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Project Name

AGL Wholesale Gas Limited

Greenhouse Gas Emissions Assessment (including Climate Change)

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Document history and status

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1	17/07/2018	Final	M. Hall	M. Davies	S. Ada
2	15/08/2018	Revision to GHG Scenarios	M. Hall	M. Davies	S. Ada
3	27/08/2018	Minor revisions	M. Hall	M. Davies	S. Ada

Contents

Glossary and Abbreviations

Abbreviation	Term	Definition
AGL	AGL Wholesale Gas Limited	The Project proponent
CO_{2-e}	Equivalent carbon dioxide emissions	Incorporates CO_2 as well as other GHG gases, converted to CO_2 equivalency using respective global warming potentials.
CO_2	Carbon dioxide	GHG gas
CH_4	Methane	GHG gas
DoEE	Department of Environment and Energy (Commonwealth)	
DWT	Dead weight tonnage	The carrying capacity of a carrier, including cargo, fuel, ballast passengers, etc.
EPA	Environmental Protection Agency	Refers to the Victorian Environmental Protection Agency
ERF	Emissions Reduction Fund	Scheme that provides incentives for a range of organisations and individuals to adopt new practices and technologies to reduce their emissions
GHG	Greenhouse gas	Any of the atmospheric gases that contribute to the greenhouse effect by absorbing infrared radiation produced by solar warming of the Earth's surface.
FSRU	Floating Storage and Regasification Unit	Facility used for the vaporisation and pressurisation of natural gas
HFCs	Hydrofluorocarbons	GHG gas
LNG	Liquefied natural gas	LNG is natural gas (predominantly methane, CH_4, with some mixture of ethane C_2H_6) that has been converted to liquid form by chilling for ease of storage or transport
N_2O	Nitrous oxide	GHG gas
NGER	National Greenhouse and Energy Reporting Act	National framework for reporting and dissemination of information related to GHG emissions, GHG projects, energy production and energy consumption.
PEM	Protocol for Environmental Management	Greenhouse gas emissions and energy efficiency in industry (2002) - an incorporated document of SEPP AQM
PFCs	Perfluorocarbons	GHG gas
SEPP AQM	State Environment Protection Policy (Air Quality Management (SEPP (AQM)) 2001	State Government of Victoria policy for management of air quality (emission sources and ambient air).
SF_6	Sulphur hexafluoride	GHG gas

Executive Summary

AGL Wholesale Gas Limited (AGL) is proposing to develop a Liquefied Natural Gas (LNG) import facility, utilising a Floating Storage and Regasification Unit (FSRU) to be located at Crib Point on Victoria's Mornington Peninsula. The project, known as the "AGL Gas Import Jetty Project" (the Project), comprises:

- The continuous mooring of a FSRU at the existing Crib Point Jetty, which will receive LNG carriers of approximately 300 m in length
- The construction of ancillary topside jetty infrastructure (Jetty Infrastructure), including high pressure gas unloading arms and a high pressure gas flowline mounted to the jetty and connecting to a flange on the landside component to allow connection to the Crib Point Pakenham Pipeline Project.

There are several other activities that are related to the Project. These include the Jetty Upgrade and the Crib Point Pakenham Pipeline Project (Pipeline Project) which are the subject of separate assessment and approval processes carried out by separate entities.

This report presents the methodologies and greenhouse gas (GHG) emission estimates associated with the implementation of the Project. The assessment has been prepared to support:

- A referral under the Victorian Environment Effects Act 1978
- Identification of requirements for approvals under the Victorian Environment Protection Act 1970
- Identification of the requirements of the *State Environment Protection Policy (Air Quality Management) 2001* (SEPP (AQM)) and the requirements of *the Protocol for Environmental Management – Greenhouse gas emissions and energy efficiency in industry 2002* (PEM).

This report addresses the potential direct and indirect impacts of the Project, through its assessment of direct and indirect GHG emissions in accordance with the SEPP AQM and the PEM. This report should be read in conjunction with the Cumulative Impact Assessment (AECOM, 2018), which provides an assessment of the potential cumulative GHG emissions of the Project together with the Pipeline Project.

The key GHG emissions for the FSRU facility are related to the consumption of natural gas by four reciprocating engines on board the FSRU as well as the disposal of excess boil-off gas. These engines will provide all power for the facility, i.e. general utility power, as well as for gas processing equipment to enable the vaporization and pressurization of the gas before it is delivered to the gas transmission pipeline. At times when the engines are idle, excess boil-off gas is disposed of at the combustor. Other GHG emission sources associated with the FSRU facility are the supply and delivery of LNG (consumed on board the FSRU), fugitive emissions (potential leaks), and the disposal (by others, off site) of waste streams.

Emissions were calculated based on the following three FSRU operating scenarios for the Project:

- **Scenario A:** no gas send-out during the year with all boil-off gas burnt at the combustor
- **Scenario B:** continuous year-round operation of the FSRU at an average of 382mmscfd high pressure gas send-out requiring 40 LNG carrier deliveries
- **Scenario C:** FSRU operating for 51% of the year at a maximum capacity of 750mmscfd (three processing trains) gas send-out requiring 40 LNG carrier deliveries

For Scenario B, the FSRU operates continuously and approximately half of the boil-off gas generated is used as fuel. The excess boil-off gas is slip-streamed into the gas export flow for delivery to the pipeline.

Under Scenario C, the FSRU would be operating for approximately half of the year only, at maximum rate of 750mmscfd. The annual average send out rate is 380 mmscfd, similar to that of Scenario B. During the downtime, the excess boil-off gas cannot be slip-streamed into the gas export flow and is instead burned at the combustor.

A summary of the calculated (Scope 1) direct emissions from sources that are owned or operated and (Scope 3) indirect emissions (other than Scope 2 emissions) are summarised in Table E.1. There is no planned electricity to be imported for the Project, so there are no anticipated Scope 2 – indirect emissions. There may be instances when electricity is required but this would not result in any material Scope 2 emissions.

Table E.1 : Total GHG emissions associated with FSRU operation

Parameter	Units	Scenario A	Scenario B	Scenario C
Energy related:				
Scope 1 GHG emissions	t $CO_{2\text{-}e}$/yr	104,486	49,366	88,224
Scope 3 GHG emissions	t $CO_{2\text{-}e}$/yr	13,286	6,231	11,184
Total GHG emissions – energy related	t $CO_{2\text{-}e}$/yr	117,772	55,596	99,408
Non-energy related:				
Scope 1 GHG emissions	t $CO_{2\text{-}e}$/yr	2,500		
Scope 3 GHG emissions	t $CO_{2\text{-}e}$/yr	47		
Total GHG emissions – non-energy related	t $CO_{2\text{-}e}$/yr	2,547		
Total GHG emissions – Project related	**t $CO_{2\text{-}e}$/yr**	**120,319**	**58,143**	**101,955**

The estimated total annual GHG emissions associated with the FSRU's operation are less than the 200,000 t $CO_{2\text{-}e}$ per annum trigger for a referral under the *Environment Effects Act 1978* as set out in the *Ministerial Guidelines for Assessment of Environment Effects under the Environment Effects Act 1978*.

This report also responds to the requirement of the *Climate Change Act 2017*, by providing an assessment of the potential impacts of climate change on the Project. Climate change projections to 2030 were used to estimate climate impacts for example any impact from projected sea level rise using information supplied by the Victorian Department for Environment, Land, Water and Planning (DELWP) 'Climate Ready Victoria' website. The assessment determined that sea level is predicted to rise by 0.1 m by 2030, with an increase in sea surface temperature of 0.5 deg. C. Climate change risks and proposed adaptation measures are presented in Table 6.3.

1. Introduction

1.1 Project Overview

AGL Wholesale Gas Limited (AGL) is proposing to develop a Liquefied Natural Gas (LNG) import facility, utilising a Floating Storage and Regasification Unit (FSRU) to be located at Crib Point on Victoria's Mornington Peninsula. The project, known as the "AGL Gas Import Jetty Project" (the Project), comprises:

- The continuous mooring of a FSRU at the existing Crib Point Jetty, which will receive LNG carriers of approximately 300 m in length
- The construction of ancillary topside jetty infrastructure (Jetty Infrastructure), including high pressure gas unloading arms and a high pressure gas flowline mounted to the jetty and connecting to a flange on the landside component to allow connection to the Crib Point Pakenham Pipeline Project.

There are several other activities that are related to the Project. These include the Jetty Upgrade and the Crib Point Pakenham Pipeline Project (Pipeline Project) which are the subject of separate assessment and approval processes carried out by separate entities.

1.2 Purpose of this Report

Jacobs Group (Australia) Pty Ltd (Jacobs) was engaged by AGL to prepare this assessment of the greenhouse gas emission impacts resulting from the Project. This report has been prepared to support:

- A referral under the Victorian *Environment Effects Act 1978*
- Identification of requirements for approvals under the Victorian *Environment Protection Act 1970*
- Identification of the requirements of the *State Environment Protection Policy (Air Quality Management) 2001* (SEPP (AQM)) and the requirements of the *Protocol for Environmental Management – Greenhouse gas emissions and energy efficiency in industry 2002* (PEM).

The Project will require energy during operation and construction. The assessment aims to provide the necessary assessment and discussion of:

- Commonwealth and State government frameworks and responses to the management of greenhouse gases
- Expected energy and non-energy related greenhouse gas emissions from the Project, including study boundaries, calculations methodologies and activity data
- Demonstration of compliance with the requisite regulatory requirements
- Implementation of 'best practice' and eco-efficient practices with respect to GHG emissions and energy consumption.

1.3 Study Area

Whilst the study is focussed on the energy use relating to the operation of the Project, the study boundary includes emissions associated with the supply and transport of LNG, as well as other indirect emissions such as fugitive emissions. A review of "Best Practice" with respect to emissions and intensity is also provided.

1.4 Project Description

The FSRU has been described in summary form below.

Delivered LNG will be procured from a range of suppliers in Asia Pacific and globally. The composition and properties of the LNG will vary depending on the source. LNG will be transferred from the LNG carrier to the FSRU by flexible hoses between the vessels, at a combined rate expected to be in the order of 8,000 to

11,000m3/hr. LNG will be pressurised and then vaporised in a regasification system on board the FSRU to deliver high pressure gas to the jetty via high pressure gas unloading arms.

The FSRU vessel will be continuously moored to receive LNG cargoes from visiting LNG carriers, store the LNG and regasify it as required to meet demand for high pressure pipeline gas.

The regasification system will be capable of delivering 500 mmscfd of “firm” gas at high reliability and up to 750mmscfd on an “as available” basis with lower reliability. The FSRU supplies heat to vapourise the LNG by circulating sea water through heat exchangers and discharged up to 7 deg C cooler from the vessel. This process is referred to as open loop regasification.

Although the FSRU is subject to an ongoing procurement process, the drivers and sources of FSRU emissions will be similar across candidate vessels driven by the need to consume boil-off gas and supply fuel to the ships power generation.

Boil-off gas is the term used to describe the small flow of vapour generated in the FSRU storage tanks by heat leakage through the tank’s insulated walls which causes the LNG to gently “simmer”. Between 0.10 and 0.15% of the cargo capacity of the FSRU will boil-off per day, generating 3.7 to 5.5 TJ/d or 105 to 160 Sm3/d of gas. There are four approaches to managing FSRU boil-off gas:

- Injection into the export gas stream from the FSRU, but this is only possible when high pressure gas is being delivered from the regas system
- Containment in the LNG storage tanks by allowing tank pressure to rise over limited periods
- Consumption as fuel, primarily in onboard gas engine power generation to support internal power demand and potentially to export power to the Victorian grid to consume excess fuel gas
- Disposal of excess gas in a combustor.

Injection of boil-off gas into the high pressure export system results in no additional emissions from the FSRU. Similarly, containment of boil-off gas in the cargo tanks does not result in any additional emissions, although the duration of this operating mode is limited by the design pressure of the storage tank and the size of tank vapour space (dependent on the fill level of the tanks). Containment of boil-off gas for periods of 15-20 days is typical.

The installed power generation is sized to support either vessel propulsion or regas operations, with propulsion generally being the larger power demand determining the installed generation capacity. For the purpose of power generation emission assessment Jacobs have reviewed carrier engine and emissions data from two candidate FSRUs and picked the larger of the two for the purpose of the assessment.

On the selected vessel four reciprocating gas engines, located on the FSRU, with a total capacity of 38.5MW and maximum fuel demand of 6.8 TJ/d are used to provide all the power required on board for regasification operations, i.e. for driving the compressors, pumps, ventilation fans, general utility, etc. The engines will also provide electric power for propulsion of the FSRU. Details of the gas engines are provided in Table 1.1. The engines are modern high efficiency 4-stroke, non-reversible marine gas engines with indirect injection of gas fuel. Natural gas will fuel each of the gas engines.

The extent to which the installed power generation capacity is used will depend on the operating mode of the vessel:

- When there is no gas send-out, only one engine (MGE No.1) will operate continuously, at approximately 50-75% capacity, to support approximately 4MW of utility power needs on the FSRU. The other three engines will not be operational. In this scenario, for the purposes of this assessment, the upper capacity of 75% of one engine has been used to estimate GHG emissions as a ‘worst case’ scenario.
- If all boil-off gas is used as power generation fuel up to 31MW of electrical power would be generated.
- At the maximum annual gas send out the regas process is estimated to consume an additional 11MW of power, bringing the total power demand to approximately 15MW.

Table 1.1 : Reciprocating gas engines

Gas engine parameter	MGE No.1	MGE No.2	MGE No.3	MGE No.4
Make & Model	Wärtsilä 6L50DF	Wärtsilä 12V50DF	Wärtsilä 12V50DF	Wärtsilä 12V50DF
Power (kW)	5,500	11,000	11,000	11,000
Rotational Speed (rpm)	514	514	514	514
Fuel Type (Gas / Liquid)	Gas / Liquid	Gas / Liquid	Gas / Liquid	Gas / Liquid

There will also be an emergency diesel generator and two auxiliary boilers which will only be used for back-up power requirements when MGE No.1 or other generators are off-line for maintenance.

1.5 Key GHG Emission Sources

The key GHG emission sources from the operation of the Project are expected to be:

- Exhaust from four gas reciprocating engines
- Exhaust from combustor for disposal of excess boil-off gas
- Fugitive emissions of natural gas (methane) from any equipment leaks, e.g. compressor seals, valve seals
- Exhaust from boilers and emergency diesel generator, when operational
- Treatment and disposal of waste products generated on the FSRU (by others, off-site)
- Supply and transport of LNG (by others, upstream of the FSRU process).

The key construction phase activities, associated with potential GHG emissions, will be:

- Installation of new high pressure gas flowline along the jetty to transport natural gas to the connection with the Pipeline Project.

GHG emissions associated with construction activities are considered minor and not material compared with the operational footprint of the Project and consequently construction GHG emissions are not quantified.

Further information regarding emission sources is provided in Section 3.2.1.

1.6 GHGs and Climate Change

The GHG inventory has been calculated in accordance with the principles of the *Greenhouse Gas Protocol* (GHG Protocol) by the World Business Council for Sustainable Development (WBCSD) and the World Resources Institute (WRI) WBCSD; WRI 2004.

Greenhouses gases include:

- Carbon dioxide (CO_2) – by far the most abundant GHG, primarily released during fossil fuel combustion
- Methane (CH_4) – from the anaerobic decomposition of carbon based material (including enteric fermentation and waste disposal in landfills)
- Nitrous oxide (N_2O) – from industrial activity, fertiliser use and production
- Hydrofluorocarbons (HFCs) – commonly used as refrigerant gases in cooling systems
- Perfluorocarbons (PFCs) – used in a range of applications including solvents, medical treatments and insulators
- Sulphur hexafluoride (SF_6) – used as an insulator in heavy duty electrical switch gear.

The key GHGs relevant to this assessment are CO_2, CH_4 and N_2O.

The GHG emissions that form the inventory can be split into three categories known as 'Scopes'. Scopes 1, 2 and 3 are defined by the GHG Protocol and can be summarised as follows:

- Scope 1 – Direct emissions from sources that are owned or operated by a reporting organisation (examples – combustion of coal for the generation of electricity, combustion of diesel in company-owned vehicles or used in on-site generators)
- Scope 2 – Indirect emissions associated with the import of energy from another source (examples – import of electricity or heat)
- 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 business travel (by air or rail) and product usage).

Figure 1.1 shows graphically the different GHG emission scopes.

The initial action for a greenhouse gas inventory is to determine the sources of GHG emissions, assess their likely significance and set a provisional boundary for the study.

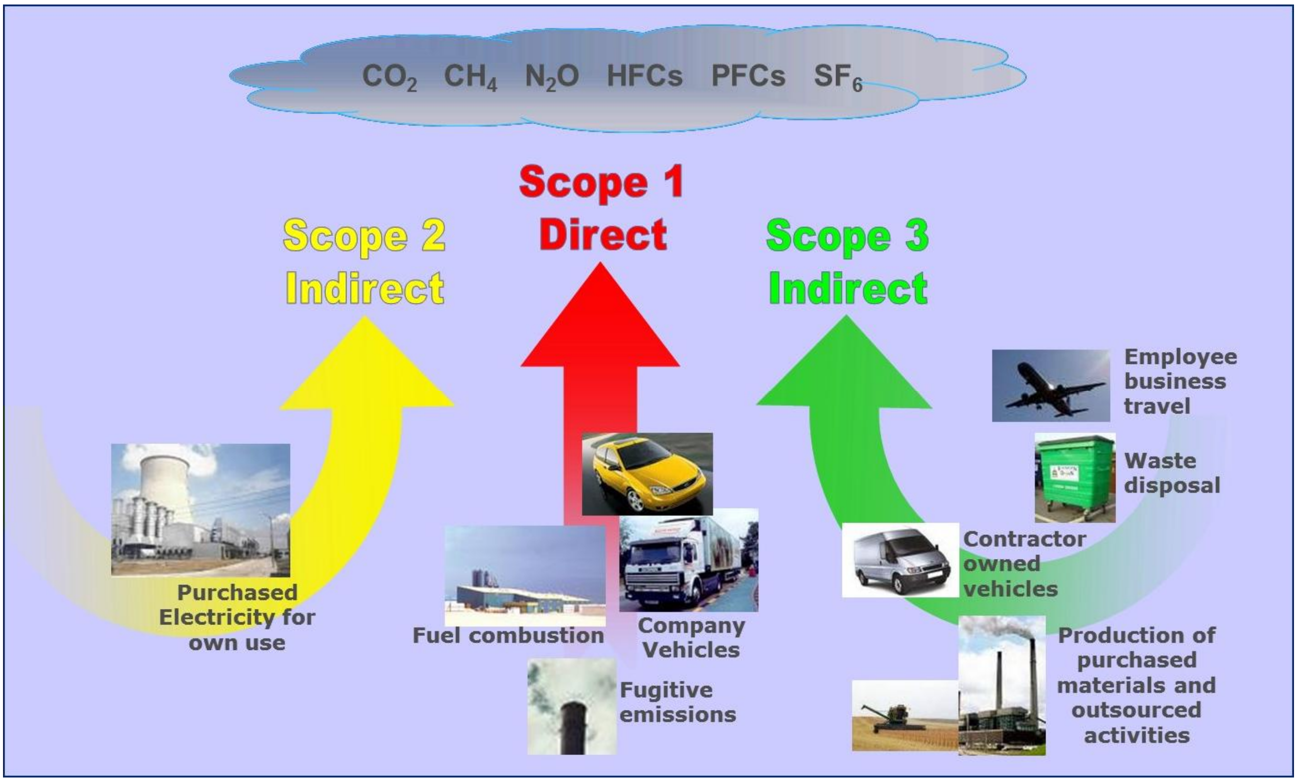

Figure 1.1 : Sources of greenhouse gases

2. Legislation, Policy and Guidelines

2.1 Overview

This section presents the regulatory requirements against which the Victorian EPA assesses compliance with GHG policy and legislation.

The EP Act requires a works approval and a licence for premises scheduled under the Schedule 1 of the Environment Protection (Scheduled Premises) Regulation 2017. Due to its air emissions the FSRU is a scheduled premises.

The Project is subject to the Victorian *Climate Change Act 2017* specifically section 17(2), (3) and (4) of Part 3 of the Act. This requires the EPA as the decision maker under the *Environment Protection Act 1970* and subordinate legislation to have regard to the potential impacts of climate change and potential contribution to the State's GHG emissions associated with the decision or action.

Clauses 18, 19 and 33 of the State Environment Protection Policy (Air Quality Management (SEPP (AQM)) 2001 (EPA, 2001) sets out the regulatory requirements that the Project needs to comply with. This is supported through the implementation of the Protocol for *Environmental Management - Greenhouse Gas Emissions and Energy Efficiency in Industry (*EPA, 2002) (PEM). The PEM is the mechanism by which EPA will assess compliance with the SEPP (AQM) policy principles.

2.2 Commonwealth Greenhouse Gas Policy

2.2.1 National Greenhouse and Energy Reporting Act 2007

The *National Greenhouse and Energy Reporting Act 2007* (Cth) (NGER Act) provides for the reporting and dissemination of information related to GHG emissions, GHG projects, energy production and energy consumption.

AGL at an organisational and facility level exceeds the threshold for reporting under the NGER Act, and as such annually reports the GHG emissions from its existing operations to the Commonwealth Government. GHG emissions associated with operation of the Project will need to be reported under the NGER Scheme.

2.2.2 Emissions Reduction Fund (ERF)

The Commonwealth Government's Direct Action Plan aims to focus on sourcing low cost emission reductions. The Direct Action Plan includes an Emissions Reduction Fund (ERF); legislation to implement the ERF came into effect on 13 December 2014 through the NGER Act and amendments in the *Carbon Farming Initiative Amendment Act 2014* (Cth).

Within the ERF, there is a safeguard mechanism which is designed to ensure that emission reductions credited, are not offset through increases elsewhere in the economy. The mechanism works through setting baseline for emissions for facilities, which emit over 100,000 $tCO_{2\text{-}e}$ annually (based on historical performance) and requiring facilities to keep their emissions below this baseline. The mechanism includes methodologies for dealing with growth and exceptional circumstances and came into operation on 1 July 2016.

2.3 Victorian Greenhouse Gas Policy

2.3.1 Climate Change Act 2017

The *Climate Change Act 2017* (Vic) sets out a clear policy framework and a pathway to 2050 that is consistent with the Paris Agreement to keep global temperature rise below two degrees Celsius above pre-industrial levels. It provides a platform for subsequent action by the Victorian Government, community and business and the long term perspective and policy stability to drive innovation and investment.

In summary, the *Climate Change Act 2017* (Vic) includes a long term carbon reduction target of net zero emissions by 2050, a requirement to set five-yearly targets and strategies, frequent reporting and mitigation measures that support climate change adaptation.

Section 17 of the *Climate Change Act 2017* (Vic) states that "Decision makers (including the EPA in making a decision on works approvals and licences) must have regard to climate change" and sub sections 17(2), (3) and (4) require decision makers to have regard to greenhouse gas emissions and climate change impacts. These sub sections state:

(2) A person making a decision or taking an action referred to in subsection (1) must have regard to -

- *a) the potential impacts of climate change relevant to the decision or action; and*
- *b) the potential contribution to the State's greenhouse gas emissions of the decision or action; and*
- *c) any guidelines issued by the Minister under section 18.*

(3) In having regard to the potential impacts of climate change, the relevant considerations for a person making a decision or taking an action are -

- *a) potential biophysical impacts; and*
- *b) potential long and short term economic, environmental, health and other social impacts; and*
- *c) potential beneficial and detrimental impacts; and*
- *d) potential direct and indirect impacts; and*
- *e) potential cumulative impacts.*

(4) In having regard to the potential contribution to the State's greenhouse gas emissions, the relevant considerations for a person making a decision or taking an action are -

- *a) potential short-term and long-term greenhouse gas emissions; and*
- *b) potential direct and indirect greenhouse gas emissions; and*
- *c) potential increases and decreases in greenhouse gas emissions; and*
- *d) potential cumulative impacts of greenhouse gas emissions.*

2.3.2 Environment Protection Act 1970

The *Environment Protection Act 1970* (Vic) (EP Act) provides a legal framework to protect the environment in the State of Victoria. It applies to noise emissions and the air, water and land in Victoria.

The EP Act requires a works approval and a licence for premises scheduled under the Schedule 1 of the *Environment Protection (Scheduled Premises) Regulation 2017*. Due to its air emissions the FSRU is a scheduled premises.

2.3.3 State Environment Protection Policy (Air Quality Management) 2001 (SEPP AQM)

The SEPP AQM is subordinate legislation made under the provisions of the EP Act to provide more detailed requirements for the application of the Act. Specifically, relevant to GHG emissions, the SEPP AQM includes:

- Clause 18 – General Requirements – including a definition of the management of emissions, generators of emissions and requirements to comply with the policy
- Clause 19 – Requirements for the management of new sources of emissions
- Clause 33 – Requirements to implement the Protocol for Environmental Management (PEM) for GHGs.

2.3.4 Protocol for Environmental Management (PEM): Greenhouse gas emissions and energy efficiency in industry (2002)

The PEM is an incorporated document of the SEPP AQM and specifies the steps that will need to be taken by businesses to demonstrate compliance with the policy principles and provisions of the SEPP (AQM) related to energy efficiency and greenhouse gas emissions. The PEM is the regulatory instrument that is used to align GHG assessment methodology and approach with the requirements under the EP Act and the SEPP AQM.

Satisfying the objectives of the SEPP AQM and the PEM will be met with the Project's commitment to implementation of best practice GHG abatement during construction and operation.

The PEM's objectives are 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.*

The approach set out in the protocol is intended to support these objectives, in particular, by promoting integrated environmental management, including energy management. The protocol supports businesses in addressing the greenhouse implications (including energy use) of their activities, and assists them to respond in ways that will strengthen their long-term business sustainability.

The PEM also seeks to streamline procedures in order to minimise duplication of requirements with other programs in which a business may be involved, such as the Energy Smart Business Program of the Sustainable Energy Authority, and the Commonwealth's Greenhouse Challenge Program.

The PEM applies to businesses which require a works approval or licence under the EP Act. AGL understands that it will require a Works Approval and a Licence as a result of air emissions exceeding specified thresholds (Type LO1- general emissions to air). Accordingly, the PEM will apply to the Project.

2.4 International Framework

On 22 April 2016, Australia signed the Paris Agreement, a global climate agreement made under the United Nations Framework Convention on Climate Change (UNFCCC) at the 21st Conference of the Parties (COP21) in Paris (30 November to 12 December 2015).

The Paris Agreement sets in place a framework for all countries to take climate action from 2020, building on existing international efforts in the period up to 2020. Key outcomes include:

- A global goal to hold average temperature increase to well below 2°C and pursue efforts to keep warming below 1.5°C above pre-industrial levels
- All countries to set mitigation targets from 2020 and review targets every 5 years to build ambition over time, informed by a global stocktake
- Robust transparency and accountability rules to provide confidence in countries' actions and track progress towards targets
- Promoting action to adapt and build resilience to climate impacts
- Financial, technological and capacity building support to help developing countries implement the Agreement.

Australia has set a target to reduce emissions by 26-28 per cent below 2005 levels by 2030, which builds on the 2020 target of reducing emissions by five per cent below 2000 levels.

This target represents a 50–52 per cent reduction in emissions per capita and a 64–65 per cent reduction in the emissions intensity of the economy between 2005 and 2030.

The Commonwealth Government has stated that Australia's 2030 target is achievable with Direct Action (refer to Section 2.3.2) with policies that reduce emissions, increase energy productivity and improve the health of soils and the environment.

As relevant to ships operating in international waters, GHGs are considered under the International Maritime Organisation (IMO) International Convention for the Prevention of Pollution from Ships (MARPOL), covering prevention of pollution by ships from operational or accidental causes. The MARPOL Convention was adopted on 2 November 1973 at IMO. As the 1973 MARPOL Convention had not yet entered into force, the 1978 MARPOL Protocol absorbed the parent Convention. The combined instrument entered into force on 2 October 1983. In 1997, a Protocol was adopted to amend the Convention and a new Annex VI was added which entered into force on 19 May 2005. MARPOL has been updated by amendments through the years.

Annex VI sets limits on non-GHG sulphur oxide (SOX¬) and nitrogen oxide (NOX) emissions from ship exhausts and prohibits deliberate emissions of ozone depleting substances; designated emission control areas set more stringent standards for SOx, NOx and particulate matter. In 2011, IMO adopted mandatory technical and operational energy efficiency measures which are expected to significantly reduce the amount of CO2 emissions from international shipping. These mandatory measures – Energy Efficiency and Design Index (EEDI) and Ship Energy Efficiency Management Plan (SEEMP) entered into force on 1 January 2013. IMO has adopted important guidelines aimed at supporting implementation of the mandatory measures to increase energy efficiency and reduce GHG emissions from international shipping.

2.5 AGL Greenhouse Gas Policy

In April 2015, AGL released a GHG policy acknowledging the causes and impacts of climate change. The policy sets out a range of commitments with respect to climate change as follows:

> *AGL commits to being a transparent and constructive stakeholder. Our public policy advocacy and internal approach to GHG mitigation will be reported in our Annual Sustainability Report. AGL specifically makes the following commitments:*
>
> - *AGL will continue to provide the market with safe, reliable, affordable and sustainable energy options*
> - *AGL will not build, finance or acquire new conventional coal-fired power stations in Australia (i.e. without CCS)*
> - *AGL will not extend the operating life of any of its existing coal-fired power stations*
> - *By 2050, AGL will close all existing coal-fired power stations in its portfolio*
> - *AGL will improve the greenhouse gas efficiency of our operations, and those in which we have an influence*
> - *AGL will continue to invest in new renewable and near-zero emission technologies*
> - *AGL will make available innovative and cost-effective solutions for our customers such as distributed renewable generation, battery storage, and demand management solutions*
> - *AGL will incorporate a forecast of future carbon pricing into all generation capital expenditure decisions*
> - *AGL will continue to be an advocate for effective long-term government policy to reduce Australia's emissions in a manner that is consistent with the long-term interests of consumers and investors.*

3. Method

3.1 Overview

This section outlines the scope and boundary of the study, outlines the methodology as outlined in the PEM and various sources of emissions within that boundary, details emissions factors used and the process of calculating emissions for the Project. The greenhouse gas inventory has been prepared in accordance with:

- The GHG Protocol by the WBCSD and the WRI
- ISO 14064-1:2006 Greenhouse gases – Part 1: Specification with guidance at the organization level for quantification and reporting of greenhouse gas emissions and removals.

Section 2.1 of PEM sets out compliance requirements for new applicants as follows:

- Step 1 – estimate energy consumption– annual energy consumption by energy type and associated GHG emissions
- Step 2 – estimate direct (non-energy related) GHG emissions
- Step 3 – Identify and evaluate opportunities to reduce greenhouse gas emissions. As the Project will use more than 500GJ of energy per annum, best practice must be identified and implemented
- Step 4 – Document the information generated in Steps 1 – 3.

3.2 Scope

The scope of this study is a greenhouse gas assessment of the proposed FSRU at Crib Point, including all material sources of emissions from and including the FSRU to the gas pipe connection with the proposed onshore infrastructure located at the foot of the jetty. The actual emission profile of the vessel will be driven by the gas send out volumes required to meet market demand and the extent to which excess boil-off gas will be disposed at the combustor. As there is uncertainty in the market demand for gas and the extent to which excess boil-off gas will be delivered to the export pipeline or combusted at the FSRU, a series of annual usage scenarios have been used to assess potential emissions.

Emissions are provided for three operating scenarios:

- **Scenario A:** no gas send-out during the year with all boil-off gas used as fuel for the power generation units, and the excess gas burnt at the combustor
- **Scenario B:** continuous year-round operation of the FSRU in Open Loop mode at an average of 382mmscfd high pressure gas send-out requiring 40 LNG carrier deliveries. Under this scenario two regasification units would be utilised
- **Scenario C:** Operation of the FSRU in Open Loop mode for 50.6% of the year at an average of 750mmscfd high pressure gas send-out requiring 40 LNG carrier deliveries. For the balance of the year the FSRU would remain idle. Under this scenario, three regasification units would be utilised.

For Scenario B, the FSRU operates continuously and approximately half of the boil-off gas generated is used as fuel. The excess boil-off gas is slip-streamed into the gas export flow for delivery to the pipeline.

Under Scenario C, the FSRU would be operating for approximately half of the year only, at maximum rate of 750mmscfd. The annual average send out rate is 380 mmscfd, similar to that of Scenario B. During the downtime, the excess boil-off gas cannot be slip-streamed into the gas export flow and is instead burned at the combustor.

3.2.1 Sources of emissions

This section sets out the emission sources as per PEM requirements, which are related to energy consumption, and those that are non-energy related.

Key operational emissions include:

- GHG emissions from the combustion of natural gas in the FSRU reciprocating gas engines
- Fugitive gas emissions from FSRU equipment items and the high pressure flowline along the jetty
- Supply and transport of LNG (by others, upstream of the FSRU process).

There would be other non-material emissions associated with the operation of the FSRU, and these are discussed in the following sub-sections, including the rationale for excluding any emissions from the Project boundary.

The gas engines will provide all of the power requirements on board the FSRU and as such, there will be no continuous requirement for electricity import. As discussed in Section 1.4, the potential for the FSRU to export power to the local grid will be discussed with FSRU providers during the design and tender phase. For the purposes of this GHG assessment, any export of electricity has not been included.

The potential GHG emissions associated from the construction activities (see Section 1.4) are:

- Fuel used to deliver construction materials to site
- Emissions associated with the extraction and manufacture of construction materials
- Fuel used on site by construction equipment/machinery and personnel vehicles.

The key materials expected to be required for the construction phase include concrete, steel, and gas pipes. As the jetty is already in place, the quantity of materials is expected to be relatively minor. In addition, the construction phase will be short (approximately six months), and therefore annual quantities of fuel use for transport and any on-site equipment, will be low. As a result, the GHG emissions arising from the construction phase are expected to be immaterial and have therefore not been included in the GHG assessment.

As discussed previously, emissions are categorised as follows:

- Scope 1 – Direct emissions from sources that are owned or operated by a reporting organisation (examples – combustion of gas for the generation of electricity, combustion of diesel in company-owned vehicles or used in on-site generators)
- Scope 2 – Indirect emissions associated with the import of energy from another source (examples – import of electricity or heat)
- 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 disposal of wastes, and product usage).

Table 3.1 identifies the sources of GHG emissions for operation of the FSRU.

Table 3.1 : Sources of GHG emissions – FSRU operation

Source	Greenhouse Gases	Included	Scope		
			1	2	3
Energy Related Emissions					
Natural Gas Consumption	CO_2, N_2O, CH_4	ü	l		l
Diesel and Marine Gas Oil (MGO) consumption (stationary sources)	CO_2, N_2O, CH_4	ü	l		l
Oils and Greases*	$CO_{2\text{-}e}$	X			
Non-Energy Related					
Fugitives - Natural Gas Pipeline leakage	CH_4	ü	l		
Solid waste products – municipal	CH_4	ü			l
Liquid waste products – sewage	CH_4	ü			l
Liquid waste products* – used oils/greases, chemicals, etc.	CH_4	X			

* Excluded on the basis of materiality

As indicated above, the potential GHG gases arising from the use and disposal of oils, greases, chemicals etc. will be minor and not considered to significantly contribute to the overall greenhouse gas emissions for the Project.

MGO will be consumed as pilot fuel in the power generation engines and as fuel in the two auxiliary boilers and diesel fuel will be consumed by the emergency generator. The emergency generator will also serve as a back-up power generation unit. As the use of these three units is expected to be rare, the GHG emissions from these sources will not be significant and have therefore not been included.

3.2.2 Emission factors and calculation methodology

Combustion of natural gas

The NGER methodologies for the calculation of GHG emissions provide four methods of calculation, Method 1 to Method 4, where Method 1 is the simplest, and applies direct National Greenhouse Accounts (NGA) emission factors.

Method 1 specifies the use of designated emission factors in the estimation of emissions. Emissions factors are used to determine emissions of greenhouse gases from processes or activities, where it is impractical to directly measure (or model) emissions. These emission factors are national average factors determined by the Department of the Environment and Energy using the Australian Greenhouse Emissions Information System (AGEIS). Method 1 is most applicable where the source of emissions is relatively homogenous, such as from the combustion of standard liquid fossil fuels, as is the case for this application.

Emissions factors for the activities described above are presented in Table 3.2. With respect to natural gas consumption the Scope 1 emission factor quoted is for Australian sourced natural gas. Gas sourced on the international market and supplied and consumed by the FSRU would have very similar properties, e.g. energy content and resulting GHG emissions.

Table 3.2 : Emissions factors

Activity	Emissions factor	Reference
Natural Gas Consumption	51.53 kg CO_{2-e} / GJ (Scope 1)	Scope 1 – National Greenhouse Accounts Factors (NGERS, 2017)
Supply of LNG [Note 1]	3.6 kg CO_{2-e} / litre (Scope 3)	Scope 3 – National Greenhouse Accounts Factors (NGERS, 2017)
Transport of LNG by tanker [Note 2]	14.5 g CO_2/tonne-km 0.02 CH_4/tonne-km 0.10 g N_2O/tonne-km	Scope 3 (IMO 2009). For tanker size 0 – 199,999 m^3. CH_4 and N_2O emissions factors estimated from ratio to CO_2 emission factor for diesel oil (IMO 2009)

Notes:

1. Scope 3 emissions factor for supply of LNG (consumed at the FSRU) is representative of upstream emissions associated with fuel combustion for the purposes of extraction, transmission and distribution of LNG within Victoria. It is acknowledged that the use of the LNG supply emission factor is conservative as it incorporates emissions resulting from distribution and transmission, which are not applicable for this Project.
2. The LNG is expected to be sourced from suppliers in the Asia Pacific area, as well as other global suppliers. As such, separate emission factors for the transport of the LNG by tanker from international locations have been included. The emission factors are sourced from the International Maritime Operations GHG Study 2009 report (IMO, 2009). The factors in this report are for CO2 emissions only. For the estimate of contributions from CH4 and N2O, respective ratios of these components to CO2 for emission factors for the use of diesel oil, again sourced from the IMO report (IMO, 2009), have been used. This approach assumes that diesel oil is the primary fuel used by the LNG carrier. It is noted that the LNG may use alternative or supplementary fuels (e.g. addition of LNG boil-off gas).

Section 2.1.2 of the NGER National Greenhouse Accounts Factors (NGERS, 2017) sets out the methodology for calculation of GHG emissions from combustion of gaseous fuels using Method 1. The following formula is used:

$$E_{ij} = \frac{Q_i \ x \ EC_i \ x \ EF_{ijoxec}}{1000}$$

where:

Eij is the emission of gas type (j), (carbon dioxide, methane or nitrous oxide), form gaseous fuel type (i) (CO2-e tonnes).
Qi is the quantity of fuel type (i) (cubic metres)
ECi is the energy content factor of fuel type (i) (GJ per cubic metre). If Qi is measured in GJ, then ECi is 1.
EFijoxec is the emission factor for each gas type (j) (which includes the effect of an oxidation factor) for fuel type (i) (kg CO2-e per GJ of fuel type (i)), as provided in Table 3.2*.*

Fugitive emissions

Fugitive emissions are Scope 3 GHG emissions. For the operation of the FSRU, there is potential for fugitive emissions from the processing, handling and transfer of natural gas and these emissions have been estimated and included in the GHG estimates.

The calculation method was adopted from guidelines within the API Compendium of GHG Emissions Methodologies for the Oil and Natural Gas Industry (API, 2009). This document, referenced by the NGERS Technical Guidelines (NGERS, 2016), provides emission factors for various individual equipment items. These were used, along with estimates of the number of equipment items, to estimate fugitive emissions from valves, compressors, flanges and pumps. A factor of safety was also included.

Emissions from waste treatment

Emissions from the disposal of wastes at an off-site location (by others) are included in Scope 3 GHG emissions. Note that only CH4 is considered as a GHG as CO2 emissions from biomass are considered part of the natural carbon cycle.

Appendix 4 of the NGERS National Greenhouse Accounts Factors (NGERS, 2017) sets out the methodology for calculation of GHG emissions from disposal of solid waste. The following formula is used:

GHG emissions (t $CO_{2\text{-}e}$) = Q_j x EF_j

Where:

Qj is the quantity of waste by type j

EFj is the emission factor of waste j

The emission factor for municipal solid waste disposed to landfill (by broad waste stream category) is 1.4 t $CO_{2\ e}$/t waste (NGERS, 2017).

The calculation of CH4 emissions generated by treatment of sewage from the FSRU at an off-site location (i.e. treatment plant operated by others) were estimated using the following formulae (NGERS, 2017):

GHG emissions (t $CO_{2\text{-}e}$) = emissions from wastewater treatment + emissions from sludge treatment – recovered methane from wastewater in an inventory year

GHG emissions from wastewater treatment (t $CO_{2\text{-}e}$) = $\{COD_w \times (1 - F_{sl}) - COD_{eff}\} \times MCF_{ww} \times EF_w$

GHG emissions from sludge treatment (t $CO_{2\text{-}e}$) = $COD_w \times F_{sl} \times MCF_{sl} \times EF_{sl}$

Where:

CODw	*Chemical Oxygen Demand (COD) in tonnes of COD per year which is the product of DCw and population (P)*
DCw	*The quantity in kilograms of Chemical Oxygen Demand (COD) per capita per year of wastewater. In the event that no waste analysis data is available, a default value of 0.0585 tonnes per person per year can be used.*
P	*The population served and measured in persons and sourced from waste treatment records.*
COD_{eff}	*The quantity of COD in wastewater discharged in effluent from the treatment plant*
F_{sl}	*Default fraction of COD removed as sludge. Should be readily available from internal records of wastewater treatment plants (default value of 0.29)*
EF_w	*Default methane emission factor for wastewater with value of 6.3 tonnes $CO_{2\text{-}e}$/tonne COD (wastewater)*
EF_{sl}	*Default methane emission factor for sludge with value of 6.3 tonnes $CO_{2\text{-}e}$/tonne COD (sludge)*
MCF_{ww} *and* MCF_{sl}	*Fraction of COD anaerobically treated in wastewater (ww) and sludge (sl). This value varies according to wastewater treatment type. IPCC defaults are:* *Managed aerobic treatment – 0* *Unmanaged aerobic treatment – 0.3* *Anaerobic digester/reactor – 0.8* *Shallow anaerobic lagoon (<2 metres) – 0.2* *Deep anaerobic lagoon (>2 metres)– 0.8*

4. Assessment

4.1 PEM Step 1 – Energy Use and Greenhouse Gas Emissions

This section details the expected fuel use and the associated GHG emissions for the operation of the FSRU for Scenarios A, B and C.

As outlined in Section 1.4, during gas send out, each of the four reciprocating engines will be operating at various capacities. If there is no gas send out, only one engine (MGE No.1) will be operational. During these times, MGE No.1 will operate at approximately 50-75% capacity (the upper capacity of 75% has been used for the purposes of this assessment), sufficient to meet the general utility power requirements of the FSRU of approximately 4 MW. Excess boil-off gas will be burned at the combustor.

During gas send out, the excess boil-off gas will be slip-streamed into the export gas flow to the onshore pipeline.

The utilisation data for the reciprocating engines for each scenario is summarised in Table 4.1.

Table 4.1 : Reciprocating engine utilisation and boil-off gas data

Parameter	Units	Scenario A	Scenario B	Scenario C
Number of LNG carrier visits per year	**Visits per year**	**0 or 1**	**40**	**40**
Gas send out	Days per year	0	365	185
Gas send out rate (instantaneous)	mmscfd	0	382	750
Gas send out flow rate, annual average	mmscfd	0	382	380
Engine – gas consumption (fuel)	GJ/year	267,728	949,789	836,893
Engine – fuel oil consumption	GJ/year	1,615	5,728	5,047
Combustor – gas consumption (excess boil off)	**GJ/year**	**1,757,631**	**0**	**867,972**

A summary of the calculated annual fuel use and Scope 1 GHG emissions for each scenario is shown in Table 4.2.

Table 4.2 : Scope 1 GHG emissions summary

Parameter	Units	Scenario A	Scenario B	Scenario C
Total gas consumption	GJ/year	2,025,359	949,789	1,704,864
Total fuel oil consumption	GJ/year	1,615	5,728	5,047
GHG Emissions – gas	tonnes per year	104,367	48,943	87,852
GHG Emissions – fuel oil	tonnes per year	119	423	373
Total GHG	**tonnes per year**	**104,486**	**49,366**	**88,224**

Scope 3 emissions are associated with the consumption of natural gas on the FSRU and result from the upstream exploration, processing, and transport of the fuel. A summary of the Scope 3 emissions attributable to natural gas consumption are provide in Table 4.3.

Table 4.3 : Scope 3 GHG emissions, natural gas consumption

Parameter	Units	Scenario A	Scenario B	Scenario C
Natural gas consumed	GJ/year	2,025,359	949,789	1,704,864
GHG emissions, exploration, production, transmission and distribution	t $CO_{2\text{-}e}$/yr	7,291	3,419	6,138
GHG emissions, transport by LNG carrier	t $CO_{2\text{-}e}$/yr	5,995	2,811	5,046
GHG emissions, total for Scope 3 LNG	**t $CO_{2\text{-}e}$/yr**	**13,286**	**6,231**	**11,184**

A summary of the GHG emissions associated with energy use are summarised in Table 4.4.

Table 4.4 : Total GHG emissions associated with energy use for FSRU operation

Parameter	Units	Scenario A	Scenario B	Scenario C
Scope 1 GHG emissions – energy use	t $CO_{2\text{-}e}$/yr	104,486	49,366	88,224
Scope 3 GHG emissions – energy use	t $CO_{2\text{-}e}$/yr	13,286	6,231	11,184
Total GHG emissions – energy use	**t $CO_{2\text{-}e}$/yr**	**117,772**	**55,596**	**99,408**

4.2 PEM Step 2– Non-energy Related Greenhouse Gas Emissions

4.2.1 Scope 1 – fugitive emissions

The key source of fugitive emissions from the FSRU and the high pressure gas flowline mounted to the jetty is potential leakage of natural gas, containing between 87.5 and 99.5% methane, from equipment items. As discussed in Section 3.2.2, the methodology in API Compendium of GHG Emissions Methodologies (API, 2009) was used to estimate the annual emissions. This document is referenced by the NGERS Technical Guidelines (NGERS, 2016).

Estimates were made for the approximate number of valves, compressors, flanges and pumps. The emission factors from the API Compendium were applied to each component to calculate the total expected GHG emissions. The global warming potential for methane of 25 was applied. A summary of the calculation results is provided in Table 4.5.

Table 4.5 : Scope 1 fugitive GHG emissions summary

Emission parameter	Units	Value
Estimated CH_4 emissions	tonnes CH_4 per year	100
GHG emissions, annual	t $CO_{2\text{-}e}$/year	2,500

4.2.2 Scope 3 – waste disposal emissions

Scope 3 GHG emissions were calculated for liquid waste (sewage) and solid waste from the FSRU. The input data for these calculations is summarised in Table 4.6.

Table 4.6 : Scope 3 input data

	Units	Value	Notes
Days each year operation	days/yr	365	
Number of staff	no.	30	Estimate
Solid waste generation per day	kg/pers/day	2.5	Estimate
COD per person per year, DC_w	t COD/pers/yr	0.0585	Default value from NGERS 2017
COD removed as sludge, F_{sl}	%	29	Default value from NGERS 2017
COD anaerobically treated in wastewater and sludge, MCF_{ww} and MCF_{sl}	%	80	Assume anaerobic digestor and reactor
Default methane emission factor for wastewater and sludge, EF_w and EF_{sl}	t $CO_{2\text{-}e}$/t COD	6.3	Default value from NGERS 2017
Recovered methane from wastewater in an inventory year, R	t CH_4	0	Assumed value (conservative)

A summary of the Scope 3 GHG emissions attributable to waste generation from the FSRU and disposal off-site is provided in Table 4.7.

Table 4.7 : Scope 3 GHG emissions from waste disposal (sewage and municipal)

GHG emission source	Units	Scenario A-C (assumes 365 days per year operation)
Sewage GHG emissions	t $CO_{2\text{-}e}$/yr	8.9
Municipal waste GHG emissions	t $CO_{2\text{-}e}$/yr	38.3
Total waste GHG emissions	t $CO_{2\text{-}e}$/yr	47.2

4.2.3 Total non-energy related emissions

A summary of the total non-energy related emissions associated with the FSRU operation are provided in Table 4.8.

Table 4.8 : Total non-energy related GHG emissions for FSRU operation

GHG emission source	Units	Scenario A-C (assumes 365 days per year operation)
Waste GHG emissions	t $CO_{2\text{-}e}$/yr	47
Fugitive GHG emissions	t $CO_{2\text{-}e}$/yr	2,500
Total non-energy related GHG emissions	t $CO_{2\text{-}e}$/yr	2,547

4.3 Uncertainties

Under Chapter 8 of NGERS Technical Guidelines – Methods 2016/207 (NGERS, 2016), the statistical uncertainty associated with Scope 1 emissions must be reported if emissions are more than 25,000 tonnes of CO2-e. This applies for all Scenario A to C. Statistical uncertainty results from natural variations (for example, random human errors in the measurement process and fluctuations in measurement equipment). Uncertainties associated with the Scope 1 emission estimates are provided in Table 4.9.

Table 4.9 : Uncertainty estimates for Scope 1 GHG emissions

GHG emissions	Energy content uncertainty, %	Emission factor uncertainty, %	Usage uncertainty, %	Aggregate uncertainty, %
CO_2 emissions				
Combustion of natural gas				
Uncertainty, %	7.0%	4.0%	7.5%	11.0% Note 1
Source of uncertainty estimate Note 2	A	A	B	
CH_4 and N_2O emissions				
Combustion of natural gas				
Uncertainty, %	7.0%	50.0%	7.5%	51.0%
Source of uncertainty estimate Note 2	C	D	E	
Fugitive leaks				
Uncertainty, %				50.0%
Source of uncertainty estimate Note 2				F

Notes:

The aggregated uncertainty is calculated according to Section 8.11 of the NGERS Technical Guidelines (NGERS, 2016). The equation is:

$$D = \sqrt{A^2 + B^2 + C^2}$$

Where:

D is the aggregated percentage uncertainty for the emission source.

A is the uncertainty associated with the emission factor for the source, expressed as a percentage.

B is the uncertainty associated with the energy content factor for the source, expressed as a percentage.

C is the uncertainty associated with the activity data for the source, expressed as a percentage.

The sources of uncertainty percentages are:

- **A** **Table in Section 8.6, sub-section 1, of NGERS, 2016**
- B Table in Section 8.6, sub-section 3, of NGERS, 2017. Usage uncertainty assumes criterion BBB, i.e. simplified measurement of consumption.
- C Section 8.7, sub-section 1 (a), of NGERS, 2016
- D Section 8.7, sub-section 1 (b), of NGERS, 2016
- E Section 8.7, sub-section 2 (d), of NGERS, 2016
- F Table in Section 8.8, NGERS, 2016

4.4 Impact Assessment

The total estimated GHG emissions for the FSRU operations are presented in Table 4.10.

Table 4.10 : Total GHG emissions associated with FSRU operation

Parameter	Units	Scenario A	Scenario B	Scenario C
Energy related:				
Scope 1 GHG emissions	t CO_{2-e}/yr	104,486	49,366	88,224
Scope 3 GHG emissions	t CO_{2-e}/yr	13,286	6,231	11,184
Total GHG emissions – energy related	t CO_{2-e}/yr	117,772	55,596	99,408
Non-energy related:				
Scope 1 GHG emissions	t CO_{2-e}/yr	2,500		
Scope 3 GHG emissions	t CO_{2-e}/yr	47		
Total GHG emissions – non-energy related	t CO_{2-e}/yr	2,547		
Total GHG emissions – Project related	**t CO_{2-e}/yr**	**120,319**	**58,143**	**101,955**

As reported in the State and Territory Greenhouse Gas Inventories report (DoEE, 2017), the total GHG emissions for Victoria in 2015 were 119.6 MtCO_{2-e}. The estimated emissions for Scenario A, B and C represent less than 0.11% of the total state emissions.

It is noted that annual GHG emissions of this order are less than the 200,000 t CO_{2-e} per annum trigger for a referral under the *Environment Effects Act 1978* as set out in the *Ministerial Guidelines for Assessment of Environment Effects under the Environment Effects Act 1978*. For clarity the 200,000 t CO_{2-e} per annum trigger are for emissions directly attributable to the Project. As such the Scope 3 energy related emissions outlined above (approximately 10% of total emissions) which includes emissions associated with exploration, production, transmission, distribution and transport of LNG to the Project Site are excluded from the calculation GHGs for comparison with the trigger for a referral under the Act.

The assessment is based on a FSRU model which uses four gas engines and a boil-off combustor operating under the scenarios outlined above.

5. Best Practice Energy and Greenhouse Gas Management

PEM Step 3 requires an assessment of Best Practice energy and GHG management. This is considered consistent with the requirements of EPA Guideline – Demonstrating Best Practice (Publication 1517 February 2017) (Best Practice Guideline).

The EPA's approach to assessing best practice is to use a risk based approach where the following items are considered:

- Scope – the activity being proposed and its relevant industry sector
- Options review – a broad summary outlining the range of options available for the proposed works (including the 'do nothing' option), and a brief indication of why they were considered or discarded
- Best practice analysis – a statement or detailed analysis commensurate to the priorities identified in the environmental risk assessment, describing how the proposal constitutes best practice
- Best practice assessment – having considered all available evidence, the assessment provides an integrated conclusion to the best practice analysis demonstrating the best combination of eco-efficient techniques, methods, processes or technology (as relevant) and summarising the justification of the preferred approach.

The Best Practice Guideline outlines suggested evidence or analysis techniques that can be used to demonstrate an assessment of best practice for a Works Approval Application. Types of evidence include:

- Literature review
- Benchmarking
- Application of the wastes hierarchy
- Integration of economic, social and environmental considerations
- Integrated environmental assessment.

With respect to review of literature, a Lloyd's Register guidance document Floating Storage and Regasification Units Version 1.3 / June 2017 (Lloyd's 2017) provides a recent summary of FSRU operations including industry best practice. The following provides a summary of elements of this document with comparison to this Project so as to consider and assess best practice with respect to project GHG emissions and their management.

Lloyd's, 2017 states that FSRUs are not new in the gas sector. They have been traditionally used as enablers for opening up new markets to LNG suppliers. Drivers that affect the approach (seaborne or land-based) adopted for bringing gas to the end consumers are many and need to be understood. These are project-specific and a combination of market-driven technological, geopolitical and environmental factors.

Seaborne storage and regasification through FSRUs is still a niche market. However, there has been significant recent growth, and market developments indicate further expansion and more business opportunities. This market evolution depends on the supply and demand developments for gas. From the supply side, this refers to developments in the production and liquefaction stage and developments in the transportation of seaborne LNG. From the demand side, it refers to the development at end consumers.

Lloyd's 2017 states that compared with land based LNG storage and regasification, FSRU's offer "lighter environmental footprints".

With respect to GHG emissions the main Project emission sources are the FSRU engines used for both power and propulsion. Lloyd's 2017 states that the power generation requirements for floating units begin at just above 1,500 kW and can go up to 40,000 kW. This depends on the power consumers and the unit's designation. As outlined in Section 1.4 and Section 4.1 for the purpose of this assessment power generation for the reference plant is assessed at the upper end of this range at 38,500 kW.

The ability of floating units to use cargo LNG as fuel is a common feature, as this offers the ability to manage boil-off gas even on units with regasification plants at times when the plant is not operating. The use of boil-off gas is further driven by the fact FSRUs operate in international waters including MARPOL designated Emission Control Areas (ECAs) where compliance with strict non-GHG air pollution emission requirements is needed.

As outlined above for this Project, emissions information was sought from a number of candidate FSRU providers. The reference plant is an FSRU with one 6-cylinder Wärtsilä 6L50DF engine with power rating

5500 kW, and three Wärtsilä 12V50DF 12-cylinder engines with power ratings 11000 kW. Wärtsilä are leading suppliers of large marine diesel engines. For the Wärtsilä 50DF engine range The Wärtsilä 50DF engine range is designed to provide high output with fuel flexibility, low emission rates, high efficiency and high reliability.

FSRU GHG emissions are a direct function of fuel consumption (GJ/year) as set out in Table 4.1 and Table 4.2. The more efficient the engines the less fuel consumption and GHGs emitted per unit of power generated. The efficiency is termed the heat rate. Figure 5.2 sets out a heat rate comparison for the Wärtsilä 50DF class engines proposed for the Project with data published by the US Energy Information Administration for gas engine power generators in the US between 2007 and 2016. The data shows the Wärtsilä engines to be approximately 20% more efficient than 2016 average heat rate efficiency. With a heat rate of 7397 kJ/kWh the Wärtsilä engines are considered as Best Available Technology (BAT) for powering the FSRU both in terms of propulsion and also onboard power generation.

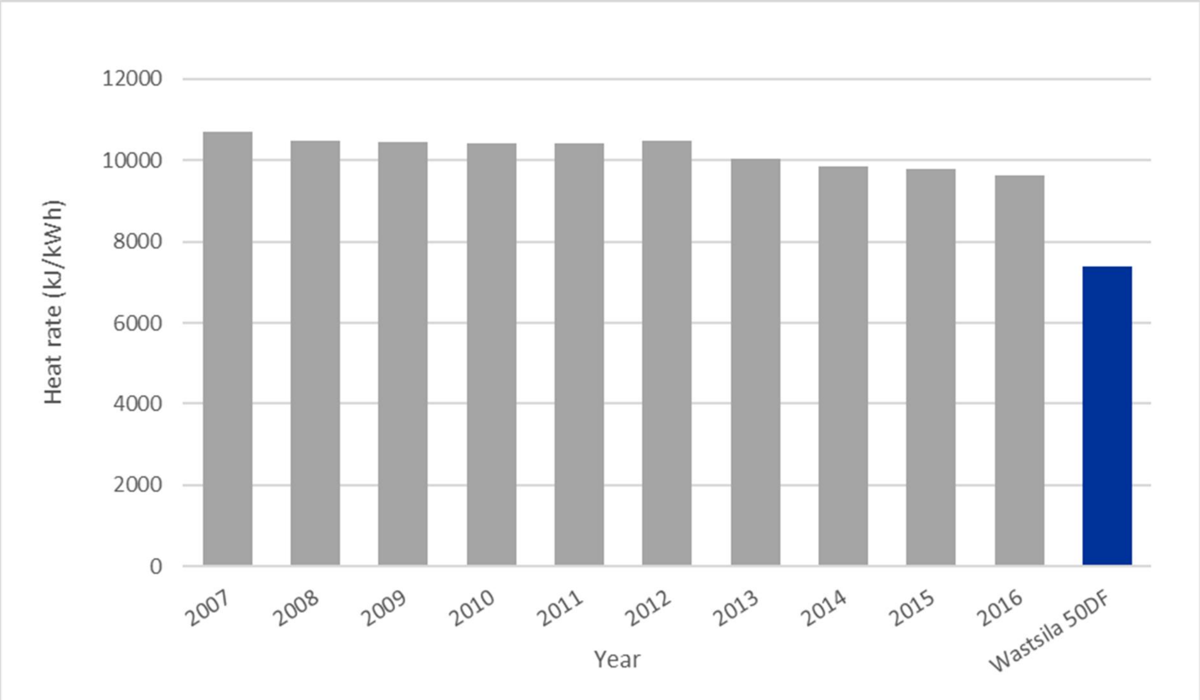

Figure 5.1 : Gas Engine Heat Rate Comparison (kJ/kWh) LHV

In line with energy and GHG best practice, natural gas imported at Crib Point will be injected to the Victorian gas transmission network, which will then be used for a variety of domestic, industrial and commercial purposes in southern Australia. Natural gas burns much more efficiently than other fuel sources (from an energy and greenhouse gas perspective) meaning that it is, by comparison, a better fuel from a greenhouse gas management perspective. Figure 5.2 shows a comparison of the greenhouse gas intensity of various fuels per gigajoule (GJ) of energy content.

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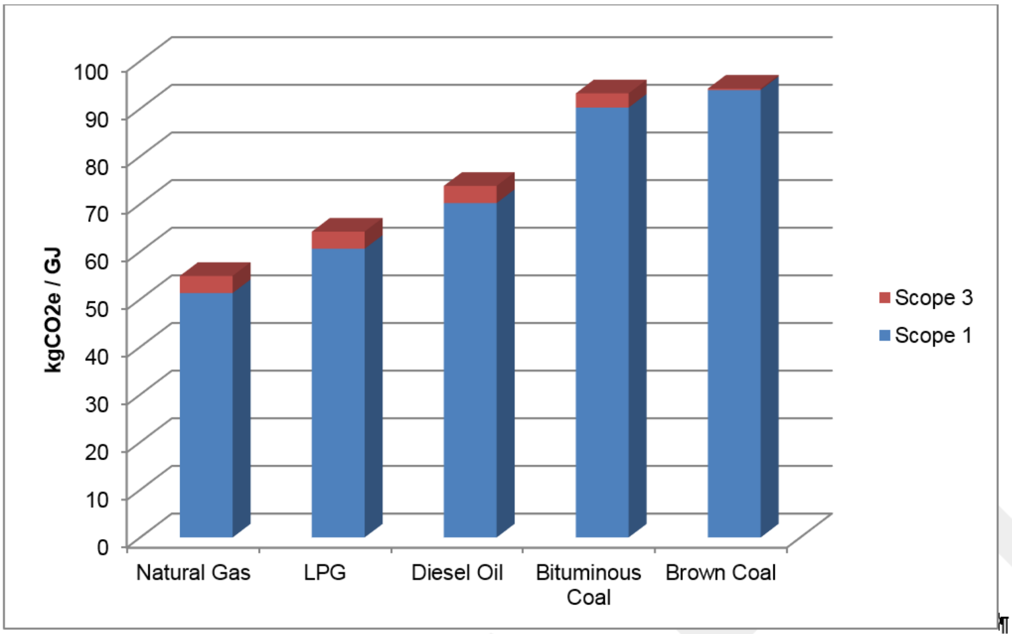

Figure 5.2 : Comparison of Natural Gas with other Fuel Types

The Scope 3 emissions shown are based on Victorian emission factors (EFs), and would be generally representative of natural gas currently used in Victoria, of which a portion would be sourced in local gas fields. In the case of imported LNG, the scope 3 emissions would be higher than the approximate 5% shown in

Figure 5.2, accounting for the international shipping of LNG to Crib Point. Nevertheless, the overall emissions compared with other fuels is considered low.

6. Climate Change Impacts

6.1 Climate Change Impacts and Adaptation

Carbon dioxide (CO_2) is a vital gas for photosynthesis and global climate regulation. Since CO_2 and other GHGs trap long wave radiation, changes in their concentrations in the atmosphere will influence the Earth's radiation balance and contribute to the warming of both the atmosphere and the Earth's surface. This phenomenon is known as the greenhouse effect.

Atmospheric CO_2 varies annually, reflecting seasonal photosynthetic activity, its release or uptake from the ocean and fires in forests and tropical savannahs. In the past 650,000 years, CO_2 concentrations have varied between 180 and 300 ppm. Since the industrial revolution, concentrations have risen from about 280 ppm to over 400 ppm.

The combined radiative forcing (the effect of greenhouse gases on global radiation balance) of greenhouse gases such as carbon dioxide, methane and nitrous oxide increased almost fourfold between 1950 and 2011 (0.6-2.3 W/m^2), including an increase of almost 50% from 2007. The warming effect of increased atmospheric greenhouse gas concentrations is considered to have contributed to the observed increase in global mean temperature of 0.7°C from 1880 (IPCC, 2013).

Climate change projections are derived using general circulation models (often referred to as global climate models or GCMs), which simulate the ocean, atmospheric and land surface processes which influence climate. The models are run under historical conditions and with scenarios representing long-term trajectories for greenhouse gas emissions or their effect on radiative forcing.

GCMs simulate climate at a global scale, typically based on grid cells with a resolution of 200-300 km. Regional climate models (RCMs) use 'down-scaling' techniques to provide climate projections at much finer resolution and better account for topographic and other local climatic influences. RCMs depend on the outputs of GCMs and while their outputs have better spatial resolution they do not necessarily produce more accurate projections than GCMs.

6.2 Policy Drivers

6.2.1 Commonwealth Government Policy Framework

The Commonwealth Government's approach to climate change adaptation is documented in its 'National Climate Resilience and Adaptation Strategy' (DoE, 2015). The scope of this strategy is to, "Highlight resilience-building by governments, businesses and communities in Australia and our region; guide effective climate change adaptation with a set of principles; and establish priority areas for future consultation and action". A number of priority areas are highlighted including:

- Coasts
- Cities and the built environment
- Agriculture, fisheries and forestry
- Water resources
- Natural ecosystems
- Health and wellbeing
- Disaster risk management
- A secure and resilient region.

6.2.2 Victorian Policy Framework

As noted in Section 2.3.1, the Climate Change Act 2017 includes a requirement that “Decision makers must have regard to climate change”. Section 17(3) of this Act defines the requirement as:

> *In having regard to the potential impacts of climate change, the relevant considerations for a person making a decision or taking an action are:*
>
> *(a) potential biophysical impacts*
>
> *(b) potential long and short term economic, environmental, health and other social impacts*
>
> *(c) potential beneficial and detrimental impacts*
>
> *(d) potential direct and indirect impacts*
>
> *(e) potential cumulative impacts.*

This section provides an assessment of the potential impacts of climate change on the Project.

6.3 Climate Change Projections

Climate Change projections for this assessment have been derived from the Victorian Department for Environment, Land, Water and Planning (DELWP) ‘Climate Ready Victoria’ website. Of these, two documents provide specific detail on climate change projections for the Gippsland Region, and detail what sort of impacts can be expected (and how the region can adapt). These are:

- Climate-Ready Victoria – Greater Melbourne – How climate change will affect the Greater Melbourne region and how you can be climate-ready
- Climate-Ready Victoria – Greater Melbourne – Climate Projections Data Sheet.

Climate projections from these sources are derived from work undertaken by the Commonwealth Science and Industry Research Organisation (CSIRO) on behalf of the Victorian Government, and are based on national projections released by CSIRO and the Bureau of Meteorology. They are based on two ‘representative concentration pathways (RCPs)’ which link emissions projections to levels of global warming. These correlate to medium and high levels of radiative forcing (measures in watts per square metre (W/m^2)), which is a measure of increased energy derived from solar radiation as a result of trapped greenhouse gases. The representative concentration pathways include:

- RCP4.5 – A medium emissions scenario representing radiative forcing peaking at $4.5W/m^2$
- RCP8.5 – A high emissions scenario (and the current trajectory) representing radiative forcing peaking at $8.5W/m^2$.

The projections from DELWP are presented in Table 6.1. The projections are available for two time periods – 2030 and 2070. As the Project is intended to operate for approximately 20 years, the projections for 2030 have been selected as the most relevant.

Table 6.1 : Greater Melbourne Region Climate Change Projections (Source DELWP)

	Climatic Parameter	2030 Low (RCP4.5)	2030 High (RCP8.5)
Annual	Average temperature (°C)	0.82 (0.45 to 1.03)	0.94 (0.63 to 1.29)
	Average rainfall (%)	–0.92 (–10.50 to 4.17)	–1.66 (–12.23 to 3.01)
	Evaporation (%)	2.83 (1.70 to 4.56)	4.30 (2.56 to 6.80)
	Wind speed (%)	–0.56 (–4.92 to 1.09)	0.86 (–2.10 to 2.86)
	Relative humidity (%)	–0.74 (–1.64 to 0.21)	–1.04 (–2.45 to –0.13)
	Solar radiation (%)	1.45 (0.42 to 2.87)	2.09 (0.42 to 3.64)
	Soil moisture (%)	–1.77 (–4.36 to –0.31)	–3.68 (–5.36 to 0.63)
Spring	Average temperature (°C)	0.80 (0.31 to 1.10)	0.93 (0.53 to 1.31)
	Average rainfall (%)	–4.14 (–11.63 to 3.95)	–6.70 (–21.15 to 4.66)
	Evaporation (%)	4.07 (1.51 to 6.40)	4.25 (2.23 to 7.85)
	Wind speed (%)	–1.88 (–6.29 to 1.55)	0.69 (–4.55 to 5.99)
	Relative humidity (%)	–1.25 (–2.72 to 0.99)	–1.64 (–3.40 to –0.24)
	Solar radiation (%)	2.04 (–0.23 to 3.89)	2.48 (–0.22 to 4.45)
	Soil moisture (%)	–3.01 (–5.66 to –1.45)	–3.89 (–8.93 to –0.28)
Summer	Average temperature (°C)	0.93 (0.37 to 1.32)	1.02
	Average rainfall (%)	0.05 (–15.33 to 8.93)	–1.16 (–17.05 to 13.94)
	Evaporation (%)	2.10 (–0.28 to 4.54)	3.44
	Wind speed (%)	–0.88 (–4.54 to 1.37)	–0.31 (–2.00 to 4.32)
	Relative humidity (%)	–0.63 (–1.88 to 1.13)	–0.69 (–3.29 to 1.00)
	Solar radiation (%)	1.04 (–0.61 to 2.35)	1.00 (–0.82 to 3.02)
	Soil moisture (%)	–1.68 (–4.36 to 0.81)	–2.76 (–5.20 to 0.79)
Autumn	Average temperature (°C)	0.78	0.92
	Average rainfall (%)	0.07 (–19.35 to 14.47)	–3.92 (–14.78 to 15.26)
	Evaporation (%)	3.47 (–0.13 to 7.49)	6.25 (1.96 to 8.92)
	Wind speed (%)	–0.47 (–4.92 to 3.45)	–0.85 (–3.64 to 4.01)
	Relative humidity (%)	–0.33 (–2.79 to 1.31)	–0.89 (–2.04 to 0.75)
	Solar radiation (%)	0.51 (–1.17 to 2.93)	1.61 (–1.20 to 3.24)
	Soil moisture (%)	–1.53 (–5.45 to 2.78)	–2.93 (–6.03 to 4.40)
Winter	Average temperature (°C)	0.60 (0.32 to 0.85)	0.74 (0.49 to 1.06)
	Average rainfall (%)	–1.34 (–12.85 to 7.65)	–2.99 (–13.09 to 7.17)
	Evaporation (%)	6.55 (–3.88 to 12.52)	7.99 (–1.11 to 16.10)
	Wind speed (%)	0.52 (–3.61 to 4.35)	1.77 (–2.35 to 6.98)
	Relative humidity (%)	–0.42 (–1.57 to 0.57)	–0.86 (–2.86 to 0.59)
	Solar radiation (%)	1.57 (–1.51 to 5.26)	2.12 (–0.25 to 6.47)
	Soil moisture (%)	–1.78 (–4.73 to 1.01)	–2.92 (–5.80 to 1.73)

Table 6.1 shows that:

- Average temperature is expected to increase by approximately 1 degree centigrade across all seasons (between both medium and high RCP scenarios). In addition to increases in average temperature, increases in hotter weather would also be expected to increase, with more frequent incidence of heatwaves

- Average rainfall is expected to decrease very slightly, with seasonal differences (not much change in Summer, but larger decreases (~5 to 6% in Spring and Winter)
- Evaporation is expected to increase (in line with lower rainfall and warmer temperatures). This is fairly even across all seasons except Winter, which shows a slight increase over the others
- Wind speed shows very little change across all seasons. Note that the averages show little change, there is a slight increase in the variability in the ranges shown for each season
- Relative humidity is expected to show a very slight decrease
- Solar radiation (%) shows a slight increase, especially in Winter and Spring
- Soil moisture (%) is expected to decline (in line with increase evaporation and lower rainfall). Changes are most prominent in Winter and Spring.

In addition to the above impacts, the following changes are expected:

- Extreme rainfall and flooding - climate change is expected to decrease annual average rainfall, but increase the number and intensity of extreme rainfall events (and increase maximum daily rainfall totals)
- Fire weather – lower rainfall, greater evaporation and higher average temperatures is likely to create a greater risk for forest fires. It would be expected that there would be a greater number of days where risks are 'extreme' or 'severe' as measured by the Forest Fire Danger Indices (FFDI).

Table 6.2 provides climate change statistics for marine parameters, as forecast for Stony Point (Crib Point). It can be seen that sea level is predicted to rise by 0.1 m by 2030. For sea level rise predictions to 2040 an alternative dataset, the Victorian Coastal Inundation Dataset[1] projects a rise of 0.2 m by 2040. This has been modelled for the Project Site and presented in the Hydrology Impact Assessment (Jacobs 2018), which shows that for 2040 sea level rise predictions there are marginal fringe sea level risk impacts along the eastern boundary. With appropriate design mitigation, a sea level rise of 0.2 m would not impact the proposed works on the site.

Table 6.2 also shows a predicted increase in sea surface temperature of 0.5 deg. C by 2030. Higher sea surface temperature may aid in gasification efficiency, in that it may allow lower flows through the heat exchanger with corresponding lower effect of entrainment (pers comm, S. Chidgey). Additionally, chlorine concentration will theoretically reduce faster, though the reduction due to a 0.5°C difference is environmentally insignificant to the chemical reactions (pers comm, S. Chidgey).

Table 6.2 : Greater Melbourne Region Climate Change Projections – Marine and Coast (Source DELWP)

Climatic Parameter Marine and Coast – Stony Point	2030 Low (RCP4.5)	2030 High (RCP8.5)
Sea level rise (m)	0.11 (0.07 to 0.16)	0.12 (0.08 to 0.17)
Sea surface temp (deg C)	0.51 (0.39 to 0.66)	0.55 (0.31 to 0.89)
Ocean acidification (pH)	-0.07 (-008 to -0.07)	-0.15 (-0.15 to -0.14)

6.4 Potential Receptors of Climate Hazards

Following identification of the potential hazards associated with climate change, this section identifies those elements of the Project which are potentially at risk as a result. Key risks are as follows:

- **Jetty infrastructure:** With expected sea level rise will this impact on the jetty and the ability of the FSRU to berth at the jetty
- **Process operations:** With expected increases in ambient temperature will this impact on gas handling and the Project power generation requirements

[1] https://www.data.vic.gov.au/s

- **Regasification:** For open loop regasification where sea water is used as a heat source for vaporising and warming LNG will this be impacted by increases in sea surface temperature.

Table 6.3 : Climate Change Risks and Proposed Treatment

Item	Climate Variable	Project Receptor	Potential Risk	Proposed Risk Treatment
1	Average temperature and increased incidence of Heatwave	Operation of the facility	If ambient temperatures are higher this may affect plant cooling systems, potentially reducing efficiency. If the temperature exceeds the maximum operating ambient temperature for the plant, then efficiency will drop and it may have to temporarily shut down. Hotter temperatures may also provide more instances of difficult conditions for plant operators. Resulting in a need to change operational patterns.	Natural gas fired reciprocating engines operate around the world in range of temperature extremes. Modern engines such as that proposed for the FSRU power plant will not be impacted in any material way by any change in average temperature or extremes over the life of the Project. Change operational patterns / management plans to manage worker exposure to heat stress during periods of hot weather.
2	Average rainfall	Operation of the facility	No risk envisaged from a potential small decrease in annual rainfall.	NA
3	Evaporation	Operation of the facility	No risk envisaged from a potential small increase in evaporation.	NA
4	Wind speed	Operation of the facility, as well as design and construction	Wind speed change projections do not indicate that the plant will be suffering from abnormally increased wind speeds and elements of the plant are not unusually susceptible to such changes.	EPC contractors are provided with (and invited to investigate further) maximum wind speeds that the plant must be built to withstand with additional tolerances - for example mooring structures. No further adaptation / resilience required.
5	Relative humidity	Operation of the facility	Reduction in relative humidity (given magnitude and direction) is not projected to cause issues for the construction or operation of the plant. It may, in fact, provide more comfortable working conditions for staff working in open air environments.	NA
6	Solar radiation	Operation of the facility as well as design and construction	Potential for elements of the plant which are susceptible to degradation from solar radiation may have a shorter lifetime than anticipated (although projections are for an average 2% increase annually). This could cause increased maintenance and increased cost to the plant.	Whilst plant is designed for historical conditions, the magnitude of the projected change in solar radiation, along with the lifetime of the intended plant (20 years) are suggested to reduce the risk.

Item	Climate Variable	Project Receptor	Potential Risk	Proposed Risk Treatment
7	Soil moisture	Operation of the facility as well as design and construction	Reduction in soil moisture content could have the potential to destabilise foundations on site for plant and equipment, as well as hard stand areas. This could result in increased costs for maintenance and repairs.	Risk low – accept.
8	Extreme rainfall and flooding	Operation of the facility as well as design and construction	At times of heavy rainfall and/or flooding, drainage impacts during construction phase and operational phase.	Drainage design will require investigation during detailed design to confirm the sea level rise and tide surge data and potential impacts dependent upon development details. Flood mitigation will not be required if there is work which will impact upon the existing flood extent and coastal hydrology on the landside component of the Project Site.
9	Extreme rainfall and flooding	Operation of the facility	There may be impacts to staff/operators and deliveries to the site at times of heavy rainfall and/or flooding.	Traffic management plans Safety management plans
10	Fire Danger Days	Operation of the facility	Potential road closures could lead to delays in deliveries to the site. Fire is a higher risk for gas pipeline network that will connect to the port infrastructure. While the pipeline is subject to a separate approvals process, where the pipeline is impacted by fire this could result in disruption to LNG deliveries.	In the event of pipeline disruption caused by fire, LNG cargoes would be diverted internationally to other markets. For long term disruptions, the FSRU is capable of sailing away.
11	Sea Level Rise	Operation of the facility	Potential for impact to the operation of the facility	The FSRU is a floating facility and will manage on a daily basis natural sea level changes associated with tidal change. The Jetty Upgrade will be designed to ensure that it will not be impacted sea level increases. The Basis of Design for the Jetty Upgrade adopts a sea level rise of 0.32 m (for the year 2070) which is greater than the sea level rise prediction for 2040. The landside facilities will be designed to ensure that they will not be impacted sea level increases.

Item	Climate Variable	Project Receptor	Potential Risk	Proposed Risk Treatment
12	Sea surface temperature	Operation of the facility	As outlined above for open loop regasification where sea water is used as a heat source for vaporising and warming LNG will be impacted by increases in sea surface temperature. Higher sea surface temperature will aid in re-gasification efficiency in the heat exchanges. In terms of the marine environment the predicted 0.5°C increase: · May allow lower flows through the heat exchanger with corresponding lower effect of entrainment. · Chlorine concentration will theoretically reduce faster, though the reduction due to a 0.5°C difference is environmentally insignificant to the chemical reactions. · There will be a slight reduction in seawater density that may change the coldwater plume behaviour. The effect will depend on the operational flows and temperature differential maintained in the heat exchanger by the operators in 2030.	NA

7. Conclusion

This assessment presents the calculated GHG emissions expected as a result of the proposed implementation of the AGL Gas Import Jetty Project, utilising a FSRU at Crib Point, Victoria. The assessment has been carried out in accordance with requirements of the SEPP AQM (EPA, 2001) and requirements of the PEM.

The key activities associated with the FSRU expected to generate GHG emissions are:

- GHG emissions from the combustion of natural gas in the FSRU reciprocating gas engines
- Fugitive gas emissions from FSRU equipment items and the high pressure flowline along the jetty
- Supply and transport of LNG (by others, upstream of the FSRU process).

GHG emissions associated with construction activities are expected to be immaterial to the assessment and were not included in the calculations.

The total annual GHG emissions estimates for the operation of the FSRU are presented in Table 7.1.

Table 7.1 : Total Annual GHG emissions associated with FSRU operation

Energy related:				
Scope 1 GHG emissions	t CO_{2-e}/yr	104,486	49,366	88,224
Scope 3 GHG emissions	t CO_{2-e}/yr	13,286	6,231	11,184
Total GHG emissions – energy related	t CO_{2-e}/yr	117,772	55,596	99,408
Non-energy related:				
Scope 1 GHG emissions	t CO_{2-e}/yr	2,500		
Scope 3 GHG emissions	t CO_{2-e}/yr	47		
Total GHG emissions – non-energy related	t CO_{2-e}/yr	2,547		
Total GHG emissions – Project related	**t CO_{2-e}/yr**	**120,319**	**58,143**	**101,955**

As reported in the State and Territory Greenhouse Gas Inventories report (DoEE, 2017), the total GHG emissions for Victoria in 2015 were 119.6 $MtCO_{2-e}$. The estimated emissions for Scenario A to C represent less than 0.11% of the total state emissions, respectively.

It is noted that annual GHG emissions of this order are less than the 200,000 t CO_{2-e} per annum trigger for a referral under the *Environment Effects Act 1978* as set out in the *Ministerial Guidelines for Assessment of Environment Effects under the Environment Effects Act 1978*.

The report also assesses potential climate change impacts with projections to 2040. The assessment was conducted in accordance with the requirements of the *Climate Change Act 2017*, and using information supplied by the Victorian Department for Environment, Land, Water and Planning (DELWP) 'Climate Ready Victoria' website. The assessment determined that sea level is predicted to rise by 0.1 m by 2030, with an increase in sea surface temperature of 0.5 deg. C. The risks associated with these climate change projections are not expected to have a material impact on the operation of the Project.

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