Appendix P Greenhouse Gas Assessment

Prepared for
Tarong West Project Co Pty Ltd
ABN: 81 679 081 040

Greenhouse Gas Assessment

Tarong West Wind Farm

10-Dec-2024
Tarong West Wind Farm

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Greenhouse Gas Assessment

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Client: Tarong West Project Co Pty Ltd

ABN: 81 679 081 040

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Abbreviations

Abbreviation	Definition
AECOM	AECOM Australia Pty Ltd
C	Carbon
CH_4	Methane
CO_2	Carbon dioxide
CO_2-e	Carbon dioxide equivalent
DAFF	Department of Agriculture, Fisheries and Forestry
DAWE	Department of Agriculture, Water and Energy
DCCEEW	Department of Climate Change, Energy, the Environment and Water
EPBC Act	Environment Protection and Biodiversity Conservation Act 1999
ERF	Emissions Reduction Fund
FullCAM	Full Carbon Accounting Model
GHG	Greenhouse Gas Emissions
GJ	Gigajoules
hr	hour
kg	Kilograms
kL	Kilolitre
km	Kilometre
kV	Kilovolts
LGA	Local Government Area
m	Metre
MNES	Matters of National Environmental Significance
MW	Megawatts
MWh	Megawatt hour
NEM	National Electricity Market
N_2O	Nitrous oxide
NGER	National Greenhouse and Energy Reporting
Q1	Quarter one of the calendar year (e.g. January to March)
QCTS	Queensland Climate Transition Strategy
QCAS	Queensland Climate Adaptation Strategy
RFI	Request for information
t	Tonnes
TJ	Terajoules
UNFCCC	United Nations Framework Convention on Climate Change
WTG	Wind turbine generators

Executive Summary

This greenhouse gas (GHG) assessment has been developed for the Tarong West Wind Farm (the Project) Public Environment Report (PER) that supports assessment of the Project under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act).

The Project will involve the construction and operation of a wind farm consisting of up to 97 wind turbine generators (WTGs) with an overall rated capacity of up to 436.5 megawatts (MW) of electricity to supply to the National Electricity Market (NEM).

This GHG assessment has been requested in accordance with the PER Guidelines for the Project. Specifically, the PER Guidelines requested an evaluation of Scope 1 and Scope 2 GHG contributions during the construction phase of the Project. Additionally, the PER Guidelines requires an estimate of the reduction in direct GHG emissions once the Project becomes operational, along with an estimation of the time required for the Project to displace its emissions.

This GHG assessment describes and estimates the Scope 1 GHG emissions anticipated from the construction of the Project. Wind farms do not generate significant GHG emissions during their operation because they rely on wind, a renewable energy resource, to produce electricity. It is not expected that Scope 1 and Scope 2 operation phase emissions would be significant and they have not been discussed further in this assessment.

Additionally, the assessment provides an estimate of the reduction in direct GHG emissions once the Project becomes operational and estimates the time required for the Project to displace the Scope 1 emissions generated during construction.

The emissions inventory for the construction of the Project for this assessment was populated based on information provided by Tarong West Project Co Pty Ltd (the Proponent). The two key sources of emissions during the Project's construction were identified as land clearing and fuel combustion from construction vehicles. The estimated GHG emissions from these two activities are presented in Table E.1.

Table E.1 Summary of GHG emissions associated with the Project's construction

Project activity	Scope	Total emissions (t CO_2-e)
Construction vehicles	1	33,866
Land clearing	1	249,499
	Total Scope 1	**283,365**

To determine the displacement period, the emissions intensity (kg/MWh) for both existing individual non-renewable energy sources and for the QLD grid as a whole was determined. The emissions avoided per year for each existing energy source was estimated assuming each energy source produced the same quantity of power as the Project (P50 of 1,309,990 MWh annually). Using the emissions avoided value (t CO_2-e per year) the displacement time in months was determined based on the estimated construction phase emissions (283,365 t CO_2-e) for the Project.

The PER Guidelines does not prescribe the manner in which displacement period is to be calculated. Therefore, this has been estimated considering a variety of existing individual non-renewable energy sources and for the QLD grid as a whole, including the contribution from renewable energy providers. Overall, the determination of displacement period using the emissions intensity for existing individual non-renewable energy sources is identified as the most relevant approach for addressing the PER Guidelines requirements.

Table E.2 shows the months required to displace Project construction emissions based on the individual power generators considered. Based on this approach the displacement period could be as fast as 3 months or as slow as 7 months (listed in Table E.2).

Table E.2 Months required to displace Project construction emissions based on existing individual power generators

Generator	Generator type	Fuel / technology type	2024-25 emissions intensity (kg/MWh)	Emissions avoided per annum (t CO2-e per year)	Approx. months for Project to displace emissions based on emissions intensity
Mt Stuart	OCGT	Liquid Fuel	1,002	1,311,608	3
Swanbank E Gas Turbine	CCGT	Gas	394	515,742	7
Millmerran	Steam Super Critical	Black Coal	825	1,079,917	4
Braemar	OCGT	Gas	617	807,647	5

Table notes:
OCGT = open cycle gas turbine
CCGT = combined cycle gas turbine
Source: AEMO - 2024 ISP Inputs and Assumptions Workbooks

To determine the reduction in GHG emissions once the Project is operational, the emissions which would be generated by other existing energy sources to produce the same quantity of power as the Project were calculated. Emissions were calculated for individual existing non-renewable power generators in QLD (refer Table E.2) and the QLD grid for the current year (2024) and future years (2028 to 2030).

The PER Guidelines do not prescribe the manner in which emissions reduction is to be calculated. Based on the range of emissions calculated for individual existing non-renewable power generators and the QLD grid as a whole, the annual emissions reduction could be as low as 471,236 t CO_2-e or as high as 1,311,608 t CO_2-e.

1.0 Introduction

This greenhouse gas (GHG) assessment has been developed for the Tarong West Wind Farm (the Project) Public Environment Report (PER) that supports assessment of the Project under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act).

The Project will involve the construction and operation of a wind farm consisting of up to 97 wind turbine generators (WTGs) with an overall rated capacity of up to 436.5 megawatts (MW) of electricity to supply to the National Electricity Market (NEM).

This GHG assessment has been requested in accordance with the PER Guidelines for the Project. Specifically, the PER Guidelines requested an evaluation of Scope 1 and Scope 2 GHG contributions during the construction phase of the Project. Additionally, the PER requires an estimate of the reduction in direct GHG emissions once the Project becomes operational, along with an estimation of the time required for the Project to displace its emissions.

Wind farms do not generate significant GHG emissions during their operation because they rely on wind, a renewable energy resource, to produce electricity. Furthermore, emissions generated from maintenance activities (e.g. routine inspections and occasional repairs) during the operation phase will be limited to emissions from fuel combustion in transport vehicles. Therefore, it is not expected that Scope 1 and Scope 2 operation phase emissions would be significant and, they have not been discussed further in this assessment.

Moreover, this technical report considers Scope 1 GHG emissions from the Project only, as no Scope 2 GHG emissions were identified for the construction of the Project.

1.1 Location

The Project site is located within the Wide Bay Burnett region, approximately 25 kilometres (km) west of Kingaroy, 85 km east of Chinchilla and 170 km northwest of Brisbane. The Project is wholly situated in the local government area (LGA) of South Burnett Regional Council.

The South Burnett region has a history of agricultural production. The region is dominated by rural land use and is characterised by numerous pastoral properties used for livestock production. South Burnett is also known for peanut production, timber production and viticulture, as well as coal mining and electricity generation.

1.2 Project timeline

The indicative Project schedule and delivery program is outlined in Table 1.

Construction is anticipated to take approximately 30 months, with commencement subject to project approvals and subsequent agreement between the contractor and Tarong West Project Co Pty Ltd (the Proponent).

The construction period will remain subject to change depending on factors such as component and materials availability, construction methodologies and weather conditions.

Table 1 Indicative Project schedule and delivery program

Milestone	Timing
Construction start	Q2 2025
Construction complete	Q4 2027
Commissioning	Q4 2027-Q1 2028
Commencement of use (Practical Completion)	Q2 2028

1.3 Infrastructure

The Project seeks to supply up to 436.5 megawatts (MW) of clean and renewable energy to the National Electricity Market (NEM). The Project contains up to 97 wind turbine generators and hardstands, and ancillary infrastructure potentially including (subject to detailed design):

- Site access and on-site access tracks, including widening sections of Ironpot Road
- One (1) site compounds
- Up to four (4) temporary laydown areas / stockpile areas
- Two (2) 33kV to 275kV substations
- One (1) switching station to connect to existing 275kV overhead powerlines
- Internal electrical reticulation consisting of overhead lines (OHL) and underground (UG) cabling
- One (1) permanent operations and maintenance facility including control centre, offices, workshop, warehouse, water tanks, septic systems and parking
- One (1) batch plants
- Washdown areas (as required to comply with site biosecurity)
- Up to three (3) borrow pits
- Three (3) permanent and four (4) temporary meteorological masts
- Helipad.

1.4 Limitations

AECOM provides this report for the express purpose of satisfying the requirements of the PER Guidelines for the Project. The information presented in this document is provided for this purpose only and is based on the best available information at the time of publication.

This report and the information herein is subject to the following limitations:

1. Estimates: The estimates provided in this report are based on the best available information at the time of publication, which may include assumptions and approximations. Due to the evolving nature of data and methodologies for GHG assessments, these estimates are subject to change, and actual carbon emissions may vary from the estimates provided. AECOM shall not be held liable for any discrepancies between the estimates presented herein and actual carbon emissions.
2. No Liability for Accuracy: While AECOM has made reasonable efforts to ensure the accuracy and reliability of the information contained in this technical note, we make no representations or warranties, whether express or implied, regarding the accuracy, completeness, or reliability of the input information used to develop emissions estimates.
3. Not Legal or Financial Advice: This report is not intended to provide legal or financial advice as it relates to GHG emissions. It is meant solely for informational purposes to support the response to the PER Guidelines for the Project.
4. Limitation of Liability: AECOM and its employees, agents, or representatives shall not be liable for any direct, indirect, incidental, consequential, or special damages arising out of or in connection with the use of this report, even if advised of the possibility of such damages.

2.0 Legislation, policy and guidelines

The following sections describe the international, Australian, Queensland (QLD), and local government legislation, policy and management frameworks applicable to the Project.

2.1 International

2.1.1 Greenhouse Gas Protocol

The Greenhouse Gas Protocol by the World Business Council for Sustainable Development and the World Resources Institute (Greenhouse Gas Protocol), provides guidance, standards, tools and training for government and businesses to measure and manage emissions and build effective programs to tackle climate change. The Greenhouse Gas Protocol establishes comprehensive global standardised frameworks for private and public sectors to measure and manage GHG emissions. It is a widely used international accounting tool for government and business leaders to understand, quantify and manage emissions.

2.1.2 ISO 14064-1:2018: Greenhouse Gases (ISO 14064-1)

ISO 14064-1 specifies principles and requirements at the organisational level for the quantification and reporting of GHG emissions and removals. ISO 14064-1 includes requirements for the design, development, management, reporting and verification of an organisation's GHG inventory.

2.2 Federal legislation and policy

2.2.1 Environment Protection and Biodiversity Conservation Act 1999

The EPBC Act provides a legal framework to protect and manage flora, fauna, ecological communities and heritage places that are Matters of National Environmental Significance (MNES).

GHG emissions and climate change are not matters regulated by the EPBC Act as MNES. However, GHG emissions may be considered where those emissions will have or are likely to have a significant impact on a protected matter. GHG emissions are both direct and indirect consequences of the Project and have been presented for assessment of the referral.

2.2.2 National Greenhouse and Energy Reporting Act 2007

The NGER Act introduces a single national framework for reporting and disseminating company information about GHG emissions, energy production, and energy consumption.

The NGER Act requires individuals or corporations who exceed certain GHG emission thresholds publicly report their GHG emissions, energy consumption and energy production each financial year.

The current GHG reporting thresholds for corporations are as follows:

- emission of more than 50,000 tonnes (t) of carbon dioxide equivalent (CO_2-e)
- production of 200 terajoules (TJ) or more of energy, or
- consumption of more than 200 TJ of energy.

2.2.3 National Greenhouse and Energy Reporting (Measurement) Determination 2008

The National Greenhouse and Energy Reporting (Measurement) Determination 2008 (NGER (Measurement) Determination) provides methods, criteria and measurement standards for calculating GHG emissions and energy data under the NGER Act. It covers Scope 1 and Scope 2 emissions and energy production and consumption.

The NGER (Measurement) Determination is updated annually to reflect improvements in emission estimation methods and changes made in response to industry feedback.

The version of NGER (Measurement) Determination as issued 30 June 2024 (Compilation No. 17) has been used to develop the GHG inventory for the Project.

2.2.4 National Greenhouse Accounts Factors (2024)

The National Greenhouse Accounts Factors (NGA Factors) (2024) (DCCEEW, 2024a) are designed for use by companies and individuals to estimate GHG emissions.

The NGA Factors are not published for the purposes of reporting under the NGER Act. While drawing on the NGER (Measurement) Determination, the methods described in the NGA Factors have a general application to the estimation of a broader range of GHG emissions inventories.

Where relevant, the GHG emissions in this inventory have been estimated in accordance with the emission factors provided in this instrument.

2.2.5 Emissions Reduction Fund

To meet its targets set under the Kyoto Protocol and Paris Agreement, the Department of Agriculture, Water and Energy (DAWE) (now, Department of Agriculture, Fisheries and Forestry (DAFF)) commissioned the Emissions Reduction Fund (ERF). The ERF is a voluntary scheme which provides incentives for Australian businesses, farmers, land holders and citizens to reduce their GHG emissions by adoption of more efficient practices and technologies.

Key elements of the ERF are as follows:

- crediting emissions reductions that go beyond business as usual standards
- selling emission reductions in the form of Australian Carbon Credit Units
- a Safeguard Mechanism, which provides a framework for Australia’s largest emitters to measure, report and manage emissions.

2.3 State Government

2.3.1 Greenhouse gas policy

The Queensland Government has set a State target to reach zero net emissions by 2050, in addition to an interim target aligned with the Australian Government’s target for GHG emission reductions by 2030.

The Queensland Government has prepared two key strategies in response to climate change:

- Queensland Climate Transition Strategy (QCTS)
- Queensland Climate Adaptation Strategy (QCAS).

The QCTS outlines how QLD will transition to a zero net emissions future that supports jobs, industries, communities and the environment.

The QCAS outlines how QLD will prepare for current and future impacts of a changing climate in a manner that reduces risk and increases resilience. The QCAS aims to address the impacts of climate change and build an innovative and resilient QLD by understanding risks, providing information, integrating climate adaptation into policy and collaborating with stakeholders.

2.3.2 Environmental legislation

The Project will be developed and operated in accordance with the *Planning Act 2017*. Activities with the potential to cause environmental harm must not contravene the *Environmental Protection Act 1994*.

2.4 Local government

The Project is located wholly within the South Burnett Regional Council LGA. Development within this council area is regulated by the South Burnett Regional Council Planning Scheme 2017. However, wind farm development cannot be made assessable development by a LGA planning scheme.

This planning scheme does not provide guidance with respect to the development of GHG emission assessments and therefore this planning scheme has not been considered further.

3.0 Methodology

3.1 Overview

The six GHGs that are required to be reported under the NGER Act and are most commonly included in GHG assessments are the following compounds and groups of compounds:

- carbon dioxide (CO_2)
- methane (CH_4)
- nitrous oxide (N_2O)
- specified hydrofluorocarbons (HFCs)
- specified perfluorocarbons (PFCs)
- sulfur hexafluoride (SF_6).

GHG emissions are generally reported in terms of carbon dioxide equivalent (CO_2-e). This is to provide a standardised unit for reporting due to different gases having varying effects on global warming impacts, known as global warming potential (GWP). The GWP refers to the GHG's potential to trap heat in the atmosphere for a certain period (generally 100 years), relative to CO_2 (which has a GWP of one). CH_4 has a GWP of 28, which means for every tonne of CH_4 emitted, it has the same global warming effect of 28 tonnes of CO_2. As a result, GHGs such as CH_4 and N_2O have a higher potential to affect global warming.

Table 2 presents the GWP of the key GHG that will be emitted by the Project.

Table 2 GWP of Key GHGs

Gas	Chemical formula	GWP
Carbon dioxide	CO_2	1
Methane	CH_4	28
Nitrous oxide	N_2O	265

3.2 Assessment scenario

3.2.1 Project GHG emissions

The Project PER Guidelines requested that Scope 1 and Scope 2 GHG contributions from the construction phase of the Project are estimated. As the PER Guidelines are specific to the Project, Scope 1 and Scope 2 emissions have been determined in respect to the Project only, rather than at corporate emissions reporting level. Based on the content requirements stated in the PER Guidelines in respect to GHG emissions, this approach is considered appropriate.

It is not expected that Scope 1 and Scope 2 operation phase emissions would be significant, therefore, they have not been discussed further in this assessment. Wind farms do not generate significant GHG emissions during their operation because they rely on wind, a renewable energy resource, to produce electricity. Furthermore, emissions generated from maintenance activities (e.g. routine inspections and occasional repairs) during the operation phase will be limited to emissions from fuel combustion in transport vehicles. The magnitude of emissions from this source will not be significant.

Additionally, the PER Guidelines requested an estimate of the reduction in direct GHG emissions once the Project becomes operational, along with an estimation of the time required for the Project to displace its emissions.

Scope 3 emissions, such as but not limited to embodied impacts of materials, combustion emissions from transport of construction materials and breakdown of waste, have been excluded from this assessment. An assessment of Scope 3 emissions was not requested by the PER Guidelines.

To identify Scope 1 and Scope 2 emissions, a request for information (RFI) was provided to the Proponent, requesting plant and equipment types and quantities required for each construction works

activity, forecast power generation required for the Project's construction, intended method for generating power and land clearing details. Information provided by the Proponent identified any power required for the construction of the Project would be generated by diesel generators, therefore, there would be no grid power required and subsequently no Scope 2 emissions associated with the Project construction. The information provided by the Proponent was utilised as to form the basis of the GHG emissions inventory.

The Scope 1 emission sources for the Project which have been considered in the GHG inventory are summarised as follows:

- diesel fuel combustion for transport energy (construction plant and equipment)
- diesel fuel combustion for stationary energy (to provide power for the site office and temporary concrete batch plants)
- vegetation clearing.

3.2.2 Project energy generation

Project energy generation will vary depending on site specific factors including wind conditions. To estimate GHG emissions reduction as a result of Project operation, this assessment has considered the forecast 50th percentile (P50) for energy generation from the Project when all 97 WTGs are operational. The P50 generation forecast for the Project once fully operational is forecast by the Proponent to be 1,308,990 MWh annually. The P50 generation forecast has been adopted as it provides a moderate estimate of energy production, representing a balance between high and low expectations. Therefore, it is considered appropriate for the purposes of estimating energy displacement time.

To determine emissions reduction, emissions from existing energy producers in QLD were estimated assuming generation of the same amount of power as the Project (1,308,990 MWh annually).

3.3 Emissions calculations

3.3.1 NGER (Measurement) Determination emission factors

The NGER (Measurement) Determination GHG emission factors considered for Scope 1 emission sources for the Project are presented in Table 3.

Table 3 Emissions factors for Scope 1 GHG emission sources

Scope of emissions	Emission source	Energy content factor	GHG emission factor				Emission factor units
			CO_2	CH_4	N_2O	Total	
1	Diesel use	38.6 GJ/kL	69.90	0.01	0.50	70.41	kg CO_2-e/GJ

3.3.2 Emission calculations for vegetation clearing

GHG emissions from land clearing have been calculated using the Full Carbon Accounting Model (FullCAM). FullCAM is a fully integrated Carbon Accounting Model for estimating and predicting all biomass, litter and soil carbon pools in forest and agricultural systems and accounts for changes in major GHGs and human-induced land use practices (DCCEEW, 2024b). FullCAM is the model used to construct Australia's national GHG emissions account for the land sector and is appropriate for the assessment of emissions from land clearing for the Project.

Due to the extent of areas for which land clearing was required, the FullCAM model was configured as "unclassified native vegetation". The model was configured over a period of 100 years, vegetation age set to 1000 years old prior to the simulation beginning. Vegetation growth was modelled as "natural regeneration".

FullCAM default settings were used as required, including for "Site", "Trees" and "Soils" categories. No fires, vegetation disturbances or vegetation management events (e.g. thinning, etc) were simulated to provide a conservative estimate of GHG emissions stored that would be released upon clearing.

3.4 Emission inventory inputs and assumptions

3.4.1 Construction

The construction works activity, duration and plant or equipment numbers and utilisation (active proportion of total construction hours) information relied upon in this report has been provided by the Proponent. Forecasting construction activity accurately is difficult. However, to provide a realistic and accurate estimate, inputs used have been developed with consideration of the expected plant requirements, duration and utilisation for the construction of the Project. To develop these inputs, construction information available for another wind farm has been considered. The reference wind farm has in the order of 200 WTGs in its design and is larger than the Project in respect to construction requirements. However, it provides an appropriate basis for estimating construction activities and equipment requirements for the purpose of this assessment.

The construction timeline and total working hours for each works activity required for the construction phase were provided by the Proponent for the Project. The total construction program (start to finish) duration is expected to be 30 months (130 weeks).

The construction activity information used for the assessment is considered the best available estimate for the purpose of estimating GHG emissions for the Project.

GHG emissions were estimated based on total derived working hours for each plant or equipment item and estimated diesel fuel consumption rates obtained from technical literature.

A summary of total derived working hours for each construction works activity is presented in Table 4.

A summary of inputs used to calculate GHG emissions for each type of plant is presented in Table 5. Hourly diesel fuel consumption rates used to estimate GHG emissions were sourced from the CAT Performance Handbook 2022 (CAT Handbook) and Transport Authorities Greenhouse Group Greenhouse Gas Assessment Workbook for Road Projects 2013 (and are referenced in Table 5).

The CAT Handbook provides fuel consumption information for various equipment models, including three fuel consumption rates; low, medium and high. For this assessment, the high fuel consumption rate was selected for each piece of equipment listed in the handbook, unless a high rate was not available. In such cases, the next highest rate (i.e., medium fuel consumption) was used. When selecting equipment models for the emissions inventory, both the suitability of the model for the construction activity and the most conservative fuel consumption rate were considered. In most cases, the equipment with the highest fuel consumption rate was chosen. However, if this equipment item did not reflect the intended construction purpose (e.g. a model designed for agricultural use), the next most conservative and appropriate option was selected.

Table 4 Total derived working hours for the construction phase

Works activity	Works duration (months)	Works duration (weeks)	Working days/week	Working days total	Working hours/day	Total derived working hours
Land clearing	5	21.5	6	129	9.5	**1,226**
Rehabilitation	5	21.5	6	129	9.5	**1,226**
Material crushing	9	40	6	240	9.5	**2,280**
Foundation pours	9	40	6	240	9.5	**2,280**
Civil works	27	117	6	702	9.5	**6,669**
Office	30	130	6	780	9.5	**7,410**

Table 5 Inputs used in the construction phase GHG emissions inventory calculations (Scope 1)

Works activity	Equipment	Number required	Utilisation % of total hours from Table 4	Total hours (per item of equipment)	Total hours	Diesel usage rate	Diesel usage rate ref.	Diesel fuel used	Energy content
			percentage	*hours*	*hours*	*L/hr*		*kL*	*GJ*
Land clearing	Dozer	1	75	919	919	40.3	CAT (2022)	37	1,429
	Grader	1	75	919	919	18.2	CAT (2022)	17	646
Rehabilitation	Excavator	1	50	613	613	10.2	CAT (2022)	6	242
	Grader	1	50	613	613	18.2	CAT (2022)	11	431
Material crushing	Impactor	2	75	1,710	3,420	36.0	Klanfar (2016)	123	4,752
	Loader	2	75	1,710	3,420	80.1	CAT (2022)	274	10,574
	Excavator	2	75	1,710	3,420	10.2	CAT (2022)	35	1,349
Foundation pours	Crane Franna 20t	1	75	1,710	1,710	44.8	W4RP (2013)	77	2,957
	Crane (all terrain) 100t	1	75	1,710	1,710	44.8	W4RP (2013)	77	2,957
	Batch plant	1	75	1,710	1,710	24.1	W4RP (2013)	41	1,591
	Loader	2	75	1,710	3,420	80.1	CAT (2022)	274	10,574
	Agitator trucks	12	75	1,710	20,520	44.8	W4RP (2013)	919	35,485
	Utility	4	75	1,710	6,840	1.1	W4RP (2013)	7	286
	Concrete boom pump 36m	2	75	1,710	3,420	44.8	W4RP (2013)	153	5,914
Civil works	Grader	4	100	6,669	26,676	18.2	CAT (2022)	486	18,748
	Roller	6	100	6,669	40,014	9.0	CAT (2022)	360	13,915
	Water Cart	8	100	6,669	53,352	17.4	Ezyquip (n.d.)	928	35,833
	Excavator > 20t	4	100	6,669	26,676	21.8	CAT (2022)	583	22,490
	Excavator < 20t	4	80	5,335	21,341	10.2	CAT (2022)	218	8,419
	Articulated dump tuck 40t	4	100	6,669	26,676	36.1	CAT (2022)	963	37,185
	Loader / backhoe	1	100	6,669	6,669	8.3	CAT (2022)	56	2,144
	Positrack	2	100	6,669	13,338	12.5	CAT (2022)	167	6,431
	Tractor	1	75	5,002	5,002	43.0	CAT (2022)	215	8,302

Works activity	Equipment	Number required	Utilisation % of total hours from Table 4	Total hours (per item of equipment)	Total hours	Diesel usage rate	Diesel usage rate ref.	Diesel fuel used	Energy content
			percentage	*hours*	*hours*	*L/hr*		*kL*	*GJ*
	Construction telehandler	1	100	6,669	6,669	411.8	CAT (2022)	2,746	106,001
	Utilities	18	100	6,669	120,042	1.1	W4RP (2013)	130	5,020
	Light trucks	4	100	6,669	26,676	22.4	CAT (2022)	598	23,065
	Side tippers (internal haulage)	8	75	5,002	40,014	36.1	CAT (2022)	1,445	55,778
	Side tippers (importing gravel)	8	75	5,002	40,014	36.1	CAT (2022)	1,445	55,778
Office	Diesel generator 140kva	1	100	7,410	7,410	10.3	W4RP (2013)	77	2,956
							Totals	12,468	481,253

Table notes:
CAT (2022): CAT Performance Handbook 2022
W4RP (2013): Greenhouse Gas Assessment Workbook for Road Projects
Ezyquip (n.d): Ezyquip Hire FVZ 260-300 Water Truck
Klanfar (2016): Klanfar et al. Fuel consumption and engine load factors of equipment in quarrying of crushed stone

3.4.2 Vegetation clearing

Clearing requirements for Project infrastructure were provided by the Proponent. Based on the number of WTGs, ancillary infrastructure, hardstands, turbine foundations and access tracks, the maximum land clearing requirement is 872 hectares (ha). A representative centre point (latitude and longitude coordinates, refer Table 6) at the Project site was chosen for which the total carbon content mass value was downloaded using FullCAM. Total carbon content mass is a value in FullCAM used to define a site's total below-ground and above-ground carbon mass. The total carbon content mass output by FullCAM is determined based on the programs database information for climatic, geophysical and vegetation community conditions.

For the purpose of estimating emissions from vegetation clearing it is assumed that all carbon is released as CO_2.

CO_2 emissions from vegetation clearing have been determined by multiplying carbon content by a factor of 3.67, which is the ratio of the atomic mass of a CO_2 molecule to the atomic mass of a carbon atom.

Table 6 Vegetation clearing inputs and assumptions

Centre coordinate		Land clearing required (ha)
Latitude	Longitude	
-26.609791	151.521534	872

4.0 GHG emissions inventory

The estimated GHG emissions from activities associated with the Project are summarised in Table 7. Table 7 shows that the total Scope 1 emissions generated by the construction phase of the Project are estimated to be **283,365 t CO_2-e**. This emissions quantity is over the life of the construction phase which is anticipated to occur over approximately 30 months.

No Scope 2 emissions were identified during the construction phase of the Project. Scope 3 emissions have not been considered as assessment of these emissions were not required under the PER Guidelines.

Table 7 Summary of GHG emissions associated with the Project's construction

Project activity	Scope	Total emissions (t CO_2-e)
Construction vehicles	1	33,866
Land clearing	1	249,499
	Total Scope 1	**283,365**

5.0 GHG displacement and reduction

The Project PER Guidelines requested an estimate of the reduction in direct GHG emissions once the Project becomes operational, along with an estimation of the time required for the Project to displace its emissions. This section addresses these requirements, however, the following items are noted:

- Once operating, the Project will serve as an energy generator for the QLD grid. The Project will not be the sole replacement for any one existing energy generator but will form part of the supply network.
- Displacement time has been estimated based on power generation achieved by the Project as though all turbines become fully operational at the same time. In reality, the Project WTGs will be commissioned in groups, which will result in a staggered increase in power generation as more WTGs are commissioned and operating. The construction emissions will also be staggered in practice. This staggering has not been included for simplicity and as it is not deemed to materially impact the outcome of the assessment.
- Displacement time has been estimated based on the Projects Scope 1 emissions from construction phase only, as no Scope 2 emissions were identified during construction and Scope 3 was not requested by the PER Guidelines. Operational emissions from Scope 1 and Scope 2 sources have not been considered as these are expected to be negligible.

5.1 Displacement time

To determine the displacement period, the following was undertaken:

- The emissions intensity (kg/MWh) for both existing individual non-renewable energy sources and for the QLD grid as a whole was determined.
- The emissions avoided per year (t CO_2-e per year) for each existing energy source (including the grid as a whole) was determined assuming each energy source produced the same quantity of power as the Project (P50 of 1,308,990 MWh annually).
- Using the emissions avoidance value (t CO_2-e per year) the displacement time in months was determined based on the estimated construction phase emissions (283,365 t CO_2-e) for the Project.
- Displacement time was estimated considering a selection of individual power generators and the QLD energy grid as a whole, for current and future years.

The approximate displacement time based on the emissions intensity for four individual existing power generators in QLD is presented in Table 8. The AEMO 2024 'ISP Inputs and Assumptions Workbooks' provides data on Australia's existing energy generators. This data revealed that four types of non-renewable generators were existing in QLD. One generator from each type of non-renewable energy source was selected to represent the different combinations of power generation technology and fuel type. Table 8 shows that the emissions intensity (kg/MWh) is different for each of the four energy technology options evaluated which influences the displacement period.

Table 8 Months required to displace Project construction emissions based on existing individual power generators

Generator	Generator type	Fuel / technology type	2024-25 emissions intensity (kg/MWh)	Emissions avoided per annum (t CO2-e per year)	Approx. months for Project to displace emissions based on emissions intensity
Mt Stuart	OCGT	Liquid Fuel	1,002	1,311,608	3
Swanbank E Gas Turbine	CCGT	Gas	394	515,742	7
Millmerran	Steam Super Critical	Black Coal	825	1,079,917	4
Braemar	OCGT	Gas	617	807,647	5

Table notes:
OCGT = open cycle gas turbine

Generator	Generator type	Fuel / technology type	2024-25 emissions intensity (kg/MWh)	Emissions avoided per annum (t CO2-e per year)	Approx. months for Project to displace emissions based on emissions intensity
CCGT = combined cycle gas turbine Source: AEMO - 2024 ISP Inputs and Assumptions Workbooks					

The emissions intensity for the QLD grid based on current (2024) emissions intensity and approximate displacement time for the QLD grid based future (2028 to 2030) emissions intensity is presented in Table 9.

The NGER (Measurement) Determination presents a GHG emissions factor for energy generation for the QLD grid for the current year. DCCEEW (2023) 'Australia's emissions projections' provides forecasted emission factors for energy generation for the QLD grid for future years. These emission factors were utilised to estimate the displacement period considering the emissions intensity of the QLD energy grid as a whole.

The indicative Project schedule anticipates practical completion and commencement of use by Q2 2028. However, as the commissioning of turbines will likely occur in groups, and as the Project timeline may be influenced by several variables, the forecast QLD grid emissions intensity has been considered for the years 2028, 2029 and 2030. As QLD develops more green energy sources, the emissions intensity of the grid is expected to decrease. The emission factors for 2024 (current) and 2028 to 2030 are presented in Table 9.

Table 9 Months required for Project to displace emissions based on current and forecast future QLD grid emissions intensity

Year	Generator type	Emissions intensity (kg/MWh)	Emissions avoided per annum (t CO2-e per year)	Approx. months for Project to displace emissions based on emissions intensity
Current				
2024	QLD grid	710	Not applicable, only presented to show current emissions intensity	
Projected				
2028	QLD grid	460	602,135	6
2029		420	549,776	7
2030		360	471,236	8
Sources: Current emission factors: NGER (Measurement) Determination 2008 Projected emission factors: DCCEEW 2023 'Australia's emissions projections'				

Based on the emissions intensity for individual non-renewable energy generators (refer Table 8), it is estimated that the emissions associated with the construction of the Project could be displaced in approximately 3 to 7 months.

This assumes that the energy generated by the WTGs directly displaces the supply from a single fossil-fuel generator which is in operation. This is a simplified analysis and does not account for specific operational conditions, such as periods when individual generators are not running or when additional generation is required to supplement demand during unfavourable wind condition.

Considering the forecast emissions intensity for 2028 to 2030, when the Project is likely to be operating, Table 9 shows that the displacement period is estimated to be between approximately 6 to 8 months when considering the aggregate intensity of emissions for the entire QLD grid.

The emission factors from DCCEEW (2023) for 2028 to 2030 are projections based on modelled assumptions and forecasts in relation to future energy generation and therefore may not represent the ultimate emissions intensity in those years. However, they are considered the best available estimation of likely future emissions intensity.

According to DCCEEW (2023), the emission intensity projections include “policies, transmission upgrades, and new or expanding projects as publicly announced”. Therefore, the Project’s impact on future QLD grid emissions intensity may already be included in the 2028 to 2030 figures presented in Table 9. Moreover, these projections also account for renewable energy in the system. On this basis, the displacement period for the existing fossil fuel generators is identified as the most relevant consideration for addressing the PER Guidelines requirements.

The PER Guidelines does not prescribe the manner in which displacement are to be calculated. Therefore, this has been estimated using a variety of methods. Based on these methods the displacement period could be as fast as 3 months or as slow as 7 months when displacing fossil fuel sources (listed in Table 8) and if the full scale of the Project is completed prior to 2030.

Although the PER Guidelines did not require the inclusion of Scope 3 emissions or operational emissions in this assessment, a study by Wiser et al. (2011) estimated the median energy payback time for wind power plants to be 5.4 months, which aligns with the findings of this assessment. The Wiser et al. (2011) study compiled 50 estimates from 20 studies that met quality and relevance criteria, and it examined the energy payback time for wind power plants, factoring in the energy required for construction, operation, and decommissioning.

5.2 Emissions reduction

To determine the reduction in GHG emissions once the Project is operational, the emissions which would be generated by other existing energy sources to produce the same quantity of power as the Project were calculated.

The emissions reduction per annum (t CO_2-e per year) based on individual existing non-renewable power generators in QLD and the QLD grid for current (2024) and future (2028 to 2030) years is presented in Table 10.

Table 10 Annual emissions reduction for each alternative energy source generating equivalent power to the Project

Generator	Emissions intensity (kg/MWh)	Project annual power generation (P50) (MWh)	Equivalent emissions reduction per annum (t CO_2-e)
Mt Stuart OCGT	1,002	1,308,990	1,311,608
Swanbank E Gas Turbine CCGT	394		515,742
Millmerran Steam Super Critical	825		1,079,917
Braemar OCGT	617		807,647
QLD Grid 2024	710		929,383
QLD Grid 2028	460		602,135
QLD Grid 2029	420		549,776
QLD Grid 2030	360		471,236

Table note:
* 2024-25 emissions intensity

Table 10 shows the following:

- Based on the emissions intensity for the four selected individual existing power generators in QLD (AEMO, 2024) the annual emissions reduction would be in the order of approximately 515,712 to 1,311,124 t CO2-e per annum.
- Based on the current year (2024) emissions intensity provided by NGER (Measurement) Determination, the estimation annual emissions reduction would be in the order of approximately 929,383 t CO2-e.

- Based on the future QLD grid emission intensity forecast provided by DCCEEW (2023) for 2028, 2029 and 2030, the annual emissions reduction would be in the order of approximately 471,236 to 602,134 t CO2-e.

According to DCCEEW (2023), the emission intensity projections include “policies, transmission upgrades, and new or expanding projects as publicly announced”. Therefore, the Project’s impact on future QLD grid emissions intensity may already be included in the 2028 to 2030 figures presented in Table 10. However, this is uncertain, and therefore the estimated annual emissions reduction for these years have been provided for completeness.

The PER Guidelines do not prescribe the manner in which reduction estimates are to be calculated. Therefore, this has been estimated using a variety of methods. Based on these methods the annual emissions reduction could be as low as 471,236 t CO_2-e or as high as 1,311,608 t CO_2-e based on the stated assumptions herein.

6.0 Conclusion

This assessment has estimated the GHG emissions anticipated during the construction of the Project. Scope 1 GHG emissions have been estimated to be 283,365 t CO2-e for the construction phase. No Scope 2 GHG emissions were identified for the construction phase. Scope 1 and Scope 2 GHG emissions for the operation phase were not investigated as they are expected to be negligible.

Additionally, the assessment has estimated the time required for the Project to displace these construction emissions based on existing energy sources in QLD and the QLD energy grid as a whole. Based on the analysis, the displacement period could be as fast as 3 months or as slow as 7 months when displacing fossil fuel sources and assuming the full scale of the Project is completed prior to 2030.

The assessment has also estimated the GHG emissions reduction which may be achieved once the Project is operational. Based on the analysis undertaken, the annual emissions reduction could be as low as 471,236 t CO_2-e or as high as 1,311,608 t CO_2-e, based on P50 energy generation.

7.0 References

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