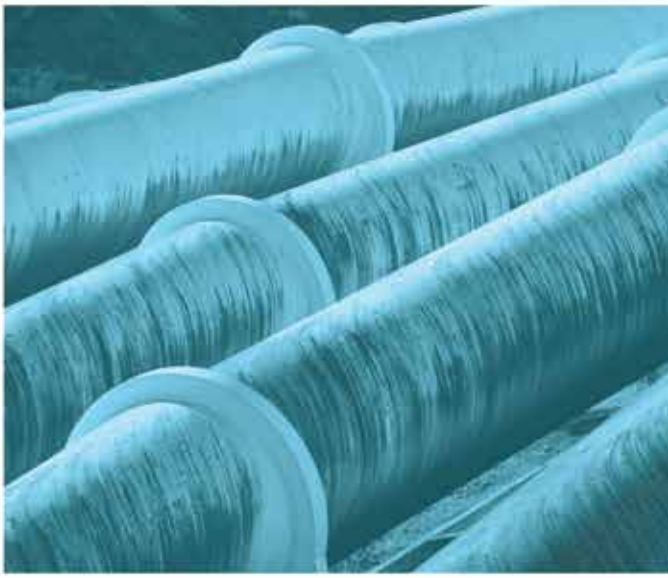
Appendix D

Clarence Colliery - Greenhouse gas emissions assessment


Clarence Colliery - Modification 6

Greenhouse gas assessment

Prepared for Centennial Coal Company Limited
August 2020

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Clarence Colliery - Modification 6

Greenhouse gas assessment

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1 Introduction

Clarence Colliery (Clarence) is an underground coal mining operation within the Western Coalfield of New South Wales (NSW) approximately 10 kilometres (km) east of Lithgow in the Lithgow local government area (LGA).

Centennial is seeking to modify DA 504-00 pursuant to Section 4.55(2) of the NSW *Environmental Planning and Assessment Act 1979* (EP&A Act) to allow for the transportation of coarse coal reject (CCR) from Reject Emplacement Area (REA) 6 and Clarence's production stream to Charbon Colliery via rail.

This greenhouse gas (GHG) assessment has been prepared to support the modification report. It provides estimates of Scope 1, 2 and 3 emissions and a comparison to State and National inventories. It also provides a comparison of GHG emissions for existing and proposed scenarios on an annual basis.

This GHG assessment has been prepared in accordance with the guidelines specified by the Commonwealth Department of Environment and Energy (DoEE) (now Commonwealth Department of Agriculture, Water and the Environment or DAWE) *National Greenhouse Accounts Factors* (NGAF) workbook (DoEE 2019).

2 Greenhouse gas calculations

2.1 Introduction

The estimation of GHG emissions for Clarence was based on the DoEE (2019) NGAF workbook. The methodologies in the NGAF workbook follow a simplified approach, equivalent to the 'Method 1' approach outlined in the *National Greenhouse and Energy Reporting (Measurement) Technical Guidelines* (Technical Guidelines) (DoE 2014). The Technical Guidelines are used for the purpose of reporting under the Commonwealth *National Greenhouse and Energy Reporting Act 2007* (the NGER Act).

For accounting and reporting purposes, GHG emissions are defined as 'direct' and 'indirect' emissions. Direct emissions (also referred to as Scope 1 emissions) occur within the boundary of an organisation and as a result of that organisation's activities. Indirect emissions are generated as a consequence of an organisation's activities but are physically produced by the activities of another organisation (DoEE 2019). Indirect emissions are further defined as Scope 2 and Scope 3 emissions. Scope 2 emissions occur from the generation of the electricity purchased and consumed by an organisation. Scope 3 emissions occur from all other upstream and downstream activities, for example the downstream extraction and production of raw materials or the upstream use of products and services.

Scope 3 is an optional reporting category (Bhatia et al 2010) and should not be used to make comparisons between organisations, for example in benchmarking the GHG intensity of products or services. Typically, only major sources of Scope 3 emissions are accounted and reported by organisations.

2.2 Emission sources

The GHG emission sources included in this assessment are listed in Table 2.1, representing the most significant sources associated with Clarence.

GHG emissions from Clarence are estimated using the methodologies outlined in the NGAF workbook, using fuel energy contents and scope 1, 2 and 3 emission factors for diesel and electricity use in NSW.

Table 2.1 Scope 1, 2 and 3 emission sources

Scope 1	Scope 2	Scope 3
Direct emissions from diesel combustion.	Indirect emissions associated with the consumption of purchased electricity.	Indirect emissions from the extraction, production and transport of diesel.
Direct emissions from LPG use.	-	Indirect emissions from the extraction, production and transport of LPG.
Fugitive emissions of coal seam methane (CH_4) and CO_2 from the ventilation shafts.	-	Indirect emissions from electricity lost in delivery in the transmission and distribution network.
Direct emissions from the use of oils and greases.	-	Indirect emissions from product coal combustion.
Direct emissions from the use of sulphur hexafluoride (SF_6).	-	Indirect emissions associated with the transport of product coal via rail and ship.
-	-	Indirect emissions from the extraction, production and transport of oil and grease.
-	-	Indirect emissions from fuel for employee travel.

2.3 Excluded emission sources

GHG emissions from potential diesel or electricity to be used during post-mining rehabilitation and decommissioning of Clarence have not been included in this assessment. The exact amount of diesel and electricity to be used in this phase is unknown at this point; however, Centennial estimates that the amount required will be significantly less than that used during mining operations. These emissions therefore have not been specifically quantified.

Post-mining activities or emissions relate to methane emissions released from stockpiled coal after it has been mined. The percentage of methane in the return ventilation air at Clarence is below 0.1%. Therefore, Clarence is not classed as a 'gassy mine'. Centennial has also indicated that coal is turned over quickly and not left in stockpiles at Clarence for any significant period of time. Consequently, emissions from post-mining activities have not been quantified in this assessment.

2.4 Activity data

Estimates of fuel, substances and electricity consumption associated with the existing and proposed operations scenarios at Clarence have been provided by Centennial. The adopted activity data for the emission estimates is presented in Table 2.2.

It is noted that the only difference between the existing and proposed scenarios is the additional diesel used in the proposed scenario to transport CCR to Charbon Colliery.

Table 2.2 Activity data inputs for GHG calculations

Process	Existing operations	Proposed operations (modification)
Annual ROM coal (t)	3,000,000	3,000,000
Annual product coal (t)	2,650,000	2,650,000
Diesel used for stationary energy purposes (L)	484,874	484,874
Diesel used for general transport energy purposes (L)	38,597	38,597
Diesel used to transport product coal via rail (L)	4,770,000	4,770,000
Diesel used to transport CCR to Charbon Colliery (L)	0	567,000
LPG (L)	1,300	1,300
Employee travel fuel (L)	111,464	111,464
Electricity (kWh)	50,507,288	50,507,288
Fugitive emissions from ventilation shaft (m^3/s)	343	343
Oil (L)	228,217	228,217
Grease (L)	3,632	3,632
Sulfur hexafluoride (SF_6) (kg)	0.8	0.8

2.5 Emission estimates

The estimated annual GHG emissions for each emission source for the existing and proposed scenarios are presented in Table 2.3 and Table 2.4, respectively. Details of the GHG emissions calculations are provided in Appendix A.

The significance of Clarence's GHG emissions relative to State and National GHG emissions is made by comparing annual average GHG emissions against the most recent available total GHG emissions inventories (calendar year 2018[1]) for NSW (131,685 kt CO_2-e) and Australia (537,446 kt CO_2-e).

Annual average GHG emissions (Scope 1 and 2) generated by Clarence in the existing and proposed scenarios represent approximately 0.043% of total GHG emissions for NSW and 0.010% of total GHG emissions for Australia, based on the National Greenhouse Gas Inventory for 2018.

The proposed modification will not result in an increase in annual Scope 1 and 2 GHG emissions at Clarence. Scope 3 emissions from Clarence are 6,597,053 t CO_2-e per year under the existing scenario and 6,597,132 t CO_2-e per year under the proposed scenario. The increase is related to diesel used by trains to transport CCR from Clarence to Charbon in the proposed scenario.

Table 2.3 Estimated annual GHG emissions – existing operations

Source	Scope 1 (t CO_2-e/year)	Scope 2 (t CO_2-e/year)	Scope 3 (t CO_2-e/year)	Total
Diesel combustion	1,419	-	736	2,154
Employee travel	-	-	266	266
LPG	2.0	-	0.1	2
Fugitive emissions from vent shafts	13,689	-	-	13,689
Oils and greases	124	-	32	156
SF_6	0.2	-	-	0
Electricity consumption	-	40,911	4,546	45,457
Product coal combustion	-	-	6,090,525	6,090,525
Transport of product coal via rail	-	-	8,586	8,586
Transport of product coal via ship	-	-	492,362	492,362
Total	**15,233**	**40,911**	**6,597,053**	**6,653,197**

[1] https://ageis.climatechange.gov.au/SGGI.aspx

Table 2.4 Estimated annual GHG emissions – proposed operations

Source	Scope 1 (t CO_2-e/year)	Scope 2 (t CO_2-e/year)	Scope 3 (t CO_2-e/year)	Total
Diesel combustion	1,419	-	814	2,233
Employee travel		-	266	266
LPG	2	-	0.1	2
Fugitive emissions from vent shafts	13,689	-	-	13,689
Oils and greases	124	-	32	156
SF_6	0.2	-	-	0
Electricity consumption	-	40,911	4,546	45,457
Product coal combustion	-	-	6,090,525	6,090,525
Transport of product coal via rail	-	-	8,586	8,586
Transport of product coal via ship	-	-	492,362	492,362
Total	**15,233**	**40,911**	**6,597,132**	**6,653,276**

3 Conclusions

This GHG assessment supports a modification application for Clarence. It provides estimates of Scope 1, 2 and 3 emissions and a comparison to State and National inventories. The assessment has been prepared in accordance with the guidelines specified by the NGAF workbook (DoEE 2019).

Annual average GHG emissions (Scope 1 and 2) generated by Clarence in the existing and proposed scenarios represent approximately 0.043% of total GHG emissions for NSW and 0.010% of total GHG emissions for Australia, based on the National Greenhouse Gas Inventory for 2018.

Scope 3 emissions from Clarence are 6,597,053 t CO_2-e per year under the existing scenario and 6,597,132 t CO_2-e per year under the proposed scenario. The increase is related to diesel used by trains to transport CCR from Clarence to Charbon in the proposed scenario.

Mitigation of GHG emissions will continue to be conducted in accordance with Centennial's *Air Quality and Greenhouse Gas Management Plan – Western Region* (Centennial 2016).

References

AEGIS 2015, *Australian Greenhouse Emissions Information System*, viewed 26 June 2020, https://ageis.climatechange.gov.au/SGGI.aspx.

Bhatia, P, Cummis, C, Brown, A, Rich, D, Draucker, L & Lahd, H 2010, Greenhouse Gas Protocol. *Corporate Value Chain (Scope 3) Accounting and Reporting Standard*. Supplement to the GHG Protocol Corporate Accounting and Reporting Standard, World Resources Institute & World Business Council for Sustainable Development.

Centennial 2016, *Air Quality and Greenhouse Gas Management Plan: Western Region*.

DoE 2014, *National Greenhouse and Energy Reporting (Measurement) Technical Guidelines*, Department of Environment.

DoEE 2019, *National Greenhouse Accounts Factors*, Commonwealth Department of Environment and Energy.

Abbreviations

CO_2-e	carbon dioxide equivalent
CCR	coarse coal reject
DoEE	Commonwealth Department of the Environment and Energy
GHG	greenhouse gas
kW	kilowatt
LGA	local government area
NGAF	National Greenhouse Accounts Factors
REA	reject emplacement area

Appendix A

Greenhouse gas calculation data

A.1 Fuel consumption

A.1.1 Diesel

GHG emissions from diesel consumption were estimated using the following equation:

$$E_{ij} = \frac{Q_i \times EC_i \times EF_{ijoxec}}{1000}$$

Where:

E_{ij}	=	Emissions of GHG from diesel combustion	(t CO_2-e)
Q_i	=	Quantity of fuel	(kL)
EC_i	=	Energy content of fuel	(GJ/kL)[2]
EF_{ijoxec}	=	Emission factor (scope 1 or 3) for diesel consumption	(kg CO_2-e/GJ)[3]

The quantity of diesel used in the existing and proposed scenarios are listed in Table 2.2. The increase in diesel in the proposed scenario is due to the CCR transported to Charbon in the proposed scenario. These emissions have and emissions relating to rail transport of product coal, have been accounted for as Scope 3 emissions. It is noted that the trains are not owned by Centennial.

GHG emission factors and energy content for diesel were sourced from the NGAF (DoEE 2019). These are presented in Table A.1.

The estimated annual existing and proposed scenario GHG emissions from diesel are presented in Table A.2.

Table A.1 Diesel GHG emission factors

Fuel type	Energy content (GJ/kL)	Scope 1 Emission Factors (kg CO_2-e/GJ)			Scope 3 Emission Factor (kg CO_2-e/GJ)
		CO_2	CH_4	N_2O	CO_2
Stationary energy	38.6	69.9	0.1	0.2	3.6
Transport energy	38.6	69.9	0.1	0.5	3.6

Table A.2 Estimated CO_2-e (tonnes) for diesel consumption per year

Scenario	Diesel use (L/annum)	Emissions (t CO_2-e)		Total
		Scope 1	Scope 3	
Existing scenario	5,293,471	1,419	736	**2,154**
Proposed scenario	5,860,471	1,419	814	**2,233**

[2] GJ = gigajoules

[3] kg CO_2-e/GJ = kilograms of carbon dioxide equivalents per gigajoule

A.1.2 LPG

GHG emissions from LPG consumption were estimated using the following equation:

$$E_{ij} = \frac{Q_i \times EC_i \times EF_{ijoxec}}{1000}$$

Where:

E_{ij}	=	Emissions of GHG from LPG combustion	(t CO_2-e)
Q_i	=	Quantity of fuel	(kL)
EC_i	=	Energy content of fuel	(GJ/kL)
EF_{ijoxec}	=	Emission factor (scope 1 or 3) for LPG consumption	(kg CO_2-e/GJ)

GHG emission factors and energy content for LPG were sourced from the NGAF (DoEE 2019). These are presented in Table A.3.

The estimated annual existing and proposed scenario GHG emissions from LPG are presented in Table A.4.

Table A.3 LPG GHG emission factors

Fuel type	Energy content (GJ/kL)	Scope 1 Emission Factors (kg CO_2-e/GJ)			Scope 3 Emission Factor (kg CO_2-e/GJ)
		CO_2	CH_4	N_2O	CO_2
LPG	25.7	60.2	0.2	0.2	3.6

Table A.4 Estimated CO_2-e (tonnes) for LPG consumption per year

Scenario	LPG use (L/annum)	Emissions (t CO_2-e)		Total
		Scope 1	Scope 3	
Existing scenario	1,300	2.02	0.12	2.14
Proposed scenario	1,300	2.02	0.12	2.14

A.1.3 Employee travel

GHG emissions from employee travel were estimated using the following equation:

$$E_{ij} = \frac{Q_i \times EC_i \times EF_{ijoxec}}{1000}$$

Where:

E_{ij}	=	Emissions of GHG from gasoline combustion	(t CO_2-e)
Q_i	=	Quantity of fuel	(kL)
EC_i	=	Energy content of fuel	(GJ/kL)
EF_{ijoxec}	=	Emission factor (scope 3) for gasoline consumption	(kg CO_2-e/GJ)

Employee fuel use was estimated using the following information:

- Number of employees = 273;
- Employee travel origins = distances travelled from a range of suburbs in the region to Clarence were calculated using Google Maps
- Work hours = 5 days per week, 47 weeks per year;
- Estimated total km travelled = 1,032,073 km return per year; and
- Fuel consumption rate of 0.108 L per km (Australian Bureau of Statistics 2018).

GHG emission factors and energy content for gasoline were sourced from the NGAF (DoEE 2019). These are presented in Table A.5.

The estimated annual existing and proposed scenario GHG emissions from employee travel are presented in Table A.6.

Table A.5 Gasoline GHG emission factors

Fuel type	Energy content (GJ/kL)	Scope 3 Emission Factor (kg CO_2-e/GJ)
		CO_2
Gasoline	34.2	3.6

Table A.6 Estimated CO_2-e (tonnes) for employee travel

Scenario	Gasoline use (L/annum)	Emissions (t CO_2-e)
		Scope 3
Existing scenario	111,464	266
Proposed scenario	111,464	266

A.2 Fugitive emissions from mine ventilation air

Fugitive methane emissions will be generated from mine ventilation air at Clarence.

Centennial has provided summary information based on monitoring data from the ventilation shaft at Clarence. The following information was used in the fugitive emissions calculations:

- the average flow rate for financial year 2019/2020 was taken to be 343 m^3/s
- the average contribution of CO_2 was 0.068%
- the average contribution of CH_4 was 0%

Centennial has confirmed that methane in the coal seam is negligible.

The percentage of CO_2 in the mine ventilation air was calculated using the above ratio. A CO_2 adjustment factor[4] to convert gas from m^3 at standard temperature and pressure (STP) to t CO_2-e was used as follows:

- CO_2 adjustment factor = 1.861×10^{-3}

The estimated annual existing and proposed scenario GHG emissions from mine ventilation air are presented in Table A.7.

Table A.7 Estimated CO_2-e (tonnes) for mine ventilation air

Scenario	Air flow (m^3/y)	Emissions (t CO_2-e)
		Scope 1
Existing scenario	10,816,848,000	13,689
Proposed scenario	10,816,848,000	13,689

[4]www.cleanenergyregulator.gov.au/DocumentAssets/Documents/Estimating%20emissions%20and%20energy%20from%20coal%20mining%20guideline.pdf

A.3 Oil use

GHG emissions from oil use were estimated using the following equation:

$$E_{ij} = \frac{Q_i \times EC_i \times EF_{ijoxec}}{1000}$$

Where:

E_{ij}	=	Emissions of GHG from oil use	(t CO_2-e)
Q_i	=	Quantity of oil	(kL)
EC_i	=	Energy content of oil	(GJ/kL)
EF_{ijoxec}	=	Emission factor (scope 1 or 3) for oil use	(kg CO_2-e/GJ)

GHG emission factors and energy content for petroleum based oils were sourced from the NGAF (DoEE 2019). These are presented in Table A.8.

The estimated annual existing and proposed scenario GHG emissions from oil use are presented in Table A.9.

Table A.8 Oil GHG emission factors

Fuel type	Energy content (GJ/kL)	Scope 1 Emission Factors (kg CO_2-e/GJ)	Scope 3 Emission Factor (kg CO_2-e/GJ)
		CO_2	CO_2
Oils	38.8	13.9	3.6

Table A.9 Estimated CO_2-e (tonnes) for oil use per year

Scenario	Oil use (L/annum)	Emissions (t CO_2-e)		Total
		Scope 1	Scope 3	
Existing scenario	228,217	123	32	155
Proposed scenario	228,217	123	32	155

A.4 Grease

GHG emissions from grease were estimated using the following equation:

$$E_{ij} = \frac{Q_i \times EC_i \times EF_{ijoxec}}{1000}$$

Where:

E_{ij}	=	Emissions of GHG from grease	(t CO_2-e)
Q_i	=	Quantity of grease	(kL)
EC_i	=	Energy content of grease	(GJ/kL)
EF_{ijoxec}	=	Emission factor (scope 1 or 3) for grease	(kg CO_2-e/GJ)

GHG emission factors and energy content for petroleum based greases were sourced from the NGAF (DoEE 2019). These are presented in Table A.10.

The estimated annual existing and proposed scenario GHG emissions from grease use are presented in Table A.11.

Table A.10 Grease GHG emission factors

Fuel type	Energy content (GJ/kL)	Scope 1 Emission Factors (kg CO_2-e/GJ)	Scope 3 Emission Factor (kg CO_2-e/GJ)
		CO_2	CO_2
Greases	38.8	3.5	3.6

Table A.11 Estimated CO_2-e (tonnes) for grease per year

Scenario	Grease use (L/annum)	Emissions (t CO_2-e)		
		Scope 1	Scope 3	Total
Existing scenario	228,217	0.5	0.5	1
Proposed scenario	228,217	0.5	0.5	1

A.5 Sulfur hexafluoride (SF_6)

Emissions of SF_6 may be released at Myuna through the use of gas in insulated switch gear and circuit breaker applications.

GHG emissions from SF_6 were estimated using the following equation:

$$E_{jk} = \frac{Stock_{jk} \times GWP}{J_{jk}}$$

Where:

E_{jk}	=	Emissions of gas type	(t CO_2-e)
$Stock_{jk}$	=	Stock of gas type	(t CO_2-e)
GWP	=	Global Warming Potential	
L_{jk}	=	default leakage rates for a year of gas type	

The default leakage gas rate for SF_6 as given in the NGAF is 0.0089. The GWP value given in the NGAF for SF_6 is 22,800.

The estimated annual existing and proposed scenario GHG emissions from SF_6 are presented in Table A.12.

Table A.12 Estimated CO_2-e (tonnes) for SF_6

Scenario	SF_6 use (kg/y)	Emissions (t CO_2-e)
		Scope 1
Existing scenario	1	0.2
Proposed scenario	1	0.2

A.6 Electricity use

GHG emissions associated with electricity consumption were estimated using the following equation:

$$E_{CO_2-e} = \frac{Q \times EF}{1000}$$

Where:

E_{CO2-e}	=	Emissions of GHG from electricity consumption	(t CO_2-e)
Q_i	=	Quantity of electricity	(MWh)[5]
EF	=	Emission factor (scope 2 or 3) for electricity consumption	(kg CO_2-e/kWh)[6]

GHG emission factors for electricity use were sourced from the NGAF (DoEE 2019). These are presented in Table A.13. the Scope 3 emissions were taken from the NSW 'latest estimate' section of the NGAF.

The estimated annual existing and proposed scenario GHG emissions from electricity are presented in Table A.14.

Table A.13 Electricity GHG emission factors

Use	Emission Factors (kg CO_2-e/kWh)	
	Scope 2	Scope 3
Electricity	0.81	0.09

Table A.14 Estimated CO_2-e (tonnes) for electricity consumption

Scenario	Electricity use (kWh)	Emissions (t CO_2-e)	
		Scope 2	Scope 3
Existing scenario	50,507,288	40,911	4,546
Proposed scenario	50,507,288	40,911	4,546

[5] MWh = megawatt hours

[6] kg CO_2-e/kWh = kilograms of carbon dioxide equivalents per kilowatt hour

A.7 Energy production from product coal (end use)

GHG emissions associated with energy production from product coal were estimated using the following equation:

$$E_{CO_2-e} = \frac{Q \times EC \times EF}{1000}$$

Where:

E_{CO2-e}	=	Emissions of GHG from electricity consumption	(t CO_2-e)
Q	=	Quantity of coal burnt	(t)
EC	=	Energy Content Factor for bituminous coal	(GJ/t)
EF	=	Emission factor for bituminous coal combustion	(kg CO_2-e/GJ)

Centennial has stated that 2.5 Mtpa of coal would be burnt overseas in both the existing and proposed scenarios.

GHG emission factors for fuel combustion were sourced from NGAF (DoEE 2019). These are presented in Table A.15. The Scope 1 emission factors were used to calculate the Scope 3 emissions from the burning of Clarence's product coal per Appendix 4 of NGAF.

The estimated annual existing and proposed scenario GHG emissions from energy production from product coal are presented in Table A.16

Table A.15 Fuel combustion GHG emission factors

Fuel type	Energy content (GJ/t)	Scope 1 Emission Factors (kg CO_2-e/GJ)		
		CO_2	CH_4	N_2O
Bituminous coal	27.0	90	0.03	0.2

Table A.16 Estimated CO_2-e (tonnes) for energy production from product coal per year

Scenario	Product coal (t/annum)	Emissions (t CO_2-e)
		Scope 3
Existing scenario	2,500,000	6,090,525
Proposed scenario	2,500,000	6,090,525

A.8 Transport of product coal

GHG emissions associated with the transport of product coal via rail and ship were estimated using the following equation:

$$E_{CO_2-e} = \frac{D \times Q \times EF}{1000}$$

Where:

E_{CO2-e}	=	Emissions of GHG from rail/shipping transport	(t CO_2-e)
D	=	Average distance travelled by rail/ship	(km)
Q	=	Quantity of coal transported	(t)
EF	=	Emission factor for rail/ship freight movement	(g CO_2/tonne-km)

GHG emission factors for rail and ship transport are not available in the NGAF. Therefore, these emission factors were sourced from various greenhouse gas assessments for coal mines. These assessments adopted the emission factors from AGO 2007 which are presented in Table A.17 below.

The estimated annual GHG emissions from transport of product coal are presented in Table A.18.

Table A.17 Rail and ship GHG emission factors

Use	Emission Factors (kg CO_2-e/tonne-km)
	Scope 3
Rail	0.0054
Ship	0.0126

Table A.18 Estimated CO_2-e (tonnes) for energy production from product coal per year

Scenario	Product coal (t/annum)	Emissions (t CO_2-e)
		Scope 3
Existing scenario - rail	2,650,000	8,586
Proposed scenario - rail	2,650,000	8,586
Existing scenario - ship	2,500,000	492,362
Proposed scenario - ship	2,500,000	492,362