

Chapter 27
Greenhouse gas

ESMERALDA GRAPHITE PROJECT

aarc ENVIRONMENTAL SOLUTIONS
APEM Group

GRAPHINEX

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Glossary, acronyms and abbreviations

Acronym or Abbreviation	Meaning
ACCU	Australian Carbon Credit Unit
BESS	Battery energy storage
CC Act	*Climate Change Act 2022*
CCCA Act	*Climate Change (Consequential Amendments) Act 2022*
CEJ Act	*Clean Economy Jobs Act 2024*
CFI Act	*Carbon Credits (Carbon Farming Initiative) Act 2011*
DCCEEW	Department of Climate Change, Energy, the Environment and Water
DESI	Department of Environment, Science and Innovation
DETSI	Department of the Environment, Tourism, Science and Innovation
DNRMMRRD	Department of Natural Resources and Mines, Manufacturing and Regional and Rural Development
DSDIP	Department of State Development, Infrastructure and Planning
DSDMIP	Department of State Development, Manufacturing, Infrastructure and Planning
ECF	Energy Content Factor
EF	Emission Factor
EIS	Environmental Impact Statement
EP Act	*Environmental Protection Act 1994*
EP Regulation	Environmental Protection Regulation 2019
EV	Electric vehicles
FullCAM	Full Carbon Accounting Model
GHG	Greenhouse Gas
GJ	Gigajoule
HGV	Heavy goods vehicle
HOFF	Hydrocarbons-off
KPI	Key Performance Indicator
KRA	Key Result Areas
LOP	Life of Project
LULUCF	Land use, land use change and forestry
MW	Megawatts

Acronym or Abbreviation	Meaning
NABERS	National Australian Built Environment Rating System
NEM	National electricity market
NGER Act	*National Greenhouse and Energy Reporting Act 2007*
PBG	Petroleum-based greases
PBO	Petroleum-based oils
PBOG	Petroleum-based oils and greases
PMLU	Post mine land use
PPA	Power Purchase Agreement
PV	Photovoltaic
ROM	Run-of-Mine
TBD	To be determined
TJ	Terajoule
TOR	Terms of Reference
UNFCCC	United Nations Framework Convention on Climate Change
USA	United States of America
WBCSD	World Business Council for Sustainable Development
WRI	World Resources Institute

27 Greenhouse gas

This chapter describes the assessment of potential greenhouse gas (GHG) emissions impacts on the existing environment. It discusses the Project's point source and diffuse greenhouse gas (GHG) emissions from the Project activities (Scope 1 and Scope 2), upstream and downstream emissions (Scope 3), naturally occurring sources, and the potential impacts on environmental values.

A Greenhouse Gas (GHG) Assessment and Decarbonisation Plan for the Project has been prepared by Katestone Environmental Pty Ltd and is presented as Appendix B.

The assessment considered the Queensland Government, Guideline – Greenhouse gas emissions, ESR/2024/6819 (GHG Guideline).

This chapter has been reconciled against the Terms of Reference (ToR) in Table 27-1.

27.1 Abatement Plan

For medium to high emitting projects, the ToR requires provision of a GHG abatement plan that meets the requirements of the Queensland Guideline Greenhouse gas emissions ESR/2024/6819 (GHG Guideline). Sections addressing the GHG abatement plan requirements of Appendix A of the GHG Guideline are listed in Table 27-1.

Table 27-1: GHG guidelines assessment and decarbonisation requirements

Requirement	Section
a. Project details	Chapter 4 , Section 27.3
b. Emissions projections and commencing abatement measures: i. Emission inventory and estimates as developed in section 3.1 of the GHG Guideline ii. Management practices proposed to be implemented at commencement to reduce GHG emissions as per section 3.3 of the GHG Guideline	Section 27.6 Section 27.7
c. GHG emissions reference point: i. Outline the level of emissions against which ongoing reduction of GHG emissions will be assessed throughout the life of the Project (reference point) (based on projected GHG emissions prior to implementation of the GHG abatement plan) ii. Provide justification for the reference points proposed	Section 27.7.1
d. Emission reduction targets: i. Identify interim Scope 1 and Scope 2 GHG emission reduction targets to be applied throughout the life of the Project ii. Identify long-term overall Scope 1 and Scope 2 GHG emission reduction targets. iii. Provide justification for the emission reduction trajectory and targets proposed and how they support the Queensland Government's GHG emission reduction targets	Section 27.8.1
e. GHG emission reduction program (as detailed in section 3.3 and Appendix A (Part B) of the GHG guideline), including: i. Implementation details including timeframes for implementation and estimated reduction of emissions expected ii. Risk assessment details including cost, practicality, effectiveness, and risks of each measure	Section 27.7.2.1, Section 27.7.2.2, Section 27.7.2.3, Section 27.7.2.4

Requirement		Section
	iii. Justification for each measure including a comparison of each proposed measure with relevant best practice environmental management standards iv. Estimates of emissions expected to be abated by each measure v. Any ongoing monitoring proposed to be undertaken to ensure the success of emission reduction measures	
f.	Advancing technologies and opportunities: i. Include provisions for regularly reviewing new technologies to identify opportunities to further reduce emissions and energy efficiency	Table 27 14 Section 27.7.5
g.	Monitoring and auditing program	Section 27.7.5
h.	Reporting: i. A program for periodic public reporting on progress towards the GHG emission reduction targets outlined in the GHG abatement plan, including details about how public reporting will be undertaken if necessary	Section 27.7.5

27.2 Environmental objectives and performance outcomes

This chapter has been prepared to assist the DETSI in carrying out the environmental objective assessment in respect of the following environmental objective prescribed in Schedule 8, Part 3, Division 1 of the EP Regulation. The detailed assessment presented in this chapter and in the Greenhouse Gas Assessment and Decarbonisation Plan (Appendix B) demonstrates that the Project will achieve performance outcome 2 for the environmental objective, as outlined in Schedule 8 of the EP Regulation because the Project will be operated in a way that achieves all the following:

- Fugitive emissions of contaminants from storage, handling and processing of materials and transporting materials within the site are prevented or minimised;
- Contingency measures will prevent or minimise adverse effects on the environment from unplanned emissions and shutdown and start up emissions of contaminants to air; and
- Releases of contaminants to the atmosphere for dispersion will be managed to prevent or minimise adverse effects on environmental values.

27.3 Legislation and guidelines

The Australian Government has signed and introduced several international agreements and enacted domestic legislation to tackle the global issue of climate change and to limit the global average temperature increase to a maximum of 2°C. The key international agreements are:

- The Paris Agreement: reduce GHG emissions to 43% below 2005 levels by 2030 and reach net zero by 2050; and
- Global Methane Pledge: reduce Australia's methane emissions by at least 30% below 2020 levels by 2030.

Commonwealth and state legislation exists to support achieving GHG emissions reduction targets. The legislation that is relevant to the Project is detailed in Table 27-2.

Table 27-2: Key Commonwealth and state legislations relevant to the Project

Legislation	Description
Commonwealth	
Climate Change Act 2022 (CC Act)	Provides a legislative framework to implement Australia's net-zero commitments by establishing the 2030 GHG emissions reduction target.
Climate Change (Consequential Amendments) Act 2022 (CCCA Act)	Embeds the GHG emissions reduction targets into 14 Commonwealth acts, including the *National Greenhouse and Energy Reporting Act 2007.*
National Greenhouse and Energy Reporting Act 2007 (NGER Act)	Establishes a national framework for corporations to report GHG emissions and energy consumption. Reporting is mandatory for corporations or facilities that have energy production, energy use, or GHG emissions that exceed 50,000 tonnes carbon dioxide equivalent (t CO_2-e) or 25,000 t CO_2-e, respectively, per year.
National Greenhouse and Energy Reporting Regulations 2008	Explain how to apply the NGER Act, i.e. reporting, data, and administrative details.
National Greenhouse and Energy Reporting (Measurement) Determination 2008 (NGER Measurement Determination)	Provides methods, criteria, and measurement standards for calculating GHG and energy data under the NGER Act, covering Scope 1 and Scope 2 emissions and energy production and consumption.
Safeguard Mechanism (Crediting) Amendment Act 2023 (Safeguard Mechanism)	Provides a framework for the largest emitters to measure, report and management their emissions. Requires large facilities, whose net emissions exceed the safeguard threshold of 100,000 t CO_2-e per year, to keep their emissions at or below emissions baselines set by the Clean Energy Regulator.
Carbon Credits (Carbon Farming Initiative) Act 2011 (CFI Act)	Provides the legislative framework for the Australian Carbon Credit Unit (ACCU) scheme.
Queensland	
Clean Economy Jobs Act 2024 (CEJ Act)	Provides emissions reduction targets for Queensland as follows: • by 30 June 2030, net GHG emissions in Queensland are reduced to an amount that is at least 30% below the net GHG emissions in Queensland for 2005; • by 30 June 2035, net GHG emissions in Queensland are reduced to an amount that is at least 75% below the net GHG emissions in Queensland for 2005; and • by 30 June 2050, net GHG emissions in Queensland are reduced to zero (the 2050 net zero emissions target).
Energy (Infrastructure Facilitation) Act 2024 (Energy Act)	Provides the legislative framework for the Queensland Government's Energy Roadmap. It facilitates the development of strategic energy infrastructure, confirms public ownership of key assets, and provides support for affected workers and communities.
Environmental Protection Act (EP Act)	Protects Queensland's environment while allowing for development that improves the total quality of life by establishing an integrated management program and environmental protection policies.
'State Planning Policy'	Expresses state interests in land use planning and development, focusing on the following planning aspects: • for liveable communities and housing; • for economic growth; • for the environment and heritage; • for safety and resilience to hazards; and • for infrastructure.

Additionally, this section has been prepared in accordance with the following guidelines:

- Queensland Government, Guideline – Greenhouse gas emissions, ESR/2024/6819 (DESI 2024h); and
- 'Greenhouse Gas Protocol Corporate Value Chain (Scope 3) Accounting and Reporting Standard' (Scope 3 Standard) (World Business Council for Sustainable Development [WBCSD] & World Resources Institute [WRI] 2011).

27.3.1 State and federal targets

GHG emissions and renewable energy targets established by the Commonwealth and Queensland governments are summarised in Table 27-3.

Table 27-3: Summary of the GHG and renewable energy targets across the nation and Queensland

GHG emission targets	Renewable energy targets
Australia	
• 2030: 43% reduction below 2005 levels, including land use, land use change and forestry (LULUCF); equivalent to 318.5 Mt CO_2-e	• 2030: 82% of electricity generation from renewable energy
• 2050: Net zero	
Queensland	
• 2030: 30% reduction below 2005 levels (equivalent to 138.1 MtCO_2-e; has been achieved ahead of time	• Queensland government has not set specific renewable energy targets
• 2035: 75% reduction below 2005 levels	
• 2050: Net zero	

Further to targets, the Queensland Government has developed several strategies that have relevance to the proposed Project, including the following:

- 'North West Queensland Economic Diversification Strategy' (DSDMIP 2019) - which recognises the importance of the resource sector in North West Queensland and identifies opportunities for the regional economy and community, through continued support to the resource sector.
- 'Queensland Energy Roadmap' (Queensland Treasury 2025) - which states that Queensland benefits from high-quality renewable resources including abundant solar energy and a largely complementary wind shape. Previous renewable energy targets have been repealed, whilst Regional Energy Hubs have replaced former Renewable Energy Zones
- 'Queensland Critical Minerals Strategy' (DNRMMRRD 2023) - which identifies the importance of supporting emerging resource sub-sectors on mining new critical minerals, such as graphite, in the Critical Minerals Zone. Consequently, as a graphite and critical minerals project, the Project will directly align with the state-wide GHG emissions reduction and renewable energy targets as well as the nation-wide commitment to tackle climate change issues.

27.4 Existing environment

The Project is a greenfield open cut graphite mine, located approximately 70 km south of Croydon in north-west Queensland. The Project is situated in an isolated inland location dominated by low intensity stock grazing. Cattle stations contribute to GHG emissions though methane (CH_4) and vegetation management or clearing, and diesel consumption in farm equipment. Road transport on nearby State and Council controlled

roads, and exploration drilling and associated activities, would also contribute to GHG emissions though fuel consumption.

The wider region also supports a range of agricultural, mining and energy projects as demonstrated by the list in Table 27-4 for projects in the north west minerals province (DSDIP 2026). GHG emissions from related construction activities and future aspects of these projects will form part of the existing environment prior to emissions associated with the Project.

Given the remote location of the Project, the Project will not be connected to the regional electricity grid, which supplies the local township of Croydon.

Table 27-4: Existing and expected projects in the region of the Project

Project name	Proponent	Project status	Indicative start	Sector	Local Government Area
Etta Plains Agricultural Development	Gulf Cotton	Construction underway	2021 ->	Agriculture	McKinlay
CopperString 2032 Project	Powerlink	Construction underway	2023 -> 2031	Infrastructure	Mount Isa to Townsville
Mount James Wind Farm	Iberdrola Australia	Financial investment decision	2026	Infrastructure	Flinders
North Queensland Super Hub - Stage 1 (Prairie Wind Farm & Wongalee project)	Windlab	Detailed design	2026	Infrastructure	Flinders
Sybella Creek Solar Farm	APA Group	Bankable or Full-feasibility	2025	Infrastructure	Mount Isa
Greater Duchess Copper Gold Project	Carnaby Resources	Pre-feasibility	2025	Resource	Cloncurry
Knapdale Range Wind Project - Dugald River Windfarm	MMG Limited	Pre-construction	2028	Infrastructure	Cloncurry
Eva Copper Project	Eva Copper Mine Pty Ltd	Financial investment decision Detailed design	2024->	Resource	Cloncurry
Saint Elmo Vanadium and High Purity Alumina Mine and Refinery	Multicom Resources Pty Ltd	Construction underway	2023->	Resource	McKinlay
Jericho Copper Mine development	AIC Mines	Construction underway	2024	Resource	Cloncurry

Project name	Proponent	Project status	Indicative start	Sector	Local Government Area
Paradise North, Paradise South & Barr Creek Phosphate Projects - Stage 1 Paradise South	North West Phosphate	Construction underway	2024	Resource	Mount Isa
PhosOne Project	North West Phosphate / Sibanye-Stillwater JV	Detailed design		Resource	Burke Carpentaria
Croydon Gold Project	Jubilee Metals	Financial investment decision	2026	Resource	Croydon
Richmond-Julia Creek Vanadium Project	Richmond Vanadium Technology Pty Ltd	Bankable or Full-feasibility	2027	Resource	Richmond
Vecco Critical Minerals Project	Vecco Group	Bankable or Full-feasibility	2025	Resource	McKinlay
North Queensland Vanadium Project	Velox Energy Materials	Pre-feasibility	2027	Resource	McKinlay Richmond
Julia Creek Vanadium and Energy Project	QEM Limited	Bankable or full-feasibility	2028	Resource	McKinlay

Reference: DSDIP (2026)

27.5 Impact assessment

27.5.1 Modelling methodology

The GHG emissions are calculated and reported according to the Scope in which they are classified.

- **Scope 1** GHG emissions are those emissions released to the atmosphere as a direct result of the activity conducted at a facility and that are under the direct control of the facility or operation.
- **Scope 2** GHG emissions are those associated with the production of electricity that is purchased and used by the facility.
- **Scope 3** GHG emissions are those associated with the provision of goods and services purchased by the facility or operation but that are not owned or controlled by the entity responsible for the facility or operation. Emissions are categorised according to Scope 3 Standard. The Scope 3 emissions categories are:
    - Category 1: Purchased goods and services;
    - Category 2: Capital goods;
    - Category 3: Fuel and energy related activities;
    - Category 4: Upstream transportation and distribution;
    - Category 5: Waste generated in operations (immaterial);

- Category 6: Business travel (immaterial);
- Category 7: Employee commuting (immaterial);
- Category 8: Upstream leased assets (immaterial)
- Category 9: Downstream transportation and distribution (Scope 3);
- Category 10: Processing of sold products;
- Category 11: Use of sold products (immaterial);
- Category 12: End-of-life treatment of sold products (immaterial);
- Category 13: Downstream leased assets (immaterial);
- Category 14: Franchises (not applicable); and
- Category 15: Investments (not applicable).

To estimate the Project's emissions, assessment boundaries were set as follows:

- operational activities of the Project under the operational control of Graphinex (Scope 1);
- waste generated in operations (Scope 1);
- purchased goods and services used by the Project (Scope 3);
- capital goods purchased for the Project (Scope 3);
- upstream production of purchased fuels (well-to-pump) and upstream electricity network losses (Scope 3);
- upstream transportation and distribution (Scope 3);
- downstream transportation and distribution (Scope 3); and
- use of sold products (Scope 3).

The annual emissions during the Project's construction and operation were calculated with projected Project activity data and the methodology recommended by the following guidelines and protocols:

- NGER Determination;
- The National Greenhouse Accounts Factors (to date);
- The Greenhouse Gas Protocol (WRI/WBCSD, 2004);
- FullCAM (Richards, 2001); and
- National Material Emission Factors Database (NABERS, 2026)

Given the assessment boundaries and projected activity data, Scope 1, and Scope 3 emissions were estimated. The Project will not generate Scope 2 emissions, due to on-site power generation.

27.5.2 Scope 1 calculations

Project activities that will contribute towards Scope 1 emissions are detailed in Table 27-5. These are differentiated by the Project phase in which they occur. The emission factors and energy content for each emissions source that was used in the assessment are summarised in Table 27-6.

Table 27-5: Project activities resulting in Scope 1 emissions

Phase	Scope 1
Construction	• Vegetation clearing

Phase	Scope 1
Operation	• Diesel combustion by mine plant • Diesel for explosives • Diesel combustion for generation of electricity • Combustion of petroleum-based oils and greases
Decommissioning	• Diesel combustion for rehabilitation activities

In accordance with the Method 1, as outlined in NGER Measurement Determination, Scope 1 emissions from the combustion of diesel and petroleum-based oils and greases (PBOGs) were calculated in the unit of t CO_2-e as follows:

$$\frac{\mathbf{Q} \times \mathbf{ECF} \times \mathbf{EF}}{\mathbf{1000}}$$

where *Q* is the quantity of the emission source (in the unit of kilolitres, kL), *ECF* is the energy content factor of the emission source (in the unit of GJ/kL), *EF* is the emission factor that describes the total amount of equivalent carbon dioxide emissions associated with the emission source (in the unit of kg CO_2-e/GJ), and the factor *1000* returns the correct units for the emissions.

The ANFO explosives used in the Project contain approximately 6% diesel by mass. The quantity of diesel combusted was calculated by multiplying the total explosives usage by 0.06. Emissions were then estimated using Method 1 as stated above and the diesel (stationary) *EF* (Table 27-6).

Meanwhile, emissions from waste in operations were assessed by total waste tonnage disposed to landfill, categorised by broad category waste streams, and multiplied by the corresponding *EF* (Table 27-6). The downstream emissions of waste did not include transportation to the waste processing facility.

Table 27-6: Energy content and emission factors for Scope 1 and Scope 3 assessment

Emission source	Energy content	Emission factor	
		Scope 1	Scope 3
Diesel (transport) [1, 2]	38.6 GJ/kL	70.4 kg CO_2-e/GJ	17.3 kg CO_2-e/GJ
Diesel (stationary) [1, 2]	38.6 GJ/kL	70.2 kg CO_2-e/GJ	-
Petroleum Oil [1, 2]	38.8 GJ/kL	13.9 kg CO_2-e/GJ	18.0 kg CO_2-e/GJ
Petroleum Grease [1, 2]	38.8 GJ/kL	3.5 kg CO_2-e/GJ	18.0 kg CO_2-e/GJ
Eucalyptus Woodland [3]	-	43.52 t C/ha	-
Melaleuca Forest and Woodland [3]	-	42.45 t C/ha	-
Eucalyptus Low Open Forest [3]	-	59.83 t C/ha	-
Eucalyptus Open Forest [3]	-	42.45 t C/ha	-
Bulk Carrier Shipping Average [4]	-	-	0.00353 kg CO_2-e/t.km
Articulated HGV (>33 t, average laden) [4]	-	-	0.00007576 t CO_2-e/km
Rigid 17 t and above (average laden) [4]	-	-	0.00017146 t CO_2-e/km
Aurizon Operational Emissions Intensity [7]	-	-	0.000013080 t CO_2-e/t.km
Concrete - >32 to >40 MPa [5]	-	-	0.232 kg CO_2-e/m^3

Emission source	Energy content	Emission factor	
		Scope 1	Scope 3
Spend-based building and infrastructure [6]	-	-	0.21 kg CO_2-e/ AUD
Commercial and industrial waste [1]	-	2.082 t CO_2-e/t	-
Graphite concentrate to BAM [8]	-	-	10 kg CO_2-e / kg BAM

[1] (DCCEEW 2025)

[2] National Greenhouse and Energy Reporting (Measurement) Determination 2008, Compilation 19

[3] Full Carbon Accounting Model (FullCAM) (Richards, 2001)

[4] Department of Energy Security and Net Zero, 2025

[5] National Material Emission Factors Database 2026

[6] Slattery Upfront Embodied Carbon Report (Dean, 2025)

[7] Aurizon Sustainability Report (2025)

[8] Gao et al. (2018)

Note: Explosives do not have a specific emission factor for NGER Act purposes; emissions are estimated for GHG Guideline purposes based on the diesel (stationary) EF.

The Full Carbon Accounting Model (FullCAM) was used to assess the carbon stocks in vegetation and soil due to land use change (Richards 2001) and the effects of land use, land use change, and forestry (LULUCF) in Australia's National Greenhouse Gas Accounts. FullCAM estimates the carbon stock change in ecosystems at a grid scale of 25 m x 25 m including:

- above and belowground biomass;
- standing and decomposing debris; and
- soil carbon resulting from land use and management activities.

To estimate the carbon dioxide equivalent that would be emitted for clearing, the total tonnes of carbon per hectare (t C /ha) values for the vegetation type (Table 27-6) are converted to t CO_2-e by multiplying them by the ratio of the molecular weight of carbon dioxide to that of carbon. Following which, the t CO_2-e is then multiplied by the vegetation type area (in hectares) cleared. Land clearing is assumed and modelled as occurring entirely in Year -1, with the pre-clearing carbon stock assumed as being emitted in the same calendar or financial year.

Additionally, the emissions intensity of production is calculated by the total CO_2-e from NGER emission sources divided by the tonnes of ROM graphite produced. This can be used as a benchmark to assess operational efficiency, compare performance across difference scales, and guide decarbonisation efforts.

27.5.3 Scope 2 calculations

Scope 2 emissions were not calculated as the Project will generate its own electricity on-site.

27.5.4 Scope 3 calculations

Project activities that will contribute towards Scope 3 emissions are detailed in Table 27-7.

Table 27-7: Project activities resulting in Scope 3 emissions

Phase	Scope 3
Construction	• Infrastructure and construction activities • Infrastructure and construction materials
Operation	• Diesel production and combustion for transport of materials and products • Upstream fuel extraction and processing • Workforce commute including road and air travel • Handling of project waste • End use of the sold product graphite • Production of purchased goods and services, and capital goods
Decommissioning	• Upstream fuel extraction and processing • End use of recycled and disposed plant and facilities

Scope 3 emissions were determined in accordance with *The Greenhouse Gas Protocol* (WRI/WBCSD 2004) where applicable. Where this was not possible, values were derived from established and recognised sources consistent with industry practice. The energy contents and emission factors used in the Scope 3 assessment are detailed in Table 27-6.

Scope 3 emissions were estimated by assessing the emissions from purchased goods and services and capital goods, fuel and energy related activities, and upstream and downstream transportation and distribution.

The Scope 3 emissions from purchased and capital goods and services were calculated using a variation of Method 1 of NGER Determination:

$$\frac{\mathbf{Q} \times \mathbf{EF}}{\mathbf{1000}}$$

where *Q* is the volume (metres cubed, m^3), mass (tonnes) or cost ($) of the materials and services, and *EF* is the published emissions factor (Table 27-6).

The Scope 3 emissions from the production of liquid fuels were estimated by applying the *EFs* for the upstream extraction and processing of liquid fuels (diesel oil and PBOGs) from Table 27-6 to the diesel consumption data, which was provided by Graphinex.

The Scope 3 emissions for upstream transportation and distribution were evaluated using freight activity data based on the number of vehicle trips, one-way transport distances and estimated goods carrying capacities for each vehicle type. These inputs were used to estimate total annual freight activity in tonne kilometres (t.km). Emissions were then calculated by applying the relevant vehicle *EF*s provided in Table 27-6.

For the construction phase, upstream freight activity includes concrete mixer trucks travelling approximately 105 km from Croydon to the Project site, based on 2,920 trips. Class 3 vehicles, low loaders, Class 9 AVs and B-doubles were assumed to travel approximately 750 km from Townsville to the Project site, based on 4,380, 730, 1,460 and 9,490 trips, respectively.

For the operation phase, supplied freight data were split into two stages. Stage 1, covering Project Years 1 to 3, includes 662 B-double trips per year from Townsville to the Project site. Stage 2, covering Project Years 4 to 53, includes 819 B-double trips per year from Townsville to the Project site. A one-way transport distance of approximately 750 km was applied for both stages.

The Scope 3 emissions for downstream transportation and distribution were evaluated using road freight, which was calculated by applying a similar methodology described for the upstream transportation and distribution. Total product tonnage was multiplied by the one-way distance from the Project site to Townsville, approximately 750 km, to estimate freight activity in tonne kilometres. Data on road freight and shipping locations along with respective tonnage of product graphite transported to each destination are provided in Appendix B, Greenhouse Gas Assessment and Decarbonisation Plan. The Articulated HGV>33 t *EF* was applied to estimate the emissions.

The downstream distribution of the Project involves the shipping of the end use graphite concentrate from the Port of Townsville to international receiving ports of USA. All shipping was assumed to occur via the Port of Townsville.

Life cycle GHG emissions for natural graphite battery anode material (BAM) production range between 5-10 kg CO_2-e per kg graphite BAM (Gao *et al*. 2018). Conversely, synthetic graphite production has an emission factor of 29.7 – 30.5 kg CO_2-e/kg BAM, due primarily to the graphetisation of calcined petroleum coke or coal-tar pitch (Pandey *et al*. 2025).

27.6 Emissions inventory

27.6.1 NGER obligations and reportable energy consumption

In accordance with the *NGER Act 2007* and supporting legislation, the Project's GHG emissions and energy use/production will need to be accounted for in the annual corporate NGER scheme.

At the facility level, the annual GHG emissions and energy use exceed the NGER scheme reporting thresholds in all project years:

- GHG: the NGER scheme facility threshold of 25,000 t CO_2-e is exceeded in all project years;
- Energy: the NGER scheme facility threshold 100 TJ (100,000 GJ) is exceeded in all project years.

The total energy consumption for the LOP is estimated at 68,225,242 GJ, detailed in Table 27-8. Diesel used in generators is the dominant energy source, accounting for 57% of LOP energy consumption, followed by diesel used in stationary plant and machinery (excluding generators) at 31% and then diesel used in the reagents process and is not combusted accounts for 9%. Diesel combusted in road registered transportation vehicles, petroleum-based oils and petroleum-based greases each account for 1% of LOP energy consumption. The Project will generate electricity onsite from generators and will not be purchasing power from the national electricity market (NEM).

Table 27-8: Summary of energy consumed for LOP (NGER category)

Source	Energy consumed (GJ)	Energy consumed (% of Total)
Diesel - stationary (excl. generators)	21,021,750	31%
Diesel - stationary (incl. generators)	39,149,201	57%
Diesel - transport	470,442	1%
Diesel - explosives	267,867	0%
Diesel - reagent (not combusted)	6,096,870	9%
Oils	609,556	1%
Greases	609,556	1%
Total	**68,225,242**	**100%**

27.6.2 Scope 1 and 2 emissions

The NGER reportable emissions are the Scope 1 emissions in Table 27-12, less GHG emissions associated with land clearing, explosives and onsite waste treatment. The NGER reportable emissions LOP emissions are estimated at 4,267,731 t CO_2-e, as detailed in Table 27-9.

The annual Scope 1 emissions are listed in Table 27-10.

There are nil Scope 2 emissions.

Table 27-9: Scope 1 emissions for the Project

Source	**GHG emissions (t CO_2-e)**				**Total Reportable to NGER Scheme**
	CO_2	**CH_4**	**N_2O**	**Total**	
Diesel - stationary (excl. generators)	1,469,420	2,102	4,204	1,475,727	1,475,727
Diesel - stationary (incl. generators)	2,736,529	3,915	7,830	2,748,274	2,748,274
Diesel - transport	32,884	5	235	33,124	33,124
Diesel - explosives	18,724	27	54	18,804	-
PBOs	8,473	-	-	8,473	8,473
PBGs	2,133	-	-	2,133	2,133
Land clearing	377,148	-	-	377,148	-
Onsite waste treatment	-	-	122	122	-
Total Scope 1	**4,645,312**	**6,049**	**12,323**	**4,663,805**	**4,267,853**

Table 27-10: Annual Scope 1 emissions for the Project

Project Year	Stationary Diesel (kL)	Transport Diesel (kL)	Land Clearing (ha)	PBOs (kL)	PBGs (kL)	Explosives (kL diesel)	Reagents (kL diesel)	Generators Diesel (kL)	Onsite Wastewater (persons)	ROM Graphite Ore (t)	ROM Graphite Concentrate (t)
Construction	6,799	234	2,413.7	388	388	0	2,925	18,782	0	-	-
1	7,966	234	0	400	400	344	2,925	18,782	192	3,500,000	100,000
2	9,406	234	0	414	414	214	2,925	18,782	192	3,500,000	100,000
3	10,106	234	0	421	421	244	2,925	18,782	192	3,500,000	100,000
4	9,227	234	0	412	412	217	2,925	18,782	192	3,500,000	200,000
5	9,620	222	0	421	421	226	2,925	18,782	192	3,500,000	200,000
6	10,771	222	0	433	433	233	2,925	18,782	192	3,500,000	200,000
7	10,653	222	0	432	432	253	2,925	18,782	192	3,500,000	200,000
8	11,400	222	0	440	440	232	2,925	18,782	192	3,500,000	200,000
9	10,565	222	0	431	431	248	2,925	18,782	192	3,500,000	200,000
10	12,309	222	0	449	449	236	2,925	18,782	192	3,500,000	200,000
11	13,601	222	0	463	463	222	2,925	18,782	192	3,500,000	200,000
12	12,507	222	0	452	452	252	2,925	18,782	192	3,500,000	200,000
13	13,880	222	0	466	466	227	2,925	18,782	192	3,500,000	200,000
14	13,708	222	0	464	464	238	2,925	18,782	192	3,500,000	200,000
15	8,280	222	0	407	407	164	2,925	18,782	192	3,500,000	200,000
16	5,166	222	0	374	374	93	2,925	18,782	192	3,500,000	200,000
17	5,341	222	0	376	376	93	2,925	18,782	192	3,500,000	200,000

Project Year	Stationary Diesel (kL)	Transport Diesel (kL)	Land Clearing (ha)	PBOs (kL)	PBGs (kL)	Explosives (kL diesel)	Reagents (kL diesel)	Generators Diesel (kL)	Onsite Wastewater (persons)	ROM Graphite Ore (t)	ROM Graphite Concentrate (t)
18	8,260	222	0	407	407	122	2,925	18,782	192	3,500,000	200,000
19	7,788	222	0	402	402	139	2,925	18,782	192	3,500,000	200,000
20	5,971	222	0	383	383	112	2,925	18,782	192	3,500,000	200,000
21	4,929	222	0	372	372	98	2,925	18,782	192	3,500,000	200,000
22	4,857	222	0	371	371	95	2,925	18,782	192	3,500,000	200,000
23	4,916	222	0	372	372	95	2,925	18,782	192	3,500,000	200,000
24	5,433	222	0	377	377	134	2,925	18,782	192	3,500,000	200,000
25	6,187	222	0	385	385	139	2,925	18,782	192	3,500,000	200,000
26	5,235	222	0	375	375	120	2,925	18,782	192	3,500,000	200,000
27	5,274	222	0	375	375	116	2,925	18,782	192	3,500,000	200,000
28	7,223	222	0	396	396	137	2,925	18,782	192	3,500,000	200,000
29	7,503	222	0	399	399	137	2,925	18,782	192	3,500,000	200,000
30	7,524	222	0	399	399	136	2,925	18,782	192	3,500,000	200,000
31	8,379	222	0	408	408	138	2,925	18,782	192	3,500,000	200,000
32	8,258	222	0	407	407	136	2,925	18,782	192	3,500,000	200,000
33	6,854	222	0	392	392	173	2,925	18,782	192	3,500,000	200,000
34	7,019	222	0	394	394	175	2,925	18,782	192	3,500,000	200,000
35	7,483	222	0	399	399	151	2,925	18,782	192	3,500,000	200,000
36	12,556	222	0	452	452	140	2,925	18,782	192	3,500,000	200,000

Project Year	Stationary Diesel (kL)	Transport Diesel (kL)	Land Clearing (ha)	PBOs (kL)	PBGs (kL)	Explosives (kL diesel)	Reagents (kL diesel)	Generators Diesel (kL)	Onsite Wastewater (persons)	ROM Graphite Ore (t)	ROM Graphite Concentrate (t)
37	14,268	222	0	470	470	98	2,925	18,782	192	3,500,000	200,000
38	12,615	222	0	453	453	113	2,925	18,782	192	3,500,000	200,000
39	12,204	222	0	448	448	130	2,925	18,782	192	3,500,000	200,000
40	10,598	222	0	431	431	155	2,925	18,782	192	3,500,000	200,000
41	15,673	222	0	485	485	169	2,925	18,782	192	3,500,000	200,000
42	14,780	187	0	475	475	46	2,925	18,782	192	3,500,000	200,000
43	14,972	187	0	477	477	0	2,925	18,782	192	3,500,000	200,000
44	15,409	187	0	482	482	0	2,925	18,782	192	3,500,000	200,000
45	11,970	187	0	446	446	0	2,925	18,782	192	3,500,000	200,000
46	10,280	187	0	428	428	0	2,925	18,782	192	3,500,000	200,000
47	13,190	187	0	458	458	0	2,925	18,782	192	3,500,000	200,000
48	13,133	187	0	458	458	0	2,925	18,782	192	3,500,000	200,000
49	11,077	187	0	436	436	0	2,925	18,782	192	2,000,000	200,000
50	11,077	187	0	436	436	0	2,925	18,782	192	-	200,000
51	11,077	187	0	436	436	0	2,925	18,782	192	-	200,000
52	11,077	187	0	436	436	0	2,925	18,782	192	-	200,000
53	3,198	187	0	353	353	0	2,925	18,782	192	-	50,000
Total	519,550	11,637	2,413.7	22,717	22,717	6,940	157,950	1,014,228	192	170,000,000	10,150,000

Project Year	Stationary Diesel (kL)	Transport Diesel (kL)	Land Clearing (ha)	PBOs (kL)	PBGs (kL)	Explosives (kL diesel)	Reagents (kL diesel)	Generators Diesel (kL)	Onsite Wastewater (persons)	ROM Graphite Ore (t)	ROM Graphite Concentrate (t)
Table notes: The unabated case considers: a 5% increase in stationary and transport diesel (kL) Project Years 5 – 53 a 40.86% increase in Generator diesel across all years resulting in 31,757 kL of diesel per year											

27.6.3 Scope 3 emissions

The total LOP Scope 3 emissions are estimated to be 104,533,872 t CO_2-e, as detailed in Table 27-11.

The majority of the Scope 3 emissions are due to shipping and export of product to the USA for refinement.

Table 27-11: Annual Scope 3 emissions for the Project

Project Year	Category 1 & 2 Purchased Goods and Services and Capital Goods	Category 3 Manufacturing of Fuel and Energy	Category 4 Upstream Distribution	Category 9 Downstream Distribution	Category 10 Processing of Sold Product	Total Scope 3 (in Australia)	Total Scope 3 (Global)
Construction	3,704	19,192	35,340	0		58,236	58,236
1	0	20,201	1,667	12,143	1,000,000	27,551	1,034,011
2	0	21,075	1,667	12,143	1,000,000	28,425	1,034,886
3	0	21,563	1,667	12,143	1,000,000	28,912	1,035,373
4	0	20,958	2,063	24,286	2,000,000	34,385	2,047,307
5	0	21,219	2,063	24,286	2,000,000	34,645	2,047,567
6	0	21,992	2,063	24,286	2,000,000	35,419	2,048,340
7	0	21,927	2,063	24,286	2,000,000	35,353	2,048,275
8	0	22,412	2,063	24,286	2,000,000	35,839	2,048,760
9	0	21,865	2,063	24,286	2,000,000	35,292	2,048,214
10	0	23,021	2,063	24,286	2,000,000	36,448	2,049,370
11	0	23,874	2,063	24,286	2,000,000	37,301	2,050,222
12	0	23,164	2,063	24,286	2,000,000	36,590	2,049,512
13	0	24,064	2,063	24,286	2,000,000	37,491	2,050,413
14	0	23,956	2,063	24,286	2,000,000	37,383	2,050,305
15	0	20,282	2,063	24,286	2,000,000	33,709	2,046,631

Project Year	Category 1 & 2 Purchased Goods and Services and Capital Goods	Category 3 Manufacturing of Fuel and Energy	Category 4 Upstream Distribution	Category 9 Downstream Distribution	Category 10 Processing of Sold Product	Total Scope 3 (in Australia)	Total Scope 3 (Global)
16	0	18,156	2,063	24,286	2,000,000	31,582	2,044,504
17	0	18,272	2,063	24,286	2,000,000	31,699	2,044,621
18	0	20,241	2,063	24,286	2,000,000	33,668	2,046,590
19	0	19,938	2,063	24,286	2,000,000	33,364	2,046,286
20	0	18,706	2,063	24,286	2,000,000	32,133	2,045,054
21	0	18,001	2,063	24,286	2,000,000	31,428	2,044,349
22	0	17,950	2,063	24,286	2,000,000	31,377	2,044,299
23	0	17,990	2,063	24,286	2,000,000	31,417	2,044,338
24	0	18,361	2,063	24,286	2,000,000	31,788	2,044,710
25	0	18,868	2,063	24,286	2,000,000	32,295	2,045,217
26	0	18,220	2,063	24,286	2,000,000	31,646	2,044,568
27	0	18,243	2,063	24,286	2,000,000	31,670	2,044,592
28	0	19,559	2,063	24,286	2,000,000	32,985	2,045,907
29	0	19,745	2,063	24,286	2,000,000	33,172	2,046,094
30	0	19,759	2,063	24,286	2,000,000	33,186	2,046,107
31	0	20,332	2,063	24,286	2,000,000	33,758	2,046,680
32	0	20,250	2,063	24,286	2,000,000	33,676	2,046,598
33	0	19,336	2,063	24,286	2,000,000	32,763	2,045,685

Project Year	Category 1 & 2 Purchased Goods and Services and Capital Goods	Category 3 Manufacturing of Fuel and Energy	Category 4 Upstream Distribution	Category 9 Downstream Distribution	Category 10 Processing of Sold Product	Total Scope 3 (in Australia)	Total Scope 3 (Global)
34	0	19,448	2,063	24,286	2,000,000	32,875	2,045,797
35	0	19,742	2,063	24,286	2,000,000	33,168	2,046,090
36	0	23,122	2,063	24,286	2,000,000	36,549	2,049,471
37	0	24,238	2,063	24,286	2,000,000	37,664	2,050,586
38	0	23,143	2,063	24,286	2,000,000	36,570	2,049,492
39	0	22,880	2,063	24,286	2,000,000	36,307	2,049,228
40	0	21,824	2,063	24,286	2,000,000	35,251	2,048,173
41	0	25,223	2,063	24,286	2,000,000	38,650	2,051,571
42	0	24,521	2,063	24,286	2,000,000	37,948	2,050,869
43	0	24,619	2,063	24,286	2,000,000	38,045	2,050,967
44	0	24,911	2,063	24,286	2,000,000	38,337	2,051,259
45	0	22,614	2,063	24,286	2,000,000	36,040	2,048,962
46	0	21,486	2,063	24,286	2,000,000	34,912	2,047,834
47	0	23,429	2,063	24,286	2,000,000	36,855	2,049,777
48	0	23,390	2,063	24,286	2,000,000	36,817	2,049,739
49	0	22,017	2,063	24,286	2,000,000	35,444	2,048,366
50	0	22,017	2,063	24,286	2,000,000	35,444	2,048,366
51	0	22,017	2,063	24,286	2,000,000	35,444	2,048,366

Project Year	Category 1 & 2 Purchased Goods and Services and Capital Goods	Category 3 Manufacturing of Fuel and Energy	Category 4 Upstream Distribution	Category 9 Downstream Distribution	Category 10 Processing of Sold Product	Total Scope 3 (in Australia)	Total Scope 3 (Global)
52	0	22,017	2,063	24,286	2,000,000	35,444	2,048,366
53	0	16,756	2,063	6,071	500,000	21,660	524,890
Average [1]	69	21,150	2,657	22,824	1,915,094	34,556	1,926,329
Total	3,704	1,142,107	143,476	1,232,502	101,500,000	1,866,010	104,021,789

[1] Average values reflect the full Life of Project (LOP) period of 54 years.

27.6.4 Summary

The Project will generate Scope 1 and Scope 3 emissions from multiple sources and processes. The Project will not generate Scope 2 emissions due to on-site power generation.

Throughout the life of Project (LOP), including construction, operation, and decommissioning, the total unabated Scope 1 GHG emissions are estimated to be 6,567,130 t CO_2-e. A summary of unabated LOP and average annual GHG emissions is provided in Table 27-12.

Scope 2 emissions are 0 t CO_2-e, as electricity will be generated on site.

Table 27-12: Summary of unabated LOP and average annual GHG emissions (tCO_2-e)

Scope	Metric	Value	Unit
Scope 1	Average Annual	121,614	t CO_2-e
	Total Emissions	6,567,130	t CO_2-e
Scope 2	Average Annual	0	t CO_2-e
	Total Emissions	0	t CO_2-e
Scope 3	Average Annual (within Australia only)	44,039	t CO_2-e
	Average Annual (outside Australia only)	1,891,774	t CO_2-e
	Total Emissions (within Australia only)	2,378,093	t CO_2-e
	Total Emissions (outside Australia only)	102,155,779	t CO_2-e
	Total Emissions	104,533,872	t CO_2-e
Total	Total GHG Emissions	111,101,003	t CO_2-e
	Total Average Annual (within Australia)	165,652	t CO_2-e
	Total Average Annual (within and outside Australia)	2,057,426	t CO_2-e
Contributions	Total Average Annual Emissions (within Australia) of Queensland Current Annual Emissions	0.12%	%
	Total Average Annual Emissions (within Australia) of Australia Current Annual Emissions	0.036%	%
	Total Average Emissions (within and outside Australia) of Global Current Annual Emissions	0.0042%	%

27.7 Mitigation measures

27.7.1 GHG emissions reference point

The GHG emissions reference point for the Project represents the level of emissions against which ongoing reduction of GHG emissions will be assessed throughout the life of the Project, based on projected GHG emissions (excluding land clearing and diesel used in explosives) prior to the implementation of GHG abatements. The GHG reference points concern only the operational phase of the Project, whereby graphite is mined and concentrate is produced.

The total NGER reportable Scope 1 GHG emissions arising from the operational phase of the Project is 4,267,731 t CO_2-e, (refer Table 27-9) with average annual Scope 1 GHG emissions of 79,032 t CO_2-e (averaged over 54 years). These form the Project baseline and reference point.

The average emission intensity of operations is 0.02 t CO_2-e / t ROM graphite.

The Proponent commits to reducing net Project Scope 1 emissions by 37% relative to the unabated reference case through the implementation of the abatement measures outlined in the following sections. This target aligns with the goal of achieving net-zero by 2050 trajectory, as outlined in the *Clean Energy Jobs Act 2024*.

27.7.2 Mitigation measures by key result area

The following mitigation measures would be applied for the Project, where practicable and cost-effective, to achieve GHG emissions abatement. They are structured by the key result areas (KRA) of the GHG Guidelines abatement hierarchy, i.e., avoid, reduce, substitute, and offset.

The indicative risks and opportunities, and potential emissions reduction associated with each management control are presented in Table 27-13. Each control has a defined action, performance measure, target, timeframe and responsible role.

27.7.2.1 Avoid

The objective is to avoid GHG emissions through design and planning decisions made before operations begin.

- **Hybrid power station (A1).** The main avoidance measure is a 21.3 MWp solar PV farm and 1.6 MWh BESS integrated with the diesel power station. It will be commissioned before first ore processing, so the Project will never operate on diesel alone. The power station is sized to an average demand of approximately 16 MW, which avoids oversizing and unnecessary fuel use.
    - Performance targets. The hybrid system is designed to achieve at least 38.7% renewable penetration and a system emissions intensity of 0.44 kg CO_2-e/kWh. Both will be verified from metered data each reporting year. Compared with a diesel-only supply, this reduces diesel power generation emissions by about 41%.
- **Land clearing (A2).** Clearing will be limited to the approved disturbance footprint of 2,413.7 ha and carried out in the year of construction. Mine planning and site layout also minimise haul distances and vehicle movements.

27.7.2.2 Reduce

Where emissions can't be avoided, the objective is to reduce the emissions intensity of operations.

- **Renewable-first dispatch (R1).** An energy management system will dispatch solar and battery power ahead of diesel. It will shut down generators when renewable supply allows, known as hydrocarbons-off (HOFF) operation, and keep running generators at efficient loads. The hours of operation and resulting diesel combusted by the power supply will be monitored monthly whilst the effectiveness of the energy management system will be reviewed annually for potential optimisations.
- **Fleet and equipment efficiency (R2).** A fleet management system will monitor idle time, payloads and haul routes, and equipment will be serviced to Original Equipment Manufacturer (OEM) schedules. The target is to reduce Scope 1 emissions from mobile fleet and stationary equipment by 5% within five years, against a baseline set from the first full year of steady-state mining.

27.7.2.3 Substitute

The objective is to progressively replace diesel with lower-emissions energy sources and technologies. Each option below has a decision point, so it will be either adopted or ruled out on defined criteria.

- **Renewable expansion (S1).** Additional solar and battery capacity will be assessed at each five-yearly Abatement Plan review. The current system is expected to generate about 52,960 MWh of renewable electricity each year.
- **Electric conveyor (S2).** A feasibility study for an in-pit to plant electric conveyor to replace diesel haul trucks will be completed by Project year 3. The study will calculate the net emissions benefit and net present value after allowing for the extra electricity demand.
- **Low-emission fleet (S3).** Battery electric and hybrid options for light vehicles, and battery electric, hybrid and trolley-assist options for mining machinery, will be evaluated at each fleet replacement.
- **Grid connection (S4).** Grid connection will be assessed once sufficient network capacity is available, such as on completion of CopperString 2032, with a decision made within 12 months of capacity becoming available. Connection would replace on-site diesel generation but introduce Scope 2 emissions, as Queensland's grid emissions factor currently exceeds that of the Project's diesel generation. This gap is expected to narrow as the grid decarbonises. A renewable power purchase agreement will be evaluated on connection
- **Renewable fuels (S5).** A feasibility study for renewable diesel and biodiesel blends in mining equipment will be completed once supply is reliable, OEM warranties are maintained, and the cost premium over conventional diesel is commercially acceptable.

27.7.2.4 Offset

Offsets will only be purchased if the Project becomes subject to the Safeguard Mechanism, which applies where Scope 1 emissions exceed 100,000 t CO_2-e per year. In that event, the Project's Safeguard baseline will become the reference point, and offsets will be used only as a last resort to address residual emissions above the baseline that cannot be reduced through on-site abatement. Preference will be given to Australian Carbon Credit Units (ACCUs) generated by Queensland-based projects, subject to availability

Table 27-13: Project GHG abatement hierarchy including Key Result Areas and KPIs

Key Result Area	Management Control (SMART)	Timeframe	Risk assessment (risks, cost, practicality, effectiveness)	Indicative Opportunities	Justification and best practice comparison	Emissions reduction estimate for Project
Targets	T1. Reference point and emission reduction targets Action: Adopt a net Scope 1 reference point equal to projected unabated emissions as set out in Table 27-14 and manage emissions to the targets below. Measure: Annual Scope 1 emissions (t CO_2-e) calculated using NGER methods and compared with the reference point for the same year and stage; emissions intensity (t CO_2-e per t graphite concentrate). Target: Scope 1 emissions 30% below the reference point by Project Year 5, with targets reviewed thereafter.	Reference point fixed in first version of GHG Abatement Plan Net Scope 1 emissions calculated annually	Production variability changes absolute emissions. The reference point is stage-specific and is restated if production differs from plan by more than 10% If Scope 1 exceeds 100,000 t CO2-e/yr, the Safeguard Mechanism baseline replaces the reference point for Scope 1	Links every measure to a target year	Application of best practice emissions reduction options for energy generation based on feasibility assessment	Reference point: 121,614 t CO_2-e/yr at steady state; 6,567,130 t CO_2-e over the life of the project (LOP) LOP emission reduction : 1,967,984 t CO_2-e; annual average emission reduction 36,444 t CO_2-e
Avoid	A0. Project alternatives considered Action: Document the design and site alternatives considered to avoid emissions, including power supply (diesel-only, hybrid, grid), purification process route, haulage method, plant location and footprint, and the alternative of not	Before EIS submission	An information request is likely if alternatives not considered Alternatives not feasible at FID (NEM connection, conveyor) are carried forward as S2 and S4	Shows that the hybrid power station (A1) was selected over diesel-only supply on emissions and cost grounds	Guideline s3.3 (Avoid): explain feasible alternatives considered to avoid or reduce emissions, including not proceeding	Principal contributor to site-wide emissions reduction (see below)

Key Result Area	Management Control (SMART)	Timeframe	Risk assessment (risks, cost, practicality, effectiveness)	Indicative Opportunities	Justification and best practice comparison	Emissions reduction estimate for Project
	proceeding. State the option selected and why. Measure: Alternatives assessment included in the EIS GHG chapter Target: Completed for EIS submission.					
	A1. Hybrid solar–diesel–BESS power station Action: Design, construct and commission a 21.3 MWp solar farm and 1.6 MWh BESS integrated with the diesel power station, so that no part of the operating phase relies on diesel-only generation. Measure: Annual renewable penetration (% of site electricity from PV/BESS) and system emissions intensity (kg CO_2-e/kWh), from metered generation and fuel data. Target: ≥38.7% renewable penetration and 0.44 kg CO_2-e/kWh, averaged over each reporting year. Monitoring: PV, BESS and generator output, and fuel use logged continuously by the EMS; annual performance report.	PV and BESS commissioned before first ore processing Performance verified at end of first full operating year	Increased generator emissions intensity from part-load operation and managing residual diesel generation Variability in renewable penetration from seasonal and weather-related intermittency High initial installation cost Battery degradation, storage performance and/or equipment failure Control system integration challenges	Energy security and independence Reduced diesel consumption and exposure to fuel price volatility Low operating and maintenance costs Predictable generation profile supporting forecasting and future grid integration Peak shaving and load shifting via BESS	Hybrid PV–BESS–diesel supply is established practice for off-grid Australian mines Selected over diesel-only supply (A0)	~41% reduction in power-generation Scope 1 emissions relative to diesel-only supply. Average reduction of 35,159 t CO_2-e/yr or 1,898,595 t CO_2-e for the LOP. Principal contributor to the site-wide 30% target

Key Result Area	Management Control (SMART)	Timeframe	Risk assessment (risks, cost, practicality, effectiveness)	Indicative Opportunities	Justification and best practice comparison	Emissions reduction estimate for Project
	A2. Minimise land clearing and carbon stock loss Action: Restrict clearing to the approved disturbance footprint Measure: Area cleared (ha) against approved footprint and schedule; clearing emissions (t CO2-e) estimated using FullCAM or NGA methods Target: Zero clearing outside the approved footprint Monitoring: Clearing permits and as-cleared surveys; reported following construction	From start of construction (2027) From start of construction	May increase the complexity of mine scheduling and access to high value resources Cost: Low Practicality: High Effectiveness: Limits clearing emissions in the inventory estimate	Reduced clearing means reduced rehabilitation requirements, PMLU obligations, and costs May improve ability to sequester extra carbon in the PMLU	Clearing emissions are within the Guideline scope (land use assessment, s2.2) although not reported under NGER Footprint control is standard practice for vegetation management	Maximum clearing emissions of 377,148 t CO_2-e included in Scope 1 inventory
Reduce	R1. Renewable-first dispatch and generator efficiency Action: Operate an energy management system (microgrid controller) that dispatches PV and BESS ahead of diesel, shuts down generators when renewable supply allows (HOFF), and loads running generators within their efficient operating range. Measure: Hours of diesel generation and the resulting kL combusted Target: 42.5% reduction in emissions resulting from the combustion of diesel for electricity generation	Energy management system commissioned with PV/BESS Annual review of energy management system effectiveness	Part-load operation raising generator emissions intensity Seasonal and weather intermittency reducing HOFF Battery degradation or equipment failure Control system integration challenges Cost: Included in A1 capex Practicality: High Effectiveness: High Technology risk: Low	Maximises return on renewable investment Fewer generator run-hours and lower maintenance Predictable energy pattern for forecasting	Automated renewable-first dispatch and generator loading control is standard for hybrid microgrids	Delivers the A1 reduction

Key Result Area	Management Control (SMART)	Timeframe	Risk assessment (risks, cost, practicality, effectiveness)	Indicative Opportunities	Justification and best practice comparison	Emissions reduction estimate for Project
	Monitoring: EMS data; monthly KIP report; annual check of meter calibration					
	R2. Mobile fleet and stationary equipment efficiency Action: Implement a fleet management system (FMS) with idle-time alerts, payload monitoring and haul-route optimisation. Service engines, generators and compressors to OEM schedules with performance monitoring. Measure: Fleet fuel intensity (L diesel per tonne of material moved); idle time (% of engine hours); average payload (% of rated); fuel use per unit output for stationary equipment. Target: Reduce fleet fuel intensity by 5% against a baseline set from the first full year of steady-state mining, to be achieved within five years of the baseline being established Monitoring: FMS and fuel dispensing records; annually reports (at a minimum)	FMS operational from start of mining Baseline set from the first full year of steady-state mining Target to be achieved 5 years after the baseline	Operational coordination complexity with haul routes, scheduling and mine utilisation Reduced flexibility in operational timing, especially during peak production Maintenance constraints Cost: Payback from fuel savings expected within three years Practicality: High Effectiveness: Medium Technology risk: Low	Reduced fuel consumption and operating costs Improved equipment efficiency and maintenance standards Lower emissions intensity per unit of material moved	FMS, idle control and payload management are standard practice in Australian open-cut mining	5% reduction in Diesel emissions from Project Years 5 to 53; equivalent to 1,285 t CO_2-e/yr (on an average basis) or 69,389 t CO_2-e for the LOP.
Substitute	S1. Renewable capacity expansion Action: Assess expanding PV and BESS capacity at each five-yearly Abatement Plan review	Review every 5 years	Land availability and capital cost Curtailment without additional storage	Further diesel reduction Lower exposure to fuel price volatility	Guideline App. A (f): regular review of new technologies and opportunities	To be quantified in feasibility study

Key Result Area	Management Control (SMART)	Timeframe	Risk assessment (risks, cost, practicality, effectiveness)	Indicative Opportunities	Justification and best practice comparison	Emissions reduction estimate for Project
	Commitment: review previous and future committed; installation conditional on the decision criteria. Decision criteria: available land constraints and levelised cost ≤ diesel generation cost Measure: annual renewable penetration (%) and site power demands Target: To be determined based on feasibility review		Cost: To be determined per additional MWp / MWh Practicality: High Effectiveness: High; limited by storage Technology risk: Low			
	S2. In-pit electric conveyor Action: Complete a feasibility study for an electric conveyor from the mine pit to the process plant, replacing diesel haul trucks. Study to include net emissions after allowing for the additional site electricity demand Commitment: feasibility study; implementation conditional Decision criteria: proceed if net present value is better than the haul truck case; T1 targets unchanged if not adopted. Measure: Study completed and decision recorded; diesel displaced (L/yr) after commissioning	Feasibility study completed by Project year 3 Implementation subject to study outcome	High upfront capital Technology readiness and operational disruption during transition Added electricity demand met partly by diesel generation, reducing net benefit unless renewables expand (S1) Cost: capex to be determined Practicality: depends on pit geometry and mine life Effectiveness: medium to high; net benefit depends on S1/S4 Technology risk: low (proven); site-specific risk moderate	Displaces haul truck diesel Higher energy efficiency than diesel haulage Lower operating costs	In-pit crushing and conveying is an established lower-emission alternative to truck haulage	To be quantified in the feasibility study

Key Result Area	Management Control (SMART)	Timeframe	Risk assessment (risks, cost, practicality, effectiveness)	Indicative Opportunities	Justification and best practice comparison	Emissions reduction estimate for Project
	Target: Feasibility study by end of Project Year 3					
	S3. Low-emission mining and light vehicle fleet Action: Evaluate battery-electric or hybrid light vehicles and battery-electric, hybrid or trolley-assist options for the heavy mining fleet at each fleet replacement cycle. Criteria: Procure low-emission options where OEM equipment is commercially available and offers a lower lifecycle cost inclusive of ancillary infrastructure (on a net present value basis) than diesel equivalents. Commitment: Evaluation studies	Evaluate low-emission mining and light vehicle fleet at each fleet replacement cycle	Charging infrastructure and capital cost Disruption during transition between diesel and electric systems Cost: light vehicles low; heavy fleet high Practicality: high (light); uncertain (heavy) Technology risk: medium to high for heavy fleet	Progressive integration of emerging technologies	Fleet electrification is cited in Guideline App. C	To be determined from evaluation
	S4. NEM connection and renewable PPA Action: Complete a NEM connection feasibility assessment Commitment: When connection becomes available	Feasibility study when connection becomes available Connection subject to network availability	Introduces Scope 2 emissions Uncertain network timing and connection cost Uncertain availability, cost and additionality of renewable PPAs Cost: To be determined for FID Effectiveness: High	Enables wider electrification (S2, S3) Substantially lower diesel consumption	Scope 2 to reduce as grid decarbonises	Up to 100% of generator Scope 1 emissions, partly replaced by Scope 2 at the Queensland grid factor, declining over time, unless covered by a renewable PPA

Key Result Area	Management Control (SMART)	Timeframe	Risk assessment (risks, cost, practicality, effectiveness)	Indicative Opportunities	Justification and best practice comparison	Emissions reduction estimate for Project
	Target: Connection decision within 12 months of capacity becoming available and feasibility assessed;		Technology risk: Low; availability risk high			
	S5. Renewable diesel and biodiesel blends Action: Complete a feasibility study for adoption of renewable diesel (HVO) or biodiesel blends in mobile or stationary equipment. Commitment: Feasibility assessment once renewable diesel and biodiesel blends are commercially available.	When supply is reliable, OEM warranties would be maintained, and cost premium could be abated	Supply availability in regional Queensland Cost premium and sustainability certification Engine compatibility Cost: Fuel premium Practicality: High (drop-in) Technology risk: Low; supply risk high	Drop-in fuel for existing equipment with little capital Reduced exposure to diesel price volatility	Recognised substitution measure (Guideline s3.3, lower-carbon fuels)	CO_2 reduced in proportion to the renewable fraction of the fuel
Review, monitoring, and reporting	G1. Abatement Plan review and public reporting Action: Review the Abatement Plan every five years, including an assessment of new technologies and progress against targets. Publish an annual progress report against the Plan targets. First review of dates following approval and commissioning. Monitoring and auditing: annual Scope 1 emissions calculated using NGER methods; independent audit against T1 by	Review of target dates following project approval and commissioning Annual reporting from first NGER year FY28 Five-yearly reviews Audit every three years	Reporting burden Public scrutiny if targets are missed	Meets Guideline requirements for technology review and public reporting Supports ESG and climate disclosure obligations	Guideline App. A (f) technology review, (g) monitoring and auditing, (h) public reporting	Enabling measure; no direct reduction claimed

Key Result Area	Management Control (SMART)	Timeframe	Risk assessment (risks, cost, practicality, effectiveness)	Indicative Opportunities	Justification and best practice comparison	Emissions reduction estimate for Project
	an appropriately qualified person every [2] years. Reporting: annual public report on Proponent's website covering emissions against T1, status of each measure (including decisions on S1–S5 with reasons) and offsets used. Measure: Review completed; annual public report published Target: Review every five years; annual report published by 31 December each year					

27.7.3 Mitigated Scope 1 emissions

Projected abated emissions achieved through the decarbonisation management controls (Table 27-13) to achieve Project objectives are presented in Table 27-14. These values are provisional and contingent on successful implementation of the management controls.

Table 27-14: Summary of unabated and abated LOP and average annual GHG emissions

Scope	Metric	GHG Emissions (t CO_2-e)
Scope 1: unabated	Average annual	121,614
	Total LOP	6,567,130
Scope 1: abated	Average annual	85,169
	Total LOP	4,599,146
Difference (unabated – abated)	Average annual	36,445
	Total LOP	1,967,984

27.7.4 Mitigated Scope 3 emissions

Graphinex will regularly review options for GHG abatement measures across the highest emitting parts of their supply chain. Scope 1 abatement measures implemented for the Project are expected to reduce associated upstream Scope 3 emissions from the extraction, production and transport of fuels consumed by the Project.

Current Scope 3 abatement measures are focused on upstream and downstream transportation and distribution, which are presently assumed to rely on road freight between Townsville and the Project site. Graphinex is reviewing the potential of using the Mount Isa line system to reduce long distance road haulage. Under this option, freight would be transported by road-train trucks approximately 285 km between the Project site and Julia Creek, then by rail approximately 650 km between Julia Creek and the Port of Townsville.

Replacing the assumed all-road freight route with the road and rail option is estimated to reduce:

- Downstream transportation and distribution emissions by approximately 216,484 t CO_2-e over the LOP; and
- Upstream transportation and distribution emissions by approximately 86,204 t CO_2-e over the LOP. This estimate does not assume rail freight is used during Project Year 1, as construction phase freight is assumed to be transported by road.

Graphinex will also investigate other Scope 3 abatement opportunities including:

- Lower emission capital goods (low carbon steel and green concrete);
- Logistics optimisation;
- Ongoing Scope 3 monitoring and evaluation by working with suppliers and customers to reduce carbon footprint; and
- Research initiatives into reducing the lifecycle and embodied carbon intensity of the Project's sold products for opportunities to contribute to lifecycle improvements of products.

International shipping to end-use countries is expected to remain the second largest Scope 3 emission source. These emissions are influenced by shipping routes, vessel availability and market demand, and are outside of Graphinex direct control.

27.7.5 Mitigation timeframes, monitoring, evaluation, reporting and assessment

Timeframes for GHG mitigation measures are included in Table 27-13.Graphinex will monitor and record all energy use and production within the facility boundary consistent with NGER requirements and methods. This data and the methods for monitoring will be available and subject to periodic internal validation and independent audit.

The facility is currently not subject to the Safeguard Mechanism as all annual emissions are below the 100,000 t CO_2-e trigger threshold. As a result, Graphinex will not be required to demonstrate year-on-year proportional reduction in emissions relative to its production-adjusted baseline. Progress against the decarbonisation objective and key result areas can be periodically reviewed for opportunities of improvement and evaluation.

Decarbonisation of the mining sector is a rapidly changing space, driven in large part by the Safeguard Mechanism requirements. Expected best practice includes planning, designing, constructing, and operating mine sites for the efficient use of diesel, whilst ultimately electrification of plant and equipment is emerging as best practice. However, there are still limitations in market availability and cost-competitiveness against traditional diesel options. Graphinex is continually investigating a range of improved diesel-use efficiency and electrification options, and these will be periodically reviewed and implemented where feasible for the Project.

Practicable and economically feasible emission reduction, abatement, or offsetting options will be considered for implementation when the business case is met. Each option will have its effectiveness monitored and reported if necessary.

27.8 Risks and likely magnitude of impacts on environmental values

27.8.1 Impacts of GHG emissions on environmental values

The increasing concentration of greenhouse gases in the atmosphere, primarily due to the combustion of fossil fuels and deforestation, is leading to the warming of oceans, land, and atmosphere. This warming increases the heat energy available in the climate system leading to changed weather patterns including more frequent and intense extreme weather events. Australia is required to provide the United Nations Framework Convention on Climate Change (UNFCCC) with National Inventory Reports annually, biennial reports every 2 years, and National Communications every 4 years. These reports include details on total and sectoral GHG emissions, progress against reduction targets, and mitigation actions.

The Project is located in the Gulf region of Queensland, which is in the wet-dry tropics (savanna) and is generally hot to very hot throughout the year. Key climate risks for this region include (Department of Energy and Climate 2024):

- increased frequency of hot days (>35^{o}C) and very hot days (>40^{o}C);
- increased likelihood of extreme bushfire weather;
- increased likelihood of variable rainfall, affected by local factors such as topography and vegetation, and broader scale weather patterns e.g. The El Niño - Southern Oscillation;
- increased frequency and severity of drought;
- increased pan evaporation rates, which in turn affects drought and fire conditions;
- less frequent but more intense tropical cyclones;
- warmer and more acidic ocean; and
- rising sea levels and more frequent coastal and open ocean extreme events.

Consequently, there is a need to reduce emissions at a state, national, and global level.

27.8.2 Contribution to Queensland's emissions reduction targets

The Project will contribute to Queensland's GHG emission reduction targets as legislated in the Clean Economy Jobs Act 2024 (CEJ Act) and the Energy (Infrastructure Facilitation) Act 2024 and are shown in Table 11. The targets are:

- 30% reduction in GHG emissions on 2005 levels by 2030;
- 75% reduction in GHG emissions on 2005 levels by 2035; and
- A net zero emissions economy achieved by 2050.

These emission targets include the 2040 interim target and the 2045 interim target decided under section 6 of the CEJ Act by the Minister. The Minister must decide the 2040 interim target by 2030, and the 2045 interim target by 2035.

Table 27-15: Project contribution to Queensland's emissions reduction targets

Queensland Targets	Project Contribution
75% on 2005 levels by 2035	Progressive emissions reduction as per GHG Abatement Plan. This will also contribute to meeting 2030 target of 30% on 2005 levels
Zero net emissions economy by 2050	Progressive reduction in emissions with implementation of GHG Abatement Plan Hybrid energy system with renewables Project operational phase is projected to end well after 2035 after which, emissions targets will be decided on a 2040 and a 2045 interim target [1]
[1] https://www.legislation.qld.gov.au/view/whole/html/inforce/current/act-2024-016	

27.8.3 Contribution to State, Australia, and Global emission budgets

The Project's cumulative abated GHG emissions were compared against remaining global, Australian and Queensland emissions budgets for the period 2027 to 2050, aligning with the Project commencement year and the net zero end point. Project emissions occurring after 2050 were excluded from this comparison.

Global remaining carbon budgets were based on the 50% probability budgets reported by Friedlingstein et al. (2025) for limiting warming to 1.5°C and 2°C. As these budgets are reported from the beginning of 2026, one year of global CO_2-emissions was subtracted to align the budgets with the Project commencement year, using the 2025 global CO_2-emissions estimate as a proxy for 2026 emissions.

For Australia and Queensland, emissions budgets were estimated as target-aligned CO_2-e budgets to net zero by 2050, rather than temperature-based carbon budgets. Australia's pathway was based on its nationally determined contribution under the Paris Agreement, while Queensland's pathway was based on the state targets outlined in the Clean Economy Jobs Act 2024. Historical annual emissions data from Australia's national Greenhouse account (Department of Climate Change, Energy, the Environment and Water, n.d.) were used to define the 2005 baseline and relevant actual emissions values used in the budget calculations.

Queensland's budget was estimated by linearly interpolating from 2024 actual emissions to the 2035 target, and then from the 2035 target to net zero in 2050. As Queensland's 2024 emissions were already below the 2030 target, the 2030 target was not used as an interpolation point to avoid assuming an increase in emissions to the 2030 threshold.

Australia's budget was estimated by subtracting actual emissions from 2021 to 2024 from the 2021 to 2030 emissions budget, then distributing the remaining 2025 to 2030 budget using a linear pathway to the 2030 target. For 2031 to 2035, Australia's published emissions budget range was adopted, with annual values interpolated to the relevant 2035 target level and then linearly reduced to net zero by 2050.

For the global comparison, all Scope 1, Scope 2 and identified Scope 3 emissions were included. As global carbon budgets are reported in CO_2, while the Project emissions inventory is reported in CO_2-e the global comparison is considered indicative. For the Australian and Queensland comparisons, only emissions occurring within Australia were included.

The Project's cumulative abated emissions from 2027 (approximate Project commencement) to 2050 (net zero) represent a small proportion of the assessed budgets, comprising approximately 0.29% of the Queensland budget, 0.068% to 0.076% of the Australian budget, and 0.036% and 0.0046% of the remaining global 1.5°C and 2.0°C carbon budgets, respectively.

27.9 TOR reconciliation table

Table 27-16: Terms of reference (ToR) reconciliation table

Terms of reference - Content requirements of the EIS		EIS Section
Section 27 - Greenhouse gas		
27.1	The following guidance is relevant for the assessment of GHG emissions: (a) Queensland Government, Guideline – Greenhouse gas emissions, ESR/2024/6819 (GHG Guideline).	Table 27-1
Greenhouse gas - Existing environment		
27.2	Describe nearby activities or sources that may emit GHG emissions (point source or diffuse) including naturally occurring (potential or actual) sources.	Section 27.3
Greenhouse gas - Impact assessment		
27.3	Provide an emissions inventory identifying the GHGs to be emitted by source from all components of the project and the phase of the project at which the emissions will occur.	Section 27.5
27.4	Provide information regarding GHG emissions and energy production and consumption consistent with requirements of *National Greenhouse and Energy Reporting Act 2007 (Cth)* and its subordinate legislation, including methodology, assumptions, emissions factors, activity data and calculations used to estimate the project's GHG emissions.	Section 27.4, Section 27.5
27.5	Demonstrate how the project will contribute to Queensland's GHG emission reduction targets as legislated in the Clean Economy Jobs Act 2024 and the Energy (Renewable Transformation and Jobs) Act 2024 over the life of the project.	Section 27.7.2
27.6	Undertake an assessment of GHG emissions, including:	
	(a) an estimate of the projected annual and cumulative Scope 1 and Scope 2 CO_2 equivalent emissions over the life of the project. Include both unabated emissions and emissions after all avoidance and abatement measures have been accounted	Section 27.5.3, Section 27.6.3
	(b) for medium to high emitting projects, provide an estimate of annual and cumulative Scope 3 emissions and total Scope 3 emissions over the life of the project.	Section 27.5.4, Section 27.6.4
27.7	Identify risks and likely magnitude of impacts to environmental values from abated Scope 1, 2 and 3 emissions (noting that only medium to high emitters are required to consider the impact of Scope 3 emissions).	Section 27.7.1
Greenhouse gas - Mitigation measures		
27.8	For medium to high emitting projects, provide a GHG abatement plan that meets the requirements of the GHG Guideline, Appendix A. The GHG abatement plan must also address the following:	Section 27.6
	(a) as part of the assessment of project alternatives, detail, compare and quantify conceptual, technological, locality, configuration, scale and individual elements or components of feasible alternatives that were considered to avoid or reduce the project's emissions	Table 27-13
	(b) identify any voluntary initiatives, or research into reducing the lifecycle and embodied energy carbon intensity of the project's processes or products	Section 27.6.4

Terms of reference - Content requirements of the EIS		EIS Section
	(c) provide a comparison of estimated annual and cumulative abated project GHG emissions with the global, national and state estimated annual emissions and remaining emission budgets up to 2050. Include all Scope 3 emissions identified in the project estimate when comparing with the remaining global comparison, and relevant Scope 3 emissions for national and Queensland comparisons	Section 27.7.3
	(d) where offsets have been identified as the primary option for compliance, develop a comprehensive carbon offsets management plan. This plan must estimate the volume of carbon offsets required for compliance over the life of the project, detail expected market availability limitations of offset credits, and demonstrate how the project will secure the required supply of offsets	Not applicable Section 27.7.2.4
	(e) for projects proposing to offset more than 30% of their emissions limits or offset outside of Queensland, provide as part of the EIS an independent review by an appropriately qualified person. This review will assess and confirm findings of the EIS that on-site GHG emission avoidance, reduction and substitution measures have been expended and why suitable and/or sufficient offsets are not available within Queensland	
	(f) when multi-year emissions reduction targets are proposed to take into account emerging technologies over that period, ensure the same emissions result will be delivered at the end of the multi-year period such that the trajectory of the Queensland emissions targets are met. A multi-year monitoring period should not be more than 5 years	
	(g) describe the assumptions and data inputs applied to develop the project emissions reduction targets. The calculation of baseline should follow the methodology outlined in the National Greenhouse and Energy Reporting (Safeguard Mechanism) Rule 2015.	
27.9	For low emitting projects, detail proposed GHG management practices to demonstrate that all reasonable and practical measures have been applied to manage GHG emissions through best practice design, process, technology, and management following the GHG abatement hierarchy: avoid, reduce, substitute and offset.	Not applicable, as not a low emitting project