** and **Section 12.1.7.2**) is then calculated assuming that this amount of power is not purchased from the Queensland grid.

For example, based on a combustion engine conversion rate of one gigajoule of energy to 106.8 kWh of electricity (SKM 2011) an estimated total life of mine of 15,379 million kWh of electricity could be generated from the IMG captured from RHM. This corresponds to an estimated potential total of 13,533 kilotonnes of CO_2-e credits towards the purchasing of electricity from the grid.

However, in order to assess the applied number of credits against electricity purchases from the grid for a given project year, the potential power generated from the combustion of the gas is compared with the electricity demand for the site for that year. There are years for which the supply of power is predicted to exceed the on site demand and, thus, there is potential to sell the excess power back to the grid.

For this assessment, however it has been assumed that all GHG emissions associated with the combustion of the IMG for the purposes of on site power generation are attributed to the project with no reduction of GHG emissions as a result of the potential sale of power back into the grid. This is considered to be conservative for the case that excess power is sold to the grid but representative of the case that excess gas is flared rather than used to generate power other than that which is used on site.

It is interesting to note that based on the NGA emission factors, the consumption of IMG for the purposes of producing power is considered 'cleaner' than power from the Queensland Grid. It is additionally noted that the emissions intensity of Queensland grid power has decreased in recent years with the greater proportion of gas-fired generation, more efficient coal plants and renewables, and that this trend will continue and potentially accelerate under the influence of the increased mandatory renewable energy target and carbon pricing.

12.2.2.2 Option 2 – Off-take to Third Party for Use Off Site

The sale and/or off-take of the collected IMG to a third party for use off site will reduce the project's base case GHG emissions inventory by an amount equal to the emissions associated with flaring of the gas that was presented in **Table 12–10** which is estimated to be 8,154 kilotonnes of CO_2-e.

12.2.2.3 Option 3 – Transport and Storage of Incidental Mine Gas on the Mining Lease

This option would involve transport and storage of the collected IMG on the mining lease so that it can be used beneficially on the mining lease. This may involve compression, liquefaction or conversion to liquids of the IMG so that it could be stored, handled and used on the lease. This option is considered technically and commercially challenging at this stage but is considered here for completeness. The implication with respect to GHG emissions for this option would be similar to that detailed in **Section 12.2.2.1** as the IMG would ultimately be combusted for energy purposes and has not been explicitly calculated.

12.2.2.4 Comparison of Greenhouse Gas Emissions Estimates for the Various Options

A summary of the results from the GHG assessment is provided in **Table 12-13** for the base case (flaring of captured IMG from RHM) and scenarios that include the generation of power for use on site (option 1) and the sale of captured gas to a third party for use off site (option 2).

Table 12-13 Summary of Greenhouse Emissions (kilotonnes of CO_2-e) for the combined GRB Mine Complex and Project Based on the Choice of Mitigation Option

Scope	Activity	GRB Mine Complex Base Case	Option 1[1]	Option 2[2]	Option 1 (%)	Option 2 (%)
1	Diesel Consumption	19,225	19,225	19,225	0.0%	0.0%
1	Fugitive Emissions	45,288	45,288	37,133	0.0%	-18.0%
1	Remote Workforce	153	153	153	0.0%	0.0%
2	Electricity (Total)	10,309	5,265[3]	10,309	-48.9%	0.0%
Total Scope 1		64,666	64,666	56,511	0.0%	-12.6%
Total Scope 2		10,309	5,265	10,309	-48.9%	0.0%
Total Scope 1 and Scope 2		74,975	69,930	66,820	-6.7%	-10.9%

Note 1: Generation of power for use on site.
Note 2: Sale of IMG to a third party.
Note 3: Additional GHG credits could be obtained via the sale of excess power back into the Queensland grid.

12.2.3 Other Greenhouse Gas Reduction Measures

While specific measures to minimise greenhouse gas emissions cannot be determined until the detailed design stage or operations stage of the project, it is expected that minimisation of greenhouse gas emissions will be achieved through a combination of:

Development of site-based programs, particularly targeting:

- electrical efficiency;
- diesel efficiency; and
- fugitive emissions.

Participation in corporate programs, including:

- energy efficiency assessments;
- mine methane management; and
- Australian emissions trading scheme.

The project will also continue to investigate potential for beneficial on site reuse of methane and also third party off-take and transport and storage as outlined in **Section 12.2.2**.

12.2.3.1 Electrical Efficiency

The project will be a large consumer of electricity, primarily as a result of underground mining methods and CHPP activities. The following activities, which are typical of site based approaches to electrical efficiency, will be undertaken where practicable and where investigations show that material emissions reductions may be achieved:

- use of high efficiency electrical motors throughout the RHM;
- use of variable speed pumps, possibly with high-efficiency linings at the Red Hill CHPP;
- regular monitoring of the compressed air circuit so that leaks are repaired in a timely manner, as this maximises the operating efficiency of the compressor; and
- maintaining light fittings to maximise light delivery in proportion to energy consumption.

12.2.3.2 Diesel Efficiency

Diesel consumption for the production of stationary energy is a major source of GHG emissions and it is normal business practice at mines to minimise the use of such sources.

12.2.3.3 Fugitive Emissions

An estimated 80 per cent of the project-related IMG will be captured and either flared (base case), used to generate on site power (mitigation option 1) or sold off site to a third party (mitigation option 2). With respect to the remaining 20 per cent of IMG that is vented directly to the atmosphere, primarily as VAM, there may be some opportunity to increase the fraction that is flared through the mixing of IMG with goaf gas. The practicality and safety of such a mitigation strategy will need to be considered as part of detailed design.

12.2.3.4 Energy Efficiency Opportunities

As noted in **Section 12.1.3.5**, the project will form part of the GRB mine complex operated by BMA for the purposes of EEO and, as such, will be incorporated in the Assessment and Reporting Schedule for BMA's second assessment cycle (July 2014 to June 2019).