Appendix J

Greenhouse Gas Assessment

MARINUS LINK

Marinus Link: Greenhouse Gas Assessment

Prepared for:

Tetra Tech Coffey Pty Ltd

May 2024

Rev 0

Prepared by:

Katestone Environmental Pty Ltd
ABN 92 097 270 276
Level 4, 154 Melbourne Street, South Brisbane
Queensland, 4101, Australia

www.katestone.global
admin@katestone.com.au
Ph +61 7 3369 3699

Document Control

Deliverable #:	D21046-27
Title:	Marinus Link: Greenhouse Gas Assessment
Version:	Rev 0
Client:	Tetra Tech Coffey Pty Ltd
Document reference:	D21046-27 Marinus Link Greenhouse Gas Assessment (Rev 0).docx
Prepared by:	PM
Reviewed by:	CM
Approved by:	CM
	16/05/2024

Contents

Tables

Figures

Glossary

Unit	Definition
°C	degrees Celsius
GJ	gigajoules
GJ/kL	gigajoules per kilolitre
ha	hectares
kg	kilograms
kg/y	kilograms per year
kL	kilolitres
km	kilometres
kV	kilovolt
kWh	kilowatt hour
L	litres
tkm	tonne kilometres
$ktCO_{2\text{-}e}$	kilotonnes of carbon dioxide equivalent
m	metres
MJ	megajoules
$MtCO_{2\text{-}e}$	million tonnes of carbon dioxide equivalent
MW	megawatt
$tCO_{2\text{-}e}$	tonnes of carbon dioxide equivalent
$tCO_{2\text{-}e}/y$	tonnes of carbon dioxide equivalent per year
tC	tonnes carbon
TJ	terajoules
t	tonnes
t/year	tonnes per year
Nomenclature	**Definition**
CH_4	Methane
CO_2	Carbon dioxide
CO_2-e	Carbon dioxide equivalent
SF_6	Sulphur hexafluoride
N_2O	Nitrous oxide
Abbreviations	**Definition**
ACCUs	Australian Carbon Credit Units
AEMO	Australian Energy Market Operator
AIS	Air insulated substation
CB	Circuit breaker
CC Act 2017	*Climate Change Act 2017* (Vic)
CC Act	*Climate Change Act 2022* (Cwth)
CCCA Act	*Climate Change (Consequential Amendments) Act 2022* (Cwth)
Cwth	Commonwealth of Australia
DCCEEW	Department of Climate Change, Energy, Environment, and Water
DTP	Department of Transport and Planning
EE Act	*Environmental Effects Act 1978* (Vic)
EES	Environment Effects Statement
EF	Emission factor
EIS	Environmental Impact Statement
EMPC Act	*Environmental Management and Pollution Control Act 1994* (Tas)
EP Act	*Environment Protection Act 2017* (Vic)
EPA	Tasmanian Environmental Protection Authority
EPBC Act	Environment Protection and Biodiversity Conservation Act (Cwth)
EPR	Environmental Performance Requirements

ERF	Emissions Reduction Fund
GED	General Environmental Duty
GHG	Greenhouse gas
GWP	Global Warming Potential
HV	High Voltage
HVAC	High voltage alternating current
HVDC	High voltage direct current
ISP	Integrated System Plan
LULUCF	Land-use, land-use change and forestry
LUPA Act	*Land Use Planning Control Act 1993* (Cwth)
LV	Low voltage
MLPL	Marinus Link Pty Ltd
MNES	Matters of National Environmental Significance
NDC	Nationally determined contribution
NEM	National Electricity Market
NGER	National Greenhouse and Energy Reporting
NGER Act	*National Greenhouse and Energy Reporting Act 2007* (Cwth)
NWTD	North-West Transmission Developments
PEM	Protocol for the Environmental Management
REZ	Renewable energy zone
ROV	Remotely Operated Underwater Vehicle
SEPP	State Environment Protection Policies
UNFCCC	United Nations Framework Convention on Climate Change

EXECUTIVE SUMMARY

Katestone Environmental Pty Ltd (Katestone) was commissioned by Tetra Tech Coffey Pty Ltd (Tetra Tech Coffey) to conduct a greenhouse gas (GHG) assessment for Marinus Link.

Marinus Link Pty Ltd (MLPL) is proposing to construct a high-voltage direct current (HVDC) electricity interconnector between Tasmania and Victoria, to be known as Marinus Link. Marinus Link will allow for the continued trading, transmission, and distribution of electricity within the National Electricity Market (NEM).

Marinus Link will be a 1500-megawatt (MW) HVDC electrical interconnector between Burnie in Tasmania and the Latrobe Valley in Victoria. Marinus Link is proposed to be executed in two stages. Each stage will consist of a 750 MW HVDC bundled cable between Tasmania and Victoria. The Marinus Link interconnector will provide a second link between the Tasmanian and Victorian electricity grids enabling energy transfer between these regions in the NEM.

Within the NEM, electricity with low GHG emissions intensity generated in Tasmania will have the potential to replace electricity generated with higher GHG emissions intensity, including electricity from coal fired power stations. Marinus Link will provide an opportunity to achieve GHG emissions reductions at a national level, contributing towards Australia's GHG emissions reduction commitments under the Paris Agreement and updated Nationally Determined Contribution (NDC).

One option is for the project alignment from the Heybridge Converter Station to Hazelwood connection, and the other options is for the project alignment from Heybridge Converter Station to Driffield connection. The GHG emission for both options exclude the Heybridge Converter Station emissions as they are reported separately.

- Heybridge Converter Station (Tasmania)
  - Annual Scope 1 and Scope 2 GHG emissions over the construction phase of the project, including land clearing in Year 1, range between 3 and 232 tCO_2-e/y.
  - Total Scope 1 and Scope 2 GHG emissions over the construction period, including land clearing, are estimated to be 508 tCO_2-e.
  - Scope 3 emissions, including from concrete and steel for construction, are estimated to be 25,582 tCO_2-e.
  - Annual Scope 1 and Scope 2 GHG emissions during operation of the project are estimated to be 1,431 tCO_2-e/y.
  - GHG emissions contributions to the Tasmanian GHG emissions inventory will reduce the -3.7 $MtCO_2$-e buffer by approximately 0.04%.
  - The project is estimated to contribute < 0.001% to the national GHG emissions inventory (as of December 2021) on an annual basis.
- Heybridge to Hazelwood project alignment (Tasmania, Commonwealth, Victoria)
  - Annual Scope 1 and Scope 2 GHG emissions over the construction period, including land clearing, range between 15 and 11,031 tCO_2-e/y.
  - Total Scope 1 and Scope 2 GHG emissions over the construction period, including land clearing, are estimated to be 53,015 tCO_2-e.
  - Scope 3 emissions, including from concrete and steel for construction, are estimated to be 162,926 tCO_2-e.

- Maximum annual total GHG emissions (Scope 1 and Scope 2) during operation of the project are estimated to be 235,128 tCO_2-e/y.
- The project is estimated to contribute no more than 0.05% of the national GHG emissions inventory (as of December 2021) on an annual basis during operation.
- The project is estimated to contribute 0.22 to 0.24% to the annual Victorian GHG emissions inventory during operation.

- Heybridge to Driffield project alignment (Tasmania, Commonwealth, Victoria)
  - Annual Scope 1 and Scope 2 GHG emissions over the construction period, including land clearing, range between 15 and 9,550 tCO_2-e/y.
  - Total Scope 1 and Scope 2 GHG emissions over the construction period, including land clearing, are estimated to be 45,611 tCO_2-e.
  - Scope 3 emissions, including from concrete and steel for construction, are estimated to be 158,510 tCO_2-e.
  - Annual Scope 1 and Scope 2 GHG emissions during operation of the project are estimated to be 201,602 tCO_2-e/y.
  - The project is estimated to contribute no more than 0.04% of the national GHG emissions inventory on an annual basis during operation.
  - The project is estimated to contribute 0.19 – 0.24% to the annual Victorian GHG emissions inventory during operation.
  - Construction of the Heybridge to Driffield Option will result in 4,416 tCO_2-e fewer Scope 3 emissions than the Heybridge to Hazelwood Option, based on current material use assumptions.

The Marinus Link will enable the delivery of low emissions electricity, estimated at 140 million tonnes of CO_2-e abatement per year by 2050, contributing towards Australia's GHG emissions reduction commitments under the Paris Agreement and updated NDC.

At a state level the project will also provide improved access to renewable energy and improve the efficiency of both Tasmania's and Victoria's electricity grid, contributing towards both the Tasmanian Government's and Victorian Government's goals of net zero greenhouse gas emissions by 2030 and 2050, respectively.

The following Environmental Performance Requirements (EPRs) are proposed for the project:

GHG01: Minimise greenhouse gas emissions in construction

Prior to commencement of project works, identify opportunities to reduce Scope 1 and Scope 2 greenhouse gas emissions (as defined in the NGER Act) so far as reasonably practicable. Measures must be consistent with the Marinus Link Sustainability Framework and include consideration of:

- Use of low emission fuels
- Maintenance of equipment and vehicles
- Minimising vegetation clearance
- Purchase of green energy
- Procurement of energy efficient machinery
- Use of low carbon emission concrete

- Use of recycled materials

The design must include measures to avoid SF_6 leakage so far as reasonably practicable.

Scope 1 and Scope 2 GHG emissions during construction must be reported annually on the Marinus Link website.

GHG02: Report on GHG emissions in operation

Prior to commencement of operation, identify opportunities to reduce operational Scope 1 and Scope 2 greenhouse gas emissions (as defined in the NGER Act) so far as reasonably practicable. Measures must be consistent with the Marinus Link Sustainability Framework and include consideration of:

- Management and maintenance of SF¬$_6$ insulated equipment in accordance with Australian Standard IEC 62271.4: 2015 – high-voltage switchgear and controlgear – Part 4: Handling procedures for sulphur hexafluoride (SF¬$_6$) and its mixtures and the Energy Network Australia Industry Guideline for SF6 Management (Document 022-2008) and prevention of release of SF¬$_6$ by using a closed cycle during installation, maintenance and decommissioning of equipment where practicable.
- Use of low emission fuels
- Maintenance of equipment and vehicles
- Purchase of green energy
- Procurement of energy efficient machinery

Scope 1 and Scope 2 emissions from operation must be reported annually on the Marinus Link website.

1. INTRODUCTION

The proposed Marinus Link (the project) comprises a high voltage direct current (HVDC) electricity interconnector between Tasmania and Victoria, to allow for the continued trading and distribution of electricity within the National Electricity Market (NEM).

The project was referred to the Australian Minister for the Environment 5 October 2021. On 4 November 2021, a delegate of the Minister for the Environment determined that the proposed action is a controlled action as it has the potential to have a significant impact on the environment and requires assessment and approval under the *Environment Protection and Biodiversity Conservation Act 1999* (Cwlth) (EPBC Act) before it can proceed. The delegate determined that the appropriate level of assessment under the EPBC Act is an environmental impact statement (EIS).

On 12 December 2021, the former Victorian Minister for Planning under the *Environment Effects Act 1978* (Vic) (EE Act) determined that the project requires an environment effects statement (EES) under the EE Act, to describe the project's effects on the environment to inform statutory decision making.

In July 2022 a delegate of the Director of the Environment Protection Authority Tasmania determined that the project be subject to environmental impact assessment by the Board of the Environment Protection Authority (the Board) under the *Environmental Management and Pollution Control Act 1994* (Tas) (EMPCA).

As the project is proposed to be located within three jurisdictions, the Victorian Department of Transport and Planning (DTP), Tasmanian Environment Protection Authority (Tasmanian EPA) and Australian Department of Climate Change, Energy, Environment and Water (DCCEEW) have agreed to coordinate the administration and documentation of the three assessment processes. One EIS/EES is being prepared to address the requirements of DTP and DCCEEW. Two EISs are being prepared to address the Tasmanian EPA requirements for the Heybridge converter station and shore crossing.

This report has been prepared by Katestone Environmental Pty Ltd (Katestone) for the Tasmanian, Victorian, and Commonwealth jurisdictions as part of the EIS/EES and two EISs being prepared for the whole project.

1.1 Purpose of this report

The objectives of this study are to apply an integrated approach to assessing potential environmental impacts that could occur because of the project, explicitly considering the following:

- Compile an inventory of the type and volume of greenhouse gas (GHG) emissions expected to be generated from construction, operation, and maintenance activities consistent with statutory reporting standards.
- Compare total GHG emissions during construction, operations, and maintenance against state and national targets; and
- Propose strategies to reduce, monitor and audit direct and indirect GHG emissions resulting from the construction and operation of the project.

2. PROJECT OVERVIEW

The project is a proposed 1500-megawatt (MW) HVDC electricity interconnector between Heybridge in northwest Tasmania and the Latrobe Valley in Victoria (Figure 1). Marinus Link is proposed to provide a second link between the Tasmanian renewable energy resources and the Victorian electricity grids enabling efficient energy trade, transmission, and distribution from a diverse range of generation sources to where it is most needed and will increase energy capacity and security across the National Electricity Market (NEM).

Marinus Link Pty Ltd (MLPL) is the proponent for the project and is a wholly owned subsidiary of Tasmanian Networks Pty Ltd (TasNetworks). TasNetworks is owned by the State of Tasmania, which also owns, operates, and maintains the electricity transmission and distribution network in Tasmania.

Tasmania has significant renewable energy resource potential, particularly hydroelectric power, and wind energy. The potential size of the resource exceeds both the Tasmanian demand and the capacity of the existing Basslink interconnector between Tasmania and Victoria. The growth in renewable energy generation in mainland states and territories participating in the NEM, coupled with the retiring of baseload coal-fired generators, is reducing the availability of dispatchable generation that is available on demand.

Tasmania's existing and potential renewable resources are a valuable source of dispatchable generation that could benefit electricity supply in the NEM. Marinus Link will allow for the continued trading, transmission and distribution of electricity within the NEM. It will also manage the risk to Tasmania of a single interconnector across the Bass Strait and complement existing and future interconnectors on mainland Australia. Marinus Link is expected to facilitate the reduction in greenhouse gas emissions at a state and national level (EIS/EES Technical Appendix C: Climate Change).

Interconnectors are a key feature of the future energy landscape. They allow power to flow between different regions to enable the efficient transfer of electricity from renewable energy zones to where the electricity is needed. Interconnectors can increase the resilience of the NEM and make energy more secure, affordable, and sustainable for customers. Interconnectors are common around the world including in Australia. They play a critical role in supporting Australia's transition to a clean energy future.

2.1 Project area

The project area is approximately 345 km in length and runs from Heybridge on the northwest coast of Tasmania across Bass Strait to Waratah Bay on the southeast coast of Victoria before heading inland north to the Driffield and Hazelwood areas (Figure 1).

Most of the alignment (90%) crosses private freehold land, predominantly comprised of agricultural and forestry land uses (Figure 2). For the remainder there are community service facilities, roads, rivers, and residential properties. The Heybridge converter station is the only section of the project located in Tasmania. The land use classification of the Heybridge site is other minimal use, i.e., an area of land that is largely unused in the context of its prime use but that may have ancillary uses. The Victorian component of the project begins at Waratah Bay before travelling inland approximately 90 km to the Driffield and/or Hazelwood areas. The entire 90 km-long alignment will require a nominal 36 m wide (minimum 20 m wide) construction corridor.

The key terrain feature associated with the Tasmanian component of the project is the northwest coastline of Tasmania, directly north of the Heybridge construction footprint. The key terrain feature associated with the Victorian component of the project is Waratah Bay, where the sea cable reaches Victoria and the Grand Ridge Mountain range which exists to the east of the land project alignment.

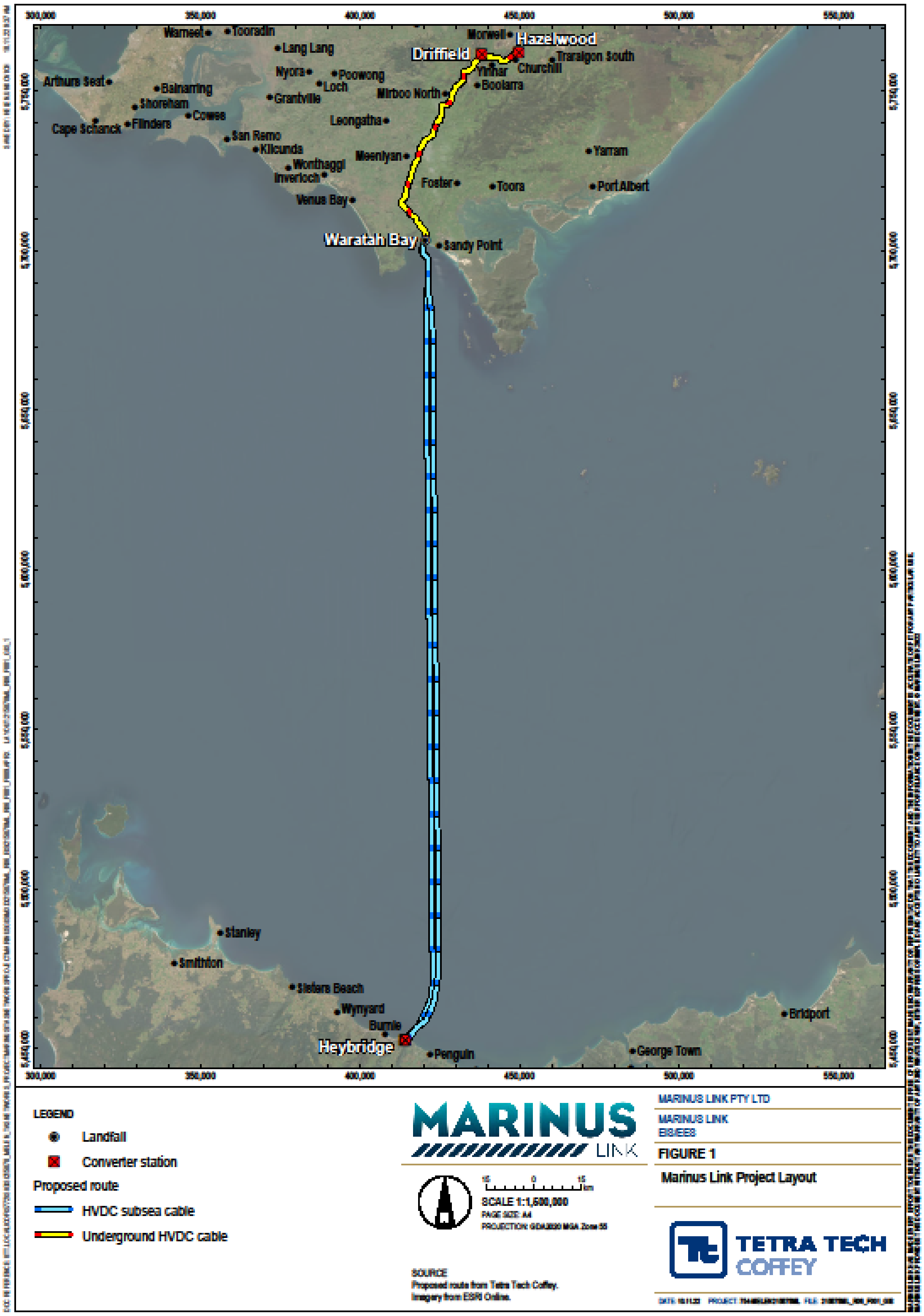

Figure 1 Marinus Link Overview (Tetra Tech Coffey, 2022)

2.2 Study focus

This study focuses on the GHG emissions from the construction and operation of the Heybridge Converter Station, and the total GHG emissions from the proposed Heybridge Converter Station[1] to Hazelwood Converter Station and from the proposed Heybridge Converter Station[1] to Driffield Converter Station. The Victorian converter station will be built at either Hazelwood or Driffield and the assessment has considered both proposed converter station sites. The potential Victorian converter station sites are adjacent to the Hazelwood–Cranbourne/Rowville 500 kV transmission lines at Driffield and adjacent to Hazelwood Terminal Station. The Driffield site is in Hancock Victorian Plantations' Thorpdale plantation west of Strzelecki Highway. The Hazelwood site is in farmland adjacent to the southern boundary of the Hazelwood Terminal Station and Tramway Road.

[1] i.e., excluding the emissions from construction and operation of the Heybridge Converter Station.

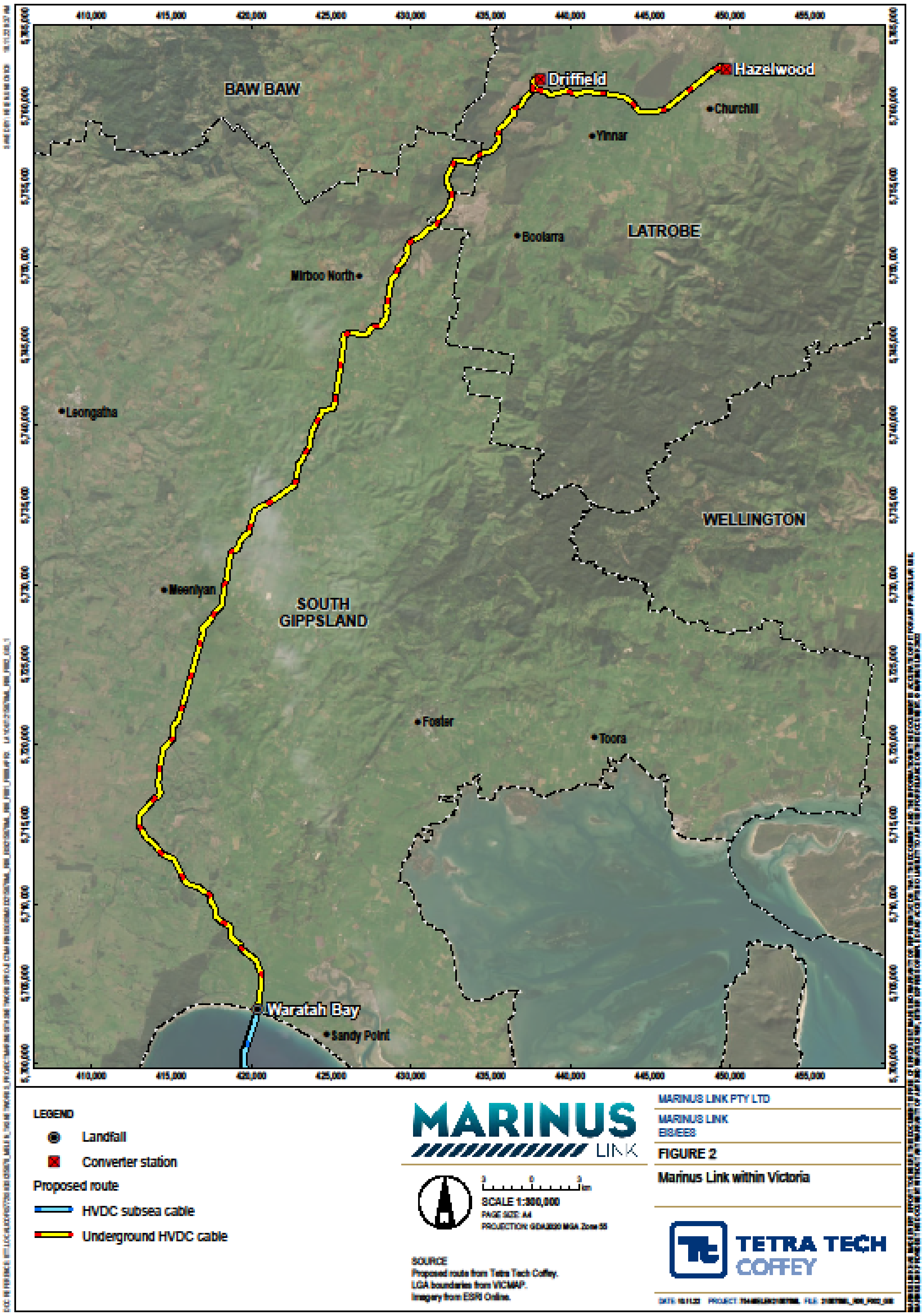

Figure 2 Marinus Link within Victoria (Tetra Tech Coffey, 2022)

3. REGULATORY FRAMEWORK, POLICY CONTEXT, AND ASSESSMENT REQUIREMENTS

3.1 Commonwealth

The Commonwealth Government has committed that Australia will reduce GHG emissions by 43% below 2005 levels by 2030 and will achieve net zero GHG emissions by 2050. It is developing new policies to drive the transition to net zero and will build on existing programs such as the Emissions Reduction Fund (ERF). The Commonwealth Government is also reviewing the Safeguard Mechanism, which requires Australia's largest emitters to keep net emissions within baseline levels, to ensure that it will conform to Australia's climate targets.

3.1.1 *Environment Protection and Biodiversity Conservation Act 1999*

The Minister for Environment has not previously been required to consider the potential impacts of a project on climate change under the EPBC Act; however, the Australian Senate is currently considering the Environment Protection and Biodiversity Conservation Amendment (Climate Trigger) Bill 2022.

3.1.2 *Climate Change Act 2022*

The *Climate Change Act* 2022 (Cwlth) (CC Act) provides the legislative framework to implement Australia's net-zero commitments and codifies Australia's net 2030 and 2050 GHG emissions reductions targets under the Paris Agreement. The legislated targets are to reduce net GHG emissions to 43% below 2005 levels by 2030, and to reduce net GHG emissions to zero by 2050.

The CC Act establishes the 2030 GHG emissions reduction target as a national target and an emissions budget. The CC Act does not impose obligations directly on companies, but it does signal sector-based reforms to achieve the GHG emissions reduction targets.

3.1.3 *Climate Change (Consequential Amendments) Act 2022*

The *Climate Change (Consequential Amendments) Act* 2022 (Cwlth) (CCCA Act) embeds the GHG emissions reduction targets into fourteen Commonwealth Acts, including the *Clean Energy Regulator Act 2011*(Cwlth), *Infrastructure Australia Act 2008* (Cwlth), *National Greenhouse and Energy Reporting Act 2007* (Cwlth), and the *Renewable Energy (Electricity) Act 2000* (Cwlth).

3.1.4 *National Greenhouse and Energy Reporting Act 2007*

The *National Greenhouse and Energy Reporting Act 2007* (Cwth) (NGER Act) establishes a national framework for corporations to report GHG emissions and energy consumption.

NGER Act mandates reporting by corporations or facilities that have energy production, energy use, or GHG emissions that exceed specified thresholds (Table 3-1). These entities are required to report on their Scope 1 and Scope 2 emissions, where:

- Scope 1 emissions – the release of GHG into the atmosphere from a facility as a direct result of an activity or series of activities (including ancillary activities) that constitute the facility. GHG emissions associated with land clearing are not covered by the NGER scheme.
- Scope 2 emissions – means the release of GHG into the atmosphere as a direct result of one or more activities that generate electricity, heating, cooling, or steam at a facility and that is consumed by the facility.

Scope 3 emissions are not included in NGER reporting due to the potential for double counting. Scope 3 emissions are defined as indirect GHG emissions, other than Scope 2 emissions, that are generated in the wider economy by a facility's supply chain or value chain. They occur because of activities at sources not owned or controlled by that facility's business.

Table 3-1 NGER annual reporting thresholds – greenhouse gas emissions and energy use

Threshold level	Threshold type	
	GHG (kt CO_2-e)	Energy production and/or consumption (TJ)
Facility	25	100
Corporate	50	200
Notes: kt CO_2-e = kilotonnes of carbon dioxide equivalent. TJ = terajoules.		

3.1.5 *National Electricity (South Australia) Act 1996*

The *National Electricity (South Australia) Act 1996* (SA) (NEA) establishes the governance framework and key obligations for the NEM, including the role and functions of the Australian Energy Market Operator (AEMO), as well as the regulation of access to electricity networks.

The NEA is supported by the National Electricity (South Australia) Regulations and National Electricity Rules.

Energy Networks Australia, the peak national body representing Australia's gas distribution and electricity transmission and distribution companies, produces a range of codes, specifications, guidelines, and handbooks to support the industry.

3.2 Tasmania

3.2.1 *Climate Change (State Action) Act 2008*

The *Climate Change (State Action) Act* (Tas) 2008 sets the Tasmanian Government's legislative framework for action on climate change. Under the Act, Tasmania has a legislated GHG reduction target of net zero emissions, or lower, from 2030, and the government is required to work with industry and business to, *inter alia*, develop sector-based emissions reduction and resilience plans, to be updated every five years. A draft of the new action plan is likely to be released for public consultation in 2023.The most recent review of state GHG emissions, Climate Action 21: Report Card 2019 (Tasmanian Climate Change Office, 2019), indicated that GHG emissions at a state level had decreased by 95% below 1990 levels (based on the 2017 reporting period).

3.2.2 Climate Action 21

Climate Action 21: Tasmania's Climate Change Action Plan 2017-2021 sets the Tasmanian Government's agenda for action on climate change through to 2021. It reflected the Tasmanian Government's commitment to addressing the critical issue of climate change and articulates how Tasmania will play its role in the global response to climate change. Climate Action 21 had several priority areas including a target to achieve zero net emissions by 2050. Advancing the state's renewable energy capability at both a state and national level was a key component of Climate Action 21.

A new whole-of government action plan is being developed by the Tasmanian Government. This plan will recognise that a new emissions target of net zero emissions by 2030 is achievable.

3.3 Victoria

3.3.1 *Climate Change Act 2017*

The CC Act 2017 sets the legislative foundation to manage climate change risks, and drive Victoria's transition to net zero emissions by 2050. A key condition under the CC Act 2017 is the requirement of the Victorian Government to develop a Climate Change Strategy every 5 years with interim targets to enable Victoria to reach its long-term net-zero emissions goal. In May 2021, the Victorian Government released Victoria's Climate Change Strategy, with key targets being:

- Reduce Victoria's greenhouse gas emissions from 2005 levels by 28-33% by 2025, and 45-50% by 2030
- 50% renewables target by 2030.

The objectives will be achieved through:

- Increasing renewable energy generation
- Reducing transport emissions by accelerating the transition to zero emission vehicles
- Halving the amount of organic waste going to landfill
- Restoring degraded landscapes and planting trees to remove emissions from the atmosphere.

3.3.2 *Environment Protection Act 2017*

The revised *Environment Protection Act 2017* (Vic) (EP Act) came into effect on 1 July 2021, replacing the *Environment Protection Act 1970*. The EP Act introduces a 'general environmental duty' (GED), which places a duty on all Victorians and Victorian businesses who engage in an activity that may cause harm to human health or the environment from pollution or waste to eliminate those risks, or if not possible to do so, to reduce those risks so far as reasonably practicable. GHG emissions are expressly defined as waste in the EP Act, and as such the minimisation of harm from GHG emissions is required to comply with the GED.

The EP Act establishes new subordinate instruments including Regulations, the Environment Reference Standard (ERS), and guidelines, and has discontinued State environment protection policies (SEPP) and Waste management policies (WMP).

3.3.3 Protocol for Environmental Management – Greenhouse Gas Emissions and Energy Efficiency

The Protocol for the Environmental Management (PEM): Greenhouse Gas Emissions and Energy Efficiency in Industry (PEM GHG) is an incorporated document of the SEPP for Air Quality Management (SEPP AQM) that is still relevant in contributing to the state of knowledge. Under the PEM GHG, all license applicants are required to:

- Step 1: Estimate energy consumption in GJ, by energy type and the associated GHG emissions in CO_2-equivalent terms.
- Step 2: Estimate direct greenhouse emissions in CO_2-equivalent terms for non-energy sources; and
- Step 3: Identify and evaluate opportunities to reduce greenhouse gas emissions.

3.3.4 Guideline for managing greenhouse gas emissions

EPA Victoria has developed a *Guideline for managing greenhouse gas emissions* (EPA Vic, 2022) under the EP Act that outlines a risk management approach that can be applied to GHG emissions for businesses and industries. The general process of the approach is as follow:

- Step 1: Identify GHG emission sources and group them according to Scope
- Step 2: Assess risks from GHG emissions
- Step 3: Implement controls to eliminate risks (or reduce risks so far as reasonably practicable) of harm from GHG emissions
- Step 4: Review controls to ensure they are effective.

3.4 Marinus Link Pty Ltd

Marinus Link Pty Ltd intends that the project will contribute to a reduction of at least 140 million tonnes of CO_2 emissions per year by 2050 due to increased NEM access to renewable energy[2]. The emission saving is calculated based on the current carbon emission intensity of the NEM. Commissioning of Marinus Link unlocks the achievement of the 200% Tasmanian Renewable Energy Target [TRET] of 10,500 MWh of additional renewable generation. This has been independently verified by the Tasmanian and Commonwealth Governments and is reflected in the Commonwealth-Tasmanian Bilateral Energy and Emissions Reduction Agreement[3].

3.5 Assessment Guidelines

As the project is proposed to be located within three jurisdictions, the Victorian Department of Transport and Planning (DTP), Tasmanian Environment Protection Authority (Tasmanian EPA) and Australian Department of Climate Change, Energy, Environment and Water (DCCEEW) have agreed to coordinate the administration and documentation of the three assessment processes. One EIS/EES is being prepared to address the requirements of DTP and DCCEEW. Two EISs are being prepared to address the Tasmanian EPA requirements for the Heybridge converter station and shore crossing.

This section outlines the requirements of assessment guidelines under Commonwealth, Tasmanian and Victorian jurisdictions relevant to GHG emissions and the linkages to other EIS/EES technical studies.

3.5.1 Commonwealth

DCCEEW have published the following guidelines for the EIS: 'Guidelines for the Content of a Draft Environmental Impact Statement – Environment Protection and Biodiversity Conservation Act 1999 – Marinus Link underground and subsea electricity interconnector cable (EPBC 2021/9053)'. The EIS guidelines do not include any requirements relevant to the assessment of greenhouse gas emissions from the project and are not addressed further in this report.

---

[2] https://www.marinuslink.com.au/2021/10/transmission-delivers-a-clean-energy-future/

[3] https://www.energy.gov.au/sites/default/files/Commonwealth-Tasmania%20Bilateral%20Energy%20and%20Emissions%20Reduction%20Agreement.pdf

3.5.2 Tasmania

The EPA Tasmania has published two sets of guidelines (September 2022) for the preparation of an EIS for the Marinus Link converter station and shore crossing. A separate set of guidelines have been prepared for each of these project components.

The sections relevant to the greenhouse gas assessment include:

Consideration of the evolving national response to climate change and greenhouse gas emissions, and the targets set in the Tasmanian Climate Change Action Plan 2017-2021 or any updated versions thereof available at the time of preparing the EIS.

- *Provide an estimate of greenhouse gas emissions, energy production and energy consumption for both construction and operational phases of the proposal, including emissions associated with vegetation removal (as relevant). Calculators are available on the Australian Government Clean Energy Regulator website.*
- *Demonstration that the development will implement cost-effective greenhouse best practice measures to achieve on going minimisation of greenhouse gas emissions. Where less emissions-intensive options are not adopted, justification should be provided and/or mechanisms to offset greenhouse gas emissions identified.*

3.5.3 Victoria

The EES scoping requirements issued by the Minister for Planning (February 2023) outline the specific matters to be assessed across a number environmental and social disciplines relevant to the project, and to be documented in the EES for the project.

The EES scoping requirements inform the scope of the EES technical studies and define the EES evaluation objectives. The EES evaluation objectives identify the desired outcomes to be achieved and provide a framework for an integrated assessment of the environmental effects of a proposed project.

3.5.3.1 EES evaluation objective

The EES evaluation objectives relevant to the greenhouse gas assessment are:

> *Section 4.5 Amenity, health, safety, and transport:*
>
> *Avoid and, where avoidance is not possible, minimise adverse effects on community amenity, health and safety, with regard to noise, vibration, air quality including dust, the transport network, greenhouse gas emissions, fire risk and electromagnetic fields.*

3.5.4 EES scoping requirements

The relevant sections of the final EES scoping requirements that this assessment has addressed are summarised in Table 2.

Table 3-2 EES scoping requirements relevant to the greenhouse gas assessment

Aspects to be assessed	Scoping Requirement	Report Section
Likely effects	Predict greenhouse gas emissions associated with the project.	Section 7
Mitigation	Describe approaches and measures to minimise greenhouse gas emissions associated with the project.	Section 8
Performance	Describe the framework for monitoring and evaluating the measures implemented to mitigate environmental amenity, human health, transport and safety effects and greenhouse gas emissions and contingencies.	Section 4.1.4 Section 8

3.6 Linkages to other reports

This report is informed by or informs the c studies outlined in Table 3.

Table 3-3 Linkages to other reports

Technical studies	Relevance to this assessment
Climate Change assessment (Katestone, 2023)	The climate change assessment report considers the potential impact of climate change and extreme weather events, arising due to increased GHG in the atmosphere, on the project.

4. CURRENT GHG EMISSIONS

GHG emissions associated with the project will contribute to State and national GHG inventories. A summary of GHG emissions inventories that have recently been published for Australia, Tasmania and Victoria are provided in Table 4-1 (Commonwealth of Australia, 2020).

Table 4-1 Annual GHG emissions for Australia, Tasmania, and Victoria

Inventory total	Australia[1]	Tasmania[1]		Victoria[1]	
	Emissions (Mt CO_2-e)[3]	Emissions (Mt CO_2-e)	Contribution to national emissions	Emissions (Mt CO_2-e)	Contribution to national emissions
Including LULUCF[2]	498	-3.7	-0.7%[4]	83	17%
Excluding LULUCF	537	7.9	1.5%	104	19%

Notes:

[1] 2020 estimates sourced from National Greenhouse Gas Inventory – Paris Agreement Inventory (https://ageis.climatechange.gov.au/)

[2] Land-use, land-use change and forestry

[3] Mt CO_2-e = million tonnes of carbon dioxide equivalent

[4] GHG sequestered by forestry accounts for Tasmania's contribution of negative emissions when LULUCF is included

Marinus Link Pty Ltd is a subsidiary of TasNetworks. TasNetworks has existing reporting obligations under the NGER scheme. Recent annual GHG emissions reported to the NGER scheme are provided in Table 4-2 (Clean Energy Regulator, 2021). Variation in annual reported emissions can partially be explained by annual changes in the emissions factor.

The majority of TasNetworks' emissions stem from the energy lost during the transportation of electricity from generators to customers, due to electrical resistance and the heating of conductors (transmission losses). Transmission losses are a function of electrical infrastructure, electrical throughput, and atmospheric conditions. TasNetworks has limited ability to improve transmission losses in existing infrastructure and changes in emissions are generally related to changing throughput and weather conditions.

Transmission losses are generally calculated based on the amount of electricity entering the network at a facility and the amount of electricity leaving the network at a facility (CER 2022). Transmission losses have been found to be approximately 3% per 1,000km for undersea cables (Gordonnat & Hunt (2020).

Table 4-2 TasNetworks NGER scheme reporting (2016-2017 to 2020-2021)

Category	Units	2016-2017	2017-2018	2018-2019	2019-2020	2020-2021
Scope 1	tCO_2-e	7,749	7,405	7,346	7,220	7,672
Scope 2		64,110	79,006	92,225	65,361	74,779
TOTAL		**71,859**	**86,411**	**99,571**	**72,581**	**82,451**
Energy use*	GJ	1,989,444	2,094,265	1,807,435	1,626,612	1,645,882

Notes: *Net energy consumed

5. ASSESSMENT METHOD

Gases of significance to climate change, associated with the project, include CO_2, CH_4, N_2O, and SF_6. The emissions of GHG emissions from the project during construction and operation have been determined based on activity data representative of the proposed activities and the methods described in the following resources:

- The National Greenhouse Accounts, October 2020 (Department of the Industry, Science, Energy and Resources, 2020)
- National Greenhouse and Energy Reporting (Measurement) Determination 2008
- The Greenhouse Gas Protocol (WRI/WBCSD, 2004).

Scope 1, 2, and 3 GHG emissions have been estimated on an annual basis for the project's lifetime. The construction period is projected to occur over five years from 2025 to 2030, although not all construction activities will occur in every year (Figure 3). The baseline operation year occurs immediately after cessation of construction and commissioning. Emission values are calculated for the Heybridge Converter Station, the Heybridge Converter Station to Hazelwood Converter Station, and the Heybridge Converter Station to Driffield Converter Station.

All calculations are made based on data and assumptions provided to Katestone by MLPL.

The emission scopes are detailed in the following sections. Table 5-1 provides a summary of the energy content of emission sources associated with the project and emissions factors for each source, measured in CO_2-e per unit of measurement of each of the sources.

5.1 Scope 1 GHG emissions

Scope 1 GHG emissions are the direct result of the activity and include:

- Diesel combustion:
  - heavy machinery and various other equipment including rigid trucks, excavators, cranes, drill rigs, front end loader, graders, water trucks and concrete agitators
  - light vehicles
  - generators.
- Marine fuel combustion
  - Sea cable laying vessel.
- Land clearing
  - Land clearing emissions, a component of LULUCF, are a Scope 1 GHG emission associated with the project. LULUCF emissions are not included in NGER scheme reporting.
- Installation, operation, and maintenance of transformers
  - SF_6 leakage.

Table 5-1 Summary of energy content and emissions factors

Emission source	Energy/carbon content		Emission factor			
	Value	Units	Scope 1	Scope 2	Scope 3	Units
Diesel (transport)	38.6	GJ/kL	70.4	-	3.6	$kgCO_2$-e/GJ[1]
Diesel (stationary purposes)	38.6	GJ/kL	70.2	-	3.6	$kgCO_2$-e/GJ[1]
SF_6	-	-	23,500	-	-	$kgCO_2$-e/GJ[1]
Forest clearing	172.47	tC/ha	632	-	-	tCO_2-e/ha[2]
Electricity (Victoria)	3.6	MJ/kWh	-	0.91	0.10	$kgCO_2$-e/kWh[1]
Electricity (Tasmania)	3.6	MJ/kWh	-	0.14	0.02	$kgCO_2$-e/kWh[1]
Electricity transmission losses	3.6	MJ/kWh	-	0.01	-	$kgCO_2$-e/kWh[1]
Aggregate	-	-	-	-	5.67	$kgCO_2$-e/t[3]
Concrete	-	-	-	-	250.6	$kgCO_2$-e/t[3]
Steel	-	-	-	-	1547	$kgCO_2$-e/t[3]
Rigid truck	-	-	-	-	0.216	$kgCO_2$-e/tkm[3]

[1]*National Greenhouse and Energy Reporting (Measurement) Determination 2008*, as amended in July 2021, and *National Greenhouse Accounts Factors* (Department of Industry, Science, Energy and Resources, 2021).

[2]*Australian National Greenhouse Accounts*, *FullCAM Full Carbon Accounting Model*, v 4.1.6.19417 (Australian Government, 2021).

[3]*Infrastructure Sustainability Materials Calculator,* v 1 (Infrastructure Sustainability Council of Australia, 2020), concrete is assumed to be precast concrete with a strength of 65Mpa.

GJ/kL = gigajoules per kilolitre, $kgCO_2$-e/GJ = kilograms of carbon dioxide equivalent per gigajoule, MJ/kWh = megajoules per kilowatt hour, kg CO_2-e/kWh = kilograms of carbon dioxide equivalent per kilowatt hour and $kgCO_2$-e/tkm = kilograms of carbon dioxide equivalent per tonne per kilometre.

5.2 Scope 2 GHG Emissions

Scope 2 GHG emissions are the indirect emissions arising from generation of electricity purchased and used by the project and include:

- Electricity consumption
  - electricity consumption of site offices during construction.
- Transmission losses:
  - losses in electricity due to resistive losses (in the form of heat when electric currents pass through conductors) and corona losses (power losses because of ionisation of the air immediately surrounding the conductor).

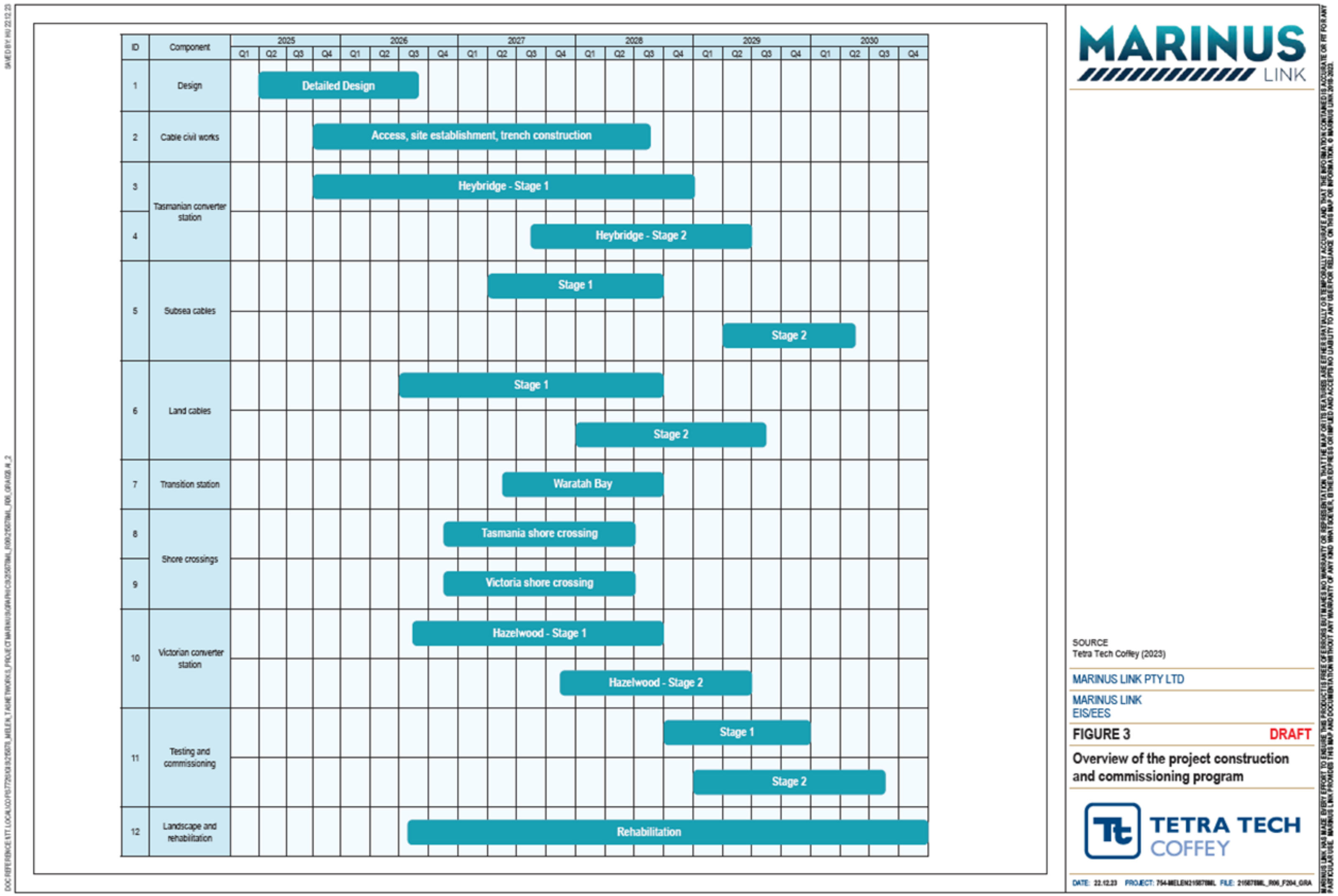

Figure 3 Indicative construction program (supplied by MLPL)

5.3 Scope 3 GHG Emissions

Scope 3 GHG emissions are indirect emissions other than Scope 2 that are generated in the wider economy because of the activity but that are not owned or controlled by the proponent of the project and include:

- Transport of construction materials via road
- Transportation of materials by sea
- Embedded emissions for major construction materials including:
    - Steel
    - Concrete
    - Gravel aggregates.

5.4 Heybridge Converter Station

5.4.1 Activity data

Activity data used to calculate GHG emissions for the Heybridge Converter Station are provided in Table 5-2. Diesel use in the first three years of construction, electricity use (including ongoing electricity use during operation), and future electricity transmission are the key activities for this site. No more than 10ha of land clearing will be required in the first year of construction. The loss of 22 kg SF_6 to the atmosphere per year during operation of the facility is assumed.

Table 5-2 Summary of activity data for the Heybridge Converter Station

Emission source			Operations						
			2025	2026	2027	2028	2029	2030	Ongoing
Diesel	Land cable	kL	-	-	-	-	-	-	-
	Switching Stations	kL	66.0	72.2	17.1		-	-	-
	Backup Generators	kL	-	-	-	-	-	-	5.0
	TOTAL	kL	66.0	72.2	17.1		-	-	5.0
Electricity (use)		MWh	65.9	131.8	131.8	131.8	131.8	22.0	6,132.0
Electricity (transmission)		MW	-	-	-	-	-	-	1500.0
Sea cable laying fuel		kL	-	-	-	-	-	-	-
SF_6		kg	-	-	-	-	-	-	22
Land disturbance		ha	≤10	-	-	-	-	-	-

Over 8,000 tonnes of steel, 40,000 tonnes of aggregate and 50,000 tonnes of concrete will be transported to the site and 615 MWh of electricity used by independent operators (Table 5-3). Assumptions in the calculation include an estimated 100,000 tonne kilometres (t.km), a measure of freight transport, which represents the transport of one tonne of goods by a given transport mode (e.g., road, rail, air, sea, inland waterways, pipeline) over one kilometre.

Table 5-3 Summary of activity data relevant to calculating Scope 3 GHG emissions associated with construction of Heybridge Converter Station

Component	Quantity	Units
Aggregate	41,300	t
Concrete	50,400	
Steel	8,200	
Transport*	100,000	t km
Diesel/Sea cable vessel fuel	0	kL
Electricity (grid)	615	MWh
Notes: *Transport requirements have been conservatively estimated based on all materials being transported along the length of the transmission line (1 km) in diesel powered rigid trucks		

5.5 Heybridge to Hazelwood Converter Station Option

5.5.1 Activity data

Scope 1 GHG emissions for the Heybridge to Hazelwood Converter Station Option are largely associated with land disturbance and diesel consumption required for the construction phase of the project. Ongoing annual GHG emissions associated with operation of the project are associated with diesel use required for operation and maintenance activities (Scope 1 emissions) and electrical transmission losses (Scope 2 emissions).

The Waratah Bay site may contain a DC transition station if the land and sea cables are provided by different suppliers. This will require SF_6 insulated switchgear as the air-insulated alternative requires a large footprint. Consequently, SF_6 emissions are assumed and modelled for this site within the Heybridge to Hazelwood Converter Station Option.

A summary of activity rates used to estimate Scope 1 and Scope 2 GHG emissions from the Heybridge to Hazelwood Converter Station Option are provided in Table 5-4. Assumptions used to estimate GHG emissions associated with the project are provided in Appendix A1.

Table 5-4 Summary of activity data for the project assuming Heybridge to Hazelwood Converter Station Option

Emission source			Operations						
			2025	2026	2027	2028	2029	2030	Ongoing
Diesel	Land cable	kL	28.4	94.1	205.3	8.0	-	-	-
	Switching Stations	kL	98.7	125.8	72.6	9.0	-	-	-
	Backup Generators	kL	-	-	-	-	-	-	10.5
	TOTAL	kL	127.1	219.9	277.9	17.0	-	-	19.1
Electricity (use)		MWh	65.9	131.8	131.8	131.8	131.8	22.0	12,352
Electricity (transmission)		MW	-	-	-	-	-	-	13,140,000
Sea cable laying fuel		kL	-	694.7	777.0	603.3	73.1	-	-
SF_6		kg	-	-	-	-	-	-	37.4
Land disturbance		ha	80.1	80.1	80.1	80.1	80.1	-	-

A summary of material use and transportation requirements used in the estimation of Scope 3 emissions is provided in Table 5-5.

Table 5-5 Summary of activity data relevant to calculating Scope 3 GHG emissions associated with the project, assuming the Heybridge to Hazelwood Converter Station Option

Component	Quantity	Units
Aggregate	318,535	t
Concrete	102,072	
Steel	81,323	
Transport*	43,803,288	t.km
Diesel/Sea cable vessel fuel	2,809	kL
Electricity (grid)	615	MWh
Notes: *Transport requirements have been conservatively estimated based on all materials being transported along the length of the transmission line (90 km) in diesel powered rigid trucks		

5.6 Heybridge to Driffield Converter Station Option

5.6.1 Activity data

Scope 1 GHG emissions for the Heybridge to Driffield Converter Station Option are largely associated with land clearing and diesel consumption required for the construction phase of the project. Ongoing annual GHG emissions associated with operation of the project are associated with diesel use required for operation and maintenance activities (Scope 1 emissions) and electrical transmission losses (Scope 2 emissions).

The Waratah Bay site may contain a DC transition station if the land and sea cables are provided by different suppliers. This will require SF_6 insulated switchgear as the air-insulated alternative requires a large footprint. Consequently, SF_6 emissions are assumed and modelled for this site within the Heybridge to Driffield Converter Station Option.

A summary of activity rates used to estimate Scope 1 and Scope 2 GHG emissions from the Heybridge to Driffield Converter Station Option are provided in Table 5-6. Assumptions used to estimate GHG emissions associated with the project are provided in Appendix A1.

Table 5-6 Summary of activity data for the project assuming Heybridge to Driffield Converter Option

Emission source			Operations						
			2025	2026	2027	2028	2029	2030	Ongoing
Diesel	Land cable	kL	28.4	94.1	205.3	8.0	-	-	-
	Switching Stations	kL	98.7	125.8	72.6	9.0	-	-	-
	Backup Generators	kL	-	-	-	-	-	-	10.5
	TOTAL	kL	127.1	219.9	277.9	17.0	-	-	19.1
Electricity (use)		MWh	65.9	131.8	131.8	131.8	131.8	22.0	12,352
Electricity (transmission)		MW	-	-	-	-	-	-	11,204,892
Sea cable laying fuel		kL	-	694.7	777.0	603.3	73.1	-	-
SF_6		kg	-	-	-	-	-	-	37.4
Land clearing		ha	69.9	69.9	69.9	69.9	69.9	-	-

Scope 3 emissions associated with major construction materials and their transportation and fossil fuels have also been estimated for the Heybridge to Hazelwood Converter Station Option. Scope 3 emissions associated with the

Heybridge to Hazelwood Converter Station Option have been estimated in line with the recommendations of the GHG Protocol, with the estimated total expected for at least 95% of actual Scope 3 GHG emissions. A summary of material use and transportation requirements used in the estimation of Scope 3 emissions is provided in Table 5-7.

Table 5-7 Summary of activity data relevant to calculating Scope 3 GHG emissions associated with the project assuming Heybridge to Driffield Converter Station Option

Component	Quantity	Units
Aggregate	291,545	t
Concrete	102,072	
Steel	78,925	
Transport*	41,238,689	t.km
Diesel/Sea cable vessel fuel	2,809	kL
Electricity (grid)	615	MWh
Notes: *Transport requirements have been conservatively estimated based on all materials being transported along the length of the transmission line (90 km) in diesel powered rigid trucks		

6. RESULTS

This assessment identifies GHG emissions for three project components:

- Heybridge Converter Station (Tasmania only)
- Heybridge to Hazelwood (Tasmania, Commonwealth, Victoria)
- Heybridge to Driffield (Tasmania, Commonwealth, Victoria).

6.1 Heybridge Converter Station

6.1.1 GHG emissions estimation: Scopes 1 and 2

The largest potential Scope 1 emissions during construction is due to diesel consumption (Table 6-1). Leakage of 22 kg SF_6 per year accounts for a significantly large single source of Scope 1 emissions during operation of the facility, due to its relatively large GWP. Electricity use on site and losses in transmission account for all the Scope 2 emissions for the Heybridge Converter Station. Vegetation clearance, i.e. 0.6 ha planted trees and 0.5 ha woody weeds, is an insignificant contribution to emissions.

Table 6-1 Summary of estimated annual Scope 1 and Scope 2 GHG emissions (tCO2-e) and energy use (GJ) for the construction and operation of Heybridge Converter Station

Scope	Year	2025	2026	2027	2028	2029	2030	Total 2025-30	Ongoing
Scope 1	Diesel consumption (vehicles)	179	196	47	-	-	-	422	16
	Diesel consumption (backup generators)	-	-	-	-	-	-	-	14
	Sea Cable	-	-	-	-	-	-	-	-
	SF_6 leakage	-	-	-	-	-	-	-	517
	Land disturbance	43	-	-	-	-	-	43	-
Scope 2	Electricity (use)	9	18	18	18	18	3	84	858
	Electricity (transmission loss)	-	-	-	-	-	-	-	26
TOTALS	Total (excl LULUCF))	189	215	65	18	18	3	508	1,431
	Total (incl LULUCF)	189	215	65	18	18	3	508	1,431
Energy use (GJ)		2,566	2,823	698	37	37	6	6,167	2,539
	Note: all numbers are rounded								

The projected contribution of GHG emissions from the operation of the Heybridge Converter Station are presented in Table 6-2. The contribution to the national emissions is insignificant at <0.001% and is a relatively small contribution to Tasmania's GHG emissions.

Table 6-2 Contribution of the Heybridge Converter Station to State and national GHG emissions ($MtCO_2$-e) during operation

Inventory total	Project	Australia[2,3]		Tasmania[2,3]	
	Emissions ($MtCO_2$-e)	Emissions ($MtCO_2$-e)	Project %	Emissions ($MtCO_2$-e)	Project %
Excluding LULUCF	0.001	537[1]	<0.001%	7.9	0.018%
Including LULUCF	0.001	498	<0.001%	-3.7[4]	-0.04%[5]

Notes: [1] Estimated maximum annual GHG emissions at December 2021

[2] 2020 estimates sourced from National Greenhouse Gas Inventory – Paris Agreement Inventory (https://ageis.climatechange.gov.au/).

[3] These emissions are based on the ongoing operations phase, not the construction phase

[4] At a state level Tasmania has net negative GHG emissions, as LULUCF sequesters more carbon dioxide than is emitted.

[5] A negative value means that these emissions reduce the net negative carbon budget for Tasmania by that fraction

6.1.2 GHG emission estimation: Scope 3

The projected Scope 3 emissions from the construction of the Heybridge Converter Station are presented in Table 6-3. The largest contributor to Scope 3 emissions at the Heybridge Converter Station by several orders of magnitude will be the concrete and steel used in construction.

Table 6-3 Summary of estimated Scope 3 emissions in tCO_2-e

Component	GHG emissions (tCO_2-e)
Aggregate	225
Concrete	12,630
Steel	12,671
Transport	21
Diesel	22
Electricity	12
TOTAL	**25,582**

6.2 Heybridge to Hazelwood Converter Station Option

6.2.1 GHG emissions estimation: Scopes 1 and 2

GHG emissions associated with the Heybridge to Hazelwood Converter Station Option have been considered and estimated on an annual basis. A summary of estimated Scope 1 and Scope 2 emissions associated with construction activities and ongoing operations, expressed as tonnes of carbon dioxide equivalent per annum (tCO_2-e/y) is presented in Table 6-4. GHG emissions associated with land clearing have been spread evenly over the five-year construction period associated with the Heybridge to Hazelwood Converter Station Option.

Maximum annual GHG emissions (Scope 1 + Scope 2) of 214,432 tCO_2-e are anticipated to occur from 2030 onwards. Ongoing operational emissions are predominantly associated with electricity transmission losses.

Table 6-4 **Summary of estimated annual Scope 1 and Scope 2 GHG emissions (tCO_2-e) and energy use (GJ) for the project assuming Heybridge to Hazelwood Converter Station Option**

Scope	Year	2025	2026	2027	2028	2029	2030	Total 2025-30	Ongoing
Scope 1	Diesel consumption (vehicles)	345	597	755	46	-	-	1,743	52
	Diesel consumption (backup generators)	-	-	-	-	-	-	-	29
	Sea Cable	-	154	77	77	-	-	308	-
	SF6 leakage	-	-	-	-	-	-	-	878
	Land disturbance	10,109	10,109	10,109	10,109	10,109	-	50,545	0
Scope 2	Electricity (use) (GJ)	45	89	89	89	89	15	416	6,518
	Electricity loss (transmission)	-	-	-	-	-	-	-	227,651
TOTALS	Total (excl LULUCF)	390	841	922	213	89	15	2,470	235,128
	Total (incl LULUCF)	10,499	10,950	11,031	10,322	10,198	15	53,015	235,128
Energy use (GJ)		4,923	11,025	13,561	2,865	300	6	32,707	3,654,575

The projected contribution of GHG emissions from the operation of the Heybridge to Hazelwood Converter Station are presented in Table 6-5. The contribution to the national emissions is small at 0.04% and is a relatively small contribution to Victoria's GHG emissions including and excluding LULUCF.

Table 6-5 **Contribution of the Heybridge to Hazelwood Converter Station to state and national GHG emissions ($MtCO_2$-e) during operation**

Inventory total	Project	Australia[2,3]		Tasmania[2,3]		Victoria	
	Emissions ($MtCO_2$-e)	Emissions ($MtCO_2$-e)	Project %	Emissions ($MtCO_2$-e)	Project[4] %	Emissions ($MtCO_2$-e)	Project %
Excluding LULUCF	0.24	537[1]	0.04%	7.9	0.018%	104.4	0.22%
Including LULUCF	0.24	498	0.05%	-3.7[4]	-0.04%[5]	83.3	0.24%

Notes: [1]Estimated maximum annual GHG emissions at December 2021

[2]2020 estimates sourced from National Greenhouse Gas Inventory – Paris Agreement Inventory (https://ageis.climatechange.gov.au/).

[3] These emissions are based on the ongoing operations phase, not the construction phase

[4]At a state level Tasmania has net negative GHG emissions, as LULUCF sequesters more carbon dioxide than is emitted.

[5] A negative value means that these emissions reduce the net negative carbon budget for Tasmania by that fraction

6.2.2 GHG emission estimation: Scope 3

Estimated Scope 3 emissions for the Heybridge to Hazelwood Converter Station Option associated with the embedded emissions of major construction materials, transport of major construction materials and fossil fuels are summarised in Table 6 6. Scope 3 GHG emissions calculated for transport did not include the transport of the cable from overseas to Australia.

Table 6-6 **Summary of estimated Scope 3 GHG emissions in tCO_2-e**

Component	GHG emissions (tCO_2-e)
Aggregate	1,806
Concrete	25,579
Steel	125,806
Transport	9,462
Diesel	261
Electricity	12
TOTAL	**162,926**

6.3 Heybridge to Driffield Converter Station Option

6.3.1 GHG emissions estimation: Scopes 1 and 2

GHG emissions associated with the Heybridge to Hazelwood Converter Station Option have been considered and estimated on an annual basis. A summary of estimated Scope 1 and Scope 2 emissions associated with construction activities and ongoing operations, expressed as tonnes of carbon dioxide equivalent per annum (tCO_2 e/y) is presented in Table 6-7**.** GHG emissions associated with land clearing have been spread evenly over the five-year construction period associated with the Heybridge to Hazelwood Converter Station Option.

Maximum annual GHG emissions (Scope 1 + Scope 2) of 183,954 tCO_2-e are anticipated to occur from 2030 onwards. Ongoing operational emissions are predominantly associated with electricity transmission losses.

Table 6-7 Summary of estimated annual Scope 1 and Scope 2 GHG emissions (tCO_2-e) and energy use (GJ) for the project assuming Heybridge to Driffield Converter Station Option

Scope	Year	2025	2026	2027	2028	2029	2030	Total 2025-30	Ongoing
Scope 1	Diesel consumption (vehicles)	345	597	755	46	-	-	1,743	52
	Diesel consumption (backup generators)	-	-	-	-	-	-	-	29
	Sea Cable	-	154	77	77	-	-	308	0
	SF6 leakage	-	-	-	-	-	-	-	878
	Land disturbance	8,628	8,628	8,628	8,628	8,628	-	43,140	0
Scope 2	Electricity (use)	45	89	89	89	89	15	416	6,518
	Electricity loss (transmission)	-	-	-	-	-	-	-	194,125
TOTALS	Total (excl LULUCF))	390	841	922	213	89	15	2,470	201,602
	Total (incl LULUCF)	9,018	9,469	9,550	8,841	8,718	15	45,611	201,602
Energy use (GJ)		4,923	11,025	13,561	2,865	300	6	32,680	3,117,045

The projected contribution of GHG emissions from the operation of the Heybridge to Hazelwood Converter Station are presented in Table 6-. The contribution to the national emissions is small at 0.04% and is a relatively small contribution to Victoria's GHG emissions including and excluding LULUCF.

Table 6-8 Contribution of the Heybridge to Driffield Converter Station to state and national GHG emissions ($MtCO_2$-e) during operation

Inventory total	Project[1]	Australia[2,3]		Tasmania[2,3]		Victoria	
	Emissions ($MtCO_2$-e)	Emissions ($MtCO_2$-e)	Project %	Emissions ($MtCO_2$-e)	Project %	Emissions ($MtCO_2$-e)	Project %
Excluding LULUCF	0.20	537	0.04%	7.9	0.018%	104.4	0.19%
Including LULUCF	0.20	498	0.04%	-3.7[4]	-0.04%[5]	83.3	0.24%

Notes: [1]Estimated maximum annual GHG emissions at December 2021
[2]2020 estimates sourced from National Greenhouse Gas Inventory – Paris Agreement Inventory (https://ageis.climatechange.gov.au/).
[3] These emissions are based on the ongoing operations phase, not the construction phase
[4]At a state level Tasmania has net negative GHG emissions, as LULUCF sequesters more carbon dioxide than is emitted.
[5] A negative value means that these emissions reduce the net negative carbon budget for Tasmania by that fraction

6.3.2 GHG emission estimation: Scope 3

Estimated Scope 3 emissions for the Heybridge to Driffield Converter Station Option associated with the embedded emissions of major construction materials, transport of major construction materials and fossil fuels are summarised in Table 6-9. Scope 3 GHG emissions calculated for transport did not include the transport of the cable from overseas to Australia.

Table 6-9 Summary of estimated Scope 3 GHG emissions in tCO_2-e

Component	GHG emissions (tCO_2-e)
Aggregate	1,653
Concrete	25,579
Steel	122,097
Transport	8,908
Diesel	261
Electricity	12
TOTAL	**158,510**

6.4 SF_6

SF_6 gas is used to insulate high performance transformers. MLPL recognises that SF_6 has a high GWP (23,500 *cf* 1 for CO_2). Emissions of SF_6 can occur during the manufacture and filling of electrical switchgear, from leakage during operation, and during maintenance throughout the equipment's lifetime.

6.4.1 Heybridge site

An Air Insulated Substation (AIS) at Heybridge will require a footprint of 145m x 105m (15,225m^2) to provide the same function as the 2,584 m^2 footprint for the proposed Gas Insulated Substation (GIS). This is not considered practicable because of space limitations. An AIS yard will not be SF_6 free as current technology still requires this in the circuit breaker (CB) interrupters. This will still require approximately 95kg per CB across the 9 CBs in the proposal.

MLPL has explored alternatives and will be applying air insulated switchgear at the proposed Hazelwood or Driffield sites where space is not limited. Dry air insulated switchgear, and compounds such as decafluoro-2-methylbutan-3-one (C5-FK) and heptafluoro-2-methylpropanenitrile (C4-FN), are currently being developed and evaluated for use in high voltage systems but are not yet commercially available for use with 220kV and 500kV (Billen et al, 2020).

6.4.2 Waratah Bay site

MLPL is committed to applying alternative gases should these become commercially available and practicable.

The Waratah Bay site may contain a DC transition station to provide connection of two different suppliers of cable, in the event land and sea cables are provided from different suppliers. If the transition station is required a SF6 Gas insulted solution is proposed, as an enclosed AIS solution will be a very large DC hall similar to the converter station at Hazelwood.

6.5 Regulatory Obligations – NGER Scheme

The Heybridge Converter Station will not be required to report its emissions to NGER Schemes if considered solely as a facility, as its total emissions will be less than the 25 ktCO_2-e/y. However, the total projected emissions for the Heybridge to Hazelwood and Heybridge to Driffield Options exceed the 50 ktCO_2-e/y threshold for both facilities and corporations. Consequently, the Marinus Link project will have to report its operating emissions under the projected profile and current regulations.

6.6 Victorian Converter Station Options

The Heybridge to Driffield Option will produce approximately 7.4 ktCO_2-e/y fewer Scope 1 and Scope 2 emissions than the Heybridge to Hazelwood Option. Similarly, under current assumptions, the Heybridge to Driffield Option will produce approximately 64.4 ktCO_2-e/y fewer Scope 3 emissions than the Heybridge to Hazelwood Option.

7. REDUCING AND MITIGATING GHG EMISSIONS

The Commonwealth Government is likely to reduce the cap on emissions from industry as we move closer to 2030 and 2050. While there are GHG emissions associated with the construction and operation of Marinus Link, Katestone acknowledges that the project will contribute to Victoria and Australia's GHG emissions reduction challenge by supplying low-emission renewable energy from Tasmania to the NEM.

The following Environmental Performance Requirements (EPR) to reduce total emissions are proposed for the project in Table 7.1.

Table 7-1 Environmental Performance Requirements

EPR ID	Environmental Performance Requirement	Project Stage

GHG01	**GHG01: Minimise greenhouse gas emissions in construction**
	• Prior to commencement of project works, identify opportunities to reduce Scope 1 and Scope 2 greenhouse gas emissions (as defined in the NGER Act) so far as reasonably practicable. Measures must be consistent with the Marinus Link Sustainability Framework and include consideration of:
	  o Use of low emission fuels
	  o Maintenance of equipment and vehicles
	  o Minimising vegetation clearance
	  o Purchase of green energy
	  o Procurement of energy efficient machinery
	  o Use of low carbon emission concrete
	  o Use of recycled materials
	The design must include measures to avoid SF_6 leakage so far as reasonably practicable.
	Scope 1 and Scope 2 GHG emissions during construction must be reported annually on the Marinus Link website
		Construction

GHG02	**GHG02: Report on GHG emissions in operation** Prior to commencement of operation, identify opportunities to reduce operational Scope 1 and Scope 2 greenhouse gas emissions (as defined in the NGER Act) so far as reasonably practicable. Measures must be consistent with the Marinus Link Sustainability Framework and include consideration of: • Management and maintenance of SF¬6 insulated equipment in accordance with Australian Standard IEC 62271.4: 2015 – high-voltage switchgear and controlgear – Part 4: Handling procedures for sulphur hexafluoride (SF¬6) and its mixtures and the Energy Network Australia Industry Guideline for SF6 Management (Document 022-2008) and prevention of release of SF¬6 by using	Operation

	a closed cycle during installation, maintenance and decommissioning of equipment where practicable. • Use of low emission fuels • Maintenance of equipment and vehicles • Purchase of green energy • Procurement of energy efficient machinery Scope 1 and Scope 2 emissions from operation must be reported annually on the Marinus Link website.	

Katestone recommends that MLPL consider the following initiatives to reduce Scope 1, Scope 2, and Scope 3 emissions associated with the project to comply with the EPR. These are recent practices adopted in large construction projects, including the electricity sector.

Scope 1 emissions

- Use blended or 100% biodiesel where this is cost-effective and does not affect the performance of generators or vehicles.
- Ensure that generators and vehicles are maintained and properly tuned for fuel efficiency.
- Ensure that SF_6 insulated equipment is managed and maintained in accordance with *Australian Standard IEC 62271.4: 2015 – high-voltage switchgear and controlgear – Part 4: Handling procedures for sulphur hexafluoride (SF_6) and its mixture* and the Energy Network Australia Industry Guideline for SF6 Management (Document 022-2008).
- Prevent release of SF_6 by using a closed cycle during installation, maintenance, and decommissioning of equipment where practicable.
- Identify and implement options to replace SF_6 insulation with alternative gases with a lower GWP as soon as commercially available and practicable.
- Minimise the extent of vegetation clearance (and soil disturbance) for the construction footprint.

Scope 2 emissions

- Purchase green electricity from Tasmania and mainland sources for construction.
- Optimise machinery, processes, and control systems to ensure maximum energy efficiency during construction.
- Design for energy efficiency in machinery, processes, and control systems for operation of the Marinus Link.
- Ensure reduction in transmission losses by ensuring transformers are correctly sized and that connection quality of ancillary conductors is improved, where practicable.

Scope 3 emissions

- Require that concrete contain low emissions binders such as fly ash, blast furnace slag, biochar, and/or geopolymer cement.
- Substitute virgin sand and aggregate in concrete with recycled aggregate.
- Optimise haulage routes for efficient transportation, minimising stopping/starting and hills where practicable.
- Avoid extended periods of vehicle idling onsite.
- Require contractors to maintain vehicles to ensure highest fuel efficiency.

Offsetting emissions

MLPL may consider offsetting project emissions through (as available):

- Purchasing Australian Carbon Credit Units (ACCU) through the Clean Energy Regulator.
- Purchasing carbon credits or carbon removal certificates through reputable international carbon markets such as Puro.earth.
- Revegetating the construction footprint where practicable and/or revegetating other degraded land.

8. SUMMARY

Scope 1, 2, and 3 emissions were estimated for the proposed Heybridge Converter Station, the Heybridge to Hazelwood connection, and the Heybridge to Driffield connection (alternative option) by jurisdiction:

- Heybridge Converter Station (Tasmania)
    - Annual Scope 1 and Scope 2 GHG emissions over the construction phase of the project, including land clearing in Year 1, range between 3 and 232 tCO_2-e/y.
    - Total Scope 1 and Scope 2 GHG emissions over the construction period, including land clearing, are estimated to be 549 tCO_2-e.
    - Scope 3 emissions, including from concrete and steel for construction, are estimated to be 25,581 tCO_2-e.
    - Annual Scope 1 and Scope 2 GHG emissions during operation of the project are estimated to be 1,431 tCO_2-e/y.
    - GHG emissions contributions to the Tasmanian GHG emissions inventory will reduce the -3.7 $MtCO_2$-e buffer by approximately 0.04%.
    - The project is estimated to contribute <0.001% to the national GHG emissions inventory (as of December 2021) on an annual basis.
- Heybridge to Hazelwood project alignment (Tasmania, Commonwealth, Victoria)
    - Annual Scope 1 and Scope 2 GHG emissions over the construction period, including land clearing, range between 15 and 11,031 tCO_2-e/y.
    - Total Scope 1 and Scope 2 GHG emissions over the construction period, including land clearing, are estimated to be 53,015 tCO_2-e.
    - Scope 3 emissions, including from concrete and steel for construction, are estimated to be 162,926 tCO_2-e.
    - Maximum annual total GHG emissions (Scope 1 and Scope 2) during operation of the project are estimated to be 235,128 tCO_2-e/y.
    - The project is estimated to contribute no more than 0.05% of the national GHG emissions inventory (as of December 2021) on an annual basis during operation.
    - The project is estimated to contribute 0.22 – 0.24% to the annual Victorian GHG emissions inventory during operation.
- Heybridge to Driffield project alignment (Tasmania, Commonwealth, Victoria)
    - Annual Scope 1 and Scope 2 GHG emissions over the construction period, including land clearing, range between 15 and 9,550 tCO_2-e/y.
    - Total Scope 1 and Scope 2 GHG emissions over the construction period, including land clearing, are estimated to be 45,611 tCO_2-e.
    - Scope 3 emissions, including from concrete and steel for construction, are estimated to be 158,510 tCO_2-e.
    - Annual Scope 1 and Scope 2 GHG emissions during operation of the project are estimated to be 201,602 tCO_2-e/y.
    - The project is estimated to contribute no more than 0.04% of the national GHG emissions inventory (as at end of financial year 2020) on an annual basis during operation.

- The project is estimated to contribute 0.19 – 0.24% to the annual Victorian GHG emissions inventory during operation.

The Marinus Link will enable the delivery of low emissions electricity, estimated at 140 million tonnes of CO_2-e abatement per year by 2050, contributing towards Australia's GHG emissions reduction commitments under the Paris Agreement and updated NDC.

At a state level the project will also provide improved access to renewable energy and improve the efficiency of both Tasmania's and Victoria's electricity grid. Marinus Link will contribute to both the Tasmanian Government's and Victorian Government's goals of net zero greenhouse gas emissions by 2030 and 2050, respectively.

REFERENCES

Australian Standards, 2015, *Australian Standard IEC 62271.4: 2015 – high-voltage switchgear and controlgear – Part 4: Handling procedures for sulphur hexafluoride (SF_6) and its mixtures*

Billen P, Maes B, Larrain M, Braet J. 2020. Replacing SF_6 in Electrical Gas-Insulated Switchgear: Technological Alternatives and Potential Life Cycle Greenhouse Gas Savings in an EU-28 Perspective. *Energies* 13(7):1807. https://doi.org/10.3390/en13071807

CER 2022. Estimating emissions and energy in the electricity generation, transmission, and distribution sectors guideline. Clean Energy Regulator, Canberra. https://www.cleanenergyregulator.gov.au/DocumentAssets/Pages/estimating-emissions-and-energy-in-the-electricity-sectors.aspx

Clean Energy Regulator (CER), 2020, National greenhouse and energy reporting data, Accessed on 3 June 2022 at http://www.cleanenergyregulator.gov.au/NGER/National greenhouse and energy reporting data

Climate Change Act 2017, Victoria State Government, Environment, Land, Water and Planning (DEECA), Accessed on 3 June 2022

Commonwealth of Australia (Cwth), 2007, *National Greenhouse and Energy Reporting Act*

Commonwealth of Australia (Cwth), 2008 *National Greenhouse and Energy Reporting (Measurement) Determination*

Commonwealth of Australia (Cwth), 2020. *State and Territory Greenhouse Gas Inventories 2018*. May 2020. Available online at: https://www.industry.gov.au/sites/default/files/2020-05/nga-state-and-territory-greenhouse-gas-inventories-2018.pdf

Department of Industry, Science, Energy and Resources (DISER), 2020a. *National Greenhouse Accounts Factors*. October 2020.

Department of Industry, Science, Energy and Resources (DISER), 2020b. *Full Carbon Accounting Model (FullCAM)*, v 4.1.6.19417

Energy Network Australia, 2008, Industry Guideline for SF_6 Management (Document 022-2008).

Environment Protection Act 2017, version 006, Victorian Legislation, Effective 01/07/2022 (In force), Accessed on 4 June 2022

EPA Vic 2022. *New guideline for minimising greenhouse gas emissions*. February 2022. Available online at: https://engage.vic.gov.au/new-draft-guideline-managing-greenhouse-gas-emissions, Accessed on 12 July 2023

Gordonnat, J., Hunt, J. 2020. Subsea cable key challenges of an intercontinental power link: case study of Australia–Singapore interconnector. *Energy Transition* 4, 169–188). https://doi.org/10.1007/s41825-020-00032-z

Infrastructure Sustainability Council of Australia, 2020. 'Infrastructure Sustainability Materials Calculator, v.1

Protocol for Environmental Management: Greenhous gas emissions and energy efficiency in the industry (824), EPA Victoria, Accessed on 4 June 2022

Tasmanian Climate Change Office, 2017, *Climate Action 21: Tasmania's Climate Change Action Plan 2017–2021*

Tasmanian Government (Tas Govt), 2014, *Climate Change (State Action) Act 2008*

TasNetworks, 2020, Managing our impact, Accessed on 3 June 2022 at https://www.tasnetworks.com.au/about-us/our-environment/managing-our-impact

TasNetworks, 2021, Climate change response, Accessed on 3 June 2022 at https://www.tasnetworks.com.au/about-us/Corporate-Social-Responsibility/Environment-and-Sustainability/Climate-Change-Response

World Resources Institute/World Business Council for Sustainable Development (WRI/WBCSD), 2004, The Greenhouse Gas Protocol – A Corporate Accounting and Reporting Standard Revised Edition March 2004. Available online: http://www.ghgprotocol.org/corporate-standard.

APPENDICES

A1 GHG EMISSIONS ESTIMATION ASSUMPTIONS

A1.1 Land disturbance and vegetation clearing

The area of land disturbance and potential vegetation clearance required was determined from vegetation cover data from the Tasmanian Land Use Live dataset and the Victorian Land Use Information System (VLUIS) overlaid with the project footprint shapefile (provided by MLPL). The areas reported in Table A1 are rounded up for presentation and the total is slightly higher than the actual value used in analysis. The carbon content stored in woody vegetation used to calculate potential GHG emissions is derived from FullCAM (DISER, 2020b) (Table A1) and will require field validation.

Table A1 Details of land disturbance and vegetation clearance for the project

Groundcover	Stored carbon in woody groundcover vegetation (t/ha)	Waratah Bay to Hazelwood	Waratah Bay to Driffield
		Area vegetation (ha)	Area vegetation (ha)
Pasture and grassland	0	277	223
Unclassified native vegetation[4]	200	41	34
Native woody cover (*Eucalyptus* woodland)	180	30	25
Hardwood plantation (*E. nitens*)	57	6	5
Softwood plantation (*Pinus radiata*)	15	0.4	0.3

A1.2 SF_6 leakage

The parameter used for the estimation of SF6 leakage are provided in Table A2.

Table A2 SF_6 leakage estimation parameters

Parameter	Units	Heybridge	Waratah Bay	Hazelwood/Driffield
Annual leakage	kg	22	8	7.35

A1.3 Diesel usage

Diesel usage for construction activities was estimated based on the following assumptions:

- Construction schedule
- Vehicle trips per quarter provided for Tasmanian and both potential Victorian Converter Station Options
- Each vehicle travels 100km per three months
- Fuel usage rate for light vehicles is 12 litres per 100km and heavy vehicles is 28 litres per 100km.

[4] Actual vegetation classification and allocation of stored carbon will require field assessment

Diesel usage that has been used to estimate emissions is detailed in Table A3 to Table A7.

Table A3 Diesel usage construction vehicles associated with land cable construction

Year	Quarter	Number of vehicles		Diesel usage (L)	
		Light vehicle	Heavy vehicle	Light vehicle	Heavy vehicle
2024	Q1	0	0	0	0
2024	Q2	0	0	0	0
2024	Q3	0	0	0	0
2024	Q4	0	0	0	0
2025	Q1	0	0	0	0
2025	Q2	216	234	2,765	6,692
2025	Q3	216	234	2,765	6,692
2025	Q4	216	234	2,765	6,692
2026	Q1	216	234	2,765	6,692
2026	Q2	216	234	2,765	6,692
2026	Q3	216	234	2,765	6,692
2026	Q4	216	234	2,765	6,692
2027	Q1	216	234	2,765	6,692
2027	Q2	216	234	2,765	6,692
2027	Q3	216	234	2,765	6,692
2027	Q4	216	234	2,765	6,692
2028	Q1	184	199	2,350	5,689
2028	Q2	0	0	0	0
2028	Q3	0	0	0	0
2028	Q4	0	0	0	0
2029	Q1	0	0	0	0
2029	Q2	0	0	0	0
2029	Q3	0	0	0	0
2029	Q4	0	0	0	0
2030	Q1	0	0	0	0
Sub totals		**2,560**	**2,773**	**32,763**	**79,305**
Total		**5,333**		**112,068**	

Table A4 Diesel usage construction vehicles associated with Heybridge Converter station

Year	Quarter	Movements per quarter		Diesel usage (L)	
		Light vehicle	Heavy vehicle	Light vehicle	Heavy vehicle
2025	Q2	0	353	0	10,096
2025	Q3	0	1,131	0	32,347
2025	Q4	100	779	1,280	22,279
2026	Q1	240	459	3,072	13,127
2026	Q2	300	526	3,840	15,044
2026	Q3	300	526	3,840	15,044
2026	Q4	300	503	3,840	14,386
2027	Q1	240	229	3,072	6,549
2027	Q2	120	209	1,536	5,977
Sub totals		**1,600**	**4,715**	**20,480**	**134,849**
Total		**6,315**		**155,329**	

Table A5 Diesel usage construction vehicles associated with transition station construction

Year	Quarter	Number of vehicles		Diesel usage (L)	
		Light vehicle	Heavy vehicle	Light vehicle	Heavy vehicle
2027	Q1	125	125	1,600	1,600
2027	Q2	425	425	5,440	5,440
2027	Q3	425	425	5,440	5,440
2027	Q4	425	425	5,440	5,440
2028	Q1	425	425	5,440	5,440
Sub totals		**1,825**	**1,825**	**23,360**	**23,360**
Total		**3,650**		**46,720**	

Table A6 Diesel usage construction vehicles associated with both Hazelwood or Driffield Victorian Converter Station Options

Year	Quarter	Number of vehicles		Diesel usage (L)	
		Light vehicle	Heavy vehicle	Light vehicle	Heavy vehicle
2025	Q2	0	213	0	6,092
2025	Q3	0	471	0	13,471
2025	Q4	0	459	0	13,127
2026	Q1	0	477	0	13,642
2026	Q2	0	476	0	13,614
2026	Q3	0	476	0	13,614
2026	Q4	0	334	0	9,552
2027	Q1	0	209	0	5,977
2027	Q2	0	209	0	5,977
Sub totals		**0**	**3,324**	**0**	**95,066**
Total		**3,324**		**95,066**	

Table A7 Diesel usage construction vehicles associated shore crossings

Year	Quarter	Tasmanian shore crossing				Victorian shore crossing			
		Number of vehicles		Diesel usage (L)		Number of vehicles		Diesel usage (L)	
		Light Vehicles	Heavy Vehicles	Light Vehicles	Heavy Vehicles	Light Vehicles	Heavy Vehicles	Light Vehicles	Heavy Vehicles
2026	Q4	552	736	7,066	21,050	552	736	7,066	21,050
2027	Q1	546	728	6,989	20,821	546	728	6,989	20,821
2027	Q2	546	728	6,989	20,821	546	728	6,989	20,821
2027	Q3	552	736	7,066	21,050	552	736	7,066	21,050
Sub totals		**2,196**	**2,928**	**28,109**	**83,741**	**2,196**	**2,928**	**28,109**	**83,741**
Total		**5,124**		**111,850**		**5,124**		**111,850**	

A1.4 Sea cable fuel usage

The subsea cables will be laid in two campaigns, with the cable lay vessel re-supplied either from the factory or with cable from cable transport vessel. Re-supply of the cable lay vessel will occur in port. Diesel usage for the cable lay vessel was estimated based on the diesel consumption estimate provided by MLPL in Table A8. The diesel consumption summary for the cable lay vessel is presented in Table A9. Cable monitoring systems will be installed to identify the location of a cable fault. Seabed inspection using an ROV will occur periodically. No exclusion zone will be established over the subsea cables.

Table A8 Subsea cable construction data

Vessel purpose	First Link – Expected Schedule	Second Link - Expected schedule	Estimated diesel consumption (tons)
Pre-lay survey (and clearance)	56 days	56 days	594t (MMA data of 5 t/day)
Cable lay	28 days	28 days	504 (assume average of 11t for cable burial DP operations)
Cable Burial	42 days	42 days	420t (assumes 5t per day)
As built survey	21 days	21 days	210t
TOTAL			1728t

Table A9 Diesel usage construction vehicles associated with Victorian Converter station construction

Year	Quarter	Sea Cable Lay Vessel	
		Days operational	Diesel usage (L)
2024	Q1	0	0
2024	Q2	0	0
2024	Q3	0	0
2024	Q4	0	0
2025	Q1	0	0
2025	Q2	0	0
2025	Q3	0	0
2025	Q4	0	0
2026	Q1	0	0
2026	Q2	76	694,745
2026	Q3	0	0
2026	Q4	0	0
2027	Q1	0	0
2027	Q2	0	0
2027	Q3	0	0
2027	Q4	85	777,017
2028	Q1	58	530,200
2028	Q2	0	0
2028	Q3	0	0

Year	Quarter	Sea Cable Lay Vessel	
		Days operational	Diesel usage (L)
2028	Q4	8	73,131
2029	Q1	0	0
2029	Q2	0	0
2029	Q3	0	0
2029	Q4	8	73,131
2030	Q1	0	0
Total		**235**	**2,148,224**

A1.5 Transmission losses

The specifications for the project call for a maximum transmission loss of 25MW within the cable at full load, or a 3.3% transmission loss. This is close to the published figure of 3% for undersea cables (Gordonnat and Hunt, 2020).

A1.6 Electricity

In the absence of specific project information, electricity consumption was based on North West Transmission Developments Project. The use of similar construction intensity and activities was the basis for this assumption. It was assumed that 615 MWh over the 6 years of construction will be used.

Operational power consumption has been calculated based on information provided for the power consumption at the converter stations.

- Heybridge converter station has a power consumption approximately 700kW
- Hazelwood / Driffield Converter Station Options have a power consumption of approximately 700kW
- Transition station has a power consumption of approximately 10kW.