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Vipac Engineers & Scientists

Bindaree Beef Pty Ltd

Bindaree Beef EIS

Greenhouse Gas Assessment

70Q-13-0318-TRP-515721-4

21 Mar 2014

Report Title: Greenhouse Gas Assessment **Job Title: Bindaree Beef EIS**	
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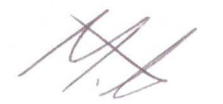
PREPARED BY: Author:	 Michelle Clifton Consulting Scientist	Date: 21 Mar 2014
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EXECUTIVE SUMMARY

Vipac Engineers & Scientists Ltd (Vipac) was commissioned to prepare a Greenhouse Gas Assessment for the proposed new rendering plant and waste water treatment system. The purpose of this report is to calculate the greenhouse gas emissions of the construction and operation of the new facility over the 30-year life of the Project.

The proposed bio-digester will generate bio-gas from production, waste product and effluent, utilising this gas for creating energy. This process eliminates the need for coal and reduces electricity needs. The net result is zero discharge of waste, improved environmental outcomes and a significant reduction in carbon emissions.

The greenhouse gas emissions for 2012-2013 were calculated to be 64.73 kilotonnes CO_2-e per annum, based on production values provided by Bindaree Beef. At full capacity the emissions would increase to 68.8 kilotonnes per annum. Comparing the results of the current and future cases at full capacity, 33.7 kilotonnes per annum is predicted to be saved. Over the 30 year life of the Project this equates to 1,013 kilotonnes of CO_2-e.

The main savings are:

- 16.07 kilotonnes CO_2-e per annum (482 kilotonnes CO_2-e over the life of the Project) is achieved by the removal of coal burning boiler and its associated transportation;
- 16.38 kilotonnes CO_2-e per annum (491 kilotonnes CO_2-e over the life of the Project) is achieved by installing the anaerobic digesters to capture methane and convert it to carbon dioxide (based on a production capacity of 1,100 cattle per day); and
- 2.2 kilotonnes CO_2-e per annum (66.5 kilotonnes CO_2-e over the life of the Project) is achieved from the reduction in purchased electricity.

This Project will reduce Bindaree Beef's overall greenhouse gas emissions by 52% per annum.

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1 INTRODUCTION

Vipac Engineers & Scientists Ltd (Vipac) was commissioned to prepare a Greenhouse Gas Assessment for the proposed new rendering plant and waste water treatment system. The purpose of this report is to calculate the greenhouse gas emissions of the construction and operation of the new facility over the 30-year life of the Project.

2 PROJECT DESCRIPTION

2.1 Overview

Bindaree Beef is one of Australia's largest meat processors and a prominent leader in the Australian meat industry. Located west of Inverell in northern NSW, the plant is capable of processing 1,100 cattle per day.

Bindaree Beef is located approximately 3 km west of the township of Inverell in northern NSW within the Inverell Shire Council local government area. The area of the abattoir and surrounding holding pens is 143 ha, whilst the adjoining farm “Alsace” is 491 ha which is also owned by Bindaree Beef.

The proposed bio-digester will generate bio-gas from production, waste product and effluent, utilising this gas for creating energy. This process eliminates the need for coal and reduces electricity needs. The net result is zero discharge of waste, improved environmental outcomes and a significant reduction in carbon emissions.

2.2 Existing Operations

The current waste processing process at Bindaree Beef involves:

- Waste effluent travels through a trommel and flotation tank before entering an anaerobic lagoon and then aerobic lagoons for treatment;
- Paunch material is separated at trommel and trucked to land fill;
- Steam (for render cooking and heating) is produced by two coal-fired boilers; and
- All animal by-products from the processing areas are cooked up in two cookers using steam generated by the coal fired boiler, flowing into four meal presses. From here it is loaded out as meat meal or tallow.

2.3 Proposed operations

In its simplest form, the Bindaree Beef Project will comprise:

- New, highly effective waste treatment system that will produce biogas, low-strength effluent and solid fertiliser products;
- Biogas utilisation system that will generate power and steam for onsite use; and
- New state-of-the-art energy efficient render plant that will use less electricity and steam.

There will be no modifications to how the cattle are processed, apart from the wastewater (red and green stream waste) being redirected to the bio-digester. The waste streams are:

- Paunch and manure (green waste stream);
- Inedible by-products; and
- Blood and wash down water (red waste stream).

2.4 Bio-digester Plant

All Bindaree Beef's red and green waste streams will be diverted from high-emitting anaerobic lagoons to power a state-of-the-art anaerobic Mesophilic Bio-digester. The process will have zero discharge within a "closed loop" system. The Bio-digester will be installed near the current processing plant. All waste effluent (red stream, green stream, paunch and cattle yards material) will be directed through the digester process. All emissions (methane) will be captured and stored in domes for use. Methane from the bio-digester will be used to run boilers to create hot water and steam, for use within the rendering plant. Methane will also be used to generate electricity to power the biodigester. The switch to renewable energy generated by the bio-digester means the abattoir will eliminate 100% of the current 7,200 tonnes of coal needed to fire the render plant boilers.

The Project will have a significant impact on the manufacturing process by transforming what were previously considered waste products into new energy sources. It will reduce the abattoir's operating costs while generating new sources of income. Figure 2-1 shows the waste generated from the manufacturing operations at Bindaree Beef.

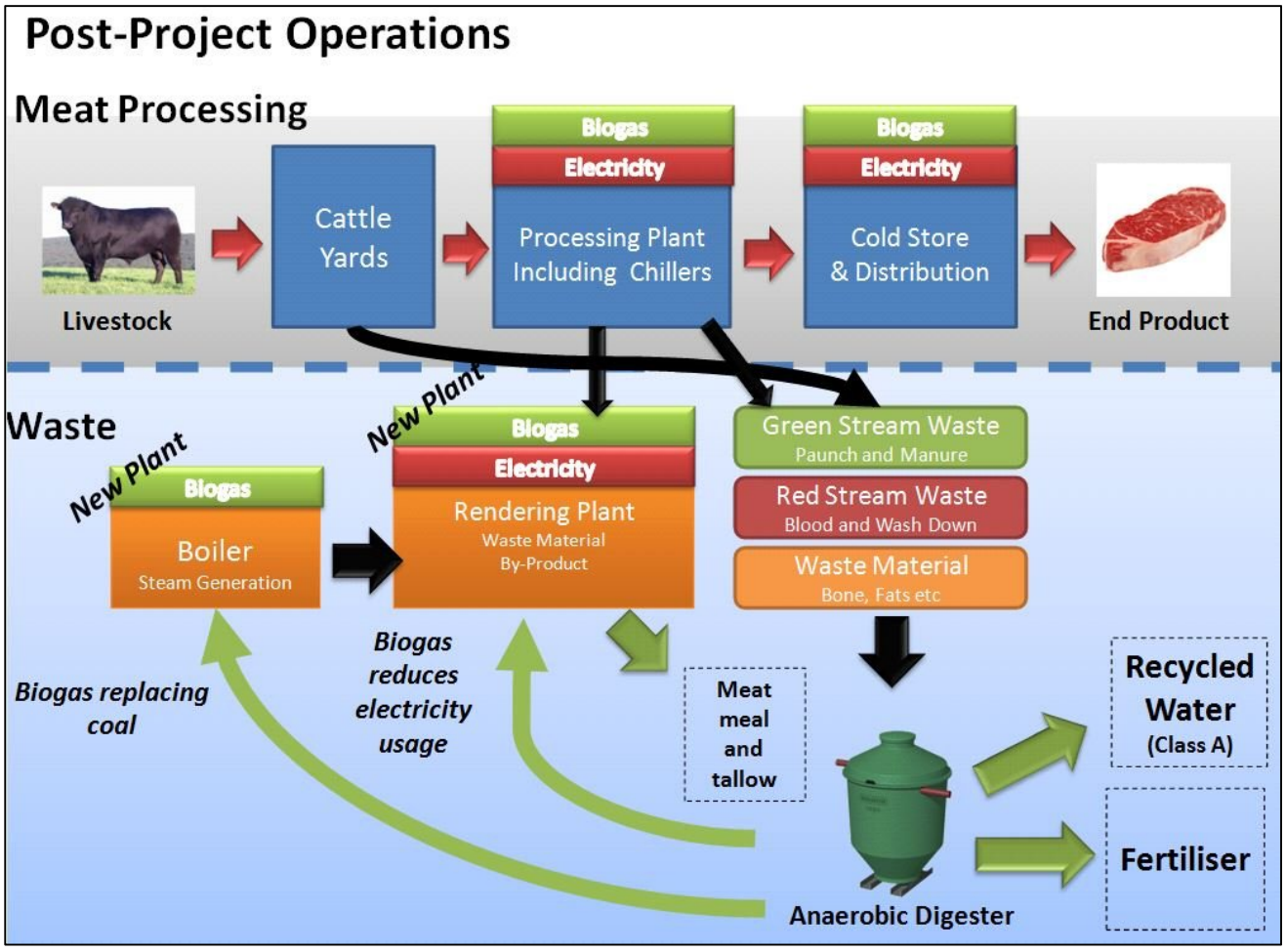

Figure 2-1: Waste Streams from the Proposed Operations

Figure 2-2 shows the proposed layout for the new rendering plant and bio-digester plant, displayed in orange.

2.5 Methane Gas Storage

The bio-digester plant will store gas in a standalone biogas storage holder. The storage holder comprises an outer membrane designed to provide protection against external climatic loads and an inner membrane separated by a pressurised air space between them. The inner membrane is free to inflate and deflate, depending on the amount of gas stored, however the outer membrane at all times remains fully inflated. The pressurised airspace between the membranes allows the gas stored in the tank to vary while providing a consistent positive pressure on the stored gas.

At full storage capacity will be approximately 9,000 m³ of Biogas with a methane content of approximately 65%-70%. The storage will generally be at full capacity at the beginning of the week and will decrease in volume towards the end of the week then return to full capacity over the weekend.

2.6 By-Products

The digestate output from the plant is a rich source of plant nutrition. During anaerobic digestion all of the nitrogen, phosphate and potash from the feedstock are retained in the digestate making it a useful organic fertiliser. The major volume of digestate, in liquid from, will be used on-farm under an appropriate crop management plan. A smaller portion of the digestate will be dried using the plant's residual heat. When the digestate is dried, the resulting product can be used as an organic fertiliser on crop pastures, either on the adjacent farm or taken off-site.

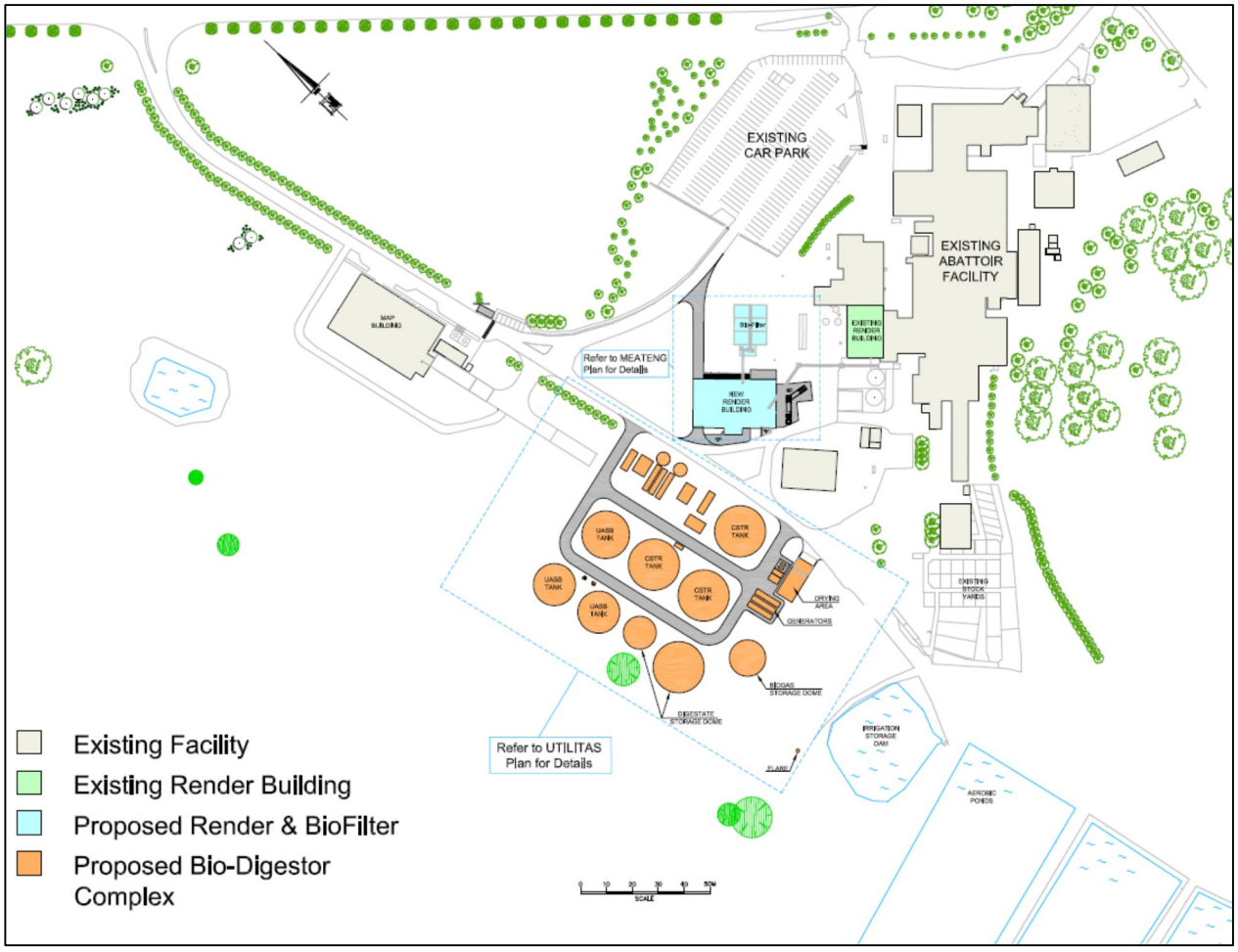

Figure 2-2: Site Layout [MEATENG Drawing Number P115 dated Feb 2014]

2.7 Rendering Plant

A rendering plant processes inedible cattle by-products from the abattoir and converts this waste material into tallow and meat meal products. The rendering plant will be upgraded to the latest energy efficient technology that makes better use of steam and electricity. The building will be fully enclosed, well ventilated with point source extraction for odour control. The rendering building will have three separate process areas; raw material receival; wet area for cooking and pressing; and dry product and storage areas.

An integral part of the new rendering plant is the use of renewable energy source (methane gas from the bio-digester plant) as a fuel source for the steam boilers. The existing plant has two coal fired boilers for generating steam, primarily for heating the continuous cookers. The proposed rendering plant has reduced thermal loading and will rely upon steam generated by a single Bio-gas fired boiler. There will be no operational down time with the commissioning of the new plant as the existing plant will continue to operate.

3 TECHNICAL CONSIDERATIONS

Climate change is a change in the average pattern of weather over a long period of time. There is evidence that our climate is changing, largely due to human activities. The Fourth Assessment Report, produced by the Intergovernmental Panel on Climate Change (IPCC) in 2007, states global warming is 'unequivocal' and 'most of the observed increase in globally-averaged temperatures since the mid-20th century is very likely due to the observed increase in greenhouse gas concentrations'.

There are multiple lines of evidence that show the Earth's climate system is warming. These include increases in global average air and ocean temperatures, widespread melting of snow and ice, and rising global average sea level. Climate change, however, is not just about global warming; the science indicates that the climate will be altered in many other ways. For example, there will be changes in rainfall patterns and ocean currents, changes to the intensity and frequency of extreme events such as storms, droughts and floods, rising global sea level and ocean acidification.

3.1 GREENHOUSE GASES & GLOBAL WARMING POTENTIAL

Greenhouse gases are a natural part of the atmosphere; they absorb and re-radiate the Sun's warmth, and maintain the Earth's surface temperature at a level necessary to support life. Human actions, particularly burning fossil fuels (coal, oil and natural gas), agriculture and land clearing, are increasing the concentrations of the gases that trap heat. This is the enhanced greenhouse effect, which is contributing to warming of the Earth.

Greenhouse gases include water vapour, carbon dioxide CO_2, methane, nitrous oxide and some artificial chemicals such as chlorofluorocarbons (CFCs). Water vapour is the most abundant greenhouse gas. Its concentration is highly variable and human activities do not directly impact on its amount in the atmosphere. The concentrations of the other greenhouse gases in the atmosphere are directly influenced by human activities. Once released into the atmosphere, many of these gases remain there for a long time.

Standard units of measurement are prescribed for the standard reportable items; emissions of each greenhouse gas are be estimated and reported in tonnes of CO_2-equivalent. Conversion factors from tonnes of emissions of each greenhouse gas to tonnes of emissions of carbon dioxide equivalent for that gas are called Global Warming Potentials (GWP) and are listed in Table 3-1.

Table 3-1: Global Warming Potentials

Greenhouse Gas		Chemical Formula	Global Warming Potential
Carbon dioxide		CO_2	1
Methane		CH_4	21
Nitrous oxide		N_2O	310
Sulphur hexafluoride		SF_6	23,900
Hydrofluorocarbons	HFC-23	CHF_3	11,700
	HFC-32	CH_2F_2	650
	HFC-41	CH_3F	150
	HFC-43-10mee	$C_5H_2F_{10}$	1,300
	HFC-125	C_2HF_5	2,800
	HFC-134	$C_2H_2F_4$ (CHF_2CHF_2)	1,000
	HFC-134a	$C_2H_2F_4$ (CH_2FCF_3)	1,300
	HFC-143	$C_2H_3F_3$ (CHF_2CH_2F)	300
	HFC-143a	$C_2H_3F_3$ (CF_3CH_3)	3,800
	HFC-152a	$C_2H_4F_2$ (CH_3CHF_2)	140
	HFC-227ea	C_3HF_7	2,900
	HFC-236fa	$C_3H_2F_6$	6,300
	HFC-245ca	$C_3H_3F_5$	560
Perfluorocarbons	Perfluoromethane	CH_4	6,500
	Perfluoroethane	C_2F_6	9,200
	Perfluoropropane	C_3F_8	7,000
	Perfluorobutane	C_4F_{10}	7,000
	Perfluorocyclobutane	c-C_4F_8	8,700
	Perfluoropentane	C_5F_{12}	7,500
	Perfluorohexane	C_6F_{14}	7,400

The Global Warming Potential figures in the above table are the figures published by the Intergovernmental Panel on Climate Change in Climate Change 1995: The Science of Climate Change (Cambridge, UK: Cambridge University Press, 1996).

3.2 DIRECT & INDIRECT EMISSIONS

Direct emissions are produced from sources within the boundary of an organisation and as a result of the organisation's activities. These emissions mainly arise from the following activities:

- Generation of energy, heat, steam and electricity, including carbon dioxide and products of incomplete combustion (methane and nitrous oxide);
- Manufacturing processes that produce emissions (for example, cement, aluminium and ammonia production);
- Transportation of materials, products, waste and people; for example, use of vehicles owned and operated by the reporting organisation;
- Fugitive emissions: intentional or unintentional GHG releases (such as methane emissions from coal mines, natural gas leaks from joints and seals); and
- On-site waste management, such as emissions from landfill sites.

Indirect emissions are emissions generated in the wider economy as a consequence of an organisation's activities, but which are physically produced by the activities of another organisation. The most important category of indirect emissions is from the consumption of electricity.

4 LEGISLATION

4.1 INTERNATIONAL POLICY

The Kyoto Protocol is an international agreement created under the United Nations Framework Convention on Climate Change (UNFCCC) in Kyoto, Japan in 1997. Australia ratified the Protocol in 2007, which came into effect in 2008.

The Kyoto Protocol aims to reduce global greenhouse gas emissions by requiring developed countries to meet internationally agreed emission reduction or limitation targets for the period 2008 - 2012. Australia committed to ensuring its greenhouse gas emissions during this period were no more than 8% above the levels they were in 1990. The second commitment period of the Kyoto Protocol commenced 1 January 2013 and ends in 2020. Australia has agreed a Kyoto target to reduce its emissions in line with the bipartisan target of reducing emissions to five per cent below 2000 levels by 2020.

4.2 NATIONAL POLICY

The Australian policy on climate change was initially set out in the National Greenhouse and Energy Reporting Act 2007 however, the policy has been updated in 2011 when the Clean energy Act received the Royal Ascent.

4.2.1 Clean Energy Act (2011)

The Clean Energy Act sets out the way that Australia will introduce a carbon price in the aim of reducing Australia's carbon pollution and move to a clean energy future. The legislation also sets out how the carbon pricing mechanism will be run, and outline business' responsibility. Additionally, the legislation sets up:

- A Clean Energy Regulator to administer the carbon pricing mechanism, the National Greenhouse and Energy Reporting scheme, the Renewable Energy Target and the Carbon Farming Initiative; and
- An independent Climate Change Authority, which will advise the Australian Government on the setting of carbon pollution caps and periodic review of the carbon pricing mechanism and other climate change laws.

4.2.2 National Greenhouse and Energy Reporting Act (2007)

The National Greenhouse and Energy Reporting Act 2007 (NGER Act) introduced a single national framework for the reporting and dissemination of information about the greenhouse gas emissions, greenhouse gas Projects, and energy use and production of corporations. The objectives of the NGER Act are to:

- Underpin the introduction of an emissions trading scheme;
- Inform government policy formulation and the Australian public;
- Help meet Australia's international reporting obligations;
- Assist Australian, state and territory government programs and activities; and
- Avoid the duplication of similar reporting requirements in the states and territories.

From 1 July 2008, corporations have been required to register and report their greenhouse gas emissions, energy production and consumption if:

- They control facilities that emit 25 kilotonnes or more of greenhouse gas (CO_2 equivalent), or produce/consume 100 terajoules or more of energy; or
- Their corporate group emits 125 kilotonnes or more greenhouse gas (CO_2 equivalent), or produces/consumes 500 terajoules or more of energy.

5 METHODOLOGY

5.1 PRINCIPLES OF REPORTING

Section 1.13 of the *Technical Guidelines for the Estimation of Greenhouse Gas Emissions by Facilities in Australian* (Department of Climate Change and Energy Efficiency, 2013) outlines the general principles for estimating emissions. The principles are as follows:

a. Transparency - emission estimates must be documented and verifiable;

b. Comparability - emission estimates using a particular method and produced by a registered corporation in an industry sector must be comparable with emission estimates produced by similar corporations in that industry sector using the same method and consistent with the emission estimates published by the Department in the National Greenhouse Accounts;

c. Accuracy - uncertainties in emission estimates must be minimised and any estimates must neither be over nor under estimates of the true values at a 95% confidence level; and

d. Completeness - all identifiable emission sources must be accounted for.

It should be noted that Bindaree Beef already report emissions under the NGER Act and are currently liable for carbon tax payments.

5.2 EMISSION SOURCES & SCOPE CLASSIFICATION

Greenhouse Gas emissions for various sources should be reported where facilities exceed the trigger level for reporting under the NGER Act. The sources of emissions are based on those provided in the IPCC Guidelines for National Greenhouse Gas Inventories.

The National Greenhouse Accounts (NGA) Factors Workbook (2013), divide the emission factors by activities as shown in the Table 5-1, the scope that emissions are reported under is determined by whether the activity is within the organisation‘s boundary (Scope 1 – Direct Emissions) or outside the organisation’s boundary (Scopes 2 and 3 – Indirect Emissions).

The scopes are described below:

- Scope 1 Emissions: Direct (or point-source) emission factors give the kilograms of carbon dioxide equivalent (CO_2-e) emitted per unit of activity at the point of emission release (i.e. fuel use, energy use, manufacturing process activity, mining activity, on-site waste disposal, etc.).
- Scope 2 Emissions: Indirect emissions from the generation of the electricity purchased and consumed by an organisation as kilograms of CO_2-e per unit of electricity consumed.
- Scope 3 Emissions: Indirect emissions for organisations that:
  a. Burn fossil fuels: to estimate their indirect emissions attributable to the extraction, production and transport of those fuels; or
  b. Consume purchased electricity: to estimate their indirect emissions from the extraction, production and transport of fuel burned at generation and the indirect emissions attributable to the electricity lost in delivery in the transmission and distribution network.

Scope 1 emissions include those from fuel use by vehicles, coal burnt in boilers and methane from wastewater systems. Scope 2 emissions are from any purchased electricity. Scope 3 emissions are from the emissions resulting from the energy required to manufacture products such as coal, diesel and equipment.

5.3 EMISSION FACTORS

Emission factors used in this assessment have been derived from either the Department of Climate Change, site-specific information or from operational details obtained from similar emission sources.

The majority of the emission factors used in this report have been sourced from the Department of Climate Change NGA Factors Workbook, 2013 as indicated in Table 5-1.

Table 5-1: Emission Factors

Scope	Emission Source	Emission Factor	Source
1	Combustion emissions from ULP (stationary)	2.38 t CO_2-e / kL	NGA Factors (2013)
	Combustion emissions from diesel (stationary)	2.68 t CO_2-e / kL	NGA Factors (2013)
	Combustion emissions from LPG (stationary)	2.29 t CO_2-e / kL	NGA Factors (2013)
	Combustion for transport (general)	2.69 t CO_2-e / kL	NGA Factors (2013)
	Combustion for transport (gasoline)	2.38 t CO_2-e / kL	NGA Factors (2013)
	Bituminous Coal	2.388 kg CO_2-e / t	NGA Factors (2013)
	Methane from Wastewater Handling (industrial)	5.3 t CO_2-e / t COD	NGA Factors (2013)
	Sludge Biogas (captured for combustion)	0.18 kg CO_2-e / m^3	NGA Factors (2013)
2	Electricity Consumption (NSW)	0.87 kg CO_2-e/kWh	NGA Factors (2013)
3	Electricity Consumption (NSW)	0.19 kg CO_2-e / kWh	NGA Factors (2013)
	Bituminous Coal	124.2 kg CO_2-e / t	NGA Factors (2013)
	Diesel consumption	0.2046 t CO_2-e /kL	NGA Factors (2013)
	Embodied energy for concrete	0.13 kg CO_2-e/kg	Sustainable Energy Research Team (2008)
	Embodied energy for low carbon steel	1.77 kg CO_2-e/kg	Sustainable Energy Research Team (2008)
	Embodied energy for stainless steel	6.15 kg CO_2-e/kg	Sustainable Energy Research Team (2008)

6 QUANTIFICATION OF EMISSIONS – CONSTRUCTION PHASE

This section will quantify the carbon dioxide equivalent emissions associated with the abattoir for the construction phase of the Project.

6.1 Direct Impacts

Direct GHG emissions during the construction phase include:

- Construction staff travelling to the abattoir;
- Delivery vehicle movements on-site; and
- Plant movements on site.

The estimated GHG emissions from the construction of the abattoir facilities are summarised in Table 6-1. The Transport Assessment by Better Transport Futures dated November 2013 states that an average of 43 additional vehicle movements will be generated during the construction phase, which includes delivery and staff movements.

The greatest direct emissions will be from the additional staff required during the construction phase. An assumption that staff will travel a 10 km round-trip in 40 vehicles per day has been made.

Table 6-1: Direct Emissions (tonnes CO_2-e) during Construction Phase

Scope	Emission Source	Amount of Material	Emissions* (t CO_2-e)
1	Delivery vehicles movements on-site	0.06 kL	0.17
	Plant movements on-site	0.68 kL	1.81
	Staff Vehicle Movements	10.8 kL	25.17
3	Embodied energy of delivery vehicles movements on-site	0.06 kL	0.01
	Embodied energy of plant movements on site	0.68 kL	0.14
	Embodied energy of staff vehicle movements	10.8 kL	2.2
Total CO_2-e Emissions (tonnes)			**30.06**

* The CO_2-e emissions presented in the table have been rounded. As such the total CO_2-e is correct but the individual elements do not add up to the total value.

The direct emissions during the construction phase are 30.06 tonnes CO_2-e during the construction phase.

6.2 Upstream Emissions

The upstream emissions have been identified as follows:

- Emissions associated with haulage of construction materials; and
- Embodied energy associated with the production of construction materials.

Calculations of required construction materials has determined approximately 157 deliveries will be made during the nine month construction period. For emission quantification, an average of 30 tonne loads per travelling an average distance of 1000 kilometers. It has been assumed that the new plant is transported from Sydney. Whilst not all deliveries will be from Sydney, a worst-case distance has been used. A typical delivery truck has a fuel efficiency of approximately 25-litres/100 km, indicating that the total diesel fuel consumption for all delivery trucks is 78.9 kL.

Scope 1 greenhouse gas emissions associated with delivery trucks is 212.5 t CO_2-e.

A similar method has been employed for all vehicles travelling to and from the site as well as vehicle movements on site. The amount of embodied energy of diesel, or the amount of energy required to produce and manufacture diesel, used on site and during haulage has also been considered and falls under Scope 3 emissions.

Other construction materials are mostly likely to be sourced and transported, for example concrete and steel. The quantities of materials were provided by MeatEng in December 2013 and the resultant embodied energy in each material has been calculated. The GHG emission estimations are shown in Table 6-2.

Table 6-2: Upstream Emissions (tonnes CO_2-e) during Construction Phase

Scope	Emission Source	Amount of Material	Emissions* (t CO_2-e)
1	Haulage of materials from off-site	78.9 kL	212.5
3	Embodied Energy of vehicle movements off-site	78.9 kL	16.15
	Embodied energy of construction materials (concrete)	4,256 tonnes (1773 m^3)	553.3
	Embodied energy of construction materials (low carbon steel)	92 tonnes	162.8
	Embodied energy of construction materials (stainless steel)	388 tonnes	2,386
	Total CO_2-e Emissions (tonnes)		**3,331**

* The CO_2-e emissions presented in the table have been rounded. As such the total CO_2-e is correct but the individual elements do not add up to the total value.

6.3 Summary of Emissions

A summary of emissions during the construction phase is presented in Figure 6-1. It can be seen that the embodied energy of the construction materials is the greatest contributor to the greenhouse gas emissions with 92% whilst upstream vehicle movements contribute 7% and direct transport movements on site equates to 1% of all emissions during the 3.1 kilotonnes CO_2-e emitted during the construction phase.

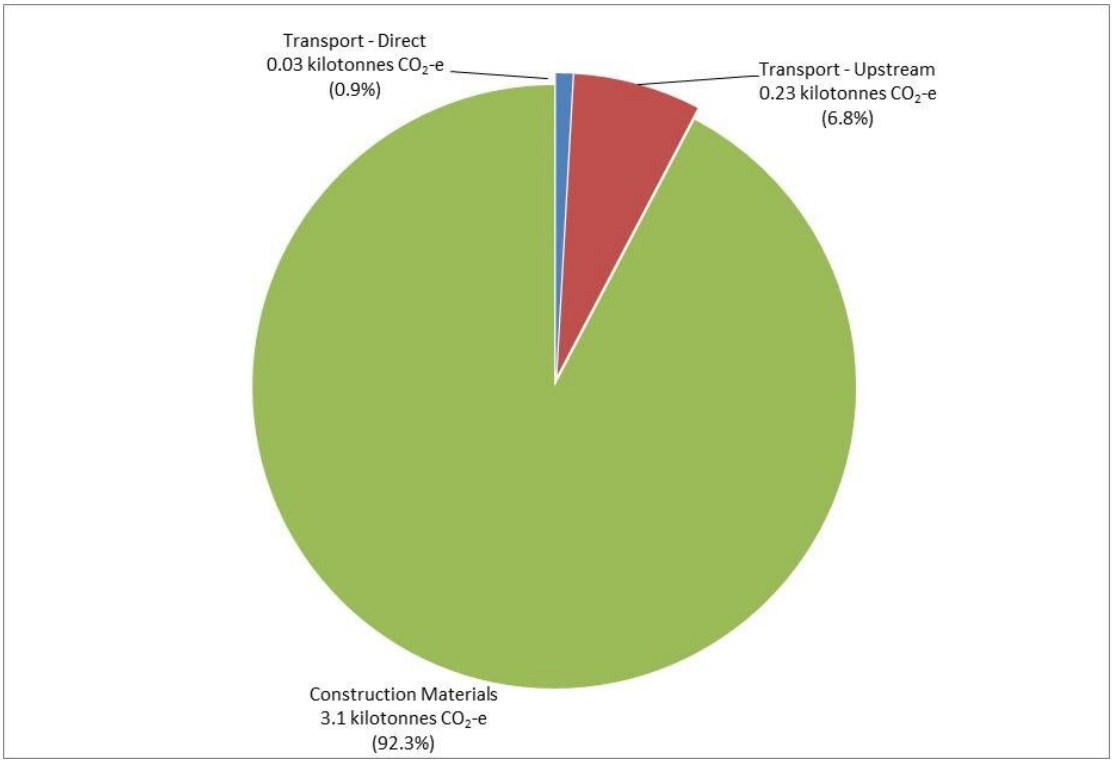

Figure 6-1: Summary of Emissions (kilotonnes CO_2-e) during Construction Phase

7 QUANTIFICATION OF EMISSIONS – OPERATIONAL PHASE

During the operational phase of the Project, the GHG emissions will be from power consumption, sludge biogas, and transport fuel emissions.

7.1 Power Generation

Data provided by Bindaree Beef identified that during the operational phase the power will be purchased for the abattoir from the grid and will operate the plant. The current and future Scope 2 and Scope 3 emissions for purchased power in NSW are shown in Table 7-1 and Table 7-2. The emissions have been calculated based on the emission factors of 0.87 kg CO_2-e/kWh for Scope 2 and 0.19 kg CO_2-e/kWh consumed.

Table 7-1: Current Electricity Emissions (tonnes CO_2-e) during Operation

Scope	Emission Source	Power Generation / Annum	Current Annual Emissions (t CO_2-e)
2	Purchased electricity	19,245,502 kWh	16,743.6
3	Purchased electricity	19,245,502 kWh	3,656.6
		Annual CO_2-e Emissions (tonnes)	**20,400.2**

Table 7-2: Future Electricity Emissions (tonnes CO_2-e) during Operation

Scope	Emission Source	Power Generation / Annum	Future Annual Emissions (t CO_2-e)
2	Purchased electricity	17,970,198 kWh	15,634
3	Purchased electricity	17,970,198 kWh	3,414
		Annual CO_2-e Emissions (tonnes)	**19,048**

These calculations show that the future total CO_2-e emission for the power generation is 19,048 tonnes per annum. For the future case the Scope 2 and 3 emissions for the 30-year life of the equipment are 469 and 102.4 kilotonnes of CO_2-e respectively, totalling 571.4 kilotonnes. This represents a reduction of 7% over the current operation.

7.2 Transport Fuel Emissions

The transport fuel emissions have been calculated for direct emissions from the transportation of goods and the upstream emissions of deliveries and staff transport to work.

Direct emissions were calculated from fuel use data provided by Bindaree Beef in December 2013. This data was for July 2013 to June 2013. The scope 1 and 3 emissions are shown in Table 7-3. The emissions from transport will remain unchanged from the current operation.

Table 7-3: Direct Emissions for Transport Fuel (tonnes CO_2-e) during Operation

Scope	Emission Source	Annual Usage	Annual Emissions (t CO_2-e)
1	Diesel for Transport	28.5 kL	77.03
	ULP for Transport	10.1 kL	23.93
3	Embodied energy of Diesel	28.5 kL	5.84
	Embodied energy of ULP	10.1 kL	1.82
		Annual CO_2-e Emissions (tonnes)	**108.6**

Upstream emissions for staff movements were based on the assumption that on average a round trip of 30 km is travelled per day in a small vehicle for 300 staff. Delivery truck frequencies were obtained from the Traffic Assessment. Personal communications with David Sneddon of Bindaree Beef confirmed that cattle can be brought in to the abattoir from afar field as Darwin or as close as Inverell, as such it has been assumed that on average a round trip is 750 km per cattle delivery. For other deliveries, a round trip of 500 km has been assumed. The annual emissions are shown in Table 7-4.

Table 7-4: Upstream Emissions for Transport Fuel (tonnes CO_2-e) during Operation

Scope	Emission Source	Daily Usage	Annual Emissions (t CO_2-e)*
1	Staff Vehicles	0.9 kL/day	668.39
	Cattle deliveries	1.5 kL/day	1,262.73
	Other deliveries	13 kL/day	10,920.17
3	Embodied energy for staff movements	0.9 kL/day	57.45
	Embodied Energy of Diesel	14.5 kL/day	925.52
		Annual CO_2-e Emissions (tonnes)	**13,834.3**

* The CO_2-e emissions presented in the table have been rounded. As such the total CO_2-e is correct but the individual elements do not add up to the total value.

As detailed in Table 7-3 and Table 7-4, over the 30-year life of the Project, direct and upstream transport emissions will emit 415 kilotonnes CO_2-e.

7.3 Stationary Fuel Emissions

Direct emissions were calculated from fuel use data provided by Bindaree Beef in December 2013. The emissions for the current and future operation are shown in Table 7-5 and Table 7-6.

Table 7-5: Current Direct Emissions for Stationary Fuel (tonnes CO_2-e) during Operation

Scope	Emission Source	Annual Usage	Annual Emissions (t CO_2-e)*
1	Diesel - Stationary	77.4 kL	207.7
	LPG - Stationary	64.9 kL	148.9
	Bituminous Coal	7353 tonnes	17,555.2
3	Embodied energy of Diesel	77.4 kL	15.8
	Embodied energy of LPG	64.9 kL	11.8
	Embodied energy of Coal	7,352.6 tonnes	913.2
		Annual CO_2-e Emissions (tonnes)	**17,939.5**

* The CO_2-e emissions presented in the table have been rounded. As such the total CO_2-e is correct but the individual elements do not add up to the total value.

Table 7-6: Future Direct Emissions for Stationary Fuel (tonnes CO_2-e) during Operation

Scope	Emission Source	Annual Usage	Annual Emissions (t CO_2-e)*
1	Diesel - Stationary	77.4 kL	207.71
	LPG - Stationary	64.9 kL	148.92
	Sludge biogas **	5,569,200 m^3	1003.34
3	Embodied energy of Diesel	77.4 kL	15.84
	Embodied energy of LPG	64.9 kL	11.76
		Annual CO_2-e Emissions (tonnes)	**1,387.6**

* The CO_2-e emissions presented in the table have been rounded. As such the total CO_2-e is correct but the individual elements do not add up to the total value.

** Data of annual Biogas captured for combustion was provided by MeatEng in Feb 2014.

For the future operation the emissions associated with the stationary fuel is 1,387.6 tonnes CO_2-e per annum, which is 41.6 kilotonnes CO_2-e over the 30 year life of the Project. This represents a reduction of 92% over the current situation.

7.4 Summary of Annual Emissions during Future Operation

The summary of the future emissions is shown in Figure 7-1. It can be seen that the greatest emissions are the power generation which accounts for 54% of annual emissions. Upstream transport emissions account for 40% and stationary fuel accounts for 6% of the 35 kilotonnes CO_2-e emitted by Bindaree Beef per annum.

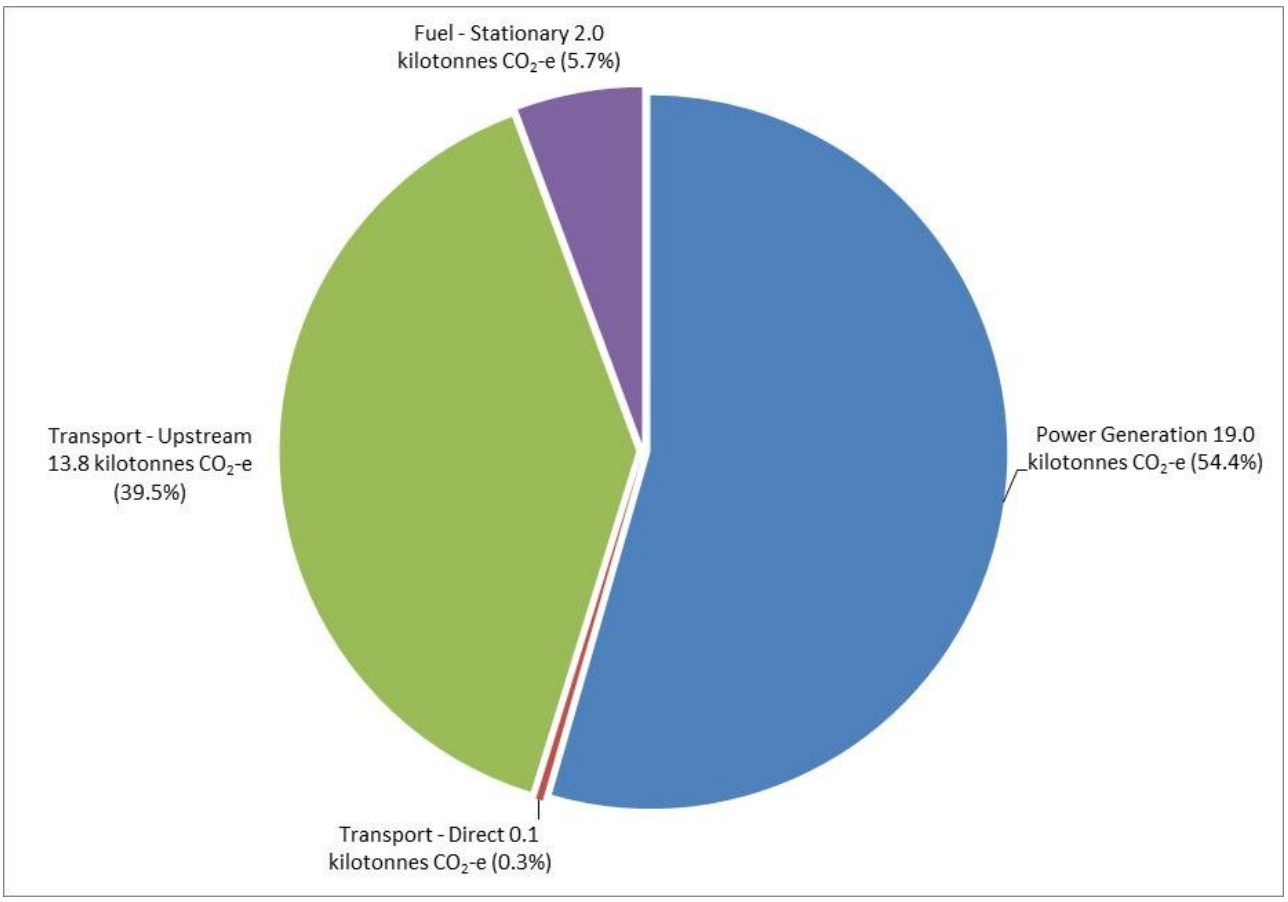

Figure 7-1: Summary of Future Annual Operational Emissions (kilotonnes CO_2-e)

8 OVERVIEW OF THE PROJECT EMISSION REDUCTIONS

8.1 Anaerobic Digesters

The amount of methane currently released from waste water handling is related to the production of the abattoir. Production data for July 2012 to June 2013 was provided by Bindaree Beef in December 2013. The total throughput during this year was 248,058 cattle with an annual production for this period was 69.5 million kilograms which generated 12.3 kilotonnes of CO_2-e. The abattoir has a maximum capacity of 1,100 cattle per day; using a ratio of 280 kg production weight per head, the maximum production is 92.47 million kg per annum. Therefore at maximum production the plant could generate 16.38 kilotonnes CO_2-e per annum.

The installation of anaerobic digesters will capture the methane (a potent greenhouse gas) and convert it to carbon dioxide by combustion in onsite boilers. These boilers will replace the currently used coal fired boiler thereby introducing a renewable resource for fuel.

The use of anaerobic digestion to create biogas can reduce greenhouse gas emissions in two distinct ways:

- When replacing an organic matter management system that utilises anaerobic conditions, it can prevent the release of methane, a greenhouse gas, into the atmosphere; and
- The biogas or bio-methane generated by the anaerobic digestion process can replace the use of fossil fuels such as coal at this site that generate greenhouse gases. The biogas generated from anaerobic digestion contains about 73% methane. This component, methane (the main component of natural gas) can produce energy. The combustion of biogas results in the conversion of methane to CO_2 and methane has 21 times the global warming potential of CO_2. This reduces the onsite greenhouse emissions significantly.

Most of the abattoirs in Australia store waste in large lagoons under anaerobic conditions. The methanogenic bacteria that thrive in this environment produce methane, which is released into the atmosphere. If this wastewater is digested, the methane can be captured and combusted. This destroys the methane and releases CO_2. Since each unit of methane has 21 times the global warming potential of CO_2, 21 units of GHG are eliminated and 1 unit is created for each unit of methane that is captured and combusted, creating an overall net gain of 20 units. This benefit is in addition to the benefit when energy created by this renewable fuel replaces energy created by combusting a fossil fuel.

8.2 Comparison of Current and Future Annual Emissions

The greenhouse gas emissions for 2012-2013 were calculated to be 64.73 kilotonnes CO_2-e per annum, based on production values provided by Bindaree Beef. At full capacity the emissions increase to 68.8 kilotonnes per annum. Comparing the results of the current and future cases at full capacity, 33.7 kilotonnes per annum is predicted to be saved.

Over the 30 year life of the Project this equates to 1,013 kilotonnes CO_2-e. The main savings are:

- 16.07 kilotonnes CO_2-e per annum as calculated (482 kilotonnes CO_2-e over the life of the Project) is achieved by the removal of coal burning and its associated transportation;
- 16.38 kilotonnes CO_2-e per annum as calculated (491 kilotonnes CO_2-e over the life of the Project) is achieved by decommissioning the existing wastewater treatment system and installing the anaerobic digesters to capture methane and convert it to carbon dioxide (based on production capacity of 1,100 cattle per day); and
- 2.2 kilotonnes CO_2-e per annum as calculated (66.5 kilotonnes CO_2-e over the life of the Project) is achieved from the reduction in purchased electricity, therefore minimising onsite emissions.

This Project will reduce Bindaree Beef's the overall greenhouse gas emissions by 52% per annum.

9 CONCLUSION

The proposed upgrade of the facility will result in significant benefits in the reduction of greenhouse gases. These benefits include the following:

- New rendering plant having a higher efficiency;
- Decommissioning of wastewater pond system;
- Removal of coal burning for boiler; and
- Installation of bio-digester for capture of methane for electricity production.

10 REFERENCES

Department of Climate Change and Energy Efficiency. (2013). *National Greenhouse Accounts Factors*. Commonwealth of Australia; Canberra.

Department of Climate Change and Energy Efficiency. (2013). *Technical Guidelines for the Estimation of Greenhouse Gas Emissions by Facilities in Australia*. Commonwealth of Australia; Canberra.

Department of Climate Change and Energy Efficiency. (2012). *Understanding Climate Change.* Commonwealth of Australia; Canberra.

Department of Climate Change and Energy Efficiency. (2012). *Clean Energy Act 2012*. Commonwealth of Australia; Canberra.

Department of Climate Change and Energy Efficiency. (2012). *National Greenhouse and Energy Reporting Act*. Commonwealth of Australia; Canberra.

Department of Environment and Heritage Australian Greenhouse Office. (2006). *AGO Factors and Methods Workbook*. Commonwealth of Australia; Canberra.

IPCC, (2006). *IPCC Guidelines for National Greenhouse Gas Inventories*.

Solomon, S., D. Qin, M. Manning, Z. Chen, M. Marquis, K.B. Averyt, M. Tignor and H.L. Miller (eds.). (2007). *Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change.* Cambridge University Press; Cambridge.

Sustainable Energy Research Team (2008). *Inventory of Carbon & Energy*. University of Bath (UK)

Appendix A: GLOSSARY

Carbon dioxide equivalent - A metric measure used to compare the emissions from various greenhouse gases based upon their global warming potential (GWP).

Climate - Usually defined as the "average weather," or more rigorously, as the statistical description in terms of the mean and variability of relevant quantities over a period of time ranging from months to thousands of years.

Climate change - Any significant change in measures of climate lasting for an extended period (decades or longer).

Coal mine methane - Coal mine methane is released from the coal seams during the process of coal mining.

Emissions - The release of a substance (usually a gas) into the atmosphere.

Emissions factor - A unique value for scaling emissions to activity data in terms of a standard rate of emissions per unit of activity (e.g., grams of carbon dioxide emitted per barrel of fossil fuel consumed)

Global warming - Global warming is an average increase in the temperature of the atmosphere near the Earth's surface and in the troposphere, which can contribute to changes in global climate patterns.

Greenhouse effect - Trapping and build-up of heat in the atmosphere (troposphere) near the Earth's surface. Some of the heat flowing back toward space from the Earth's surface is absorbed by water vapour, carbon dioxide, ozone, and several other gases in the atmosphere and then reradiated back toward the Earth's surface. If the atmospheric concentrations of these greenhouse gases rise, the average temperature of the lower atmosphere will gradually increase.

Greenhouse Gas (GHG) - Any gas that absorbs infrared radiation in the atmosphere. Greenhouse gases as defined by Australian Regulations:

Carbon dioxide (CO_2) - naturally occurring gas, and a by-product of burning fossil fuels and biomass, as well as land-use changes and other industrial processes. It is the reference gas against which other greenhouse gases are measured.

Methane (CH_4) - produced through anaerobic (without oxygen) decomposition of waste in landfills, animal digestion, decomposition of animal wastes, production and distribution of natural gas and petroleum, coal production, and incomplete fossil fuel combustion

Nitrous oxide (N_2O) - a powerful greenhouse gas. Major sources of nitrous oxide include soil cultivation practices, especially the use of commercial and organic fertilizers, fossil fuel combustion, nitric acid production, and biomass burning.

Hydrofluorocarbons (HFCs) - compounds containing only hydrogen, fluorine, and carbon atoms. They were introduced as alternatives to ozone depleting substances in serving many industrial, commercial, and personal needs. HFCs are emitted as by-products of industrial processes and are also used in manufacturing.

Perfluorocarbons (PFCs) - a group of human-made chemicals composed of carbon and fluorine only. PFCs do not harm the stratospheric ozone layer, but they are powerful greenhouse gases.

Sulphur hexafluoride (SF_6) - a colourless gas soluble in alcohol and ether, and slightly soluble in water. A very powerful greenhouse gas used primarily in electrical transmission and distribution systems and as a dielectric in electronics.

Hydrocarbons - Substances containing only hydrogen and carbon including fossil fuels.

Metric tonne - Common international measurement for the quantity of greenhouse gas emissions.

Natural gas - Underground deposits of gases consisting of 50 to 90 percent methane (CH_4) and small amounts of heavier gaseous hydrocarbon compounds.

Nitrogen oxides (NO_X) - Gases consisting of one molecule of nitrogen and varying numbers of oxygen molecules. Nitrogen oxides are produced in the emissions of vehicle exhausts and from power stations.

Ozone (O_3) - A triatomic form of oxygen is a gaseous atmospheric constituent. In the troposphere, it is created both naturally and by photochemical reactions involving gases resulting from human activities (photochemical smog).