



Hail Creek Coking Coal (HCOC) Eastern Margin Extension – EPBC Referral

Attachment C

EPBC REFERRAL GREENHOUSE GAS ASSESSMENT
(SLR, 2025h)



Hail Creek Open Cut Eastern Margin Extension

EPBC Referral - Greenhouse Gas Assessment

Hail Creek Coal Holdings Pty Limited

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Basis of Report

This report has been prepared by SLR Consulting Australia (SLR) with all reasonable skill, care and diligence, and taking account of the timescale and resources allocated to it by agreement with Hail Creek Coal Holdings Pty Limited (the Client). Information reported herein is based on the interpretation of data collected, which has been accepted in good faith as being accurate and valid.

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Acronyms and Abbreviations

Abbreviation or term	Description
%	percent
ACCU	Australian carbon credit units
ANREU	Australian National Registry Emissions Unit
CH ₄	methane
CO ₂	carbon dioxide
CO ₂ -e	CO ₂ equivalents
Cth	Commonwealth of Australia
DCCEEW	Department of Climate Change, Energy, the Environment and Water
DETSI	Department of Environment, Tourism, Science and Innovation
DISER	Department of Industry, Science Environment and Resources (now DETSI)
EA	Environmental Authority
EP Act	<i>Environmental Protection Act 1994</i>
ERBC Act	<i>Environment Protection and Biodiversity Conservation Act 1999</i>
ERF	Emissions Reductions Fund
FY	financial year
GCAA	Glencore Coal Assets Australia
GHG	greenhouse gas
GJ	gigajoule
ha	hectares
HCC	Hail Creek Holdings Pty Limited
HCOC	Hail Creek Open Cut
LPG	liquid petroleum gas
ML	Mining Leases
Mtpa	million tonnes per annum
N ₂ O	nitrous oxide
NCAS	National Carbon Accounting System
NDC	Nationally Determined Contribution
NGA	National Greenhouse Accounts
NGER Act	<i>National Greenhouse and Energy Reporting Act 2007</i>
ROM	Run of Mine
SF ₆	sulfur hexafluoride
SLR	SLR Consulting Australia Pty Ltd
TAGG	Transport Authorities Greenhouse Group
UN	United Nations
UNFCCC	United Nations Framework Convention on Climate Change



1.0 Introduction

SLR Consulting Australia Pty Ltd (SLR) was engaged by Hail Creek Holdings Pty Limited (HCC), a subsidiary of Glencore Coal Assets Australia (GCAA) to prepare a greenhouse gas (GHG) assessment for the proposed extension of Hail Creek Open Cut (HCOC) mine (the Action), located in the Bowen Basin in Central Queensland.

HCOC is authorised through Environmental Authority (EA) EPML00661913 and Mining Leases (MLs) 4738 and 700026. Construction of HCOC commenced in December 2001. HCC became the operator of HCOC in August 2018.

Coal is mined using conventional open-cut strip-mining methods, with approval to produce up to 20 million tonnes of product coal per annum (Mtpa). Coal is also approved to be mined by underground methods, however to date, the mine has not utilised underground mining methods for mining.

Due to changes in mine sequencing, improvements in mining efficiency and further resource definition, the Project proposes an extension to the approved mining footprint in four distinct areas, as shown in **Figure 1**.

HCC is seeking approval for the Project from the Queensland Department of Environment, Tourism, Science and Innovation (DETSI), under Section 226 of the *Environmental Protection Act 1994* (EP Act). The Project may also require approval from the Commonwealth Minister for the Environment and Water under Part 3, Division 1 provisions of the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) should the Project be determined to be a controlled action.

The Action for which a controlled action determination is being sought under the EPBC Act involves mining operations within the individual areas provided below:

- Kemmis Pit Extension (Area 1) - clearing and mining of an additional 6.3 hectares (ha) of surface disturbance, comprising two small polygons of approximately 4.5 ha and 1.8 ha, to extend the currently approved footprint of Kemmis Pit;
- Homevale Pit and Hail Creek Diversion (Area 2) - clearing and mining of 136.6 ha for a new 'Homevale Pit' located in the corner of ML4738 to the north;
- Exevale Pit Extension (Area 3) - clearing and mining of an additional 140.3 ha of surface disturbance to extend the currently approved footprint of Exevale Pit; and
- Carrinyah Pit Extension (Area 4) - clearing and mining of an additional 396.0 ha of surface disturbance to extend the currently approved footprint of Carrinyah Pit.

A total additional approximate 679.2 ha of land is proposed to be disturbed.

An analysis of the potential greenhouse gas (GHG) emissions that would arise from the Proposed Action has been undertaken to inform the EPBC Act referral. This report presents a summary of the predicted GHG emissions that will arise from the Action, should it be approved, along with the proposed mitigation and management measures to be implemented.



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EPBC REFERRAL

FIGURE 1
PROPOSED AMENDMENT AREAS

LEGEND

- EA Authorised Extent of Disturbance
- EA Amendment Proposed Extent of Disturbance
- Mining Lease



Coordinate System: GDA2020 MGA Zone 55
Scale: 1:60,000 at A3
Project Number: 626.30128
Date: 24-Mar-2025
Drawn by: AS



2.0 Legislative and Policy Context

There are concurrent legislative frameworks for the regulation of GHG emissions at both the Commonwealth and State levels.

2.1 Commonwealth

Commonwealth regulatory frameworks for the management and reduction of GHG emissions include the Australian Carbon Credit Unit (ACCU) Scheme and the Safeguard Mechanism established under the *National Greenhouse and Energy Reporting Act 2007* (NGER Act).

The ACCU Scheme aims to provide incentives for a range of organisations and individuals to adopt new practices and technologies to reduce their emissions, and to provide a legal obligation for Australia's top emitters to maintain their emissions below their emissions limit (or baseline) (defined by the Safeguard Mechanism). It allows for the generation of ACCUs, which are a tradeable financial product, with one ACCU representing one tonne of carbon dioxide equivalents (CO₂-e) that would have otherwise been released to the atmosphere.

The Australian National Registry Emissions Unit (ANREU) is an online system that allows users to track ownership and transactions of emissions units, including ACCUs. Organisations and individuals can own, transfer, cancel, deliver, surrender or relinquish ACCUs via ANREU.

The Safeguard Mechanism was established under the NGER Act and applies to facilities with direct Scope 1 emissions of more than 100,000 tonnes of CO₂-e per year, which are defined as "covered facilities". HCOC is a covered facility under the Safeguard Mechanism.

This framework establishes a baseline against which a facility's emissions reported under the NGER Act are compared. During 2022 – 2023, major reforms to the Safeguard Mechanism were enacted to reflect Australia's emissions reduction targets set out in the *Climate Change Act 2022* (Cth) and its Nationally Determined Contribution (NDC) under the Paris Agreement, which are currently as follows:

- Reducing Australia's net greenhouse gas emissions to 43% below 2005 levels by 2030;
- Reducing Australia's net greenhouse gas emissions by 62–70% below 2005 levels by 2035 to support the transition to net zero; and
- Reducing Australia's net greenhouse gas emissions to zero by 2050.

These reforms require covered facilities to deliver a proportional share of Australia's 2030 climate target. Following the reforms, baselines will decline in a predictable and gradual way across all covered facilities. The reforms are based on emission intensity, production-adjusted, and subject to legislated decline rates.

The decline rate for Safeguard baselines is currently as follows:

- 4.9% per year to 2029 - 2030; and
- 3.285% from 2030 onwards.

It is anticipated that further refinements to the Safeguard Mechanism may be required to support achievement of Australia's 2035 NDC.

If a facility exceeds its baseline, they have the option to surrender ACCUs or Safeguard Mechanism Credits (SMCs) to offset emissions. If a facility's emissions are less than its baseline, it will be awarded SMCs which it can choose to bank for future use or sell to other Safeguard facilities.



2.2 Queensland Government

2.2.1 Queensland Climate Action Plan

The Queensland Government has committed to action on climate change through the Queensland Climate Action Plan, and also in 2024 committed to the following renewable energy targets¹ and emissions reduction targets²:

- 50% renewable energy target by 2030;
- 70% renewable energy by 2032;
- 80% renewable energy by 2035;
- 30% emission reduction below 2005 levels by 2030;
- 75% emissions reduction below 2005 levels by 2035; and
- Zero net emissions by 2050.

The current Queensland Government however has announced its intent to reappeal the above renewable energy targets, while still supporting Australia's net-zero goal by 2050³. The current policy favours an energy portfolio that combines fossil fuel generation with selective renewable projects, emphasising grid reliability and economic stability. Under the recently released Energy Roadmap, State-owned coal-fired power stations will continue to operate longer than previously planned, with gas also playing a bigger role in the energy mix to support the grid. There is also an increased focus on private investment for renewables and firming capacity, with the establishment of the Queensland Energy Investment Fund.

The Queensland Government is also developing the following six sector emissions reduction plans to ensure all industries are engaged in realising a net zero future:

- Energy;
- Resources;
- Agriculture and land;
- Transport;
- Industry; and
- Built environment.

2.2.2 Guideline: Greenhouse Gas Emissions

In May 2024, DETSI released the *Guideline Greenhouse Gas Emissions* (the Guideline) (DETSI 2025), which clarifies existing application requirements under the EP Act and provides information about how to meet these requirements in relation to GHG emissions. The Guideline sets out the minimum expectations for GHG emissions information to be provided with applications for new EAs and applications to amend existing EA's and was referred to in preparing the GHG Assessment report provided as supporting information for the EA Amendment Application for the Action.

2.2.3 HCOC Approvals

There are no specific conditions contained within the HCOC EA relating to the management of GHG emissions.

¹ *Energy (Renewable Transformation and Jobs) Act 2024*

² *Clean Economy Jobs Act 2024*

³ *Energy Roadmap, October 2025*



3.0 HCOC Coal Production and Export Markets

3.1 Annual Extraction and Production Rates

Both coking and bituminous (thermal) coal are produced by HCOC. **Table 1** presents the proposed Run of Mine (ROM) coal extraction rates for the mine plan split between the currently approved and Action mining areas.

The timing of the Project's production quantities and associated GHG emissions is subject to the required approvals being granted. The expected coal product throughputs from the current mine plan, split between the currently approved and Action mining areas, are presented in **Table 2**. As indicated by **Table 2**, the combined coking and thermal coal annual production rates are well within the current EA production limit of 20 Mtpa ROM coal.

Table 1 HCOC ROM Extraction Rates

Year	Estimated ROM Extraction Rate (tonnes/annum)		
	Mine Plan Excluding Action	Action Only	Mine Plan Including Action
2026	9,563,920	457,629	10,021,550
2027	9,056,405	571,668	9,628,074
2028	8,051,756	1,776,499	9,828,255
2029	4,790,676	2,595,376	7,386,053
2030	5,599,540	1,536,809	7,136,349
2031	5,398,946	2,532,846	7,931,792
2032	6,200,122	1,764,636	7,964,759
2033	5,380,130	771,249	6,151,379
2034	3,289,915	2,787,365	6,077,280
2035	362,357	3,500,214	3,862,571
2036	0	4,252,443	4,252,443
2037	0	3,873,888	3,873,888
2038	0	2,497,038	2,497,038
Total	57,693,767	28,917,661	86,611,429



Table 2 HCOC Coal Production Rates

Year	Estimated Coal Production Rate (tonnes/annum)		
	Mine Plan Excluding Action	Action Only	Mine Plan Including Action
Coking Coal			
2026	5,269,592	260,689	5,530,281
2027	5,293,759	293,236	5,586,995
2028	4,664,791	837,636	5,502,427
2029	3,071,726	1,398,743	4,470,470
2030	3,538,838	1,014,392	4,553,230
2031	3,710,154	1,219,555	4,929,709
2032	4,330,218	446,099	4,776,317
2033	3,616,283	483,121	4,099,404
2034	1,969,372	1,791,101	3,760,473
2035	281,731	2,147,392	2,429,123
2036	108,794	2,609,640	2,718,433
2037	100,680	2,430,107	2,530,787
2038	59,156	1,619,482	1,678,638
Total	36,015,093	16,551,193	52,566,286
Thermal Coal			
2026	2,781,165	108,916	2,890,082
2027	2,443,669	162,763	2,606,431
2028	2,254,257	525,698	2,779,955
2029	1,253,062	656,595	1,909,657
2030	1,225,228	308,975	1,534,203
2031	1,152,479	731,851	1,884,331
2032	1,466,852	739,304	2,206,156
2033	1,103,182	196,486	1,299,669
2034	854,342	666,794	1,521,136
2035	141,410	897,221	1,038,632
2036	41,371	1,084,422	1,125,793
2037	36,306	915,406	951,711
2038	1,073,656	501,369	1,575,025
Total	15,826,978	7,495,801	23,322,779



3.2 Export Markets

HCOC's export market countries for the 2022 - 2024 calendar years are listed in **Table 3**. HCOC's primary export market is Asia, with China being the largest export destination over the past three years. It is anticipated that future export destinations for HCOC coal will continue to follow similar patterns. However, as coal sales are market-driven, export destinations may change in the future.

The countries that HCOC coal has been exported to, as identified below, all have NDCs under the Paris Agreement, or have followed international standards recognised by the UNFCCC and published their own NDCs document in support of the Paris Agreement.

Table 3 HCOC Saleable Coal Export Destinations

Export Destination	NDC Status
Brazil Chile China India Indonesia Japan South Africa South Korea Thailand Republic of Türkiye Ukraine Uruguay Vietnam	NDC published
Belgium France Germany Italy Luxembourg Netherlands Poland Spain	EU member; NDC submitted as part of the EU bloc
Hong Kong	Hong Kong is not a separate Party to the Paris Agreement; its climate actions are included under China's NDC.
Taiwan	Taiwan is not recognised as a sovereign state by the United Nations (UN). As a result, they are not a member of the UN and cannot participate in the UNFCCC, which oversees the Paris Agreement. However, Taiwan has followed the international standards recognised by the UNFCCC and published their own NDCs document in support of the Paris Agreement.

Historically, the top five export market countries for HCOC coal are (in order of largest to smallest):

- 1 China
- 2 Japan
- 3 South Korea
- 4 Vietnam
- 5 Republic of Türkiye



4.0 GHG Assessment Methodology

4.1 Overview

The calculation of GHG emissions from the Action has been performed in a five-stage desktop assessment process:

- 1 Definition of the Action boundary (i.e. the Action disturbance footprint);
- 2 Identification of GHG emission sources within the Action during construction and operation;
- 3 Identification of emission calculation methods and emission factors for each source;
- 4 Identification of the activity data for each emission source required for the calculations; and
- 5 Calculation of estimated GHG emissions.

Emissions were predominately calculated based on the NGER Measurement Determination (NGER Measurement Determination 2008) and the Australian National Greenhouse Account Factors (DCCEE 2025).

The GHG emissions estimated for the Action were compared against the most recent publicly available state and national GHG emissions to assess their potential contribution to Australia's emissions inventory and thus their potential impact on Australia's ability to meet GHG reduction targets and policies.

A number of assumptions have been relied upon in compiling the GHG emission inventory for the Action. GHG emissions from the key sources identified for the Action have been estimated based on the current emission factors published for use in reporting GHG emissions under the NGER Scheme, which rely on estimates of the level of intensity of each activity (referred to as activity data). This includes parameters such as projected fuel consumption rates and electricity consumption. The activity data used in the calculations has been compiled based on the current available Action design information and in consultation with HCOC management. The basis of the emission estimates and activity data are detailed in the relevant subsections in **Section 4.4**.

4.2 Boundary Definition

The boundaries adopted for the GHG emission inventory compiled for the Action as part of this GHG assessment are as follows:

- As there is no construction phase associated with the Action other than land clearing, which is part of normal operational activities for the mine, a separate emission inventory for construction has not been compiled;
- GHG emissions will occur during decommissioning and rehabilitation of the mine at the end of its life. Due to the uncertainty regarding the timing and activity data relevant to the mine closure and rehabilitation, and given that the Action would not significantly impact the scale of emissions, GHG emissions associated with the end-of-life phase of the mine and associated infrastructure have not been estimated as part of this study;
- The assessment has considered Scope 1, Scope 2 and Scope 3 emissions associated with the Action; and
- The geographical boundary set for the Scope 1 and Scope 2 emissions considered in the GHG assessment covers the HCOC site. All related activities outside of this



geographical boundary with significant GHG emissions have been addressed under Scope 3.

4.3 Identification of GHG Emission Sources

GHG emission sources were identified through a review of previous GHG emission inventories compiled for the HCOC, and the Action description. The potential emissions associated with the Action that were considered in preparing this GHG assessment are listed below. In relation to Scope 3 emissions, the assessed emission sources are limited to the main sources of GHG emissions associated with the proposed future HCOC operations (Action only, and for the mine plan including the Action).

- Scope 1:
 - Land clearing;
 - Fossil fuel combustion in mobile and fixed plant;
 - Consumption of oils and greases;
 - Fugitive emissions from extraction of coal; and
 - Emissions associated with the leakage of SF₆ from switchgear.
- Scope 2:
 - Electricity consumption.
- Scope 3:
 - Production and supply of fuels consumed;
 - Transmission losses associated with electricity consumption;
 - Emissions associated transfer of product coal via rail to Dalrymple Bay Coal Terminal;
 - Emissions associated with transfer of product coal via ship from Dalrymple Bay Coal Terminal to overseas ports; and
 - Emissions associated with combustion of product coal.

There will also be GHG emissions from HCOC associated with the following activities/sources, however due to the Action having minimal impact compared to current emissions, and thus their expected small contribution to overall emissions (likely <1%), they were deemed to not be material to the assessment and were excluded from the emission inventory:

- Refrigerant leakage from cooling systems; and
- Emissions from the on-site and off-site treatment and disposal of solid and liquid waste.

The emission sources that were included in the emission calculations are summarised in **Table 4**.



Table 4 Action Scope 1, Scope 2 and Scope 3 GHG Emission Sources

Emission Source	Scope 1/ Scope 2 Reportable under NGER	Scope 1	Scope 2	Scope 3
Vegetation clearing	No	✓	x	x
Fugitive emissions from extraction of coal	Yes	✓	x	x
Use of diesel fuel	Yes	✓	x	✓
Use of unleaded petrol	Yes	✓	x	✓
Consumption of electricity	Yes	x	✓	x
Transmissions losses from purchased electricity	No	x	x	✓
Storage of sulphur hexafluoride gases	Yes	✓	x	x
Use of oils and greases	Yes	✓	x	✓
Transport of product by rail and ship	No	x	x	✓
Usage of product coal by end user	No	x	x	✓

4.4 Calculation Methods and Emission Factors Used

A summary of the emission estimation methods and sources of emission factors used is provided in **Table 5**. Further information is provided below.

4.4.1 Vegetation Clearing

Clearing of vegetation results in GHG emissions as it eliminates carbon sinks - plants and soil that naturally absorb and store carbon dioxide - and releases the stored carbon into the atmosphere when that biomass is removed or decomposes. Vegetation clearing emissions are not reportable under the NGER Scheme and no emission calculation methodologies or emission factors are given for GHG emission estimation for land clearing in the *Measurement Determination 2008* or the National Greenhouse Accounts (NGA) Factors Workbook published each year.

GHG emissions from vegetation clearing associated with the Action have been calculated using the Department of Industry, Science Environment and Resources (DISER) FullCAM model to derive an emission factor in t CO₂-e per hectare cleared. FullCAM was developed under the National Carbon Accounting System (NCAS) at the then Australian Greenhouse Office to provide a dynamic account of the changing stocks of carbon in Australia's land systems since 1970 by integrating data on land cover change, land use and management, climate, plant productivity, and soil carbon over time. FullCAM estimates carbon stock change and GHG emissions at fine spatial and temporal scales, and uses a wide range of spatially referenced data.

The FullCAM model was run with reference to the *Requirements for use of the Full Carbon Accounting Model (FullCAM) with the Emissions Reduction Fund (ERF) methodology determination: Carbon Credits (Carbon Farming Initiative—Avoided Clearing of Native Regrowth) Methodology Determination 2015* (DISER 2020).



4.4.2 Fugitive Emissions from Coal Mining

Historically, fugitive emissions from the extraction of coal at HCOC have been estimated using the default Method 1 emission factor from the NGER Measurement Determination.

Since 2022, HCOC has conducted drilling programs and technical studies to develop a gas assignment model for the in-situ methane (CH₄) and CO₂ in place at HCOC, prior to extraction of coal, which has allowed HCOC to first commence reporting under Method 2 for the FY23/24 period. This gas assignment model has also been used to estimate the site-specific fugitive emissions each year of the proposed Action when extracting coal. The resulting annual CH₄ and CO₂ emission estimates were provided to SLR for use in compiling the Scope 1 emissions inventory.

Table 5 GHG Emission Calculation Methodologies

Emission Source	Details	Emission Factors
Vegetation clearance	Loss of carbon sink	FullCAM (DISER 2020)
Diesel Use - stationary	Power generation and off-road equipment	Schedule 1, Part 3, NGER Measurement Determination 2008 (Compilation No. 19)
LPG Use - Stationary		
Diesel Use - transport	Road registered vehicles	Schedule 1, Part 4, Division 4.3, NGER Measurement Determination 2008 (Compilation No. 19), Heavy duty (Euro I)
Gasoline Use - transport		Schedule 1, Part 4, Division 4.2, NGER Measurement Determination 2008 (Compilation No. 19), post-2004 vehicles
Consumption of petroleum-based oils and greases	-	Schedule 1, Part 3, NGER Measurement Determination 2008 (Compilation No. 19)
SF ₆ leakage	Gas-insulated switchgear and circuit breaker applications	Part 4.5, Chapter 4, NGER Measurement Determination 2008 (Compilation No. 19)
Fugitive emissions	Fugitive CH ₄ and CO ₂ associated with extracted ROM coal	Method 2 HCOC gas assignment model for the in-situ CH ₄ and CO ₂
Electricity consumption	Power generation (Scope 2) and transmission losses (Scope 3)	Location-based approach, using forecasted emission factors from <i>Australia's Emissions Projections 2023</i> (DCCEEW 2024) out to 2040. For 2040 to 2050, it was assumed that the emission factors will continue to decline linearly to zero by 2050, in line with Australia's commitment to net zero emissions by 2050
Product coal transport	Rail	Aurizon Emissions Calculator (https://www.aurizon.com.au/sustainability/environment/emissions-calculator)
	Ship	Mobile Combustion Greenhouse Gas Protocol Transport Calculation Tool, version 2.7
Combustion of product coal by end user	Bituminous coal Coking coal	National Greenhouse Accounts Factors (DCCEEW 2025)



5.0 Estimated GHG Emissions for the Proposed Action

5.1 Scope 1 and Scope 2 Emissions

The annual estimated Scope 1 and Scope 2 GHG emissions for the Action (i.e. emissions associated with the mining of coal within the proposed extension areas only) are presented in **Figure 2** and **Table 6**.

Figure 2 shows that the main sources of Scope 1 emissions over the life of the Action would be associated with fugitive emissions from coal extraction (63%), and the consumption of diesel in non-road registered vehicles (35%). Scope 2 emissions from the generation of electricity consumed as a result of the Action are estimated to be just over 1% of the total Scope 1 and Scope 2 emissions.

Based on the threshold for medium to high Scope 1 and Scope 2 GHG emission category emitting applications set out in the Guideline of 25,000 tonnes CO₂-e or more per year (DETSI 2025), the Action is classified as a **medium to high emitter**.

The total Scope 1 emissions estimated from the Action correlates to an approximate average emissions intensity value of 0.1095 t CO₂-e per t ROM coal.

The Action's net Scope 1 emission intensity will be subject to HCOC's requirements under the Safeguard Mechanism, and it is expected that the Action's net Scope 1 emissions (and intensity) will be materially lower than the gross emissions (and intensity) estimates presented herein. The Project's net Scope 1 emission intensity under the Safeguard Mechanism is estimated to be 0.0526 t CO₂-e per t ROM coal which is approximately 48% of the gross emissions intensity estimates presented above.

In addition, as noted in **Section 3.0** the combined coking and thermal coal annual production rate projections for the mine plan including the Action are well below the current EA limit of 20 Mtpa ROM coal (see **Table 2**). The GHG emission projections for the ongoing operations at HCOC are therefore also well below the levels that would occur if mining was to occur at the approved production rate.

Figure 2 Estimated Annual Scope 1 and 2 GHG Emissions – Action Only

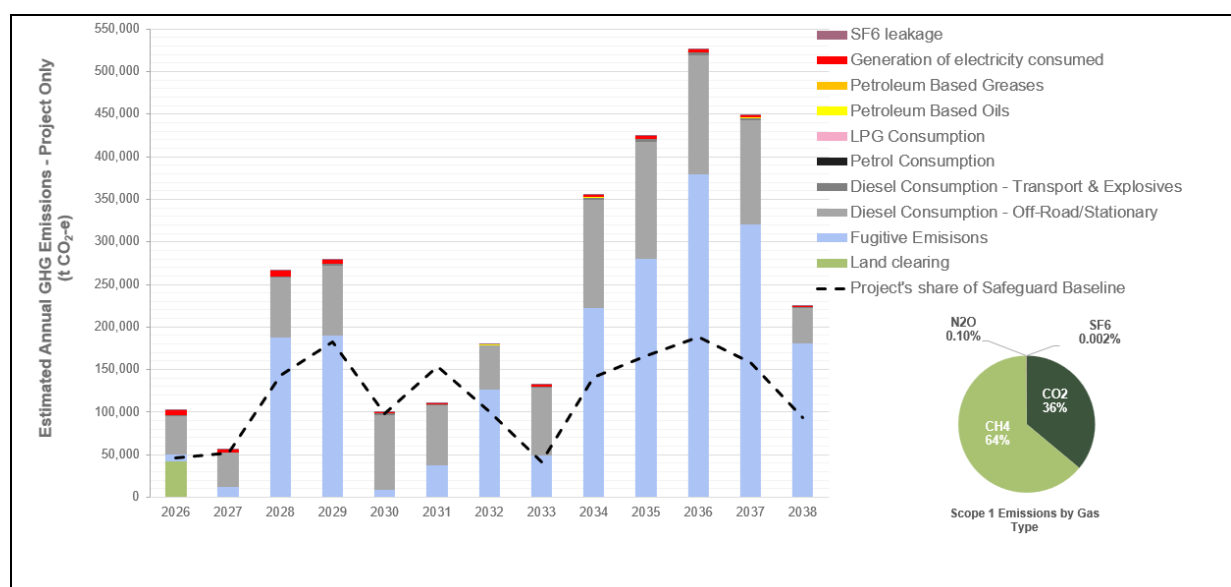


Table 6 Estimated Annual Scope 1 and 2 GHG Emissions (Action Only)

Mine Plan Schedule	Estimated Scope 1 Emissions (t CO ₂ -e) for the Action											Estimated Scope 2 Emissions for the Action (t CO ₂ -e)	Total Estimated Scope 1 + 2 Emissions for the Action (t CO ₂ -e)
	Vegetation Clearing	Fuel Combustion				Fugitive Emissions			Oils and Greases	SF ₆ Leakage	Total Scope 1 Emissions		
		CO ₂	CH ₄	N ₂ O	Total	CO ₂	CH ₄	Total					
2026	42,335	45,706	67	134	45,907	405	7,742	8,147	116	-	96,505	5,731	102,236
2027	-	40,689	59	118	40,866	464	11,668	12,132	97		53,094	2,631	55,725
2028	-	71,863	105	210	72,179	629	186,721	187,350	178		259,706	5,946	265,652
2029	-	83,431	123	245	83,799	953	189,284	190,237	208		274,244	5,164	279,408
2030	-	89,116	130	259	89,505	702	8,174	8,876	226		98,606	1,877	100,483
2031	-	71,152	103	206	71,461	1,960	35,959	37,919	210		109,590	1,099	110,689
2032	-	52,174	76	151	52,401	1,019	125,441	126,460	162		179,024	638	179,662
2033	-	80,202	117	234	80,553	396	48,879	49,275	298		130,127	1,551	131,678
2034	-	128,589	188	375	129,152	1,003	221,580	222,583	579		352,315	3,179	355,494
2035	-	139,870	205	409	140,483	1,173	279,139	280,312	592		421,387	3,068	424,455
2036	-	142,070	208	415	142,693	1,413	377,896	379,309	621	17	522,640	3,310	525,950
2037	-	124,248	182	363	124,793	759	319,973	320,732	608	17	446,149	2,470	448,620
2038	-	41,770	61	122	41,953	232	180,904	181,135	461	17	223,566	1,428	224,994
Annual Average	3,257	85,452	125	249	85,827	854	153,335	154,190	335	4	243,612	2,930	246,542
Total Life of Action	42,335	1,110,879	1,622	3,243	1,115,744	11,106	1,993,362	2,004,468	4,357	50	3,166,954	38,093	3,205,047



5.2 Scope 3 Emissions

The annual estimated Scope 3 GHG emissions are presented for the life of the Action in **Table 7** and **Figure 3**, which show that the main source of Scope 3 emissions from the Action are estimated to be associated with the combustion of the product coal, comprising approximately 93% of the total estimated Scope 3 emissions.

Figure 3 Estimated Annual Scope 3 GHG Emissions – Action Only

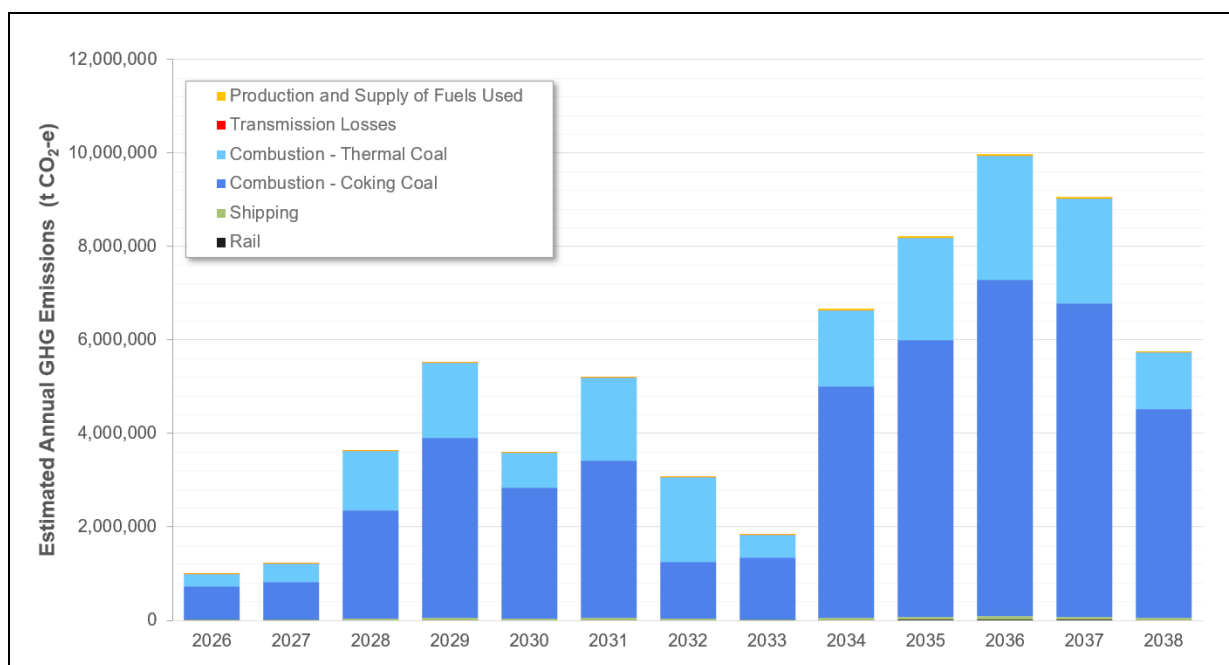


Table 7 Annual Estimated Scope 3 Emissions (Action only)

Mine Plan Schedule	Estimated Scope 3 Emissions (t CO ₂ -e) for the Action						
	Production and Supply of Fuels*	Product Transport by Rail	Product Transport by Ship	Combustion - Coking Coal	Combustion - Thermal Coal	Transmission Losses	Total Scope 3
2026	11,475	1,054	7,967	719,737	265,373	777	1,006,384
2027	10,206	1,301	9,830	809,596	396,568	335	1,227,834
2028	18,036	3,889	29,388	2,312,630	1,280,854	728	3,645,525
2029	20,942	5,863	44,305	3,861,791	1,599,781	626	5,533,307
2030	22,374	3,775	28,527	2,800,635	752,812	221	3,608,342
2031	17,905	5,566	42,065	3,367,070	1,783,141	194	5,215,940
2032	13,141	3,381	25,553	1,231,636	1,801,299	98	3,075,108
2033	20,269	1,939	14,650	1,333,848	478,735	222	1,849,663
2034	32,640	7,011	52,983	4,945,050	1,624,629	424	6,662,737
2035	35,449	8,685	65,630	5,928,735	2,186,062	236	8,224,796
2036	36,035	10,537	79,630	7,204,955	2,642,172	276	9,973,605
2037	31,606	9,543	72,116	6,709,282	2,230,368	494	9,053,408
2038	10,985	6,050	45,717	4,471,227	1,221,576	143	5,755,698
Global Emissions							
Annual Average	21,620	5,276	39,874	3,515,091	1,404,875	367	4,987,104
Total	281,062	68,594	518,359	45,696,189	18,263,369	4,773	64,832,347
Inside Australia							
Annual Average	4,324	5,276	-	-	-	367	9,968
Total	56,212	68,594	-	-	-	4,773	129,580
Outside Australia							
Annual Average	17,296	-	39,874	3,515,091	1,404,875	-	4,977,136
Total	224,850	-	518,359	45,696,189	18,263,369	-	64,702,767

* For the purposes of categorising emissions as inside/outside of Australia, a 20/80 split was assumed based on the Australian refinery share of petroleum product sales in the 2024-25 financial year being reported as 23%, with the remainder imported (from: <https://www.energy.gov.au/energy-data/australian-petroleum-statistics>).



5.3 Summary

A summary of the estimated emissions is provided in **Table 8**, including estimates of:

- The total average annual scope 1, 2 and 3 (within Australia only) emissions as a percentage of Australia's annual national emissions for the latest reported year; and
- The total average annual scope 1,2 and 3 (within and outside Australia) emissions as a percentage of annual global emissions.

The estimated annual average Scope 1, 2 and 3 emissions within Australia from the Action (256,510 t CO₂-e) represent approximately 0.057% of Australia's 2022 emissions. The estimated annual average Scope 1, 2 and 3 emissions within and outside Australia from the Action (5,233,646 t CO₂-e) represent approximately 0.011% of the estimated global 2021 emissions.

Table 8 Summary of Estimated GHG Emissions for the Action

Parameter		Value
Average annual scope 1 GHG emissions (tonnes CO ₂ -e)	(a)	243,612
Total scope 1 GHG emissions (tonnes CO ₂ -e)	(b)	3,166,489
Average annual scope 2 GHG emissions (tonnes CO ₂ -e)	(c)	2,930
Total scope 2 GHG emissions (tonnes CO ₂ -e)	(d)	38,093
Average annual scope 3 GHG emissions, reporting emissions within Australia and outside Australia separately (tonnes CO ₂ -e)	(e)	(within Australia) 9,968
		(outside Australia) 4,977,136
Total scope 3 GHG emissions, reporting emissions within Australia and outside Australia separately (tonnes CO ₂ -e)	(f)	(within Australia) 129,580
		(outside Australia) 64,702,767
Total GHG emissions (tonnes CO ₂ -e)	sum of (b), (d) and (f)	68,036,929
Total average annual scope 1, 2 and 3 (within Australia only) emissions as a percentage of Australia's annual national emissions for the latest reported year, using the Department's published estimates for the Paris Agreement inventory ^a	-	0.057%
Total average annual scope 1,2 and 3 (within and outside Australia only) emissions as a percentage of annual global emissions, using global emissions data for the latest year reported available from the Climate Watch's Historical GHG emissions site ^b	-	0.011%
a. ageis.climatechange.gov.au/ (446.4 Mt CO₂-e reported for year ending 2024, as per https://www.dcceew.gov.au/sites/default/files/documents/nggi-quarterly-update-december-2024.pdf.) b. www.climatewatchdata.org/ghg-emissions?end_year=2024&start_year=1990 (49.51 Gt CO₂-e reported for 2022)		



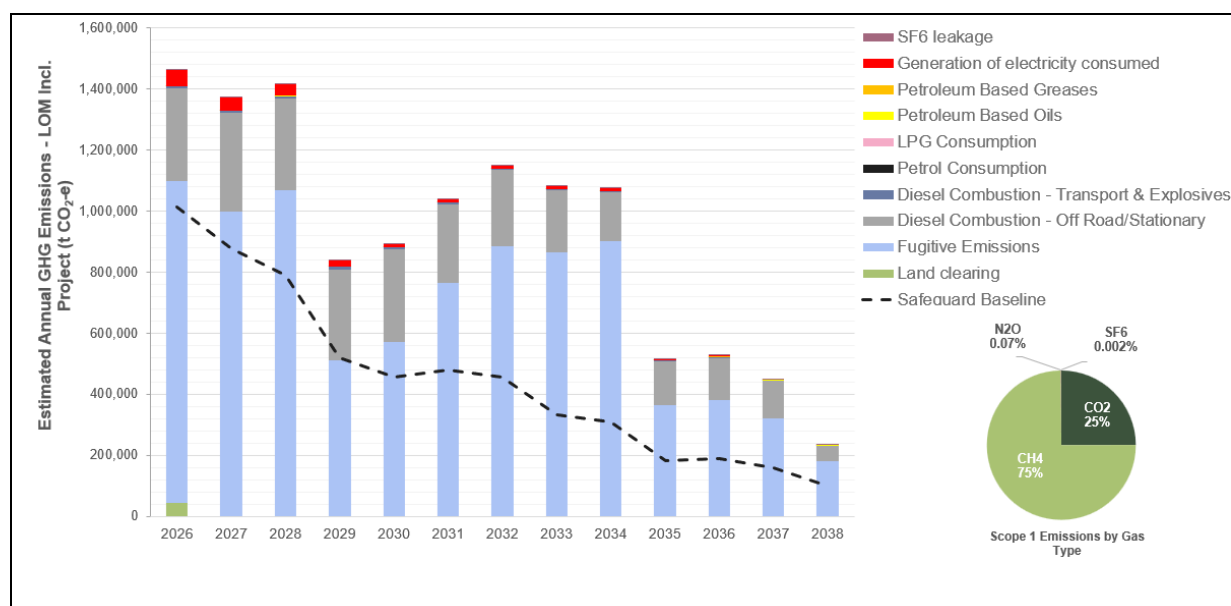
6.0 Management Measures

6.1 Safeguard Mechanism

As described in **Section 2.1**, HCOC is subject to the requirements of the Safeguard Mechanism, which has recently undergone significant reform. The Safeguard Mechanism reform is part of the Commonwealth Government's measures to achieve the national emission reduction target of 43% by 2030. Scope 1 GHG emissions associated with the Action will be included in the site's Safeguard Baseline assessments and reporting requirements as part of the overall HCOC operations.

Error! Reference source not found. presents the anticipated HCOC Safeguard Mechanism baseline, based on the site's approved site-specific emissions intensity determination, which represents the net annual Scope 1 emissions. This figure presents the estimated Scope 1 emissions from the HCOC operations (inclusive of the Action). Scope 1 emissions (excluding land clearing emissions) above this baseline will need to be mitigated or offset under the Safeguard Mechanism.

Figure 4 Estimated Annual Scope 1 and 2 Emissions – Mine Plan Including the Action



It is expected that the Action's net Scope 1 emissions (and intensity) will therefore be materially lower than its gross emissions (and intensity). As a covered facility, the Action will contribute proportionately to Australia's emissions reduction obligations through the Safeguard Mechanism, with declining baselines ensuring commensurate reductions in line with national targets and Australia's NDC commitments under the Paris Agreement.

6.2 Glencore's Climate Change Strategy

Glencore's Climate Change Strategy is to responsibly manage the decline of its global thermal coal portfolio. As the world moves towards a low-carbon economy, Glencore is focused on supporting the energy needs of today whilst investing in its transition metals portfolio. The metals Glencore produces, sources and markets will support the global ambition to decarbonise.



Consistent with the commitment to responsibly manage the decline of its thermal coal portfolio, Glencore has established total Scope 1, 2 and 3 emissions reduction targets, with a 15% reduction by the end of 2026, a 25% reduction by 2030, and a 50% reduction by the end of 2035, against a 2019 baseline, with a longer-term ambition of achieving net zero emissions by the end of 2050. These targets are comparable to the emission reduction objectives outlined in the QLD Climate Action Plan of:

- 30% emission reduction below 2005 levels by 2030;
- 75% emissions reduction below 2005 levels by 2035; and
- Zero net emissions by 2050.

Glencore's 2024-2026 Climate Action Transition Plan (Glencore 2024) outlines its position on climate and energy transition and the strategies it currently proposes to use to manage its transition, including:

- Recognising that thermal coal for electricity generation remains a necessary source of energy in many countries – providing grid stability, supporting energy access and security, and contributing to socioeconomic development in many markets. Glencore supports regulatory efforts to transition towards cleaner power generation and to reduce underlying demand for fossil fuels.
- To support anticipated global energy needs, Glencore plans to continue to progress select brownfield coal investments at existing mines but will continue to align with the Group emissions reduction targets and commitment to a managed decline of the coal portfolio overall.
- To continue driving improved operational performance in its industrial activities through a strong focus on identifying and delivering cost-effective emissions reduction opportunities.
- To continue to evolve technical and economic assessments to identify emissions reduction opportunities across the portfolio. This enables Glencore to identify and implement investments in abatement opportunities that are practically and commercially viable. Where opportunities are deemed not sufficiently ready, Glencore will continue to collaborate with industry and OEM partners to study and invest in research and development to drive technology maturation and scale requirements to improve commerciality.
- To identify and invest in value-enhancing growth opportunities in Glencore's metals portfolio that meet market requirements, including a focus on commodities fundamental for the transition to a low-carbon economy, such as copper, nickel, zinc, aluminium and cobalt.

6.3 Abatement Plan

Under the Guideline (DETSI 2025), EA applications for operations that exceed the threshold for medium to high emitters must also contain a GHG Abatement Plan. Where the amendment is for an EA that already has a GHG abatement plan in place, the application may include an amended GHG abatement plan.

HCC's plan to continue mining incorporates measures to maximise energy efficiency and minimise GHG emissions. HCC has also prepared a draft GHG Abatement Plan for the Action, which sets out the emissions management and reduction measures to be implemented for the Action.



HCC will continue to investigate means of reducing the emission intensity of its operations (including the Project) by maintaining current practices for fossil fuel minimisation, and investigating emerging technologies and further efficiencies for fossil fuel and open cut fugitive emissions reduction, such as:

- Continue to implement operational control efficiencies such as minimising haul distances, and optimising ramp gradients, payload management and scheduling activities to optimise equipment use.
- Continue to assess technologies to improve efficiencies and reduce emissions including through equipment purchase strategies, fuel switching, fleet electrification, open-cut pre-drainage, and use of electricity from renewable sources and consider implementation where reasonable and feasible.



7.0 Conclusions

The Action will generate an estimated 3.20 Mt CO₂-e of Scope 1 and 2 emissions related to the extraction and processing of ROM coal over the life of the Action.

Fugitive emissions are estimated to contribute 63% of the Action Scope 1 and 2 emissions, while diesel emissions from non-road registered vehicles are estimated to contribute 34%.

HCOC is subject to the requirements of the Safeguard Mechanism, which has recently undergone significant reform. The Safeguard Mechanism reform is part of the Commonwealth Government's measures to achieve the national emission reduction target of 43% by 2030. Scope 1 GHG emissions associated with the Action will be included in the site's Safeguard baseline assessments and reporting requirements as part of the overall HCOC operations. It is therefore expected that the Action's net Scope 1 emissions (and intensity) will be materially lower than the gross emissions (and intensity) estimates presented in this report.

Queensland's renewable energy targets are not considered to be substantially impacted by the Action as all product coal from the Action is proposed to be exported to offshore end users.

The Action is also estimated to generate a total of 64.83 Mt CO₂-e of Scope 3 emissions. The majority of these emissions will be generated by offshore customers when the product coal is combusted for electricity generation/steelmaking. Emission reduction strategies regarding Scope 3 emissions are the consideration of the respective countries that demand thermal and coking coal.

HCOC will continue to operate as a Safeguard facility. A draft GHG abatement plan has been developed for the Action in accordance with the Guideline (DETSI 2025) that sets out GHG emissions management and reduction measures for the Action.



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HAIL CREEK OPEN CUT

GLENCORE



DRAFT GHG Abatement Plan – Hail Creek Eastern Margin Extension Project

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1. Purpose

This Draft Greenhouse Gas (GHG) Abatement Plan (plan) for the Hail Creek Eastern Margin Extension Project (HCEP) has been prepared to support the assessment of Hail Creek Coal Holdings Pty Limited's (HCCH) application to amend its environmental authority (EA) EPML00661913.

This plan has been prepared to meet the requirements of the DETSI Greenhouse Gas Emissions Guideline (DETSI, 2024) (the Guideline). It summarises the projected GHG emissions to be generated by the HCEP and describes ongoing emission mitigation and management measures proposed to be considered (and if practicable and feasible, implemented) throughout the life of the project, to reduce Scope 1 and Scope 2 GHG emissions. It also includes a detailed description of the methodology and input data used to estimate the Scope 1 emission reduction targets in accordance with the Commonwealth Safeguard Mechanism, and details of the proposed feasibility study of pre-drainage as part of potential abatement measures to reduce methane emissions.

Production from the HCEP would be integrated into the Hail Creek Open Cut (HCOC) operation. HCOC is a facility under the Commonwealth Safeguard Mechanism. An objective of this plan is to describe how emissions from the HCEP will be measured and managed to ensure consistency with the reporting framework of the National Greenhouse and Energy Reporting (NGER) Scheme, and the performance expectations of the Commonwealth Safeguard Mechanism.

Emissions from HCOC are considered in Glencore's current decarbonisation targets for its global industrial portfolio. Glencore has committed to responsibly manage the decline of its thermal coal portfolio, and has established total Scope 1, 2 and 3 industrial carbon dioxide equivalent (CO₂-e) emissions reduction targets (against a 2019 baseline) of: 15% reduction by the end of 2026; 25% reduction by the end of 2030; and 50% reduction by the end of 2035, all of which are leading towards Glencore's 2050 net zero emissions ambition, subject to a supportive policy environment.

2. Scope

This plan applies specifically to the HCEP. The HCEP comprises the activities to be authorised by EA amendment application A-EA-AMD-100576264 (if approved). While it is acknowledged that the activities and processes described within this plan are typically undertaken as part of broader operational practices at HCOC, the scope of commitments outlined in this document is strictly limited to the HCEP.

References to HCOC throughout this document are provided for contextual and operational alignment purposes only and do not imply an extension of the commitments beyond the HCEP. In meeting the commitments specific to the HCEP, HCCH may rely upon, and reference assessments, data, and operational procedures developed for the broader mining complex, provided they are applicable to the HCEP.

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3. Emissions Projections and Commencing Abatement Measures

3.1 Emission Inventory and Estimates

HCOC is a moderate emission intensity operation in comparison to other coal mining operations. Variability in emission intensity is observed across the HCOC deposit, driven by changes in mining depth and the coal seams being extracted:

- Fugitive emissions are dependent on gas content, and this is variable dependent on the depth of coal seams being targeted in specific mining areas. The gas composition is methane-dominant.
- Fossil fuel emissions are driven by mine plan requirements, and typically increase with increasing strip ratio i.e. typically, as mine gets deeper, a higher proportion of rock material needs to be extracted relative to coal.

The emissions inventory for the HCEP is as per the Hail Creek Open Cut Eastern Margin Extension Project – Information Request Response (Appendix I: Greenhouse Gas Assessment (HCOC, 2025), and is summarised in the table below.

3.2 GHG Emissions Reference Point

The emissions inventory for the HCEP and the net Scope 1 emissions under the Safeguard Mechanism form the reference points for potential future (additional) emissions reductions for the HCEP to be assessed against.

Table 1 Emissions Inventory for HCEP (Mt CO₂e) (Reference point)

	Scope 1	Scope 2	Total (Scope 1 + 2)	Net Scope 1	Total (Net Scope 1 + 2)
Total emissions over life of HCEP (2026 to 2038)	3.167 ¹	0.038	3.205	1.521 ²	1.559 ³

¹ Includes vegetation clearing emissions of 0.067 Mt CO₂e

² Reflects HCEP's pro-rata share of the HCOC Complex Safeguard Baseline, based on HCEP's ROM coal production. Net Scope 1 is defined as the lower value of either the Safeguard Mechanism baseline or the gross Scope 1 emission each year e.g. if HCEP is in a pro-rate crediting position (Safeguard Mechanism Credit) in a year, its gross Scope 1 emission is what contributes to the Net Scope 1 calculation. Hence net scope 1 reflects emissions after compliance with the Safeguard Mechanism is achieved.

³ Ibid

3.3 Management Practices Proposed to be Implemented at Commencement to Reduce GHG Emissions

HCCH considers the GHG abatement hierarchy in its evaluation of options for emissions reduction, as depicted in Figure 1.

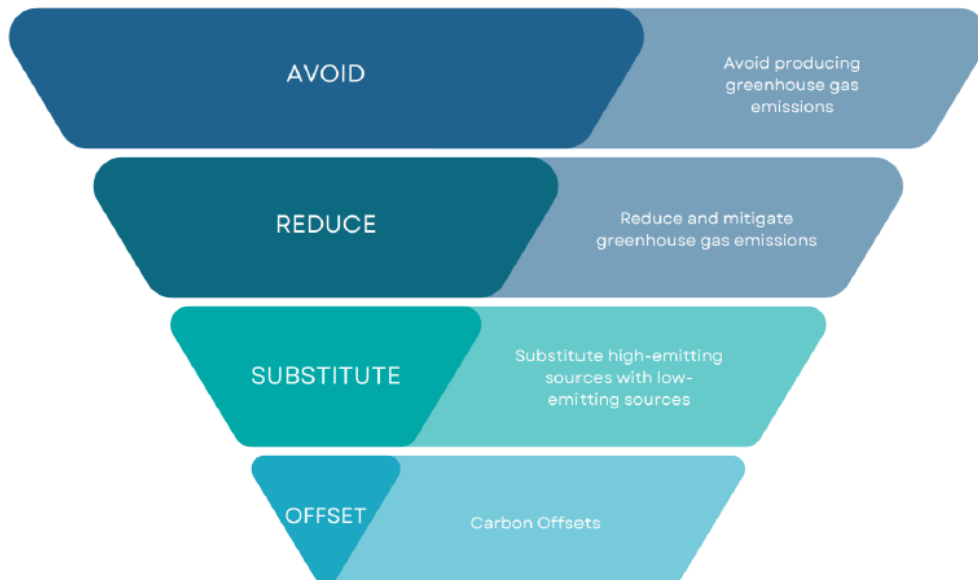


Figure 1 GHG Abatement Hierarchy (excerpt from DETSI Greenhouse gas emissions Guideline (DETSI, 2024))

The HCEP's emissions estimates reflect current operational practices at HCOC to maximise energy efficiency and minimise diesel consumption. HCCH will continue to investigate means of reducing the emissions from its operations by assessing existing and emerging technologies for emissions reduction, as described below.

3.3.1 Management of Fossil Fuel Emissions

Fossil fuel emissions constitute a considerable portion of HCOC's Scope 1 emissions, and fossil fuel is also a significant cost driver. To address this, HCCH implements a series of embedded operational practices aimed at reducing fossil fuel consumption and minimising associated emissions. These practices align with the mitigation hierarchy - avoiding, reducing, and substituting emissions.

1. Procurement Practices

HCCH's procurement practices typically include the consideration of fuel efficiency as a criterion in equipment selection, thereby reducing fuel consumption and emissions.

Procurement practices also consider the availability and suitability of cabled electric machines, which would provide a means of reducing Scope 1 emissions (whilst increasing Scope 2 emissions, subject to the expected greening of the grid). HCOC has historically used electric draglines and shovels and continues to utilise electric shovels for a significant proportion of waste excavation. The nature of the cabled connection renders such equipment useful for specific, usually high volume, tasks. As equipment is replaced, forecasts of their respective uses will be assessed including whether cabled electric supply might be appropriate.

2. Mine Design, Planning, and Equipment Selection

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HCCH's business planning processes incorporate the following practices to minimise fossil fuel consumption:

- **Optimised Mine Layout:** Designing the mine layout to enhance operational efficiency and selecting appropriate equipment for mining and haulage activities.
- **Early Rehabilitation Scheduling:** Planning for rehabilitation activities early in the mining process to minimise the need for future rehandle and/or hauling material over long distances and elevations beyond the pit workings.
- **Haulage Destination Planning:** Planning the delivery of hauled material to minimise material handling, haul distance and elevation changes, thereby decreasing fuel consumption.
- **Haul Route Optimisation:** Iteratively optimising haul routes to reduce equipment operating hours and, consequently, fuel consumption.
- **Loading Efficiency:** Operational monitoring through fleet dispatch systems, progressively examining and matching the interaction between loading units and trucks to minimise wastage, improve haul cycle times, and optimise the amount of material moved per equipment operating hour.
- **Payload Optimisation:** Planning and monitoring haulage performance to ensure that loading equipment capacity aligns with the haulage capacity of the fleet, maximising efficiency and reducing fuel usage.

3. Equipment Maintenance

- The mobile equipment fleet and fixed plant are maintained in accordance with supplier specifications. Ad-hoc maintenance is conducted when equipment monitoring systems identify anomalies, ensuring optimal performance and fuel efficiency.
- Equipment operation is carried out by competent personnel trained in the use of relevant equipment, including adherence to standard operating procedures. Training emphasises practices that maximise productivity and fuel efficiency.

4. Haul Road Maintenance

- Haul roads are designed to optimise energy efficiency, considering factors such as gradient and surface material.
- Regular maintenance is performed to ensure that haul road gradients and rolling resistance are minimised. Remedial actions are undertaken based on operational monitoring to maintain optimal conditions.

5. Performance Monitoring and Feedback

- HCCH conducts regular reporting of historical and actual performance as part of operational processes. This includes evaluations at intervals ranging from on a shift basis, weekly, and monthly to annual and multi-year assessments.
- HCOC's performance is benchmarked against other Glencore operating sites to assess equipment performance and identify opportunities for improvement.

3.3.2 Management of Fugitive Emissions

Fugitive emissions represent a significant portion of HCOC's Scope 1 emissions. HCOC has an extensive exploration database and significant knowledge of the sub-surface gas content, which has been

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utilised to inform the gas assignment model for the HCOC. This comprehensive database demonstrates that the gas content of the coal seams increases with depth and has a methane dominant composition. Hence the potential viability of pre-drainage is anticipated to be variable across the HCOC, depending on the depth of the coal seams being targeted and other factors described below.

The pre-drainage of open cut methane emissions is an emerging application and currently classified as research and development (R&D) by the Australian Government's Climate Change Authority (CCA, 2024). The CCA observes that whilst pre-drainage is a well-established practice for safety management in underground coal mines, the context of application at open cut coal mines is different and has a range of complexities which need to be considered.

HCCH has conducted initial studies to assess the viability of conducting open-cut pre-drainage and has determined that further studies are necessary to progress to the next stage.

HCCH will investigate the feasibility and effectiveness of gas pre-drainage in the HCEP area within 2 years of approval of HCEP (if approval is granted). Upon completion, the feasibility study will be provided to DETSI.

This investigation will consider the following variables.

1. Gas-in-place Characterisation

The gas content at HCOC varies based on the depth of the targeted coal seams, with an overall trend indicating that gas content increases with depth. The gas composition at HCOC is predominantly methane. Currently, approved operations are mining deeper areas of the mine that generally have higher gas content, while future mining areas proposed within the HCEP area are projected to be shallower, resulting in relatively lower gas content.

2. Gas Reservoir Properties

Gas saturation and coal seam permeability are key drivers of pre-drainage effectiveness:

- Permeability determines the ability for gas to flow within and out of the coal seams. Areas of low permeability may require some form of gas well stimulation to achieve adequate flow rates.
- Gas saturation influences the available gas volume for recovery. Low gas saturation may necessitate the production and disposal of water to facilitate the movement and extraction of gas.

Subject to the outcomes of study scoping, HCCH may seek to carry out further data collection to address the listed variables.

3. Pre-drainage Methods for Methane at Open Cut Mines as an Emerging Application

Pre-drainage is a well-established practice for safety management in underground coal mines. It typically targets the coal seam to be mined (and sometimes surrounding seams that could contribute methane to the ventilation air), which are generally thicker with minimal partings and higher gas content. In underground mines, pre-drainage typically employs a combination of short-holes and long-holes, which can be drilled vertically or horizontally, and either across or within the coal seams and through which the gas is extracted.

In contrast, open-cut coal mines often extract seams of varying thickness (as thin as 0.3m) and seam dip, and gas content can fluctuate with mining depth. This variability poses complexities for pre-drainage feasibility. Therefore, drainage in open-cut mines is considered an emerging

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application (CCA, 2024) that requires evaluation for its appropriateness in variable and dynamic open-cut operational environments.

When assessing the suitability of pre-drainage methods in open-cut mines, several factors must be considered such as seam thickness, gas content, seam dip, interaction with the mine plan, available pre-drainage timeframe, and drilling concentration/pattern. Both existing and emerging methods for pre-drainage will be considered in this assessment.

4. Methane Combustion and/or Utilisation

The concentration and volume of extracted gas will need to be evaluated for abatement and utilisation purposes. Pre-drainage feasibility can be enhanced by factors such as cost-effective drainage methods, directing gas to flares for combustion, or utilising it based on feasible volumes:

- Various utilisation cases across the industry have been identified, and Glencore has previously used methane drained from its underground operations for both onsite and offsite power generation.
- Utilisation cases that involve significant capital investment, such as onsite power stations, would require substantial methane volumes over extended periods of mine life to be economically viable.

5. Regulatory Aspects

An evaluation of the potential environmental impacts associated with any pre-drainage activity, as well as any necessary regulatory approvals, must be conducted. Additionally, an assessment of carbon accounting methods within the NGER Scheme to attribute the reduction of gas-in-place will also need to be performed.

3.3.3 Evaluation of Existing Emissions Reduction Technologies

As part of broader Glencore business planning processes, existing (“off-the-shelf”) emissions reduction technologies are evaluated for potential future implementation at HCOC, such as alternative fuels, and renewable energy. An example of Glencore’s evaluation of existing emissions reduction technologies for potential future implementation at HCOC is described in Appendix A.

3.3.4 Monitoring of Emerging Emissions Reduction Technologies

As part of broader Glencore business planning processes, emerging/developing emissions reduction technologies are evaluated for potential future implementation at HCOC such as alternative drive trains. An example of Glencore’s evaluation of emerging emissions reduction technologies for potential use at HCOC is described in Appendix B.

4. GHG Emission Reduction Targets

HCOC is subject to GHG emissions reduction targets as part of both regulatory and corporate (voluntary) frameworks, as described below. The Commonwealth Safeguard Mechanism provides the regulated quantitative performance standard that HCOC (inclusive of HCEP) needs to comply with.

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4.1 Commonwealth Safeguard Mechanism Emissions Reduction Targets

HCOC is a Safeguard facility under the Commonwealth Safeguard Mechanism. The Safeguard Mechanism commenced on 1st July 2016 and applies to facilities that emit more than 100,000 tonnes of carbon dioxide equivalent (t CO₂-e) gas per financial year. This extends to businesses across a broad range of industry sectors, including mining. The Safeguard Mechanism is administered by the Australian Government's Department of Climate Change, Energy, the Environment and Water (DCCEEW).

Together with the reporting obligations under the National Greenhouse and Energy Reporting Act 2007 (NGER Act), the Safeguard Mechanism provides a framework for Australia's largest emitters to measure, report, and manage their emissions. The Safeguard Mechanism sets legislated limits, known as baselines, on the GHG emissions from qualifying facilities. The Safeguard Mechanism was reformed in 2023 with the aim of ensuring applicable facilities such as HCOC contribute a proportionate share to Australia meeting its GHG emission reduction commitments. Australia's current legislated emissions reduction commitment is to reduce GHG emissions to 43% below 2005 levels by 2030, and net zero by 2050. Australia has also recently established a 2035 target to reduce emissions by 62% to 70%.

4.1.1 Emissions Baseline

Under the Safeguard Mechanism, facilities such as HCOC are given a baseline against which their Scope 1 emissions levels will be assessed. A Safeguard facility must keep its net emissions levels at or below its baseline or face civil penalties. HCOC's estimated Safeguard baseline (with HCEP) is provided in Appendix C, whilst HCEP's share of HCOC's estimated Safeguard baseline is provided in Appendix D.

4.1.2 Emissions Reduction & Baseline Decline Rate

Under the Safeguard reforms, there is a requirement for net emissions across the Safeguard Mechanism to reduce by 4.9% annually from financial year (FY) 24 to FY30, then by approximately 3.3% from FY31 to reach net zero by 2050. These rates have been calculated to ensure that Australia remains on track with its legislated GHG emission reduction targets. The Commonwealth Government has also scheduled a review during FY27 to evaluate performance against the reformed Safeguard Mechanism and to determine if baseline decline rates need to be revised.

Additionally, total absolute emissions from Safeguard facilities are also required to decrease over time, measured over a 5- year rolling average. From 1st July 2025, the rolling average of Safeguard covered emissions over the previous 5-year period are required to be lower than the 5-year rolling average from 3 years earlier. From 1st July 2027, the 5-year rolling average of Safeguard covered emissions is required to be lower than the 5-year rolling average from 2 years earlier.

4.1.3 Managing Excess Emissions

Safeguard obligations rest with the person with operational control of the Safeguard facility. This person is referred to as the 'responsible emitter' and may be an individual, a body corporate, a trust, a corporation sole, a body politic or a local governing body. The responsible emitter is required to keep the Safeguard facility's net emissions at or below its emissions baseline.

Responsible emitters with a Safeguard facility that has, or is likely to, exceed its baseline have several options to manage the excess emissions situation:

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- Pursue activities that would reduce the relevant emissions of the facility.
- Surrender prescribed carbon units to reduce the net-emissions of the facility - Australian Carbon Credit Units (ACCUs) and Safeguard Mechanism Credits (SMC) are currently the only prescribed units.
- Apply for a multi-year monitoring period that provides flexibility in how emissions are managed over a longer period.
- Apply for an exemption where excess emissions are due to exceptional circumstances such as a natural disaster or criminal activity.

4.1.4 Emissions Reduction Pathways for HCOC under the Safeguard Mechanism

The Safeguard Mechanism provides HCOC with both regulatory frameworks and financial incentives to reduce its emissions. HCOC's efforts to reduce emissions, as outlined in Section 3.2, will result in either of the following outcomes:

1. **Reduction in the Need for Australian Carbon Credit Units (ACCUs) or Safeguard Mechanism Credits (SMCs):** If HCOC's emissions are below its baseline, it will reduce its need to acquire ACCUs or SMCs to offset excess emissions.
2. **Generation of Safeguard Mechanism Credits (SMCs):** Emissions below the baseline result in the creation of SMCs, each representing one tonne of CO₂-e emissions avoided. These credits can be traded or banked for future use.

These outcomes may offset some of the costs associated with implementing emissions reduction technologies, thereby enhancing their economic feasibility. Consequently, the Safeguard Mechanism incentivises HCCH to continuously monitor and evaluate existing and emerging technologies to assess their applicability and potential for emissions reduction at HCOC.

4.2 Glencore Emissions Reduction Targets

Glencore's Climate Action Transition Plan (Glencore, 2024) describes Glencore's commitment to responsibly manage the decline of its global thermal coal portfolio. As the world moves towards a low-carbon economy, Glencore is focused on supporting the energy needs of today whilst investing in its transition metals portfolio. The metals Glencore produces, sources and markets will support the global ambition to decarbonise.

Consistent with the commitment to responsibly manage the decline of its thermal coal portfolio, Glencore has established total Scope 1, 2 and 3 industrial CO₂-e emissions reduction targets (against a 2019 baseline) of:

- 15% reduction by the end of 2026;
- 25% reduction by the end of 2030;
- 50% reduction by the end of 2035;
- A longer-term ambition of achieving net zero industrial CO₂-e emissions by the end of 2050, subject to a supportive policy environment.

Emissions from HCOC are considered in Glencore's emissions reduction targets.

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Glencore's 2024-2026 Climate Action Transition Plan outlines its position on climate and energy transition and the strategies it currently proposes to use to manage its transition, including:

- Recognising that thermal coal for electricity generation remains a necessary source of energy in many countries – providing grid stability, supporting energy access and security, and contributing to socioeconomic development in many markets. Glencore supports regulatory efforts to transition towards cleaner power generation and to reduce underlying demand for fossil fuels.
- To support anticipated global energy needs, Glencore plans to continue to progress select brownfield coal investments at existing mines but will continue to align with the Group emissions reduction targets and commitment to a managed decline of the coal portfolio overall.
- To continue driving improved operational performance in its industrial activities through a strong focus on identifying and delivering cost-effective emissions reduction opportunities.
- To continue to evolve technical and economic assessments to identify emissions reduction opportunities across the portfolio. This enables Glencore to identify and implement investments in abatement opportunities that are practically and commercially viable. Where opportunities are deemed not sufficiently ready, Glencore will continue to collaborate with industry and OEM partners to study and invest in research and development to drive technology maturation and scale requirements to improve commerciality.
- To identify and invest in value-enhancing growth opportunities in Glencore's metals portfolio that meet market requirements, including a focus on commodities fundamental for the transition to a low-carbon economy, such as copper, nickel, zinc, aluminium and cobalt.

4.3 Scope 3 Emissions

Whilst the Guideline does not require Scope 3 emissions to be discussed in the plan, HCCH provides discussion on emissions from the use of product coal from the HCEP.

HCOC's primary export market for the 2022 – 2024 calendar years is Asia, with China being the largest export destination. It is anticipated that future export destinations for HCOC coal will continue to follow similar patterns. However, as coal sales are market-driven, export destinations may change in the future.

The countries that HCOC coal has been exported to, all have Nationally Determined Contributions (NDCs) under the Paris Agreement or have followed international standards recognised by the United Nations Framework Convention on Climate Change (UNFCCC) and published their own NDCs document in support of the Paris Agreement.

5. GHG Emission Reduction Program

As described in Section 3.2, 4 and Appendices A, B, and C, HCCH will continue to investigate options for reducing the emissions from its operations by evaluating existing and emerging technologies for emissions reduction.

Currently, neither Scope 1 abatement initiatives relating to diesel emissions nor Scope 2 initiatives relating to electricity consumption are considered practicable or feasible for implementation at HCOC.

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However, Glencore will continue to review and update these assessments as part of its ongoing business planning processes.

5.1 Pre-drainage Feasibility Study at HCEP

HCCH will complete an investigation into the feasibility and effectiveness of gas pre-drainage in the HCEP area within 2 years of approval of HCEP (should approval be granted). Upon completion, the feasibility study will be provided to DETSI.

6. Advancing Technologies and Opportunities

As part of business planning processes, Glencore will continue to support HCOC by assessing existing and emerging technologies for emissions reduction and energy efficiency. This work will be conducted on a 3-yearly basis (unless material changes are identified earlier). These 3-yearly reviews form a qualitative performance measure for regularly monitoring and evaluating opportunities to further reduce emissions and improve energy efficiency.

7. Monitoring, Reporting, Auditing and Publishing

The NGER Scheme, established by the NGER Act, provides a national framework for reporting and disseminating company information about greenhouse gas emissions, energy production, energy consumption and other information specified under NGER legislation.

There are two thresholds that determine whether a company has a requirement to report under the NGER Act, facility, and corporate thresholds. HCOC as a facility exceeds the 25kt CO₂-e threshold and is therefore required to submit annual NGER reports to the Clean Energy Regulator (CER). HCOC undertakes monitoring, reporting and auditing requirements in accordance with its NGER obligations. These obligations will also apply to the HCEP

HCOC is also a Commonwealth Safeguard facility and Scope 1 emissions data from HCOC will be published by the CER on their website on an annual basis. If approved, the HCEP would be incorporated in the HCOC for purposes of Safeguard Mechanism facility reporting.

In April each year, the CER publishes information relating to the Safeguard Mechanism for the previous financial year⁴. This includes information about each Safeguard facility:

- Safeguard outcomes, including progress towards the Commonwealth's emissions reductions commitments;
- Baselines and emissions;
- Multi-year monitoring periods;
- Trade-exposed baseline-adjusted facilities;

⁴ Data from the Clean Energy Regulator is available at <https://cer.gov.au/markets/reports-and-data/safeguard-data>

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- Emissions-intensity determinations; and
- NGER method data.

The above requirements of the NGER Scheme and Commonwealth Safeguard Mechanism form the monitoring, reporting, auditing, and publishing performance measures for HCOC that will also apply to the HCEP.

8. Review and Improvement

Every three years this plan will be reviewed for effectiveness in achieving the requirements of the Guideline. This plan will be updated to address any matters identified during the review process.

9. Document Information

Relevant legislation, standards and other reference information will be regularly reviewed and monitored for updates and should be included in the site management system. Related documents and reference information in this section provides the linkage and source to develop and maintain site compliance information.

9.1 Reference Information

Reference information, listed in **Table 2** Reference Information

below, is information that is directly referred to for the development of this document.

Table 2 Reference Information

Title
Climate Change Authority (CCA), 2024, Sector Pathways Review 2024, available at < https://www.climatechangeauthority.gov.au/sector-pathways-review >
Department of Environment, Science and Innovation – Queensland Government (DETSI), 2024, Guideline Greenhouse gas emissions, available at < https://www.detsi.qld.gov.au/policies?a=272936%3Apolicy_registry%2Fera-ql-greenhouse-gas-emissions.pdf >
Glencore, 2024, 2024-2026 Climate Action Transition Plan, available at < https://www.glencore.com/sustainability/esg-a-z/climate-change >
Hail Creek Open Cut (HCOC), 2025, Hail Creek Open Cut Eastern Margin Extension Project – Information Request Response (Appendix I: Greenhouse Gas Assessment) (authored by SLR), available at < https://www.glencore.com.au/operations-and-projects/coal/current-operations/hail-creek-open-cut#information-request-response >

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Appendix A - Existing Technologies for Emissions Reduction

As part of its business planning framework, Glencore supports HCOC by evaluating existing emissions reduction technologies to assess the relative feasibility and effectiveness of various initiatives.

These assessments are typically conducted during the annual business planning process. Abatement initiatives are examined by considering a range of criteria including estimated costs, emissions reduction potential, and practicability of deployment.

- Scope 1 abatement initiatives considered for HCOC include options to reduce diesel-related emissions through the use of biofuels and fuel additives.
- Scope 2 initiatives focus on electricity consumption and include options such as renewable power purchase agreements and the development of onsite renewable energy infrastructure (e.g., solar and/or wind installations, with and without battery storage).

Currently, neither Scope 1 abatement initiatives relating to diesel emissions nor Scope 2 initiatives relating to electricity consumption are considered practicable or feasible for implementation. However, Glencore will continue to review and update these assessments as part of its ongoing business planning processes.

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Appendix B - Emerging Technologies for Emissions Reduction

As part of its business planning processes, Glencore supports HCOC by evaluating emerging technologies with the potential to reduce emissions. By definition, such technologies are in varying stages of development and must progress through established Technology Readiness Levels (TRL) and Commercial Readiness Indexes (CRI) before they can be deployed at scale.

Due to their early-stage nature, emerging technologies are associated with a higher degree of uncertainty—particularly regarding the quantification of potential benefits and the timing of their implementation. Accordingly, Glencore assesses these technologies based on their current TRL and CRI status, as well as indicative timeframes for commercial deployment.

Given the inherent uncertainty in both technical and economic outcomes, it is not considered appropriate to provide quantified emissions reduction estimates or economic forecasts for emerging technologies at this stage.

The areas discussed below summarise Glencore’s evaluation of emerging technologies for potential implementation at HCOC.

Opportunities to reduce fugitive methane emissions

Mitigating fugitive methane emissions at open cut mines is considered an emerging area, currently in the R&D phase (CCA, 2024). Glencore plans to further investigate the feasibility of pre-drainage at HCEP, as discussed in section 3.3.2.

Opportunities to reduce diesel emissions

Given the off-road mining fleet is the largest user of diesel, further information is provided on the status of available technology and opportunities at HCOC for reducing diesel emissions.

A joint industry program facilitated by the International Council on Mining and Metals (ICMM), the Initiative for Cleaner, Safer Vehicles (ICSV), exists to leverage the broader industry learnings for solving constraints to the development of emissions reduction technologies in mining equipment.

Based on existing relationships and governance requirements, the ICMM and Charging Interface Initiative e.V. (CharIN), with involvement of the original equipment manufacturers (OEM), are the industry bodies with the most influence to help achieve the emission reduction objectives. CharIN is a not-for-profit global organisation in the field of charging systems for electric vehicles of all types around the world. It provides a community of technological collaborators, with over 300 members and eight years of work and learnings that can be built on.

Glencore is a founding and active member of the ICSV program, and therefore HCOC is able to stay abreast of technological developments and implementation progress through association with these bodies, which it does so on a regular basis. Using this available information and Glencore’s industry knowledge, Glencore undertook an assessment of the readiness of alternative technologies to diesel powered equipment for the mining sector and engaged Hatch Pty Ltd (ICSV Technical and Facilitation Support) to peer review this work. A summary of the findings is provided below.

The frameworks and methodology used by the Australian Renewable Energy Agency (ARENA) were used to assess readiness of technology for use in the mining sector by considering both the TRL, and CRI of the technology. These concepts are illustrated in Figure 2.

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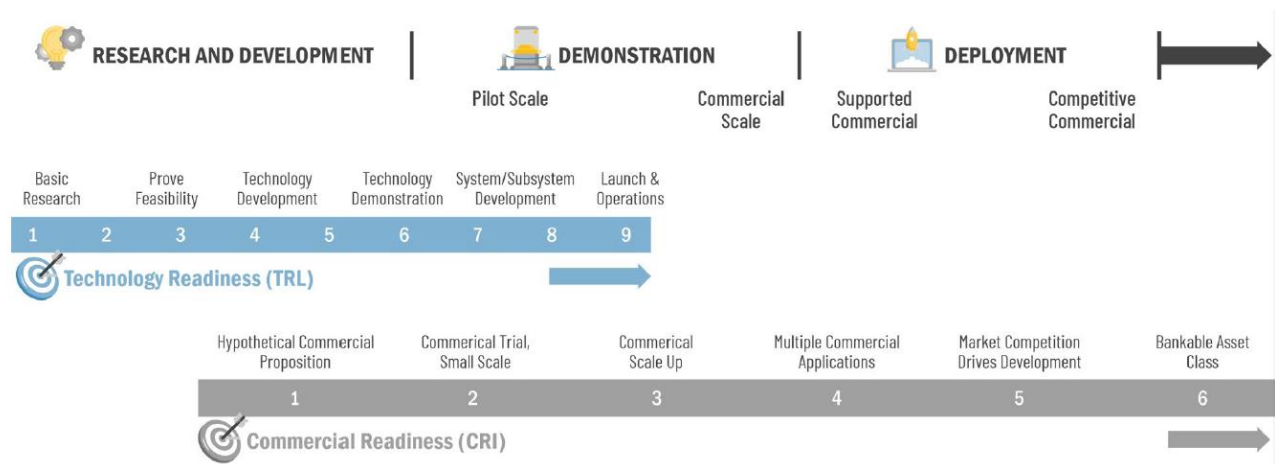


Figure 2 Technology Readiness Level and Commercial Readiness Index concepts

The review considered electrically powered equipment, as well as equipment powered by alternative fuels such as hydrogen, biofuels, ammonia and synthetic diesel. The findings are summarised below.

An overview of the potential technologies for powering surface mining equipment, currently typically powered by diesel, is shown below in Figure 3. It shows the current TRL status of a range of technologies that might be suitable. Diesel as a fuel supply is, as a technology, refined and adopted. 20% biodiesel blends and catenary supplied electric power are also at TRL9. The second phase of assessment towards commercial adoption is the CRI and, when considering commercial readiness, diesel is again a fully adopted and commercially competitive fuel for mining equipment. As will be discussed below, 100% biodiesel and catenary power while technologically ready, are not as advanced on a CRI basis and not as readily adopted.

Figure 3 also shows that while technologies such as hybrid, fuel cell or battery power solutions are developing and being adopted in smaller scale sectors such as for automotive, they are not yet adequately developed for use with mining equipment. Glencore will continue reviewing technologies on a regular ongoing basis to assess their development status and suitability for adoption at HCOC.

PHASES	TRL	DESCRIPTION	RECIPROCATING ENGINES >30 L	GRID SUPPLIED	HYBRID STORAGE/ ENGINE	HYBRID STORAGE/ FUEL CELL	HYBRID STORAGE
			Diesel Hydrogen Ammonia Bio-Diesel - 20% Synthetic Diesel - 100%	Catenary Trailing cable	Storage / Engine / Regen Storage / Engine / Static Charge / Regen Storage / Engine / Catenary / Regen	Storage / Fuel Cell / Regen Storage / Fuel Cell / Static Charge / Regen Storage / Fuel Cell / Catenary / Regen Storage / Fuel Cell / Catenary / Static Charge / Regen	Storage / Regen Storage / Engine / Static Charge / Regen Storage / Catenary / Regen Storage / Catenary / Static Charge / Regen
Basic research	1	Basic principles and research					
	2	Application formulated					
	3	Proof of concept					
Applied research	4	Components validated in laboratory environment					
	5	Integrated components demonstrated in a laboratory environment					
Development	6	Prototype demonstrated in relevant environment					
	7	Prototype demonstrated in operational environment					
	8	Technology proven in operational environment					
Implementation	9	Technology refined and adopted					

Figure 3 Potential technologies for powering surface mining equipment with current TRL

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Electric powered equipment

Several technologies exist for electrically powered equipment, including tethered cable electric machines, and high capacity overhead catenary systems. As demonstrated in Figure 4, catenary system technology is well developed for trucks with an overhead mounted system, and electric tethered cable system for hydraulic face shovel configured excavators in hard rock mining applications. However, there are a number of complexities and constraints to their implementation in a coal mining geological environment as discussed below.

High capacity overhead catenary systems can be used to support diesel-electric truck fleets and potentially hybrid or battery powered fleets. Overhead catenary support for diesel-electric trucks is used in some limited non-coal instances globally; however, there is little opportunity to use this sort of system in the coal sector and HCOC in particular. This is mainly due to the progressive nature of mine advancement during coal extraction and the subsequent continual changing of the location of suitable haul ramps, which would necessitate continually moving the significant support infrastructure involved.

In relation to cabled electric machines, draglines, shovels and large capacity drills are available as shown in Figure 4. HCOC has historically used electric draglines and shovels and continues to utilise electric shovels for a significant proportion of waste excavation. The nature of the cabled connection renders them useful for specific, usually high volume, tasks only. As a multi-seam open cut where equipment requires frequent relocation, several smaller hydraulic diesel-fuelled equipment are required for efficient mining. These are available as electric cable supplied machines however are too restrictive for the flexibility required at HCOC. Similarly smaller drills that require flexibility of movement within the mine are more appropriate as diesel machines.

In summary, some equipment is utilised as electric cable supplied machines at HCOC however the further use of electric equipment for all excavators and drills is constrained by practicality and efficiency. As excavators and drills are replaced, forecasts of their respective uses will be assessed including whether cable supply might be appropriate.

Sustainable Fuel Options and Hydrogen

There are a range of sustainable fuel options which are commercially available as well as under development. Such fuels can be used in conventional internal combustion engines (ICE) across sectors including mining, road transport, rail, maritime, aviation, and as chemical feedstocks.

Sustainable fuels can be blended with fossil fuels to a blend limit (fatty acid methyl ester - FAME and ethanol) or to any ratio up to 100% (hydrogenated vegetable oil - HVO, synthetic), without requiring any technical adjustments to the vehicle. The use of 100% renewable diesel, such as HVO, in ICE vehicles could achieve a 100% reduction in Scope 1 emissions.

The use of sustainable fuels is expected to grow significantly over the next 20 years, decreasing fossil fuel consumption in hard-to-abate sectors, driven by regulatory mandates, particularly in the road transport and aviation sectors.

Currently, there are significant barriers to the use of sustainable fuels including cost and limited availability. Sustainable fuels also face issues of ethical provenance as their feedstocks may have the potential to displace food-growing activities and have land use impacts e.g. deforestation. Sustainable fuels also differ in their extent of application or the ability to “drop-in” or substitute fossil fuel diesel use.

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Glencore's coal operations have previously used biofuels in mining equipment (i.e. B20, which is a diesel fuel containing 20% biofuel); however, operations do not currently use this fuel due to both cost and availability.

As shown below, the use of hydrogen as a fuel in mining equipment does not currently meet TRL requirements for implementation and is therefore not yet an option for the industry. Further research and development are needed before this technology could be considered for use at an operation like HCOC.

Glencore will continue to monitor and assess the potential use of sustainable and alternative fuel options for application at HCOC over the project life.

			GRID SUPPLIED ELECTRICAL POWER										RECIPROCATING ENGINES (> 30L OPTIONS)									
PHASES	TRL	DESCRIPTION	 DIESEL ELECTRIC WITH CATENARY					 ELECTRIC TETHERED CABLE					 HYDROGEN					 BIODIESEL (20%)				
			Trucks overhead mounted	Trucks parallel side mounted	Excavators	Loaders and dozers	Ancillary	Trucks	Excavators / Shovel	Excavators / Backhoe	Loaders and dozers	Ancillary	Drills	Trucks	Excavators	Loaders	Dozers	Ancillary	Trucks	Excavators	Loaders	Dozers
Basic research	1	Basic principles and research																				
	2	Application formulated																				
	3	Proof of concept																				
Applied research	4	Components validated in laboratory environment																				
	5	Integrated components demonstrated in a laboratory environment																				
Development	6	Prototype demonstrated in relevant environment																				
	7	Prototype demonstrated in operational environment																				
	8	Technology proven in operational environment																				
Implementation	9	Technology refined and adopted																				

Figure 4 Mining equipment optionality with current TRL – grid supplied electrical power and alternate fuels

Appendix C - HCOC Safeguard Baseline

The table below provides the workings for HCOC's estimated Safeguard baseline.

This baseline reflects production from the HCOC LOM⁵ including the HCEP.

Table 3 HCOC Safeguard Baseline

Site-specific emissions intensity			0.13377		t CO2e/ROM t					
Industry average emission intensity			0.06530		t CO2e/ROM t					
Financial year	Proportion of Site-specific emissions intensity	Industry average emission intensity	Hybrid emission intensity (undeclared)	SGM decline rates	Effective cumulative SGM decline	Hybrid emission intensity (declined)	Calendar year	Hybrid emission intensity (declined) - averaged across the two relevant financial years	ROM Tonnes (LOM including HCEP)	SGM Baseline = hybrid emission intensity (declined) X ROM tonnes
			<i>t CO2e/ROM t</i>			<i>t CO2e/ROM t</i>		<i>t CO2e/ROM t</i>	<i>ROM t</i>	<i>t CO2e</i>
FY2026	85%	15%	0.1235	4.900%	85.3%	0.1053	CY2026	0.10094	10,021,550	1,011,606
FY2027	80%	20%	0.1201	4.900%	80.4%	0.0965	CY2027	0.09101	9,628,074	876,294
FY2028	70%	30%	0.1132	4.900%	75.5%	0.0855	CY2028	0.08030	9,828,255	789,177

⁵ In this context, "LOM" or "Life of Mine" refers to the business plans that support both the approved activities and the additional activities to be authorised by the EA amendment application A-EA-AMD-100576264 (if approved).

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Financial year	Proportion of Site-specific emissions intensity	Industry average emission intensity	Hybrid emission intensity (undeclined)	SGM decline rates	Effective cumulative SGM decline	Hybrid emission intensity (declined)	Calendar year	Hybrid emission intensity (declined) - averaged across the two relevant financial years	ROM Tonnes (LOM including HCEP)	SGM Baseline = hybrid emission intensity (declined) X ROM tonnes
FY2029	60%	40%	0.1064	4.900%	70.6%	0.0751	CY2029	0.07025	7,386,053	518,871
FY2030	50%	50%	0.0995	4.900%	65.7%	0.0654	CY2030	0.06376	7,136,349	455,011
FY2031	50%	50%	0.0995	3.285%	62.4%	0.0621	CY2031	0.06049	7,931,792	479,793
FY2032	50%	50%	0.0995	3.285%	59.1%	0.0589	CY2032	0.05722	7,964,759	455,745
FY2033	50%	50%	0.0995	3.285%	55.8%	0.0556	CY2033	0.05395	6,151,379	331,870
FY2034	50%	50%	0.0995	3.285%	52.6%	0.0523	CY2034	0.05068	6,077,280	308,001
FY2035	50%	50%	0.0995	3.285%	49.3%	0.0490	CY2035	0.04741	3,862,571	183,128
FY2036	50%	50%	0.0995	3.285%	46.0%	0.0458	CY2036	0.04414	4,252,443	187,708
FY2037	50%	50%	0.0995	3.285%	42.7%	0.0425	CY2037	0.04087	3,873,888	158,332
FY2038	50%	50%	0.0995	3.285%	39.4%	0.0392	CY2038	0.03760	2,497,038	100,000
FY2039	50%	50%	0.0995	3.285%	36.1%	0.0360				

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Appendix D - HCEP's share of HCOC's Safeguard Baseline

The table below provides the workings for HCEP's share of HCOC's estimated Safeguard baseline.

This baseline share reflects production from the HCEP only.

Table 4 HCEP share of HCOC's Safeguard Baseline

Site-specific emissions intensity			0.13377		t CO2e/ROM t					
Industry average emission intensity			0.06530		t CO2e/ROM t					
Financial year	Proportion of Site-specific emissions intensity	Industry average emission intensity	Hybrid emission intensity (undeclared)	SGM decline rates	Effective cumulative SGM decline	Hybrid emission intensity (declined)	Calendar year	Hybrid emission intensity (declined) - averaged across the two relevant financial years	ROM Tonnes (HCEP only)	HCEP's share of HCOC's SGM Baseline = hybrid emission intensity (declined) X ROM tonnes
			<i>t CO2e/ROM t</i>			<i>t CO2e/ROM t</i>		<i>t CO2e/ROM t</i>	<i>ROM t</i>	<i>t CO2e</i>
FY2026	85%	15%	0.1235	4.900%	85.3%	0.1053	CY2026	0.10094	457,630	46,195
FY2027	80%	20%	0.1201	4.900%	80.4%	0.0965	CY2027	0.09101	571,668	52,030
FY2028	70%	30%	0.1132	4.900%	75.5%	0.0855	CY2028	0.08030	1,776,499	142,647
FY2029	60%	40%	0.1064	4.900%	70.6%	0.0751	CY2029	0.07025	2,595,376	182,325
FY2030	50%	50%	0.0995	4.900%	65.7%	0.0654	CY2030	0.06376	1,536,809	97,986
FY2031	50%	50%	0.0995	3.285%	62.4%	0.0621	CY2031	0.06049	2,532,846	153,212

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Financial year	Proportion of Site-specific emissions intensity	Industry average emission intensity	Hybrid emission intensity (undeclined)	SGM decline rates	Effective cumulative SGM decline	Hybrid emission intensity (declined)	Calendar year	Hybrid emission intensity (declined) - averaged across the two relevant financial years	ROM Tonnes (HCEP only)	HCEP's share of HCOC's SGM Baseline = hybrid emission intensity (declined) X ROM tonnes
FY2032	50%	50%	0.0995	3.285%	59.1%	0.0589	CY2032	0.05722	1,764,636	100,973
FY2033	50%	50%	0.0995	3.285%	55.8%	0.0556	CY2033	0.05395	771,249	41,609
FY2034	50%	50%	0.0995	3.285%	52.6%	0.0523	CY2034	0.05068	2,787,365	141,266
FY2035	50%	50%	0.0995	3.285%	49.3%	0.0490	CY2035	0.04741	3,500,214	165,949
FY2036	50%	50%	0.0995	3.285%	46.0%	0.0458	CY2036	0.04414	4,252,443	187,708
FY2037	50%	50%	0.0995	3.285%	42.7%	0.0425	CY2037	0.04087	3,873,888	158,332
FY2038	50%	50%	0.0995	3.285%	39.4%	0.0392	CY2038	0.03760	2,497,038	93,893
FY2039	50%	50%	0.0995	3.285%	36.1%	0.0360				

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Hail Creek Coking Coal (HCOC) Eastern Margin Extension – EPBC Referral

Attachment C

EPBC REFERRAL GREENHOUSE GAS ASSESSMENT
(SLR, 2025h)



Hail Creek Open Cut Eastern Margin Extension

EPBC Referral - Greenhouse Gas Assessment

Hail Creek Coal Holdings Pty Limited

PO Box 107, Glenden QLD 4734

Prepared by:

SLR Consulting Australia

SLR Project No.: 626.30128.00020

10 December 2025

Revision: v3.0

Revision Record

Revision	Date	Prepared By	Checked By	Authorised By
V1.0	22 July 2025	K Lawrence	J A Cox	K Lawrence
V2.0	15 August 2025	K Lawrence	J A Cox	K Lawrence
V3.0	10 December 2025	N Shahbazi	K Lawrence	K Lawrence

Basis of Report

This report has been prepared by SLR Consulting Australia (SLR) with all reasonable skill, care and diligence, and taking account of the timescale and resources allocated to it by agreement with Hail Creek Coal Holdings Pty Limited (the Client). Information reported herein is based on the interpretation of data collected, which has been accepted in good faith as being accurate and valid.

This report is for the exclusive use of the Client. No warranties or guarantees are expressed or should be inferred by any third parties. This report may not be relied upon by other parties without written consent from SLR.

SLR disclaims any responsibility to the Client and others in respect of any matters outside the agreed scope of the work.



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Acronyms and Abbreviations

Abbreviation or term	Description
%	percent
ACCU	Australian carbon credit units
ANREU	Australian National Registry Emissions Unit
CH ₄	methane
CO ₂	carbon dioxide
CO ₂ -e	CO ₂ equivalents
Cth	Commonwealth of Australia
DCCEEW	Department of Climate Change, Energy, the Environment and Water
DETSI	Department of Environment, Tourism, Science and Innovation
DISER	Department of Industry, Science Environment and Resources (now DETSI)
EA	Environmental Authority
EP Act	<i>Environmental Protection Act 1994</i>
ERBC Act	<i>Environment Protection and Biodiversity Conservation Act 1999</i>
ERF	Emissions Reductions Fund
FY	financial year
GCAA	Glencore Coal Assets Australia
GHG	greenhouse gas
GJ	gigajoule
ha	hectares
HCC	Hail Creek Holdings Pty Limited
HCOC	Hail Creek Open Cut
LPG	liquid petroleum gas
ML	Mining Leases
Mtpa	million tonnes per annum
N ₂ O	nitrous oxide
NCAS	National Carbon Accounting System
NDC	Nationally Determined Contribution
NGA	National Greenhouse Accounts
NGER Act	<i>National Greenhouse and Energy Reporting Act 2007</i>
ROM	Run of Mine
SF ₆	sulfur hexafluoride
SLR	SLR Consulting Australia Pty Ltd
TAGG	Transport Authorities Greenhouse Group
UN	United Nations
UNFCCC	United Nations Framework Convention on Climate Change



1.0 Introduction

SLR Consulting Australia Pty Ltd (SLR) was engaged by Hail Creek Holdings Pty Limited (HCC), a subsidiary of Glencore Coal Assets Australia (GCAA) to prepare a greenhouse gas (GHG) assessment for the proposed extension of Hail Creek Open Cut (HCOC) mine (the Action), located in the Bowen Basin in Central Queensland.

HCOC is authorised through Environmental Authority (EA) EPML00661913 and Mining Leases (MLs) 4738 and 700026. Construction of HCOC commenced in December 2001. HCC became the operator of HCOC in August 2018.

Coal is mined using conventional open-cut strip-mining methods, with approval to produce up to 20 million tonnes of product coal per annum (Mtpa). Coal is also approved to be mined by underground methods, however to date, the mine has not utilised underground mining methods for mining.

Due to changes in mine sequencing, improvements in mining efficiency and further resource definition, the Project proposes an extension to the approved mining footprint in four distinct areas, as shown in **Figure 1**.

HCC is seeking approval for the Project from the Queensland Department of Environment, Tourism, Science and Innovation (DETSI), under Section 226 of the *Environmental Protection Act 1994* (EP Act). The Project may also require approval from the Commonwealth Minister for the Environment and Water under Part 3, Division 1 provisions of the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) should the Project be determined to be a controlled action.

The Action for which a controlled action determination is being sought under the EPBC Act involves mining operations within the individual areas provided below:

- Kemmis Pit Extension (Area 1) - clearing and mining of an additional 6.3 hectares (ha) of surface disturbance, comprising two small polygons of approximately 4.5 ha and 1.8 ha, to extend the currently approved footprint of Kemmis Pit;
- Homevale Pit and Hail Creek Diversion (Area 2) - clearing and mining of 136.6 ha for a new 'Homevale Pit' located in the corner of ML4738 to the north;
- Exevale Pit Extension (Area 3) - clearing and mining of an additional 140.3 ha of surface disturbance to extend the currently approved footprint of Exevale Pit; and
- Carrinyah Pit Extension (Area 4) - clearing and mining of an additional 396.0 ha of surface disturbance to extend the currently approved footprint of Carrinyah Pit.

A total additional approximate 679.2 ha of land is proposed to be disturbed.

An analysis of the potential greenhouse gas (GHG) emissions that would arise from the Proposed Action has been undertaken to inform the EPBC Act referral. This report presents a summary of the predicted GHG emissions that will arise from the Action, should it be approved, along with the proposed mitigation and management measures to be implemented.



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LEX 83395

EPBC REFERRAL

FIGURE 1
PROPOSED AMENDMENT AREAS

LEGEND

- EA Authorised Extent of Disturbance
- EA Amendment Proposed Extent of Disturbance
- Mining Lease



Coordinate System: GDA2020 MGA Zone 55
Scale: 1:60,000 at A3
Project Number: 626.30128
Date: 24-Mar-2025
Drawn by: AS



2.0 Legislative and Policy Context

There are concurrent legislative frameworks for the regulation of GHG emissions at both the Commonwealth and State levels.

2.1 Commonwealth

Commonwealth regulatory frameworks for the management and reduction of GHG emissions include the Australian Carbon Credit Unit (ACCU) Scheme and the Safeguard Mechanism established under the *National Greenhouse and Energy Reporting Act 2007* (NGER Act).

The ACCU Scheme aims to provide incentives for a range of organisations and individuals to adopt new practices and technologies to reduce their emissions, and to provide a legal obligation for Australia's top emitters to maintain their emissions below their emissions limit (or baseline) (defined by the Safeguard Mechanism). It allows for the generation of ACCUs, which are a tradeable financial product, with one ACCU representing one tonne of carbon dioxide equivalents (CO₂-e) that would have otherwise been released to the atmosphere.

The Australian National Registry Emissions Unit (ANREU) is an online system that allows users to track ownership and transactions of emissions units, including ACCUs. Organisations and individuals can own, transfer, cancel, deliver, surrender or relinquish ACCUs via ANREU.

The Safeguard Mechanism was established under the NGER Act and applies to facilities with direct Scope 1 emissions of more than 100,000 tonnes of CO₂-e per year, which are defined as "covered facilities". HCOC is a covered facility under the Safeguard Mechanism.

This framework establishes a baseline against which a facility's emissions reported under the NGER Act are compared. During 2022 – 2023, major reforms to the Safeguard Mechanism were enacted to reflect Australia's emissions reduction targets set out in the *Climate Change Act 2022* (Cth) and its Nationally Determined Contribution (NDC) under the Paris Agreement, which are currently as follows:

- Reducing Australia's net greenhouse gas emissions to 43% below 2005 levels by 2030;
- Reducing Australia's net greenhouse gas emissions by 62–70% below 2005 levels by 2035 to support the transition to net zero; and
- Reducing Australia's net greenhouse gas emissions to zero by 2050.

These reforms require covered facilities to deliver a proportional share of Australia's 2030 climate target. Following the reforms, baselines will decline in a predictable and gradual way across all covered facilities. The reforms are based on emission intensity, production-adjusted, and subject to legislated decline rates.

The decline rate for Safeguard baselines is currently as follows:

- 4.9% per year to 2029 - 2030; and
- 3.285% from 2030 onwards.

It is anticipated that further refinements to the Safeguard Mechanism may be required to support achievement of Australia's 2035 NDC.

If a facility exceeds its baseline, they have the option to surrender ACCUs or Safeguard Mechanism Credits (SMCs) to offset emissions. If a facility's emissions are less than its baseline, it will be awarded SMCs which it can choose to bank for future use or sell to other Safeguard facilities.



2.2 Queensland Government

2.2.1 Queensland Climate Action Plan

The Queensland Government has committed to action on climate change through the Queensland Climate Action Plan, and also in 2024 committed to the following renewable energy targets¹ and emissions reduction targets²:

- 50% renewable energy target by 2030;
- 70% renewable energy by 2032;
- 80% renewable energy by 2035;
- 30% emission reduction below 2005 levels by 2030;
- 75% emissions reduction below 2005 levels by 2035; and
- Zero net emissions by 2050.

The current Queensland Government however has announced its intent to reappeal the above renewable energy targets, while still supporting Australia's net-zero goal by 2050³. The current policy favours an energy portfolio that combines fossil fuel generation with selective renewable projects, emphasising grid reliability and economic stability. Under the recently released Energy Roadmap, State-owned coal-fired power stations will continue to operate longer than previously planned, with gas also playing a bigger role in the energy mix to support the grid. There is also an increased focus on private investment for renewables and firming capacity, with the establishment of the Queensland Energy Investment Fund.

The Queensland Government is also developing the following six sector emissions reduction plans to ensure all industries are engaged in realising a net zero future:

- Energy;
- Resources;
- Agriculture and land;
- Transport;
- Industry; and
- Built environment.

2.2.2 Guideline: Greenhouse Gas Emissions

In May 2024, DETSI released the *Guideline Greenhouse Gas Emissions* (the Guideline) (DETSI 2025), which clarifies existing application requirements under the EP Act and provides information about how to meet these requirements in relation to GHG emissions. The Guideline sets out the minimum expectations for GHG emissions information to be provided with applications for new EAs and applications to amend existing EA's and was referred to in preparing the GHG Assessment report provided as supporting information for the EA Amendment Application for the Action.

2.2.3 HCOC Approvals

There are no specific conditions contained within the HCOC EA relating to the management of GHG emissions.

¹ *Energy (Renewable Transformation and Jobs) Act 2024*

² *Clean Economy Jobs Act 2024*

³ *Energy Roadmap, October 2025*



3.0 HCOC Coal Production and Export Markets

3.1 Annual Extraction and Production Rates

Both coking and bituminous (thermal) coal are produced by HCOC. **Table 1** presents the proposed Run of Mine (ROM) coal extraction rates for the mine plan split between the currently approved and Action mining areas.

The timing of the Project's production quantities and associated GHG emissions is subject to the required approvals being granted. The expected coal product throughputs from the current mine plan, split between the currently approved and Action mining areas, are presented in **Table 2**. As indicated by **Table 2**, the combined coking and thermal coal annual production rates are well within the current EA production limit of 20 Mtpa ROM coal.

Table 1 HCOC ROM Extraction Rates

Year	Estimated ROM Extraction Rate (tonnes/annum)		
	Mine Plan Excluding Action	Action Only	Mine Plan Including Action
2026	9,563,920	457,629	10,021,550
2027	9,056,405	571,668	9,628,074
2028	8,051,756	1,776,499	9,828,255
2029	4,790,676	2,595,376	7,386,053
2030	5,599,540	1,536,809	7,136,349
2031	5,398,946	2,532,846	7,931,792
2032	6,200,122	1,764,636	7,964,759
2033	5,380,130	771,249	6,151,379
2034	3,289,915	2,787,365	6,077,280
2035	362,357	3,500,214	3,862,571
2036	0	4,252,443	4,252,443
2037	0	3,873,888	3,873,888
2038	0	2,497,038	2,497,038
Total	57,693,767	28,917,661	86,611,429



Table 2 HCOC Coal Production Rates

Year	Estimated Coal Production Rate (tonnes/annum)		
	Mine Plan Excluding Action	Action Only	Mine Plan Including Action
Coking Coal			
2026	5,269,592	260,689	5,530,281
2027	5,293,759	293,236	5,586,995
2028	4,664,791	837,636	5,502,427
2029	3,071,726	1,398,743	4,470,470
2030	3,538,838	1,014,392	4,553,230
2031	3,710,154	1,219,555	4,929,709
2032	4,330,218	446,099	4,776,317
2033	3,616,283	483,121	4,099,404
2034	1,969,372	1,791,101	3,760,473
2035	281,731	2,147,392	2,429,123
2036	108,794	2,609,640	2,718,433
2037	100,680	2,430,107	2,530,787
2038	59,156	1,619,482	1,678,638
Total	36,015,093	16,551,193	52,566,286
Thermal Coal			
2026	2,781,165	108,916	2,890,082
2027	2,443,669	162,763	2,606,431
2028	2,254,257	525,698	2,779,955
2029	1,253,062	656,595	1,909,657
2030	1,225,228	308,975	1,534,203
2031	1,152,479	731,851	1,884,331
2032	1,466,852	739,304	2,206,156
2033	1,103,182	196,486	1,299,669
2034	854,342	666,794	1,521,136
2035	141,410	897,221	1,038,632
2036	41,371	1,084,422	1,125,793
2037	36,306	915,406	951,711
2038	1,073,656	501,369	1,575,025
Total	15,826,978	7,495,801	23,322,779



3.2 Export Markets

HCOC's export market countries for the 2022 - 2024 calendar years are listed in **Table 3**. HCOC's primary export market is Asia, with China being the largest export destination over the past three years. It is anticipated that future export destinations for HCOC coal will continue to follow similar patterns. However, as coal sales are market-driven, export destinations may change in the future.

The countries that HCOC coal has been exported to, as identified below, all have NDCs under the Paris Agreement, or have followed international standards recognised by the UNFCCC and published their own NDCs document in support of the Paris Agreement.

Table 3 HCOC Saleable Coal Export Destinations

Export Destination	NDC Status
Brazil Chile China India Indonesia Japan South Africa South Korea Thailand Republic of Türkiye Ukraine Uruguay Vietnam	NDC published
Belgium France Germany Italy Luxembourg Netherlands Poland Spain	EU member; NDC submitted as part of the EU bloc
Hong Kong	Hong Kong is not a separate Party to the Paris Agreement; its climate actions are included under China's NDC.
Taiwan	Taiwan is not recognised as a sovereign state by the United Nations (UN). As a result, they are not a member of the UN and cannot participate in the UNFCCC, which oversees the Paris Agreement. However, Taiwan has followed the international standards recognised by the UNFCCC and published their own NDCs document in support of the Paris Agreement.

Historically, the top five export market countries for HCOC coal are (in order of largest to smallest):

- 1 China
- 2 Japan
- 3 South Korea
- 4 Vietnam
- 5 Republic of Türkiye



4.0 GHG Assessment Methodology

4.1 Overview

The calculation of GHG emissions from the Action has been performed in a five-stage desktop assessment process:

- 1 Definition of the Action boundary (i.e. the Action disturbance footprint);
- 2 Identification of GHG emission sources within the Action during construction and operation;
- 3 Identification of emission calculation methods and emission factors for each source;
- 4 Identification of the activity data for each emission source required for the calculations; and
- 5 Calculation of estimated GHG emissions.

Emissions were predominately calculated based on the NGER Measurement Determination (NGER Measurement Determination 2008) and the Australian National Greenhouse Account Factors (DCCEE 2025).

The GHG emissions estimated for the Action were compared against the most recent publicly available state and national GHG emissions to assess their potential contribution to Australia's emissions inventory and thus their potential impact on Australia's ability to meet GHG reduction targets and policies.

A number of assumptions have been relied upon in compiling the GHG emission inventory for the Action. GHG emissions from the key sources identified for the Action have been estimated based on the current emission factors published for use in reporting GHG emissions under the NGER Scheme, which rely on estimates of the level of intensity of each activity (referred to as activity data). This includes parameters such as projected fuel consumption rates and electricity consumption. The activity data used in the calculations has been compiled based on the current available Action design information and in consultation with HCOC management. The basis of the emission estimates and activity data are detailed in the relevant subsections in **Section 4.4**.

4.2 Boundary Definition

The boundaries adopted for the GHG emission inventory compiled for the Action as part of this GHG assessment are as follows:

- As there is no construction phase associated with the Action other than land clearing, which is part of normal operational activities for the mine, a separate emission inventory for construction has not been compiled;
- GHG emissions will occur during decommissioning and rehabilitation of the mine at the end of its life. Due to the uncertainty regarding the timing and activity data relevant to the mine closure and rehabilitation, and given that the Action would not significantly impact the scale of emissions, GHG emissions associated with the end-of-life phase of the mine and associated infrastructure have not been estimated as part of this study;
- The assessment has considered Scope 1, Scope 2 and Scope 3 emissions associated with the Action; and
- The geographical boundary set for the Scope 1 and Scope 2 emissions considered in the GHG assessment covers the HCOC site. All related activities outside of this



geographical boundary with significant GHG emissions have been addressed under Scope 3.

4.3 Identification of GHG Emission Sources

GHG emission sources were identified through a review of previous GHG emission inventories compiled for the HCOC, and the Action description. The potential emissions associated with the Action that were considered in preparing this GHG assessment are listed below. In relation to Scope 3 emissions, the assessed emission sources are limited to the main sources of GHG emissions associated with the proposed future HCOC operations (Action only, and for the mine plan including the Action).

- Scope 1:
 - Land clearing;
 - Fossil fuel combustion in mobile and fixed plant;
 - Consumption of oils and greases;
 - Fugitive emissions from extraction of coal; and
 - Emissions associated with the leakage of SF₆ from switchgear.
- Scope 2:
 - Electricity consumption.
- Scope 3:
 - Production and supply of fuels consumed;
 - Transmission losses associated with electricity consumption;
 - Emissions associated transfer of product coal via rail to Dalrymple Bay Coal Terminal;
 - Emissions associated with transfer of product coal via ship from Dalrymple Bay Coal Terminal to overseas ports; and
 - Emissions associated with combustion of product coal.

There will also be GHG emissions from HCOC associated with the following activities/sources, however due to the Action having minimal impact compared to current emissions, and thus their expected small contribution to overall emissions (likely <1%), they were deemed to not be material to the assessment and were excluded from the emission inventory:

- Refrigerant leakage from cooling systems; and
- Emissions from the on-site and off-site treatment and disposal of solid and liquid waste.

The emission sources that were included in the emission calculations are summarised in **Table 4**.



Table 4 Action Scope 1, Scope 2 and Scope 3 GHG Emission Sources

Emission Source	Scope 1/ Scope 2 Reportable under NGER	Scope 1	Scope 2	Scope 3
Vegetation clearing	No	✓	x	x
Fugitive emissions from extraction of coal	Yes	✓	x	x
Use of diesel fuel	Yes	✓	x	✓
Use of unleaded petrol	Yes	✓	x	✓
Consumption of electricity	Yes	x	✓	x
Transmissions losses from purchased electricity	No	x	x	✓
Storage of sulphur hexafluoride gases	Yes	✓	x	x
Use of oils and greases	Yes	✓	x	✓
Transport of product by rail and ship	No	x	x	✓
Usage of product coal by end user	No	x	x	✓

4.4 Calculation Methods and Emission Factors Used

A summary of the emission estimation methods and sources of emission factors used is provided in **Table 5**. Further information is provided below.

4.4.1 Vegetation Clearing

Clearing of vegetation results in GHG emissions as it eliminates carbon sinks - plants and soil that naturally absorb and store carbon dioxide - and releases the stored carbon into the atmosphere when that biomass is removed or decomposes. Vegetation clearing emissions are not reportable under the NGER Scheme and no emission calculation methodologies or emission factors are given for GHG emission estimation for land clearing in the *Measurement Determination 2008* or the National Greenhouse Accounts (NGA) Factors Workbook published each year.

GHG emissions from vegetation clearing associated with the Action have been calculated using the Department of Industry, Science Environment and Resources (DISER) FullCAM model to derive an emission factor in t CO₂-e per hectare cleared. FullCAM was developed under the National Carbon Accounting System (NCAS) at the then Australian Greenhouse Office to provide a dynamic account of the changing stocks of carbon in Australia's land systems since 1970 by integrating data on land cover change, land use and management, climate, plant productivity, and soil carbon over time. FullCAM estimates carbon stock change and GHG emissions at fine spatial and temporal scales, and uses a wide range of spatially referenced data.

The FullCAM model was run with reference to the *Requirements for use of the Full Carbon Accounting Model (FullCAM) with the Emissions Reduction Fund (ERF) methodology determination: Carbon Credits (Carbon Farming Initiative—Avoided Clearing of Native Regrowth) Methodology Determination 2015* (DISER 2020).



4.4.2 Fugitive Emissions from Coal Mining

Historically, fugitive emissions from the extraction of coal at HCOC have been estimated using the default Method 1 emission factor from the NGER Measurement Determination.

Since 2022, HCOC has conducted drilling programs and technical studies to develop a gas assignment model for the in-situ methane (CH₄) and CO₂ in place at HCOC, prior to extraction of coal, which has allowed HCOC to first commence reporting under Method 2 for the FY23/24 period. This gas assignment model has also been used to estimate the site-specific fugitive emissions each year of the proposed Action when extracting coal. The resulting annual CH₄ and CO₂ emission estimates were provided to SLR for use in compiling the Scope 1 emissions inventory.

Table 5 GHG Emission Calculation Methodologies

Emission Source	Details	Emission Factors
Vegetation clearance	Loss of carbon sink	FullCAM (DISER 2020)
Diesel Use - stationary	Power generation and off-road equipment	Schedule 1, Part 3, NGER Measurement Determination 2008 (Compilation No. 19)
LPG Use - Stationary		
Diesel Use - transport	Road registered vehicles	Schedule 1, Part 4, Division 4.3, NGER Measurement Determination 2008 (Compilation No. 19), Heavy duty (Euro I)
Gasoline Use - transport		Schedule 1, Part 4, Division 4.2, NGER Measurement Determination 2008 (Compilation No. 19), post-2004 vehicles
Consumption of petroleum-based oils and greases	-	Schedule 1, Part 3, NGER Measurement Determination 2008 (Compilation No. 19)
SF ₆ leakage	Gas-insulated switchgear and circuit breaker applications	Part 4.5, Chapter 4, NGER Measurement Determination 2008 (Compilation No. 19)
Fugitive emissions	Fugitive CH ₄ and CO ₂ associated with extracted ROM coal	Method 2 HCOC gas assignment model for the in-situ CH ₄ and CO ₂
Electricity consumption	Power generation (Scope 2) and transmission losses (Scope 3)	Location-based approach, using forecasted emission factors from <i>Australia's Emissions Projections 2023</i> (DCCEEW 2024) out to 2040. For 2040 to 2050, it was assumed that the emission factors will continue to decline linearly to zero by 2050, in line with Australia's commitment to net zero emissions by 2050
Product coal transport	Rail	Aurizon Emissions Calculator (https://www.aurizon.com.au/sustainability/environment/emissions-calculator)
	Ship	Mobile Combustion Greenhouse Gas Protocol Transport Calculation Tool, version 2.7
Combustion of product coal by end user	Bituminous coal Coking coal	National Greenhouse Accounts Factors (DCCEEW 2025)



5.0 Estimated GHG Emissions for the Proposed Action

5.1 Scope 1 and Scope 2 Emissions

The annual estimated Scope 1 and Scope 2 GHG emissions for the Action (i.e. emissions associated with the mining of coal within the proposed extension areas only) are presented in **Figure 2** and **Table 6**.

Figure 2 shows that the main sources of Scope 1 emissions over the life of the Action would be associated with fugitive emissions from coal extraction (63%), and the consumption of diesel in non-road registered vehicles (35%). Scope 2 emissions from the generation of electricity consumed as a result of the Action are estimated to be just over 1% of the total Scope 1 and Scope 2 emissions.

Based on the threshold for medium to high Scope 1 and Scope 2 GHG emission category emitting applications set out in the Guideline of 25,000 tonnes CO₂-e or more per year (DETSI 2025), the Action is classified as a **medium to high emitter**.

The total Scope 1 emissions estimated from the Action correlates to an approximate average emissions intensity value of 0.1095 t CO₂-e per t ROM coal.

The Action's net Scope 1 emission intensity will be subject to HCOC's requirements under the Safeguard Mechanism, and it is expected that the Action's net Scope 1 emissions (and intensity) will be materially lower than the gross emissions (and intensity) estimates presented herein. The Project's net Scope 1 emission intensity under the Safeguard Mechanism is estimated to be 0.0526 t CO₂-e per t ROM coal which is approximately 48% of the gross emissions intensity estimates presented above.

In addition, as noted in **Section 3.0** the combined coking and thermal coal annual production rate projections for the mine plan including the Action are well below the current EA limit of 20 Mtpa ROM coal (see **Table 2**). The GHG emission projections for the ongoing operations at HCOC are therefore also well below the levels that would occur if mining was to occur at the approved production rate.

Figure 2 Estimated Annual Scope 1 and 2 GHG Emissions – Action Only

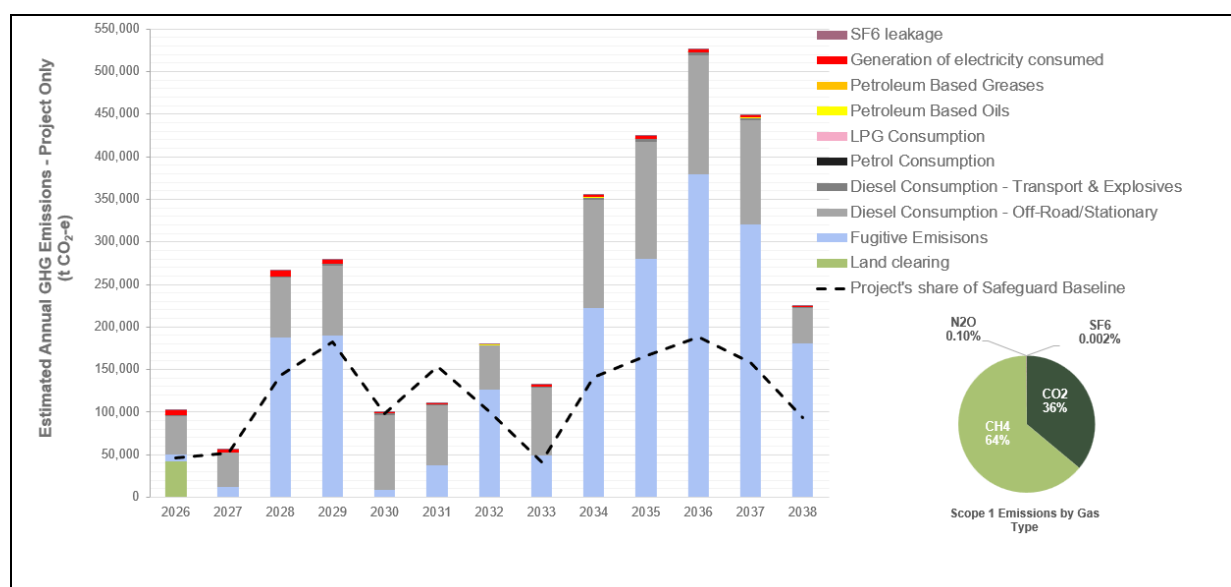


Table 6 Estimated Annual Scope 1 and 2 GHG Emissions (Action Only)

Mine Plan Schedule	Estimated Scope 1 Emissions (t CO ₂ -e) for the Action											Estimated Scope 2 Emissions for the Action (t CO ₂ -e)	Total Estimated Scope 1 + 2 Emissions for the Action (t CO ₂ -e)
	Vegetation Clearing	Fuel Combustion				Fugitive Emissions			Oils and Greases	SF ₆ Leakage	Total Scope 1 Emissions		
		CO ₂	CH ₄	N ₂ O	Total	CO ₂	CH ₄	Total					
2026	42,335	45,706	67	134	45,907	405	7,742	8,147	116	-	96,505	5,731	102,236
2027	-	40,689	59	118	40,866	464	11,668	12,132	97		53,094	2,631	55,725
2028	-	71,863	105	210	72,179	629	186,721	187,350	178		259,706	5,946	265,652
2029	-	83,431	123	245	83,799	953	189,284	190,237	208		274,244	5,164	279,408
2030	-	89,116	130	259	89,505	702	8,174	8,876	226		98,606	1,877	100,483
2031	-	71,152	103	206	71,461	1,960	35,959	37,919	210		109,590	1,099	110,689
2032	-	52,174	76	151	52,401	1,019	125,441	126,460	162		179,024	638	179,662
2033	-	80,202	117	234	80,553	396	48,879	49,275	298		130,127	1,551	131,678
2034	-	128,589	188	375	129,152	1,003	221,580	222,583	579		352,315	3,179	355,494
2035	-	139,870	205	409	140,483	1,173	279,139	280,312	592		421,387	3,068	424,455
2036	-	142,070	208	415	142,693	1,413	377,896	379,309	621	17	522,640	3,310	525,950
2037	-	124,248	182	363	124,793	759	319,973	320,732	608	17	446,149	2,470	448,620
2038	-	41,770	61	122	41,953	232	180,904	181,135	461	17	223,566	1,428	224,994
Annual Average	3,257	85,452	125	249	85,827	854	153,335	154,190	335	4	243,612	2,930	246,542
Total Life of Action	42,335	1,110,879	1,622	3,243	1,115,744	11,106	1,993,362	2,004,468	4,357	50	3,166,954	38,093	3,205,047



5.2 Scope 3 Emissions

The annual estimated Scope 3 GHG emissions are presented for the life of the Action in **Table 7** and **Figure 3**, which show that the main source of Scope 3 emissions from the Action are estimated to be associated with the combustion of the product coal, comprising approximately 93% of the total estimated Scope 3 emissions.

Figure 3 Estimated Annual Scope 3 GHG Emissions – Action Only

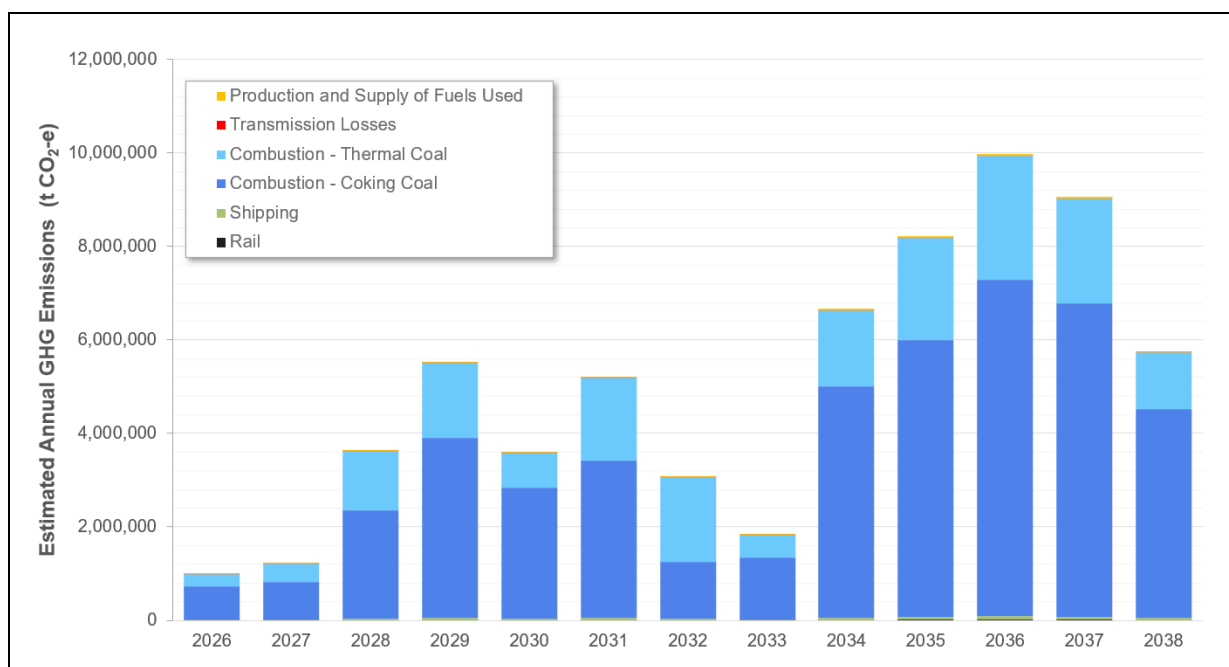


Table 7 Annual Estimated Scope 3 Emissions (Action only)

Mine Plan Schedule	Estimated Scope 3 Emissions (t CO ₂ -e) for the Action						
	Production and Supply of Fuels*	Product Transport by Rail	Product Transport by Ship	Combustion - Coking Coal	Combustion - Thermal Coal	Transmission Losses	Total Scope 3
2026	11,475	1,054	7,967	719,737	265,373	777	1,006,384
2027	10,206	1,301	9,830	809,596	396,568	335	1,227,834
2028	18,036	3,889	29,388	2,312,630	1,280,854	728	3,645,525
2029	20,942	5,863	44,305	3,861,791	1,599,781	626	5,533,307
2030	22,374	3,775	28,527	2,800,635	752,812	221	3,608,342
2031	17,905	5,566	42,065	3,367,070	1,783,141	194	5,215,940
2032	13,141	3,381	25,553	1,231,636	1,801,299	98	3,075,108
2033	20,269	1,939	14,650	1,333,848	478,735	222	1,849,663
2034	32,640	7,011	52,983	4,945,050	1,624,629	424	6,662,737
2035	35,449	8,685	65,630	5,928,735	2,186,062	236	8,224,796
2036	36,035	10,537	79,630	7,204,955	2,642,172	276	9,973,605
2037	31,606	9,543	72,116	6,709,282	2,230,368	494	9,053,408
2038	10,985	6,050	45,717	4,471,227	1,221,576	143	5,755,698
Global Emissions							
Annual Average	21,620	5,276	39,874	3,515,091	1,404,875	367	4,987,104
Total	281,062	68,594	518,359	45,696,189	18,263,369	4,773	64,832,347
Inside Australia							
Annual Average	4,324	5,276	-	-	-	367	9,968
Total	56,212	68,594	-	-	-	4,773	129,580
Outside Australia							
Annual Average	17,296	-	39,874	3,515,091	1,404,875	-	4,977,136
Total	224,850	-	518,359	45,696,189	18,263,369	-	64,702,767

* For the purposes of categorising emissions as inside/outside of Australia, a 20/80 split was assumed based on the Australian refinery share of petroleum product sales in the 2024-25 financial year being reported as 23%, with the remainder imported (from: <https://www.energy.gov.au/energy-data/australian-petroleum-statistics>).



5.3 Summary

A summary of the estimated emissions is provided in **Table 8**, including estimates of:

- The total average annual scope 1, 2 and 3 (within Australia only) emissions as a percentage of Australia's annual national emissions for the latest reported year; and
- The total average annual scope 1,2 and 3 (within and outside Australia) emissions as a percentage of annual global emissions.

The estimated annual average Scope 1, 2 and 3 emissions within Australia from the Action (256,510 t CO₂-e) represent approximately 0.057% of Australia's 2022 emissions. The estimated annual average Scope 1, 2 and 3 emissions within and outside Australia from the Action (5,233,646 t CO₂-e) represent approximately 0.011% of the estimated global 2021 emissions.

Table 8 Summary of Estimated GHG Emissions for the Action

Parameter		Value
Average annual scope 1 GHG emissions (tonnes CO ₂ -e)	(a)	243,612
Total scope 1 GHG emissions (tonnes CO ₂ -e)	(b)	3,166,489
Average annual scope 2 GHG emissions (tonnes CO ₂ -e)	(c)	2,930
Total scope 2 GHG emissions (tonnes CO ₂ -e)	(d)	38,093
Average annual scope 3 GHG emissions, reporting emissions within Australia and outside Australia separately (tonnes CO ₂ -e)	(e)	(within Australia) 9,968
		(outside Australia) 4,977,136
Total scope 3 GHG emissions, reporting emissions within Australia and outside Australia separately (tonnes CO ₂ -e)	(f)	(within Australia) 129,580
		(outside Australia) 64,702,767
Total GHG emissions (tonnes CO ₂ -e)	sum of (b), (d) and (f)	68,036,929
Total average annual scope 1, 2 and 3 (within Australia only) emissions as a percentage of Australia's annual national emissions for the latest reported year, using the Department's published estimates for the Paris Agreement inventory ^a	-	0.057%
Total average annual scope 1,2 and 3 (within and outside Australia only) emissions as a percentage of annual global emissions, using global emissions data for the latest year reported available from the Climate Watch's Historical GHG emissions site ^b	-	0.011%
a. ageis.climatechange.gov.au/ (446.4 Mt CO₂-e reported for year ending 2024, as per https://www.dcceew.gov.au/sites/default/files/documents/nggi-quarterly-update-december-2024.pdf.) b. www.climatewatchdata.org/ghg-emissions?end_year=2024&start_year=1990 (49.51 Gt CO₂-e reported for 2022)		



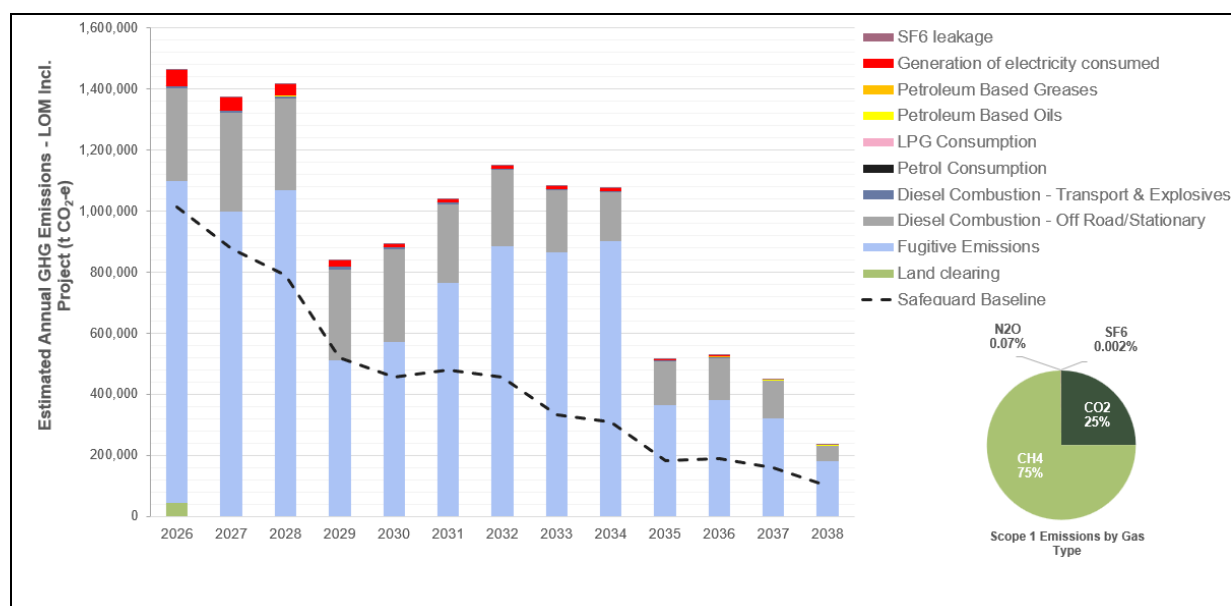
6.0 Management Measures

6.1 Safeguard Mechanism

As described in **Section 2.1**, HCOC is subject to the requirements of the Safeguard Mechanism, which has recently undergone significant reform. The Safeguard Mechanism reform is part of the Commonwealth Government's measures to achieve the national emission reduction target of 43% by 2030. Scope 1 GHG emissions associated with the Action will be included in the site's Safeguard Baseline assessments and reporting requirements as part of the overall HCOC operations.

Error! Reference source not found. presents the anticipated HCOC Safeguard Mechanism baseline, based on the site's approved site-specific emissions intensity determination, which represents the net annual Scope 1 emissions. This figure presents the estimated Scope 1 emissions from the HCOC operations (inclusive of the Action). Scope 1 emissions (excluding land clearing emissions) above this baseline will need to be mitigated or offset under the Safeguard Mechanism.

Figure 4 Estimated Annual Scope 1 and 2 Emissions – Mine Plan Including the Action



It is expected that the Action's net Scope 1 emissions (and intensity) will therefore be materially lower than its gross emissions (and intensity). As a covered facility, the Action will contribute proportionately to Australia's emissions reduction obligations through the Safeguard Mechanism, with declining baselines ensuring commensurate reductions in line with national targets and Australia's NDC commitments under the Paris Agreement.

6.2 Glencore's Climate Change Strategy

Glencore's Climate Change Strategy is to responsibly manage the decline of its global thermal coal portfolio. As the world moves towards a low-carbon economy, Glencore is focused on supporting the energy needs of today whilst investing in its transition metals portfolio. The metals Glencore produces, sources and markets will support the global ambition to decarbonise.



Consistent with the commitment to responsibly manage the decline of its thermal coal portfolio, Glencore has established total Scope 1, 2 and 3 emissions reduction targets, with a 15% reduction by the end of 2026, a 25% reduction by 2030, and a 50% reduction by the end of 2035, against a 2019 baseline, with a longer-term ambition of achieving net zero emissions by the end of 2050. These targets are comparable to the emission reduction objectives outlined in the QLD Climate Action Plan of:

- 30% emission reduction below 2005 levels by 2030;
- 75% emissions reduction below 2005 levels by 2035; and
- Zero net emissions by 2050.

Glencore's 2024-2026 Climate Action Transition Plan (Glencore 2024) outlines its position on climate and energy transition and the strategies it currently proposes to use to manage its transition, including:

- Recognising that thermal coal for electricity generation remains a necessary source of energy in many countries – providing grid stability, supporting energy access and security, and contributing to socioeconomic development in many markets. Glencore supports regulatory efforts to transition towards cleaner power generation and to reduce underlying demand for fossil fuels.
- To support anticipated global energy needs, Glencore plans to continue to progress select brownfield coal investments at existing mines but will continue to align with the Group emissions reduction targets and commitment to a managed decline of the coal portfolio overall.
- To continue driving improved operational performance in its industrial activities through a strong focus on identifying and delivering cost-effective emissions reduction opportunities.
- To continue to evolve technical and economic assessments to identify emissions reduction opportunities across the portfolio. This enables Glencore to identify and implement investments in abatement opportunities that are practically and commercially viable. Where opportunities are deemed not sufficiently ready, Glencore will continue to collaborate with industry and OEM partners to study and invest in research and development to drive technology maturation and scale requirements to improve commerciality.
- To identify and invest in value-enhancing growth opportunities in Glencore's metals portfolio that meet market requirements, including a focus on commodities fundamental for the transition to a low-carbon economy, such as copper, nickel, zinc, aluminium and cobalt.

6.3 Abatement Plan

Under the Guideline (DETSI 2025), EA applications for operations that exceed the threshold for medium to high emitters must also contain a GHG Abatement Plan. Where the amendment is for an EA that already has a GHG abatement plan in place, the application may include an amended GHG abatement plan.

HCC's plan to continue mining incorporates measures to maximise energy efficiency and minimise GHG emissions. HCC has also prepared a draft GHG Abatement Plan for the Action, which sets out the emissions management and reduction measures to be implemented for the Action.



HCC will continue to investigate means of reducing the emission intensity of its operations (including the Project) by maintaining current practices for fossil fuel minimisation, and investigating emerging technologies and further efficiencies for fossil fuel and open cut fugitive emissions reduction, such as:

- Continue to implement operational control efficiencies such as minimising haul distances, and optimising ramp gradients, payload management and scheduling activities to optimise equipment use.
- Continue to assess technologies to improve efficiencies and reduce emissions including through equipment purchase strategies, fuel switching, fleet electrification, open-cut pre-drainage, and use of electricity from renewable sources and consider implementation where reasonable and feasible.



7.0 Conclusions

The Action will generate an estimated 3.20 Mt CO₂-e of Scope 1 and 2 emissions related to the extraction and processing of ROM coal over the life of the Action.

Fugitive emissions are estimated to contribute 63% of the Action Scope 1 and 2 emissions, while diesel emissions from non-road registered vehicles are estimated to contribute 34%.

HCOC is subject to the requirements of the Safeguard Mechanism, which has recently undergone significant reform. The Safeguard Mechanism reform is part of the Commonwealth Government's measures to achieve the national emission reduction target of 43% by 2030. Scope 1 GHG emissions associated with the Action will be included in the site's Safeguard baseline assessments and reporting requirements as part of the overall HCOC operations. It is therefore expected that the Action's net Scope 1 emissions (and intensity) will be materially lower than the gross emissions (and intensity) estimates presented in this report.

Queensland's renewable energy targets are not considered to be substantially impacted by the Action as all product coal from the Action is proposed to be exported to offshore end users.

The Action is also estimated to generate a total of 64.83 Mt CO₂-e of Scope 3 emissions. The majority of these emissions will be generated by offshore customers when the product coal is combusted for electricity generation/steelmaking. Emission reduction strategies regarding Scope 3 emissions are the consideration of the respective countries that demand thermal and coking coal.

HCOC will continue to operate as a Safeguard facility. A draft GHG abatement plan has been developed for the Action in accordance with the Guideline (DETSI 2025) that sets out GHG emissions management and reduction measures for the Action.



8.0 References

- DCCEEW. 2025. *Australian National Greenhouse Accounts Factors 2025*. Australian Government. Department of Climate Change, Energy, the Environment and Water.
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- DETSI. 2025. *Guideline - Greenhouse Gas Emissions*. Version 1.00, Brisbane: Department of Environment, Tourism, Science and Innovation.
- DISER. 2020. *Requirements for use of the Full Carbon Accounting Model (FullCAM) with the Emissions Reduction Fund (ERF) methodology determination: Carbon Credits (Carbon Farming Initiative—Avoided Clearing of Native Regrowth) Methodology Determination 2015*. Version 3, Canberra: Department of Industry, Science, Energy and Resources, Australian Government.
- Glencore. 2024. *2024-2026 Climate Action Transition Plan*.
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- NGER Act. 2007. *National Greenhouse and Energy Reporting Act. Inc Amendments to Safeguard Mechanism (Crediting) Amendment Act 2023*. Office of Parliamentary Counsel, Canberra.
- NGER Measurement Determination. 2008. *National Greenhouse and Energy Reporting (Measurement) Determination 2008. Inc. Amendments to National Greenhouse and Energy Reporting (Measurement) Amendment (2023 Update) Determination 2023*. Office of Parliamentary Counsel, Canberra.







Australian Government

**Department of Climate Change, Energy,
the Environment and Water**

Notification of suspension of timeframe for referral and assessment approach decisions

Hail Creek Open Cut (HCOC) – Eastern Margin Extension, Hail Creek, Queensland (EPBC ref: 2025/10403)

This notice sets out an agreement made under sections 75(7) and 88(5) of the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act).

Proposed action

person proposing to take the action	Hail Creek Coal Holding Pty Ltd ABN: 71625050722
proposed action	To extend an existing open cut coal mine (EPBC 2014/7240) at Hail Creek, Queensland, including the operation and extension of three existing pits, and developing one new pit, and diverting Hail Creek.

Suspension period

suspension period	The timeframe for the referral and assessment approach decisions has been suspended for 10 business days, by agreement with the person proposing to take the action and the designated proponent. The revised statutory deadline is 30 March 2026.
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Person authorised to enter agreement:

Name and position	s. 22(1)(a)(ii) Director Queensland North Assessments
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Signature

s. 22(1)(a)(ii)

Date of decision	13 March 2026
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Australian Government

Department of Climate Change, Energy,
the Environment and Water

EPBC 2025/10403

s. 47F(1)

GCAA Approvals Coordinator
Level 44, 1 Macquarie Pl,
SYDNEY NSW
2000 Australia

s. 47F(1) glencore.com.au

Suspension of timeframe for referral and assessment approach decisions for *Hail Creek Open Cut (HCOC) - Eastern Margin Extension*

Dear s. 47F(1)

I am writing to you about your proposal to extend and operate an existing open cut coal mine (EPBC 2014/7240) at Hail Creek, Queensland, including the extension of three existing pits, developing one new pit and diverting Hail Creek.

On 13 March 2026, in discussion with the department, you agreed to suspend the timeframe for the referral and assessment approach decisions in accordance with section 75(7) and section 88(5) of the *Environment Protection and Biodiversity Conservation Act 1999*.

As a delegate of the Minister for the Environment and Water, I agree to suspending the timeframe for decision on the referral and assessment approach.

The referral and assessment approach decisions are now due on 30 March 2026.

A notice of my agreement specifying the period of suspension is attached for your information and will be published on the department's website.

If you have any questions, please contact the project manager s. 22(1)(a)(ii) by email to s. 22(1)(a)(ii) @dcceew.gov.au, or telephone 03 6161 8814 and quote the EPBC reference number shown at the beginning of this letter.

Yours sincerely,

s. 22(1)(a)(ii)

Director
Queensland North Assessments
13 March 2026



For release under the FOI Act

Australian Government

Department of Climate Change, Energy,
the Environment and Water

Tax Invoice

Page: 1 of 1 LEX 83395

Invoice Date : 06 March 2026
 Invoice No. s. 47E(d)
 Your Account No. [REDACTED]
 Our ABN : 63573932849
 Date Printed : 06 March 2026

HAIL CREEK COAL HOLDINGS PTY LIMITED
 Level 44, 1 Macquarie PI
 SYDNEY NSW 2000

For enquiries please contact via email
AppropriationManagement@dcceew.gov.au

Item Description	Qty	Unit	Unit Price	Line Total
Additional Information S76 Fee	1	EA	\$1,701.00	\$1,701.00
Total Out of Scope Supplies				\$1,701.00
Total Amount Owning:				\$1,701.00

*** Total Amount Owning Includes GST of:

\$0.00

EPBC No: 2025/10403

Project Title: Hail Creek Open Cut (HCOC) – Eastern Margin Extension

PAYMENT ADVICE

TOTAL AMOUNT \$1,701.00

PAYMENT DUE WITHIN 30 DAYS

HAIL CREEK COAL HOLDINGS PTY LIMITED
 ABN (71625050722)

Invoice Date : 06 March 2026
 Invoice No. s. 47E(d)
 Account No. [REDACTED]

Credit Card Visit <https://ips.dcceew.gov.au> to make a secure credit card payment
 A surcharge fee applies to credit card payments



s. 47E(d)

Mobile & Internet Banking – BPAY®

Make this payment from your preferred bank account.

Direct Deposit

Payment details:

s. 47E(d)

Released by National EPA under the FOI Act 1982

<https://doi.org/10.1038/s44168-025-00296-5>

Quantifying the regional to global climate impacts of individual fossil fuel projects to inform decision-making

Check for updates

Nerilie J. Abram^{1,2,3} ✉, Nicola Maher^{1,2}, Sarah Perkins-Kirkpatrick^{2,4}, Georgina M. Falster^{1,2,5,6}, Terry P. Hughes⁷, Katrin J. Meissner^{8,9}, Louise J. Slater¹⁰, Andrew D. King^{11,12}, Andrew J. Pitman^{8,9}, Gillian Moon¹³ & Wesley Morgan¹³

Every additional tonne of carbon dioxide emissions adds to global warming¹. This means that decisions to approve new fossil fuel projects represent pivotal moments in shaping Earth's future climate trajectory. Yet, the specific additional global warming caused by project-level CO₂ emissions, and the impacts of that warming, are rarely incorporated into decision-making on the acceptability of new fossil fuel projects. Here, we show how quantifying this additional warming enables concrete, foreseeable consequences to be identified and evaluated in a formal risk assessment framework. This approach reveals that major socioeconomic and environmental consequences can be attributed to CO₂ emissions associated with individual fossil fuel projects, contrary to the pervasive unquantified claims of negligible risks by project proponents. Furthermore, as countries pursue rapid decarbonisation aligned to their Nationally Determined Contributions, the CO₂ emissions from individual fossil fuel projects can, within decades, dominate and even exceed legislated national emission limits. The practical, future-focused approaches demonstrated here offer a critical bridge between climate science and decision-making, with immediate relevance to choices that will shape Earth's climate for decades to centuries to come.

Earth's climate over the coming decades to centuries will be determined by cumulative global emissions of carbon dioxide (CO₂)¹ (Fig.1a). Limiting global CO₂ emissions, and thereby limiting global warming, relies on cooperation, commitments and actions towards emission reductions that are implemented at national and sub-national scales². Within these jurisdictions, the approval/permitting of new or extended fossil fuel extraction occurs on a project-by-project basis. This means that decisions with long-term commitments to future CO₂ emissions and their consequences are made at a project-level, which on their own can appear to be too small to significantly influence global climate change. This raises a fundamental question in the nexus between science and decision-making: if every project

is considered too small to matter, does that imply that no individual project bears responsibility for any climate change consequences?

Approval of new or extended fossil fuel projects considers many factors, including their anticipated greenhouse gas emissions. For example, in Australia, one of the world's major fossil fuel producers³, the proponents of new fossil fuel projects are required to submit project proposals that detail their anticipated greenhouse gas emissions and associated impacts. There are established protocols for calculating and reporting greenhouse gas emissions of fossil fuel production and use⁴. However, there is no required or best-practice framework for quantifying the consequences of these anticipated emissions. Across a range of project proposals under various

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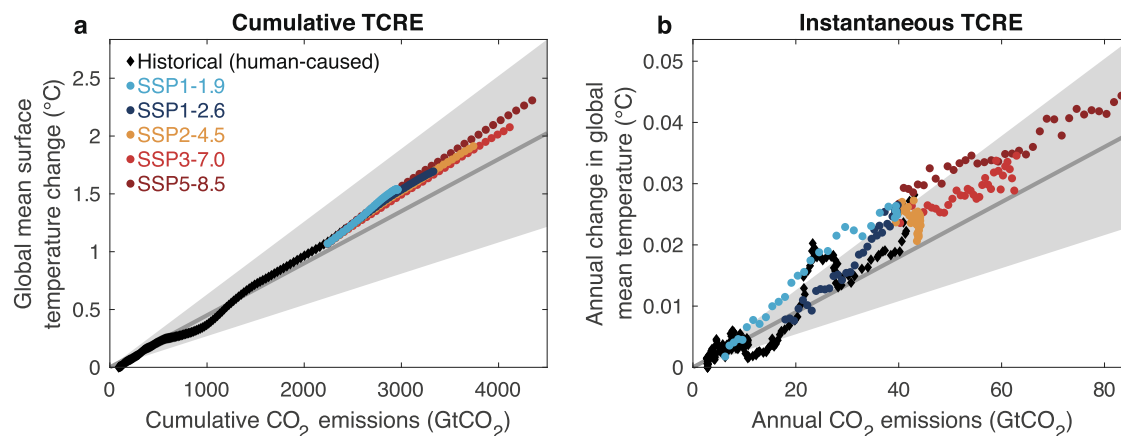


Fig. 1 | The transient climate response to CO₂ emissions (TCRE). **a** The near-linear relationship between cumulative CO₂ emissions and human-caused global warming demonstrated for historical data (1850–2019) and future emission scenarios synthesised across the multi-model mean of CMIP6 simulations (2014–2050). Future scenarios are based on Shared Socioeconomic Pathways (SSPs) ranging from very low emissions (SSP1-1.9) to very high emissions (SSP5-8.5)

futures. Data are from Fig. SPM.10 of ref. 1. **b** The same near-linear relationship is also evident for annual CO₂ emissions and the additional human-caused warming each year, derived from the same datasets. Grey line in both panels shows the IPCC best estimate of the TCRE (0.45 °C of warming caused by 1000 GtCO₂) and grey shading shows the 66–100% likelihood range of the TCRE (0.27 °C to 0.63 °C of warming caused by 1000 GtCO₂).

Australian jurisdictions, and multiple proponents including global carbon majors^{5,6}, we demonstrate three pervasive areas where a climate-science basis is currently lacking in fossil fuel project proposal documents (Supplementary Table 1). Firstly, proponents consistently describe their project-level greenhouse gas emissions as negligible in the context of global emissions and as having an unquantifiable contribution to global warming. Secondly, because their global warming contribution is unquantified and assumed negligible, the climate change impacts of individual projects are also unquantified and assumed to be inconsequential. And thirdly, descriptions of project contributions to national or global emissions inventories fail to incorporate committed decarbonisation trajectories over the lifecycle of the proposed projects. Given the immediate risks of climate change, and the deep emission reductions required to meet national and international climate mitigation commitments, there is an urgent need for science-based tools that can support decision-making. Specifically, science-based approaches are needed to quantify the context and consequences of new fossil fuel projects at the point of their approval.

Bridging the divide between scientific evidence and decision-making requires frameworks that link greenhouse gas emissions to tangible consequences. The historical responsibility for climate warming, and its economic damages, has been established for nations⁷ and major fossil fuel companies⁵. The economic costs of future climate warming and associated changes in climate variability and extremes have also been projected^{8,9}, and are expected to disproportionately impact poorer, low-latitude countries that are also often the least responsible for climate change. Scientific progress in quantifying and attributing climate change consequences is underpinning litigation claims worldwide^{6,10}. But there remains a divide in bringing actionable scientific evidence into decision-making at a level that can play a role in reducing future climate harms. Using a case study approach, we demonstrate a simple and robust method for quantifying the additional global warming that can be anticipated from the CO₂ emissions of individual fossil fuel projects. This is a critical step that then enables the specific, tangible consequences of a project to be quantified, which in turn can be used to assess whether the project's risks are acceptable. We further illustrate the time-evolving context of project-level CO₂ emissions with respect to Nationally Determined Contributions (NDC) to climate change mitigation, which enables proposals for new or extended fossil fuel projects to be evaluated alongside concurrent commitments to rapid emission reductions. The novelty and potential impact of our future-focused, project-level framework is that it brings the best-available scientific evidence into decision-making at the point where decisions are being made now that will commit future CO₂ emissions for many decades to come. These are the

decision points that will be critical to setting the world's future climate trajectory.

Results

Quantifying CO₂-induced warming

The IPCC 6th Assessment Report states that *every additional tonne of CO₂ emissions adds to global warming*¹. Following IPCC protocols, this statement in the Summary for Policymakers has been approved by all 195 IPCC member governments as an accurate representation of the scientific evidence assessed by the IPCC¹¹. The statement is made in the context of evidence for the 'Transient Climate Response to CO₂ Emissions' (TCRE); a simple yet robust metric that connects the primary cause of climate change (CO₂ emissions) to its principal measure (the change in global mean surface temperature)¹² (Fig. 1a). The IPCC assesses that the best estimate of the TCRE is that every 1000 billion tonnes (gigatonnes; Gt) of CO₂ emissions causes 0.45 °C of additional warming, with a 66–100% likelihood of warming between 0.27 °C to 0.63 °C¹. The robust evidence for this TCRE relationship spans process understanding, direct observations and climate model simulations¹¹. The TCRE has been defined based on global cumulative CO₂ emissions since 1850. It is the primary basis for determining the remaining carbon budgets that must not be exceeded if global warming is to be limited to particular policy relevant thresholds^{2,13,14}, including the 1.5 °C ambition and the well-below 2 °C goal of the Paris Agreement¹⁵.

The near-linear increase in global temperatures due to ongoing CO₂ emissions is expected (with high confidence) to continue over this century and for global warming up to at least 2 °C¹¹. This is regardless of the intensity of future emissions, and includes the emission reduction pathways required to limit warming to well-below 2 °C (e.g., SSP1-1.9 and SSP1-2.6 emission scenarios; Fig. 1a). CO₂ is well-mixed and long-lived in the atmosphere (Methods), and zero-CO₂ emission scenarios demonstrate that the global warming caused by past CO₂ emissions persists over many centuries, even after net CO₂ emissions cease entirely^{16–19}. The TCRE reflects the near-immediate climate warming response to CO₂ emissions that persists for centuries, while over millennial and longer timescales the equilibrium response of the climate to elevated atmospheric CO₂ concentrations results in further atmospheric surface warming as the energy budget balances across different parts of the Earth system, including the ocean²⁰. In the future, the TCRE could become higher than current assessments if positive feedbacks within the Earth system are activated, amplifying the warming caused by anthropogenic CO₂ emissions. For example, if human-generated CO₂ emissions cause enough warming to exceed the tipping point for rapid permafrost thaw²¹, releasing large quantities of additional greenhouse gases

into the atmosphere, then the resulting global warming would exceed expectations based solely on the TCRE relationship for anthropogenic CO₂ emissions¹¹. The TCRE is applied indiscriminately to all human-caused CO₂ emissions, however in reality the relationship is more nuanced for CO₂ emissions associated with land use change as these also involve associated changes in the land carbon sink and planetary surface albedo⁷.

The TCRE relationship provides a simple approach, based on robust scientific evidence, to quantify the additional global warming that can be anticipated due to individual fossil fuel projects. There is no assessed minimum emissions level where the TCRE relationship ceases to persist between CO₂ emissions and the global warming they cause¹¹. Process-based understanding of how CO₂ acts as a greenhouse gas to cause climate warming extends down to the molecular level^{22–26}. This implies that the near-linear relationship quantified for cumulative global CO₂ emissions and total global warming should apply to any level of CO₂ emissions that are made within the context where there is high confidence in the TCRE (i.e., fossil CO₂ emissions made this century, and for global warming up to at least 2°C). Indeed, an equivalent near-linear relationship exists between annual anthropogenic CO₂ emissions and additional human-caused warming each year¹⁴ (Fig. 1b). The TCRE has been used to quantify the annual and total contributions to historical global warming attributable to individual nations⁷. The application to quantify the additional warming caused by CO₂ emissions from individual fossil fuel projects is equivalent in method and scale to this previously established use. This is consistent with the IPCC assessment that every additional tonne of CO₂ emissions adds to global warming, and underpins the application of the TCRE at emission levels far smaller than the gigatonne scale used to quantify cumulative global CO₂ emissions.

Additional warming from project-level emissions

Quantification of the additional warming caused by individual fossil fuel projects is a critical evaluation tool. To illustrate this, we use a case study of the Scarborough gas project that has recently been approved for development offshore of northwest Australia²⁷ (Fig. 2). Liquefied Natural Gas (LNG) production from the Scarborough and North Scarborough fields is currently expected to start in 2026 and continue for 31 years, with potential for further expansion or extension to other gas fields in the Greater Scarborough resource. The Scarborough Offshore Project Proposal²⁷ defined the anticipated scope and environmental outcomes of the project as part of the regulatory approval process. This included estimates for routine greenhouse gas emissions related to the production, processing and consumption of Scarborough LNG. In its detailed impact evaluation, the report states that “it is not possible to link greenhouse gas emissions from Scarborough with climate change or any particular climate-related impact given that the estimated emissions associated with Scarborough are negligible in the context of existing and future predicted global greenhouse gas concentrations” (Supplementary Table 1)²⁷. The consequence of greenhouse gas emissions from the Scarborough project was therefore evaluated by the project proponents as “negligible for all receptors”.

The estimated greenhouse gas emissions from the Scarborough project total 876 million tonnes (Mt) of CO₂ emissions over the anticipated lifetime of the project²⁷. This incorporates CO₂ emissions associated with offshore production, onshore processing and domestic and international use of Scarborough gas (Methods). Equation 1 quantifies the best estimate of the additional global warming caused by CO₂ emissions from this project, based on the TCRE, as:

$$\text{Additional warming (}^{\circ}\text{C)} = \text{Emissions (Mt CO}_2\text{)} \times \frac{0.45 (^{\circ}\text{C})}{1,000,000 (\text{Mt CO}_2)} \quad (1)$$

The best estimate is that the 876 Mt of CO₂ emissions from this project will cause 0.00039 °C of additional global warming, with a 66–100% likelihood of causing global warming of between 0.00024 °C and 0.00055 °C (Fig. 2; Methods). While direct measurement of global mean temperature

changes is not possible with this level of precision, the agreement across multiple, consistent and independent lines of high-quality evidence (i.e., robust evidence using IPCC calibrated language²⁸) gives high confidence in the near-linear relationship between CO₂ emissions and global warming that is quantified through the TCRE¹¹. Thus, the additional warming that will be caused by CO₂ emissions from the Scarborough project (or any other fossil fuel project) is knowable and can be quantified based on the anticipated CO₂ emissions of the project.

Quantifying consequences

Quantification of the additional warming caused by individual fossil fuel projects enables tangible consequences of this additional warming to be quantified and evaluated in a risk assessment framework. A range of human, environmental and economic impacts are attributable to human-caused global warming. This includes evidence for severe impacts on human and natural systems that have already occurred at current levels of global warming^{29,30}, and projected future warming that will continue to worsen the frequency and intensity of many climate change-related hazards¹. These regional consequences in many cases scale with global warming levels, and hence, with CO₂ emissions. They can therefore provide more relatable and relevant measures of climate change risks for decision-makers than quantification of additional global warming alone³¹. Here, we use examples of impacts that are known to be strongly associated with global warming to demonstrate a framework for quantifying tangible consequences of the additional warming caused by an individual fossil fuel project.

The human cost of global warming can be quantified by considering the number of people who will be left outside of the “human climate niche”³². The human climate niche describes the climate conditions in which human societies have historically thrived and is defined by the distribution of the human population with respect to mean annual temperature. This distribution is shaped by the effects of climate on people, and on the species and resources that sustain or challenge us, and has been highly consistent for millennia^{32,33}. Unlike economic impact measures, the human climate niche framework for quantifying the human cost of global warming considers all lives as equal, regardless of wealth and is inclusive of those already alive and yet to be born³². The anticipated global population by the mid-21st century under middle-of-the-road socioeconomic pathways is around 9.5 billion people³⁴. In a world with 9.5 billion people, every 1 °C of additional global warming is projected to cause a 13.8 ± 1.6% increase in the global population exposed to a local climate shift where the mean annual temperature exceeds 29 °C and is beyond the hot edge of the human climate niche³² (Fig. 2a; Supplementary Fig. 1a). Considering the full cold-to-hot distribution of the climate niche, as well as anticipated demographic change, allows for further quantification that 9.5 ± 1.0% of the global population will be left outside of the human climate niche for every 1 °C of additional global warming³². Based on these relationships, the 0.00039 °C (0.00024 °C–0.00055 °C likely range) of additional global warming caused by CO₂ emissions from the Scarborough project will result in a best estimate of 516,000 people (308,000–732,000 likely range) being exposed to unprecedented heat, and 356,000 people (213,000–504,000 likely range) being left outside of the human climate niche (Fig. 2a; Methods).

One of the many consequences of exposure outside the human climate niche is increased mortality. At current levels of human-caused global warming, there has already been an observable and rapidly escalating rise in heat-related excess deaths^{35–37}, including mass mortality events³⁸. In many of the worst-affected regions of the world, principally developing nations with tropical (hot and humid) climates, robust data to quantify the human mortality burden of global warming is not yet available. In Europe, where suitable health data is available across 854 cities³⁶, recent work has quantified that under a low mitigation and low adaptation scenario (SSP3-7.0), the death burden of climate change will increase by 49% this century³⁹. Using the middle-of-the-road emissions and demographic scenario (SSP2-4.5) for projected European deaths (Fig. 2b, Supplementary Fig. 2a), it can be estimated that in Europe alone the additional climate warming caused by the Scarborough project will result in an additional 484 heat-related deaths by

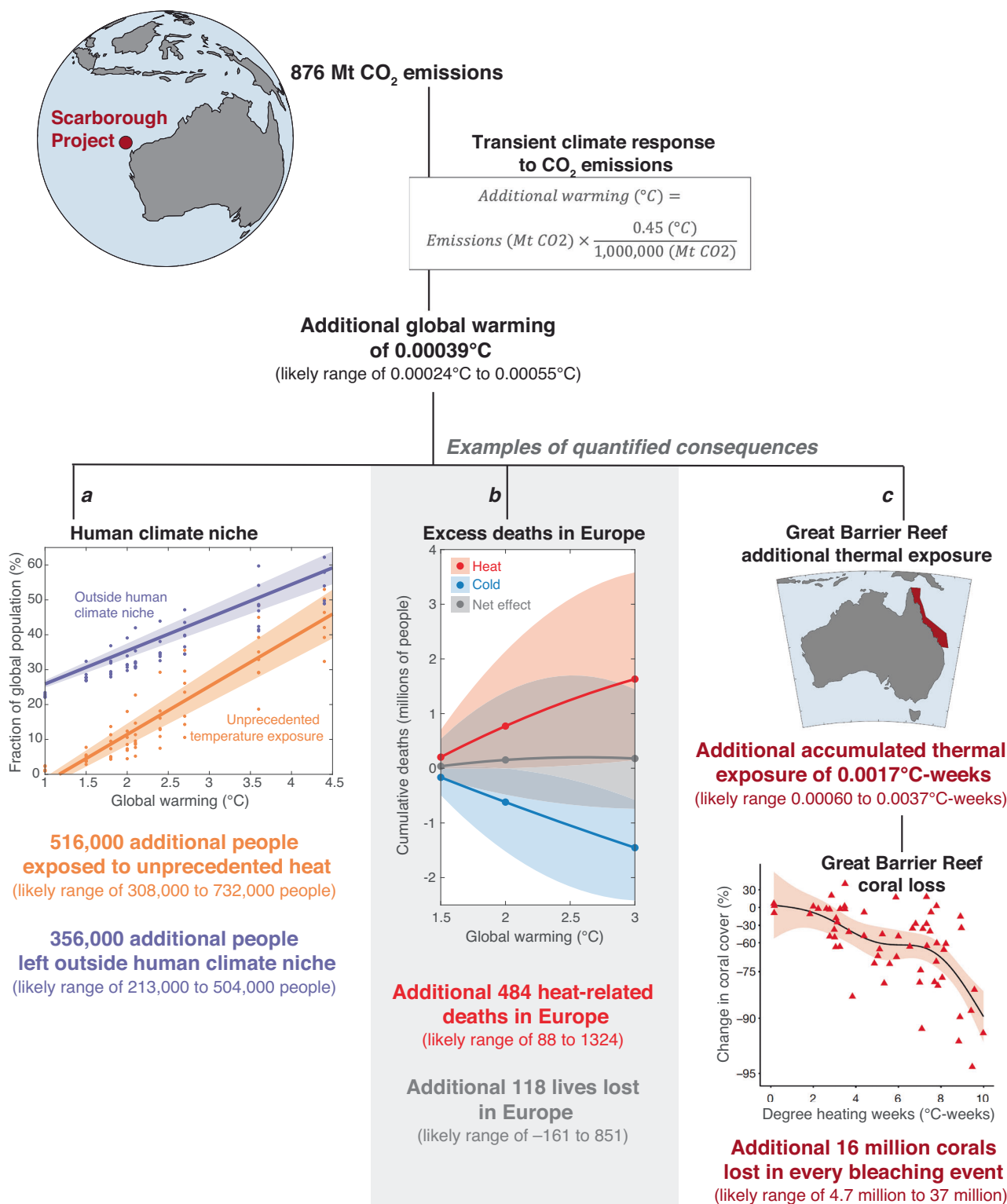


Fig. 2 | Example of the quantification of the consequences of project-level CO₂ emissions. The approach is illustrated using the Scarborough offshore gas project as a case study but is applicable to any fossil fuel project. Emissions from the Scarborough project of 876 Mt CO₂ can be anticipated (based on the TCRE) to cause a best estimate of 0.00039 °C of additional global warming. The consequences of this additional warming are expected to result in best estimates of, **a** an additional 516,000 people globally exposed to unprecedented heat and 356,000 left outside the human climate niche in a world with 9.5 billion people³² (Supplementary Fig. 1 also quantifies impacts for global populations of 6.9 billion and 11.2 billion people); **b** an

additional 484 heat-related deaths in Europe, and a total of 118 additional lives lost in Europe (net effect) by the end of this century under a middle-of-the-road emissions pathway (SSP2-4.5)³⁹ (Supplementary Fig. 2 also quantifies impacts under the high emissions SSP3-7.0 scenario); and, **c** additional thermal exposure in the Great Barrier Reef Marine Park (Supplementary Fig. 3) that results in an additional 16 million coral colonies lost in every future bleaching event on the Great Barrier Reef (lower panel after ref. 43). See Methods for calculation details, and text in the “quantifying consequences” section for more detailed descriptions of the examples illustrated in this figure.

the end of this century (with a likely range of 88 to 1324 additional heat-related deaths; Methods). Heat-related excess deaths in Europe are projected to be most common in southern regions³⁹, and when taking into account reduced cold-related deaths primarily in northern Europe, the net effect of additional warming caused by Scarborough project emissions is estimated to cost 118 lost lives (−161 to 851 likely range) in Europe alone.

Human-caused climate warming is also having detrimental consequences for natural systems that people value and depend upon. The Great Barrier Reef (GBR) is a UNESCO World Heritage site that is protected under Australian environmental laws⁴⁰. The severe impact of human-caused global warming on coral reefs is evident in the newly emerging phenomenon of mass coral bleaching and mortality events⁴¹. The GBR has experienced six mass bleaching events during the last decade (2016, 2017, 2020, 2022, 2024, and 2025), caused by heat extremes that are beyond the range of natural climate variability⁴². These repeated bleaching events mean that the existential threat to the GBR ecosystem from human-caused climate warming is now being realised^{41–44}. Back-to-back mass bleaching events have already occurred twice in consecutive summers, and with further global warming, mass bleaching of corals will soon occur every summer. The severity of coral bleaching and mortality depends on the intensity of marine heatwaves (positive sea temperature anomalies relative to the long-term average) and their duration (usually measured in weeks), which are combined in the ‘Degree Heating Week’ (DHW) thermal exposure metric⁴⁵. During the 2016 mass bleaching event on the GBR an accumulated heat exposure of 5 °C-weeks–6 °C-weeks resulted in an average loss of 60% of corals, and 8 °C-weeks–10 °C-weeks increased the average loss to 90% of corals⁴³. Each increase in heat exposure of 1 °C-weeks resulted in the death of 2–5% more corals⁴³. The 0.00039 °C (0.00024 °C–0.00055 °C likely range) of additional global warming caused by CO₂ emissions from the Scarborough project would increase accumulated thermal exposure on the GBR by 0.0017 °C-weeks (0.00060 °C–0.0037 °C-weeks likely range; Methods; Supplementary Fig. 3). Over the entire GBR, this would result in the death of an additional 16 million coral colonies (4.7 to 37 million likely range) during every future mass bleaching event (Fig. 2c, Methods).

The additional global warming attributable to a single fossil fuel project has quantifiable consequences for people and the environment (Fig. 2), and these can be robustly evaluated in a risk assessment framework. Risk assessments typically use the likelihood of an outcome, and the consequence of that outcome, to determine whether the risk of an activity is acceptable (Supplementary Fig. 4). The “negligible (level F) for all receptors” impact level of greenhouse gas emissions that was reached in the proponent’s risk assessment of the Scarborough project (Supplementary Table 1)²⁷ is assigned where consequences are expected to be localised and have no lasting effect (Supplementary Fig. 4). The quantified, evidence-based approach that we demonstrate here does not support this assessment of a negligible impact. We quantify additional warming, and examples of its consequences, with an uncertainty range that encompasses a likelihood of 66% or higher. In the Scarborough risk assessment framework these constitute a “likely” (51 to 80% chance) to “highly likely” (>80% chance) outcome (Supplementary Fig. 4a). The additional warming caused by CO₂ emissions from the Scarborough project will persist for multiple decades to centuries and cause long-term impacts across a range of environmental and social receptors, as illustrated by the examples developed above (Fig. 2a–c). In the Scarborough risk assessment framework these long-term impacts to communities and highly valued ecosystems equate to the highest levels (levels A and B) of consequence (Supplementary Fig. 4b). When these quantified assessments of likelihood and consequence are combined, the result is a risk rating of “severe” (Supplementary Fig. 4c). In an approval process, a severe risk rating should necessitate actions to reduce residual risk to an acceptable level.

Climate change mitigation context

In addition to assessing the acceptability of the consequences of CO₂ emissions from new fossil fuel projects, another important policy consideration is how these proposed emissions relate to national emission

reduction commitments. Fossil fuel projects span multiple decades, meaning that approval of new or newly extended fossil fuel projects today typically commit additional CO₂ emissions through to and beyond 2050 (Supplementary Table 1). Frequently, the context of annual emissions of these individual fossil fuel projects is quantified to be only a small percentage of today’s CO₂ emissions relative to state, national or global emissions levels (Supplementary Table 1). For example, the anticipated annual domestic emissions of the Scarborough project of 6.2 Mt CO₂ per year (based on scope 1 emissions and 15% of production that is reserved for domestic consumption; Methods) are equivalent to 1.6% of Australia’s fossil CO₂ emissions in 2024. However, the rapidly depleting remaining carbon budgets available to limit global warming to well-below 2 °C^{11,13} necessitate deep and rapid CO₂ emission reductions this decade, and achieving net-zero emissions by around mid-century⁴⁶. This means that an appropriate emissions context of new fossil fuel projects should encompass a rapidly decarbonising world.

National Determined Contributions (NDCs) provide an unambiguous, policy-aligned target for assessing the emissions context of proposed fossil fuel projects. Remaining carbon budgets for limiting global warming are determined at the global level^{11,13}, but emission reduction commitments and actions are implemented at national and sub-national levels. Principles of fairness that encompass capability, equality and responsibility have been discussed for guiding national allocations of the remaining global carbon budget^{2,47}. The Australian Government has previously determined that a national allocation of 0.97% might be considered as Australia’s fair share of the remaining global carbon budget to guide national emission reduction targets⁴⁸. Australia’s 2022 NDC⁴⁹ is a legislated commitment to reduce national greenhouse gas emissions by 43% below 2005 levels by 2030, and to achieve net-zero emissions by 2050. This is broadly equivalent to Australia doing its fair share to limit global warming to 1.7 °C with around a 50–67% likelihood of success (Fig. 3a; Supplementary Fig. 5; Supplementary Fig. 6).

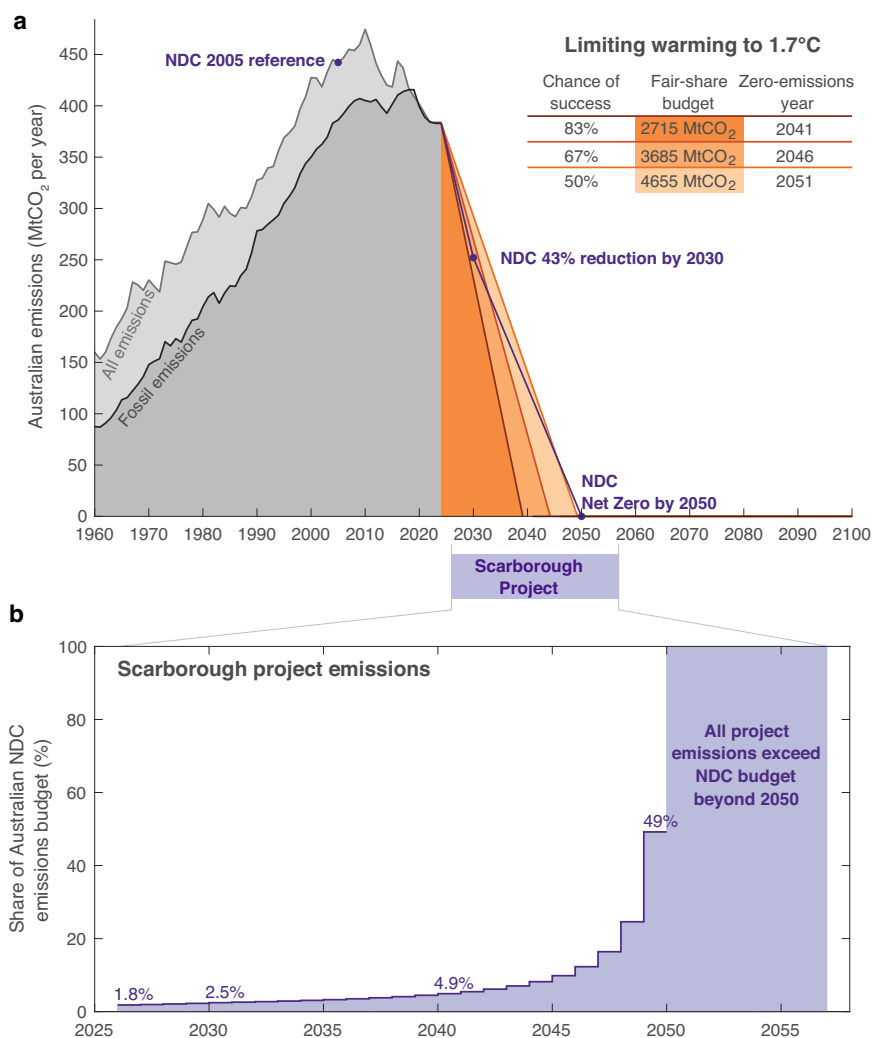
Scarborough project emissions can be anticipated to constitute a rapidly increasing fraction of the national CO₂ emissions budget under Australia’s committed climate change mitigation pathway (Fig. 3b). The expected annual CO₂ emissions from production, processing and domestic consumption of Scarborough gas (i.e., emissions covered under Australia’s national greenhouse gas inventory; Methods) will be around 1.9% of the national annual CO₂ budget at the commencement of production in 2026. This proportion rises to 2.5% by 2030 and 4.9% by 2040. By 2049, the anticipated Australian emissions from the Scarborough project alone will comprise half (49%) of Australia’s entire annual CO₂ emissions budget. Beyond 2050, all CO₂ emissions from the Scarborough project would require durable CO₂ removal from the atmosphere of an equivalent quantity to be consistent with Australia’s NDC.

CO₂ removal is necessary in net-zero pathways to compensate for hard-to-abate emissions, but should not be employed to avoid the rapid, near-term emission reductions required to achieve Paris Agreement goals^{50,51}. In 2023, human activities to move CO₂ from the atmosphere into durable geological storage (i.e., effectively reversing the carbon flux caused by fossil fuel combustion) amounted to only 0.04 Mt CO₂ globally⁵², which is equivalent to only 0.6% of the planned annual Australian emissions from the Scarborough project. The context illustrated here for Scarborough emissions represents a single project. However, the reality is that many approved and proposed fossil fuel projects, both in Australia (Supplementary Table 1) and globally⁷, now have life spans that extend through the time when nations have committed to substantially reducing emissions and achieving net zero. The context of project-level and aggregated fossil fuel emissions commitments relative to climate change mitigation commitments, as well as the significant financial burdens, technological limitations and environmental risks of durable CO₂ removal at scale^{50,51,53}, will become increasingly pressing factors as the remaining carbon budgets for limiting global warming continue to decline.

Discussion

Our analysis demonstrates how tangible and quantified examples of socio-economic and environmental consequences, across regional to global scales,

Fig. 3 | Australia's emission reduction pathway commitment and the changing context of Scarborough project emissions. **a** Australia's historical CO₂ emissions from 1960 to 2024 are shown for fossil (black line) and total (grey line) emissions, along with Australia's 2022 Nationally Determined Contribution (NDC; purple line) for emission reductions of 43% by 2030 (relative to 2005 levels) and net-zero emissions by 2050. Orange shading and table details show linear emission reduction pathways from the start of 2025 that are consistent with Australia's fair share of the remaining global carbon budget for limiting warming to 1.7 °C (Methods; See Supplementary Figs. 5 and 6 for the equivalent analyses for remaining carbon budget pathways to limiting warming to 1.5 °C and 2.0 °C, respectively). **b** Demonstration of the rising contribution of Scarborough project CO₂ emissions that fall under Australian carbon reporting (production, processing and domestic consumption) relative to Australia's NDC emissions reduction pathway.



can be brought into science-informed decision-making in ways that recognise that every fraction of a degree of additional warming matters. The most pressing concerns of decision-makers related to future CO₂ emissions may vary depending on the climate change vulnerabilities and values of the jurisdiction where new fossil fuel projects are being approved, or of the groups and nations where future emissions will have particularly dangerous and costly consequences. These factors may determine decisions on which consequences to prioritise when quantifying the impact of future CO₂ emissions⁵⁴. For example, in Australia a range of nationally significant animals, plants, habitats, water resources or places, including the GBR Marine Park (Fig. 2c), are protected by national legislation through the Environmental Protection and Biodiversity Conservation Act⁴⁰. Significant impacts on these Matters of National Environmental Significance⁴⁰ can be addressed in environmental approvals for proposed fossil fuel projects under Australia's jurisdiction. In other jurisdictions, human rights laws may provide instruments for climate change litigation, such as recent high-profile examples in Europe⁵⁴. In these settings the quantification of consequences for people (Fig. 2a), including excess mortality (Fig. 2b), may have the greatest relevance for decision-making. The International Court of Justice (ICJ) recently concluded in a unanimous Advisory Opinion that States have binding legal obligations under international law to prevent significant harm to the climate system and to reduce emissions to levels capable of achieving the 1.5 °C Paris Agreement goal (para. 457 of ref. 55). States must apply best available science to all their climate-related decision-making (paras. 278, 284, 298, and 347 of ref. 55). The ICJ Advisory Opinion is highly relevant for national decision-making on the compatibility of

proposed fossil fuel projects with achieving a State's climate change mitigation commitments for rapid decarbonisation over the coming decades (Fig. 3), including the ICJ conclusion that Developed States may be committing internationally wrongful acts by granting new fossil fuel project licences (para. 427 of ref. 55).

The approaches demonstrated here provide a science-based foundation that can be employed by companies, governments, decision-makers, governance boards, climate consultants and legal practitioners in quantifying the consequences of continued fossil fuel production and use, and in assessing whether these projects fall within acceptable levels of environmental and societal risk. In particular, we argue that companies proposing new or extended fossil fuel projects must better account for the impacts of their projected emissions. It is no longer defensible to simply state that their consequences will be negligible (Supplementary Table 1) when scientific evidence allows significant impacts to be anticipated and quantified (Fig. 2; Supplementary Fig. 4). A science-based approach also allows for a more explicit assessment of the financial burdens that result when new fossil fuel projects are approved, including through implicit assumptions and dubious feasibility^{50,53} of rapidly increasing large-scale CO₂ removal as continued fossil fuel production and use coincide with national decarbonisation commitments (Fig. 3). This work has developed the quantification process for a small number of example consequences, but many other consequences of additional warming can also be anticipated. Future work will broaden the quantified consequences so that the best-available scientific evidence is able to more readily be incorporated into climate-relevant decision-making globally. The future-focused framework developed here reinforces that

every tonne of CO₂ emissions adds to global warming, and that every fraction of a degree of additional warming matters¹.

Methods

All datasets and documents used for the analyses in this paper are derived from publicly available sources. These data sources are specified in the Methods text below, and in the analysis source code (<https://doi.org/10.5281/zenodo.16516964>).

Transient climate response to CO₂ emissions (TCRE)

The TCRE relationship used in this study is derived from the IPCC 6th Assessment Report of Working Group 1. The IPCC assessed that the *best estimate* is that 0.45 °C of global warming results from every 1000 Gt CO₂ emissions, with a *likely range* of global warming between 0.27 °C and 0.63 °C for every 1000 Gt CO₂ emissions¹.

Following established protocols for IPCC calibrated language²⁸, the *best estimate* represents the most likely value of the TCRE, and the *likely range* quantifies the possible range of TCRE values around the best estimate that are assessed to have a 66–100% likelihood (i.e., greater than 66% likelihood). IPCC assessments of likelihood involve statistical approaches to quantify uncertainty used alongside expert judgement. In the case of the TCRE, the *likely range* was derived from the statistical 90–100% likelihood of the TCRE (i.e., the 5th to 95th percentiles that statistically define a *very likely range* around the *best estimate*) in combination with expert judgement to account for incomplete coverage of all Earth system components in the approaches that were used to statistically define the TCRE. This consolidated assessment thus conservatively uses the statistical 5th–95th percentile range to describe a *likely range* (66–100% likelihood) of the TCRE¹¹.

It is well established that CO₂ is a well-mixed and long-lived gas in the atmosphere. This means that human-caused CO₂ emissions from fossil fuel combustion influence global climate in the same way, regardless of where these emissions are made. It also means that the climate warming impact of CO₂ emissions is sustained over timescales of multiple centuries to millennia. Short-lived greenhouse gases, notably methane (CH₄), cause warming that is sustained only over decadal timescales and for which an analogous TCRE relationship is not expected¹¹. For this reason, this study only quantifies the additional warming and consequences of project-level CO₂ emissions. For fossil fuel projects, CO₂ emissions are the dominant greenhouse gas that is produced (typically >99%; see example for Scarborough emissions below).

Scarborough emissions

Greenhouse gas emission data is derived from the Scarborough Offshore Project Proposal²⁷. Anticipated routine greenhouse gas emissions from the project are summarised in units of CO₂-equivalent. To facilitate application of the TCRE to determine the additional global warming caused by the Scarborough project, the CO₂-equivalent emission estimates are converted to CO₂ emissions using available information as follows:

Offshore production: Emissions (scope 1) from offshore production are derived from Table 7–14 and Table 7–15 of ref. 27. These are used to determine that fuel gas emissions of 9.88 Mt CO₂-equivalent are comprised of 99.7% CO₂, and flaring emissions of 1.38 Mt CO₂-equivalent are comprised of 95.4% CO₂. Scarborough gas has a CO₂ composition of 0.1 mol% (page 378 of ref. 27), and so offshore fugitive emissions of 0.26 Mt CO₂-equivalent (primarily CH₄) are omitted from the CO₂ emission estimates. Emissions from installation, construction and decommissioning of the offshore production infrastructure are estimated at 1 Mt CO₂-equivalent (page 378 of ref. 27), and are converted to CO₂ using 99.3% CO₂ composition derived from Australian Government national greenhouse gas accounting guidelines for heavy duty diesel fuel used for transport⁴.

Onshore processing: Emissions (scope 1) from onshore processing of Scarborough gas are derived from Tables 7–17 of ref. 27. Reservoir CO₂ emissions of 0.55 Mt CO₂-equivalent are assumed to be 100% CO₂. Processing emissions of 87.42 Mt CO₂-equivalent use the fuel gas emissions composition of 99.7% CO₂.

Consumption: End use emissions (scope 3) for Scarborough gas are derived from Table 7–19 of ref. 27. Under the domestic gas reservation policy of Western Australia, 15% of Scarborough gas production is required to be marketed in Western Australia (p. 387 of ref. 27). This amounts to 92.69 Mt CO₂-equivalent emissions from domestic consumption. International use amounts to 685.84 Mt CO₂-equivalent. The CO₂ composition of these emissions is estimated at 99.7%, based on Australian government greenhouse gas reporting for gas distributed by pipeline⁴.

Scarborough project emissions are provided²⁷ as fixed estimates without uncertainty values. As such, any uncertainty associated with emissions from the project are not incorporated in error calculations in this study.

Anticipated CO₂ emissions from Scarborough gas total 876 Mt CO₂ over the life of the project. Total CO₂ emissions are used in this study to quantify the additional warming and consequences of the Scarborough project. Of the total emissions, 192 Mt CO₂ fall under Australian jurisdiction for carbon accounting purposes (i.e., the emissions from production, processing and domestic consumption). The component of Australian emissions is used to demonstrate the time-evolving context of the Scarborough project relative to Australia's Nationally Determined Contribution to emission reductions.

The following text describes the methods used to quantify consequences and context of emissions from the Scarborough project, however, these are applicable in the same way to any project-level fossil fuel emissions. As such, in the following text we refer simply to the Project, rather than continuing to specify the Scarborough project.

Quantifying additional warming

The additional global warming that will be caused by CO₂ emissions from the Project is quantified using the TCRE through Eq. 1:

$$\text{Additional warming (}^{\circ}\text{C)} = \text{Emissions (Mt CO}_2\text{)} \times \frac{0.45 (^{\circ}\text{C})}{1,000,000 (\text{Mt CO}_2)}$$

This results in a *best estimate* of 0.00039 °C of additional global warming that will be generated by the 876 Mt CO₂ emissions from the Project. To calculate the *likely range* of additional global warming, the best estimate constant of 0.45 °C is substituted with 0.27 °C and 0.63 °C in the equation above, generating the *likely range* of 0.00024 °C–0.00055 °C of additional global warming.

Quantifying consequences

For each of the quantified consequences demonstrated here, we use a Monte Carlo approach to fully propagate uncertainty. Errors are propagated using 100,000 realisations that randomly sample the uncertainty distributions of each variable used in quantifying consequences. Following the same approach used by the IPCC in determining the TCRE (see TCRE methods text above), we quantify a conservative *likely range* of consequences by calculating the 5th and 95th percentiles across the 100,000 realisations that sample the uncertainty distributions.

To propagate uncertainty in additional warming, we randomly sample a normal distribution¹¹ around the mean TCRE (mean = 0.45 °C, σ = 0.11 °C) and use this to calculate 100,000 realisations of the additional warming that can be anticipated for CO₂ emissions from the Project. The 5th and 95th percentiles of this distribution correspond to additional warming of 0.00024 °C and 0.00055 °C, consistent with the IPCC-defined *likely range* of the TCRE.

Human climate niche: Quantification of the impacts of additional global warming caused by the Project are derived from the relationships developed in ref. 32, and the associated code archive⁵⁶. We quantify impacts based on a world with 9.5 billion people, which represents a middle-of-the-road shared socioeconomic pathway (SSP2) by the middle of the 21st century.

Two aspects of how global warming will affect people in relation to the human climate niche are quantified³² (Supplementary Fig. 1a).

Unprecedented heat exposure quantifies the proportion of the global population whose local climate shifts to be beyond the upper limit of the human climate niche (i.e., above a mean annual temperature of 29 °C). In a world with 9.5 billion people this increases linearly by $13.8 \pm 1.6\%$ (mean and 95% confidence interval) per °C of global warming. The number of people left outside of the human climate niche takes into account the full temperature distribution of the human climate niche, with the proportion of the global population left outside the human climate niche increasing linearly by $9.5 \pm 1.0\%$ per °C of global warming in a world with 9.5 billion people. The uncertainty in these relationships is randomly sampled 100,000 times assuming a normal distribution around the mean.

Supplementary Fig. 1a shows the data used to calculate the number of people moved outside of the human climate niche through additional global warming for the middle-of-the-road (SSP2 in 2070) scenario of a world with 9.5 billion people. Supplementary Fig. 1b, c, further demonstrate the consequences for scenarios with lower (6.9 billion) and higher (11.1 billion) global population scenarios, as quantified in ref. 32.

Excess mortality in Europe: Quantification of excess deaths in Europe due to the additional warming caused by the Project is based on relationships determined across 854 European cities and quantified for various future climate scenarios^{39,57}. We note that this example is used due to the availability of data from Europe to be able to quantify the excess deaths associated with additional warming. Some other parts of the world will be more severely impacted than Europe by excess deaths as a result of additional global warming, but data availability currently precludes quantification of these consequences.

Consistent with our approach for the human climate niche, we quantify excess climate change-related deaths in Europe using a middle-of-the-road (SSP2-4.5) future climate scenario. We extract data for cumulative excess deaths using a climate-change only option that has removed the effects of changing demographics under a no climate change scenario. Cumulative deaths are based on all age groups and a 0% adaptation scenario. The dataset quantifies cumulative deaths between 2015–2099, and so may slightly overestimate deaths caused by the Project where CO₂ emissions will occur over the 2026–2057 period. However, this should be countered by our approach of calculating additional deaths above 1.5 °C of global warming, which is near to today's climate warming level and so discounts any intensification of the impact of emissions on European deaths as global warming worsens over the lifetime of the Project.

Using the parameters described above, we extract Europe-wide information for cold-related deaths, heat-related deaths and total deaths at 1.5 °C, 2.0 °C, and 3.0 °C global warming levels (Supplementary Fig. 2a). Information for cumulative deaths at 4.0 °C is omitted as this level of global warming is poorly constrained in the SSP2-4.5 scenario of future climate simulations. Cumulative deaths data is provided as a best estimate, as well as lower and upper bounds that represent a 95% confidence interval. To estimate the additional deaths in Europe caused by the Project, we fit polynomials to the best estimate and 95% confidence interval data across the 1.5 °C to 3.0 °C global warming levels. We then use these polynomial functions to calculate the consequences of additional warming caused by the Project above 1.5 °C (e.g., the additional deaths at 1.50039 °C global warming level for the best estimate of additional warming, compared to deaths at 1.5 °C). The 95% confidence interval is not symmetrically distributed around the best estimate of cumulative deaths, and varies based on the level of additional warming. To account for this, the uncertainty distribution is randomly sampled 100,000 times based on a normal distribution that is defined by the 95% confidence interval at the level of additional warming above 1.5 °C caused by the Project, and the midpoint of this confidence interval.

The quantification of additional deaths in Europe is also repeated using the same methods, but for the impact of global warming levels defined in a high emissions (SSP3-7.0) scenario (Supplementary Fig. 2b).

Coral loss on the GBR: The consequences of additional warming caused by the Project for coral loss on the GBR requires first determining how global warming relates to thermal stress in the Great Barrier Reef

Marine Park (GBRMP). Thermal exposure is measured using the Degree Heating Weeks (DHW) parameter that is indicative of conditions that lead to coral bleaching and mortality^{41,58}. We examine the relationship between DHW and global warming using global mean surface temperature anomalies from the Berkeley Earth global temperature record (monthly resolution)⁵⁹ and the 5km-resolved DHW dataset from the NOAA Coral Reef Watch product (daily resolution)^{45,58}. These datasets illustrate that the annual, summer-centred maximum of accumulated DHW averaged over the GBRMP has been increasing at 4.4-times (± 1.0 standard error; °C-weeks per °C) the rate of annual (July–June) global mean surface temperature (Supplementary Fig. 3a, b). This relationship is based on fitting a linear model, which is expected to be an appropriate estimate for the small magnitudes of additional warming being examined in this study. However, over larger magnitudes of additional global warming it is expected that the increase in DHW will be non-linear, as demonstrated by the lognormal distribution of the spatial relationship between the 5 km grid level (12222 individual grid cells) annual maximum of accumulated DHW over the GBRMP with annual (July–June) global mean surface temperature (Supplementary Fig. 3c, d). The linear model (Supplementary Fig. 3b) estimates that 0.00039 °C of additional global warming will result in a best estimate of additional thermal exposure in the GBRMP of 0.0017 °C-weeks, and 100,000 random samples of a lognormal distribution of uncertainty on this relationship based on the spatial relationship across the GBRMP (Supplementary Fig. 3d) results in a 5–95% range of 0.00060 °C-weeks to 0.0037 °C-weeks.

Determining how increasing thermal stress relates to anticipated coral loss on the GBR uses information on the observed relationship between heat exposure and coral cover losses, alongside estimates of the area of coral reef habitats within the GBRMP and the density of coral colonies within these habitats.

The empirical relationship between heat exposure and observed losses of corals on the GBR during the 2016 mass bleaching event estimates that each increase in heat exposure of 1 °C-weeks resulted in the death of 2–5% more corals (Fig. 2c)⁴³. This defines a best estimate of 3.5% coral cover loss per °C-weeks, and an uncertainty around this central estimate that has a normal distribution with $\sigma = 0.91$.

The GBRMP includes an estimated 1.06 million hectares of coral habitat (hard substrate) at depths of 0–20 m⁶⁰. This is used as a conservative fixed estimate in our calculations and may underestimate total reef area. For example, another study that also measured deeper reefs estimated reef area to be more than 3-times larger (3.47 million hectares)⁶¹.

The number of corals per hectare is highly variable and poorly documented because coral abundance is typically measured as percent cover. Approximately 270,000 colonies larger than 9 cm² in size were counted per hectare on a Pacific reef⁶². Counts like this are highly sensitive to cutoffs in the minimum size of individuals recorded (e.g., the smallest size visible underwater to the naked eye, or in photographs or videos), and it is not feasible to count the youngest corals at the scale of hectares because newly recruited corals are microscopic. Their densities can exceed thousands per square metre⁶³ and far outnumber older and larger corals⁶⁴. Consequently, we conservatively assume that, on average, 250,000 individual coral colonies larger than 1 cm in diameter currently occur per hectare on each of the 1.06 million hectares of coral habitat on the GBR (i.e., an average density of 25 corals per m² of reef habitat). This average fixed estimate of density discounts many billions of juvenile corals that are smaller than 1 cm.

Based on the relationship between DHW and coral cover, each increase in heat exposure of 1 °C-weeks results in a loss of 2–5% of corals, which represents an average decline per hectare of 5000 to 25,000 individual coral colonies (from an original average of 250,000). Consequently, across all 1.06 million hectares of shallow coral habitat on the GBR, a further increase in accumulated thermal exposure of 0.0017 °C-weeks (*likely range* of 0.00060 °C to 0.0037 °C-weeks) would result in the loss of 16 million corals (*likely range* of 4.7–37 million corals) during every future mass bleaching event. Within a decade or two, mass bleaching on the GBR, and elsewhere, is likely to occur every summer^{41,42}.

This quantification of consequences of Project emissions focuses only on losses of corals due to additional warming worsening the intensity of marine heatwave events. It discounts the compounding impacts of diminishing return-times between mass coral bleaching events, and of concurrent ocean acidification and intensified flooding that also degrade reef ecosystems⁶⁵. The calculation of coral loss assumes that the relationship between DHW and coral losses on the GBR remains constant in the future. However, it is plausible that mortality rates in response to DHW could increase if the proportion of weedy, heat-susceptible corals increases over coming decades. Weedy corals are the first to rebound after bleaching events, despite their susceptibility to heat stress, and their prevalence may rise in response to repeated mass bleaching events⁴⁴. Our quantification focuses only on losses of corals, without quantifying the impacts of worsening heat stress on other climate-sensitive species in the GBRMP such as mangroves, sea grasses, turtles, dugongs and sea birds. The loss of millions of corals will also reduce the population sizes of many species that depend on corals and the habitat they provide, including juveniles and adults of many fish species⁶⁶. Many critical ecological processes, including calcification, reef growth, predation, and symbiosis will be further diminished throughout the GBR.

Climate mitigation context

Australia's 2022 Nationally Determined Contribution⁴⁹ is for a 43% reduction in greenhouse gas emissions by 2030 (relative to 2005 emissions), and net-zero emission by 2050. The emissions reduction pathway of Australia's NDC from actual emission levels at the start of 2025 is calculated using a linear reduction rate (Fig. 3a).

To give context to these emission reduction commitments we demonstrate them relative to historical emissions data from the Global Carbon Budget 2024⁵² (data accessed: <https://globalcarbonbudget.org/gcb-2024/>). The Global Carbon Budget 2024 provides annual CO₂ emissions datasets at global and national scales to the end of 2023, along with published estimates for global emission in 2024⁵². Australia's emissions for 2024 are assumed to be equivalent to 2023 emissions, which is a valid approximation based on Australian Government reporting⁶⁷.

The historical emissions data for Australia are based on annual fossil CO₂ emissions, as well as land-use change (LUC) emissions, which we take as the average of two accounting methods (OSCAR and HN23 datasets; the BLUE and LUCE datasets were excluded as they are highly variable at national scales, making them inconsistent with national emissions reporting). We note that the emission reduction and negative emission trends (i.e., reforestation) in Australian LUC emissions from the Global Carbon Budget are not as strong as for Australian Government emissions reporting⁶⁷, due to government-reported inventories also including the natural land sink in managed forests⁵².

To demonstrate how Australia's NDC relates to the remaining carbon budget for limiting warming to policy-relevant thresholds (Fig. 3a; Supplementary Figs. 5 and 6), we use the remaining global carbon budgets from the start of 2024¹³ adjusted for estimated 2024 emissions⁵² to reflect the remaining carbon budget from the start of 2025. In 2013, the Australian Government determined that Australia's "fair share" of the remaining global carbon budget should be 0.97%⁴⁸. From 2013–2024 (inclusive) Australia's total CO₂ emissions were 1.03% of global CO₂ emissions, based on global and national inventories of the Global Carbon Budget⁵². We adjust for Australia's proportion of actual global emissions between 2013 and 2024 in determining Australia's fair share of the remaining carbon budget from the start of 2025. This approach sets Australia's fair-share budget relative to 2013 (i.e., when the fair-share was established by the Australian Government) and adjusts for both changes in scientific evidence for the remaining global carbon budget¹³ and for Australia's actual emission rate since the fair-share was established. Linear emission reduction pathways⁴⁹ are used to show the pathways that would be consistent with Australia achieving its fair share to limit warming to 1.5 °C (Supplementary Fig. 5), 1.7 °C (Figs. 3a) and 2.0 °C (Supplementary Fig. 6) with a 50, 67, and 83% chance of success. Australia's 2022 NDC is broadly consistent with a fair-share emission

reduction pathway to limit global warming to 1.7 °C with between a 50% and 67% chance of success.

For each year of the Project, we calculate the proportion of Project emissions (using only CO₂ emissions that fall under Australia's jurisdiction for carbon reporting) relative to anticipated annual total Australian emissions based on a linear reduction of emissions from the start of 2025 that achieves Australia's NDC (Fig. 3b).

Software

All analysis and figure panels were generated with MATLAB 2024b software. This included using the M_Map mapping package⁶⁸.

Data availability

All datasets and documents used for the analyses in this paper are derived from publicly available sources. These data sources are specified in the Methods text, and in the analysis source code.

Code availability

MATLAB code for the analyses performed in this study is available at Zenodo: <https://doi.org/10.5281/zenodo.16516965>. Future work will be linked to this Zenodo archive, including development of a Python version of the code, and an interactive app that can be utilised for proposed project-level fossil fuel emissions that are made anywhere in the world. Future work will also extend the quantified consequences across a greater range of examples to aid translation of the methods demonstrated here into applications across various sectors and locations.

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Author contributions

N.J.A. conceived the study. N.J.A. and T.P.H. developed the analysis, with contributions from N.M., G.M.F., and S.P.K. N.J.A. wrote the analysis code and prepared the figures. N.J.A. led the writing, and all authors contributed to discussions and editing of the manuscript.

Competing interests

This manuscript builds upon consultancy work previously undertaken by N.J.A. and T.P.H. as independent experts for the Australian Conservation Foundation engaged through the Environmental Defenders Office.

Additional information

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