1 INTRODUCTION

This chapter quantifies greenhouse gas emissions from all components of the Queensland Curtis LNG (QCLNG) Project, identifies mitigation measures and benchmarks the LNG Component against existing LNG facilities. In addition, it considers the Project in the context of proposed legislation as well as detailing legislative compliance, monitoring and reporting requirements.

Potential impacts that a changing climate may have on the Project are discussed further in *Volume 5, Chapter 2* of this Environmental Impact Statement (EIS).

1.1 DESCRIPTION OF PROJECT ENVIRONMENTAL OBJECTIVES

The Project environmental objective for greenhouse is: to minimise impacts on human life and ecological systems arising from climate change by reducing Project greenhouse gas emissions as much as practicable.

1.2 OVERVIEW

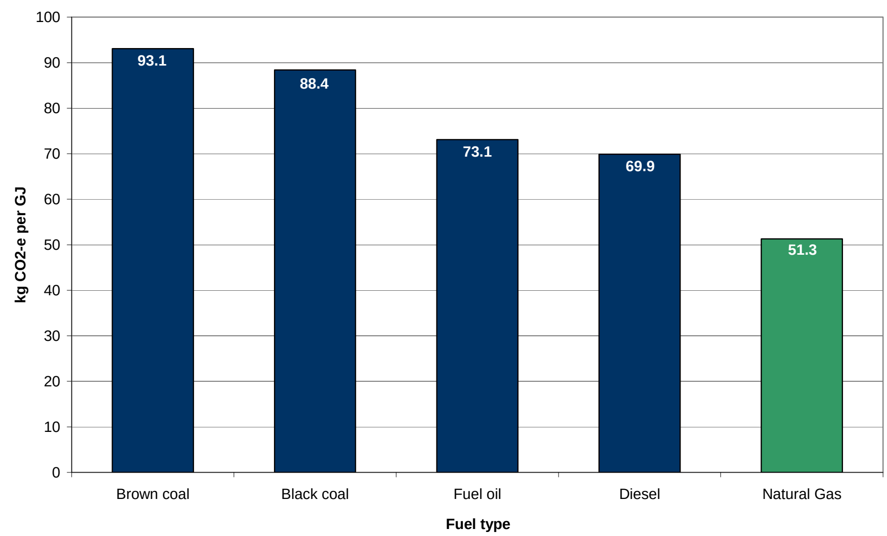
Climate change, as defined by the United Nations Framework Convention on Climate Change (UNFCCC), "is a change of climate that is attributed directly or indirectly to human activity that alters the composition of the global atmosphere and that is in addition to natural climate variability". The emission of greenhouse gases has been linked to climate change.

The extraction of coal seam gas (CSG) and conversion to liquefied natural gas (LNG), will generate greenhouse gases. QGC intends to mitigate the Project's impact on climate change by applying the energy efficient design and technology coupled with appropriate management strategies, monitoring and reporting.

LNG technology has an important role to play in addressing climate change. LNG is natural gas cooled to -162ºC, at which point it becomes a liquid occupying about 1/600th of its original gaseous volume. This process makes it possible to safely and economically transport natural gas – a cleaner energy source with the lowest carbon emissions of all fossil fuels – to markets around the world.

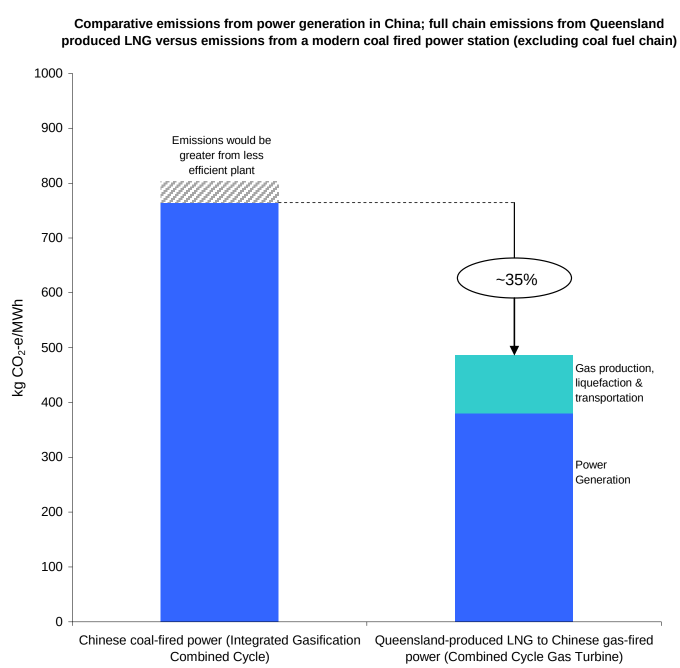
Natural gas has lower carbon intensity than oil or coal and is regarded as a transition fuel as the world increasingly looks to renewable energy. *Figure 7.1.1* compares the direct emission intensities of selected fuels on the basis of greenhouse gas emitted per unit of energy. The figure shows that natural gas produces 51.3 kg CO_2–e per gigajoule (GJ) compared with diesel, fuel oil and black coal which emit between 69.9 - 93.1 kg CO_2–e per GJ. However, *Figure 7.1.1* does not consider emissions associated with extraction, processing and transportation.

Figure 7.1.1 Comparative Greenhouse Gas Emissions Intensities of Common Fuels[1]



LNG's role in international efforts to reduce greenhouse emissions from fossil fuels is further illustrated in *Figure 7.1.2.* When exported to markets such as Korea, Taiwan and China, LNG helps displace more carbon-intensive fuels such as coal.

Figure 7.1.2 LNG's Role as a Lower Carbon Transition Fuel



Source: Adapted from Coal in a Sustainable Society, Australia 2001 & BG analysis

1 Source: Australian Government (2008) National Greenhouse and Energy Reporting (Measurement) Determination

The Intergovernmental Panel on Climate Change (IPCC) has identified fuel switching from more greenhouse gas-intensive fuels to natural gas in power generation as a key mitigation technique available to reduce greenhouse gas emissions.

LNG exported from Australia often displaces coal or oil in power generation. Based on BG Group estimates and Australian Government data, LNG delivered from Queensland to China and used to generate power will produce at least 35% less greenhouse gas emissions than coal (refer to *Figure 7.1.2*).

- For these reasons, governments around the world are encouraging the production of LNG (and consumption of natural gas) to help reduce greenhouse gas emissions where energy consumption is exponentially increasing as a result of population and industrial growth.

1.3 *POLICY APPROACH*

The proposed Carbon Pollution Reduction Scheme (CPRS) represents the Australian Government's primary policy approach to reducing emissions of greenhouse gases from Australian industry. To encourage industry to help address climate change, the Australian Government set a long-term target to reduce emissions of greenhouse gases by 60 per cent of 2000 levels by 2050[2].

The Australian Government has announced that its short-term (2020) target will be dependent on a global agreement to reduce emissions of greenhouse gases as follows:

- by up to 25 per cent below 2000 levels by 2020 if all major economies commit to substantially *restrain* emissions and advanced economies take on *reductions* comparable to Australia[3]
- by an unconditional 5 per cent reduction in carbon pollution below 2000 levels by 2020, which represents a reduction of approximately 27 per cent on a per capita basis[4].
- The Queensland Government supports natural gas as a transition fuel through its gas policy. This policy requires electricity retailers and other large electricity users to source at least 13 per cent of their electricity from gas-fired generation. Under the Queensland Government's ClimateSmart 2050 policy[5] this will increase to 18 per cent by 2020.

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2 Australian Government (December 2008) Carbon Pollution Reduction Scheme Australia's Low Pollution Future White Paper Volume 1

3 Australian Government (May 2009) Summary Key changes to the Carbon Pollution Reduction Scheme Legislation

4 Australian Government (December 2008) Carbon Pollution Reduction Scheme Australia's Low Pollution Future White Paper Volume 1

5 Queensland Government (2007) ClimateSmart 2050:Queensland climate change strategy 2007: a low-carbon future

QGC's parent, BG Group, recognises climate change as a key environmental issue and has committed to reducing its annual greenhouse gas emissions by 1 million tonnes in 2012 against a 'no action' base case. Internal standards and processes have been implemented to drive performance towards this target. The target will be achieved through improving the energy efficiency of the company's existing operations as well as employing advanced technologies in the design of new developments. Performance towards the target is reported annually in the BG Group Sustainability Report[6].

Consistent with the BG commitment to reduce emissions, the QCLNG Project will employ advanced, proven technologies and liquefaction plant design to limit greenhouse gas emissions.

QGC has identified mitigation strategies which reduce the greenhouse gas emissions by an estimated 27% from the initial concept design (refer to *Section 2.4*). This means the project will emit significantly less greenhouse gases than many similar LNG projects around the world, placing Queensland and Australia at the forefront of the LNG industry and greenhouse gas reduction technology.

6 http://www.bg-group.com/Sustainability/Pages/SRReport.aspx

2 PROJECT

This assessment considers greenhouse gas emissions for the following components of the QCLNG Project:

- **Gas Field Component** – a significant coal seam gas (CSG) field in the Surat Basin of southern Queensland developed to support a two train LNG project.
- **Pipeline Component** – a 380-kilometre underground Export Pipeline from the Gas Field and other associated pipelines.
- **LNG Component** – a gas liquefaction facility on Curtis Island, adjacent to Gladstone, initially comprising two processing units, or “trains”, to be followed by a third train.

2.1 SOURCES CONSIDERED IN THIS ASSESSMENT

This assessment presents emissions of greenhouse gases from sources within the boundary of the Project and as a result of the Project’s activities.

All assumptions presented in this chapter are on the basis that no grid electricity will be purchased; all electricity requirements for on-site operations be generated by gas turbines using CSG. However, use of grid electricity in the Gas Field Component is still an option under consideration.

Emissions of greenhouse gases will result from activities associated with all components of the Project, primarily combustion of CSG for compression and power generation. Combustion in compression turbines occurs throughout all components of the Project; at the LNG Facility: Gas Field Component (Field Compression Stations and Central Processing Plants) and Pipeline Component (e.g. inline compression station).

The other main sources of emissions associated with the construction and operations of the Project have been assessed and are detailed in *Table 7.2.2.*

2.2 EMISSIONS ESTIMATION METHODOLOGY

Greenhouse gas emissions presented in this assessment were calculated using the default emissions factors provided in the National Greenhouse and Energy Reporting System (NGERS)[7], developed and endorsed by the Australian Government.

Emission factors for calculating emissions of greenhouse gas are generally expressed in the form of a quantity of a given greenhouse gas emitted per unit of energy (kg CO_2-e /GJ) or fuel (t CH_4/t gas).

7 Australian Government (2008) *National Greenhouse and Energy Reporting (Measurement) Determination*

Emission factors are used to calculate greenhouse gas emissions by multiplying the emission factor (e.g. kg CO_2/GJ energy in diesel) with activity data (e.g. kilolitres of diesel x energy content of diesel used).

The emission factors used for calculating the Project's greenhouse gas impacts are provided in *Table 7.2.1* below.

Table 7.2.1 Default NGERS Emission Factors

		Emission Factors (kg CO_2-e/GJ)		
Emission	**Energy Content**	**CO_2**	**CH_4**	**N_2O**
Combustion of Coal Seam Methane	37.7 x 10^{-3} GJ/m^3	51.1	0.2	0.03
Diesel Oil – Stationary Sources	38.6 GJ/kL	69.2	0.1	0.2
Diesel Oil – Transport	38.6 GJ/kL	69.2	0.2	0.5
Gasoline – Transport	34.2 GJ/kL	66.7	0.6	2.3
		Emission Factors (t CO_2-e/pipeline km)		
Fugitive emissions from natural gas transmission	-	0.02	8.7	-
		Emission Factors (t CO_2-e/t fuel flared)		
Flaring of Natural Gas	-	2.7	0.1	0.03

2.3 GREENHOUSE GAS EMISSIONS FROM THE PROJECT

Greenhouse gas emissions have been estimated for each of the Project components. *Figure 7.2.1* below details estimated annual emissions from the Project over a 20 year operations period. This figure shows the increase in emissions over the lifetime of the Project as each processing unit, or "train", is commissioned. Further detail regarding emission estimates for each phase is provided in *Table 7.2.3*.

Figure 7.2.2 presents the greenhouse gas emission estimates for the operational phase of the Project. This includes a three train facility on Curtis Island and the Gas Field development and operation to support a two train facility. Activities at the LNG Facility represent approximately two-thirds of greenhouse gas emissions from the Project. Approximately 77 PJ of CSG per annum will be consumed in the extraction, transportation and liquefaction of the CSG during the operational stage, representing 11 per cent of the CSG extracted per annum.

Table 7.2.3 details the emissions estimation per annum from each of the Project phases – construction, commissioning and operation across each of the Project components. This table shows that for all Project components, the operational phase generates the largest emissions. Data presented in this table (and throughout Section 2.3) is representative of the current design of the Project.

Table 7.2.2 Main Greenhouse Emissions Sources Considered in each Phase of this Assessment

Project Phase	Upstream	Pipeline	LNG Facility
Construction	• **Transport:** truck movements for pipe deliveries, well development, compressor unit transportation, construction of campsites, heavy plant equipment transportation • **Combustion:** CSG combustion during development and testing of exploration wells **Personnel:** general vehicle movements.	**Transport:** truck movements for pipe deliveries and construction of campsites **Personnel:** general vehicle movements	• **Transport:** on-site vehicle movements • **Combustion:** diesel usage for stationary energy sources such as power generation. Temporary. • **Personnel:** ferry movements
Commissioning	Included in operations	Not applicable	• **Combustion:** CSG combustion in operating equipment (heaters, compressor and power generation turbines) **Flaring:** flaring of CSG
Operation	• **Transport:** vehicle movements associated with wellhead maintenance. • **Combustion:** wellhead pumps, compressors at Field Compression Stations (FCS) and Central Processing Plants (CPP), power generation at FCS and CPP • **Flaring/venting:** emissions from FCS and CPP during upset conditions.	• **Combustion**: compressors at the inline compressor station • **Fugitive:** fugitive emissions from transmission pipeline	• **Combustion**: gas for power generation, heating and compression • **Venting:** carbon dioxide extracted from the feed gas **Flaring:** During maintenance and upset conditions and off-specification gas from arriving ships

Figure 7.2.1 Annual Greenhouse Gas Emissions Estimates Over the Project Lifetime[8]

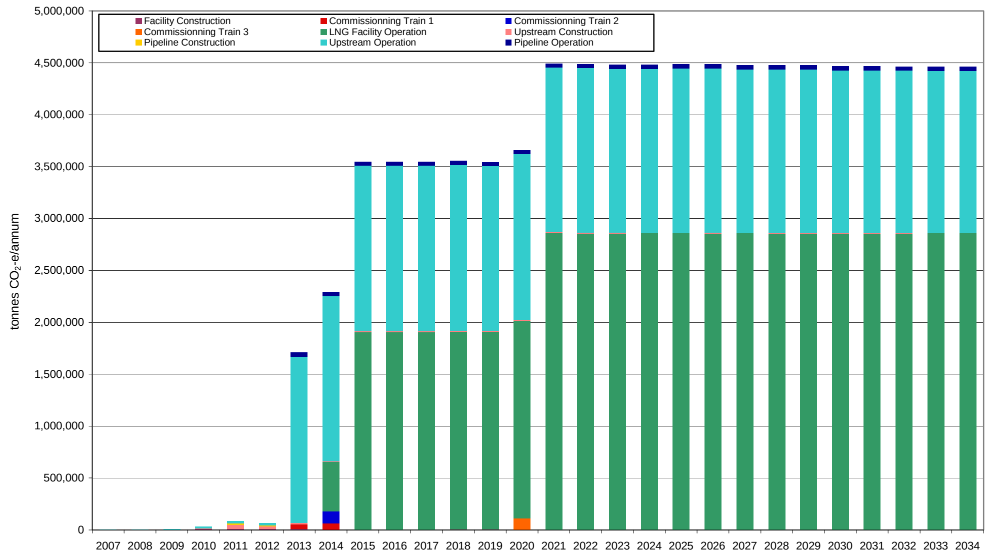


Figure 7.2.2 Greenhouse Gas Emissions Estimates for the Operational Phase of the Project

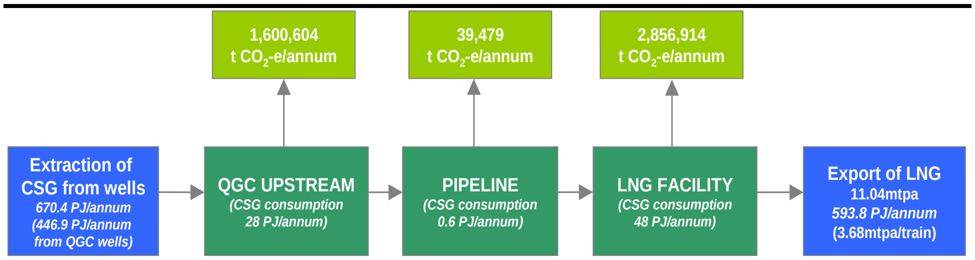


Table 7.2.3 Summary of Maximum Annual Greenhouse Gas Emissions Associated with the Project

Project component	Construction [1] (tCO_2-e/annum)	Commissioning [2] (tCO_2-e/annum)	Operation [3] (tCO_2-e/annum)
Gas Field[4]	38,979	-	1,600,604
Pipeline	16,439	-	39,479
LNG Facility	10,303	112,348	2,856,914

1. Construction emissions from each Project component are anticipated to occur concurrently. Construction of the LNG Facility is anticipated to commence in 2010 with construction of the first two trains lasting approximately 45 months. Construction of Gas Field and Pipeline Components will commence in 2011 lasting approximately 18 months (excluding well development which continues throughout the life of the Project). Data presented in this table are indicative of emissions over a 12-month period, not annual average emissions.
2. Commissioning of each train is anticipated to last seven months; as such annual emissions presented in the table will occur only over a seven-month period.
3. Operational emissions for Project components occur concurrently. Data presented in this table are representative of a three-LNG-train operation. All three trains are expected to operate from 2021 onwards.
4. For a two train Gas Field Component only

8 Estimate based on a three train LNG facility on Curtis Island, and the Gas Field development and operation (including export pipeline) to support a two train facility.

Table 7.2.4 details the emission estimates for each phase of the Project's expected life.

Table 7.2.4 Summary of Project Life Greenhouse Gas Emissions Associated with the Project

Phase	Duration	Total Emissions (tCO_2-e)
GAS FIELD		
Construction [2]	26 years	213,868
Operation [1]	28 years	34,884,962
PIPELINE		
Construction	18 months	24,658
Operation [1]	22 years	868,536
LNG FACILITY		
Construction	89 months[3]	76,413
Commissioning	21 months	337,044
Operation [1]	20 years[1]	51,900,601
TOTAL PROJECT EMISSIONS		**94,972,214 tCO_2-e**

1. Duration of operation is based on an estimated 20-year project life. Total LNG Facility operational emissions are based on 20 years operation
2. Gas Field construction includes the drilling of new CSG wells, which occurs throughout the life of the Project. Construction of pipelines and processing facilities occur over an approximate 18-month period.
3. LNG Facility construction is estimated based on concurrent construction of trains 1 and 2 as described in *Volume 2 Chapter 13* in addition to an indicative construction duration for construction of train-3 subsequent to commission of Train 2.

To provide a comparison between Project components, on the basis of only a two train project approximately half of emissions are a result of the LNG Facility. The majority of remaining emissions result from compression and processing at the FCSs and CPPs in the Gas Field Component area.

The total greenhouse gas emissions over the lifetime of the project are estimated to be 95 million tCO_2-e (94,972,214 tCO_2-e). This is based upon the Project application of a three train facility on Curtis Island and Gas Field operations to support a two train facility.

This incorporates the effect of a number of innovative measures to reduce emissions which are detailed in *Section 2.4*. The impacts of this on climate change are discussed in *Volume 5, Chapter 2*.

2.4 MITIGATION MEASURES

Combustion of CSG is the primary source of greenhouse gas emissions from the Project. Mitigation measures have therefore focused on maximising the efficiency of activities that require CSG combustion.

2.4.1 *Mitigation in the LNG Facility Design*

Careful examination of alternative technologies and processes to improve efficiency and minimise emissions of greenhouse gases has shaped the Project.

Key components of the process design include the liquefaction system, cooling system, turbine drivers, power generation and fuel system. Alternatives were evaluated in the preliminary studies as well as in the Pre-Front End Engineering and Design (Pre-FEED) phase of the Project.

The process started with an initial concept design for the Project, developed and based upon the proven technologies employed in BG Group's Atlantic LNG (first LNG produced in 1999) and Egyptian LNG (first LNG produced in 2005) liquefaction plants. BG Group's next generation of LNG trains are targeting a significant reduction in greenhouse gases on a unit production (greenhouse gas intensity) over previous BG Group liquefaction plants.[9]

Four technically feasible liquefaction technologies were assessed. These technologies were viewed broadly equivalent from an environmental standpoint for their similar levels of operational efficiency and energy requirements.

The ConocoPhillips Optimized Cascade^{SM} technology was selected for the following reasons:

- benchmarking with existing LNG plants - a proven LNG technology and has performed well in comparison to other alternatives
- BG Group is familiar with the Optimized Cascade^{SM} process through its position as a stakeholder in the Atlantic LNG and Egyptian LNG liquefaction plants
- the LNG Facility can easily accommodate variations in gas composition and volume.

2.4.1.1 *Benchmarking the Concept Design*

A common metric to compare efficiency of LNG developments is a measurement of tonnes of greenhouse gas emitted to the atmosphere for each tonne of LNG produced. This calculation is expressed as **tCO_2-e/tLNG**. This measure of greenhouse gas intensity provides a benchmark by which to compare greenhouse emissions of various LNG facilities.

Emissions intensity of LNG facilities is influenced by a range of internal (technology) and external (environmental/geographic) factors.

9 BG Project Report, Economic Comparison between Nuovo Pignone PGT25+G4 and MS5002-D (Frame 5D), QCLNG-HOU-ENG-POC-RPT-0006

Technological and process factors that influence greenhouse gas intensity include:

- choice of liquefaction technology
- assumptions regarding the amount of flaring that may be required
- power generation – choice of energy source, technology and configuration
- waste heat recovery.

The main factors external to the process that have a significant impact on greenhouse gas efficiency are:

- the ambient temperature at the LNG facility (combustion efficiency improves with cooler temperatures)
- the CO_2 content of the gas entering the LNG Facility.

Carbon dioxide contained in the feed gas stream must be removed prior to the liquefaction process and therefore higher CO_2 content feed gas results in greater CO_2 removal prior to liquefaction. Vented reservoir CO_2 will directly influence the greenhouse gas footprint of an LNG plant.

In the case of the Project, the CO_2 content of the feedstock CSG is minimal. Reservoir CO_2 is less than 1 per cent and has been assumed as 1 per cent for the purposes of emission estimation. Actual CO_2 content of the CSG is expected to be lower than this, and may be as low as 0.2 per cent.

Notwithstanding these differences, benchmarking emissions intensity of the Project against other LNG projects provides a measure of performance in the industry. Benchmarking was undertaken as a comparison of greenhouse gas intensity for a range of LNG facilities and the QCLNG Concept Design. Concept design is how the Project is presented prior to the identification and modelling of mitigation measures and strategies, which are incorporated in the current design. Benchmarking of concept design (and comparison with the current design) is included in *Figure 7.2.4*

Greenhouse gas intensity of the current design was then assessed, based on the current design which considered primary greenhouse gas emission sources, and therefore opportunities to significantly reduce emissions, from the Facility resulting from the following:

- gas turbine selection for compression
- waste heat recovery
- gas turbine selection for electricity generation.

A Best Available Techniques (BAT) analysis of these key LNG processes (compression, power generation and heating) performed during design of the LNG Facility is discussed below.

2.4.1.2 *Gas Turbine Selection for Compression*

The Project will employ aero-derivative gas turbines, matching the reliability of proven technology with the most efficient gas turbines available for the Optimized Cascade^{SM} LNG process.

While increased efficiency reduces greenhouse gas emissions, the turbines are also designed to cut emissions of other pollutants, such as nitrogen oxides.

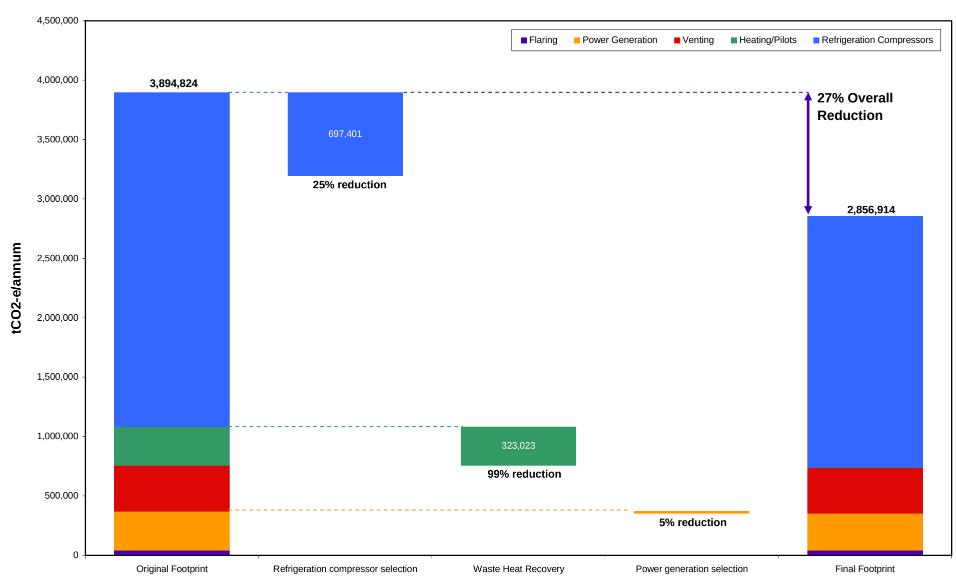
The original concept design for gas turbine compression within the Project proposed General Electric (GE) ‘Frame 5D’ turbines, proven technology currently in use at the Egyptian LNG and Atlantic LNG liquefaction plants.

A BAT review of turbine options approved for the Optimized Cascade^{SM} LNG process revealed aero-derivative turbines were a recent, improved option. GE LM2500+ aero-derivative turbines are in use at the Darwin LNG facility operated by ConocoPhillips.

The compressor turbine selection review undertaken as part of the design process has resulted in the selection of the next generation GE ‘LM2500+G4’ turbine.

The compressor turbines will employ inlet air chilling, an innovation that improves the turbines’ efficiency.

Figure 7.2.3 Best Available Technique Reduction Options



As indicated in *Figure 7.2.3* above, the selection of aero-derivative turbines and inlet air chilling results in a 25 per cent reduction in greenhouse gas emissions (697,401 tonnes of CO_2-e) associated with refrigeration compression compared to the concept design.

2.4.1.3 *Waste Heat Recovery*

Process heat is required as part of plant operations. The concept design proposed the use of gas-fired heaters to provide process heat.

Waste heat recovery units, an alternate option for supplying process heat, were evaluated. Waste heat recovery uses the rejected heat from refrigeration compressor turbine drivers to provide heat required for other processes.

Installing process-derived waste heat recovery lowers fuel consumption by eliminating direct-fired heaters, resulting in reduced greenhouse gas (and air quality pollutant) emissions.

As indicated in *Figure 7.2.3*, the selection of waste heat recovery results in a 99 per cent reduction in greenhouse gas emissions (323,023 tonnes of CO_2-e) associated with process heat requirements compared to the concept design.

2.4.1.4 *Gas Turbine Selection for Electricity Generation*

The concept design for power generation at the LNG facility proposed Solar Taurus 70 turbines, which is proven technology currently used at Egyptian LNG and Atlantic LNG.

The turbine selection review undertaken as part of the design process led to the selection of the GE LM2500+G4 turbine, the same model as proposed for the refrigeration compression.

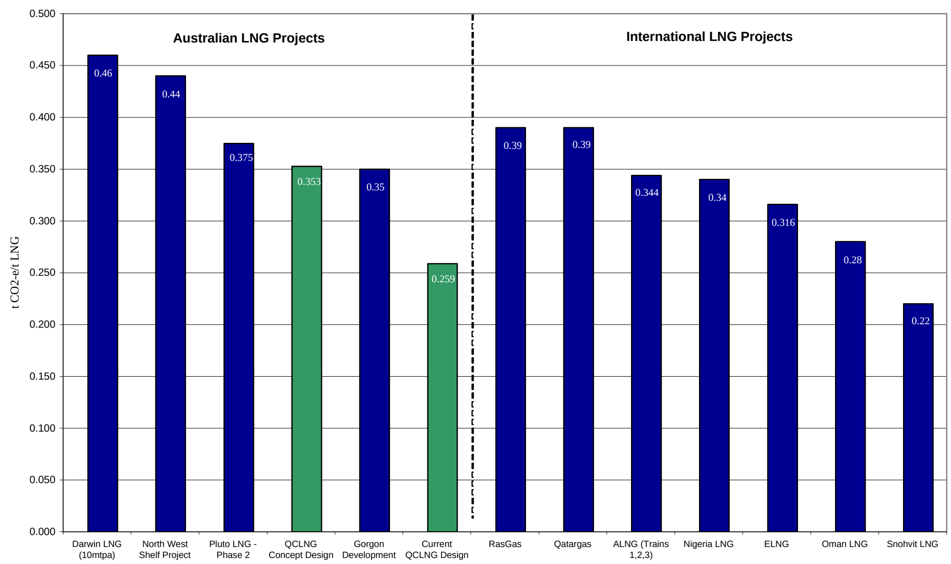
As indicated in *Figure 7.2.3* the selection of GE LM2500+G4 turbines results in a 5 per cent reduction in greenhouse gas emissions (17,486 tonnes of CO_2-) associated with compression compared to the concept design.

2.4.1.5 *Benchmarking the Current Design*

The BAT analysis of key LNG processes (i.e. compression, power generation and heating) has led to the current design for the Project. A 27 per cent reduction in emissions intensity against the concept design has been achieved through innovative technology and design.

A comparison of the greenhouse gas emissions intensity of the concept and current design options is shown in *Figure 7.2.4* compared with other LNG facilities. The facilities are grouped by location (Australian and international). Of the facilities shown, Atlantic LNG, Egyptian LNG and Darwin LNG use the ConocoPhillips Optimized Cascade technology. The Projects included in this benchmarking have been selected as they are the Projects for which data can be publically obtained.

Figure 7.2.4 Benchmarked Greenhouse Emissions Intensity [10] [11]



This analysis shows that the Project will incorporate one of the least greenhouse gas intensive LNG facilities in the world. Only the Snohvit LNG development has a better LNG greenhouse gas efficiency.

The Snohvit LNG Project, located just above the Arctic Circle, comprises subsea development of an offshore gas field with subsequent re-injection of reservoir CO_2. The published emission intensity of the operation (0.22 t $CO_{2\text{-e}}$ / t LNG) is based on the assumption that all reservoir CO_2 will be injected into the subsurface (i.e. includes reservoir vented/abated emissions). Further, the colder operating temperatures when compared to Queensland allow the gas turbines, and the LNG process in general, to operate more efficiently.

2.4.2 Mitigation in the Gas Field Component and Pipeline Component

The Project represents one of the first developments to use CSG as the feedstock for LNG production. The use of CSG presents a number of technical challenges that differ from those encountered in traditional gas reservoir LNG production. Approximately 100 CSG wells are required to produce the same volume of gas as a typical single offshore well. As a result, the use of CSG requires a significant field-gathering network to transport the gas from an eventual 6,000 wells (for a two train LNG facility) through Field

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10 Based on BG Data (QCLNG, ALNG, ELNG Projects) and Gorgon LNG Project GHG assessment, accessed via: http://www.gorgon.com.au/03-man_environment/EIS/gorgon_ch13_LR.pdf

11 Data presented in this analysis for QCLNG concept and current design has the same venting and flaring assumptions

Compression Stations (FCSs), Central Processing Plants (CPPs) and eventually the export pipeline to the LNG Facility.

In the Gas Field and Pipeline Components of the Project, compressing the CSG is the primary generator of greenhouse gas emissions. Gas-fired compressors will be used at each of the proposed 27 FCSs and the nine CPPs throughout the CSG fields and the pipeline. Greenhouse gas emissions will be one of the aspects further evaluated for reduction as the detail of the compression design is optimised and turbines chosen.

Other opportunities that are proposed to be evaluated to reduce the emissions in the Gas Field and Pipeline Component include:

- optimisation of the gas field development including the size and number of CPPs
- opportunities for waste heat recovery
- selection of compressor types.

3 ASSESSMENT

3.1 NATIONAL AND STATE GREENHOUSE EMISSIONS CONTRIBUTION

The estimate of emissions from all Project components during peak operation is 4,496,997 tCO_2-e per annum. This is based upon the Project application of a three train facility on Curtis Island and Gas Field operations to support a two train facility.

In 2006, annual greenhouse gas emissions in Australia were estimated at 576,035,430 t CO_2-e[12]. Emissions in Queensland for that year were 170,933,344 t CO_2-e.

Based on this data, annual emissions from the Project are equivalent to approximately 0.78 per cent of Australia's annual emissions in 2006 and 2.63 per cent of Queensland's annual emissions in 2006 based on the current design.

3.2 CARBON POLLUTION REDUCTION SCHEME (CPRS)

The CPRS will set an annual cap, which represents the total greenhouse gas emissions that can be emitted by all (approximately 1,000) entities in the scheme. The initial scheme cap will be commensurate with the Government short-term target of a reduction between 5 per cent and 25 per cent of 2000 levels of greenhouse gas emissions by 2020, depending on the level of international agreement.

The Project has an obligation under the CPRS as annual emissions from the Project exceed the 25,000 t CO_2-e threshold. The CPRS scheme is proposed to commence in 2011 while train one is expected to commence operation in 2014.

12 Reporting year 2006, Kyoto framework, Australian Greenhouse Emissions Information System http://www.ageis.greenhouse.gov.au/

4 ONGOING MONITORING & MANAGEMENT

4.1 GREENHOUSE GAS MANAGEMENT PLAN

Ongoing management and monitoring for the construction, commissioning and operational phases of the Project ensures that commitments for energy efficiency and greenhouse gas-emission minimisation are met.

Management, monitoring and auditing provisions will be incorporated in a Greenhouse Gas Management Plan (GHGMP), which will be a component of the wider Environment Management Plan (EMP) and QGC's Environmental Management System (EMS). This overall approach includes the management, measurement and recording of:

- energy use
- greenhouse gas emissions
- transport activities
- waste management.

The GHGMP will incorporate and coordinate the following Project requirements:

- the BG Group Greenhouse Gas Management Standard
- QCLNG Project commitments
- Australian Government requirements
- Queensland Government reporting requirements
- participation in voluntary reporting programmes.

Throughout the design process, assessment of greenhouse gas mitigation options will continue. While many of the key Project decisions relating to equipment selection have been made, the opportunity exists to continue to optimise energy consumption throughout the Project.

Elements of the Project that require further consideration include:

- construction activities - selection of the final options for transportation (of people and equipment) and fuel at stationary sources
- drilling – the ongoing efficiency and opportunity for improvement during the ongoing drilling program
- flare mitigation – during the detailed design stage to minimise flaring during commissioning and operation
- commissioning of the LNG Facility – detailed plan which will minimise emissions of greenhouse gas

- operation – design and review of processes and operational procedures which assess alternatives, maximising efficiency and minimising emissions associated with flaring, loading of ships and operation of compression stations.

4.2 AUDITING AND REPORTING REQUIREMENTS

The Project is subject to a number of regulatory requirements in addition to BG Group requirements. Among BG's environmental objectives, it aims:

- to minimise the emission of carbon dioxide and methane per unit of hydrocarbon produced/transmitted
- to make a material reduction in these emissions from a business-as-usual baseline.

To contribute to achieving these objectives, all BG Group facilities:

- quantify emissions of greenhouse gases
- identify options to reduce those emissions
- document local targets for emission reductions.

4.2.1 *National Greenhouse and Energy Reporting System (NGERS)*

NGERS requires reporting of greenhouse gas emissions and energy data to the Department of Climate Change (Cth). NGERS commenced on 1 July 2008, with reporting for the first year (01 July 2008 – 30 June 2009) required to be submitted by 31 October 2009. Subsequent reports are required to be submitted by 31 October each year.

4.2.2 *Carbon Pollution Reduction Scheme*

The CPRS is expected to commence on 1 July 2011. Large emitters (those with emissions greater than 125,000 t CO_2-e/annum) are required to have their annual emissions reports audited by an independent third party prior to submission to the Regulator. Upon submission of an annual emissions report, the entity is required to surrender enough emissions permits to cover their emissions obligations.

4.3 PROJECT COMMITMENTS

- The following management measures will be employed with the aim of minimising energy consumption and greenhouse gas emissions:
- In design and operation:

  - evaluate opportunities to optimise the greenhouse gas emissions as the design progresses through Front End Engineering
  - update the forecast of greenhouse gas emissions as the design is finalised to act as a benchmark against which the operation of the plant may be measured
  - establish within the operational and maintenance management systems the controls required to monitor performance and control emissions

- annual reporting of emissions and the results of emissions mitigation programmes.
- For construction activities, include in the construction management plans for the Project:
  - the consideration of energy efficiency and reducing greenhouse gas emissions
  - strategies to reduce the number of vehicle kilometres travelled as part of construction phase
  - procurement to consider the efficiency of all new mobile and fixed equipment, both diesel and electric powered.

These greenhouse mitigation and monitoring programs will be used as appropriate throughout the life of the Project.

5 CONCLUSION

It is important that new energy projects employ technology and designs to minimise the intensity of their emissions.

Estimated emissions from all components of the Queensland Curtis LNG (QCLNG) Project during peak operation of the three LNG processing units, or "trains", is 4,496,997 t CO_2-e per annum (on the basis of a 2 train upstream development). The major emissions sources of the Project are the LNG Facility, Field Compression Stations and Central Processing Plants in the Gas Field Component of the Project.

The Project design will employ advanced and efficient technology, including aero-derivative gas turbines in the LNG Facility. This leads to a 27 per cent reduction in greenhouse gas-emissions intensity from concept to current design as presented in this Environmental Impact Statement (EIS). The LNG Component will be one of the most emissions efficient in the world.

Management, monitoring and auditing of greenhouse gases will be incorporated in a Greenhouse Gas Management Plan, a component of a wider Environment Management Plan (EMP) and BG Group's Environmental Management System (EMS).

The combination of design, technology and management of the QCLNG Project will set a standard for greenhouse gas management and LNG operations both in Australia and internationally.