Vulcan South Project
GHG Abatement Opportunities

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Acronyms and Abbreviations

Table 1: Acronyms and Abbreviations

Acronyms and Abbreviations	
Australian Carbon Credit Unit	ACCU
Carbon Dioxide Equivalent	CO_2e
Coal Handling and Preparation Plant	CHPP
Financial Year	FY
Free on Board	FOB
Gigajoule	GJ
Global Warming Potential	GWP
Greenhouse gas	GHG
Kilo tonnes	kt
Kilo tonne of carbon dioxide equivalent	$ktCO_2e$
Kilo tonnes per annum	ktpa
Life of Mine	LOM
Million tonnes	Mt
Million tonnes per annum	Mtpa
Mine Infrastructure Area	MIA
National Greenhouse Accounts Factors	NGA Factors 2023
National Greenhouse and Energy Reporting (Measurement) Determination	NGER Measurement Determination or 'the Determination'
National Greenhouse and Energy Reporting Act 2007	the NGER Act
National Greenhouse and Energy Reporting Scheme	NGERS
Run of mine	ROM
Safeguard Mechanism Credits	SMC
The Greenhouse Gas Protocol Corporate Value Chain (Scope 3) Accounting and Reporting Standard	'Value Chain Standard'
Tonne	t
Tonne of carbon dioxide equivalent	tCO_2e
Tonnes per hour	tph
Total Cost of Ownership	TCO
Train load-out	TLO
Transmission and Distribution	T&D
World Business Council for Sustainable Development	WBCSD
World Resources Institute	WRI

Introduction

This GHG emissions abatement opportunities report for the South Project has been prepared to summarise findings of a Scope 1, 2 and 3 emissions assessment of the project, identify opportunities for GHG abatement and to document Vitrinite's commitments to GHG emissions abatement measures, specific to the Vulcan South Project. The report has been informed by assessments and advice provided by Energy Link Services.

Project Overview

Vitrinite's Vulcan South Project is located north of Dysart and approximately 45 km south of Moranbah in Queensland's Bowen Basin, neighbouring several established mining operations, including BHP's Peak Downs and Saraji mines. The Project will target hard coking coal which has been identified through previous exploration activities.

The Project is a small-scale mining operation which includes open cut mining areas and a smaller highwall mining trial area. The Project is expected to operate for eight years and extract approximately 13.5 Mt of run of mine (ROM) coal consisting predominately of hard coking coal (with an incidental thermal secondary product[1]) at a rate of up to 1.95 million tonnes per annum (Mtpa).

The Project will target the Alex and multiple Dysart Lower coal seams. Truck and shovel mining operations will be employed to mine the pits.

A mine infrastructure area (MIA) will be established along with a modular coal handling and preparation plant (CHPP), rail loop and train load-out facility (TLO) at a location between the northern and central pits. The CHPP will include tailings dewatering technologies to maximise water recycling and to produce a dry tailings waste product for permanent storage within active waste rock dumps. No wet tailings are proposed and therefore no tailings dams are required.

The highwall mining activities will only be undertaken in the year 1 of operations. The CHPP will not be operational until the year 3 of operations. Coal excavated in the period up until the CHPP is operational will be directed to nearby CHPP facilities.

More information on Vulcan South can be found on Vitrinite's website [2].

[1] Coal produced is destined for steel manufacturing, not for electricity generation.

GHG Emissions Inventory Framework

GHG emissions are categorised as Scope 1, 2 and 3 emissions:

- Scope 1 – Direct emissions (emission related to activities occurring within the boundary of a facility, which are under the operational control of the entity).
- Scope 2 – Indirect emissions (emissions related to secondary energy imported to a facility, such as electricity, which are under the operational control of another entity).
- Scope 3 – Indirect emissions (related to upstream and downstream activities caused/required by the activities of the entity, but at sources controlled by other entities).

This GHG inventory encompasses Scope 1, 2, and 3, with no duplication of emissions between these Scopes. Therefore, a company's Scope 3 inventory excludes emissions already accounted for as Scope 1 or Scope 2 by the same company. Scope 3 emissions, stemming from entities in the value chain, are distinct to prevent duplication within Scope 1 and Scope 2, ensuring accurate emissions accounting. More information on GHG emissions and the different Scopes is provided in Appendix A.

The GHG emissions estimation framework was based on the Greenhouse Gas Protocol Corporate Value Chain (Scope 3) Accounting and Reporting Standard (the Value Chain Standard) [1], which presents the three Scopes pictorially as shown in Figure 1.

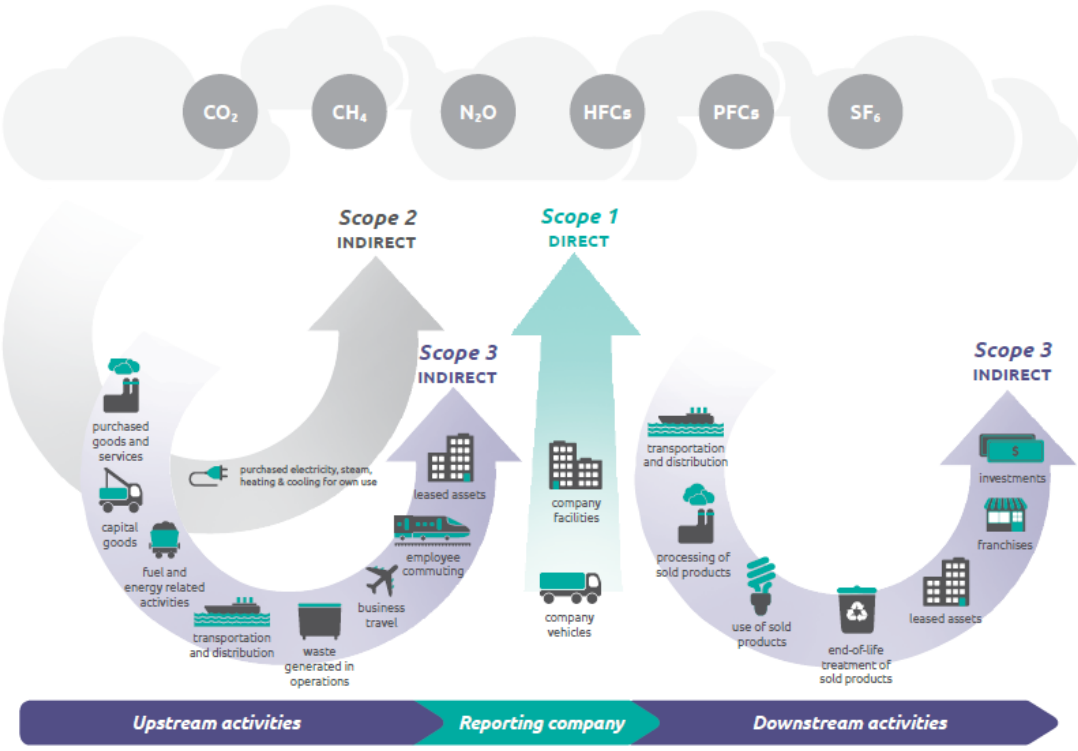

Figure 1: Overview of GHG Protocol Scopes and emissions across the value chain

Vulcan South GHG Emissions Breakdown

As shown in Figure 2, the most material emission source for the Project is the combustion of the product (Use of Sold Product, Scope 3 Category 11). This is the most material emission source for any metallurgical coal mining facility. At present, there is no abatement potential for this category, as such, its discussion is excluded from this report.

The next largest emission source is downstream transport and distribution (Scope 3, Category 9) and open cut fugitive emissions (Scope 1), these are shown on the right-hand portion of Figure 2, along with the balance of the emissions for the Scope 1, Scope 2 and Scope 3 categories.

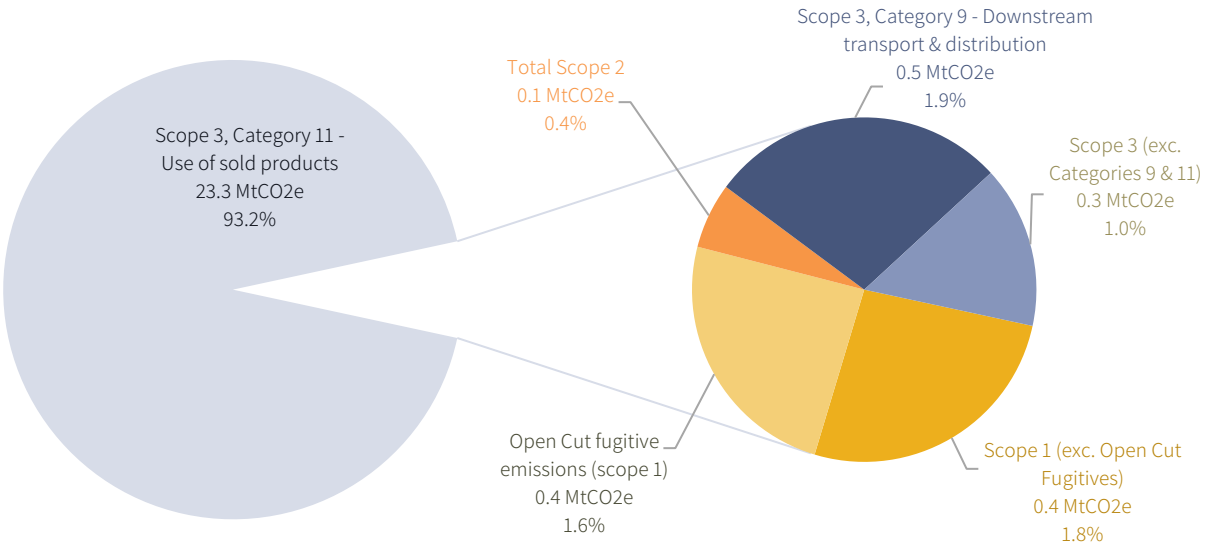

Figure 2: GHG emissions breakdown, high-level

The data in Figure 2 is the aggregation of various contributing emissions sources, these are further detailed in Figure 3. Scope 3, category 11 has been removed from Figure 3.

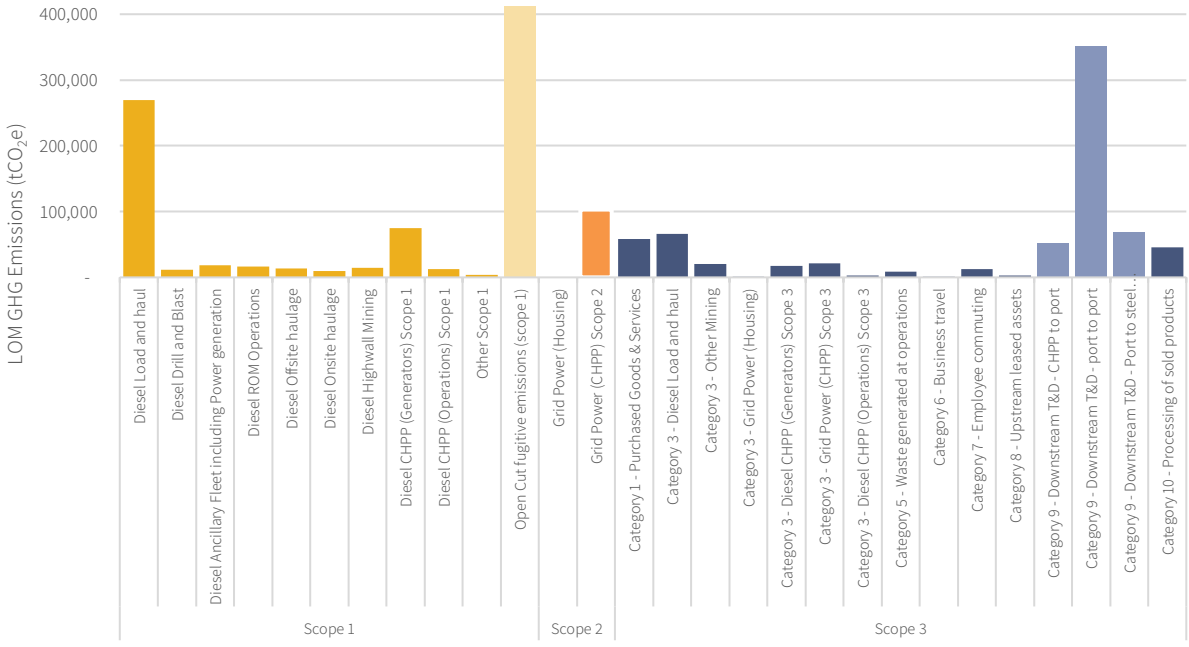

Figure 3: Emissions Breakdown - Detailed, excluding Scope 3, Category 11

An expanded breakdown of each of the GHG emissions categories of Figure 3 is provided in Table 2. The quantities are provided in kilo tonnes of carbon dioxide equivalent ($ktCO_2e$) (i.e. 1,000 tCO_2e).

Table 2: GHG Emissions Breakdown, $ktCO_2e$

Description	Total $ktCO_2e$	% Scope 1 & 2	% of total (exc. Cat 11)
Diesel Load and haul	269	28.03%	15.92%
Diesel Drill and Blast	12	1.20%	0.68%
Diesel Ancillary Fleet including Power generation	19	1.93%	1.10%
Diesel ROM Operations	17	1.74%	0.99%
Diesel Offsite haulage	13.2	1.38%	0.78%
Diesel Onsite haulage	9.5	0.99%	0.56%
Diesel Highwall Mining	15	1.53%	0.87%
Waste - sewage (septic anaerobic digestion)	0.1	0.01%	0.00%
Construction CHPP LCA Scope 1	3.4	0.35%	0.20%
Diesel CHPP (Generators) Scope 1	74.5	7.75%	4.40%
Diesel CHPP (Operations) Scope 1	12.8	1.33%	0.76%
Rail loop construction Scope 1	0.1	0.01%	0.01%
Scope 1 (exc. Open Cut Fugitives)	444	46.26%	26.27%
Open Cut fugitive emissions (scope 1)	411.9	42.89%	24.36%
Total Scope 1	856	89.15%	50.63%
Grid Power (Housing)	0.9	0.10%	0.06%
Grid Power (CHPP) Scope 2	103.3	10.75%	6.11%
Total Scope 2	104	10.85%	6.16%
Upstream emissions			
Category 1 - Purchased Goods & Services	59	-	3.47%
Category 2 - Capital Goods	-	-	-
Category 3 - Diesel Load and haul	66	-	3.92%
Category 3 - Diesel Drill and Blast	3	-	0.17%
Category 3 - Diesel Ancillary Fleet including Power generation	5	-	0.27%
Category 3 - Diesel ROM Operations	4	-	0.24%
Category 3 - Diesel Offsite haulage	3	-	0.19%
Category 3 - Diesel Onsite haulage	2	-	0.14%
Category 3 - Diesel Highwall Mining	4	-	0.21%
Category 3 - Grid Power (Housing)	0	-	0.01%
Category 3 - Diesel CHPP (Generators) Scope 3	17	-	1.03%
Category 3 - Grid Power (CHPP) Scope 3	21	-	1.25%
Category 3 - Diesel CHPP (Operations) Scope 3	3	-	0.18%
Category 4 - Upstream transportation & distribution	-	-	-
Category 5 - Waste generated at operations	8.8	-	0.52%
Category 6 - Business travel	0.7	-	0.040%
Category 7 - Employee commuting	12	-	0.72%
Category 8 - Upstream leased assets	2.8	-	0.17%
Downstream emissions			
Category 9 - Downstream T&D - CHPP to port	52.5	-	3.10%
Category 9 - Downstream T&D - port to port	352.2	-	20.83%
Category 9 - Downstream T&D - Port to steel factory	68.4	-	4.05%
Category 10 - Processing of sold products	45	-	2.68%
Category 12 - End of life treatment of sold products	-	-	-
Category 13 - Downstream leased assets	-	-	-
Category 14 - Franchises	-	-	-
Category 15 - Investments	-	-	-
Scope 3 (exc. Cat 11)	731		43.21%
Category 11 - Use of sold products	23,328		
Total Scope 3	24,059		
Total Scope 1, Scope 2 and Scope 3	25,019		

Mitigation and Abatement Opportunities

Opportunities to reduce GHG emissions associated with the Vulcan South Project include design options, operational efficiencies to reduce energy demand and improved estimation techniques applied to calculation of fugitive emissions from the open cut mine. Table 3 provides an overview of the opportunities and an estimate of the emissions abatement potential the opportunity presents. As the project is in its planning phase, there are not actual baseline emissions, therefore an estimate of the baseline has been made. Assumptions relevant to the estimate of the baseline and the opportunity for abatement are discussed in the final column.

Table 3: Mitigation and Abatement Opportunities

No	Opportunity	Description	Baseline* estimate ($ktCO_2e$)	Emissions reduction potential	Additional Commentary
1	Method 2 open cut fugitive GHG emissions determination	Vitrinite will apply Method 2 estimation techniques to account for the fugitive emissions from the open cut. Method 2 fugitive emissions estimation for open cut involves establishing a mine-specific gas model as described in the sections 3.21 to 3.26 of the NGER Measurement Determination. The mine gas model determines the site's specific GHG emissions associated to the open cut mining activities for the Project. This will allow a more accurate quantification of the fugitive GHG emissions of the mine, which is shallower than other mines in the vicinity and drilling studies have indicated a low gas content in the coal seam.	~410	50-75% *This pertains to the application of higher order estimation techniques.*	Using preliminary sample data, Vitrinite estimates the application of Method 2 calculation techniques will reduce the reported fugitive emissions by 50-75% when compared to the application of the default, Method 1 emissions factor. The application of Method 2 for an open cut coal extraction involves developing a mine-specific model to calculate the in-situ methane and carbon dioxide in place prior to extraction of coal. This approach draws heavily on using an expert 'Estimator' that diligently documents an unbiased representative gas model.
2	Coal Handling Preparation Plant (CHPP) optimisation from design	Vitrinite is designing a new, highly efficient CHPP which will employ an optimised circuitry to suit the coal to be extracted at the Vulcan South mine (e.g. size fraction distribution and designing the plant flows to suit the quality and size of the mined coal).	*Already committed*	10-25%	Vitrinite has used nine third-party CHPP plants to wash their coal from current operations. This experience has provided them with unique insights on the different operation efficiencies and allowed them to specify plant flows and operating conditions that suit the mine's coal quality. The tailored designed CHPP will result in efficiency gains compared to existing plants through; electrical specification changes from IE2 to IE3, increased equipment maintenance, and
		Once constructed, the CHPP operating settings will be optimised to minimise the	~230	0-5%	

		use of additives to enhance yield and efficiency. This will result in both reduced energy and an enhanced quality of product.			technology advancement/improvements.
3	Enhanced excavator utilisation	The truck and excavator matching (or bucket to tray ratio optimisation) enables the maximisation of the excavator passes to completely load the truck's payload. This has a significant impact on fuel efficiency. Additionally, introducing efficient work procedures and setting key performance indicators (KPIs) for excavation rates and minimising energy use during shift changeovers will increase the utilisation of the excavators.	~340	2%	The measurement of this initiative is proposed to be undertaken via benchmarking energy use in onsite vehicles and equipment per tonne waste / ROM extracted from other similar operations. The GHG emissions savings estimation is based on efficiencies against a business-as-usual scenario, where idle time and excavator utilisation is not managed.
4	Install VSD in motors and pumps (CHPP)	Vitrinite will optimise energy use via the implementation of variable speed drives (VSD) in motors and pumps throughout the CHPP as part of its design and construction. Furthermore, the correct motor and pump sizing throughout the CHPP will enable efficient energy usage.	~220	0-5%	For the initial CHPP design, approximately 35% of CHPP electricity load relates to the use of motors and pumps without VSDs - 25% of load from motors or pumps >50kW without VSD. Assuming a 20% potential reduction for VSD installations - potentially 5% reduction opportunity.
5	Road Optimisation	Vitrinite will implement road optimisation, including road design and enhanced road maintenance practices that are expected to reduce the energy consumed by haulage. Vitrinite is also considering the use of additives that are expected to decrease the rolling resistance of roads, decrease water usage, and positively impact the energy consumption from haulage activities. This will also result in reduced tyre damage due to improved intersections, reduced	~350	2%	Industry research and studies indicate that a site can achieve up to 2% savings in fuel consumption through circuit optimisation (i.e., reduced stop signs, managing ramp grades and maintaining good road conditions to facilitate efficient operations). It is expected this will result in improvements in fuel efficiency and productivity benefits (e.g. availability of equipment). The GHG emissions savings estimation is based on efficiencies against a business-as-usual scenario, where the roads are designed as per the relevant standards, without the optimised alternatives described.

		loading faces, roads and spillage.			
6	Energy Optimisation	Use of energy efficient equipment / implement energy efficiency or saving activities in auxiliary services, lighting, compressed air, etc. as the replacement becomes needed.			
7	Green Power (PPA)	Vitrinite will enter into a corporate Power Purchase Agreement (PPA) for all grid supplied electricity to negate the Scope 2 emissions associated with the Vulcan South Project.	~130	0-100%	Can abate up to 100% using Green Power or PPA. The electricity supplied to site will be sourced from renewable sources that will have no GHG emissions associated with the electricity generation.
8	Shipping Optimisation	Vitrinite has an opportunity to influence the scope 3 emissions related to the shopping of its product by utilising larger vessels for exporting product to markets which are closer to Australia.	~350	5-10%	A reduction in scope 3 emissions results from the use of larger vessels. The market is expected to shift away from Europe and South America, to be more Asian-focused – this will result in shorter shipping routes.

** Baseline estimates are the estimated GHG emissions which would occur without intervention and relate to the 8-year LOM period.*

Commitments

Vitrinite is committed to the implementation of the following actions to reduce GHG emissions associated with the Vulcan South Project. All actions except for shipping optimisation (option 8) relate to actions which affect GHG emissions under Vitrinite's operational control.

Table 4: GHG Emissions Reduction/ Abatement Commitments

No	Opportunity	Scope	Commitment	Timeline
1	Method 2 open cut fugitive GHG emissions determination	1 *This pertains to the application of higher order estimation techniques.*	To invest in the required site work (e.g. drilling), model development and ongoing reporting requirements needed to enable Method 2 reporting for open cut fugitive emissions.	By end of 2025
2	Coal Handling Preparation Plant (CHPP) optimisation	1, 2 & 3	Purpose built CHPP for new mine.	*Included in Project design*
		1, 2 & 3	Operating settings of new CHPP will be optimised.	Within two years of the commissioning of the CHPP
3	Enhanced excavator utilisation	1 & 3	Establish efficient work procedures and setting key performance indicators (KPIs) for excavator utilisation rates.	Two years from mining commencement
4	Install VSD in motors and pumps (CHPP)	2 & 3	Seek to optimise power consumption as much as practicable via use or non-use of VSDs throughout the CHPP plant.	Before two years after the commissioning of the CHPP
		2 & 3	Conducting assessments of potential savings for all motors greater than 50kW in the CHPP.	
		2 & 3	Install VSDs wherever energy savings are projected to be greater than 10%.	
5	Road Optimisation	1 & 3	Incorporate '*energy in design'*, where the haul roads will be designed aiming to have an optimised circuit (i.e. reduced stop signs, managing ramp grades and maintaining good road conditions to facilitate efficient operations).	Two years from mining commencement
6	Energy Optimisation	1, 2 & 3	Procurement policies to include GHG emissions / operating costs.	Two years from mining commencement
		1, 2 & 3	Commit to energy audit.	Five years from mining commencement
7	Green Power (PPA)	2 & 3	10% Green power	Within a year of being connected to the grid
		2 & 3	Evaluate available Green Power options when negotiating the procurement of electricity supply.	Within a year of being connected to the grid

No	Opportunity	Scope	Commitment	Timeline
8	Shipping Optimisation	3	To implement business strategies to consider: – GHG emissions in decision making matrix when signing coal sales agreement. – The use of larger ships for shipments, where practical.	Within two years of first FOB sale

References

1 World Resources Institute/World Business Council for Sustainable Development (WRI/WBCSD) (2011) Corporate Value Chain (Scope 3) Accounting and Reporting Standard, retrieved from: https://ghgprotocol.org/sites/default/files/standards/Corporate-Value-Chain-Accounting-Reporing-Standard_041613_2.pdf

2 MetServe (2022) Supporting Information for Site-specific Environmental Authority Application, retrieved from: https://vitrinite.com.au/wp-content/uploads/2022/06/Vulcan-South_EA-Application-Supporting-Information-Document-MET00285309-017.pdf

Appendix A: GHG Emissions Background

The United Nations Framework Convention on Climate Change (UNFCCC) Kyoto Protocol (the Kyoto Protocol) identified six anthropogenic greenhouse gas (GHG) emissions (UN, 1998). These include:

- Carbon Dioxide (CO_2);
- Nitrous Oxide (N_2O);
- Methane (CH_4);
- Perflurocarbons (PFCs);
- Hydroflurocarbons (HFCs); and
- Sulphur Hexafluoride (SF_6).

For the purposes of this greenhouse gas (GHG) assessment, the GHG emissions considered only CO_2, N_2O and CH_4 emissions. All GHG emission quantities are provided in tonnes of carbon dioxide equivalent (tCO_2e).

The CO_2e of a particular GHG emission is calculated based on its Global Warming Potential (GWP). The GWP reflects the relative global warming impact that one metric tonne of a particular GHG emission source has relative to one metric tonne of carbon dioxide (tCO_2). The GWPs for gases relevant to this study have been taken from the National Greenhouse and Energy Reporting Regulations (the NGER Regulations) and are provided in Table 5.

Table 5: Global Warming Potentials

GHG	Chemical Formula	GWP
Carbon Dioxide	CO_2	1
Methane	CH_4	28
Nitrous Oxide	N_2O	265

Operational Boundary (GHG Emissions Scopes)

Defining an operational boundary assists with the determination of GHG Emissions associated with a facility. Identifying the operational boundary also assists with determining and categorising GHG emissions sources as *direct* and *indirect* GHG emissions through the identification of three Scope level of GHG emissions (Scope 1, Scope 2 and Scope 3) (ISO, 2006). These Scope levels are defined in Table 6.

Table 6: Carbon Emissions Scope Details

Scope	Details
Scope 1	Direct GHG emissions which occur from sources that are owned or controlled by an organisation. Examples of Scope 1 emissions include the emissions from on-site fuel combustion for electricity generation purposes, or emissions associated with diesel combustion from transport activities.
Scope 2	Indirect GHG emissions are emitted from the generation of purchased electricity, heat or steam consumed by an organisation (i.e. the emissions do not physically occur within the boundary of the facility).
Scope 3	Indirect GHG emissions are generated in the wider economy as a result of an organisation's activities, however these emissions physically occur elsewhere. For example, the emissions from waste disposed at a third party's operated landfill facility.