Western Renewables Link

TECHNICAL REPORT

M Greenhouse Gas Impact Assessment

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EES Technical Report M

Greenhouse Gas Impact Assessment

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AusNet Transmission Group Pty Ltd

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Glossary

AusNet	AusNet Transmission Group Pty Ltd
BGTS	Existing Bulgana Terminal Station
Carbon sink	A natural or man-made reservoir that absorbs and stores more carbon and carbon chemicals than it releases. Carbon sinks include the oceans and vegetation. The loss of carbon sink leads to a reduced absorption of carbon from the atmosphere.
CH_4	Methane
CO_2	Carbon dioxide
CO_2e	Carbon dioxide equivalent (i.e. the consolidation of all greenhouse gases of a project into a single value, expressed as the equivalent amount of CO_2 required to meet its global warming potential)
DELWP	The former Department of Environment, Land, Water and Planning
DISER	Commonwealth Department of Industry, Science, Energy and Resources
DTP	Department of Transport and Planning
Environment Effects Act	*Environment Effects Act 1978*
EES	Environment Effects Statement
EPBC Act	*Environment Protection and Biodiversity Conservation Act 1999*
EPRs	Environmental Performance Requirements
GED	General environmental duty
GHG	Greenhouse Gas
HFC	Hydrofluorocarbon
kV	kilovolt
NEM	National Electricity Market
N_2O	Nitrous oxide
NGER	National Greenhouse and Energy Reporting
OLARS	Ozone Licensing and Reporting System (under the *Ozone Protection and Synthetic Greenhouse Gas Management Act 1989*)
PEM	*Protocol for Environmental Management: Greenhouse gas emissions and energy efficiency in industry (2002)*
PFC	Perfluorochemical
Principal Contractor	During the construction stage, there will be multiple principal contractors and sub-contractors involved in the delivery of the different project components. This EES refers to Principal Contractor as a catch all term for the contractor responsible for the works.
Project Area	The Project Area encompasses all areas that would be used to support the construction and operational components of the Project considered in the EES. The Project Area is contained within the Project Land and encompasses the following: ▪ Permanent infrastructure: - Transmission tower structures

	- Upgrade and connection to the Bulgana Terminal Station - Connection to the Sydenham Terminal Station - An upgrade of Elaine Terminal Station - The new 500kV terminal station near Bulgana - Access tracks required for operation ▪ Temporary construction areas and infrastructure including: - Distribution line crossovers - Hurdles - Laydown areas - Stringing pads - Access tracks - Tower assembly areas - Workforce accommodation facilities.
Project Land	The Project Land encompasses all land parcels that could be used for the purpose of temporary Project construction and permanent operational components. The Project Land corresponds with the extent of the Specific Controls Overlay proposed in the draft Planning Scheme Amendment for the Project. This generally includes the entire land parcel intersected by a Project component.
Proposed Route	The Proposed Route is approximately 100 to 170m wide and encompasses the nominal future easement for the proposed new transmission line (including a buffer either side), and the terminal station areas. The Proposed Route is located within the Project Area.
SF_6	Sulfur hexafluoride
State of knowledge	All information that should be reasonably known regarding the greenhouse gas emission risks of a project, in addition to measures to manage and mitigate of those risks.
Study area	The area in which greenhouse gas emissions from the Project may be produced and/or where emissions from the Project will have an impact on climate change.
220kV	220kV transmission line
500kV	500kV transmission line

Executive summary

The Western Renewables Link Project (the Project) proposes a new transmission line starting at Bulgana, near Stawell in Victoria's west, and extending approximately 190km to Sydenham in Melbourne's north-west. The Project will enable the connection of new renewable energy generated in western Victoria into the National Electricity Market and increase the Victorian transmission capacity. The Project is being delivered by AusNet Transmission Group Pty Ltd (AusNet).

This Greenhouse Gas (GHG) Impact Assessment forms part of the Environment Effects Statement (EES) prepared for the Project in accordance with the *Environment Effects Act 1978*. This report and the methodology applied in preparing this report, responds to the requirements set out in the EES scoping requirements, with a view to assessing greenhouse gas issues, including emissions associated with the construction activities, operation and decommissioning of Project.

The purpose of the Greenhouse Gas Impact Assessment is to quantify the predicted emissions from the construction, operation and decommissioning of the Project. The results of the assessment allow the Project to be placed in the context of Commonwealth and state goals and targets for greenhouse gas emissions and facilitate the monitoring and management of greenhouse gas emissions.

Overview

The purpose of this report is to assess the potential greenhouse gas impacts associated with the Project and to define the Environmental Performance Requirements (EPRs) necessary to meet the EES evaluation objectives.

Greenhouse gas emissions arise from activities conducted during construction, operation and decommissioning of the Project. With the advent of human induced climate change and its resulting impacts, the Commonwealth and State Governments have set targets for the reduction and mitigation of greenhouse gas emissions. The purpose of this assessment is to provide an understanding of the greenhouse gas emissions associated with the Project and to allow the Project to be placed in the context of state and Commonwealth goals and policy. The assessment also reviews and presents appropriate mitigation measures to apply to the Project to reduce the predicted emissions.

Existing conditions

Greenhouse gas emissions produced in Victoria and Australia have been tracked and detailed through the Australian National Greenhouse Accounts, a series of reports published by the Commonwealth Department of Industry, Science, Energy and Resources (DISER). These accounts are used to fulfil Australia's greenhouse gas inventory reporting commitments, provide the official basis for tracking progress towards Australia's emission reduction commitments, inform future emission reduction commitments and support the creation of domestic emission reduction policies.

As displayed in Table ES.1, greenhouse gas emissions between 2012 and 2022 have been steadily trending downwards.

Table ES.1 Victorian and Australian greenhouse gas emissions, 2012 - 2022

Source of Emissions	Reported greenhouse gas emissions (Mt CO_2e)										
	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
Victoria	133	120	113	113	104	100	91	87	83	80	85
Australia	579	561	556	541	512	510	514	506	494	465	433

Impact assessment key findings

The assessment determined several key activities across construction, operation and decommissioning of the Project which would produce greenhouse gas emissions, including:

- Construction:
  - Fuel use in site offices and site vehicles
  - Fuel use by plant and equipment during construction
  - Embedded emissions in materials, notably cement and steel used in the towers and terminal stations
  - Haulage of materials, waste and soil
  - Degradation of waste in landfill
  - Vegetation clearing.
- Operation:
  - Fuel use in inspection vehicles
  - Fuel use by maintenance equipment
  - Grid electricity usage in terminal stations
  - Embedded emissions in replacement materials
  - Emission of sulfur hexafluoride (SF_6) from circuit breakers.
- Decommissioning:
  - Energy use in plant and equipment dismantling the transmission line, transmission towers and terminal stations
  - Energy used in plant and equipment to excavate the concrete footings
  - Energy used in plant and equipment in site restoration and rehabilitation
  - Energy usage in the use of site vehicles
  - Energy used in site offices
  - Energy used in the haulage of material from site to the disposal destination.

The key outcomes of the Greenhouse Gas Impact Assessment, assuming no mitigation is applied, are:

- Total greenhouse gas emissions of 464 kilotonnes of carbon dioxide equivalent (CO_2e) are predicted to be emitted during the construction of the Project.
- Total greenhouse gas emissions of 27.03 to 0.27 kilotonnes of CO_2e are predicted to be emitted annually during the operation of the Project, a figure which reduces over time due to electricity grid decarbonisation.
- Without mitigation, the construction of the Project would constitute approximately 0.3% of Victoria's overall greenhouse gas emissions and 0.05% of Australia's emissions, while the operation of the Project would constitute 0.03% to less than 0.01% of Victoria's, and 0.006% to less than 0.001% of Australia's overall greenhouse gas emissions.
- As the intention of the Project is to increase the uptake of renewable energy by improving connectivity of renewable energy sources in western Victoria to the national grid, the Project would ultimately be aiding in the reduction of emissions associated with grid electricity consumption, including the consumption of grid electricity by the Project's own terminal stations. As such, the operation of the Project is in alignment with the goals of the Victorian *Climate Change Act 2017* and Commonwealth *2030 Emissions Reduction Target*. The qualitative assessment of the decommissioning of the Project found that most material used in the Project, such as steel and concrete, could be recycled and reused as an alternative or supplement to newly produced material.

Environmental Performance Requirements

Environmental management measures were identified to reduce overall emissions, including exploring options for the adoption of low emission construction materials or the use of renewable energy in construction and maintenance equipment. Additionally, two EPRs have been provided focusing on energy abatement and best practice in sustainability. These included:

SG1: Develop and implement sustainability targets and a Sustainability Management Plan:

1. Develop and implement sustainability targets and specify ratings to reduce construction and operational greenhouse gas emissions.
2. To aid in achieving the targets, the Principal Contractor must develop and implement a Construction Sustainability Management Plan prior to the commencement of construction and an Operational Sustainability Management Plan prior to the commencement of operation that contain measures to meet the sustainability targets and specified ratings and include the requirement to monitor and report on the progress of achieving the sustainability targets and implementation of the Sustainability Management Plans. At a minimum, this will include:
    a. Measures to minimise fuel combustion where possible.
    b. Adopting the waste management hierarchy in accordance with the *Environment Protection Act 2017*.
    c. Vendors must adopt technology to minimise handling of sulfur hexafluoride (SF_6) during delivery and maximise the efficiency of SF_6 utilisation as far as reasonably practicable when its use cannot be avoided.
    d. Measures to track and manage sulfur hexafluoride (SF_6) utilisation, including a leak detection and repair (LDAR) strategy to effectively detect and rapidly manage any SF_6 leaks.

SG2: Environmentally sustainable design:

1. Select and source materials in detailed design, and monitor energy and carbon use during construction, to reduce greenhouse gas emissions associated with materials and energy consumption as far as practicable.
2. Investigate, document and implement opportunities to use green power sourced from renewable energy and bio diesel where practicable.
3. Integrate sustainable design practices into the design process to minimise, to the extent practicable, greenhouse gas emissions arising from construction, operations and maintenance of the Project in line with the ratings and targets selected as part of SG1.

EPRs EM2 (Construction Environmental Management Plan) and EM11 (Decommissioning Management Plan) also apply to this impact assessment.

Conclusion

The Greenhouse Gas Impact Assessment for the Project identified a number of emission sources during the construction and operation of the Project and quantified the likely emissions to be generated. The assessment found that with no mitigation applied:

- 464 kilotonnes of carbon dioxide equivalent (CO_2e) are predicted to be emitted during the construction of the Project.
- 35.8 to 0.27 kilotonnes of CO_2e are predicted to be emitted annually during the operation of the Project, a figure which reduces over time due to electricity grid decarbonisation.

Environmental management measures were identified to reduce overall emissions, and EPRs were provided focusing on energy abatement and best practice in sustainability to aid in the management of greenhouse gas emissions from the Project. Through the implementation of these mitigation measures and EPRs, the greenhouse gas emissions from the Project would be avoided and mitigated as far as reasonably practicable, meeting the evaluation objective in the EES scoping requirements.

1. Introduction

1.1 Background

The Western Renewables Link Project (the Project) proposes a new transmission line starting at Bulgana, near Stawell in Victoria's west, and extending approximately 190km to Sydenham in Melbourne's north-west. The Project will enable the connection of new renewable energy generated in western Victoria into the National Electricity Market and increase the Victorian transmission capacity. The Project is being delivered by AusNet Transmission Group Pty Ltd (AusNet).

The Project was originally referred to the former Minister for Planning under the *Environment Effects Act 1978* (Environment Effects Act) on 9 June 2020 by AusNet and it was determined that an Environment Effects Statement (EES) was required. On 22 August 2023, the Minister for Planning determined that the Project has the potential to cause significant environmental effects and that an EES was required to inform decision-makers in the granting of key approvals for the Project. In summary the key changes in the new proposed Project scope are:

- The urgent Sydenham Terminal Station Rebuild will be assessed and approved separately. A connection into the Sydenham Terminal Station forms part of Western Renewables Link scope
- The 220kV portion of the transmission line is proposed to be uprated to 500kV
- The new terminal station north of Ballarat will no longer be required
- A new 500kV terminal station near Bulgana will be required, including a new 220kV connection to the existing Bulgana Terminal Station.

The Commonwealth Government's Department of Agriculture, Water and the Environment (DAWE) — now Department of Climate Change, Energy, the Environment and Water (DCCEEW) — has also confirmed that the Project is a 'controlled action' and will require assessment and approval under the *Environment Protection and Biodiversity Conservation (EPBC) Act 1999* (EPBC Act). The Commonwealth has determined that it will use the bilateral assessment agreement and rely on the Victorian Government's assessment process (EES) to inform an approval decision under the EPBC Act.

1.2 Purpose of this report

The purpose of this report is to assess the potential greenhouse gas impacts associated with the Project and to define any Environmental Performance Requirements (EPRs) necessary to determine the environmental outcomes that the Project must meet, to be achieved through the implementation of mitigation measures during construction, operation and decommissioning, and address the EES evaluation objectives.

The specific objectives of the impact assessment are to:

- Predict and provide an understanding of the greenhouse gas emissions associated with the construction, operation and decommissioning of the Project.
- Place emissions from the Project in the context of state and Commonwealth goals and policy.
- Review and present appropriate mitigation measures to apply to the Project to reduce the predicted emissions.

1.3 Structure of the report

The report is structured in the following way:

- **Introduction** (this section) which provides background details for the Project and outlines the purpose and structure of the Greenhouse Gas Impact Assessment.

- **EES scoping requirements** (Section 2) where the EES scoping requirements relevant to greenhouse gas are set out, and an indication of where each component of the EES scoping requirements has been considered and addressed in the Greenhouse Gas Impact Assessment.
- **Project description** (Section 3), where Project components and activities relevant to the assessment are explained including the locations and activities with the highest associated greenhouse gas-related impacts.
- **Legislation, policy and guidelines** (Section 4) which lists the Commonwealth, state and other documents relevant to the assessment.
- **Method** (Section 5) where the approach applied to assess potential greenhouse gas impacts associated with the Project is explained.
- **Existing conditions** (Section 6) which establishes the historical and existing greenhouse gas emissions associated with Victoria and Australia, which the Project's greenhouse gas emission performance will be assessed against.
- **Impact assessment** (Section 7 to Section 10), where initial and residual greenhouse gas impacts during the construction, operation and decommissioning of the Project, including potential cumulative impacts from other nearby developments and projects are evaluated. Measures to mitigate or otherwise effectively manage the potential impacts are also presented here.
- **Environmental Performance Requirements** (Section 11) which set out the environmental outcomes to be achieved through the implementation of mitigation measures during construction, operation and decommissioning. While some EPRs are performance based to allow flexibility in how they will be achieved, other include more prescriptive measures that must be implemented. Compliance with the EPRs will be required as a condition of the Project's approval.
- **Conclusion** (Section 12) where the objectives, methods, outcomes and recommendations of the assessment are presented.

1.4 Related studies

This report should be read in conjunction with the following related technical reports, from which this report draws specific information:

- Technical Report A: Biodiversity Impact Assessment. Vegetation clearing from the biodiversity impact assessment was used to inform the Greenhouse Gas Impact Assessment.
- Technical Report P: Transport Impact Assessment. Transport routes and haulage details from the Transport Impact Assessment were utilised when developing greenhouse gas calculations for this assessment.

2. EES scoping requirements

The Scoping Requirements – Western Renewables Link Environment Effects Statement (DTP, 2023) set out in detail the matters to be investigated, assessed and documented in the EES for the Project and are referred to in this report as the EES scoping requirements.

2.1 EES evaluation objectives

The EES scoping requirements specify evaluation objectives which provide a framework to guide an integrated assessment of environmental effects of the Project, in accordance with the *Ministerial guidelines for assessment of environmental effects under the Environment Effects Act 1978, Eighth edition, 2023*. The evaluation objectives identify desired outcomes in the context of key legislative and statutory policies, as well as the principles and objectives of ecologically sustainable development and environmental protection, including net community benefit.

The evaluation objective relevant to the Greenhouse Gas assessment is set out in Section 4.5 (Community amenity, safety, roads and transport) of the EES scoping requirements:

> *Avoid, or minimise where avoidance is not possible, adverse effects for community amenity, health and safety, with regard to construction noise, vibration, dust, lighting, waste, greenhouse gas emissions, transport network, operational noise, fire risk management and electromagnetic radiation.*

In order to meet the evaluation objective, it is necessary to understand the potential impact of the Project on state and federal greenhouse gas emissions so that impacts can be appropriately avoided or mitigated. Understanding potential impacts requires an impact assessment which quantifies the potential greenhouse gas emissions associated with the construction, maintenance, operation and decommissioning of the Project.

This report aims to quantify and assess the greenhouse gas emissions associated with the Project so that the Project's contribution to state and federal greenhouse gas emissions during construction, operation and decommissioning of the Project can be appropriately managed via Environmental Performance Requirements.

2.2 Assessment of specific environmental effects

The EES scoping requirements set out the key issues that the Project poses to the achievement of the evaluation objective. The scoping requirements also list potential effects of the Project and identify where mitigation measures may be required.

The scoping requirements pertaining to greenhouse gas are set out in Section 4.5 (Community amenity, safety, roads and transport) of the scoping requirements. These are reproduced in Table 2.1, together with directions to the reader as to where these items have been addressed in this report.

Table 2.1 Greenhouse gas scoping requirements

Aspect	Scoping requirement	Relevant sections
Key issues	Potential for emissions of greenhouse gases to result from the project.	Section 7, Section 8 and Section 9
Mitigation measures	Identify Project design and management measures that will assist in reducing greenhouse gas emissions resulting from the project.	Section 7.2.5, Section 8.3 and Section 9.3
Likely effects	Quantify anticipated greenhouse gas emissions from the project during its construction and operations and assess the implications of these emissions in the context of the targets outlined in the *Climate Change Act 2017*.	Section 7, Section 8 and Section 9
Performance criteria	Describe the intended approach to monitoring, measuring and reporting the greenhouse gas emissions resulting from project construction or operation.	Section 11

3. Project description

3.1 Project overview

The Project aims to address the current constraints of the western Victorian transmission network by providing the additional capacity, reliability and security needed to drive the development of further renewable electricity generation in western Victoria. By doing so, the Project supports the transition from coal-generated electricity to renewables and the efficient connection of renewable electricity into the National Electricity Market.

The Project comprises the construction and operation of a new approximately 190km overhead double circuit 500kV transmission line between Bulgana in Victoria's west and Sydenham in Melbourne's north-west. To support the connection of the new transmission line, the following works are proposed:

- The construction and operation of a new 500kV terminal station near Bulgana and a 220kV transmission line connection to the existing Bulgana Terminal Station
- Expansion of the existing Bulgana Terminal Station
- Connection works at the Sydenham Terminal Station including the modification of a bay and a bay extension with associated infrastructure
- Upgrade of the existing Elaine Terminal Station, through the diversion of an existing line
- Protection system upgrades at connected terminal stations.

The Project's main features are summarised in Figure 3.1 and the location is shown in Figure 3.2.

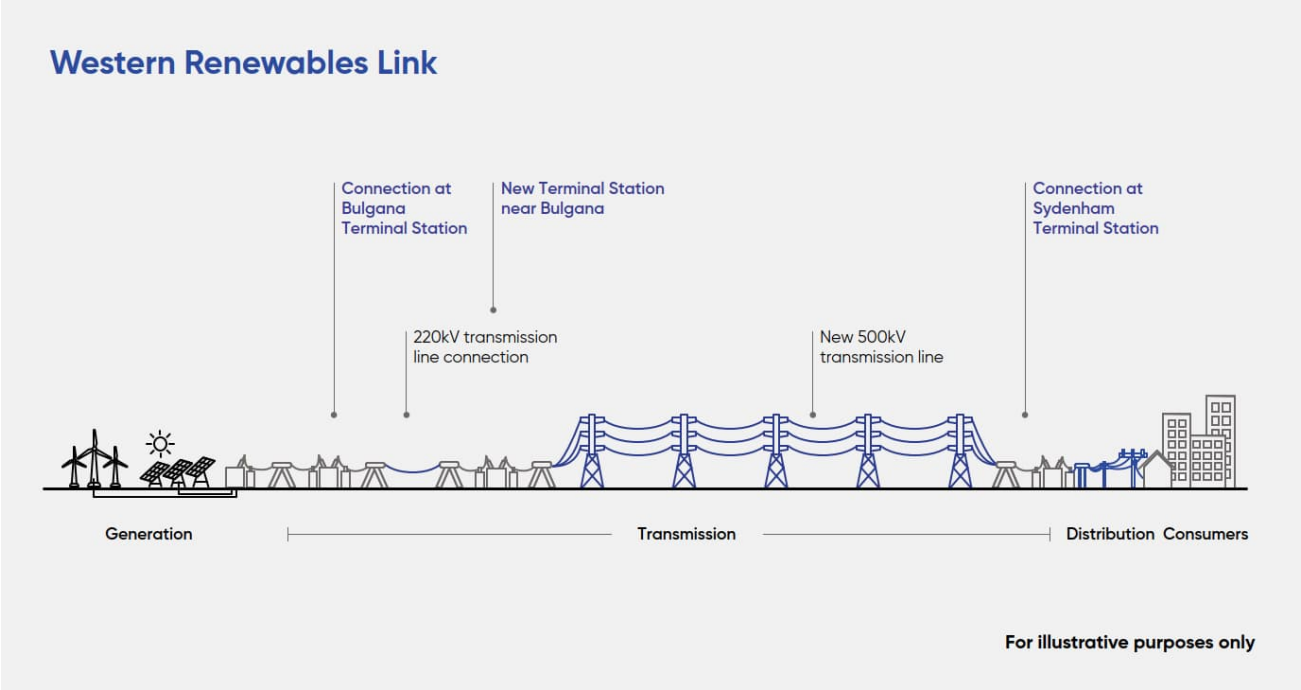

Figure 3.1 Western Renewables Link (Source: AusNet, 2024)

The Project can be described by the following key terms:

- **Project Land**: The Project Land encompasses all land parcels that could be used for the purpose of temporary Project construction and permanent operational components. The Project Land is shown in Figure 3.2.
- **Project Area**: The Project Area is contained within the Project Land and encompasses all areas that would be used to support the construction and operation of the Project. The Project Area is shown in Figure 3.2.

- **Proposed Route**: The Proposed Route is approximately 100 to 170m wide and encompasses the nominal future easement for the proposed new transmission line (including a buffer either side), and the terminal station areas. The Proposed Route is located within the Project Area.

The Proposed Route commences at the existing Bulgana Terminal Station with a 220kV transmission line connection to the new 500kV terminal station approximately 2.3km to the north-east. The Proposed Route then runs from the new 500kV terminal station to the north of the existing Ballarat to Horsham transmission line, where it runs parallel to the existing transmission line for approximately 60km. East of Lexton, the Proposed Route deviates from the Ballarat to Horsham transmission line, passing through the northern section of the Waubra Wind Farm between Mount Bolton and Mount Beckworth. Continuing east, the Proposed Route passes south of the Berry Deep Lead gold mining precinct and north of Allendale and Kingston. North of Kingston the Proposed Route turns south-east to Mount Prospect. From Mount Prospect to near Dean, the Proposed Route is adjacent to the existing Ballarat to Bendigo transmission line. Near Dean, the Proposed Route deviates from the existing transmission line to run south, then east through Bolwarrah, Bunding and Myrniong to Darley. The Proposed Route then continues eastward crossing Merrimu Reservoir north of Long Forest and along the northern boundary of MacPherson Park at Melton, connecting to the existing electricity network at the Sydenham Terminal Station.

The Project crosses six local government areas (LGAs), namely:

- Shire of Northern Grampians
- Shire of Pyrenees
- City of Ballarat
- Shire of Hepburn
- Shire of Moorabool
- City of Melton.

For the purposes of this Greenhouse Gas Impact Assessment, the 'study area' adopted is based on the area in which greenhouse gas emissions from the Project may be produced and/or where emissions from the Project will have an impact on climate change. This is further discussed in Section 5.2.

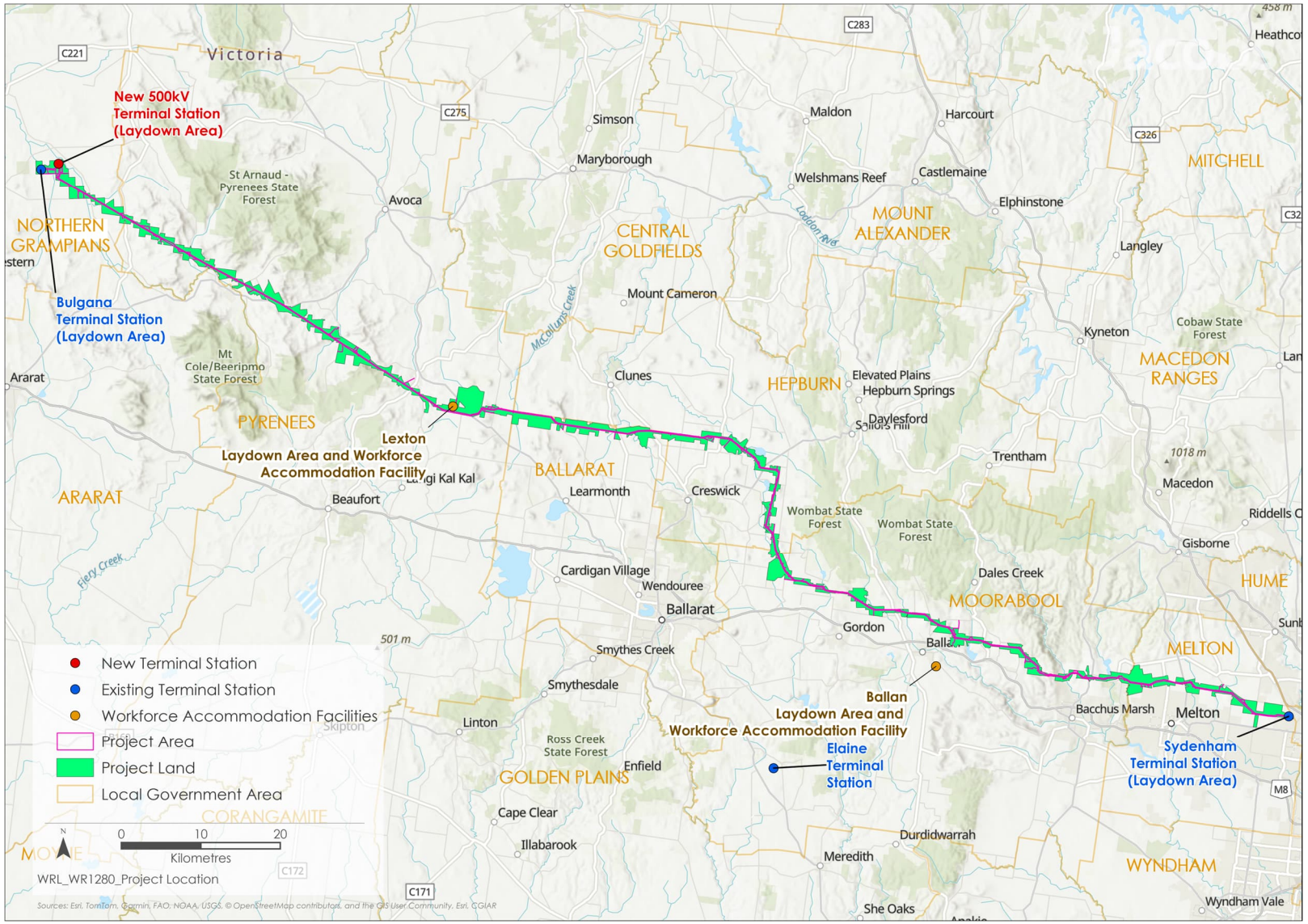

Figure 3.2 Project location (Source: Jacobs 2025)

3.2 Project infrastructure

The Project includes both permanent and temporary infrastructure, as described in Section 3.2.1 and Section 3.2.2. The Project has been progressively refined from an initial broad area of interest as described in **EES Chapter 5: Project development**.

3.2.1 Permanent infrastructure

The proposed Project includes the construction of infrastructure listed in Table 3.1. Further detail is provided in **EES Chapter 6: Project description**.

Table 3.1 Project infrastructure – key components*

Double circuit lattice towers	418 double circuit towers.
Single circuit lattice towers	36 single circuit towers (18 sets of two side-by-side).
Approximate length of 500kV transmission line route	Approximately 190km, between Bulgana in Victoria's west to Sydenham in Melbourne's north-west.
Approximate length of 220kV transmission line route	Approximately 2.5km, between the existing Bulgana Terminal Station to the new terminal station.
Terminal Stations	A new 500kV terminal station and associated infrastructure near Bulgana to be connected to the existing Bulgana Terminal Station via a 220kV connection.
	Expansion of the existing Bulgana Terminal Station to support connection of the new 500kV terminal station near Bulgana.
	A connection to the Sydenham Terminal Station, including the modification of a 500kV bay and a new 500kV bay extension with associated infrastructure
	Relocation and diversion of existing 220kV transmission lines at Elaine Terminal Station.

* Note: These figures are approximate and subject to final detailed design, which will consider further landholder consultation and geotechnical, site and other investigations.

For the safe and reliable operation of the transmission line, an easement is needed for the operation of the transmission line, and other related infrastructure to protect public safety and to provide access for maintenance and repair purposes. The transmission line easements will be typically between 70 and 100m wide for the Project.

The transmission line design requirements are specified by the Australian standard AS/NZS 7000:2016 Overhead Line Design and AusNet's Electricity Safety Management Scheme. Key assumptions and considerations of the transmission towers that will form part of the Project and have been used as the basis of this report are described below.

- Transmission towers (towers) support the overhead conductors (wires or lines) at the required height above the ground to meet regulations and safety requirements. The preferred tower configuration will be a galvanised steel lattice structure similar to those found elsewhere across Victoria and within the national network. The typical tower height for the Project is between 60 to 80m.
- Each tower has four footings which will typically be 1.8m in diameter and 9m deep. The four footings base width will be between 10 to 17m wide. During construction, ground disturbance around each tower will typically be no greater than 50 by 70m.
- The spacing or span length between each tower is determined by the height from the ground that the conductors need to be to achieve the required ground clearance in the middle of the span. Typical span length is between 450 to 550m for the transmission line. Longer span lengths are possible over sensitive areas or to avoid impacts, however longer spans require taller towers to provide safe ground clearances and wider easements to allow for greater sway of the conductors. Similarly, where it is difficult to achieve the

required ground clearance in the middle of the span, due to topography or obstacles, the tower span may be reduced.

- Each span comprises 26 conductors, made up of 12 conductors on each side of the tower cross arms and two ground wires across the top of the tower. Each conductor is approximately 32mm thick and made of aluminium wire strands with a steel core.
- As part of the Project, the existing Bulgana Terminal Station will be expanded to support the connection of the new 500kV terminal station into the existing 220kV switchyard. The new 500kV terminal station will support the connection of the Project transmission line and future connections. The new terminal station will require additional land to the north-east of the existing Bulgana Terminal Station.
- Upgrades required at Elaine Terminal Station will involve the relocation of existing 220kV transmission line and diversion of an existing 220kV line into the terminal station. The footprint of the terminal station will not change, and all new equipment will be approximately the same height and scale as existing structures and equipment at the Elaine Terminal Station.
- Connection works are proposed at Sydenham Terminal Station. The existing Sydenham Terminal Station will be re-built through the Sydenham Terminal Station Rebuild Project, prior to the Project works. The Project will connect into Sydenham through the modification of a 500kV bay and new 500kV bay extension.

3.2.2 Temporary infrastructure

During construction there will be additional work areas, including vehicle access tracks, temporary tower stringing pads, distribution line crossover points, potential hurdle locations, temporary laydown areas and workforce accommodation facilities.

Temporary laydown areas associated with the terminal stations and the transmission line will be used to sort materials, pre-assemble Project components and store equipment, vehicles and other supplies that support construction activities. Temporary fencing, gates, security systems and lighting will also be installed at the laydown areas. The Project will establish five laydown areas; two of which will be located at existing terminal station sites (Bulgana and Sydenham), one at the new 500kV terminal station near Bulgana, and an additional two sites at intermediate locations between the stations south-east of Lexton and south-east of Ballan. The two intermediate laydown areas are required for the construction of the transmission line. The size of each site (including workforce accommodation facilities) will vary depending on storage requirements. The site south-east of Lexton will be up to approximately 12ha and the site south-east of Ballan will be up to approximately 24ha.

AusNet proposes to utilise temporary construction workforce accommodation facilities to accommodate construction workforce personnel. Two facilities are proposed; one in each of the western and eastern portions of the Project, co-located with each of the intermediate laydown areas. Each facility will have capacity for up to 350 personnel and will provide individual accommodation units, a communal kitchen and meals area, laundry, gym facilities, mobile and Wi-Fi boosters and serviced cleaning. The layouts of the proposed accommodation facilities will be determined by the Principal Contractor.

3.3 Summary of key Project activities

3.3.1 Construction

Construction of the Project will include preparatory activities (e.g., site investigations, establishment of laydown areas etc.), establishment of temporary infrastructure (such as water and wastewater infrastructure and power supplies), construction of towers and transmission line stringing works; construction works at terminal stations; site rehabilitation works; and pre-commissioning activities.

The overall construction duration of the Project is approximately two years. This schedule is dependent on adjustments required to deliver the Project and the granting of approvals within certain timeframes. For tower assembly and transmission line stringing, work will not be constant, with specialist crews following each other along the route doing specific jobs (clearing, site preparation, tower construction, conductor stringing, site

rehabilitation, etc). As each work crew leaves a site (or property) there may be days, weeks, or possibly months of inactivity until the next crew arrives. The cumulative duration of construction work at each tower (i.e., time on each property) will be approximately 9 to 22 weeks (over a two year period). Once construction is complete, site rehabilitation will occur and commissioning activities will include final inspections and other safety and pre-operational checks. Construction of the Project is anticipated to commence in late 2026 and be completed by late 2028.

Key activities associated with the construction of towers include:

- Site preparations, including necessary vegetation clearance
- Construction of vehicle access tracks and minor upgrades to existing roads and tracks
- Tower foundation construction
- Tower structure assembly and erection
- Transmission line stringing works
- Commissioning
- Site rehabilitation.

The works proposed at the new 500kV terminal station near Bulgana, the existing Bulgana Terminal Station and Sydenham Terminal Station will be constructed over a period of approximately 20 months, with key activities including:

- Site preparations, access and necessary vegetation clearance
- Earthworks
- Construction of footings, foundations and drainage systems
- Installation of structures and equipment
- Commissioning
- Landscaping and rehabilitation.

3.3.2 Operations

The operation and maintenance of transmission lines are subject to stringent regulatory controls to ensure public safety and the uninterrupted supply of electricity. All transmission line operators are required to comply with these controls and provide regular reports to the relevant authorities, including Energy Safe Victoria.

The key operation stage activities for the transmission line include:

- Scheduled inspections of the transmission line and easement (either by vehicle patrols or LiDAR/aerial surveys)
- Ongoing vegetation management to maintain safety clearances under the transmission line
- Tower maintenance inspections
- Repairs and maintenance to address issues found in above inspections.

While the terminal stations are operated remotely, staff are present at stations for inspections or maintenance. Routine inspections will occur bi-monthly, with personnel checking the overall condition of the terminal station's assets.

3.3.3 Decommissioning

The Project's transmission line is designed for a service life of 80 years, while the terminal station works have been designed for a minimum life of 45 years. The terminal station works will be maintained and upgraded to

enable the terminal stations to remain operational for the service life of the transmission line. At the end of the service life of the transmission line, the infrastructure will either be decommissioned or upgraded to extend its service life to maintain the security and reliability of the transmission network as determined by the network planner at that time. In the event of decommissioning the key activities may involve:

- Lowering the overhead transmission line and ground wires to the ground and cutting them into manageable lengths to roll onto drums or reels for disposal as scrap metal
- Removing insulators and line hardware from structures at the site and disposal at an approved waste facility
- Dismantling towers in manageable sections, removing from the site and selling steel as scrap
- Excavation of footings below finish surface level
- Decommissioning and removal of terminal stations
- Easement restoration and rehabilitation, where required.

3.3.4 Activities relevant to the Greenhouse Gas Impact Assessment

The following activities have been identified as potential greenhouse gas emission sources:

- Construction:
  - Fuel combustion during construction activities by construction plant and equipment, including:
    - Generators used on site
    - Site vehicles
    - Vegetation clearing
    - Construction works
    - Construction of Powercor crossings
    - Construction of towers and terminal stations
    - Post-construction landscaping
  - Embedded emissions in construction materials
  - Emissions from the haulage of material to site
  - Emissions from the haulage of waste from site
  - Emissions from the haulage of soil to and from site
  - Emissions from the degradation of construction waste in landfill
  - Emissions from laydown area activities
  - Emissions from workforce accommodation facilities
  - Loss of carbon sink due to vegetation clearing.
- Operation:
  - Fuel combustion in the use of inspection vehicles
  - Fuel combustion in the use of maintenance equipment
  - Grid electricity usage in terminal stations
  - Embedded emissions in replacement materials
  - Leakage of sulphur hexafluoride (SF_6) and fluorinated gases (hydrofluorocarbons [HFCs] and perfluorochemicals [PFCs]) from terminal stations
  - Loss of electrical efficiency in the transmission line.

- Decommissioning:
  - Energy usage during decommissioning and demolition activities
  - Energy usage during excavation works
  - Energy usage during rehabilitation works
  - Energy usage in the use of site vehicles
  - Energy used in site offices
  - Emissions from the haulage of material and waste from site
  - Emissions from the haulage of fill to site.

Emissions associated with these activities formed the basis of the assessment.

4. Legislation, policy and guidelines

This section provides an overview of key international, Commonwealth and state legislation relevant to greenhouse gas matters, including identifying primary and likely secondary approval requirements for the Project.

4.1 International legislation

Table 4.1 Key international legislation relevant to greenhouse gas

Policy	Implications for the Project
COP21, COP26 & COP28	
Following the 2015 Paris Climate Conference, known as COP21, international agreements were made for signatories to: ▪ Keep global warming well below 2.0 degrees Celsius, with an aspirational goal of 1.5 degrees Celsius ▪ Submit revised emission reduction targets every five years (from 2018), with the first being effective from 2020, and goals set to 2050 ▪ Define a pathway to improve transparency and disclosure of emissions ▪ Make provisions for financing the commitments beyond 2020. In response to this conference, Australia has committed to reduce emissions to 26 to 28 per cent of 2005 levels by 2030. Further commitments were made following the 2021 Glasgow Climate Conference, COP26. Following COP26, Australia adopted a net zero emissions by 2050 target, along with several low emission technology stretch goals. In August 2022, the Australian government further committed Australia to a new target, aimed at reducing greenhouse gas emissions by 43% below 2005 levels by 2030, a 15% increase on the previous 2030 target. Additional to the commitments made through the outcomes of COP21 and COP26, the United Nations Framework Convention on Climate Change highlighted the influence of synthetic greenhouse gases on the greenhouse gas effect. Under Annex A of the Kyoto Protocol, four of the seven gases to which the protocol applied (hydrofluorocarbons, perfluorocarbons, sulphur hexafluoride and nitrogen trifluoride) were synthetic greenhouse gases. COP28 was held in Dubai, with the outcomes of focus being based on the 'four pillars' of the conference, i) fast-tracking a just, orderly, and equitable energy transition; ii) fixing climate finance; iii) focusing on people, lives and livelihoods; and iv) underpinning everything with full inclusivity. As a result of COP28, Australia was one of 190 countries to agree to 'transition away from fossil fuels' under the COP28 UN climate change declaration. Additionally, Australia also committed to: ▪ Triple global renewable energy generation by 2030 under the global renewable and energy efficiency pledge ▪ An ambitious new framework on the global goal on adaptation, which will support a global step-up in adaptation action and support	Sets emissions reduction targets, which have been adopted by the Commonwealth government. These targets inform the Project's sustainability performance targets.

Policy	Implications for the Project
The Greenhouse Gas Protocol	
The Greenhouse Gas Protocol is a collaboration between the World Resources Institute and the World Business Council for Sustainable Development. The Protocol provides a globally standardised framework and guideline for the calculation and reporting of carbon footprints and developing mitigation measures.	The protocol provides the framework used in this assessment to assess greenhouse gas emissions from the Project.

4.2 Commonwealth legislation

Table 4.2 Key Commonwealth legislation relevant to greenhouse gas

Policy	Implications for the Project
National Greenhouse and Energy Reporting Act 2007	
The Commonwealth Government uses the National Greenhouse and Energy Reporting (NGER) legislation for the measurement, reporting and verification of Australian greenhouse gas emissions. This legislation is used for a range of purposes, including being used for international greenhouse gas reporting purposes. Under the *National Greenhouse and Energy Reporting Act 2007* (NGER Act), constitutional corporations in Australia which exceed thresholds for greenhouse gas emissions, energy production or consumption are required to measure and report data to the Clean Energy Regulator on an annual basis. The *National Greenhouse and Energy Reporting (Measurement) Determination 2008* identifies a number of methodologies to account for greenhouse gas from specific sources relevant to the Project. This includes emissions of greenhouse gases from direct fuel combustion (fuels for transport energy purposes), emissions associated with consumption of power from direct combustion of fuel (e.g., diesel generators used during construction), and from consumption of electricity from the grid.	The methodologies and emission factors developed in accordance with the act were used in the assessment of greenhouse gas emissions from the Project. The Project is expected to produce emissions greater than the NGER reporting threshold and so would be required to report its Scope 1 and 2 greenhouse gas emissions and energy consumption data to the Clean Energy Regulator in accordance with the Act. Furthermore, AusNet is already registered as a corporation under the NGER Act and would need to the emissions from the Project under its own corporate emissions thresholds. The Principal Contractor engaged to construct the Project would also be required to report their Scope 1 and 2 greenhouse gas emissions and energy consumption.
Ozone Protection and Synthetic Greenhouse Gas Management Act 1989	
The *Ozone Protection and Synthetic Greenhouse Gas Management Act 1989* (OPSGGM Act) controls the import, export and usage of ozone depleting substances along with synthetic GHG. There are three main objectives: ▪ Control and manage the manufacturing, import, export, usage and disposal of ozone depleting substances and synthetic greenhouse gases; ▪ Achieve a faster and greater reduction in the levels of production and use of ozone depleting substances than are required under the Montreal Protocol (international treaty); and ▪ Promote responsible management and handling of ozone depleting substances and synthetic greenhouse gases to minimise their impact on the atmosphere. A tool under the OPSGGM Act is the Ozone Licensing and Reporting System (OLARS) - a licencing system developed to facilitate control of the manufacture, importation, exportation and use of ozone depleting substances and synthetic GHG. Through the system, the government can manage these substances by enforcing licences on their import, export and manufacture. The systems also requires licensees to report their manufacture, importation, exportation and usage rates to facilitate the tracking of the substances.	The Act's intention of promoting responsible management and handling of SF_6 to minimise its impact on the atmosphere forms a base for mitigation to reduce SF_6 leakage impacts. AusNet may need a licence for the use of SF_6 in circuit breakers depending on the quantities of SF_6 and type of circuit breakers adopted in the finalised design of the Project.

Policy	Implications for the Project
Climate Solutions Fund	
The Australian Government's Direct Action Plan was introduced on 1 July 2014 and aims to focus on sourcing low cost emission reductions. The Direct Action Plan included an Emissions Reduction Fund (ERF), now known implement the ERF came into effect on 13 December 2014, and is now considered to be the centrepiece of the Australian Government's policy suite to reduce emissions. The implementation of a 'safeguard mechanism' came into effect on 1 July 2016 aimed at requiring Australia's largest emitters of more than 100,000 tonnes of carbon dioxide equivalents (t CO_2e) a year to keep net emissions at or below baseline emissions levels.	Emissions reduction and sequestration methodologies are available under the ERF which could provide the Project with the opportunity to earn carbon credits as a result of emissions reduction activities. The Project is not considered likely to result in operational emissions above the safeguard mechanism threshold and so would not be subject to the requirement to keep net emissions at or below baseline levels.

4.3 State legislation

Table 4.3 Key state legislation relevant to greenhouse gas

Policy	Implications for the Project
Environment Effects Act 1978	
The *Environment Effects Act 1978* (Environment Effects Act) provides for the assessment of projects that may have a significant effect on the environment by enabling the Minister administering the Act to decide that an EES should be prepared. An EES may be required where: ▪ There is a likelihood of regionally or State significant adverse environmental effects ▪ There is a need for an integrated assessment of social and economic effects of a project or relevant alternatives ▪ Normal statutory processes would not provide a sufficiently comprehensive, integrated, and transparent assessment. The process under the Environment Effects Act is not an approval process in itself; rather it is an assessment process that enables statutory decision-makers to make decisions about whether a project with potentially significant environmental effects should proceed.	On 22 August 2023, the Minister for Planning determined that the Project requires assessment through an EES under the Environment Effects Act, due to matters as set out in the Statement of Decision on Referral No. 2023R-04, and summarised below: ▪ The area of interest for the Project supports significant environmental values and other social values, potential aggregate impacts on which are of at least regional significance. ▪ Multiple alignment and design alternatives for the Project within the area of interest require rigorous and transparent assessment and refinement. ▪ An EES responds to community interest in Project siting, alignment and design alternatives by providing appropriate opportunities for public input. The Minister for Planning issued the EES scoping requirements in November 2023 (Section 2), which have informed this assessment.
Climate Change Act 2017	
Victoria's *Climate Change Act 2017* establishes a long-term target of net zero greenhouse gas emissions by 2050. The *Climate Change Act 2017* also requires five yearly interim emissions reduction targets, developed as part of a Climate Change Strategy. The *Climate Change Act 2017* introduced a new set of policy objectives and an updated set of guiding principles to embed climate change in government decision making. From 2021, the legislation also requires the development of 'Adaptation Action Plans' for key systems that are vulnerable to the impacts of climate change, by reducing emissions from government operation and across key market sectors. The *Climate Change Act 2017* has also developed a system of periodic reporting, which includes the requirement for annual greenhouse gas emissions reporting and regular standalone reports from independent bodies on the science and data related to greenhouse gas emissions and climate change in Victoria.	It is a requirement of the Act that government decisions take into account the potential contribution to the Victorian greenhouse gas emissions. This informs the Project's sustainability performance targets which consider consistency with reducing emissions in alignment with the Act.

Policy	Implications for the Project
Environment Protection Act 2017	
The Victorian *Environment Protection Act 2017* focuses on preventing waste and pollution impacts, rather than managing those impacts after they have occurred. The cornerstone of the environmental protection legislation is the general environmental duty (GED). The GED requires Victorians to understand and minimise their risks of harm to human health and the environment, from pollution and waste, including the emission of greenhouse gases. Under the *Environment Protection Act 2017*, this duty requires minimising these risks so far as reasonably practicable. When dealing with a risk or harm, demonstrating that the person or business undertaking the activity has adopted the measures that are reasonably practicable under the GED can be achieved through assessing the level of severity of the risk, implementing measures that are suitable and available to the business to eliminate or reduce the risk, and reviewing controls to ensure they are effective.	Establishes the General Environmental Duty. In reference to this Project, this involves the adoption of measures to reduce carbon emissions from the Project so far as reasonably practicable.
Victoria's Climate Change Strategy (2021)	
Victoria's Climate Change Strategy is a roadmap to net-zero emissions and a climate resilient Victoria by 2050 developed by the Department of Environment, Land Water and Planning (DELWP) (now Department of Energy, Environment and Climate Action (DEECA)). The Government has set targets to reduce the state's greenhouse gas emissions from 2005 levels by 28 to 33% by 2025 and 45 to 50% by 2030. Victoria's Climate Change Strategy includes actions to achieve these emissions reduction targets. This includes a commitment for all Victorian Government operations, including metropolitan trains, to be powered by 100% renewable energy by 2025. As part of the strategy, six Renewable Energy Zones will be established, including in western Victoria, where renewable energy infrastructure will be built and connected to the market through transmission networks, allowing for the allowing for the adoption of large-scale renewables and reducing Victoria's reliance on fossil fuels.	As part of the Strategy's 'A clean energy economy pledge', the strategy sets a goal of 50% of the state's energy being sourced from renewables. A key aspect of achieving this goal is the establishment of renewable energy zones, and transmission infrastructure to connect those zones to the grid. This Project is one of the transmission lines connecting a renewable energy zone to the grid, and hence this Project plays a role in meeting the goals of the strategy.
Victoria's Renewable Energy Action Plan (2018)	
The Renewable Energy Action Plan outlines the action that the Victorian Government is taking to encourage investment in its energy sector to ensure energy security and move away from fossil fuel energy sources. The Action Plan invests $146 million across three focus areas, with incentives to reduce greenhouse gas producing energy sources and invest in renewable energy infrastructure.	The goals for the plan inform the context surrounding the justification for the Project.
Victoria Planning Provisions Scheme	
The Victorian Planning Provisions provide policies, provisions, and ordinances to control and manage land use and development. The Victorian Planning Provisions provide the framework for Victoria's planning schemes. The schemes are comprised of a number of clauses with varying purposes and goals in relation to planning and development. Below are excerpts of three clauses pertaining to greenhouse gas emissions, in reference to energy and infrastructure: ▪ Clause 01 – Purposes of this planning scheme:	The clauses establish goals pertaining to greenhouse gas in relation to infrastructure and utilities planning and development which the Project falls under.

Policy	Implications for the Project
▪ To provide a clear and consistent framework within which decisions about the use and development of land can be made. ▪ To provide for the implementation of State, regional and local policies affecting land use and development. ▪ To support responses to climate change. ▪ Clause 15 – Built environment and heritage: ▪ Planning should promote development that is environmentally sustainable and minimise detrimental impacts on the built and natural environment. ▪ Planning should facilitate development that: ▪ Supports the transition to net zero greenhouse gas emissions. ▪ Clause 56.09-2 – Electricity, telecommunications and gas objectives: ▪ To reduce greenhouse gas emissions by supporting generation and use of electricity from renewable sources.	
Protocol for Environmental Management: Greenhouse gas emissions and energy efficiency in industry (2002) (PEM)	
The PEM was an incorporated document of State Environment Protection Policy (Air Quality Management) (SEPP (AQM)) which specified the steps that needed to be taken by businesses to demonstrate compliance with the policy principles and provisions of SEPP (AQM) related to energy efficiency and greenhouse gas emissions. The PEM was the regulatory instrument that was used to align greenhouse gas assessment methodology and approach with the requirements under the *Environment Protection Act 2017* and SEPP (AQM). The PEM's objectives were as follows: *The protocol aims to ensure that Victorian businesses subject to EPA works approvals and licensing system that have an impact on the environment in terms of their energy consumption and greenhouse gas emissions (as defined in the protocol):* ▪ *Take up cost-effective opportunities for greenhouse gas mitigation, noting that in many cases they will achieve cost savings through greater energy efficiency* ▪ *Integrate consideration of greenhouse and energy issues within existing environmental management procedures and programs.* While the PEM is no longer an incorporated document it still informs the state of knowledge on minimising greenhouse gas emissions.	Though the PEM is no longer an incorporated document, it still informs the state of knowledge on minimising greenhouse gas emissions and informs the assessment methodology.
Environment Reference Standard	
The *Environment Reference Standard* (ERS) (Victoria Government 2021) is a subordinate instrument made under the Environment Protection Act. The ERS was gazetted on 26 May 2021. The ERS identifies environmental values for Victoria in the areas of air quality, noise, water and contaminated land; and defines indicators and objectives to measure those values. The ERS supports the protection of the environment from pollution and waste by providing a benchmark to assess and report on environmental conditions in the whole or any part of Victoria. The	Environmental values (GHG and Climate Change) relevant to the Project are assessed in a way that is both appropriate (the methods used match the type of indicators, objectives and the setting) and proportionate (the methods used match the Project's complexity and the extent of potential impacts). The following environmental values (ambient air environment) are relevant to the Project: ▪ Life, health and wellbeing of humans

Policy	Implications for the Project
ERS does not set out enforceable compliance limits; rather, risks of harm to human health and the environment from pollution and waste must be minimised as far as reasonably practicable, in accordance with the GED. The ERS works alongside the GED. Although it is not a compliance standard and does not set compliance limits (EPA, 2021b), the ERS must be considered by responsible authorities when making planning decisions.	▪ Life health and wellbeing of other forms of life including the protection of ecosystems and biodiversity ▪ Local amenity and aesthetic enjoyment ▪ Visibility ▪ The useful life and aesthetic appearance of buildings, structures, property and materials ▪ Climate systems that are consistent with human development, the life, health and well-being of humans and the protection of ecosystems and biodiversity. The matters to be considered in the EES scoping requirements, amenity and environmental quality (in this case, GHG and Climate Change) align with the ERS values. These values have been considered in the development of the Project's air quality objectives, Environmental Performance Requirements and management and mitigation measures.
Publication 2048: Guideline for minimising greenhouse gas emissions	
Publication 2048: *Guideline for minimising greenhouse gas emissions* forms the primary documentation used by business to understand their obligations under the GED in relation to greenhouse gas emissions under the *Environment Protection Act 2017*. Publication 2048 details the steps required for the assessment of GHG emissions in line with the requirements of the *Environment Protection Act 2017*: ▪ Step 1 – Identification of greenhouse gas emission sources ▪ Step 2 – Assessing the risks of harm from greenhouse gas emissions ▪ Step 3 – Identify and implement controls to minimise risks arising from greenhouse gas emissions ▪ Step 4 – Review controls to ensure they are effective.	Publication 2048 provides high-level guidance on the assessment and management of greenhouse gas emissions with regards to the General Environmental Duty. The methodology adopted in this assessment has been designed to follow the four steps detailed in the guideline.
Recycling Victoria Policy and Action Plan 2020	
Recycling Victoria is the Victorian Government's 10-year policy and action plan for waste and recycling. It aims to facilitate a transition to a circular economy by transforming how Victoria uses materials and reuses, repairs and recycles.	Informs the Project's sustainability performance targets including both waste management and the design and specification of materials.
Victorian Recycled First Policy	
The policy requires bidders on infrastructure projects to demonstrate how they will optimise their use of sustainable materials. It aims to drive greater use of these materials, encourage innovation and develop demand for recycled and reused materials.	The Principal Contractor must ▪ Demonstrate how they will optimise the use of recycled and reused materials ▪ Report on the types and volumes of recycled and reused products they used.

4.4 Local legislation

Table 4.4 Key state legislation relevant to greenhouse gas

Policy	Description	Implications for the Project
Pyrenees Shire Council Climate Change Response and Mitigation Action Plan	The plan highlights a number of challenges faced by the council and the planned approaches to addressing these challenges. The plan also details proposed actions by council to address greenhouse gas emissions within the local government area.	Mitigation measures and EPRs associated with the Project will be applied to reduce greenhouse gas emissions from the Project in line with the goals of the policy.
Ballarat Net Zero Emissions Plan	The plan establishes the City of Ballarat's target of net-zero emissions by 2030. The plan details the goals, actions and responsibilities in achieving the target.	
Hepburn Z-NET	Z-NET is a collaborative partnership between the Hepburn Shire council and local community groups, establishing the target of net-zero energy by 2025 and net-zero emissions by 2030. Z-NET details the roles and responsibilities in achieving these goals across the local government area.	
Moorabool Shire Sustainable Environment Strategy 2016 - 2026	The strategy aims to provide a framework for environmental program planning and decision making for sustainable development, climate adaption and greenhouse gas emission reduction. In particular, the strategy sets the objectives to reduce fossil fuel usage, increase the uptake in renewable energy sources and shift the Council's procurement towards low emissions products and services.	
City of Melton Environment Plan 2017 - 2027	The plan, among other environmental aspects, sets the following key targets for the local government area: ▪ 20% reduction in greenhouse gas emissions on 2015/2016 levels by 2020/2021. ▪ Zero-net emissions by 2040.	

5. Method

5.1 Overview

This section describes the method that was used to assess the potential impacts of the Project. Risk screening was applied to prioritise the key issues for impact assessment. Measures to avoid, minimise and manage potential effects have then been developed to address these impacts. The following sections outline the method adopted for the Greenhouse Gas Impact Assessment.

5.2 Study area

As emissions associated with the Project will fall into the total emissions for Victoria and Australia as a whole, the Greenhouse Gas Impact Assessment considers the Project's part in state-wide and nationwide greenhouse gas accounting, goals and targets. Additionally, greenhouse gas emissions and the resulting impacts on climate are a global issue, and the effects of emissions from this Project could have a contributing impact on climate issues across the world. A number of emissions associated with the Project are scope 3 emissions (i.e. indirect emissions associated with the Project, see Section 5.5.2 and Figure 5.1), such as embedded emissions in construction materials and fuel, which would be produced outside of the Project locations.

Due to the above, the study area for the Greenhouse Gas Impact Assessment spans well beyond the physical construction and operational boundary of the Project.

5.3 Existing conditions

To understand the baseline greenhouse gas emissions for comparison with Project emissions, reported greenhouse gas data from Australia's National Greenhouse Accounts were adopted.

Australia's National Greenhouse Accounts, produced by the Commonwealth Department of Climate Change, Energy, the Environment and Water (DCCEW), details annual reported greenhouse gas emissions. The accounts are used to provide the official basis for tracking progress towards Australia's emission reduction commitments, inform future emission reduction commitments and support the creation of domestic emission reduction policies.

Australia's National Greenhouse Accounts (DCCEEW, 2024) provide a detailed database of state and federal greenhouse gas emission data. This includes a breakdown of emissions by year and by state.

The reported Victorian and Australian level greenhouse gas emission data from the last ten years of reporting (2012 – 2022) provided in Australia's National Greenhouse Accounts were compiled to determine current emissions and emissions trends. The emissions data for the most recent available year (2022) were then used as a benchmark to determine the contribution the Project will make to Victorian and Australian emissions. The results of this are detailed in Section 6.

5.4 Risk screening

A risk screening process was undertaken to identify the greenhouse gas-related risks associated with the design, construction, operation and decommissioning of the Project and to provide for the appropriate level of investigation. The outcomes of the risk assessment identified the key issues that were taken forward into the impact assessment stage (see Sections 7.1, 8.1 and 9.1).

5.5 Impact assessment method

The method for the greenhouse gas impact assessment included:

- Identifying key issues (as described in Section 5.4) to be addressed in the impact assessment

- Identifying potential impacts of Project construction, operation, and decommissioning by quantifying emissions and determining the emission contribution at a state and federal level, and according to the impact ratings developed for the greenhouse gas assessment summarised below.
- Potential impacts of the Project were measured against the existing conditions by assessing the significance of the impacts, taking into consideration mitigation measures. Mitigation measures to reduce the potential impacts have been recommended in accordance with the mitigation hierarchy (avoid, minimise, manage, rehabilitate and offset) and these have then informed the development of EPRs.
- Identifying any other potential developments that could lead to cumulative impacts when considered together with the Project
- Prepare EPRs to define the environmental outcomes to be achieved through the implementation of mitigation measures during construction, operation and decommissioning. While some EPRs are performance based to allow flexibility in how they will be achieved, others include more prescriptive. Compliance with the EPRs will be required as a condition of the Project's approval.
- Determining the residual impacts associated with the construction, operation, and decommissioning of the Project, and evaluating their significance in accordance with the criteria described above.
- Table 5.1 shows the specific ratings applied when assessing relevant aspects of potential greenhouse gas impacts. These criteria were used to assess the overall residual impact of Project activities on greenhouse gas.

Table 5.1 Discipline specific impact ratings for greenhouse gas

Rating	Greenhouse gas impact ratings
Negligible	Construction Scope 1 and Scope 2 GHG emissions are insignificant, that is emissions are less than 5,000 t CO_2e p.a. Operational Scope 1 and Scope 2 GHG emissions are insignificant, i.e., the Project is near to or on par with the 'no project' scenario.
Minor	Construction or operational Scope 1 and Scope 2 GHG emissions are below the NGER Scheme reporting threshold (25,000 t CO_2e p.a.).
Moderate	Construction or operational Scope 1 and Scope 2 GHG emissions trigger the NGER Scheme reporting threshold (25,000 t CO_2e p.a.).
Major	Construction or operational Scope 1 and Scope 2 GHG emissions exceed the individual referral trigger under the *Environment Effects Act 1978* (200,000 t CO_2e p.a.).
Severe	Construction or operational Scope 1 and Scope 2 GHG emissions represent a non-negligible proportion of Victoria's total GHG emissions (> 1%).

5.5.1 Assessment overview

To comply with the GED, a person proposing to undertake an activity that may give rise to a risk of harm to human health or the environment (including greenhouse gas emission), must understand the risks to the environment or human health arising from the activity or project, and adopt measures to minimise and mitigate those risks so far as reasonably practicable.

The following sections detail the approach to the greenhouse gas impact assessment in order to satisfy, as far as reasonably practicable, the requirements of the GED. To do this, the assessment methodology has been developed based upon guidance from *EPA Publication 2048: Guideline for minimising greenhouse gas emissions*, in addition to the *Protocol for Environmental Management: Greenhouse gas emissions and energy efficiency in industry (2002) (PEM).* As stated in Section 4.3, the PEM is no longer an incorporated document, however it still informs the state of knowledge on minimising greenhouse gas emissions.

Publication 2048 sets out compliance requirements for new applicants or development licences:

- Step 1 – Identifying your GHG emission sources

- Step 2 – Assessing risks of harm from GHG emissions
- Step 3 – Identify and implement controls to minimise risks arising from GHG emissions
- Step 4 – Review controls to ensure they are effective.

Section 2.1 of the PEM sets out compliance requirements for new applicants or development licences:

- Step 1 – estimate energy consumption – annual energy consumption by energy type and associated greenhouse gas emissions
- Step 2 – estimate direct (non-energy related) greenhouse gas emissions (e.g., business travel or use of products)
- Step 3 – identify and evaluate opportunities to reduce greenhouse gas emissions
- Step 4 – document the information generated in Steps 1 to 3.

Based on the requirements above (and noting the PEM is no longer an incorporated document), the methodology has been developed based on the requirements of Publication 2048, though the PEM's direction to estimate energy and non-energy emissions separately has still been followed to provide greater understanding around the emission sources considered.

5.5.2 Source of emissions

In order to assist with the quantification of emissions in the assessment, emissions have been developed into a greenhouse gas inventory. A greenhouse gas inventory (sometimes referred to as a carbon footprint) is an assessment of the life cycle greenhouse gas emissions associated with a product, service, or event. All greenhouse gases are aggregated and reported as a single number of 'carbon dioxide equivalents', so when referring to carbon foot printing, an aggregated calculation of all greenhouse gases is assumed.

The greenhouse gas inventory has been prepared in accordance with:

- The Greenhouse Gas Protocol issued by the World Business Council for Sustainable Development and the World Resources Institute.
- ISO 14064-1:2006 Greenhouse gases – Part 1: Specification with guidance at the organisation level for quantification and reporting of greenhouse gas emissions and removals.

The greenhouse gases associated with the Project include:

- Carbon dioxide (CO_2)
- Methane (CH_4)
- Nitrous oxide (N_2O).
- Sulphur hexafluoride (SF_6).

The greenhouse gas emissions assessment includes a number of sources. Emissions are categorised into three different scopes in the Greenhouse Gas Protocol as follows (refer to Figure 5.1 for a schematic diagram distinguishing scope types):

- **Scope 1** – Direct emissions from sources that are owned or operated by a reporting organisation (for example, combustion of fuel used in on-site vehicles or in power generation)
- **Scope 2** – Indirect emissions associated with the import of energy from another source (for example, purchase of electricity)
- **Scope 3** – Other indirect emissions (other than Scope 2 energy imports) which are a direct result of the operations of the organisation but from sources not owned or operated by them (examples include embedded emissions in raw materials such as bricks, business travel by air or rail, and haulage and disposal of materials and waste).

Both Publication 2048 and the PEM adopt these scopes. In the PEM, greenhouse gas emissions are categorised into energy and non-energy related greenhouse gas expressed in CO_2 equivalent terms (or CO_2e). Energy related greenhouse gas emissions include emissions from the use of fuels or consumption of electricity. Non-energy related greenhouse gas emissions include process emissions (e.g., emissions from chemical reactions or direct releases of greenhouse gases from activities such as land clearing) and incidental emissions (e.g., use of products).

The results of this assessment are presented in terms of the above-listed 'Scopes' to help understand the direct and indirect impacts of the Project.

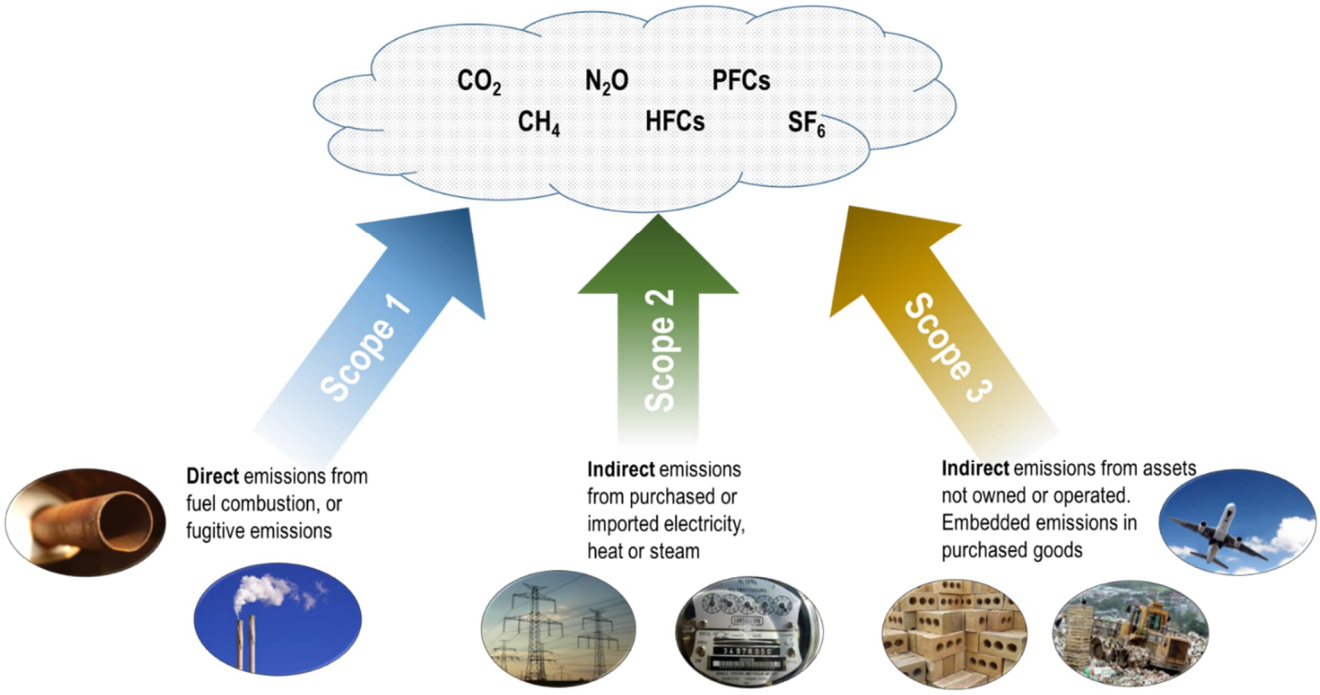

Figure 5.1 Sources of greenhouse gases (Source: Jacobs, 2022)

5.5.3 Greenhouse gas assessment boundaries

The initial action for a greenhouse gas assessment, in accordance with Step 1 of Publication 2048, is to determine the sources of greenhouse gas emissions and set a boundary for the study. The assessment boundaries define the source and scope of greenhouse gas emissions to be included in the assessment. Table 5.2 and Table 5.3 summarise the emissions sources and activities considered within the Project's assessment boundary for construction and operation, according to scope. Note that some emissions sources are split into more than one scope. This is typically the case where there are direct emissions (e.g., combustion of fuel in a vehicle operated as part of the Project) as well as indirect emissions (extraction and processing of the fuel before it is used).

Table 5.2 Construction greenhouse gas emission sources

Emission Source	Included	Emission scope (as per Section 5.5.2)		
		Scope 1	Scope 2	Scope 3
Fuel use – diesel consumption in plant and equipment during construction	✓	●		●
Construction materials	✓			●
Fuel use – transport of construction materials	✓			●
Fuel use – transport of spoil and other earth	✓			●
Fuel use – transport of construction waste	✓			●
Degradation of waste in landfill	✓			●
Loss of carbon sink – land clearing and soil disturbance	✓			●
Electricity use – electricity consumed in Project offices and equipment	× (Diesel generators used for power)		●	●

Table 5.3 Operational greenhouse gas emission sources

Emission Source	Included	Emission scope (as per Section 5.5.2)		
		Scope 1	Scope 2	Scope 3
Line loss across the network	✓		●	●
Grid electricity usage in terminal stations	✓		●	●
Sulphur hexafluoride leakage from circuit breakers in terminal stations	✓	●		
Fuel use – diesel consumption in plant and equipment during maintenance	✓	●		●
Maintenance materials	✓			●
Fuel use – transport of maintenance materials	✓			●
Fuel use – transport of maintenance waste	✓			●

5.5.4 Emission factors

Step 2 of Publication 2048, as well as both Step 1 and Step 2 of the PEM require the calculation of the greenhouse gas emissions of the Project.

Due to the number of emission sources and complexity of emission rates and quantities from various emission sources, direct measurements or modelling of greenhouse gas emissions can be impractical. Instead, emissions factors can be used to calculate estimated greenhouse gas emissions. These factors represent the predicted greenhouse gas emissions per a particular unit of measurement (such as quantity of fuel or distance travelled in a particular vehicle), and hence by multiplying these more easily measurable units against the emissions factors, a reliable prediction of greenhouse gas emissions from that component can be obtained.

Appropriate emissions factors for the Project were derived from the National Greenhouse Accounts (NGA) Factors published by the Commonwealth Department of Climate Change, Energy, the Environment and Water.

Where factors were not provided in the NGA documents, factors from sources such as the UK Department of Environment, Food and Rural Affairs (DEFRA) were used instead. The emissions factors for relevant sources are presented in Table 5.4.

Table 5.4 Emissions factors summary with references

Activity	Emissions factor	Reference
Diesel use (transport)	Scope 1 CO_2 – 2.698 tCO_2e / kL CH_4 – 0.000 tCO_2e / kL N_2O – 0.019 tCO_2e / kL Scope 3 0.6678 tCO_2e / kL	National Greenhouse Accounts Factors 2024 (NGA, 2024)
Petrol use (transport)	Scope 1 CO_2 – 2.305 tCO_2e / kL CH_4 – 0.001 tCO_2e / kL N_2O – 0.007 tCO_2e / kL Scope 3 0.5882 tCO_2e / kL	National Greenhouse Accounts Factors 2024 (NGA, 2024)
Diesel use (stationary)	Scope 1 CO_2 – 2.698 tCO_2e / kL CH_4 – 0.004 tCO_2e / kL N_2O – 0.008 tCO_2e / kL Scope 3 0. 6678 tCO_2e / kL	National Greenhouse Accounts Factors 2024 (NGA, 2024)
Embedded emissions – Steel	2.65 tCO_2e / t	EPD – BlueScope XLERPLATE® steel plate 2020 (EPD558)
Embedded emissions – Concrete	0.974 tCO_2e / t	AusLCI – ordinary 24 portland cement, Australian average/AU U + 200 tkm transport, truck, 40t load/AU U
Embedded emissions – Aggregate	0.005 tCO_2e / t	AusLCI Shadow database – Gravel, unspecified, at mine/CH U/AusSD U
Embedded emissions – Aluminium	19.993 tCO_2e / t	AusLCI Shadow database – Aluminium – referenced to 'Aluminium, primary, at plant/RER U/UssSD U'
Embedded emissions – Copper	2.546 tCO_2e / t	AusLCI Shadow database – Copper, at regional storage/RER U/AusSD U & Wire drawing, copper/RER U/AusSD U
Embedded emissions – Asphalt	0.056 tCO_2e / t	AusLCI – Asphalt, Hot mix, 4.75% virgin bitumen, at plant/AU U
Embedded emissions – Fibreglass reinforced plastic	9.226 tCO_2e / t	Glass fibre reinforced plastic, polyamide, injection moulding, at plant/RER U/AusSD U
Embedded emissions – Silicon rubber	2.670 tCO_2e / t	*WSTP south end plant process selection report – Appendix H CO2 emission factors database* (Veolia, 2011)
Embedded emissions – Fibre Optics	72.92 tCO_2e / t	*Carbon Footprint Estimation in Fiber Optics Industry: A Case Study of OFS Fitel, LLC* (Inakollu et al., 2017)

Activity	Emissions factor	Reference
Embedded emissions – High density polyethylene	3.03 tCO_2e / t	AusLCI Shadow database – Polyethylene, HDPE, granulate, at plant/RER U/AusSD U & Extrusion, plastic film/RER U/AusSD U
Embedded emissions – Sand	0.004 tCO_2e / t	AusLCI Shadow database – Sand, at mine/CH U/AusSD U
Sulphur hexafluoride Leakage from terminal station circuit breakers	23,500 tCO_2e / t	National Greenhouse Accounts Factors 2024 (NGA, 2024)
Haulage (Articulated truck (>33t) 0% Laden)	Scope 3 CO_2 – 0.61785 kg CO_2e / km CH_4 – 0.00015 kg CO_2e / km N_2O – 0.01438 kg CO_2e / km	UK Government GHG Conversion Factors for Company Reporting – Department for Business, Energy & Industrial Strategy (UK) – 2024 (DBEIS, 2024)
Haulage (Articulated truck (>33t) 100% Laden)	Scope 3 CO_2 – 0.05709 kg CO_2e /t. km CH_4 – 0.00001 kg CO_2e / t.km N_2O – 0.00079 kg CO_2e / t.km	UK Government GHG Conversion Factors for Company Reporting – Department for Business, Energy & Industrial Strategy (UK) – 2024 (DBEIS, 2024)
General Cargo Ship (Average)	Scope 3 CO_2 – 0.01305 kg CO_2e /t. km CH_4 – 0.000000 kg CO_2e / t.km N_2O – 0.000016 kg CO_2e / t.km	UK Government GHG Conversion Factors for Company Reporting – Department for Business, Energy & Industrial Strategy (UK) – 2024 (DBEIS, 2024)
Degradation in Landfill	Scope 3 Food – 2.1 t CO_2e / t Paper and cardboard – 3.3 t CO_2e / t Garden and green – 1.6 t CO_2e / t Wood – 0.7 t CO_2e / t Textiles – 2.0 t CO_2e / t Sludge – 0.4 t CO_2e / t Nappies – 2.0 t CO_2e / t Rubber and leather – 3.3 t CO_2e / t Inert waste (including concrete/ metal/ plastics/ glass) – 0.0 t CO_2e / t	National Greenhouse Accounts Factors – August 2024 (NGA, 2023)
Loss of Carbon Sink	Based on ‘Potential Biomass Class 2’: Vegetation Class C (Open Forest) – 209 t CO_2e/ ha Vegetation Class D (Open Woodland) – 209 t CO_2e/ ha Vegetation Class E (Callitris Forest and Woodland) – 217 t CO_2e/ ha Vegetation Class F (Mallee and Acacia Woodland and Shrubland) – 287 t CO_2e/ ha Vegetation Class H (Heathlands) – 309 t CO_2e/ ha Vegetation Class I (Grassland) – 110 t CO_2e/ ha	Greenhouse Gas Assessment Workbook for Road Projects (TAGG, 2013)

5.5.5 Grid electricity emission factors

Factors relating to the usage of grid electricity are expected to change over the modelled life of the Project. Victoria's electricity grid is projected to become less carbon intensive over the lifetime of the Project. The federal Department of Climate Change, Energy, the Environment and Water's *Australia's emissions projections 2023* provides projected grid electricity factors up to 2035. For years beyond 2035, the projections note that net zero emissions are predicted by 2050. As such, a linear reduction in emissions factors associated with the grid from 2035 to 2050 has been assumed as displayed below in Table 5.5.

Table 5.5 Emission factor projections for grid electricity – Victoria

Factor	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045	2046	2047	2048	2049	2050
VIC – Scope 2 Only	0.79	0.75	0.7	0.68	0.63	0.59	0.4	0.39	0.38	0.31	0.24	0.12	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
VIC – Scope 2 + 3	0.85	0.81	0.75	0.74	0.69	0.64	0.43	0.42	0.41	0.34	0.26	0.13	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
VIC - Scope 3 Only	0.06	0.06	0.05	0.06	0.06	0.05	0.03	0.03	0.03	0.03	0.02	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

5.5.6 Assessment of greenhouse gas impact

To assist with the development of control and mitigation measures to minimise GHG emission in line with Step 3 of Publication 2048, the significance of the Project emissions on a state and Commonwealth level has been assessed by comparing the total Project greenhouse gas emissions against annual state and Commonwealth greenhouse gas emissions. The results of this analysis are used to qualitatively assess the performance of the Project against the Victorian *Climate Change Act 2017* target of net zero emissions by 2050, and the Commonwealth *2030 Emissions Reduction Target* to reduce greenhouse emissions impacts to 2005 levels by 2030.

The emissions associated with the laydown areas and workforce accommodation facilities and Powercor crossings are also expressed in isolation of the overall construction emissions, so their portion of emissions in comparison to the overall emissions can be readily understood.

5.5.7 Assessment of decommissioning greenhouse gas emissions

It is noted that the design life of the Project will extend multiple decades into the future, and as a result there is a high likelihood that changes in technologies and policy would have a significant impact on greenhouse gas emissions by the time of decommissioning. Due to this, it is difficult to accurately predict the emissions associated with decommissioning activities.

As such, a qualitative assessment of the greenhouse gas emissions resulting from the decommissioning of the Project has been adopted. The assessment considers greenhouse gas emitting activities associated with typical decommissioning works, and based on these activities suggests mitigation measures typically used to reduce greenhouse gas emissions during these activities.

5.5.8 Cumulative impacts

In order to understand the cumulative greenhouse gas impacts, the Project and its emissions are placed within the context of other emission sources in Australia and the world, noting the global contribution of greenhouse gases to the atmosphere. The Project is also placed into the context of its adjoining infrastructure (i.e., renewable energy sources) to identify the positive impact the Project will have by facilitating renewable energy usage of the electrical grid.

5.5.9 Development of mitigation measures

In accordance with Step 3 of Publication 2048, following the assessment of greenhouse gas impacts and the identification of the amount of CO_2e produced and the key sources of emissions, mitigation measures have been developed. The mitigation measures have been considered in reference to the GED. Under the GED, proponents need to understand and minimise their risks of harm to human health and the environment, from pollution and waste. Hence, in order to sufficiently satisfy the GED, mitigation measures have been considered based on their effectiveness in addressing key emissions sources and feasibility in their implementation.

An energy reduction hierarchy has been adopted to guide and assist in the development of mitigation measures. The hierarchy has been detailed in Table 5.6.

Table 5.6 Energy Reduction Hierarchy

Tier	Sustainability	Measure	Description
1	Most Effective	Energy Saving	Adopt behaviours and activities to reduce actions which require energy and produce emissions
2		Energy Efficiency	Adopt energy efficient technology which require less energy and produce lesser emissions
3		Renewable Technology	Adopt more sustainable, low-carbon energy sources to power activities
4		Low Carbon Technology	Adopt conventional fossil fuels utilising low carbon technology, such as Carbon Capture and Storage
5	Least Effective	Conventional Technology	Adopt conventional fossil fuels and undertake activities with a 'business as usual' approach

5.5.10 Residual impacts

While the mitigation measures will facilitate a reduction in the greenhouse gas impacts associated with the Project, the measures would not remove all emissions. An evaluation of the potential emissions remaining and key emission sources remaining has been undertaken and is provided in Section 7.4, Section 0 and 9.4 for construction, operation and decommissioning, respectively.

5.5.11 Additional assessment considerations

5.5.11.1 Line losses and auxiliary load

As electricity flows through transmission networks from the source of electricity to the end receiver; a number of physical factors such as electrical resistance will lead to a portion of the electricity to be 'lost'. These 'losses' tend to increase as the distance of the electricity source increases from the end receiver. The reduction in the efficiency of the transmission line as a result of the line losses in turn impacts on the emissions efficiency of the energy sources supplying energy along those lines. Additionally, as the electricity travels through the terminal stations which make up part of the transmission line infrastructure, some electricity will be consumed by the terminal stations in order to operate. This auxiliary load will further contribute to the losses as well as additional consumption of electricity along the transmission line.

The Project was developed for the purpose of removing constraints on the transportation of energy from current renewable sources located in Victoria's west to energy users in Melbourne, and to allow new generation sources in Victoria's west to come online. As such, new energy entering the grid as a result of the Project will be from renewable energy which is generated at zero emissions and will therefore not contribute to an increase in emissions attributed to line losses or auxiliary loads. Line losses and auxiliary loads on the Project have therefore been scoped out of this assessment.

5.6 Stakeholder engagement

Stakeholders and the community were consulted to support the preparation of this report and to inform the development of the Project and understanding of its potential impacts.

Table 5.7 lists specific engagement activities that have occurred in relation to Greenhouse gas, with more general engagement activities occurring at all stages of the Project. Feedback received during community consultation sessions is summarised in Section 5.7 relevant to the Greenhouse gas impact assessment.

Table 5.7 Stakeholder engagement undertaken for Greenhouse Gas Impact Assessment

Stakeholder	Date	Matters discussed/raised	Actions taken to address
DJPR Agriculture Victoria	October and November 2021, August 2022	▪ General comments regarding the methodology of the assessment and the team undertaking it. ▪ Clarification around use of refrigerant emissions, and their inclusion in the assessment	▪ Details around the team undertaking the assessment and the methodology of the assessment have been clarified. ▪ Refrigerants were confirmed to not be emitted by the Project, and SF_6 emissions were included in the assessment.
AEMO	January 2022	▪ Considerations for assessment of sulphur hexafluoride (SF_6). ▪ Processes and development of suitable EPRs.	▪ SF_6 emissions were included in the assessment. ▪ EPRs were revised since the receipt of these comments.
Former DELWP, Regional Planning Services (now DTP)	November 2022	▪ Inclusion of relevant Victoria Planning Scheme requirements. ▪ Development of suitable Project outcome objectives.	▪ Goals of the greenhouse gas impact assessment have been shifted to align with the planning scheme clauses. ▪ EPRs and mitigation were revised since the receipt of these comments.
Moorabool Shire Council	November 2021 and January 2023	▪ Method of assessment, including consideration of alternatives. ▪ Assessment of emissions associated with temporary hardstands.	▪ Clarification to be provided in the main EES document to address the consideration of alternative options. ▪ Inclusion of Project aspects such as temporary hardstands were included in the assessment.
Former DELWP IAU (now DTP)	November 2021 and January 2023	▪ Inclusion of relevant findings from recent United Nations Climate Change Conferences. ▪ Mitigation and management, including implementation of measures of a hierarchical basis. ▪ Request for clarification around the suggested sustainability rating schemes.	▪ Outcomes of the latest UNCCC have been incorporated into the policy section of the assessment. ▪ An energy reduction hierarchy has been adopted to assess the effectiveness of mitigation. ▪ EPRs were revised since the receipt of these comments to remove the suggestion of any specific rating schemes. Hence there is no need to provide any further clarification.
EPA Victoria	November 2021 and November 2022	▪ Legislative and policy requirements, method of assessment and recommended mitigation and management, with these noted as being appropriately considered and applied. ▪ Recommendations for ongoing reporting, including the publication of Project emissions.	▪ EPA's guidance noted and adopted for the remainder of the assessment. ▪ Project greenhouse gas reporting requirements revised to match EPA's requirements.

5.7 Community feedback

In addition to consultation undertaken with specific stakeholders, consultation has been ongoing with the community throughout the design development and the EES process. To date there has been no community feedback specifically relating to greenhouse gas matters.

5.8 Assumptions, limitations, and uncertainties

The following assumptions, limitations and uncertainties apply to this impact assessment:

- All data that has been provided to Jacobs by AusNet for the intention of calculating potential greenhouse gas emissions, as well as the assumptions used to calculate this data have been detailed in Appendix A.
- As mentioned in Section 5.5.7, it is difficult to accurately predict the emissions associated with decommissioning activities due to the high likelihood that changes in technologies and policy would have a significant impact on greenhouse gas emissions by the time of decommissioning. As such, emissions from the decommissioning of the Project have been qualitatively assessed to determine the greenhouse gas risk, on the assumption that activities to be undertaken for the decommissioning are similar to construction activities without the emissions attributed to the clearing of vegetation and embedded emissions.
- A number of assumptions have been adopted for the assessment based on estimated data. Aspects of the Project where estimated data from Jacobs' designers or specialists has been adopted, and where that data is subject to change as part of final design include:
  - Terminal station material quantities
  - Assumptions have been made regarding a number of inputs pertaining to the Elaine Terminal Station and its connection to the Project, including:
    - Construction activities and plant/equipment required of the connections to Elaine Terminal Station from the Project
    - Materials associated with the upgrades to Elaine Terminal Station
    - Construction waste quantities associated with Elaine Terminal Station
    - Haulage routes to Elaine Terminal Station
    - SF_6, HFC and PFC emission from Elaine Terminal Station (if applicable)
    - Fill and/or spoil associated with the Elaine Terminal Station connection construction (if applicable)
    - Electricity consumption associated with the Project related portion of Elaine Terminal Station.
- As such, the values displayed in in Section 7 and Section 8 may change. Despite this, it is not expected that any changes to predictions based on the inclusion of the above data would be significant, and hence the overall assessment outcomes are unlikely to materially change.

6. Existing conditions

Greenhouse gas emissions produced in Victoria and Australia have been tracked and detailed through Australia's National Greenhouse Accounts, a series of reports published by DISER. These accounts are used to fulfil Australia's greenhouse gas inventory reporting commitments, provide the official basis for tracking progress towards Australia's emission reduction commitments, inform future emission reduction commitments and support the creation of domestic emission reduction policies.

Australia's National Greenhouse Accounts (DCCEEW, 2024) provides a detailed database of state and federal greenhouse gas emissions data. These inventories are used to track and monitor greenhouse gas emissions both at a state and Commonwealth level. The Victorian and Australian greenhouse gas emissions over the last decade of available data (2012 – 2022), broken down by sector, have been compiled and detailed in Table 6.1.

Table 6.1 Victorian and Australian greenhouse gas emissions, 2012 - 2022

Location	Sector	Reported annual greenhouse gas emissions (Mt CO_2e)										
		2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
Victoria	Energy	110	102	99	103	101	98	88	85	81	78	77
	Industrial processes	4	3	3	3	3	3	3	4	4	4	4
	Agriculture	16	16	16	16	15	16	17	16	16	16	15
	Land use, land-use change and forestry	1	-4	-7	-13	-18	-20	-20	-20	-20	-21	-15
	Waste	3	2	2	3	3	3	2	3	3	3	3
	Total	**133**	**120**	**113**	**113**	**104**	**100**	**91**	**87**	**83**	**80**	**85**
Australia	Energy	425	419	411	422	431	433	436	434	419	404	397
	Industrial processes	32	30	30	30	31	31	32	33	32	33	33
	Agriculture	81	82	82	79	78	82	81	75	73	78	77
	Land use, land-use change and forestry	27	17	20	-3	-40	-50	-47	-49	-43	-64	-88
	Waste	14	13	13	13	13	13	13	13	13	13	14
	Total	**579**	**561**	**556**	**541**	**512**	**510**	**514**	**506**	**494**	**465**	**433**

As displayed in Figure 6.1, greenhouse gas emissions between 2012 and 2022 have been steadily trending downwards.

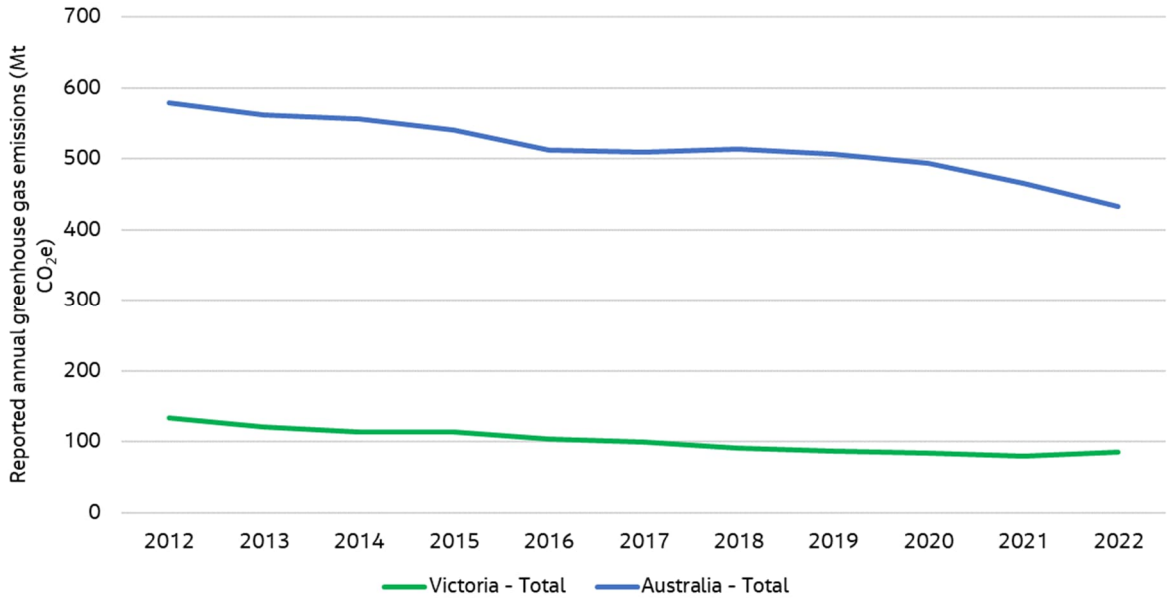

Figure 6.1 Trends in Victorian and Australian greenhouse gas emissions, 2012 - 2022

As emissions data for 2023 and 2024 are not currently available, greenhouse gas emission data for the most recent available year (2022) has been adopted as the benchmark for assessing the implications of the greenhouse emissions produced by the Project. The overall emissions from the construction and operation of the Project will be compared to the emissions of both Australia and Victoria to determine the potential contribution of greenhouse gas emissions the Project will make at a state and Commonwealth level.

7. Construction impact assessment

7.1 Key issues

The initial risk screening identified risks associated with the production of greenhouse gas emissions during the construction of the Project. The risk screening identified emissions embedded in construction materials as being the primary source of greenhouse gas risk during construction. Since the risk screening, other sources had been identified as key construction greenhouse gas emission risks, including:

- Fuel consumption in construction activities, as well as Project vehicles and generators
- Emissions from the haulage of construction materials, waste, and earth
- Loss of carbon sink due to the clearing of vegetation
- Degradation of construction waste in landfill.

7.2 Estimation of construction impacts

As detailed in Section 3.3.4, sources of emissions during the construction of the Project include the operation of generators powering site offices, consumption of fuel in site vehicles and construction plant and equipment, as well as fuel used in haulage of materials, waste, and soil to and from site. Other emissions sources include the emissions embedded in construction materials, loss of carbon sink through the clearing of vegetation and the degradation of construction waste in landfill. The emission scopes associated with these sources are outlined in Table 5.2, while the emissions associated with the sources have been assessed in the following sections.

Inputs used in the development of these calculations have been provided in Appendix A.

7.2.1 Energy related greenhouse gas emissions

Energy related emissions associated with the construction of the Project include those from the consumption of fuel used on site. This is detailed in the section below.

7.2.1.1 Fuel consumption in construction plant and equipment, generators, and on-site vehicles

Fuel will be required during the construction of the Project to power the construction plant and equipment, on-site light vehicle usage (and movements not associated with the transport of construction workforce personnel from the workforce accommodation facilities to site), and generators at construction sites, laydown areas and workforce accommodation facilities. These fuel consumption values have been developed based on a schedule of construction equipment developed in conjunction with AusNet, and then multiplied by typical equipment fuel consumption rates. Full details are provided in Appendix A. Table 7.1 displays the emissions projected to occur from the combustion of fuel during construction.

Fuel combustion related to the haulage of material and earth has been further detailed in Section 7.2.2.2.

Table 7.1 Emissions associated with the combustion of fuel during construction

Emissions source	Fuel	Estimated fuel combusted (kL)	Energy consumption (GJ)	Scope 1 emissions factor (t CO_2e / kL)	Scope 3 emissions factor (kg CO_2e / GJ)	Scope 1 emissions (t CO_2e)	Scope 3 emissions (t CO_2e)	Total emissions (Scope 1 & Scope 3) (t CO_2e)
Construction plant and equipment	Diesel	16,534	638,222	2.71	17.3	44,803	11,041	55,844
	Aviation fuel	1,550	51,309	2.24	18	3,472	924	4,396
Site generators	Diesel	1,785	68,912	2.71	17.3	4,838	1,192	6,030
On-site and non-accommodation vehicle movements	Petrol	1,136	38,862	2.31	17.2	2,628	668	3,296
Total		**21,005**	**797,305**			**55,741**	**13,825**	**69,566**

7.2.1.2 Worker movements

In addition to the movement of light vehicles on site and light vehicles accessing site from Melbourne and other nearby towns, a significant number of vehicles will be employed to transport construction workforce personnel from the workforce accommodation facilities to the construction sites. Transportation requirements were provided by AusNet, with estimates of the number of vehicles required and the distances of the trips provided by the Jacobs traffic team. Full details are provided in Appendix A, while the emissions are shown in Table 7.2 below.

Table 7.2 Emissions associated with worker movements during construction.

Worker movements	Kilometres (km)	Estimated fuel combusted (kL)	Energy consumption (GJ)	Scope 1 emissions factor (t CO2e / kL)	Scope 3 emissions factor (kg CO2e / GJ)	Scope 1 emissions (t CO2e)	Scope 3 emissions (t CO2e)	Total emissions (Scope 1 & Scope 3) (t CO_2e)
Worker movements – light vehicles	13,396,057	Petrol – 1,487	50,854	2.31	17.2	3,439	875	4,314
Worker movements – heavy vehicles	2,665,304	Diesel - 325	68,912	2.71	17.3	884	217	1,101
Total	**16,061,361**	**1,812**	**119,766**			**4,323**	**1,092**	**5,415**

7.2.2 Non-energy related greenhouse gas emissions

Non-energy related emissions associated with the construction of the Project include embedded emissions in construction materials, clearing of vegetation and the transport of waste and materials. These are detailed in the sections below.

7.2.2.1 Embedded emissions in construction materials

Embedded emissions refer to the CO_2e emissions associated with the production of the materials used in the construction of the Project. Material quantities required to construct all aspects of the Project were provided by AusNet and the Jacobs design team, which were then multiplied by the emission factors below. Full details are provided in Appendix A. Table 7.3 displays the embedded emissions projected to result from the construction of the Project.

Table 7.3 Embedded emissions associated with the materials used during construction

Material	Quantity (t)	Scope 3 emissions factor (t CO_2e / t)	Scope 3 emissions (t CO_2e)
Aluminium	6,777	19.99	135,480
Aggregate	42,816	0.01	216
Concrete	111,606	0.97	108,674
Copper	165	2.55	419
Fibreglass reinforced plastic	15	9.23	142
High density polyethylene	39	3.03	117
Optic fibre (in cables)	12	72.92	852
Sand	7,640	0.004	29
Silicone rubber	43	2.67	114
Steel	32,494	2.65	86,109
Total	**201,606**		**332,152**

7.2.2.2 Haulage of construction materials, soils, and waste

Emissions will result from the combustion of diesel during the haulage of construction materials and fill to site, as well as the removal of excavated soil (cut and spoil) and construction waste from site. Haulage distances to and from site were identified by the Jacobs transport team, which were then multiplied by the applicable fill, spoil, waste, and material amounts provided by AusNet and the Jacobs terminal station design teams to determine the tonne kilometres used to derive the emission. Full details are provided in Appendix A. The emissions are shown in Table 7.4 below.

Table 7.4 Emissions associated with haulage during construction

Hauled material	Tonne Kilometres (t.km)[1]	Scope 3 emissions factor (t CO_2e / t.km)	Scope 3 emissions (t CO_2e)
Construction material haulage – sea	380,294,563	0.00001321	5,024
Construction material haulage – land	19,143,990	0.00005789	1,108
Fill/spoil haulage	4,417,500	0.00005789	256
Construction waste haulage	37,594	0.00005789	2
Total	**403,893,647**	**N/A**	**6,390**

Note 1: Tonne Kilometres are a unit of freight representing the transportation of one tonne of material over one kilometre. This is obtained by calculating the tonnes of material needing to be transported by the kilometres distance between the source and destination.

7.2.2.3 Degradation of waste in landfill

As waste degrades in landfill, greenhouse gas emissions are released in the form of methane gas. The emissions associated with the degradation of waste produced by the Project are detailed in Table 7.5. It should be noted that the values presented in Table 7.5 represent lifetime emissions from waste degradation in a landfill. In reality, waste disposed in a landfill will degrade and emit over a period of decades.

Waste quantities and rates at which the waste is disposed of to landfill have been provided by AusNet. Full details are provided in Appendix A. It should be noted that no demolition of existing structures is proposed for the Project. As such, all waste detailed below is generated from packaging and similar items associated with the delivery of the materials to site.

Table 7.5 Emissions associated with degradation of waste in landfill

Waste	Waste quantity (t)	Waste reused/ recycled (%)	Waste to landfill quantity (t)	Scope 3 emissions factor (t CO_2e / t)	Scope 3 emissions (t CO_2)
Timber	571	0	571	0.70	399
Steel	171	0	171	0.00	0.00
Plastic	4	0	4	0.00	0.00
Cardboard	6	0	6	3.30	21
Total	**752**	**N/A**	**753**	**N/A**	**420**

7.2.2.4 Loss of carbon sink

It is noted within EES Chapter 6: Project description and Technical Report E: Land Use and Planning Impact Assessment, that where the Project runs parallel to the existing transmission lines, such as the Ballarat to Horsham line, that the Project will partially utilise existing transmission lines' easements to minimise the overall amount of land clearing required to facilitate the construction and operation of the Project. However, at sections outside of these areas, clearing of vegetation during the construction of the Project will be required.

The overall amount and type of vegetation cleared to facilitate the terminal stations and transmission line was determined in Technical Report A: Biodiversity Impact Assessment. Full details are provided in Appendix A. The associated emissions are shown in Table 7.6.

Table 7.6 Emissions associated with the loss of carbon sink during construction

Estimated vegetation clearing	Quantity (ha)	Scope 1 emissions factor (t CO_2e / ha)	Scope 1 emissions (t CO_2e)
Class C (Open Forest)	103	209	21,518
Class D (Open Woodlands)	116	209	24,164
Class F (Mallee and Acacia Woodland)	3	287	768
Class H (Heathlands)	6	309	1,836
Class I (Grassland)	12	110	1,284
Total	**240**	**N/A**	**49,570**

7.2.3 Total construction greenhouse gas impact

By combining the individual source and activity estimates determined above, it was predicted that construction of the Project would result in 463,512 t CO_2e Scope 1, 2 and 3 greenhouse gas emission over the construction period, which is 231,756 t CO_2e annually, noting the two-year construction duration. The breakdown of emissions is summarised in Table 7.7.

Table 7.7 Total construction Project emissions

Emissions source	Energy consumption (GJ)	Scope 1 emissions (t CO_2e)	Scope 2 emissions (t CO_2e)	Scope 3 emissions (t CO_2e)	Total emissions (t CO_2e)
Fuel consumption in construction plant and equipment, generators, and on-site vehicles	797,305	55,740	0	13,825	69,566
Embedded emissions	N/A	0	0	332,152	332,152
Haulage	N/A	0	0	6,390	6,390
Worker movements	119,766	4,323	0	1,092	5,415
Vegetation clearing	N/A	49,570	0	0	49,570
Degradation of construction waste in landfill	N/A	0	0	420	420
Total	**917,072**	**109,633**	**0**	**353,879**	**463,512**
Annual total (assumed 2-year construction period)	**458,536**	**54,817**	**0**	**176,939**	**231,756**

Of the emissions predicted for the construction of the Project, laydown areas and workforce accommodation facilities were predicted to constitute 11,805 t CO_2e (5,902 t CO_2e annually), while activities associated with the Powercor crossings would constitute 4,881 t CO_2e (2,441 t CO_2e annually). A full breakdown of the emissions associated with each is provided in Table 7.8.

Some of the emissions associated with the lack of carbon sink due to vegetation clearing would also be associated with the laydown areas and the Powercor crossings. However, as the vegetation clearing values were presented for the entire project footprint as opposed to being broken down by Project component, the exact clearing values for the laydown areas and the Powercor crossings could not be determined. However, due to the relatively small footprint of the laydown areas and Powercor crossings in relation to the Project as a whole, it is not anticipated that the loss of carbon sink emissions from these two components would form a large proportion of the overall Project loss of carbon sink emissions.

Table 7.8 Laydown areas and Powercor crossing construction Project emissions

Project element	Source	Energy consumption (GJ)	Scope 1 emissions (t CO_2e)	Scope 2 emissions (t CO_2e)	Scope 3 emissions (t CO_2e)	Total emissions (t CO_2e)
Laydown areas and workforce accommodation facilities	Fuel consumption in construction plant and equipment, generators, and on-site vehicles	73,277	5,124	0	1,267	6,391
	Worker movements	118,995	4,323	0	1,092	5,414
	Total	**192,272**	**9,446**	**0**	**2,359**	**11,805**
	Annual total (assumed 2-year construction period)	**96,272**	**4,723**	**0**	**1,179**	**5,902**
Powercor crossings	Fuel consumption in construction plant and equipment, generators, and on-site vehicles	29,196	2,044	0	505	2,549
	Construction materials (embedded emissions)	N/A	0	0	2,280	2,280

Project element	Source	Energy consumption (GJ)	Scope 1 emissions (t CO_2e)	Scope 2 emissions (t CO_2e)	Scope 3 emissions (t CO_2e)	Total emissions (t CO_2e)
	Haulage of material, waste and earth	N/A	0	0	52	52
	Total	**29,196**	**2,044**	**0**	**2,837**	**4,881**
	Annual Total (Assumed 2-year construction period)	**14,598**	**1,022**	**0**	**1,419**	**2,441**

As illustrated in Figure 7.1, embedded emissions form approximately 72% of emissions from the construction of the Project, with stationary plant and equipment forming approximately 15% of construction emissions. The remaining emissions are primarily resultant from vegetation clearing.

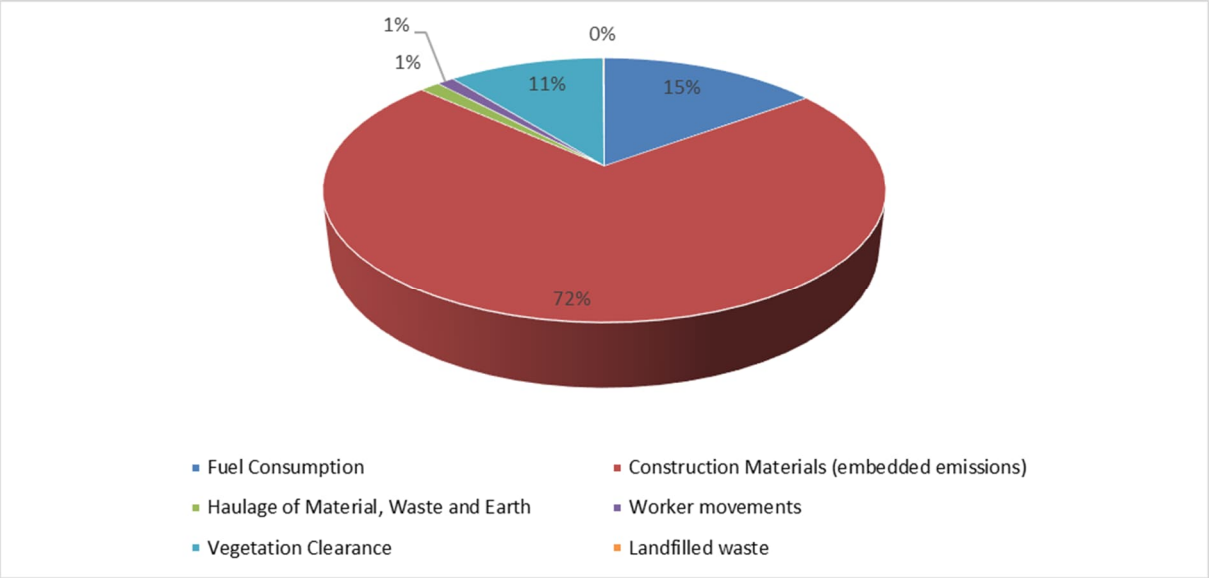

Figure 7.1 Construction emissions by source

As displayed in Figure 7.2, emissions from the Project are split between Scope 1 and Scope 3 emissions, with Scope 3 accounting for approximately 76% of emissions and Scope 1 accounting for 24%.

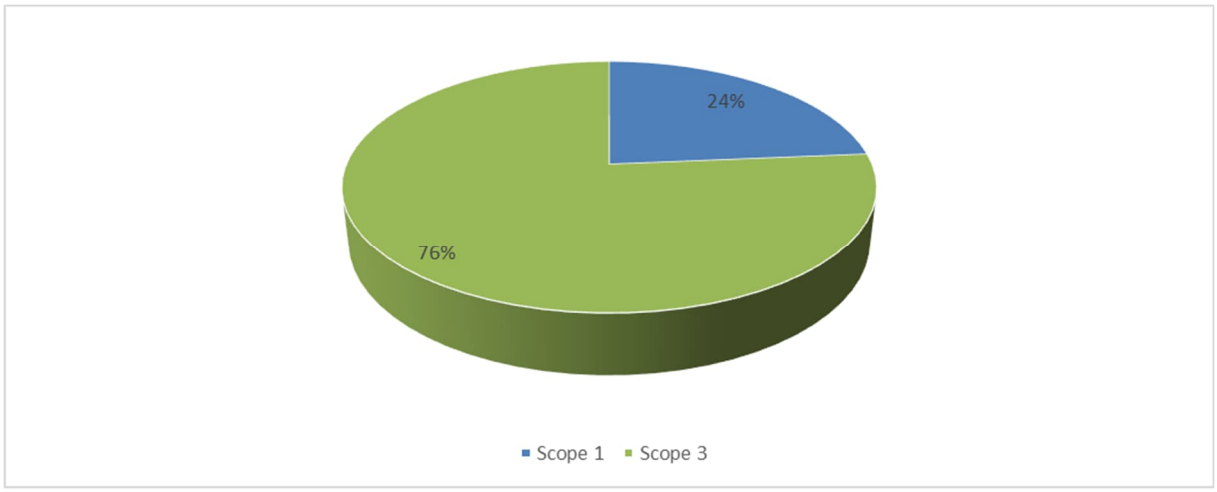

Figure 7.2 Construction emissions by scope

7.2.4 Implications of construction greenhouse gas

As the annual, unmitigated Scope 1 and Scope 2 emissions from the construction of the Project would be greater than 25,000 t CO_2e annually, it would fall under the 'Moderate' significance rating as described in Table 7.8. The annual, unmitigated emission contributions of the construction of the Project towards the total annual emissions of Victoria and Australia (from the State and Territories GHG Inventory 2022 (DISER, 2024)) are detailed in Table 7.9. As displayed, the construction of the Project would constitute approximately 0.3% of Victoria's overall greenhouse gas emissions, while constituting 0.05% of Australia's emissions. Noting that construction would last two years in duration and given the generally low emissions in comparison to the Victorian total emissions, in addition to the Project's intention to increase the uptake of renewable energy by improving connectivity of renewable energy sources in western Victoria to the national grid, the Project is in line with the requirements of the *Climate Change Act 2017*. Likewise, this would fit with the goals of the Commonwealth *2030 Emissions Reduction Target*.

Table 7.9 Emission contributions of the Project in the context of overall state and Commonwealth emissions

Stage of Project	Project emissions (Mt CO_2e/year)	2022 Victorian emissions (Mt CO_2e/ year)	2022 Australian emissions (Mt CO_2e/ year)	Project contribution to Victorian annual emissions	Project contribution to Australian annual emissions
Construction	0.23	84.7	432.6	0.3%	0.05%

7.2.5 Laydown areas

As displayed in Table 7.8, combined Scope 1 and Scope 2 emissions from the establishment and operation of the laydown areas and accommodation facilities would fall below 5,000 t CO_2e, and hence would receive a 'negligible' rating. Emissions from the operation of the laydown facilities alone, would fall even further below this. EPRs SG1 and SG2 both contain measures that would manage greenhouse gas impacts during the operation of the laydown areas. Residual impacts would remain 'negligible' following the application of these EPRs.

7.2.6 Workforce accommodation facilities

As above, combined emissions from the laydown areas and the accommodation facilities would fall below 5,000 t CO_2e, and hence would receive a 'negligible' rating. The accommodation facilities themselves would fall even lower.

7.3 Mitigation of impacts

The management measures to address greenhouse gas emissions during construction and satisfy the GED have been presented in Table 7.10 and have been developed to minimise greenhouse gas emissions during construction of the Project.

Table 7.10 Construction greenhouse gas management measures

Management	Priority in energy reduction hierarchy	Responsibility	Timing
Adopt construction procedures to minimise fuel combustion where possible. This includes shutting off equipment when not in use and adopting more fuel-efficient equipment.	1 - Energy Saving	Principal Contractor	Pre – construction, construction
Undertake detailed modelling to confirm that cut and fill balances are managed to minimise any unnecessary movements of material.	1 - Energy Saving	Principal Contractor	Pre – construction, construction
Explore opportunities to use renewable energy sources during construction.	3 – Renewable Technology	Principal Contractor	Pre – construction, construction
Explore opportunities for the electrification of construction equipment during construction.	3 – Renewable Technology	Principal Contractor	Pre – construction, construction

7.4 Residual impacts

Using the above mitigation measures, it would be expected that the remaining greenhouse gas emissions would be a lower value than those originally estimated. The Infrastructure Sustainability Council considers a reduction in construction greenhouse emissions of 30% as leading practice emission mitigation. As identified in Figure 7.1, embedded emissions form the largest source of emissions. With consideration of the 30% leading practice reduction in emissions, residual Scope 1 and Scope 2 greenhouse gas emissions would still remain greater than 25,000 t CO_2e, and hence the residual impacts would remain in the 'Moderate' category as per Table 5.1.

As displayed in Table 7.8 and noted in Section 7.2.5 and Section 7.2.6, combined Scope 1 and Scope 2 emissions from the establishment and operation of the laydown areas and accommodation facilities would fall below 5,000 t CO_2e, and hence would receive a 'negligible' rating. As a result, following the application of relevant mitigation measures, impacts would remain 'negligible'.

8. Operations impact assessment

8.1 Key issues

The initial risk screening identified risks associated with the production of greenhouse gas emissions during the operation of the Project. The risk screening identified emissions from transmission line operation and maintenance as being the primary source of greenhouse gas risk during the operational stage. Since the risk screening, other sources had been identified as key operation greenhouse gas emission risks, including:

- Electricity consumption in terminal stations
- Leakage of SF_6
- Embedded emissions in replacement equipment.

8.2 Estimation of operation impacts

The sources of emissions during the operation of the Project are detailed in Section 3.3.4, and include the consumption of fuel during inspection and maintenance activities, embedded emissions in replacement materials, electricity consumption in terminal stations and leakage of SF_6 from circuit breakers. The emission scopes associated with these sources are outlined in Table 5.3, while the emissions associated with the sources have been assessed in the following sections.

Inputs used in the development of these calculations are provided in Appendix A.

8.2.1 Energy related greenhouse gas emissions

Energy related emissions associated with the operation of the Project include those from the consumption of fuel during inspection and maintenance activities as well as line losses along the transmission line. These are detailed in the section below.

8.2.1.1 Fuel consumption

Fuel will be required during the operation of the Project, to power vehicles used for inspections. Maintenance activities will be undertaken around the transmission towers and terminal stations; however, these activities will be performed on a 'when required' basis. Due to this, emissions cannot be easily quantified due to the variable durations and equipment requirements for these activities. As per Section 8.2.2.1, the majority of items which will need more frequent maintenance and replacement are small parts and hence the associated maintenance and replacement works are expected to contribute a negligible amount of greenhouse gas emissions. It should be noted that as the function of the transmission line is reliant on timely and effective maintenance of the line, not undertaking or inadequately undertaking maintenance may result in additional emissions as a result of lost efficiency or the requirement of emergency maintenance works.

Table 8.1 below displays the emissions projected to occur from the combustion of fuel during operation.

Table 8.1 Emissions associated with the combustion of fuel during operation

Emissions source	Fuel type	Diesel combusted (kL)	Energy consumption (GJ)	Scope 1 emissions factor (t CO_2e / kL)	Scope 3 emissions factor (kg CO_2e / GJ)	Scope 1 emissions (t CO_2e)	Scope 3 emissions (t CO_2e)	Total emissions (t CO_2e)
Inspection vehicles	Diesel	2	92	2.72	17.3	6	2	8
Total			**92**			**6**	**2**	**8**

8.2.1.2 Line losses

As discussed in Section 5.5.11.1, line losses have not been quantified for this Project given it will facilitate renewable energy generation and distribution in and from Western Victoria.

8.2.1.3 Electricity usage

The four terminal stations associated with the Project will require electricity to perform standard operations. The existing Bulgana Terminal Station and new terminal station near Bulgana will both be powered by the electricity flowing through the transmission line itself, while the Sydenham Terminal Station will be powered by a separate grid connection. As discussed in Section 5.5.11.1, due to the fact that the transmission line will be connecting renewable energy to the grid, line losses and auxiliary load (such as the usage of electricity by the existing Bulgana Terminal Station and the new terminal station near Bulgana) will be predominately associated with renewable energy sourced electricity, and hence will not have emissions associated with it. The Sydenham Terminal Station, however, will be powered by a separate grid connection via Jemena feeders and hence is assumed to be powered by electricity representing the average National Electricity Market mix of generators. The Elaine Terminal Station will consume a comparable amount of electricity to Sydenham Terminal Station, however like the existing Bulgana Terminal Station and the new terminal station near Bulgana it assumed that this electricity would be sourced from renewables and hence will not have associated emissions.

Table 8.2 Emissions associated with the usage of electricity in terminal stations

Emissions source	Electricity source	Annual electricity usage (MWh)	Annual energy consumption (GJ)	Scope 2 emissions factor (t CO_2e / MWh)	Scope 3 emissions factor (t CO_2e / MWh)	Annual emissions (t CO_2e)
Electricity consumption – Sydenham Terminal Station	Separate Grid Connection	62,250*	224,100	Variable – see Section 5.5.11.1 Maximum (Projected): 2029: 0.4: Minimum (Projected): 2035: 0.01 2050 Onwards: 0	Variable – see Section 5.5.11.1 Maximum (Projected): 2029: 0.03: Minimum (Projected): 2035: 0 2050 Onwards: 0	Refer to Table 8.3
Electricity consumption – Existing Bulgana Terminal Station	Western Renewables Link	210,000	756,000	N/A – see Section 5.5.11.1 and above	N/A – see Section 5.5.11.1 and above	Nil
Electricity consumption – New 500kV terminal station near Bulgana						
Electricity consumption – Elaine Terminal Station	Western Renewables Link	62,250	224,100	N/A – see Section 5.5.11.1 and above	N/A – see Section 5.5.11.1 and above	Nil

** Full electricity consumption of Sydenham Terminal Station (i.e., both the Western Renewables Link and non-Western Renewables Link portions of the terminal station) was 166 GWh. This value was then divided based on the number of bays within the terminal station that were associated with Western Renewables Link (1.5 bays of 4 bays total) to determine an approximate Western Renewables Link-associated electricity consumption.*

As previously shown in Table 5.5, as the grid continues to undergo decarbonisation, the emissions associated with the usage of grid electricity will in turn reduce, until full decarbonisation in 2050. As such, over the 45-year life of the terminal stations, the emissions associated with their operation will progressively reduce to zero over time.

The emissions associated with the electricity consumption by the Sydenham Terminal Station are detailed in Table 8.3. As detailed in Section 3.3.1, the Project is proposed to be constructed by late 2028. Hence, emissions for 2029 assume a full year of operation. Should construction be delayed and operation not commence until during 2029, emissions for that year would be less than presented.

Table 8.3 Emissions associated with the usage of electricity in the Sydenham Terminal Station over time

Year	Emissions (t/CO_2e)		
	Scope 2	**Scope 3**	**Total**
2029*	24,900	1,868	26,768
2030	24,278	1,868	26,145
2031	23,655	1,868	25,523
2032	19,298	1,868	21,165
2033	14,940	1,245	16,185
2034	7,470	623	8,093
2035	623	0	623
2036	581	0	581
2037	540	0	540
2038	498	0	498
2039	457	0	457
2040	415	0	415
2041	374	0	374
2042	332	0	332
2043	291	0	291
2044	249	0	249
2045	208	0	208
2046	166	0	166
2047	125	0	125
2048	83	0	83
2049	42	0	42
2050*	0	0	0

** Emissions assume a full year of Project operations*

8.2.2 Non-energy related greenhouse gas emissions

Non-energy related emissions associated with the construction of the Project include embedded emissions in replacement materials and the leakage of SF_6 from terminal stations. These are detailed in the sections below.

8.2.2.1 Embedded emissions in replacement equipment

Over the life of the Project, certain equipment may need to be replaced. Equipment will be replaced on a "when required" basis with an estimated two items of line hardware such as insulators, spacers and dampers predicted to be replaced annually, as well as larger terminal station equipment such as protection relays, supervisory control and data acquisition (SCADA) equipment, quality of service management equipment, batteries, metering equipment, fire equipment and security and communications equipment predicted to be replaced once every 15 to 20 years. Components such as circuit breakers and transformers are predicted to perform for a duration longer than 50 years.

Due to the vastly differing types of equipment and the fact that the equipment will be replaced on a when required basis, the associated emissions cannot be easily quantified. Given the items predicted to be replaced annually are typically small parts, it is expected that the embedded emissions in the replacement equipment would contribute a negligible amount of greenhouse gas emissions.

8.2.2.2 Leakage of sulphur hexafluoride

No components within the terminal stations will use fluorinated gases such as HFCs or PFCs. However, circuit breakers used in the terminal stations of the Project have been identified as using SF_6., and the specifications of the circuit breakers noted that the circuit breakers may leak SF_6 into the atmosphere. While excellent as an insulating medium in the circuit breakers, SF_6 is an extremely potent greenhouse gas, and is 23,500 times more effective at trapping infrared radiation than an equivalent amount of CO_2. The CO_2 equivalent emissions associated with projected SF_6 leakage are detailed in Table 8.4.

Table 8.4 Emissions associated with sulphur hexafluoride leakage

Emissions source	Annual SF_6 leaked (t)	Scope 1 emissions factor (t CO_2e / t)	Scope 1 emissions (t CO_2e)	Total annual emissions (t CO_2e)
SF_6 leakage from terminal station circuit breakers	0.01	23,500	262	262
HFC leakage from equipment	0	7,190 – 11,100	0	0
PFC leakage from equipment	0	79 – 12,400	0	0
Total	**0.01**	N/A	**262**	**262**

8.2.3 Total operational greenhouse gas impact

The operation of the Project is predicted to have an overall greenhouse gas emission of 27,038 to 270 tonnes of CO_2e annually, depending on the year in question.

The breakdown of annual emissions is provided in Table 8.5, while total emissions over the Project's 80-year life are displayed in Table 8.6.

Table 8.5 Annual operational Project emissions

Emissions source	Energy consumption (GJ)	Scope 1 emissions (t CO_2e)	Scope 2 emissions (t CO_2e)	Scope 3 emissions (t CO_2e)	Total annual emissions (t CO_2e)
Fuel consumption in inspection vehicles	92	6	0	2	8
Grid electricity usage	224,100	0	24,900 to 0	1,868 to 0	26,768 to 0
Transmission line electricity usage	N/A	N/A	N/A	N/A	N/A
Embedded emissions	N/A	Negligible	Negligible	Negligible	Negligible
Line losses	N/A	N/A	N/A	N/A	N/A
SF_6 leakage from circuit breakers	N/A	262	0	0	262
Total	**224,192 to 92**	**268**	**24,900 to 0**	**1,870 to 2**	**27,038 to 270**

Table 8.6 Total operational Project emissions

Emissions source	Energy consumption (GJ)	Scope 1 emissions (t CO_2e)	Scope 2 emissions (t CO_2e)	Scope 3 emissions (t CO_2e)	Project life emissions (t CO_2e)
Fuel consumption in inspection vehicles	7,326	516	0	127	643
Grid electricity usage	17,928,000	0	119,520	9,338	128,858
Transmission line electricity usage	N/A	N/A	N/A	N/A	N/A
Embedded emissions	N/A	Negligible	Negligible	Negligible	Negligible
Line losses	N/A	N/A	N/A	N/A	N/A
SF_6 leakage from circuit breakers	N/A	20,981	0	0	20,981
Total	**17,935,326**	**21,497**	**119,520**	**9,464**	**150,481**

As displayed in Table 8.5 and Table 8.6, emissions from the consumption of grid electricity is by far the greatest driver of emissions during the operation of Project, with emissions from the leakage of SF_6 from circuit breakers being the next most significant contributor. Other sources such as inspection and maintenance activities, along with those associated with embedded emissions and line losses making up a negligible proportion of the overall emissions. However, as the decarbonisation of the grid continues, the overall emissions associated with the grid energy usage will decrease, and the other emissions sources will form a greater proportion of annual emissions, until the predicted full decarbonisation of the grid, in which no further emissions from grid electricity usage would result. This is displayed in Figure 8.1.

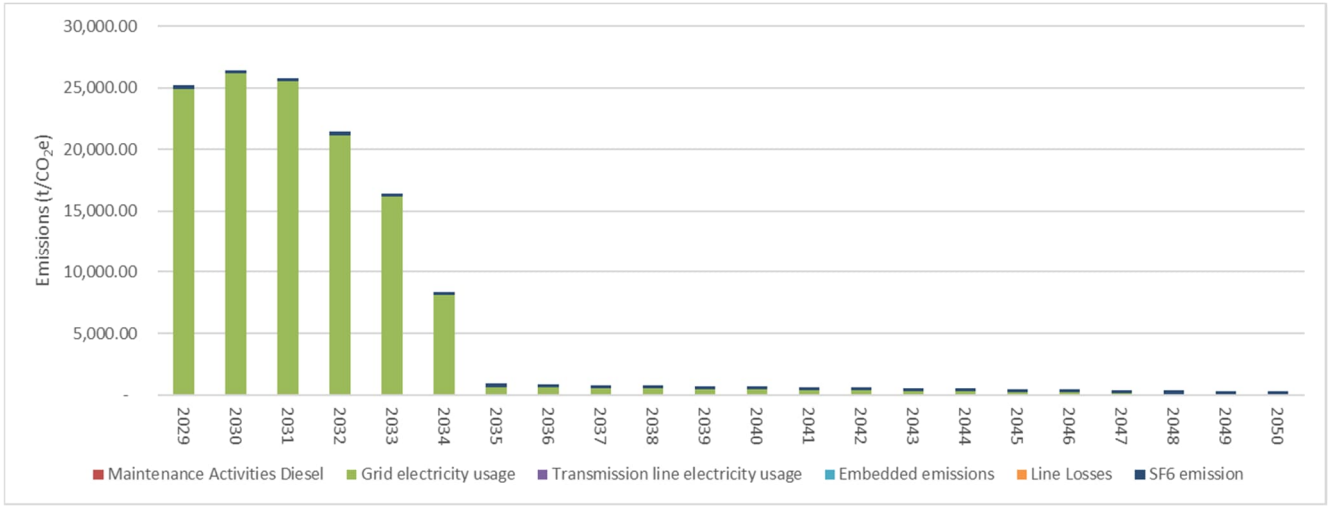

Figure 8.1 Change in emission source contributions over time

Under the worst-case emissions year of 2029, the emission scopes closely aligned with electricity usage (i.e., Scopes 2 and 3) have been predicted to be by far the greatest form of emissions associated with the operation of the Project. Over time however, this will reduce, and Scope 1 emissions (associated with SF_6 leakage) will become more prominent.

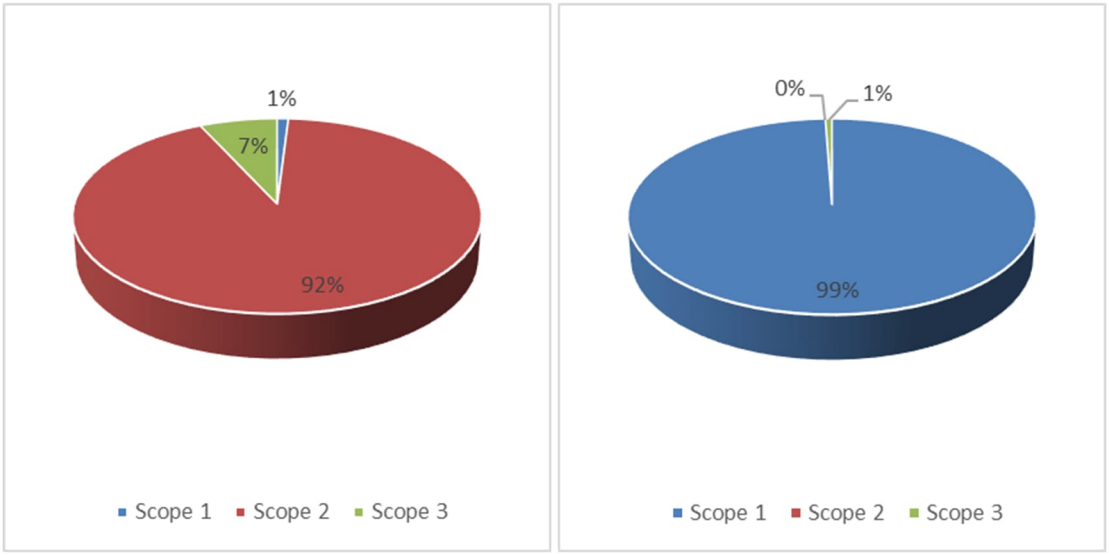

Figure 8.2 Operational emissions by scope (2028 left vs 2050 right)

8.2.4 Implications of operational greenhouse gas

As the annual, unmitigated Scope 1 and Scope 2 emissions from the operation of the Project would initially be greater than 25,000 t CO_2e annually, it would fall under the 'Moderate' significance rating as described in Table 5.1. However, as grid decarbonization continues, this would reduce down to a 'Minor' significance rating. The annual, unmitigated emission contributions of the operation of the Project towards the total annual emissions of Victoria and Australia (from the State and Territories GHG Inventory 2022 (DISER, 2024)) are detailed in Table 8.7. As displayed, the operation of the Project would constitute around 0.03% to less than 0.01% of Victoria's, and 0.006% to less than 0.001% of Australia's overall greenhouse gas emissions. As its the Project's intention to increase the uptake of renewable energy by improving connectivity of renewable energy sources in western Victoria to the national grid, the Project will actively aid in the reduction of emissions associated with grid electricity consumption, including the consumption of grid electricity by the Project's own terminal stations. As such, the Project will be working in line with the goals of the *Climate Change Act 2017* in addition to the goals of the Australian Government *2030 Emissions Reduction Target*.

Table 8.7 Emission contributions of the Project in the context of overall Victorian and Australian emissions

Stage of Project	Annual Project emissions (Mt CO_2e/year)	2022 Victorian emissions (Mt CO_2e/year)	2022 Australian emissions (Mt CO_2e/year)	Project contribution to Victorian annual emissions	Project contribution to Australian annual emissions
Operation	0.0270 – 0.0003	84.7	432.6	0.03% - <0.01%	0.006% - <0.001%

8.3 Mitigation of impacts

The management measures required to address greenhouse gas emissions during the operational stage of the Project predominately pertain to the maintenance and inspection activities, and hence some mitigation measures for construction are also applicable for the operation. These measures are displayed in Table 8.8. These measures will be put in place to manage emission as far as reasonably practicable in line with the requirements of the GED.

Note that for line losses, several greenhouse gas mitigation measures have already been adopted into the Project design. These include adopting conductor and conductor bundle configurations to reduce thermal and coronal losses. Other design choices include designing line transpositions and line conductor separation to reduce losses due to reactive current and installing reactive compensation equipment at terminal stations where necessary. Acknowledging these measures and design options, further mitigation measures to reduce line losses have not been recommended.

Table 8.8 Operational greenhouse gas management measures

Management	Priority in energy reduction hierarchy	Responsibility	Timing
Adopt inspection and maintenance procedures to minimise fuel combustion where possible. This includes shutting off equipment when not in use and adopting more fuel-efficient equipment.	1 – Energy Saving	Principal Contractor	Pre-operation, operation
Explore opportunities to use renewable energy sources in inspection vehicles where practical.	3 – Renewable Technology	Principal Contractor	Pre-operation, operation
Undertake best practice management and maintenance measures are undertaken during the storage and usage of SF_6. Accounting of SF_6 inventory to assure efficient tracking of SF_6 utilisation Assure vendors use cylinder delivery systems which can minimise handling during SF_6 delivery and maximise gas utilisation from each cylinder Develop and maintain an effective *Leak detection and repair* (LDAR) strategy to effectively detect and rapidly manage any SF_6 spills from Project infrastructure.	1 – Energy Saving	Proponent, vendor	Pre-operation, operation

8.4 Residual impacts

Similar to construction, the mitigation measures would facilitate a reduction in Greenhouse gas emissions, however some residual emissions will remain. Any emissions during operation will primarily be as a result of electricity consumption from the grid, in addition to smaller contributions associated with the leakage of SF_6 from circuit breakers and from vehicles used in inspection and maintenance activities. As the Project's purpose is to increase the connectivity of renewable energy sources to the grid, it is actively contributing to the reduction of its own emissions. Other actions, such as maintaining a proactive approach to SF_6 management, and adopting low emission and/or electric vehicles during inspection and maintenance activities would provide the best opportunity for minimising any residual impacts. Residual Scope 1 and Scope 2 greenhouse gas impacts in the initial year would likely remain greater than 25,000 t CO2e, and hence would have a 'Moderate' significance rating as per Table 5.1. Like the unmitigated operational greenhouse gas emission, the grid continues to undergo decarbonization, the significance rating would reduce to 'Minor'.

9. Decommissioning impact assessment

9.1 Key issues

Noting the likelihood of changes in technologies and policy which could impact Greenhouse gas emissions by the time decommissioning could occur, it is difficult to predict the emissions associated with decommissioning.

As such, the emissions resulting from the decommissioning of the Project have been qualitatively assessed to determine the greenhouse gas risk for the decommissioning process. Generally, the activities to be undertaken for decommissioning are similar to construction activities, though without the emissions attributed to the clearing of vegetation and embedded emissions.

9.2 Decommissioning greenhouse gas impacts

Emissions during decommissioning stages would most likely result from energy consumption, in the following forms:

- Plant and equipment dismantling the transmission line, transmission towers and terminal stations
- Plant and equipment to excavate the concrete footings
- Plant and equipment in site restoration and rehabilitation
- Site vehicles operating on site
- Site offices
- Haulage of material from site to the disposal destination
- Haulage of fill to site for site restoration and landscaping.

Due to the predominate materials used in the Project being steel and concrete, along with a sizeable amount of aluminium, a large portion of Project materials would be recycled and reused. This would have a positive greenhouse gas impact by supplanting some of the demand for these materials which otherwise could have been filled by newly produced (and more emissions intensive) materials.

As these activities are similar to those during construction, the unmitigated Scope 1 and Scope 2 emissions could indicatively be categorised under the 'Moderate' significance rating as described in Table 5.1. However, given the likely improvements in emission reducing technology and renewable energy availability at the time of decommissioning, the significance rating could potentially be 'Minor' or 'Negligible'.

9.3 Mitigation of impacts

As the greenhouse gas emission sources for the decommissioning stage are similar to the construction stage emission sources, mitigation measures for construction stage are also applicable for the decommissioning stage. These measures are provided in Table 9.1.

Table 9.1 Decommissioning greenhouse gas management measures

Management	Priority in energy reduction hierarchy	Responsibility	Timing
Adopt procedures to minimise energy usage where possible during decommissioning activities. This includes shutting off equipment when not in use and adopting more fuel-efficient equipment.	1 – Energy Saving	Principal Contractor	Decommission planning
Explore opportunities to use renewable energy sources during construction.	3 – Renewable Technology	Principal Contractor	Pre – construction, construction
Explore opportunities to recycle steel, concrete and other materials as an alternative to sending the material to landfill.	3 – Renewable Technology	Principal Contractor	Decommission planning

9.4 Residual impacts

As previously discussed, it is difficult to articulate potential greenhouse gas emissions during the decommissioning activities as changes to technologies would likely introduce emissions reductions above what is currently possible. However, as a high-level evaluation, emissions similar to what has been calculated for construction would be expected. Assuming the same 30% reduction in construction emissions as described in Section 7.4, residual decommissioning Scope 1 and Scope 2 greenhouse gas emissions could still remain in the 'Moderate' category as per Table 5.1. However, with consideration to the likely improvements to emissions reductions and renewable energy availability, the significance rating could potentially be 'Minor' or 'Negligible'.

10. Cumulative impacts

A cumulative impact assessment considers the impacts of a project together with the impacts of other relevant projects that may interact spatially and temporally to change the level of impact on environmental, social or cultural values. **EES Chapter 4: EES assessment framework and approach** identifies relevant future projects that are proportionate to the scale and potential significance of the impacts of Western Renewables Link Project (WRL); that have sufficient information publicly available in an EES or an environmental approvals application; and that have a spatial and temporal relationship to WRL. Cumulative impacts may occur when incremental, successive and combined effects of actions or projects are added to other proposed actions or projects.

Unlike many other cumulative impact considerations which typically have a localised impact around the project in question, greenhouse gas emissions contribute towards a global greenhouse gas impact. Hence, when considering cumulative greenhouse gas impacts, local projects are not any more relevant than any other greenhouse gas emitting project across Victoria, Australia, or the world.

A more relevant assessment of cumulative greenhouse gas impacts would be in the form of a comparison of WRL emissions against Victorian and Federal greenhouse gas emissions, as undertaken in Section 7.2.4 and Section 8.2.4. These allow for the understanding of WRL's greenhouse gas emission contribution at a state and federal level.

Another consideration regarding greenhouse gas emissions is that WRL is also contributing to the reduction in greenhouse gas emissions. By connecting the renewable energy sources in the west of Victoria to the national grid, WRL is assisting with the uptake of renewable energy usage and reduced usage of fossil fuels. This in turn is assisting with other actions to reduce the overall emissions of Victoria to achieve the targets of the Victorian *Climate Change Act 2017* as well as Australia as a whole, in line with the goals of the Commonwealth *2030 Emissions Reduction Target*.

11. Environmental Performance Requirements

11.1 EPRs

Environmental Performance Requirements (EPRs) set out the environmental outcomes to be achieved through the implementation of mitigation measures during construction, operation and decommissioning. While some EPRs are performance based to allow flexibility in how they will be achieved, others include more prescriptive measures that must be implemented. Compliance with EPRs will be required as a condition of the Project's approval.

To meet the EES evaluation objective of avoiding and/or minimising greenhouse gas impacts, the EPRs outlined in Table 11.1 are recommended.

Table 11.1 Greenhouse Gas Environmental Performance Requirements

EPR code	Environmental Performance Requirements	Project component	Stage
SG1	**Develop and implement sustainability targets and a Sustainability Management Plan** 1. Develop and implement sustainability targets and specify ratings to reduce construction and operational greenhouse gas emissions. 2. To aid in achieving the targets, the Principal Contractor must develop and implement a Construction Sustainability Management Plan prior to the commencement of construction and an Operational Sustainability Management Plan prior to the commencement of operation that contain measures to meet the sustainability targets and specified ratings and include the requirement to monitor and report on the progress of achieving the sustainability targets and implementation of the Sustainability Management Plans. At a minimum, this will include: a. Measures to minimise fuel combustion where possible. b. Adopting the waste management hierarchy in accordance with the *Environment Protection Act 2017*. c. Vendors must adopt technology to minimise handling of sulfur hexafluoride (SF_6) during delivery and maximise efficiency of SF_6 utilisation as far as reasonably practicable when its use cannot be avoided. d. Measures to track and manage sulfur hexafluoride (SF_6) utilisation, including a leak detection and repair (LDAR) strategy to effectively detect and rapidly manage any SF_6 leaks.	All	Design, construction, operation
SG2	**Consider environmentally sustainable design** 1. Select and source materials in detailed design, and monitor energy and carbon use during construction, to reduce greenhouse gas emissions associated with materials and energy consumption as far as practicable. 2. Investigate, document and implement opportunities to use green power sourced from renewable energy and bio diesel where practicable. 3. Integrate sustainable design practices into the design process to minimise, to the extent practicable, greenhouse gas emissions arising from construction, operations and maintenance of the Project in line with the ratings and targets selected as part of SG1.	All	Design, construction, operation

In addition to the EPRs recommended specific to greenhouse gas, other related EPRs are listed in the table below for reference.

Table 11.2 Additional EPRs related to greenhouse gas

EPR code	Environmental Performance Requirements	Project component	Stage
EM2	**Develop and implement a Construction Environmental Management Plan** 1. Prior to the commencement of construction, develop and implement a Construction Environmental Management Plan (CEMP) with associated subplans as required by relevant EPRs in accordance with the Environmental Management Framework to manage the environmental impacts associated with construction in accordance with the mitigation hierarchy. 2. The CEMP must be developed in consultation with relevant stakeholders as required by relevant EPRs, reviewed by AusNet, and reviewed and verified by the Independent Environmental Auditor (IEA) for compliance with the EPRs prior to the commencement of construction. 3. The CEMP subplans must address applicable EPRs including those relevant to surface water, groundwater, geology and soils, contaminated land, biodiversity, air, noise, historical heritage, bushfire protocols, weed and pest management. 4. The CEMP and its subplans must comply with the EPRs and relevant environmental legislation, and performance must be reported to AusNet and relevant government agencies as appropriate.	All	Construction
EM11	**Develop and implement a Decommissioning Management Plan** 1. Prior to commencement of decommissioning, develop and implement a Decommissioning Management Plan detailing mitigation measures required to manage the environmental impacts associated with decommissioning and seek to minimise the risk of harm to human health or the environment of all activities associated with decommissioning 2. Management and mitigation measures shall be consistent with environmental management strategies, practices, and technologies current at the time and shall include, but not be limited to measures for communications and stakeholder engagement, environmental protection measures, waste management and recycling, emergency response and measures to minimise disturbance to agriculture, recreation and other enterprises.	All	Decommissioning

11.2 Monitoring

As a corporation registered under the NGER Act, and as required under Step 4 of Publication 2048, AusNet will continue to follow the NGER guidelines for monitoring and reporting of emissions produced by the Project. Additionally, in accordance with guidance from the EPA, reporting of Scope 1 and Scope 2 emissions should be carried out on a quarterly basis instead of an annual basis during construction, and the reporting be made publicly available on the Project website. This reporting and the associated requirements would form part of the Project CEMP (as per EPR EM2 in Table 11.2).

Furthermore, in line with EPR SG1 in Table 11.1, the Sustainability Management Plans would include monitoring and reporting to keep progress on achieving the sustainability. This would in turn inform the effectiveness of mitigation measures and assist with the reduction of greenhouse gas emissions throughout the life of the Project.

12. Conclusion

The Greenhouse Gas Impact Assessment for the Project identified emission sources during the construction and operation of the Project and quantified the likely emissions to be generated.

12.1 Existing conditions

Greenhouse gas emissions produced in Victoria and Australia have been tracked and detailed through Australia's National Greenhouse Accounts, a series of reports published by DCCEW. These accounts are used to fulfil Australia's greenhouse gas inventory reporting commitments, provide the official basis for tracking progress towards Australia's emission reduction commitments, inform future emission reduction commitments and support the creation of domestic reduction policies.

As greenhouse gas emissions between 2012 and 2022 have been steadily trending downwards, with Victorian emissions reducing from 133 Mt CO_2e in 2012 to 85 Mt CO_2e in 2022. Likewise, Australian emissions have reduced from 579 Mt CO_2e in 2012 to 433 Mt CO_2e in 2022.

12.2 Construction impact assessment

The assessment identified the following key emissions sources producing CO_2e:

- Fuel combustion during construction activities by construction plant and equipment, including:
  - Generators used on site
  - Generators for site offices
  - Site vehicles
  - Vegetation clearing
  - Excavation works
  - Laydown activities
  - Fuel use and vehicle movements associated with workforce accommodation facilities
  - Powercor crossings
  - Construction of towers and terminal station
  - Post-construction landscaping.
- Embedded emissions in materials, notably concrete and steel
- Haulage of materials, waste and soil
- Loss of carbon sink due to vegetation clearing.

The key outcomes of the construction impact assessment, assuming no mitigation is applied, are:

- Total greenhouse gas emissions of 464 kilotonnes of CO_2e are predicted to be emitted during the construction of the Project
- Embedded emissions were the main source of CO_2e emissions during construction
- Scope 1 and Scope 3 emissions comprised approximately 24% and 76% of CO_2e emissions each during construction, respectively.

With no mitigation applied, the construction of the Project would constitute approximately 0.3% of Victoria's overall greenhouse gas emissions and 0.05% of Australia's emissions. Noting that construction would last two years in duration and that the Project's intention is to increase the uptake of renewable energy by improving connectivity of renewable energy sources in western Victoria to the national grid, the Project is in line with the requirements of the Victorian *Climate Change Act 2017* and Commonwealth *2030 Emissions Reduction Target*.

12.3 Operational impact assessment

The assessment identified the following key emissions sources producing CO_2e:

- Fuel use in inspection vehicles
- Fuel use by maintenance equipment
- Grid electricity usage in terminal stations
- Leakage of SF_6 from circuit breakers within the terminal stations.

The key outcomes of the operational impact assessment, assuming no mitigation is applied, are:

- Total greenhouse gas emissions of 27.03 to 0.27 kilotonnes of CO_2e are predicted to be emitted annually during the operation of the Project, depending on grid decarbonisation
- Grid electricity consumption in terminal stations was the main source of CO_2e emissions during operation
- Scope 2 and 3 emissions were the prominent forms of emission during operation, associated with the above grid electricity usage.

With no mitigation applied, the operation of the Project would constitute 0.03% to less than 0.01% of Victoria's, and 0.006% to less than 0.001% of Australia's overall greenhouse gas emissions. Additionally, as the purpose of the Project is to facilitate the connection of renewable energy sources to energy receivers, the Project is expected to contribute to its own emissions reduction, in addition to a reduction in greenhouse gas emissions across the grid.

12.4 Environmental Performance Requirements

Environmental management measures were identified to reduce overall emissions, including exploring options for the adoption of low emission construction materials or the use of renewable energy in construction and maintenance equipment. Additionally, the following EPRs have been provided focusing on energy abatement and best practice in sustainability. These included:

SG1: Develop and implement sustainability targets and a Sustainability Management Plan:

1. Develop and implement sustainability targets and specify ratings to reduce construction and operational greenhouse gas emissions.
2. To aid in achieving the targets, the Principal Contractor must develop and implement a Construction Sustainability Management Plan prior to the commencement of construction and an Operational Sustainability Management Plan prior to the commencement of operation that contain measures to meet the sustainability targets and specified ratings and include the requirement to monitor and report on the progress of achieving the sustainability targets and implementation of the Sustainability Management Plans. At a minimum, this will include:
    a. Measures to minimise fuel combustion where possible.
    b. Adopting the waste management hierarchy in accordance with the *Environment Protection Act 2017*.
    c. Vendors must adopt technology to minimise handling of sulfur hexafluoride (SF_6) during delivery and maximise the efficiency of SF_6 utilisation as far as reasonably practicable when its use cannot be avoided.
    d. Measures to track and manage sulfur hexafluoride (SF_6) utilisation, including a leak detection and repair (LDAR) strategy to effectively detect and rapidly manage any SF_6 leaks.

SG2: Environmentally sustainable design:

1. Select and source materials in detailed design, and monitor energy and carbon use during construction, to reduce greenhouse gas emissions associated with materials and energy consumption as far as practicable.

2. Investigate, document and implement opportunities to use green power sourced from renewable energy and bio diesel where practicable.
3. Integrate sustainable design practices into the design process to minimise, to the extent practicable, greenhouse gas emissions arising from construction, operations and maintenance of the Project in line with the ratings and targets selected as part of SG1.

Through the implementation of the mitigation measures and the above EPRs (including the general EPRs EM2 and EM11), the greenhouse gas emissions from the Project would be avoided and mitigated as far as reasonably practicable, meeting the evaluation objective in the EES scoping requirements.

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Appendix A. Additional Information

This appendix provides details of the inputs used in the development of the greenhouse gas calculations.

A.1 Construction

A.1.1 Fuel usage

Fuel usage by construction plant and equipment has been calculated based on initial construction equipment details provided by AusNet, and the developed construction equipment and durations were confirmed with AusNet prior to use. Fuel consumption rates for each piece of equipment were adopted from those listed in Table 5-5 of *Greenhouse Gas Assessment Workbook for Road Projects* (TAGG, 2013). Where the equipment or an equivalent was not in the table, fuel consumption rates were developed based on equipment specification sheets.

Details are tabulated in Table A.1 below.

Table A.1 Construction equipment usage for the Project

Structure	Stage	Equipment used in construction	Quantity of equipment	Duration
Transmission tower	Site preparation	Bulldozer	x1	2 days per tower
		Excavator	x1	
		Roller	x1	
		Grader	x1	
		Trucks	x1	
		Light vehicles	Detailed in Section 0.	
	Tower foundation works	Piling rig	x1	5 days per tower
		Rock drill	x1	
		Concrete truck	x1	
		Trucks	x1	
		Light vehicles	Detailed in Section 0.	
	Tower assembly works	Semi-trailers	x1	2 weeks per tower
		Skid steer loader	x1	
		Mobile crane	x1	
		Large crane	x2	
		Light vehicles	Detailed in Section 0.	
	Transmission line stringing	Helicopter	x1	6 km (of 190km transmission line) per month
		8x8 truck	x2	
		Mobile crane	x1	
		Elevated work platforms	x8	
		Pullers, tensioners, breaks	x3	
		Light vehicles	Detailed in Section 0.	
500kV terminal station near Bulgana	Site preparation	Bulldozers	x2	2 weeks
		Skid steers	x2	
		Mobile crane	x1	
		Light vehicles	Detailed in Section 0.	

Structure	Stage	Equipment used in construction	Quantity of equipment	Duration
		Trucks	x7	
	Earthworks	Bulldozers	x2	6 months
		Excavators	x2	
		Skid steers	x2	
		Road roller	x1	
		Truck and Dogs	x2	
		Concrete trucks	x10	
		Light vehicles	Detailed in Section 0.	
		Trucks	x7	
	Installation works	Mobile crane	x1	6 months, 2 weeks
		Piling rig	x1	
		Front-end loader backhoe	x1	
		Elevated work platforms	x2	
		Forklifts	x2	
		Scissor lifts	x2	
		Light vehicles	Detailed in Section 0.	
		Trucks	x7	
	Landscaping	Excavators	x2	1 month
		Skid steers	x2	
		Light vehicles	Detailed in Section 0.	
	Demobilisation	Skid steers	x2	1 month
		Mobile crane	x1	
		Light vehicles	Detailed in Section 0.	
		Trucks	x7	
Sydenham terminal station	Installation works	Mobile crane	x1	6 months, 2 weeks
		Piling rig	x1	
		Front-end loader backhoe	x1	
		Elevated work platforms	x2	
		Forklifts	x2	
		Scissor lifts	x2	
		Light vehicles	Detailed in Section 0.	
		Trucks	x7	
	Landscaping	Excavators	x2	1 month
		Skid steers	x2	
		Light vehicles	Detailed in Section 0.	
	Demobilisation	Skid steers	x2	1 month
		Mobile crane	x1	
		Light vehicles	Detailed in Section 0.	
		Trucks	x7	

Structure	Stage	Equipment used in construction	Quantity of equipment	Duration
Laydown areas	Removal of topsoil and vegetation	Bulldozer	x1	2 weeks per laydown area
		Excavator	x1	
		Roller	x1	
		Grader	x1	
		Trucks	x1	
		Light vehicles	Detailed in Section 0.	
	Stockpiling topsoil	Bulldozer	x1	2 weeks per laydown area
		Excavator	x1	
		Trucks	x1	
		Light vehicles	Detailed in Section 0.	
	Levelling, adding rock and compaction	Bulldozer	x1	1 month per laydown area
		Excavator	x1	
		Roller	x1	
		Trucks	x1	
		Light vehicles	Detailed in Section 0.	
	Laydown operations	Concrete batching plant (only at transmission line laydown areas)	x1	Remainder of construction period (assumed 26 months per laydown area, 18 months for batching plants)
		Trucks	x1	
		Light vehicles	Detailed in Section 0.	
Powercor crossing (assumed all undergrounded)	Site Preparation	Bobcat	x1	½ week per crossing
		Trucks	x1	
		Light vehicles	Detailed in Section 0.	
	Trenching	Excavator	x2	½ week per crossing
		Trucks	x1	
		Light vehicles	Detailed in Section 0.	
	Infill and Demobilisation	Excavator	x1	1 week per crossing
		Concrete truck	x1	
		Trench roller	x2	
		Trucks	x1	
		Light vehicles	Detailed in Section 0.	

A.1.2 Site vehicle usage on-site

Table 5-3 of the *Greenhouse Gas Assessment Workbook for Road Projects* (TAGG, 2013) provides a monthly assumed fuel usage from on-site vehicle movements and a general factor for trips to site, based on the number of light vehicles used on each individual site. Based on the equipment details discussed with AusNet, is it is assumed that four site vehicles are in operation during every construction stage (as detailed in Section A.1.1) at every construction site and laydown area.

A.1.3 Site generators

Based on advice from AusNet, it was noted that a 40kVa to 70kVa generator would be used to power sites where mains connections were not possible. As a conservative assumption, a single 70 kVA generator was assumed to be adopted at each construction site for the entire respective construction period, in addition to at each laydown area for the entirety of that laydown area's construction period. Based on specification sheets for 70 kVA generators, an assumed fuel consumption of 12.2 L/hr for 12 hours a day was adopted.

A.1.4 Material quantities

Material quantities for terminal stations were provided by the Jacobs' terminal station team and were approved by AusNet. These are simplified and detailed in Table A.2 below:

Table A.2 Material requirements of terminal stations

Terminal station	Material	Tonnage
500kV terminal station near Bulgana	Steel	923
	Aluminium	11
	Copper	140
	Concrete	4,104
Sydenham	Steel	325
	Aluminium	7
	Copper	25
	Concrete	1,697

Material quantities for transmission towers were provided by AusNet. These are detailed in Table A.3.

Table A.3 Material requirements of the transmission towers

Type of tower	Number of towers	Average steel per tower (t)	Average foundation volume per tower (assumed filled with concrete) (m^3)	Average reinforcement steel (t)
500kV Double Circuit Light Suspension Tower	252	37	74	12
500kV Double Circuit Suspension Tower, capable of 10 deg Angles	58	49	95	15
500kV Double Circuit Suspension Tower, capable of 20 deg Angles	18	53	101	16
500kV Double Circuit Strain Towers Capable of angles up to 30 deg	36	75	152	24
500kV Double Circuit Strain Towers Capable of angles up to 45 deg	21	86	165	26
500kV Double Circuit Strain Towers capable of angles up to 60 deg	33	98	198	32
500kV Single Circuit Suspension or Strain Towers (pair of towers)	28	32	64	10
TOTAL	**446**	**21,375**	**42,661**	**6,826**

Conductors were also provided by AusNet and have been detailed below in Table A.4. Conductors were divided into their aluminium, steel and (in the case of the OPGWs) optical fibre components using dimensions provided in their specification sheets.

Table A.4 Material requirements of conductors

Conductor/ Cable	Quantity	Unit weight (t/km)	Total weight (t)	Steel weight (t)	Aluminium weight (t)	Fibre optics weight (t)
Olive ASCR/GZ	4,584 km	1.96	8985	2,498	6,487	0
Pawpaw ASCR/GZ	60 km	2.24	134	37	98	0
OPGW	387 km	0.61	236	52	173	12

Details of other transmission line components, notably insulators and mid span joints were also provided by AusNet and are detailed in Table A.5.

Table A.5 Material requirements of other transmission line components

Component	Quantity	Material	Material per Unit (kg)	Material Total (t)
Insulator	3,828	Fibreglass	4	15
		Silicone rubber	11	42
		Steel	17	65
Mid Span Joints	1,984	Steel	28	56
		Aluminium	1	2

Materials associated with the undergrounding of cables associated with the Powercor crossings were developed based inputs provided by AusNet. These are detailed in Table A.6.

Table A.6 Material requirements of Powercor crossings

Element	Quantity	Dimensions	Material	Depth of material (m)	Overall material Total (t)
Powercor Crossing	60	Nominal width: 0.6mm Overall length: 9219m	Heavy duty plastic sheet	0.008	39
			Concrete	0.165	2,190
			Covering sand	0.45	4,729
			Bedding sand	0.277	2,911

Temporary crane pads will be adopted for the construction of the towers and terminal stations. These pads will be constructed out of road base (aggregates in this assessment. The details of the crane pads are detailed in Table A.7.

Table A.7 Crane pad quantities

Structure	Quantity	Dimensions (m) per pad	Volume (m^3) per pad	Mass of aggregate per pad (t)	Total weight (t)
Crane Pad	438	10*16*0.25m	40	96	42,048

A.1.5 Fill and spoil

Cut and Fill balances were provided by AusNet. The total fill requirements of 120,000m^3 for the existing Bulgana Terminal Station was provided, while it was confirmed that a total of 27,000m^3 of spoil will be removed during the construction of the Project.

A.1.6 Waste

Calculations for the waste generated during construction were provided by AusNet. These have been simplified and detailed in Table A.8.

Table A.8 Waste estimations provided for construction

Waste type	Total waste (t)	Percentage to be recycled	Waste to landfill (t)
Wood	571	0%	571
Cardboard	6	0%	6
Plastic	4	0%	4
Steel	171	0%	171
Total	**752**	**N/A**	**752**

A.1.7 Haulage

Based on discussions with AusNet regarding material sourcing and disposal, alongside the webGIS of haulage routes, the following distances have been adopted for the assessment:

- Materials
  - Transmission Line
    - Steel, aluminium, optic fibre, fibreglass reinforced plastic, silicone rubber and heavy duty plastic sourced from China (9617km shipping from Shanghai to Port of Melbourne, average of 119km haulage from Port of Melbourne to laydown areas, and average of 33km haulage from laydown to site
    - Concrete, aggregate and sand sourced locally (Melbourne, Ballarat, Ararat or Stanwell), average of 50km to laydown area, and average of 33km haulage from laydown to site
  - Bulgana Terminal Station
    - Steel, aluminium and copper sourced from China (9617km shipping from Shanghai to Port of Melbourne, 221km haulage from Port of Melbourne to site
    - Concrete sourced locally (Stanwell), 20km to site.
  - Sydenham Terminal Station
    - Steel, aluminium and copper sourced from China (9617km shipping from Shanghai to Port of Melbourne, 30km haulage from Port of Melbourne to site
    - Concrete sourced locally (Melbourne), 30km to site.
- Cut and Fill
  - Transmission Line
    - Assumed local disposal of spoil (Melbourne, Ballarat, Ararat or Stanwell), average of 50km to disposal
  - Bulgana Terminal Station
    - Fill sourced locally (Stanwell), 20km to site.

- Waste
  - Transmission line and terminal stations
    - Assumed local disposal of waste (Melbourne, Ballarat, Ararat or Stanwell), average of 50km to disposal

A.1.8 Worker movements

The requirements for vehicle movements (both cars and "heavy vehicles") were provided by AusNet. The Jacobs traffic team used this data to calculate the number of required trips as well the typical distance covered. These are provided in Table A.9. For the purpose of the calculation, it was assumed "heavy vehicles" were large minivans.

Table A.9 Worker movements required for construction

Site movements	Number of light vehicle movements per day (out of laydown)	Number of heavy vehicle movements per day (out of laydown)	Typical distance (km) travelled per day (one-way)
Bulgana laydown area	63.3	12.6	18.0
Lexton laydown area including workforce accommodation facilities	171.0	34.0	21.5
Ballan laydown area including. workforce accommodation facilities	157.3	31.3	29.2
Sydenham laydown area	72.8	14.5	18.2

A.1.9 Vegetation clearing

Greenhouse gas impacts resulting from the clearing of vegetation along the Proposed Route are based on the Greenhouse Gas Assessment Workbook for Road Projects (TAGG, 2013). The workbook establishes 'Biomass Classes' (determined through the location of the Project) and 'Vegetation Classes' (based on the specific type of vegetation being cleared). Based on this workbook, the most appropriate biomass class is 'Class 2'.

The types of vegetation predicted to be cleared were identified/defined by the Jacobs biodiversity team based on data provided by the Department of Environment Land Water and Planning, in addition to field measurements and site surveys. These have been provided in Table A.10 Cleared vegetation classification.

Table A.10 Cleared vegetation classification

Ecological Vegetation Classes (DELWP classification)	Greenhouse Gas Assessment Workbook for Road Projects Vegetation Class	Area (hectares)
Vegetation patches		
Box Ironbark Forest	C – Open Forest	1.7
Grassy Dry Forest	C – Open Forest	54.9
Heathy Dry Forest	C – Open Forest	2.1
Herb-rich Foothill Forest	C – Open Forest	34.4
Riparian Forest	C – Open Forest	1.1
Shrubby Dry Forest	C – Open Forest	1.6
Valley Grassy Forest	C – Open Forest	4.9
Alluvial Terraces Herb-rich Woodland	D – Open Woodlands	15.5
Creekline Grassy Woodland	D – Open Woodlands	11.2

Ecological Vegetation Classes (DELWP classification)	Greenhouse Gas Assessment Workbook for Road Projects Vegetation Class	Area (hectares)
Creekline Herb-rich Woodland	D – Open Woodlands	4.4
Floodplain Riparian Woodland	D – Open Woodlands	0.2
Grassy Woodland	D – Open Woodlands	60.6
Hillcrest Herb-rich Woodland	D – Open Woodlands	0.3
Plains Grassy Woodland	D – Open Woodlands	10.9
Plains Woodland	D – Open Woodlands	2.7
Riparian Woodland	D – Open Woodlands	0.1
Sedgy Riparian Woodland	D – Open Woodlands	0.2
Swampy Riparian Woodland	D – Open Woodlands	1.2
Stream Bank Shrubland	F – Mallee & Acacia Woodland	1.7
Swamp Scrub	F – Mallee & Acacia Woodland	0.9
Rocky Chenopod Woodland	H - Heathlands	5.8
Plains Grassland	I - Grasslands	6.9
Plains Grassy Wetland	I - Grasslands	4.5
Scattered trees		
Grassy Dry Forest	C – Open Forest	0.8
Herb-rich Foothill Forest	C – Open Forest	0.8
Riparian Forest	C – Open Forest	0.1
Shrubby Dry Forest	C – Open Forest	0.1
Valley Grassy Forest	C – Open Forest	0.5
Alluvial Terraces Herb-rich Woodland	D – Open Woodlands	0.3
Creekline Grassy Woodland	D – Open Woodlands	0.9
Grassy Woodland	D – Open Woodlands	2.7
Plains Grassy Woodland	D – Open Woodlands	3.5
Plains Woodland	D – Open Woodlands	0.8
Swampy Riparian Woodland	D – Open Woodlands	0.1
Swamp Scrub	F – Mallee & Acacia Woodland	0.1
Rocky Chenopod Woodland	H - Heathlands	0.2
Plains Grassland	I - Grasslands	0.2

A.2 Operation

A.2.1 Inspection vehicles

Predictions for inspection vehicle usage during the first 30 years of operation have been provided by AusNet following the RFI process. These are summarised in Table A.11. Based on these inputs, the assumption of one worker per vehicle was assumed for the maintenance. With these inputs, the Greenhouse Gas Assessment Workbook for Road Projects (TAGG, 2013) assumption for vehicles was adopted to calculate the emissions associated with the inspection vehicles used on the Project.

Table A.11 Average man hour and man days for inspection works

Parameter	Time
30 Year - Average Man Hours	1,753 hours
30 Year - Average Man Days	219 days

A.2.2 Maintenance equipment

Maintenance equipment data was provided by AusNet in response to an RFI. The equipment is detailed below.

- Transmission tower line maintenance
  - Elevated working platform
  - Mobile crane
  - Task truck
  - Construction truck
  - 4x4 vehicles
- Terminal station maintenance
  - Scissor lift
  - Knuckle Boom
  - Spider Boom
  - Straight boom
  - Telehandler
  - Mobile Crane.

As per the same RFI response as the one that provided the inspection activity assumptions, no assumptions for repair hours have been provided as these will be dependent on what is identified as requiring repairs.

A.2.3 Sulphur hexafluoride leakage

Sulphur hexafluoride will be used in circuit breakers in terminal stations and have been noted to leak SF_6. The inputs used to calculate the SF_6 leakage are provided in Table A.12.

Table A.12 Sulphur hexafluoride leakage

Material	Circuit breaker	Capacity of SF_6 per circuit breaker (t)	Number of circuit breakers	Total capacity of SF_6 (t)	Annual leakage rate of SF_6 from circuit breakers	Annual leakage of SF_6 (t)
Sulphur hexafluoride	220kV	0.099	8	0.79	0.5%	0.004
	500kV	0.120	12	1.44		0.007
	Total			**2.23**		**0.01**

A.2.4 Grid electricity usage

It is noted that the two terminal stations associated with the Project, at Sydenham and near Bulgana, will require electricity during their operation. The Sydenham terminal station will be powered by Jemena feeders (i.e., from the wider National Electricity Market), while the Bulgana terminal station will take its electrical energy requirements from the transmission line itself via station services transformers. As per AusNet advice, the electricity consumption of Elaine Terminal Station should be similar to Sydenham Terminal Station, though the

terminal station would be powered by the transmission line like Bulgana Terminal Station. The electricity usage is detailed in Table A.13.

Table A.13 Electricity usage in terminal stations

Terminal station	Annual electricity usage	Electricity source
Sydenham	62.3 GWh*	Grid (Jemena Feeders)
Bulgana	210 GWh	Transmission line (500/220/22kV power transformers via 22kV/415V station services transformers)
500kV terminal station near Bulgana		
Elaine	62.3 GWh	Transmission line

** Sydenham Terminal Station's total energy consumption is 166 GWh annually. The Project portion of Sydenham will be 1.5 bays out of the total of four (37.5% of the terminal station), and hence the electricity consumption of the Project portion of the Project would be equally proportional to the overall electricity consumption of the terminal station.*

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