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APPENDIX S.2 – Environmental Impact Statement

Greenhouse gas assessment

Prepared for Lake Lyell Project Pty Ltd

Lake Lyell Pumped Hydro Energy Storage

Greenhouse gas assessment

Lake Lyell Project Pty Ltd

E221111 RP12.2

November 2025

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Executive summary

ES1 Background

EnergyAustralia Portfolio Holdings Pty Ltd (EnergyAustralia) in partnership with EDF power solutions Australia (EDFA), referred to as Lake Lyell Project Pty Ltd (LLP) as trustee, is developing the Lake Lyell Pumped Hydro Energy Storage (PHES) project (the project). The project will have the capacity to store up to 3,080 megawatt hours (MWh) of energy, and generate at 385 megawatts (MW) for 8 hours or generate up to around 440 MW for a shorter period.

This report presents a greenhouse gas (GHG) assessment to accompany the environmental impact statement for the project. The GHG assessment has been compiled in accordance with the *NSW Guide for Large Emitters*. Based on the criteria in the *NSW Guide for Large Emitters*, the project would be classified as a large emitter. However, the purpose of the project is to support the decarbonisation of the electricity grid. The project's scope 1 emissions during operation will be very low, and it has been designated as a large emitter based almost entirely on its gross electricity consumption from the grid, and the associated scope 2 GHG emissions. A large proportion of the electricity consumed would be returned to the grid as renewable energy. The scope 2 emissions will also decrease as the grid decarbonises. Consequently, some of the steps of the *NSW Guide for Large Emitters* were not considered to be relevant, or else could not be addressed in detail.

The GHG assessment covers the financial years 2026-27 to 2030-31 for construction, and financial years 2031-32 to 2049-50 for operation. The main findings of the assessment are summarised below.

ES2 Gross emissions from the project

In terms of gross emissions from the project:

- Scope 1 and scope 2 emissions:
  - The total scope 1 and scope 2 emissions during the construction of the project would be 116 kilotonne (kt) CO_2-e and 26 kt CO_2-e, respectively.
  - During construction, the largest contributor to scope 1 and scope 2 emissions would be diesel consumption (57%).
  - Practically all emissions during project operation would be due to gross electricity consumption. During the operation of the project, total scope 1 emissions would be low (1 kt CO_2-e), whereas scope 2 emissions would be relatively high (1,144 kt CO_2-e).
  - Scope 2 emissions during operation would reduce with time, being around 157 kt CO_2-e/year in 2031-32, and 36 kt CO_2-e/year from 2039-40. The reduction would be due to the progressive decarbonisation of the electricity grid.
  - The aggregated scope 1 and scope 2 emissions over the project life, including both construction and operation, would be 1,286 kt CO_2-e, of which 9% would be scope 1 and 91% would be scope 2.
  - The scope 1 emission intensity over the life of the project would be negligible.
  - The scope 2 emissions intensity profile essentially reflects Australian Government's projections of the emissions intensity of the grid, allowing for the difference between the energy consumed and generated by the project. The average scope 2 emission intensity over the life of the project would be 0.063 tonne (t) CO_2-e per MWh.

- Scope 3 emissions:
  - The total scope 3 emissions during the construction of the project would be 76 kt CO_2-e. During the operation of the project, total scope 3 emissions would be 36 kt CO_2-e. The aggregated scope 3 emissions over the project life, including both construction and operation, would be 112 kt CO_2-e.
  - Upstream emissions for embodied emissions in construction materials and diesel consumption would together be responsible for 95% of scope 3 emissions during the construction phase. During operation, practically all scope 3 emissions would be due to electricity consumption.

ES3 Selection of mitigation measures

Although it is not strictly a mitigation measure – as it is the rationale for the project and part of its normal operation – the return of electricity to the grid will greatly offsets the project's effective scope 2 emissions during operation. This is based on the assumption that the electricity returned to the grid would otherwise have to be produced elsewhere with the prevailing energy mix for the grid.

A range of other mitigation measures are proposed for the minor emission sources.

ES4 Emissions with mitigation measures

The largest reduction in emissions based on the net electricity consumption would be in the first full year of operation (2031-32), and would be 125 kt CO_2-e. The overall emission reduction over the life of the project would be 915 kt CO_2-e.

TABLE OF CONTENTS

Executive summary **ES.1**

1 Introduction **1**

1.1 Background 1

1.2 Assessment guidelines and requirements 1

2 Project summary **5**

3 Legislative and policy context **7**

3.1 Greenhouse gases and emission scopes 7

3.2 International context 9

3.3 Australian Context 9

3.4 NSW context 11

4 Greenhouse gas assessment **13**

4.1 Overview 13

4.2 Step 1: Assessment boundary 15

4.3 Step 2: Calculation of GHG emissions and prioritisation (as designed) 19

4.4 Step 3: Selection of mitigation measures 27

4.5 Step 4: Emissions with mitigation measures 29

4.6 Step 5: Emission benchmarking and goal setting 32

4.7 Step 6: Offsets strategy 32

4.8 Step 7: Independent expert review 32

5 Summary and conclusions **33**

5.1 Background 33

5.2 Gross emissions from the project 33

5.3 Selection of mitigation measures 34

5.4 Emissions with mitigation measures 34

5.5 Other considerations 34

References **35**

Abbreviations **37**

Annexures

Annexure A	GHG emission calculation methods	A.1
Annexure B	Activity data	B.1
Annexure C	Emissions data	C.1

Tables

Table 1.1	SEARs requirements (greenhouse gases)	2
Table 3.1	Greenhouse gases and characteristics	7
Table 3.2	Overarching NSW Government legislation and policy	11
Table 3.3	Key NSW EPA legislation and policy	12
Table 4.1	NSW EPA criteria for identifying large emitters	13
Table 4.2	GHG emission sources included in the assessment	17
Table 4.3	GHG emission sources excluded from the assessment	18
Table 4.4	Annual scope 1 and scope 2 emissions	20
Table 4.5	Project life scope 1 and scope 2 emissions	21
Table 4.6	Annual scope 3 emissions	22
Table 4.7	Project life scope 3 emissions	23
Table 4.8	Annual emission intensity during project operation	24
Table 4.9	Ranking of scope 1 and scope 2 sources based on project life emissions	25
Table 4.10	Ranking of scope 3 sources based on project life emissions	26
Table 4.11	GHG mitigation measures (project construction)	28
Table 4.12	GHG mitigation measures (project operation)	29
Table 4.13	Annual gross and net scope 1 and scope 2 emissions	30
Table 4.14	Project life gross and net scope 1 and scope 2 emissions	31
Table A.1	Energy content and emission factors – diesel consumption	A.1
Table A.2	Emission factor – explosives use	A.2
Table A.3	Vegetation cleared during project construction	A.3
Table A.4	GHG emission factors for vegetation clearing	A.3
Table A.5	Scope 2 GHG emission factors for electricity consumption	A.4
Table A.6	Energy content and scope 3 emission factors – liquid fuel consumption	A.5
Table A.7	Scope 3 GHG emission factors for electricity consumption	A.5
Table A.8	GHG emission factors – embodied emissions	A.6
Table A.9	Energy content and emission factors – diesel consumption	A.6
Table A.10	Emission factor for sea transport	A.7
Table B.1	Annual activity data	B.1
Table B.2	Quantities of construction materials	B.2
Table C.1	Scope 1 and scope 2 emissions by source and year	C.1
Table C.2	Scope 3 emissions by source and year	C.2

Figures

Figure 1.1	Regional setting	3
Figure 1.2	Project setting	4
Figure 2.1	Project layout	6
Figure 3.1	Overview of GHG emission scopes (WRI & WBCSD 2013)	8
Figure 4.1	GHG assessment boundary and emission sources	16
Figure 4.2	Annual scope 1 and scope 2 emissions	21
Figure 4.3	Annual scope 3 emissions	23
Figure 4.4	Contributions to scope 1 and scope 2 emissions	25
Figure 4.5	Contributions to scope 3 emissions	26
Figure 4.6	Gross and net scope 1 and scope 2 emissions for the project	31

1 Introduction

1.1 Background

EnergyAustralia Portfolio Holdings Pty Ltd (EnergyAustralia) in partnership with EDF power solutions Australia (EDFA), referred to as Lake Lyell Project Pty Ltd (LLP) as trustee, is developing the Lake Lyell Pumped Hydro Energy Storage (PHES) Project (the project). The project will have the capacity to store up to 3,080 megawatt-hours (MWh) of energy, and generate at 385 megawatts (MW) for 8 hours or generate up to around 440 MW for a shorter period. At a basic level, it will consist of upper and lower water reservoirs, a pipeline connecting them, and a hydro-electric power station connected to the national energy grid that is capable of generating or consuming electricity.

The project is located approximately 5 kilometres (km) west of Lithgow and 110 km west of the Sydney central business district, shown in Figure 1.1 and Figure 1.2. The project takes advantage of existing infrastructure (i.e. Lake Lyell) associated with Mt Piper power station which will be decommissioned in the coming decades and allows Lake Lyell to continue to serve a specific purpose in electricity generation (consistent with its existing use).

In June 2024, the Minister for Planning and Public Spaces declared the project to be critical State significant infrastructure (CSSI). Accordingly, approval for the project is required under Part 5, Division 5.2 of the NSW *Environmental Planning and Assessment Act 1979* (EP&A Act). This requires the preparation of an environmental impact statement (EIS) for the project in accordance with Secretary's environmental assessment requirements (SEARs) and the approval of the Minister. EMM Consulting Pty Limited (EMM) has been engaged by LLP to prepare the EIS.

This greenhouse gas (GHG) assessment is an appendix to the project's EIS and should be read in conjunction with it. The GHG assessment addresses the SEARs issued for the project.

The remainder of this report is structured as follows:

- Chapter 3 outlines the key legislative and policy assessment requirements for GHGs.
- Chapter 4 provides an assessment of the GHG emissions from the project, following the stepwise approach described in the *NSW Guide for Large Emitters*.
- Chapter 5 provides the summary and conclusions of the assessment.

1.2 Assessment guidelines and requirements

This GHG assessment has been prepared with reference to relevant guidelines, policies and industry requirements, and following consultation with stakeholders, including relevant government agencies and the community. Guidelines and policies referenced are as follows:

- *NSW Guide for Large Emitters* (NSW EPA 2025).

The *NSW Guide for Large Emitters* categorises a project as either (i) a new project or (ii) a modification to an existing project. In this context, the project is treated as a **new project**. The *NSW Guide for Large Emitters* defines the criteria for identifying whether a given project is a large emitter of GHGs. Based on these criteria, EMM concluded that the project **would be a large emitter** (refer to Section 4.1.2), and the GHG assessment therefore follows the steps in the *NSW Guide for Large Emitters*.

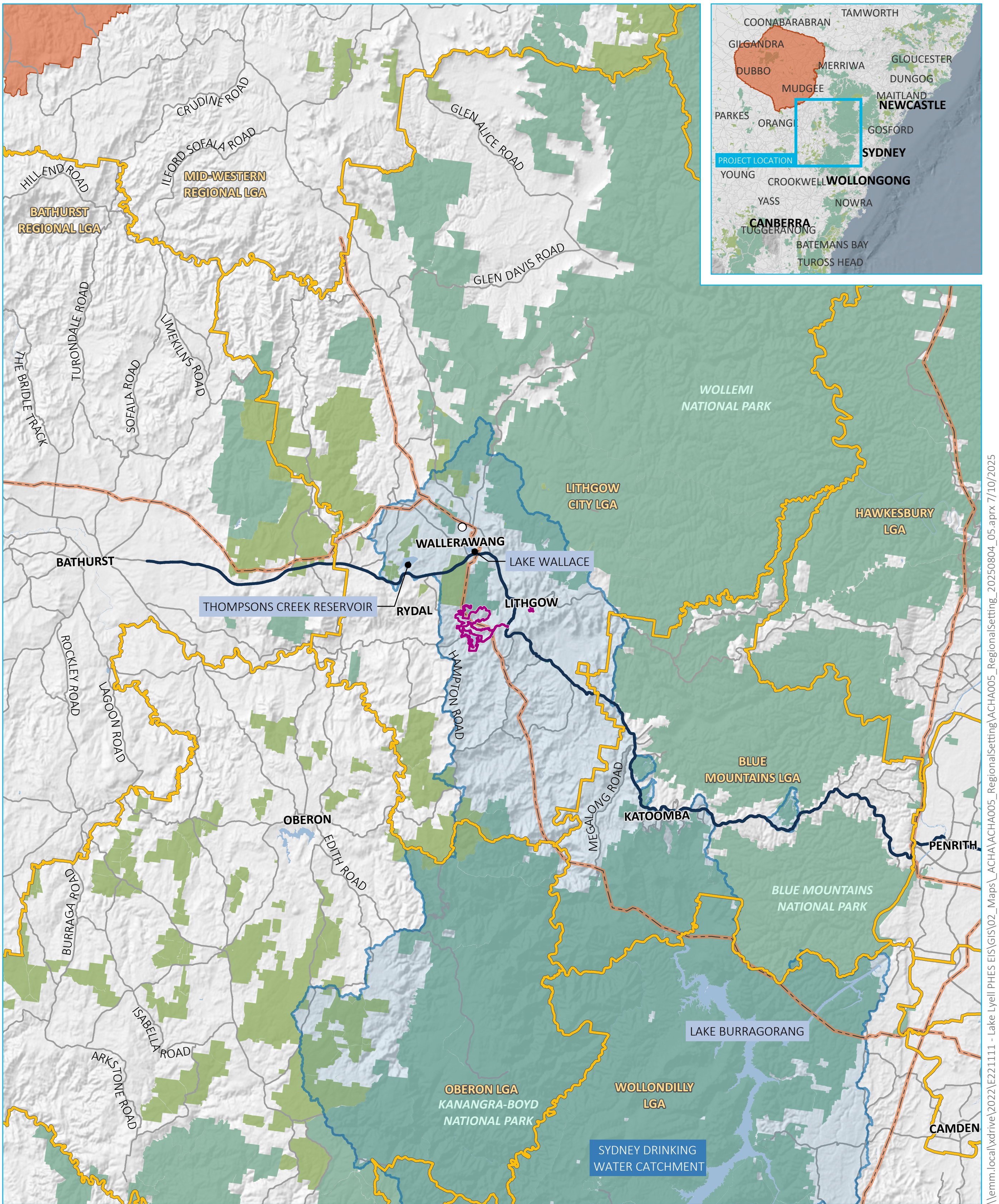
1.2.1 SEARs

This GHG assessment has been prepared in accordance with the requirements of the NSW Department of Planning, Housing and Infrastructure (DPHI) and relevant agencies, which are set out in the SEARs for the project, issued on 17 November 2025. The SEARs identify matters which must be addressed in the EIS. Individual requirements relevant to this GHG assessment and where they are addressed in this report are listed in Table 1.1.

The report includes estimates of GHG emissions for the project and measures to reduce these emissions. A separate climate change risk assessment (CCRA) has been prepared, and forms part of the EIS.

Table 1.1 SEARs requirements (greenhouse gases)

Requirement	Section addressed
Air – including:	
An assessment of the particulate matter and greenhouse gas emissions of the project.	This report and the Air Quality Impact Assessment (Appendix S1 to the EIS)
An assessment of the likely greenhouse gas impacts of the project including measures to minimise emissions, having regard to the targets set in the Climate Change (Net Zero Future) Act 2023, and in accordance with the EPA's NSW Guide for Large Emitters if required if emissions trigger the threshold as a large emitter.	This report



Source: EMM (2025); Lake Lyell Project Pty Ltd (2025); ABS (2021); DCSSS (2024); GA (2009); ESRI (2025)

KEY

- Project area

Existing environment

- Mt Piper Power Station
- Major road
- Great Western Highway
- 330 kV transmission line
- Named waterbody
- NPWS reserve
- State forest
- Local government area
- Sydney Drinking Water Catchment
- Central West Orana Renewable Energy Zone

INSET KEY

- Major road
- NPWS reserve
- State forest
- Central West Orana Renewable Energy Zone

Regional context

Lake Lyell PHES
Greenhouse Gas Assessment
Figure 1.1

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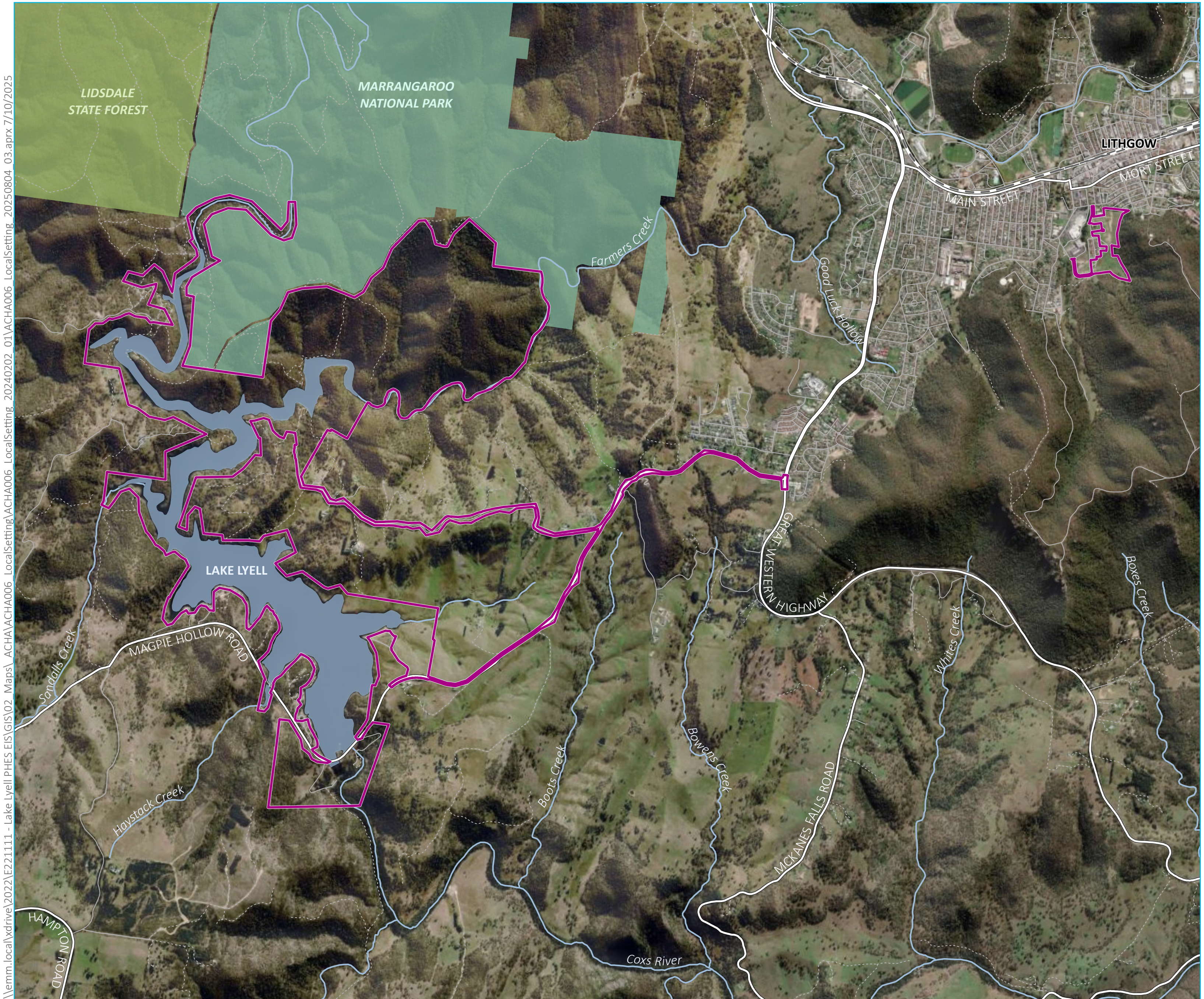

KEY

- Project area

Existing environment

- Rail line
- Major road
- Minor road
- Vehicular track
- Named watercourse
- Named waterbody
- NPWS reserve
- State forest

Source: EMM (2025); Lake Lyell Project Pty Ltd (2025); DCSSS (2024); GA (2009); ESRI (2025)

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Local context

Lake Lyell PHES
Greenhouse Gas Assessment
Figure 1.2

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2 Project summary

A detailed description of the project, including an overview of its design, construction and operation is provided in the project's EIS. The EIS (specifically Chapter 3 and Appendix B) should be read in conjunction with this report. A summary of the project's key elements is provided below.

The project design, as shown in Figure 2.1, can be broadly categorised into:

- pumped hydro generation components – including a 5.3 gigalitre (GL) upper reservoir to be constructed behind the southern ridge of Mount Walker, a 33.5 GL lower reservoir (existing Lake Lyell), inlet/outlet structures, and an underground powerhouse, surge shaft and waterway tunnels
- transmission connection components – including a new high-voltage switchyard and connection to the existing 330 kilovolt (kV) transmission line that runs through the site
- site access and ancillary facilities – including upgrade of existing and construction of new access roads and bridges, a diversion and infill of a section of Lake Lyell, administration and utilities
- other construction components or works – including geotechnical investigations, temporary workforce accommodation, site work pads, laydown areas and facilities, and spoil management.

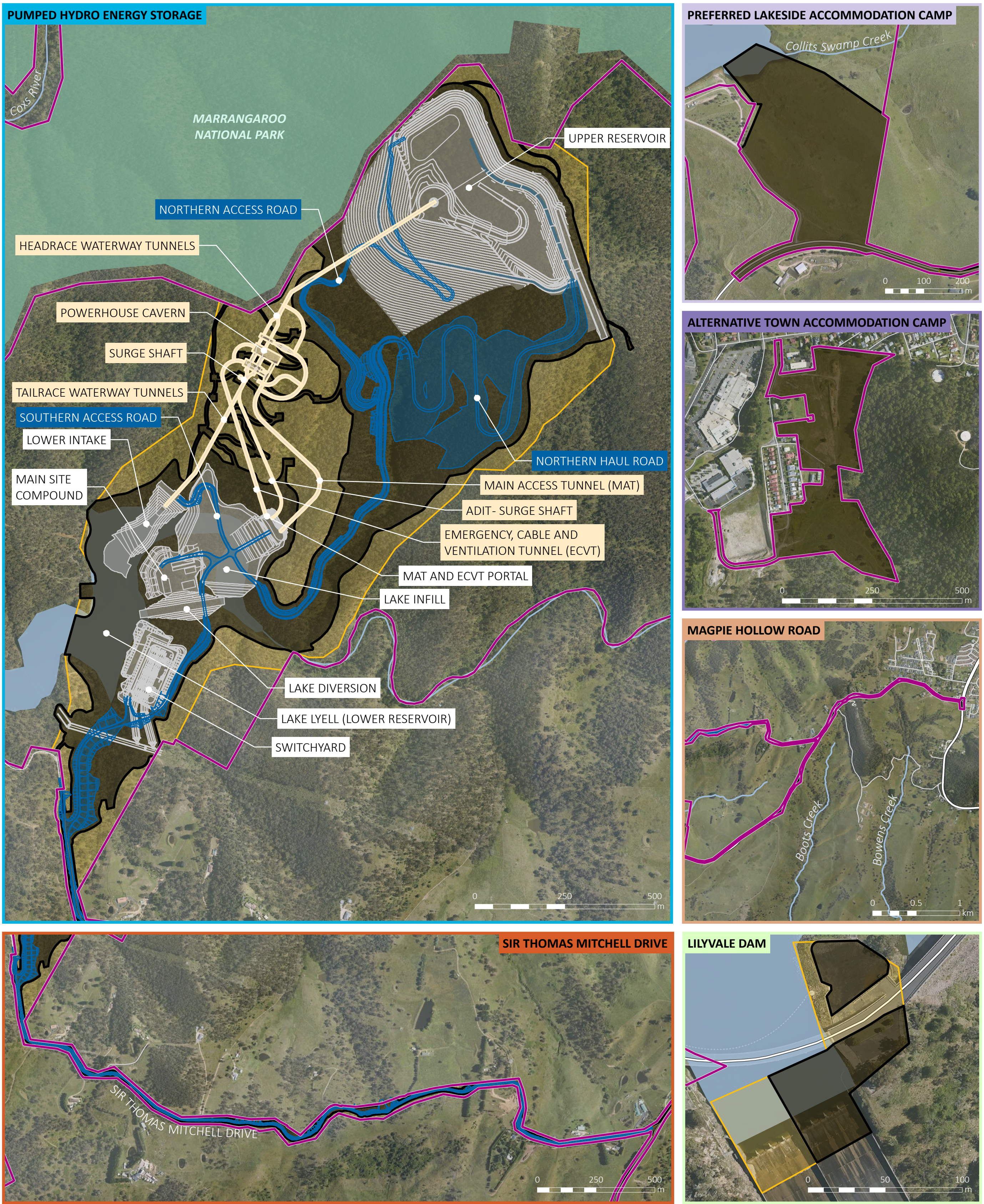
Construction will be completed in stages, including:

- pre-construction / enabling works – consisting of initial access works (internal and external roads), geotechnical investigations, site establishment and preparation of the workers' accommodation camp
- main works – consisting of all other construction activities needed to enable operation of the project.

During operation, the project will act as an electrical energy storage system through the conversion of electrical to kinetic energy to gravitational energy and back via water as it is transferred from the elevated upper reservoir to a lower reservoir. The project will provide services to the wholesale 'spot' market on the National Electricity Market (NEM), and support ancillary services used to manage the power system reliably.

After the 80 to 100-year design life of the project, the asset may remain viable for a plant refurbishment and extension of life as has been seen for other older assets globally. Following the plant's final refurbishment or once it has reached the end of its serviceable life then the project would look to return the site to a more natural state and encourage community beneficial use.

For the purpose of this GHG assessment, the operational life of the project is taken to cover the period between the opening (financial) year of 2031-32 and an end year of 2049-50. The end year represents the target year for net-zero GHG emissions in NSW.



Source: EMM (2025); Lake Lyell Project Pty Ltd (2025); DCSSS (2024); GA (2009); MetroMap (2025)

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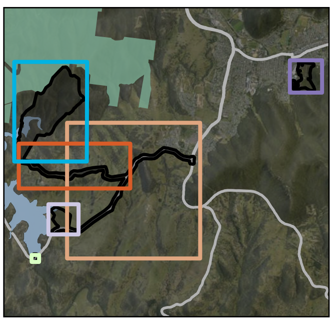

KEY

- Project area
- Permanent road
- Above ground design
- Underground design
- Construction envelope
- Disturbance footprint

Existing environment

- Major road
- Minor road
- Named watercourse
- Named waterbody
- NPWS reserve

Project overview

Lake Lyell PHES
Greenhouse Gas Assessment
Figure 2.1

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3 Legislative and policy context

This chapter of the report introduces the main GHGs that are the focus of legislation and policy, and the concept of emission scopes. The chapter also summarises the legislative and policy context as it relates to the assessment, mitigation and reporting of GHG emissions. The chapter includes the international context, the Australian context and the NSW context.

3.1 Greenhouse gases and emission scopes

3.1.1 Greenhouse gases

When sunlight strikes the earth's surface, some of it emitted back toward space as infrared radiation (heat). The term 'greenhouse gases' refers to gases that absorb this infrared radiation and trap its heat in the atmosphere. This process – the greenhouse effect – contributes to global warming and climate change.

The GHGs addressed under the Commonwealth *National Greenhouse and Energy Reporting Act 2007* (NGER Act – see Section 3.3.3) are summarised in Table 3.1. The most important gases in relation to the project are carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O) and sulfur hexafluoride (SF_6).

Table 3.1 Greenhouse gases and characteristics

Greenhouse gas	Characteristics	Global warming potential (GWP)[(a)]	Atmospheric lifetime (years)[(a)]
Carbon dioxide (CO_2)	The most abundant GHG in the atmosphere. Fossil fuel combustion is a major source of CO_2.	1	N/A[(b)]
Methane (CH_4)	Typically released as a fugitive emission, as well as from fuel combustion.	28	12
Nitrous oxide (N_2O)	Released during fuel combustion.	265	121
Sulfur hexafluoride (SF_6)	Used as an insulator in electrical switchgear.	23,500	3,200
Hydrofluorocarbons (HFCs)	Commonly used as refrigerant gases in cooling systems.	Dependent on HFC type	Dependent on HFC type
Perfluorocarbons (PFCs)	Used in a range of applications including solvents and insulators.	Dependent on PFC type	Dependent on PFC type

a) From Intergovernmental Panel on Climate Change (IPCC) Fifth Assessment Report (AR5).

b) No single atmospheric lifetime can be given for carbon dioxide because it moves throughout the earth system at differing rates.

Given that the various GHGs have different global warming potentials (GWPs), it is convenient to express emissions using a common unit. For this purpose, the term 'carbon dioxide equivalent' (CO_2-e) has been defined. For any mass and type of GHG, CO_2-e signifies the mass of CO_2 which would have the equivalent global warming impact. CO_2-e emissions are calculated based on the GWPs of specific gases adopted by the Parties to the United Nations Framework Convention on Climate Change (UNFCCC) and its Kyoto Protocol. In this assessment, GHG emissions are presented in terms of CO_2-e.

3.1.2 Emission scopes

For accounting and reporting purposes, GHG emissions are referred to as 'direct' or 'indirect', and defined according to three 'scopes' (1, 2 and 3). Examples of scope 1, 2 and 3 emissions are provided in Figure 3.1. The purpose of differentiating between the emission scopes is to avoid the potential for double counting, where two or more organisations assume responsibility for the same emissions.

The three scopes are defined as follows:

- Scope 1 relates to direct emissions from sources within the boundary of a given organisation (or project), and as a result of the organisation's activities. Scope 1 emissions are determined for the point of release (on-site). They include, for example, emissions from solid and liquid fuel combustion, fugitive emissions of methane, and leaks of SF_6.

- Scope 2 relates to indirect emissions associated with the purchase of electricity, steam, heat or cooling at a site. Scope 2 emissions are physically generated outside an organisation's boundaries, such as through the burning of fuel (e.g. coal, natural gas) at an external power station in the case of electricity, but they are included in an organisation's emissions as they are a result of its energy use.

- Scope 3 relates to all other indirect emissions (i.e. other than scope 2) which occur outside the boundary of an organisation but as a result of actions by the organisation, and are generated in the wider economy. Scope 3 emissions may occur upstream, such as during the extraction and production of fossil fuels, or downstream, such as from the transport of an organisation's product to customers.

This GHG assessment is mainly concerned with scope 1 and scope 2 emissions, as defined under the NGER Act, but it also considers scope 3 emissions, as defined within Australia's National Greenhouse Accounts for facility reporting (DCCEEW 2024a).

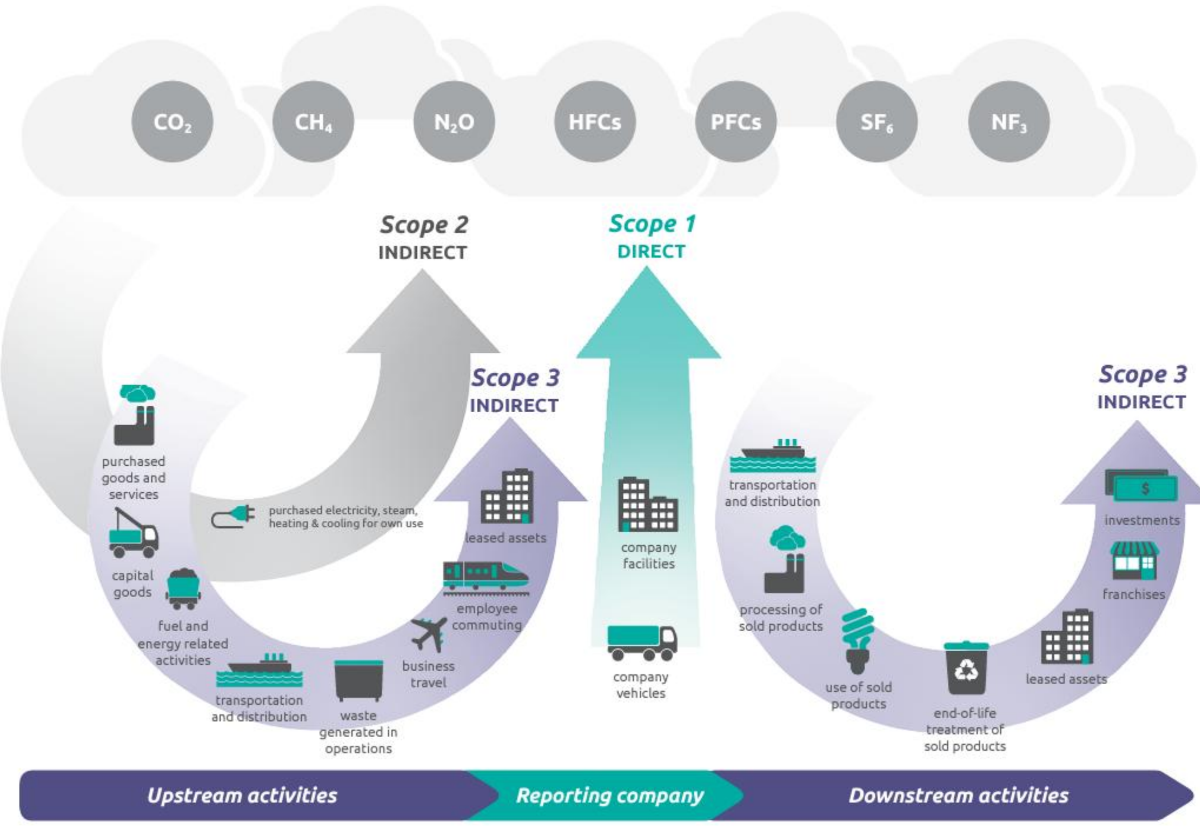


Figure 3.1 Overview of GHG emission scopes (WRI & WBCSD 2013)

3.2 International context

3.2.1 Intergovernmental Panel on Climate Change

The Intergovernmental Panel on Climate Change (IPCC) is the United Nations body for assessing the science in relation to climate change. The IPCC prepares comprehensive assessment reports about the state of scientific, technical and socio-economic knowledge on climate change, its impacts and future risks, and options for reducing the rate at which climate change is taking place. The first assessment report of the IPCC served as the basis for negotiating the UNFCCC. The IPCC released its Sixth Assessment Report (AR6) in 2022/2023. The IPCC also produces a variety of guidance documents and recommendation methodologies for compiling GHG emission inventories.

3.2.2 United Nations Framework Convention on Climate Change

The UNFCCC entered into force in March 2004 and provides the basis for concerted international action to mitigate climate change and to adapt to its impacts. With 198 Parties, the UNFCCC has nearly universal membership. The Conference of the Parties to the Convention (COP) is used to advance the implementation of the UNFCCC.

The objective of the UNFCCC is to stabilise GHG emissions 'at a level that would prevent dangerous anthropogenic interference with the climate system'. It states that 'such a level should be achieved within a time-frame sufficient to allow ecosystems to adapt naturally to climate change, to ensure that food production is not threatened, and to enable economic development to proceed in a sustainable manner'[1].

3.2.3 Paris Agreement

The Paris Agreement, which the Australian Government has signed, is a legally binding international treaty on climate change. It was adopted by the (then) 196 Parties to the UNFCCC at the 21st United Nations Climate Change Conference (COP21) in Paris, France in December 2015, and entered into force in November 2016. Its overarching goal is to hold the increase in the global average temperature to well below 2°C above pre-industrial levels, and pursue efforts to limit the temperature increase to 1.5°C above pre-industrial levels. Under the Paris Agreement, all parties are required to put forward GHG emission-reduction targets through Nationally Determined Contributions (NDCs). All parties are required to report on national emissions, with a review of targets every five years from 2020.

3.3 Australian Context

3.3.1 Climate Change Act 2022

The Commonwealth *Climate Change Act 2022* (CC Act) provides the legislative framework for implementing Australia's net-zero commitments under the Paris Agreement, and sets out Australia's GHG emission-reduction targets. Australia has committed to reducing its GHG emissions by 43% below 2005 levels by 2030, and achieving net-zero emissions by 2050. The CC Act also introduced a requirement for an annual climate change statement to parliament, supported by independent advice from the Climate Change Authority (CCA).

[1] https://unfccc.int/process-and-meetings/the-convention/what-is-the-united-nations-framework-convention-on-climate-change

3.3.2 Global Methane Pledge

The Australian Government has also signed the Global Methane Pledge (GMP). The GMP was launched at the 26th United Nations Climate Change Conference (COP26) by the European Union and the United States. It is a voluntary commitment, with 122 signatories working collectively to reduce global CH_4 emissions across all sectors by at least 30% below 2020 levels by 2030.

3.3.3 The National Greenhouse and Energy Reporting Act and Scheme

The NGER Act, administered by the Commonwealth Government, establishes a national framework (the NGER Scheme) for corporations to report GHG emissions, energy consumption and energy production. The framework covers the measurement, reporting and verification of GHG emissions.

Companies that exceed the NGER Scheme thresholds[2] of 25,000 tonnes (t) CO_2-e per year for a facility, or 50,000 t CO_2-e per year for a corporation, are required to register and report annually on their scope 1 and scope 2 emissions to the Clean Energy Regulator (CER).

The NGER Act is underpinned by the Commonwealth *National Greenhouse and Energy Reporting Regulations 2008* and the *National Greenhouse and Energy Reporting (Measurement) Determination 2008* (the Measurement Determination). The Measurement Determination provides methods, criteria and measurement standards for calculating GHG emissions and energy data. It covers scope 1 and scope 2 emissions, energy production and consumption.

3.3.4 The Safeguard Mechanism

The NGER Act also provides a framework for Australia's highest emitting facilities to manage and report on their GHG emissions. This framework is the Safeguard Mechanism[3], which was first legislated in 2014 and has been in place since 2016. Reforms to the Safeguard Mechanism took effect in 2023, to ensure that the facilities it covers will contribute to meeting Australia's GHG emission-reduction targets.

In general terms, the Safeguard Mechanism applies to facilities[4] with scope 1 emissions[5] of more than 100,000 t CO_2-e per year, known as Safeguard facilities. It sets legislated limits – known as baselines – on the GHG emissions of these facilities. These baselines decrease on a trajectory that is consistent with achieving Australia's GHG emission-reduction targets of 43% below 2005 levels by 2030, and net zero by 2050. The baselines will decrease at 4.9% per year from 2023 to 2030, followed by 3.285% per year thereafter.

If a Safeguard facility exceeds its baseline, then it must take actions to reduce its emissions, such as surrendering Australian Carbon Credit Units (ACCUs) or Safeguard Mechanism Credits (SMCs) equal to the excess emissions. Facilities that have emissions below their baselines may apply to receive SMCs.

In 2023-24 there were 219 Safeguard facilities. These facilities produced 31% of Australia's GHG emissions in that year (CER 2025).

[2] The thresholds are also stated in terms of energy production/consumption.

[3] https://www.dcceew.gov.au/climate-change/emissions-reporting/national-greenhouse-energy-reporting-scheme/safeguard-mechanism

[4] Grid-connected electricity generators are treated separately.

[5] The threshold applies to actual (gross) emissions from a facility, and does not take into account any offset or displaced emissions.

3.4 NSW context

The overarching NSW Government legislation and policy documents that are broadly relevant to this GHG assessment are summarised in Table 3.2.

The NSW Environment Protection Authority (EPA) is one of the primary environmental regulators for NSW. Although it has historically regulated some GHGs, the EPA has traditionally focussed on the local and regional impacts of projects and developments on health and the environment. It has recently expanded its focus to more explicitly regulate the causes and consequences of climate change in NSW. The EPA policy documents that are relevant to this GHG assessment are summarised in Table 3.3.

Table 3.2 Overarching NSW Government legislation and policy

Title	Description	Reference
NSW *Climate Change (Net Zero Future) Act 2023* (the Net Zero Act)	Establishes guiding principles for action to address climate change that consider the impacts, opportunities and need for action in NSW. Legislates NSW target reductions in GHG emissions of 50% of 2005 levels by 2030, 70% of 2005 levels by 2035, and net zero emissions by 2050. Sets an objective for NSW to be more resilient to a changing climate. Establishes an independent, expert Net Zero Commission to monitor, review, report on and advise on progress towards the targets.	-
NSW Climate Change Policy Framework	Sets out the NSW Government's long-term goals of achieving net-zero emissions by 2050, and making NSW more resilient and better adapted to a changing climate.	NSW OEH (2016)
Net Zero Plan Stage1: 2020–2030 (the Net Zero Plan)	Foundation for NSW's action on climate change. It outlines the NSW Government's plan to grow the economy, create jobs and reduce emissions during the 2020s.	NSW DPIE (2020)
Net Zero Plan Stage 1: 2020–2030 Implementation Update *Net Zero Plan Implementation Update 2022*	These provide updates on the key achievements of NSW Government under the Net Zero Plan, and commit NSW to reducing emissions by 50% below 2005 levels by 2030, and 70% below 2005 levels by 2035.	NSW DPIE (2021a) NSW OECC (2022)
NSW Climate Change Adaptation Strategy	Sets out the NSW Government's strategic approach for managing the impacts of climate change on the State.	NSW Government (2022)
NSW Waste and Sustainable Materials Strategy 2041	Sets out how NSW will transition to a circular economy over the next 20 years, including key reforms for reducing GHG emissions from materials (embedded carbon) and the waste sector.	NSW DPIE (2021b)
NSW Guide for Large Emitters	This defines the GHG assessment requirements for new projects and modifications to existing facilities that are likely to have 'large' emissions.	NSW EPA (2025)

Table 3.3 Key NSW EPA legislation and policy

Title	Description	Reference
NSW *Protection of the Environment Administration Act 1991*	Outlines the EPA's statutory objectives and duty to address climate change. Section 6 of the Act outlines the EPA's statutory objectives to protect the environment and human health. The key elements are: • to protect, restore and enhance the quality of the environment in NSW, having regard to the need to maintain ecologically sustainable development • to reduce the risks to human health and prevent the degradation of the environment, including by taking action in relation to climate change. Section 9 of the Act imposes a statutory duty on the EPA to develop environmental quality objectives, guidelines and policies to ensure environment protection. This includes protection of the environment from climate change.	-
NSW *Protection of the Environment Operations Act 1997* (POEO Act)	Sets out EPA's statutory powers and regulatory tools, including environment protection licensing. Schedule 1 of the Act sets out the types of activities that need a licence. The EPA is required to consider its statutory objectives (above) when exercising its licensing functions.	-
Climate Change Policy	Supports and builds upon NSW Government's climate change policies and initiatives. The main purpose is to address: • the EPA's statutory objectives to protect, restore and enhance the quality of the environment in NSW, and to reduce the risks to human health and prevent the degradation of the environment • the EPA's statutory duty to develop environmental quality objectives, guidelines and policies to ensure environment protection from climate change.	NSW EPA (2023a)
Climate Change Action Plan 2023–26	Designed to deliver the Climate Change Policy. The Action Plan sets out: • the specific actions the EPA will take over the three years that it covers • the regulatory action the EPA will consider over the medium to longer term, where an increased regulatory response may be required to support the NSW Government's climate change commitments and policies, including achieving net-zero emissions in NSW by 2050.	NSW EPA (2023b)
Strategic Plan 2024–29	Describes how the EPA will deliver stewardship for the environment to protect, restore and enhance the environment and human health. It sets out commitments to effective regulation and a focus on high quality environmental outcomes across all of EPA's work. The plan details objectives and outcomes for three key areas: • caring for country • driving action on climate change • enabling a safe circular economy.	NSW EPA (2024)
Waste Delivery Plan	Outlines the actions the EPA take to reduce the harmful impact of waste and drive behaviours that create a circular economy. The Waste Delivery Plan includes actions to reduce carbon emissions and building the resilience of the waste sector to climate change.	NSW EPA (2021)

4 Greenhouse gas assessment

4.1 Overview

The GHG assessment has been compiled in accordance with the *NSW Guide for Large Emitters* (NSW EPA 2025). This firstly involved categorising the project, identifying whether it would be a large emitter, and then following the required assessment steps.

4.1.1 Categorisation of project

The *NSW Guide for Large Emitters* distinguishes between two categories of project:

1. new proposals that are likely to have large emissions
2. proposed modifications to existing licensed premises that are likely to have large *additional* GHG emissions.

The proposed project would be category (1).

4.1.2 Large emitter status

The assessment requirements of the *NSW Guide for Large Emitters* apply to a given project if it is identified as a large emitter. NSW EPA considers a project to have large emissions if it meets three criteria, and the application of these criteria to the project is shown in Table 4.1. The third criterion actually requires the definition of assessment scenarios and the calculation of GHG emissions. The results of the supporting GHG calculations for the project are presented in Section 4.3.3. The emission estimates excluded any carbon offsets. The threshold for large emitters of 25,000 t CO_2-e was projected to be exceeded in all years of operation.

Table 4.1 NSW EPA criteria for identifying large emitters

Criterion	Applicability to project
Does the project require development assessments and approvals under the EP&A Act?	Yes
Does the project involve one or more scheduled activities under Schedule 1 of the POEO Act and/or will be carried out at an existing licensed premises?	Yes
Is the project likely to emit (within the GHG assessment boundary) 25,000 t or more of scope 1 and 2 emissions (CO_2-e) in any financial year during the operational life of the project?	Yes (see summary of emission calculations in Section 4.3.3)

Based on the application of the criteria, it has been concluded that the project **would be classified as a large emitter**.

Although the project has been identified as a large emitter according to the *NSW Guide for Large Emitters*, it is a pumped hydroelectric energy storage scheme, and its purpose is to support the decarbonisation of the electricity grid. Its direct ('scope 1') GHG emissions during operation will be very low, and it has been designated as a large emitter based almost entirely on its gross electricity consumption from the grid, and the associated indirect ('scope 2') GHG emissions. A large proportion of the electricity consumed would be returned to the grid as renewable energy. The scope 2 emissions will also decrease as the grid decarbonises.

This report follows the stepwise approach to GHG assessment defined in the NSW Guide for Large Emitters. However, given the above, some of the steps were not considered to be relevant, or else could not be addressed in detail.

4.1.3 Assessment steps

As the project has been identified as a large emitter, the GHG assessment followed the eight distinct steps in the *NSW Guide for Large Emitters*, as summarised below.

- **Step 1**: Describe the assessment boundary and scenarios
  - This involves describing the GHG assessment boundary established for the project, the project stages, the project timeframe and the scenarios included.
- **Step 2**: Characterise and prioritise sources of GHG emissions
  - This involves calculating annual emissions for all sources of scope 1, 2 and 3 emissions, and prioritising the sources for mitigation.
  - The NSW Guide for Large Emitters provides guidance on the calculation of GHG emissions at step 4. However, the prioritisation of emissions in step 2 required emissions to be calculated earlier. Therefore, in this report it has been assumed that step 4 involves a recalculation of emissions following the identification of mitigation measures.
- **Step 3**: Select measures to avoid and reduce emissions
  - This step involves the identification and characterisation of mitigation measures, taking into account the EPA's mitigation hierarchy.
- **Step 4**: Estimate emissions with mitigation measures
  - This step involves recalculating emissions, considering any emissions avoidance and mitigation measures that will be implemented.
- **Step 5**: Emission benchmarking and goal setting
  - This step involves establishing long-term and interim emission-reduction goals for the project for scope 1 and scope 2 emissions, considering regulatory obligations (e.g. Safeguard Mechanism) and proposed mitigation. The goals should include efforts to reduce emissions leading towards net zero by 2050, and must consider the NSW interim net emission-reduction targets.
- **Step 6**: Offsets strategy
  - This step involves describing any carbon offset strategies to address residual project emissions that cannot be avoided or reduced.
- **Step 7**: Independent expert review
  - Projects with scope 1 and 2 emissions exceeding 100,000 t CO_2-e per year at any time over the operational life require mitigation assessments to be verified by an independent expert reviewer. This threshold would be exceeded in every year of operation for the project (see Section 4.3.3). However, for reasons given later in the report, an independent review was not commissioned by LLP.
- **Step 8**: GHG assessment report
  - This step involves the production of a GHG assessment report (i.e. this report). The report broadly follows the structure and content described in Appendix C of the *NSW Guide for Large Emitters*.

The application of these steps is described in more detail below.

4.2 Step 1: Assessment boundary

Step 1 in the *NSW EPA Guide for Large Emitters* involves defining the following for a given project:

- the emission sources
- the stages
- the timeframe
- the emission scenarios to be assessed.

These aspects are addressed below.

4.2.1 Emission sources

For new developments (such as the project), *NSW Guide for Large Emitters* states that the GHG assessment boundary relates to the activities that would be authorised by an environment protection licence (EPL).

In this report, the GHG assessment boundary for the project has been treated *conceptually* in terms of emission sources, as shown in Figure 4.1. The figure shows the emission sources that were included, and those that were potentially relevant but excluded (the reasons for exclusion are explained later in this section).

The emission sources that were **included** in the assessment represented the most significant sources associated with the project. These sources are also summarised in Table 4.2.

Scope 2 emissions from the use of electricity from the grid have been calculated on the basis of **gross** electricity consumption. This calculation does not consider the amount of electricity returned to the grid by the project.

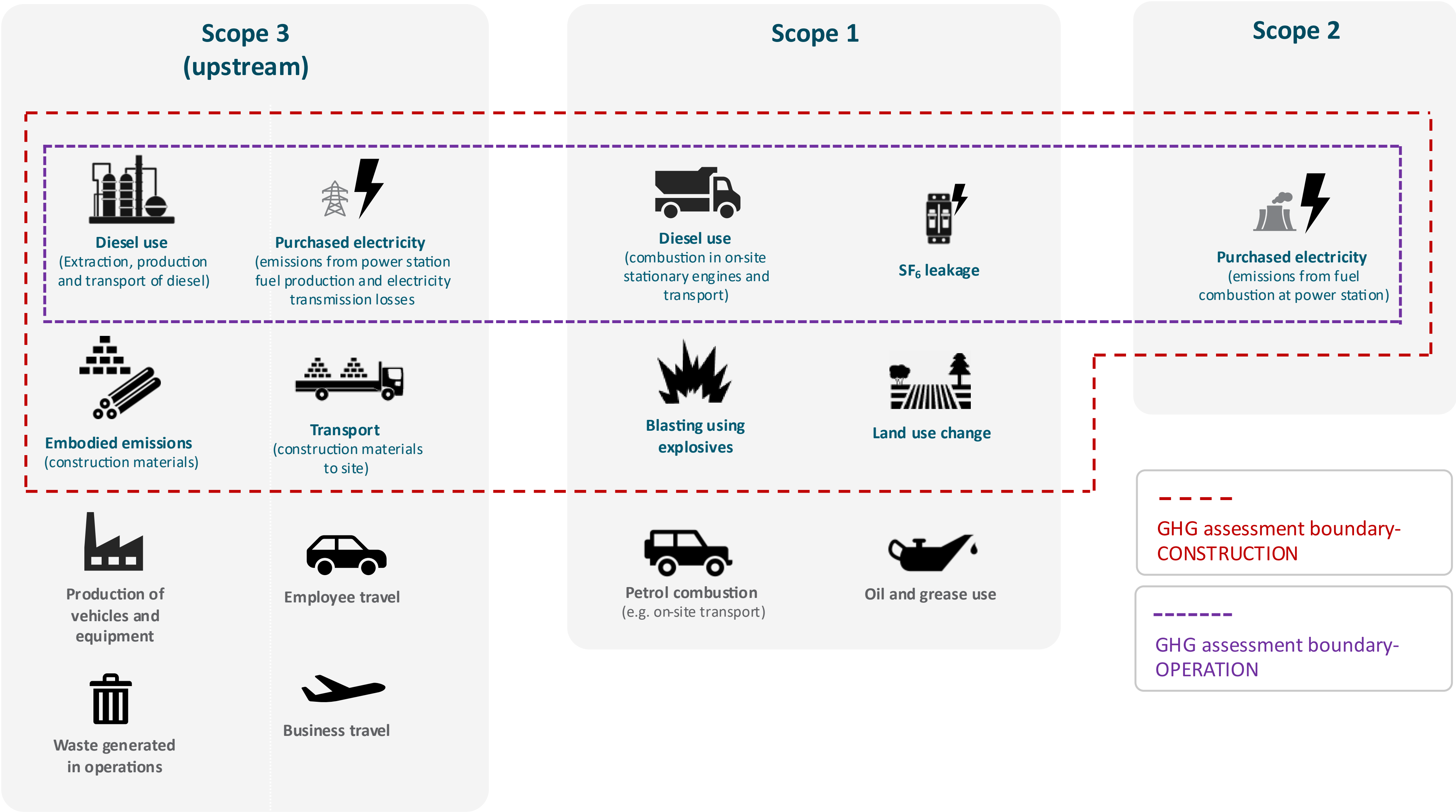


Figure 4.1 GHG assessment boundary and emission sources

Table 4.2 GHG emission sources included in the assessment

Activity	Scope 1	Scope 2	Scope 3 (upstream)
Project construction			
Liquid fuel combustion (diesel) – stationary	**Yes** Direct emissions from diesel combustion in on-site plant and equipment (e.g. land clearing, earthworks, construction)	N/A[(a)]	**Yes** Indirect emissions from diesel extraction, production and supply
Liquid fuel combustion (diesel) – transport	No	N/A	**Yes** Indirect emissions associated with transport of construction materials to site
Explosives	**Yes** Direct emissions from combustion of fuel from explosives use	N/A	No
On-site land use changes	**Yes** Effective emissions associated with loss of the carbon sink due to the clearing of vegetation	N/A	N/A
Electricity use	N/A	**Yes** Indirect emissions associated with consumption of electricity from the grid	**Yes** Indirect emissions from the extraction, production and transport of the fuel burned during electricity generation, and indirect emissions attributable to the electricity lost in delivery in the transmission and distribution network
Embodied emissions in construction materials	N/A	N/A	**Yes** Indirect emissions associated with production of construction materials
Project operation			
Liquid fuel combustion (diesel) – stationary	**Yes** Direct emissions from diesel combustion in on-site plant and equipment (emergency generators)	N/A[(a)]	**Yes** Indirect emissions from diesel extraction, production and supply
SF_6 leakage	**Yes** Leakage from electrical switchgear and transformers	N/A	No
Electricity use	N/A	**Yes** Indirect emissions associated with consumption of electricity from the grid	**Yes** Indirect emissions for transmission losses for grid electricity

(a) N/A = not applicable

Several potential GHG sources were **excluded** from the assessment, as identified in Table 4.3. Where a particular source was excluded from the assessment, this was either because it was not relevant, activity data for it were not readily available, or its emissions were unlikely to be material (i.e. they would have been too low over the life of the project to materially change the outcomes of the assessment or influence decision-making). No downstream scope 3 emission sources were considered to be relevant to the project.

Table 4.3 GHG emission sources excluded from the assessment

Project phase	Scope	GHG source	Reason for exclusion
Construction	Scope 1	Consumption of liquid fuels other than diesel (e.g. petrol)	Would not be material
		Emissions from the project reservoirs	See text below
		Consumption of oils and greases	Would not be material
	Scope 3 (upstream)	Consumption of liquid fuels other than diesel (e.g. petrol)	Would not be material
		Consumption of oils and greases	Would not be material
		Manufacture of construction vehicles and equipment	Data unavailable
		Employee travel (to and from the project)	Would not be material
		Business travel	Would not be material
		Waste generated	Would not be material
Operation	Scope 3 (upstream)	Sources identified above for construction	Would not be material

The creation of a freshwater reservoir can result in changes in GHG emissions. For example, after filling, any organic matter under the flooded area decomposes, releasing CO_2 and CH_4 through various mechanisms. However, in the case of the project, the lower reservoir would be the existing Lake Lyell, and the area under the upper reservoir would be lined / rock. The amount of inundated vegetation (and hence GHG emissions from the reservoirs) due to the project would be negligible. GHG emissions from the reservoirs were excluded from the assessment.

The *NSW Guide for Large Emitters* also requires emission sources to be categorised according to IPCC sectors and sub-sectors, as applied in Australia's national emission projections. For this assessment, all scope 1 emission sources are categorised as follows:

- IPCC sector = Electricity generation
- IPCC sub-sector = Pumped hydro (storage)

4.2.2 Project stages

The *NSW Guide for Large Emitters* states that the GHG assessment must consider all relevant stages of the project (as appropriate), such as construction, operation, decommissioning, closure and post-closure. For the project, only the construction and operational phases were considered to be relevant. Any activities relating to decommissioning, closure and post-closure would occur in the distant future (well beyond 2050).

4.2.3 Project timeframe

In NSW (and Australia) the GHG reporting convention (including the *NSW Guide for Large Emitters*) is aligned with financial years.

The GHG assessment covers the following periods:

- Financial years 2026-27 to 2030-31 for construction.
- Financial years 2031-32 to 2049-50 for operation.

4.2.4 Emissions scenarios

Step 1 of the *NSW Guide for Large Emitters* requires the definition of emission scenarios. For new developments (such as the project), there is only one emissions scenario to be considered (i.e. the project).

The *NSW Guide for Large Emitters* requires that scope 1 and scope 2 emissions are estimated based on maximum capacity and planned operational throughput. However, for this project, as a pumped hydro scheme, this distinction is not considered to be relevant. The results therefore reflect a single (planned) operational condition.

4.3 Step 2: Calculation of GHG emissions and prioritisation (as designed)

Step 2 in the *NSW EPA Guide for Large Emitters* involves calculating gross GHG emissions for the project as designed, and then prioritising emission sources for mitigation.

4.3.1 Relevant greenhouse gases

The GHGs that are relevant to the assessment are CO_2, CH_4, N_2O and SF_6.

4.3.2 Calculation approach

Details of the GHG emission calculation methodology for the project are provided in Annexure A. The supporting activity data (e.g. fuel consumption, electricity consumption) are given in Annexure B.

4.3.3 Emission estimates

The results of the GHG emission calculations for the project are summarised in the following sections. A breakdown of the emission results by year and by source is provided in Annexure C. For ease of presentation, the results for individual gases are not included.

i Scope 1 and scope 2 emissions

The scope 1 and scope 2 emissions in each financial year of the project life, are given in Table 4.4 and Figure 4.2. The construction and operational periods are shown separately. Total and average emissions over the project life are provided in Table 4.6.

The total scope 1 and scope 2 emissions during the construction of the project would be 116 kilotonne (kt) CO_2-e and 26 kt CO_2-e, respectively. During the operation of the project, total scope 1 emissions would be low (1 kt 1CO_2-e), whereas scope 2 emissions would be relatively high (1,144 kt CO_2-e) on account of the project's gross electricity consumption. Scope 2 emissions would reduce with time, being around 157 kt CO_2-e/year in 2031-32, and 36 kt CO_2-e/year from 2039-40. The reduction would be due to the progressive decarbonisation of the electricity grid. The aggregated scope 1 and scope 2 emissions over the project life, including both construction and operation, would be 1,286 kt CO_2-e, of which 9% would be scope 1 and 91% would be scope 2. On average, this would equate to 53.6 kt CO_2-e/year.

Table 4.4 Annual scope 1 and scope 2 emissions

Financial year	GHG emissions (kt CO_2-e/year)		
	Scope 1	Scope 2	Scope 1 + scope 2
Project construction			
2026-27	12.6	0	12.6
2027-28	28.1	9.3	37.4
2028-29	32.5	10.7	43.2
2029-30	29.3	5.0	34.3
2030-31	13.0	1.2	14.2
Project operation			
2031-32	<0.0003	156.5	156.5
2032-33	<0.0003	108.4	108.4
2033-34	<0.0003	108.4	108.4
2034-35	<0.0003	84.3	84.3
2035-36	<0.0003	72.2	72.2
2036-37	<0.0003	72.2	72.2
2037-38	<0.0003	72.2	72.2
2038-39	<0.0003	72.2	72.2
2039-40	<0.0003	36.1	36.1
2030-41	<0.0003	36.1	36.1
2041-42	<0.0003	36.1	36.1
2042-43	<0.0003	36.1	36.1
2043-44	<0.0003	36.1	36.1
2044-45	<0.0003	36.1	36.1
2045-46	<0.0003	36.1	36.1
2046-47	<0.0003	36.1	36.1
2047-48	<0.0003	36.1	36.1
2048-49	<0.0003	36.1	36.1
2049-50	<0.0003	36.1	36.1

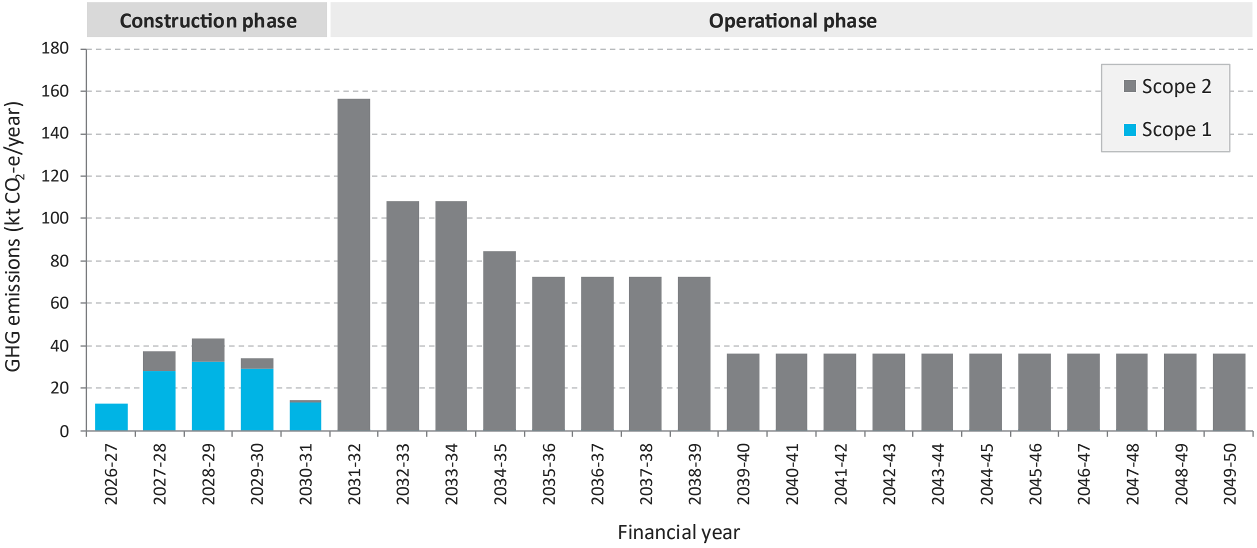


Figure 4.2 Annual scope 1 and scope 2 emissions

Table 4.5 Project life scope 1 and scope 2 emissions

	GHG emissions (kt CO_2-e/year)		
	Scope 1	Scope 2	Scope 1 + scope 2
Project construction			
Average (kt CO_2-e/year)	23.1	5.2	28.3
Total (kt CO_2-e)	115.6	26.1	141.7
Project operation			
Average (kt CO_2-e/year)	0.05	61.5	61.6
Total (kt CO_2-e)	0.96	1,143.8	1,144.8
Project construction and operation			
Average (kt CO_2-e/year)	4.9	48.7	53.6
Total (kt CO_2-e)	116.5	1,169.9	1,286.4

The NGER Act defines a facility threshold for combined scope 1 and scope 2 emissions of 25,000 t CO_2-e/year. The project is predicted to exceed this threshold. LLP would therefore have an obligation to report emissions from the project under the NGER scheme[6].

6 This was confirmed in a personal communication from the Clean Energy Regulator.

ii Scope 3 emissions

The scope 3 emissions in each financial year of the project are given in Table 4.6 and Figure 4.3. Again, only the estimates for total CO_2-e are shown. Total and average emissions over the project life are provided in Table 4.7.

The total scope 3 emissions during the construction of the project would be 76 kt CO_2-e. During the operation of the project, total scope 3 emissions would be 36 kt CO_2-e. The aggregated scope 3 emissions over the project life, including both construction and operation, would be 112 kt CO_2-e.

Table 4.6 Annual scope 3 emissions

Financial year	GHG emissions (kt CO_2-e/year)
	Scope 3
Project construction	
2026-27	9.4
2027-28	22.2
2028-29	22.7
2029-30	16.5
2030-31	5.4
Project operation	
2031-32	12.0
2032-33	<0.0001
2033-34	<0.0001
2034-35	12.0
2035-36	12.0
2036-37	<0.0001
2037-38	<0.0001
2038-39	<0.0001
2039-40	<0.0001
2030-41	<0.0001
2041-42	<0.0001
2042-43	<0.0001
2043-44	<0.0001
2044-45	<0.0001
2045-46	<0.0001
2046-47	<0.0001
2047-48	<0.0001
2048-49	<0.0001
2049-50	<0.0001

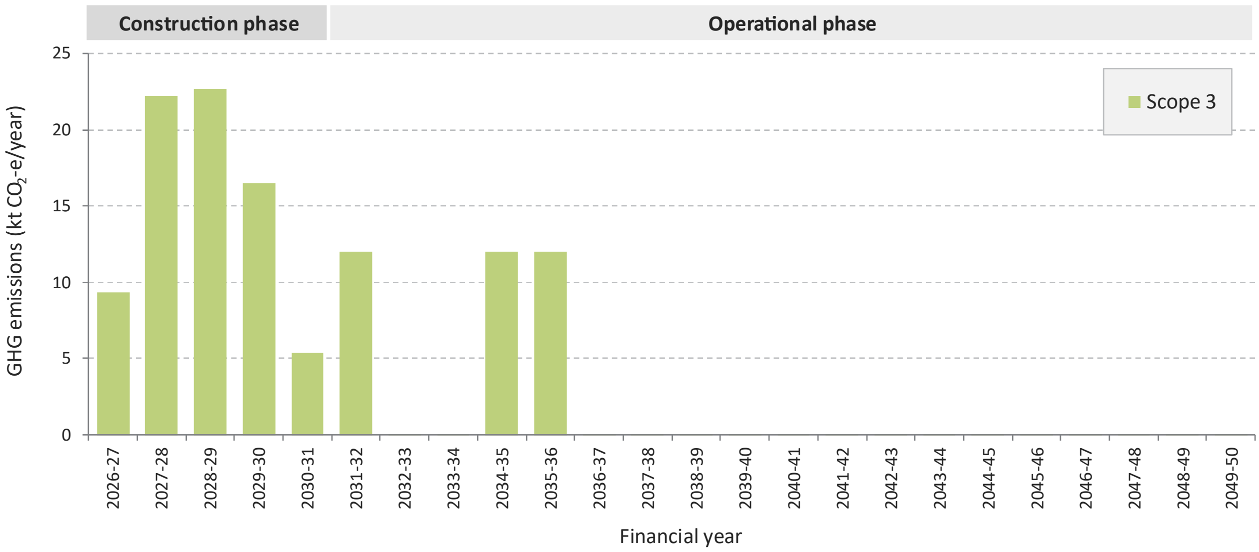


Figure 4.3 Annual scope 3 emissions

Table 4.7 Project life scope 3 emissions

Project life	GHG emissions (kt CO_2-e/year)
	Scope 3
Project construction	
Average (kt CO_2-e/year)	15.2
Total (kt CO_2-e)	76.1
Project operation	
Average (kt CO_2-e/year)	1.9
Total (kt CO_2-e)	36.1
Project construction and operation	
Average (kt CO_2-e/year)	4.7
Total (kt CO_2-e)	112.3

iii Emission intensity

The *NSW Guide for Large Emitters* also requires the calculation of scope 1 and scope 2 emissions intensity per unit of production or activity for the primary scheduled activity under Schedule 1 of the POEO Act. Production variables are also stated the *Safeguard Mechanism: Prescribed production variables and default emissions intensities* (DCCEEW 2024c). For on-site electricity generation, the production variable is MWh of electricity generated or exported, and the emission intensity is stated as tonnes of CO_2-e per MWh. For this assessment, the electricity returned to the grid was used as the basis of the emission intensity calculations.

The annual emission intensities for the project are given in Table 4.8. The scope 1 emission intensity of the project would be negligible. The scope 2 emissions intensity profile essentially reflects Australian Government's projections of the emissions intensity of the grid (DCCEEW 2024b), allowing for the difference between the energy consumed and generated by the project. The average scope 2 emission intensity over the life of the project would be 0.063 t CO_2-e per MWh.

Table 4.8 Annual emission intensity during project operation

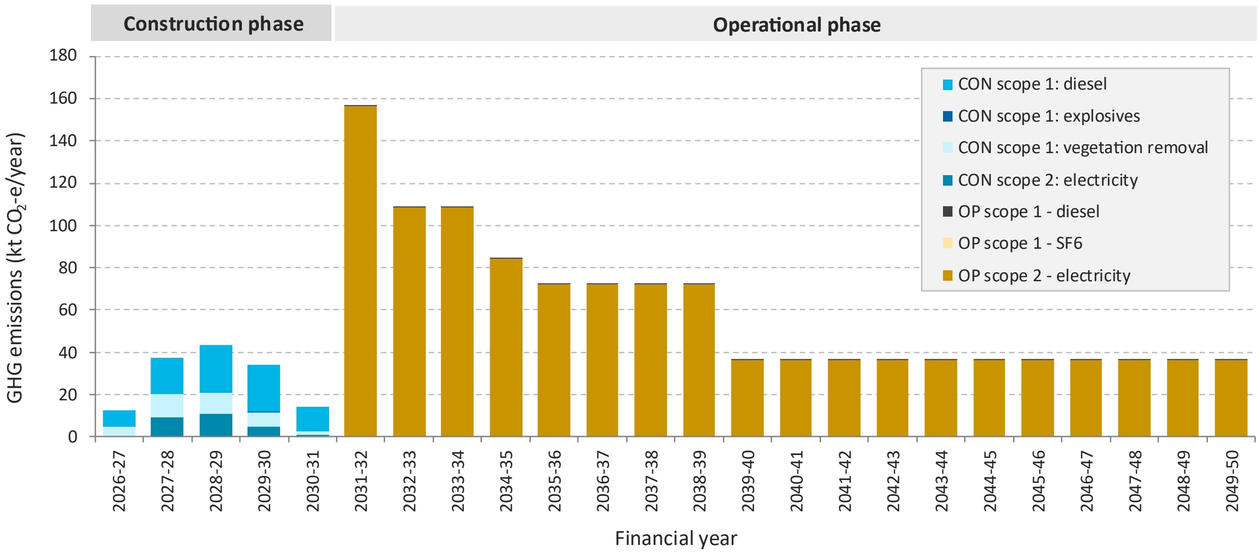
Financial year	Emission intensity (t CO_2-e / MWh returned to grid)	
	Scope 1	Scope 2
2031-32	<0.0001	0.1625
2032-33	<0.0001	0.1125
2033-34	<0.0001	0.1125
2034-35	<0.0001	0.0875
2035-36	<0.0001	0.0750
2036-37	<0.0001	0.0750
2037-38	<0.0001	0.0750
2038-39	<0.0001	0.0750
2039-40	<0.0001	0.0375
2030-41	<0.0001	0.0375
2041-42	<0.0001	0.0375
2042-43	<0.0001	0.0375
2043-44	<0.0001	0.0375
2044-45	<0.0001	0.0375
2045-46	<0.0001	0.0375
2046-47	<0.0001	0.0375
2047-48	<0.0001	0.0375
2048-49	<0.0001	0.0375
2049-50	<0.0001	0.0375
Average	**<0.0001**	**0.0625**

4.3.4 Prioritisation of emission sources

i Scope 1 and scope 2 emissions

The contributions of the different sources to annual scope 1 and scope 2 emissions are shown in Figure 4.4. In Table 4.9, the sources of scope 1 and scope 2 emissions are ranked according to their contribution to emissions over the life of the project. The construction phase and the operational phase are shown separately. On this basis, diesel consumption would be responsible for 57% of the total scope 1 and scope 2 emissions during construction. The other main sources during construction would be vegetation removal (24%) and electricity consumption (18%).

Practically all emissions during project operation would be due to electricity consumption.



CON= construction; OP = operation

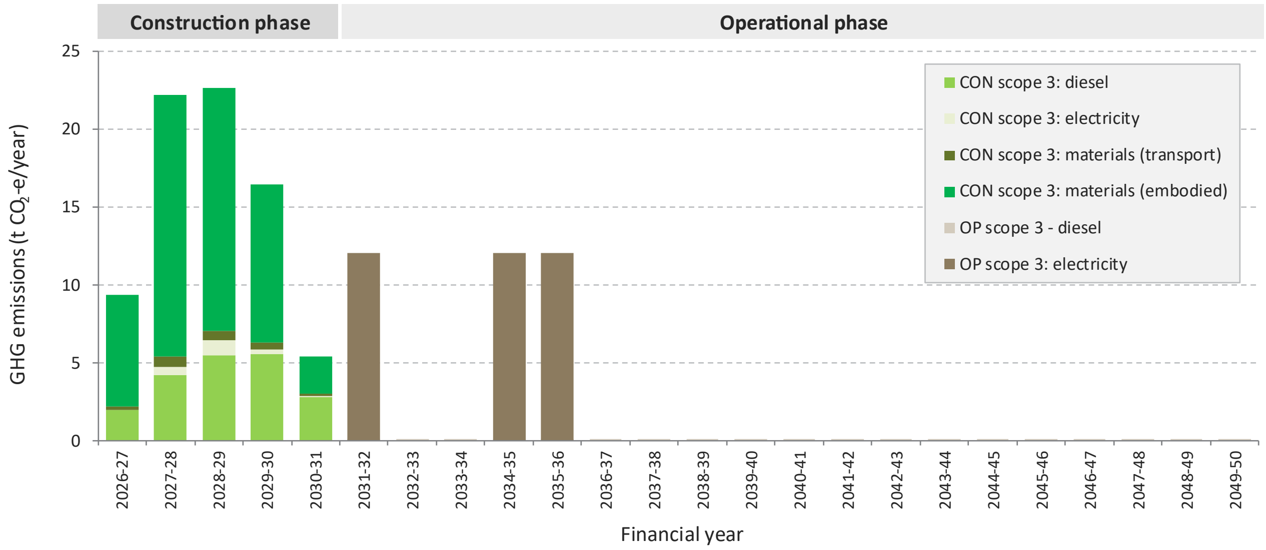
Figure 4.4 Contributions to scope 1 and scope 2 emissions

Table 4.9 Ranking of scope 1 and scope 2 sources based on project life emissions

Ranking	Source	Scope	Project life emissions (kt CO_2-e)	Contribution (%)
Project construction				
1	Diesel consumption	Scope 1	80.7	57.0%
2	Vegetation removal (loss of carbon sink)	Scope 1	34.0	24.0%
3	Electricity consumption	Scope 2	26.1	18.4%
4	Explosives	Scope 1	0.9	0.6%
	Total		**141.7**	**100.0%**
Project operation				
1	Electricity consumption	Scope 2	1,143.8	99.9%
2	SF_6 leakage	Scope 1	1.0	0.1%
3	Diesel consumption	Scope 1	0.0	0.0%
	Total		**1,144.8**	**100.0%**

ii Scope 3 emissions

The contributions of the different sources to annual scope 3 emissions are shown in Figure 4.5. Table 4.10 shows the ranking of sources for scope 3 emissions over the life of the project. Upstream emissions for embodied emissions in construction materials and diesel consumption would together be responsible for around 95% of scope 3 emissions during the construction phase. During operation, practically all scope 3 emissions would be due to electricity consumption.



CON= construction; OP = operation

Figure 4.5 Contributions to scope 3 emissions

Table 4.10 Ranking of scope 3 sources based on project life emissions

Ranking	Source	Scope	Project life emissions (kt CO_2-e)	Contribution (%)
Project construction				
1	Materials (embodied emissions)	Scope 3	52.2	68.6%
2	Diesel consumption	Scope 3	19.9	26.1%
3	Electricity consumption	Scope 3	2.0	2.7%
4	Materials (transport to site)	Scope 3	2.0	2.7%
	Total		**76.1**	**100.0%**
Project operation				
1	Electricity consumption	Scope 3	36.1	100.0%
2	Diesel consumption	Scope 3	0.0	**0.0%**
	Total		**36.1**	**100.0%**

4.4 Step 3: Selection of mitigation measures

Step 3 of the *NSW Guide for Large Emitters* requires the selection of mitigation measures for emissions (focussing on the operational phase), taking into account the EPA's mitigation hierarchy. The mitigation hierarchy places most importance on avoiding GHG emissions, followed by reduction, substitution and offsetting. Offsetting is only seen as a 'last resort' after all reasonable avoidance, reduction and substitution measures have been taken, and is only to be considered for any residual emissions.

The majority of the emissions from operation of the project are classified as scope 2. Box 8 of the *NSW Guide for Large Emitters* notes that options for reducing scope 2 emissions include:

- energy efficiency practices
- installation of on-site renewable power generation such as solar energy, and energy storage such as batteries
- purchasing renewable energy certificates
- entering into green power purchasing agreements.

4.4.1 Scope 1 and scope 2 emissions

i Return of electricity to the grid

The NEM is one of the world's largest interconnected power networks, providing electricity throughout Australia's eastern and southern states. The NEM is overseen by an independent body, the Australian Energy Market Operator (AEMO). Electricity within the NEM has traditionally been dependent on coal-fired power plants. However, the energy transition is well underway, with sources of electricity within the NEM set to shift drastically, with variable renewable energy (VRE) technologies and firming technologies set to supplant coal-fired assets.

As the energy market transitions to more VRE generation, PHES plays an important role in both storing VRE when supply is greater than demand to enable a 'time shift' in electricity supply, as well as firming the VRE to help maintain grid stability. The project is ideally placed to meet the urgent and critical need to deliver 4.8 GW of medium duration storage in support of the energy transition.

Although it is not strictly a mitigation measure, the operation of the project provides critical support to the energy transition. The rationale for the project, and part of its normal operation, is the return of electricity to the grid. This will greatly reduce the project's *effective* scope 2 emissions during operation. This is based on the assumption that the electricity returned to the grid would otherwise have to be produced elsewhere, and with the prevailing energy mix for the grid.

ii Other measures

The other GHG mitigation measures proposed during the construction and operation of the project are listed in Table 4.11. and Table 4.12, respectively.

Table 4.11 GHG mitigation measures (project construction)

Measure	Proposed for the project	Detail, comment or justification
Removal of carbon sink and disposal of vegetation		
Rehabilitation/ planting	Yes	Rehabilitation of areas disturbed during pre-construction and construction will be undertaken progressively during all stages and phases of the project. Progressive rehabilitation will be conducted, including spoil emplacement areas and areas used for construction ancillary facilities no longer needed during operation. At the end of the project's life, approximately 87 hectares (ha) in total will be rehabilitated to native ecosystem (including native vegetation and rock landscape).
Disposal of vegetation	Yes	Approximately 20% of vegetation will be turned into mulch to be re-used on-site. The remaining 80% will be managed using specialised mobile biochar processing equipment (pyrolysis) which is not anticipated to result in significant GHG emissions.
Diesel use in vehicles and equipment		
Fuel/energy efficiency	Yes	Consideration of fuel/energy efficiency during procurement of vehicles and equipment. Investigate the feasibility of installing and utilising energy-efficient technologies, such as the use of LED lights on fixed plant and buildings, and energy-efficient pumps. The proponent has considered the feasibility of variable speed drives and at this location, variable speed drives would not provide significant benefit over fixed speed drivers with regard to design and construction requirements, scheme efficiency and cost. Variable speed drives would require further and more complex underground works (and subsequent surface impacts) at greater cost, and would not significantly increase scheme efficiency to balance these other key aspects.
Electric vehicles/equipment	Yes	Investigate purchase of electric vehicles and equipment to reduce or eliminate on-site diesel use.
Vehicle maintenance	Yes	Maintenance of vehicles and equipment according to manufacturers' specifications to optimise fuel consumption.
Pre-start inspection	Yes	Performing pre-start inspections at each shift on mobile plant and vehicles.
Haul distances	Yes	Haul distances will be minimised as far as practicable to reduce diesel consumption.
Haul road maintenance	Yes	Haul roads will be routinely maintained to reduce truck tyre rolling resistance.
Extraction practices	Yes	Review of extraction practices to minimise double handling of materials and associated diesel combustion.
Engine idling	Yes	Idling of diesel vehicles and equipment will be minimised wherever feasible.
Embodied emissions		
Low-carbon materials	Yes	Procurement of low carbon alternatives where viable (e.g. use of lower carbon cement alternatives).
Materials from local sources	Yes	Sourcing materials from local sources where possible.

Measure	Proposed for the project	Detail, comment or justification
Other measures		
On-site renewable energy	Yes	Installation of on-site renewable energy source (e.g. solar) to supplement diesel use for powering equipment where possible.
Refrigerants	Yes	Use of refrigerants with a low (or zero) global warming potential where possible at accommodation camp.
Training	Yes	Education and signage to encourage energy efficiency at accommodation camp.
Motion detectors	Yes	Where possible use of motion detectors for lighting in common areas of the accommodation camp.
Waste generation	Yes	The generation of waste will be minimised as far as possible. Recycled or renewable materials will be used were practical.

Table 4.12 GHG mitigation measures (project operation)

Measure	Proposed for the project	Detail, comment or justification
Electricity consumption		
Use of renewable grid electricity	Yes	Pumped hydro is intended to utilise intermittent renewable energy in order to provide power during peak demand periods, as well provide resilience and stability to the grid. Consequently, the electricity required for the scheme is expected to come from renewable energy sources (although there may sometimes be times where other sources of electricity are required to support the grid).
Tracking electricity and fuel usage.	Yes	Electricity and fuel usage will be tracked on a regular basis.

4.4.2 Scope 3 emissions

The only scope 3 emissions during project operation are those associated with the consumption of purchased electricity. These emissions result from the extraction, production and transport of the fuel burned during electricity generation, and the indirect emissions attributable to the electricity lost in delivery in the transmission and distribution network. No specific mitigation measures are proposed for scope 3 emissions, as these will also decrease as the grid decarbonises.

4.5 Step 4: Emissions with mitigation measures

4.5.1 Return of electricity to the grid

Table 4.13 and Figure 4.6 show the annual gross and net scope 1 and scope 2 emissions. In the net emissions results, scope 2 emissions are calculated based on the electricity purchased from the grid (1,204,000 MWh/year) minus the electricity supplied to the grid (963,200 MWh/year). Table 4.14 shows the project life gross and net scope 1 and scope 2 emissions. The largest reduction in emissions based on the net electricity consumption would be in the first full year of operation (2031-32), and would be 125 kt CO_2-e. The overall emission reduction over the life of the project would be 915 kt CO_2-e.

Table 4.13 Annual gross and net scope 1 and scope 2 emissions

Financial year	Scope 1 + scope 2 GHG emissions (kt CO_2-e/year)		
	Gross emissions	Net emissions	Difference
Project construction			
2026-27	12.6	12.6	0.0
2027-28	37.4	37.4	0.0
2028-29	43.2	43.2	0.0
2029-30	34.3	34.3	0.0
2030-31	14.2	14.2	0.0
Project operation			
2031-32	156.6	31.4	-125.2
2032-33	108.4	21.7	-86.7
2033-34	108.4	21.7	-86.7
2034-35	84.3	16.9	-67.4
2035-36	72.3	14.5	-57.8
2036-37	72.3	14.5	-57.8
2037-38	72.3	14.5	-57.8
2038-39	72.3	14.5	-57.8
2039-40	36.2	7.3	-28.9
2030-41	36.2	7.3	-28.9
2041-42	36.2	7.3	-28.9
2042-43	36.2	7.3	-28.9
2043-44	36.2	7.3	-28.9
2044-45	36.2	7.3	-28.9
2045-46	36.2	7.3	-28.9
2046-47	36.2	7.3	-28.9
2047-48	36.2	7.3	-28.9
2048-49	36.2	7.3	-28.9
2049-50	36.2	7.3	-28.9

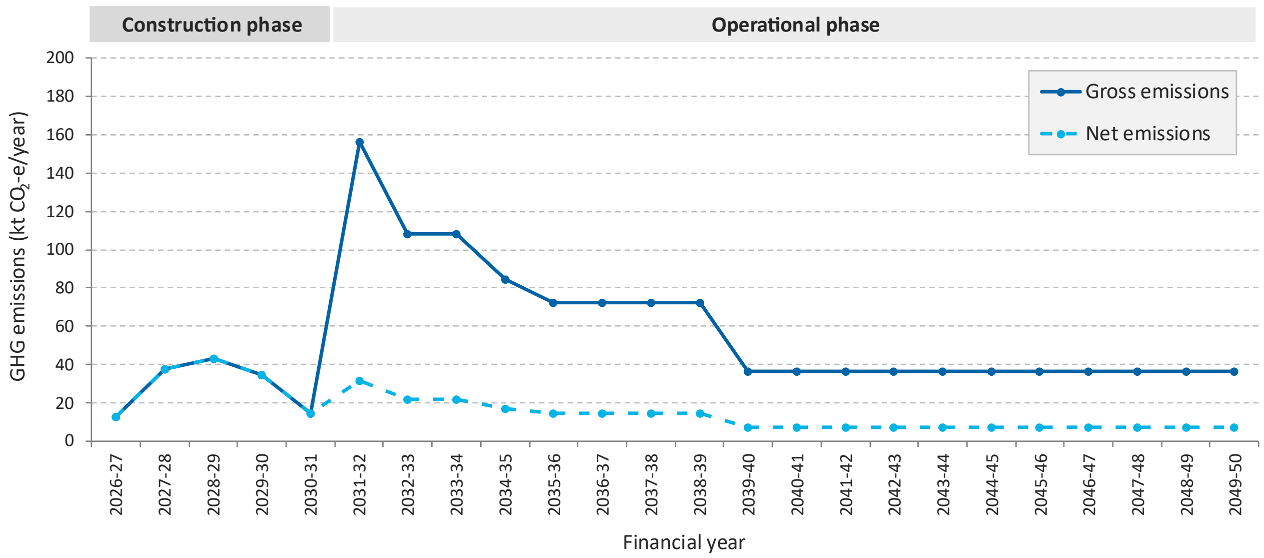


Figure 4.6 Gross and net scope 1 and scope 2 emissions for the project

Table 4.14 Project life gross and net scope 1 and scope 2 emissions

	Scope 1 + scope 2 GHG emissions (kt CO_2-e/year)		
	Gross emissions	**Net emissions**	**Difference**
Project construction			
Average (kt CO_2-e/year)	28.3	28.3	0.0
Total (kt CO_2-e)	141.7	141.7	0.0
Project operation			
Average (kt CO_2-e/year)	60.3	12.1	-48.2
Total (kt CO_2-e)	1,144.8	229.7	-915.0
Project construction and operation			
Average (kt CO_2-e/year)	53.6	15.5	-38.1
Total (kt CO_2-e)	1,286.4	371.4	-915.0

4.5.2 Other measures

The effects of the other mitigation measures, as identified in Section 4.4.1, have not been quantified. During operation, and from 2039-40, once the return of electricity to the grid has been taken into account, the residual GHG emission during project operation is around 7 kt CO_2-e/year, and around 99% of this is due to net electricity consumption.

4.6 Step 5: Emission benchmarking and goal setting

The *NSW Guide for Large Emitters* requires the GHG assessment to address the anticipated regulatory obligations for the project under the Safeguard Mechanism, to consider how the project scope 1 emissions compare to NSW emissions, and to set out long-term and interim scope 1 and scope 2 emission goals for the project.

The project would not be a Safeguard facility, and therefore the Safeguard Mechanism is not considered further.

The operational scope 1 emissions from the project are negligible and constant (0.1 kt CO_2-e/year due to SF_6 leakage). It has therefore been assumed that emission-reduction targets are not necessary.

4.7 Step 6: Offsets strategy

Given the nature of the project (a pumped hydroelectric energy storage scheme to support the decarbonisation of the electricity grid), an offset strategy has not been proposed at this time. As previously discussed, the project has been designated as a large emitter based almost entirely on its gross electricity consumption from the grid, and the associated indirect ('scope 2') GHG emissions. A large proportion of the electricity consumed by the project would be returned to the grid as renewable energy and scope 2 emissions will also decrease as the grid decarbonises. LLP is committed to reducing GHG emissions as far as practicable through the measures identified in Section 4.5.

4.8 Step 7: Independent expert review

Between 2030-31 and 2034-35, the project would have annual operational scope 1 and scope 2 emissions above 100,000 t CO_2-e per year. According to the NSW Guide for Large Emitters, the GHG assessment should therefore be verified by an independent expert reviewer. However, the effective (net) emissions from the project under normal operational conditions will be much lower than 100,000 t CO_2-e per year. On this basis, an independent expert review has not been commissioned.

5 Summary and conclusions

5.1 Background

This report presents a GHG assessment to accompany the EIS for the project. The GHG assessment has been compiled in accordance with the *NSW Guide for Large Emitters*. Based on the criteria in the *NSW Guide for Large Emitters*, the project would be a large emitter, and the GHG assessment therefore follows the steps in the NSW Guide for Large Emitters, with project being treated as a new project. However, the purpose of the project is to support the decarbonisation of the electricity grid. The project's scope 1 emissions during operation will be very low, and it has been designated as a large emitter based almost entirely on its gross electricity consumption from the grid, and the associated scope 2 GHG emissions. A large proportion of the electricity consumed would be returned to the grid as renewable energy. The scope 2 emissions will also decrease as the grid decarbonises. Consequently, some of the steps were not considered to be relevant, or else could not be addressed in detail.

The GHG assessment covers the financial years 2026-27 to 2030-31 for construction, and the financial years 2031-32 to 2049-50 for operation. The main findings of the assessment are summarised below.

5.2 Gross emissions from the project

In terms of gross emissions from the project:

- Scope 1 and scope 2 emissions
  - The total scope 1 and scope 2 emissions during the construction of the project would be 116 kt CO_2-e and 26 kt CO_2-e, respectively.
  - During construction, the largest contributor to scope 1 and scope 2 emissions would be diesel consumption (57%).
  - Practically all emissions during project operation would be due to gross electricity consumption. During the operation of the project, total scope 1 emissions would be low (1 kt CO_2-e), whereas scope 2 emissions would be relatively high (1,144 kt CO_2-e).
  - Scope 2 emissions would reduce with time, being around 157 kt CO_2-e/year in 2031-32, and 36 kt CO_2-e/year from 2039-40. The reduction would be due to the progressive decarbonisation of the electricity grid.
  - The aggregated scope 1 and scope 2 emissions over the project life, including both construction and operation, would be 1,286 kt CO_2-e, of which 9% would be scope 1 and 91% would be scope 2.
  - The scope 1 emission intensity over the life of the project would be negligible.
  - The scope 2 emissions intensity profile essentially reflects Australian Government's projections of the emissions intensity of the grid, allowing for the difference between the energy consumed and generated by the project. The average scope 2 emission intensity over the life of the project would be 0.063 t CO_2-e per MWh.
- Scope 3 emissions
  - The total scope 3 emissions during the construction of the project would be 76 kt CO_2-e. During the operation of the project, total scope 3 emissions would be 36 kt CO_2-e. The aggregated scope 3 emissions over the project life, including both construction and operation, would be 112 kt CO_2-e.

- Upstream emissions for embodied emissions in construction materials and diesel consumption would together be responsible for 95% of scope 3 emissions during the construction phase. During operation, practically all scope 3 emissions would be due to electricity consumption.

5.3 Selection of mitigation measures

The majority of the emissions from operation of the project are classified as scope 2, and therefore this is the focus of mitigation.

Although it is not strictly a mitigation measure – as it is the rationale for the project and part of its normal operation – the return of electricity to the grid will greatly offset the project's effective scope 2 emissions during operation. This is based on the assumption that the electricity returned to the grid would otherwise have to be produced elsewhere with the prevailing energy mix for the grid.

A range of other mitigation measures are proposed for the minor emission sources.

5.4 Emissions with mitigation measures

The largest reduction in emissions based on the net electricity consumption would be in the first full year of operation (2031-32), and would be 125 kt CO_2-e. The overall emission reduction over the life of the project would be 915 kt CO_2-e.

5.5 Other considerations

The project would not be a Safeguard facility, and there the requirements of the Safeguard Mechanism have not been considered.

The operational scope 1 emissions from the project would be negligible (0.1 kt CO_2-e/year due to SF_6 leakage). It has therefore been assumed that emission-reduction targets are not necessary.

The net emissions from the project under normal operational conditions will be much lower than 100,000 t CO_2-e per year. On this basis, an independent expert review has not been commissioned.

References

ABS 2020, Survey of Motor Vehicle Use, Australia, 12 months ended 30 June 2020, 92080DO001_202006, Australian Bureau of Statistics, Canberra.

CER 2025, 2023–24 safeguard data insights, Clean Energy Regulator, https://cer.gov.au/document_page/2023-24-safeguard-data-insights

DCC 2008, National Greenhouse Accounts Factors, Department of Climate Change, Canberra, January 2008.

DCCEEW 2021, Australian National Greenhouse Accounts Factors, Department of Climate Change, Energy, the Environment and Water, Canberra, 2021.

DCCEEW 2024a, Australian National Greenhouse Accounts Factors, Department of Climate Change, Energy, the Environment and Water, Canberra.

DCCEEW 2024b, Australia's emissions projections 2024, Department of Climate Change, Energy, the Environment and Water, Canberra, November 2024.

DCCEEW 2024c, Safeguard Mechanism: Prescribed production variables and default emissions intensities, Australian Government Department of Climate Change, Energy the Environment and Water, Canberra, https://www.dcceew.gov.au/climate-change/publications/safeguard-mechanism-document

DEFRA 2024, UK Government GHG Conversion Factors for Company Reporting, https://www.gov.uk/government/publications/greenhouse-gas-reporting-conversion-factors-2024

NSW DPIE 2020, Net Zero Plan Stage 1: 2020–2030, NSW Department of Planning, Industry and Environment, Parramatta, https://www.environment.nsw.gov.au/topics/climate-change/net-zero-plan

NSW DPIE 2021a, Net Zero Plan Stage 1: 2020–2030 Implementation Update, NSW Department of Planning, Industry and Environment, Parramatta, https://www.environment.nsw.gov.au/research-and-publications/publications-search/net-zero-plan-stage-1-2020-30-implementation-update

NSW DPIE 2021b, NSW Waste and Sustainable Materials Strategy 2041, Stage 1: 2021–2027, Department of Planning, Industry and Environment, Parramatta, https://www.dpie.nsw.gov.au/our-work/environment-energyand-science/waste-and-sustainable-materials-strategy

NSW EPA 2021, Waste Delivery Plan, NSW Environment Protection Authority, Parramatta, https://www.epa.nsw.gov.au/publications/recyclereuse/21p3399-waste-delivery-plan

NSW EPA 2023a, EPA Climate Change Policy, NSW Environment Protection Authority, Parramatta, https://www.epa.nsw.gov.au/-/media/epa/corporate-site/resources/climate-change/23p4264-climate-change-policy.pdf

NSW EPA 2023b, Climate Change Action Plan 2023–26, NSW Environment Protection Authority, Parramatta, https://www.epa.nsw.gov.au/-/media/epa/corporate-site/resources/climate-change/23p4265-climate-change-action-plan-2023-26.pdf

NSW EPA 2024, Strategic Plan 2024–29 - Protect tomorrow together, NSW Environment Protection Authority, Parramatta, https://www.epa.nsw.gov.au/About-us/Strategy-and-reporting/Strategic-Plan#:~:text=Our%20Strategic%20Plan%202024%E2%80%9329,next%20five%20years%20and%20beyond

NSW EPA 2025, NSW Guide for Large Emitters – Guidance on how to prepare a greenhouse gas assessment as part of NSW environmental planning processes, NSW Environment Protection Authority, January 2025, https://www.epa.nsw.gov.au/Your-environment/Climate-change/nsw-guide-large-emitters

NSW Government 2022, NSW Climate Change Adaptation Strategy, State of New South Wales, Sydney, https://www.climatechange.environment.nsw.gov.au/nsw-climate-change-adaptation-strategy

NSW OECC 2022, Net Zero Plan Implementation Update 2022, Office of Energy and Climate Change, NSW Treasury, December 2022, https://www.energy.nsw.gov.au/sites/default/files/2022-12/NSW-Net-Zero-Plan-Implementation-Update-2022.pdf

NSW OEH 2016, NSW Climate Change Policy Framework, NSW Office of Environment and Heritage, Sydney, https://www.environment.nsw.gov.au/topics/climatechange/policy-framework

TAGG 2013a, Greenhouse Gas Assessment Workbook for Road Projects, Transport Authorities Greenhouse Group, February 2013.

TAGG 2013b, Supporting Document for Greenhouse Gas Assessment Workbook for Road Projects, Transport Authorities Greenhouse Group, February 2013.

WRI & WBCSD 2013, Technical Guidance for Calculating Scope 3 Emissions, version 1.0. World Resources Institute and World Business Council for Sustainable Development).

Abbreviations

ACCU	Australian Carbon Credit Unit
CER	Clean Energy Regulator
CH_4	methane
CO_2	carbon dioxide
CO_2-e	carbon dioxide equivalent
COP	Conference of the Parties (to the UNFCCC)
DCCEEW	(Commonwealth) Department of Climate Change, Energy, the Environment and Water
EIS	environmental impact statement
EMM	EMM Consulting Pty Limited
GHG	greenhouse gas
GWP	global warming potential
ha	hectare
IPCC	Intergovernmental Panel on Climate Change
km	kilometre
kt	kilotonne
kV	kilovolt
MW	megawatt
MWh	megawatt-hour
NSW DCCEEW	NSW Department of Climate Change, Energy, the Environment and Water
NSW EPA	NSW Environment Protection Authority
PHES	pumped hydro energy storage
SEARs	Secretary’s Environmental Assessment Requirements
SF_6	sulfur hexafluoride
t	tonne
UNFCCC	Nations Framework Convention on Climate Change

Annexure A

GHG emission calculation methods

creating opportunities

A.1 Scope 1 emissions

A.1.1 Liquid fuel consumption (diesel)

For each greenhouse gas *i* (CO_2, CH_4 and N_2O), annual scope 1 emissions from the on-site consumption (through combustion) of diesel fuel were estimated using the following equation:

$$E_i = \frac{Q \times EC \times EF_i}{1{,}000}$$

Equation A.1

where:

E_i	=	GHG emission for gas *i*	(t CO_2-e/year)
Q	=	quantity of fuel	(kL/year)
EC	=	energy content of fuel	(GJ/kL)[7]
EF_i	=	emission factor for gas *i*	(kg CO_2-e/GJ)[8]

During the construction phase of the project, diesel would be used in on-site plant and equipment (e.g. land clearing, earthworks, construction).

During the operational phase of the project, small amounts of diesel would be used in emergency generators.

The energy content and GHG emission factors for diesel use in construction equipment are presented in Table A.1. The quantity of diesel fuel (kL) used in the assessment is given in Annexure B.

Table A.1 Energy content and emission factors – diesel consumption

Project phase	Activity	Energy content (GJ/kL)	Scope 1 emission factor (kg CO_2-e/GJ)			Reference
			CO_2	CH_4	N_2O	
Construction	Stationary combustion of liquid fuels (diesel)	38.6	69.9	0.1	0.2	DCCEEW (2024a) (Table 8, diesel oil)

A.1.2 Blasting using explosives

GHG emissions from use of explosives (assumed to be emulsion) for blasting during construction were estimated using the following equation:

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

Equation A.2

Where:

E_{CO2-e}	=	emissions of GHG from explosives (emulsion) use	(t CO_2-e/year)
Q	=	quantity of explosives	(t/year)
EF	=	emission factor (scope 1) for explosives (emulsion) use	(t CO_2-e/t explosive)

7 GJ = gigajoules

8 kg CO_2-e/GJ = kilograms of carbon dioxide equivalents per gigajoule

The GHG emission factor was sourced from the NGAF (DCC 2008), as shown in Table A.2. There are no more recent emission factors available in the NGAF documents for explosives use.

Table A.2 Emission factor – explosives use

Project phase	Fuel type	Scope 1 emission factor (t CO_2-e/t)	Source
Construction	Emulsion	0.17	DCC (2008) (Table 4, emulsion)

A.1.3 Land use changes

GHG emissions from the loss of the carbon sink associated with the removal of vegetation were estimated using the method from the TAGG Workbook and the Carbon Gauge tool (TAGG 2013a, 2013b). GHG emissions were estimated using the following equation:

$$E_{CO_2-e} = \sum_{i-1}^{i=n} A_i \times EF_i$$

Equation A.3

Where:

$E_{CO2\text{-}e}$	=	GHG emissions from vegetation clearing	(t CO_2-e/year)
A_i	=	area of vegetation of type *i*	(t/year)
EF_i	=	emission factor for vegetation of type *i*	(t CO_2-e/ha)

The calculations require classification of vegetation types which are then assigned to a specific emission factor. The main steps in the methodology included:

1. Determine of the types and areas of vegetation to be cleared over the course of the project.
2. Link the vegetation type to a vegetation class as given in Table 2 of TAGG (2013a).
3. Use the maps given in Appendix E of TAGG (2013a) to determine the 'maximum potential biomass class' based on the project's location.
4. Use the vegetation type and maximum potential biomass class to look up the CO_2-e emission factor for each vegetation class.
5. Multiply the area of vegetation cleared with the emission factor for each vegetation class and combine to estimate the total GHG emissions.

Table A.3 presents the total amount of vegetation and vegetation types estimated to be cleared as part of the project's construction phase. The areas and types of vegetation to be cleared were analysed based on data collated by the EMM. The associated emission factors are given in Table A.4.

The total emissions over the construction period were allocated to financial years based on the general construction schedule, using the number of construction days as a proxy for vegetation clearing.

Table A.3 Vegetation cleared during project construction

Vegetation class (TAGG 2013a)	Vegetation type	Amount cleared (ha)[(a)]	Source
B	Eucalypt tall open forest	42.0	Calculated by EMM.
C	Open forest	53.6	
D	Open woodlands	24.7	
TOTAL		**120.3**	

(a) Total for all construction years.

Table A.4 GHG emission factors for vegetation clearing

Vegetation class (TAGG 2013a)	Vegetation type	Maximum potential biomass class (TAGG 2013a)	Emission factors (t CO_2-e/ha)	Source
B	Eucalypt tall open forest	3	237	Table 2, TAGG (2013)
C	Open forest		307	
D	Open woodlands		307	

A.1.4 SF_6 leakage

SF_6 leakages occur from gas-insulated switchgear and circuit breaker applications.

GHG emissions from SF_6 were estimated using the following equation:

$$E = stock \times L \qquad \text{Equation A.4}$$

Where:

E	=	GHG emission	(tonnes CO_2-e/year)
stock	=	stock of SF_6	(tonnes CO_2-e)
L	=	leakage rate of SF_6	(proportion per year)

The default leakage gas rate for SF_6 is 0.0089 per year (DCCEEW 2021). To convert the mass of SF_6 into CO_2-e, it was multiplied by the GWP of SF_6 (23,500). The SF_6 stock is given in Annexure B.

A.2 Scope 2 emissions

During project construction, electricity would be purchased from the grid. There would be no electricity purchase during the first year of construction, with any electrical equipment being powered by diesel generators.

During project operation, electricity will be both purchased from the grid and supplied back to the grid. The calculation of scope 2 emissions was based on the **gross** electricity consumption from the grid.

Annual scope 2 GHG emissions associated with on-site electricity consumption were estimated using the following equation:

$$E_{CO_2-e} = \frac{Q \times EF}{1,000}$$

Equation A.5

where:

E_{CO2-e} = GHG emissions associated with on-site electricity consumption (t CO_2-e/year)

Q = quantity of electricity (MWh/year)[9]

EF = emission factor for electricity consumption (kg CO_2-e/MWh)

The scope 2 emission factors for electricity consumption were taken from *Australia's emissions projections 2024* (DCCEEW 2024b). These values are presented in Table A.5. The GHG emissions intensity of electricity generation is projected to decrease in the future, as the sector decarbonises. The amount of electricity consumed in each year is given in Annexure B.

Table A.5 Scope 2 GHG emission factors for electricity consumption

Project phase	Financial year	Emission factor (t CO_2-e/MWh)	Reference
Construction	2026-27	0.40	DCCEEW (2024b) (values for NSW/ACT in Table 46)
	2027-28	0.34	
	2028-29	0.21	
	2029-30	0.15	
	2030-31	0.15	
Operation	2031-32	0.13	
	2032-33	0.09	
	2033-34	0.09	
	2034-35	0.07	
	2035-36	0.06	
	2036-37	0.06	
	2037-38	0.06	
	2038-39	0.06	
	2039-40 and later	0.03	

9 MWh = megawatt hours

A.3 Scope 3 emissions (upstream)

A.3.1 Extraction, production and transport of liquid fuel (diesel)

Upstream scope 3 emissions for diesel consumption were calculated using Equation A.1. The energy content and scope 3 GHG emission factors for diesel are presented in Table A.6. The quantities of diesel fuel (kL) used in the assessment are given in Annexure B.

Table A.6 Energy content and scope 3 emission factors – liquid fuel consumption

Project phase	Activity	Energy content (GJ/kL)	Scope 3 emission factor (kg CO_2-e/GJ)	Reference
Construction	Stationary combustion of liquid fuels (diesel)	38.6	17.3	DCCEEW (2024a) (Table 8, diesel oil)

A.3.2 Electricity consumption

Annual scope 3 GHG emissions associated with on-site electricity consumption were estimated using Equation A.4, in combination with the gross electricity consumption values in Annexure B and the scope 3 emission factors in Table A.7. The scope 3 emission factors for electricity consumption were taken from *Australia's emissions projections 2024* (DCCEEW 2024b).

Table A.7 Scope 3 GHG emission factors for electricity consumption

Project phase	Financial year	Scope 3 emission factor (t CO_2-e/MWh)	Reference
Construction	2026-27	0.03	DCCEEW (2024b) (derived from values for NSW/ACT in Tables 46 and 47)
	2027-28	0.02	
	2028-29	0.02	
	2029-30	0.01	
	2030-31	0.01	
Operation	2031-32	0.01	
	2032-33	0[a]	
	2033-34	0[a]	
	2034-35	0.01	
	2035-36	0.01	
	2036-37 and later	0[a]	

a) Scope 3 emission factor is zero.

A.3.3 Embodied emissions

GHG emissions from embodied emissions (the emissions created over the life cycle of construction materials, from creation to disposal) were estimated using the following equation:

$$E_{CO_2-e} = Q_k \times EF_k$$

Equation A.6

Where:

$E_{CO2\text{-}e}$	=	emissions of GHG from material *k*	(t CO_2-e)
Q_k	=	quantity of material *k*	(t)
EF_k	=	emission factor for material *k*	(t CO_2-e/y)

The GHG emission factors for the construction materials that were considered in the assessment are presented in Table A.8. The activity data (material quantities) for the calculations are provided in Annexure B.

Table A.8 GHG emission factors – embodied emissions

Project phase	Material	Emission factor (t CO_2-e/t)	Source
Construction	Aggregate	0.007	TAGG (2013a) Table D.4
	Portland cement	0.82	
	Sand	0.003	
	Steel (liner, secondary)	1.05	
	Steel (reinforcement)	1.05	
	Geomembrane (as PVC)	2.41	

A.3.4 Material transport

Emissions were also calculated for the transport of the materials to the project. For all materials except geomembranes, materials would be sourced from locations in Australia, and would be transported to the project site by truck. For geomembranes, the material would be sourced from China and transported to Sydney by sea, followed by transport to the project site by truck. The associated distances are given in Annexure B.

The energy content and GHG emission factors for diesel use in trucks are presented in Table A.9. Diesel was calculated based on an Australian average value for articulated trucks of 53.1 L/100 km (ABS 2020). The GHG emission factor for sea transport is given in Table A.10.

Table A.9 Energy content and emission factors – diesel consumption

Project phase	Activity	Energy content (GJ/kL)	Scope 1 emission factor (kg CO_2-e/GJ)			Reference
			CO_2	CH_4	N_2O	
Construction	Transport fuel emissions: HDV Euro IV+, diesel	38.6	69.9	0.07	0.04	DCCEEW (2024a) (Table 9)

Table A.10 Emission factor for sea transport

Transport mode	Emission factor (kg CO_2-e/tonne-km)	Reference
Sea	0.01321	DEFRA (2024) [a] (Freighting goods / cargo ship, bulk carrier)

a) The DEFRA scope 1 emission factors were used for estimating transport emissions. The DEFRA database represents a comprehensive suite of emission factors that cover a wide range of activities, including energy, transport, water and waste disposal. These emission factors (most recently published in 2024) are more recent than those in the Australian NGER (Safeguard) Rule 2015, and are slightly more conservative.

Annexure B

Activity data

EMM
creating opportunities

B.1 Annual activity data

The activity data for use in the GHG emission calculations were provided by Energy Australia. The annual data are provided in Table B.1.

Table B.1 Annual activity data

Financial year	Diesel (kL/year)[(a)]	Explosives (emulsion) (t/year)[(b)]	Vegetation removed (ha/year)[(b)]	SF_6 stock (kg/year)	Electricity consumption (MWh/year)[(b)]	Electricity returned to grid (MWh/year)
Project construction						
2026-27	2,891.0	652.6	16.5	-	0	-
2027-28	6,250.0	1,503.8	38.8	-	27,290.0	-
2028-29	8,150.0	1,583.4	35.9	-	50,852.7	-
2029-30	8,300.0	904.9	23.5	-	33,244.9	-
2030-31	4,200.0	355.3	5.6	-	7,882.8	-
Project operation						
2031-32	0.1	-	-	240.0	1,204,000	963,200
2032-33	0.1	-	-	240.0	1,204,000	963,200
2033-34	0.1	-	-	240.0	1,204,000	963,200
2034-35	0.1	-	-	240.0	1,204,000	963,200
2035-36	0.1	-	-	240.0	1,204,000	963,200
2036-37	0.1	-	-	240.0	1,204,000	963,200
2037-38	0.1	-	-	240.0	1,204,000	963,200
2038-39	0.1	-	-	240.0	1,204,000	963,200
2039-40	0.1	-	-	240.0	1,204,000	963,200
2030-41	0.1	-	-	240.0	1,204,000	963,200
2041-42	0.1	-	-	240.0	1,204,000	963,200
2042-43	0.1	-	-	240.0	1,204,000	963,200
2043-44	0.1	-	-	240.0	1,204,000	963,200
2044-45	0.1	-	-	240.0	1,204,000	963,200
2045-46	0.1	-	-	240.0	1,204,000	963,200
2046-47	0.1	-	-	240.0	1,204,000	963,200
2047-48	0.1	-	-	240.0	1,204,000	963,200
2048-49	0.1	-	-	240.0	1,204,000	963,200
2049-50	0.1	-	-	240.0	1,204,000	963,200

a) The distribution of diesel use across the years of the construction period was provided by EnergyAustralia.
b) The distribution of activity across the years of the construction period was based on a construction schedule provided by EnergyAustralia.

B.2 Construction materials

The quantities of construction materials for the project, and the transport distances, are given in Table B.2.

Table B.2 Quantities of construction materials

Project phase	Material	Mass (t)[(a)]	Transport distance		
			Road (external) (km)	Road (within site) (km)	Sea (km)
Construction	Aggregate	134,280	0	5	-
	Portland cement	55,620	220	5	-
	Sand	53,712	200	5	-
	Steel (liner, secondary)	3,574	630	5	-
	Steel (reinforcement)	1,600	90	5	-
	Geomembrane (as PVC)	38	150	5	11,000

a) The distribution of activity across the years of the construction period was based on a construction schedule provided by EnergyAustralia.

Annexure C
Emissions data

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The estimates of scope 1 and scope 2 emissions (CO_2-e) for the project are given by source and year in Table C.1, and scope 3 emissions are given in Table C.2.

Table C.1 Scope 1 and scope 2 emissions by source and year

Financial year	GHG emissions by calendar year (kt CO_2-e/year)						
	Scope 1				Scope 2	Scope 1 total	Scope 1 + scope 2 total
	Diesel	Explosives	Vegetation removal	SF_6 leakage	Electricity (gross)		
Project construction							
2026-27	7.8	0.1	4.7	-	0.0	12.6	12.6
2027-28	16.9	0.3	11.0	-	9.3	28.1	37.4
2028-29	22.1	0.3	10.2	-	10.7	32.5	43.2
2029-30	22.5	0.2	6.6	-	5.0	29.3	34.3
2030-31	11.4	0.1	1.6	-	1.2	13.0	14.2
Project operation							
2031-32	0.0	-	-	0.1	156.5	0.1	156.5
2032-33	0.0	-	-	0.1	108.4	0.1	108.4
2033-34	0.0	-	-	0.1	108.4	0.1	108.4
2034-35	0.0	-	-	0.1	84.3	0.1	84.3
2035-36	0.0	-	-	0.1	72.2	0.1	72.3
2036-37	0.0	-	-	0.1	72.2	0.1	72.3
2037-38	0.0	-	-	0.1	72.2	0.1	72.3
2038-39	0.0	-	-	0.1	72.2	0.1	72.3
2039-40	0.0	-	-	0.1	36.1	0.1	36.2
2030-41	0.0	-	-	0.1	36.1	0.1	36.2
2041-42	0.0	-	-	0.1	36.1	0.1	36.2
2042-43	0.0	-	-	0.1	36.1	0.1	36.2
2043-44	0.0	-	-	0.1	36.1	0.1	36.2
2044-45	0.0	-	-	0.1	36.1	0.1	36.2
2045-46	0.0	-	-	0.1	36.1	0.1	36.2
2046-47	0.0	-	-	0.1	36.1	0.1	36.2
2047-48	0.0	-	-	0.1	36.1	0.1	36.2
2048-49	0.0	-	-	0.1	36.1	0.1	36.2
2049-50	0.0	-	-	0.1	36.1	0.1	36.2
Average (kt CO_2-e/year) [(a)]	**16.1**	**0.2**	**4.7**	**0.1**	**48.7**	**4.9**	**53.6**
Total (kt CO_2-e)	**80.7**	**0.9**	**34.0**	**1.0**	**1,169.9**	**116.5**	**1,286.4**

a) Based on non-zero years only.

Table C.2 Scope 3 emissions by source and year

Financial year	GHG emissions by calendar year (kt CO_2-e/year)				
	Scope 3				Scope 3 total
	Diesel	Materials (transport)	Materials (embodied)	Electricity (gross)	
Project construction					
2026-27	1.9	0.3	7.2	0.0	9.4
2027-28	4.2	0.7	16.8	0.5	22.2
2028-29	5.4	0.6	15.6	1.0	22.7
2029-30	5.5	0.4	10.2	0.3	16.5
2030-31	2.8	0.1	2.4	0.1	5.4
Project operation					
2031-32	0.0	-	-	12.0	12.0
2032-33	0.0	-	-	0.0	0.0
2033-34	0.0	-	-	0.0	0.0
2034-35	0.0	-	-	12.0	12.0
2035-36	0.0	-	-	12.0	12.0
2036-37	0.0	-	-	0.0	0.0
2037-38	0.0	-	-	0.0	0.0
2038-39	0.0	-	-	0.0	0.0
2039-40	0.0	-	-	0.0	0.0
2030-41	0.0	-	-	0.0	0.0
2041-42	0.0	-	-	0.0	0.0
2042-43	0.0	-	-	0.0	0.0
2043-44	0.0	-	-	0.0	0.0
2044-45	0.0	-	-	0.0	0.0
2045-46	0.0	-	-	0.0	0.0
2046-47	0.0	-	-	0.0	0.0
2047-48	0.0	-	-	0.0	0.0
2048-49	0.0	-	-	0.0	0.0
2049-50	0.0	-	-	0.0	0.0
Average (kt CO_2-e/year) [(a)]	**4.0**	**0.4**	**10.4**	**1.9**	**4.7**
Total (kt CO_2-e)	**19.9**	**2.0**	**52.2**	**38.1**	**112.3**

a) Based on non-zero years only.

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