Carbon Credits (Carbon Farming Initiative) (Destruction of Methane from Piggeries using Engineered Biodigesters) Methodology Determination 2013 [1]

Carbon Credits (Carbon Farming Initiative) Act 2011

I, MARK DREYFUS, Parliamentary Secretary for Climate Change and Energy Efficiency, make this Methodology Determination under subsection 106 (1) of the *Carbon Credits (Carbon Farming Initiative) Act 2011*.

Dated 29 January 2013

MARK DREYFUS

Parliamentary Secretary for Climate Change and Energy Efficiency

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Part 1 Preliminary

1.1 Name of Determination

This Determination is the Carbon Credits (Carbon Farming Initiative) (Destruction of Methane from Piggeries using Engineered Biodigesters) Methodology Determination 2013.

1.2 Commencement

This Determination is taken to have commenced on 1 July 2010.

1.3 Definitions

In this Determination:

Act means the *Carbon Credits (Carbon Farming Initiative) Act 2011* as in force from time to time.

additional waste means waste that is not piggery manure.

American Public Health Association method means a method approved by the American Public Health Association Agency.

A link to these methods is available at: http://www.climatechange.gov.au

anaerobic decomposition means biological process where organic matter is broken down by bacteria in the absence of oxygen.

biogas means a mixture of gases that is generated as a result of anaerobic decomposition of organic material.

biogas capture system means a unit that captures and holds biogas, and includes pumps and pipes leading to any combustion device.

Bo means the maximum methane producing capacity for manure.

carbon dioxide equivalence (CO_2-e) means the carbon dioxide emissions equivalence of a substance that produces greenhouse gas emissions.

combustion device means an open flare or a closed flare, an internal combustion engine or a gas boiler.

continuously stirred tank reactor means a tank operated in a steady state with mixing to achieve uniform composition and temperature for which inputs and products are continuously added and withdrawn.

continuous monitoring system means the equipment used continuously to acquire data, process the data, and deliver the required information.

conventional piggery means a facility that houses pigs within sheds with slatted floors where effluent is flushed to a central system and does not include deep litter housing systems or outdoor piggeries.

deep litter housing system means housing that is comprised of large open-sided sheds or structures, that contain deep litter flooring, including rice hulls, straw or sawdust, to accommodate groups of pigs.

digestate means the sludge that flows from an engineered biodigester.

Effluent and Manure Management Database means the Effluent and Manure Management Database for the Australian Dairy Industry published by Dairy Australia in 2008, which is available at http://www.climatechange.gov.au

enclosed flare means a device where residual gas is burned in a cylindrical or rectilinear enclosure that includes a burning system and a damper where air for the combustion reaction is admitted.

engineered biodigester means a closed unit in which the biological treatment of biomass or other organic matter occurs through anaerobic digestion. This includes, but is not limited to, high rate anaerobic lagoons, plug-flow reactors, continuously stirred tank reactors, fixed film digesters, and upflow anaerobic sludge blanket digesters.

fixed film digester means a tank digester in which methane forming microorganisms grow on supporting media such as wood chips or small plastic rings that fill a digestion column.

flaring system means the system used to combust biogas, which includes an open flare or an enclosed flare.

frequently sparking flare means a flare that sparks at least every 2 seconds.

gas boiler means a combustion device for gaseous fuels, including biogas, that is used for heating water or raising steam.

GWP_{CH4} means the global warming potential of methane, as prescribed in the NGER Regulations.

highly variable Bo substrate means food waste, vegetable matter, and green pruning.

high rate anaerobic lagoon means a purpose-built lagoon into which animal manure, including piggery manure, is fed and which is fitted with mixing devices and heating elements to produce biogas.

internal combustion engine means an engine in which the combustion of a fuel occurs with an oxidizer in a combustion chamber.

laboratory means a laboratory that has an established capability in Bo measurement and a documented quality management system in accordance with AS ISO/IEC 17025:2005.

lagoon means a dam into which effluent is deposited, stored, and treated.

monitoring instrument means an instrument for measuring a quantity or a biophysical characteristic.

NATA means the National Association of Testing Authorities, Australia (ACN 004 379 748).

National Measurement Act means the *National Measurement Act 1960* as in force from time to time.

NGER (Measurement) Determination means the National Greenhouse and Energy Reporting (Measurement) Determination 2008 as in force from time to time.

NGER Regulations means the National Greenhouse and Energy Reporting Regulations 2008 as in force from time to time.

open flare means a device where residual gas is burned in open air with or without any auxiliary fuel assistance.

PigBal model means PigBal Version 2.14 produced by Queensland Department of Primary Industries, which is used to calculate nutrient and salt content in the waste from a piggery and is comprised of:

- the PigBal Manual; and
- the PigBal workbook.

A link to the Pigbal model is available at: http://www.climatechange.gov.au

piggery manure means a mixture of water, excreta, liquid waste and slurry generated from the piggery shed, piggery feedpad or any pig housing.

plug-flow reactor means a tank into which animal manure, including piggery manure, flows and displaces volume which causes an equal amount of material to flow out and does not require mechanical mixing.

post treatment means the treatment of digestate before it is applied to land and may include effluent liquid and solid separation, liquid effluent storage, aerobic and anaerobic treatment of digestate, drying and pelletising.

pre-treatment means the treatment of effluent before it enters a biodigester and may include screening, liquid/solid separation, thickening, crushing, pulping, mixing, pasteurisation, and pH adjustment.

Regulations means the Carbon Credits (Carbon Farming Initiative) Regulations 2011 as in force from time to time.

standard conditions has the same meaning provided in the NGER (Measurement) Determination.

sub-optimal flaring occurs if there is no record of the temperature of the exhaust gas of a flare or if the recorded temperature is less than 500°C for any period exceeding 20 minutes in any particular hour.

system failure includes failure of engineered biodigester cover materials, the digester vessel, or the gas collection system or a failure that occurs as a result of operator error or other unintended occurrence.

upflow anaerobic sludge blanket digester means a tank digester that forms a blanket of granular suspended sludge through which waste water flows at optimal velocity and is processed by anaerobic microorganisms to produce biogas.

US EPA Method means the test method by the same name approved by the United States Environmental Protection Agency as amended from time to time.

A link to this method is available at: http://www.climatechange.gov.au

venting event means the release of biogas into the atmosphere that occurs:

(a) deliberately, for safety or maintenance purposes; or

(b) unintentionally, due to a system failure.

volatile solids (VS) means that portion of the total solids converted to volatile (combustible) gases when heated at 550 degrees Celsius (+/- 50 degrees) for at least one hour.

Note Other words and expressions used in this Determination have the meaning given by the Act. These terms include:

baseline

eligible offsets project

emission

greenhouse gas

offsets project

offsets report

project

project area

project proponent

Regulator

reporting period

1.4 Kind of project to which this Determination applies

Note See paragraph 106(1)(a) of the Act.

This Determination applies to a project that:

(a) is an agricultural emissions avoidance project; and

(b) proposes to capture and combust biogas generated by the anaerobic decomposition of piggery manure by directing a piggery manure stream into an engineered biodigester.

Part 2 Requirements for declaration as eligible project

Note See paragraphs 27(4)(c), 35(2)(a) and 106(1)(b) of the Act and regulations 1.12 and 3.26 of the Regulations.

2.1 Eligible projects

To be declared an eligible offsets project, a project to which this Determination applies must meet the requirements in this Part.

Note These requirements are in addition to those set by the Regulations for applications for a declaration.

2.2 Requirement 1—Project mechanism

The project must propose to:

(a) use one or more engineered biodigesters to prevent the emission of biogas;

(b) collect the biogas from the engineered biodigester; and

(c) combust the methane component of the biogas to convert it to carbon dioxide.

2.3 Requirement 2—Engineered biodigesters

(1) The engineered biodigesters used in the project must:

(a) replace or be installed instead of anaerobic lagoons at a conventional piggery;

(b) receive piggery manure that would otherwise be directed to a lagoon to undergo anaerobic decomposition;

(c) have been replaced or installed in accordance with paragraph (1) (a) after 1 July 2010.

2.4 Requirement 3—Waste

(1) Subject to subsection (2), only piggery manure may be deposited into the engineered biodigesters used in the project.

Additional waste

(2) Additional waste may be deposited into an engineered biodigester used in the project under the following circumstances:

(a) where the additional waste is combined with piggery manure to make a homogenous stream in accordance with subsection (3);

(b) where the additional waste is categorised, before it is combined with piggery manure, in accordance with subsections (4) or (5) as either:

(i) CFI eligible waste; or

(ii) CFI ineligible waste;

(c) where the additional waste is tested for VS before it enters the engineered biodigester in accordance with section 5.3;

(d) where the additional waste is categorised as CFI eligible additional waste—the waste would have been treated in an anaerobic lagoon if it was not accepted by the proponent; and

(e) where the additional waste is categorised as CFI ineligible additional waste—the volume of methane released from that waste:

(i) will not exceed 50% of the total methane released from the engineered biodigester;

(ii) will not contain more than 20% methane from highly variable Bo substrates; and

(iii) will not contain more than 20% methane from a single substrate that is a highly variable Bo substrate.

Note The measured methane sent to the combustion devices is capped at the theoretical volume of methane from the piggery and CFI eligible waste streams, and Australian Carbon Credit Units will not be issued for the destruction of methane from CFI ineligible waste.

Homogenous stream

(3) For the purposes of this Determination, a homogenous stream is a combination of piggery manure and additional waste that:

(a) maintains a pH range of between 6 and 8 in the engineered biodigester; and

Note For the avoidance of doubt, this means that the addition of the homogenous stream should not result in a change in pH range that moves below 6 or above 8.

(b) has an average particle size of less than 5 millimetres, unless the engineered biodigester is:

(i) a plug-flow digester; or

(ii) a UASB digester.

CFI eligible additional waste

(4) For the purposes of this Determination, CFI eligible additional waste is waste that comprises of one or more of the types listed in Schedule 1; and

CFI ineligible additional waste

(5) For the purposes of this Determination, CFI ineligible additional waste is:

(a) additional waste of the kind specified in Schedule 2; or

(b) additional waste that is not one of the following:

(i) waste of the kind specified in Schedule 1;

(ii) waste of the kind specified in Schedule 2; or

(iii) piggery manure.

2.5 Requirement 4—Flaring systems

(1) Any flaring system used in the project must:

(a) use a frequently sparking flare to ensure continuous destruction of methane when the flare is operational; or

(b) include a temperature monitoring system that ensures the flare is operating at the temperature required for complete combustion of methane; and

(c) include a control system that:

(i) shuts down biogas flow through to the flare when the flare temperature drops below the temperature required for complete combustion of methane; and

(ii) prevents biogas flow through the flare when the flare is not operational.

Part 3 Requirements for operation of eligible projects

Note See paragraphs 27 (4) (c), 35 (2) (a) and 106 (1) (b) of the Act and regulation 3.26 of the Regulations.

3.1 Operation of eligible projects

An eligible offsets project must be operated in accordance with this Part.

Division 3.2 Project classification

3.2 Project must be classified

A project to which this Determination applies must be classified, in accordance with this Division, as either:

(a) a standard project: or

(b) an additional waste project.

3.3 Standard projects

(1) For the purposes of this Determination, a project is a standard project if:

(a) it does not include additional waste; or

(b) it includes additional waste that is incidental.

(2) The inclusion of additional waste is taken to be incidental if, in a reporting period:

(a) the volume of an individual source of additional waste entering a biodigester is less than 0.5% of the total volume of piggery manure;

(b) the total volume of all individual sources of additional waste added to the piggery manure waste is less than 2% of the total volume of waste entering the biodigester; and

(c) the total increase by volume in biogas produced after all individual sources of additional waste in the feed is added to the biodigester is less than 3 %.

3.4 Additional waste projects

(1) For the purposes of this Determination, a project is an additional waste project if:

(a) it includes additional waste; and

(b) the additional waste is not incidental within the meaning provided by subsection 3.3 (2).

Division 3.3 Greenhouse gas assessment boundary

3.5 Greenhouse gases that must be accounted for

The following greenhouse gases from the following sources within the project must be taken into account when making calculations under Part 4. No other gases may be taken into account in respect of a source.

	Source	**Greenhouse gas**
Baseline	Greenhouse gas emissions from piggery manure and CFI eligible additional waste treated in an anaerobic lagoon	Methane (CH_4)
Project	Electricity generation —gas capture and combustion via internal combustion engine	Methane (CH_4)
		Nitrous oxide (N_2O)
	Electricity from the grid and fuel used for pre-treatment, gas capture and combustion and post-treatment	CO_2
		CH_4
		N_2O
	Gas capture and combustion via gas boiler used to heat water or generate steam	Methane (CH_4)
		Nitrous oxide (N_2O)
	Gas capture and combustion via flaring	Methane (CH_4)
		Nitrous oxide (N_2O)
	Engineered biodigester fugitive emissions	Methane (CH_4)
	Effluent from the engineerd biodigester; open storage of liquid effluent component during post treatment	Methane (CH_4)
	Aerobic post treatment of digestate	Methane (CH_4)
		Nitrous oxide (N_2O)

	Anaerobic post treatment of digestate	Methane (CH_4)

Part 4 The net abatement amount

Division 4.1 The net abatement amount

4.1 The net abatement amount

Note See paragraph 106 (1) (c) of the Act.

For an eligible offsets project to which this Determination applies, the carbon dioxide equivalent net abatement amount for the project in relation to a reporting period for the project is taken to be:

(a) the quantity of methane emissions avoided as a consequence of the project, minus emissions from project activities;

(b) where those quantities are calculated in accordance with Division 4.3.

Division 4.2 Baseline

4.2 How the baseline is calculated

Note See paragraph 106 (4) (f) and section 107 of the Act.

For an eligible offsets project to which this Determination applies, the baseline must be calculated as follows:

(a) where the project is classified as a standard project—in accordance with section 4.3; and

(b) where the project is classified as an additional waste project—in accordance with section 4.4 or 4.5, whichever is applicable.

4.3 Calculating the baseline for a standard project

(1) If a project is classified as a standard project, the baseline must be calculated as follows:

(a) by determining the VS using the PigBal model in accordance with the Pigbal Manual; and

(b) multiplying the VS by:

(i) the maximum methane producing capacity from VS in piggery manure (Bo); and

(ii) the methane conversion factor (MCF), which is the portion of Bo that is achieved under temperature and treatment specifications.

Note the baseline for a standard project must be calculated in accordance with Division 4.3.

4.4 Calculating the baseline for an additional waste project that contains only CFI eligible additional waste

(1) This section applies where:

(a) a project is classified as an additional waste project; and

(b) the additional waste only contains only CFI eligible additional waste.

(2) The baseline for an additional waste project that contains only CFI eligible additional waste must be calculated as follows:

(a) for the part of the stream that is piggery manure—using the method outlined in section 4.3;

(b) for the part of the stream that is CFI eligible additional waste—using the method outlined in subsection (3); and

(c) the values of (a) and (b) must be added together to determine the total amount of methane generated from piggery manure and CFI eligible additional waste.

(3) For CFI eligible additional waste, the baseline must be calculated as follows:

(a) by measuring the VS in accordance with section 5.3; and

(b) multiplying the VS by:

(i) the maximum methane producing capacity from VS in the CFI eligible additional waste (Bo) as prescribed in Schedule 1; and

(ii) the methane conversion factor (MCF), which is the portion of Bo that is achieved under temperature and treatment specifications.

Note These calculations must be performed for each CFI eligible additional waste stream.

4.5 Calculating the baseline for an additional waste project that contains only CFI ineligible additional waste or a combination of additional CFI eligible additional waste and CFI ineligible addition waste

(1) This section applies where:

(a) a project is classified as an additional waste project; and

(b) the additional waste only contains CFI ineligible additional waste or contains a combination of CFI eligible additional waste and CFI ineligible additional waste.

(2) The baseline for an additional waste project that only contains CFI ineligible additional waste or a combination of CFI eligible additional waste and CFI ineligible additional waste must be calculated using:

(a) Method 1, as outlined in subsection (3); and

(b) Method 2, as outlined in subsection (4); and

(c) the lower value from Method 1 and Method 2.

Method 1

(3) For the purposes of paragraph (2) (a), Method 1 is:

(a) the value for the piggery manure and the CFI eligible additional waste—calculated in accordance with section 4.4;

Method 2

(4) For the purposes of paragraph (2) (b), Method 2 is:

(a) taking the total volume of methane combusted from all waste in the project, calculated in accordance with subsection (5); and

(b) subtracting the volume of methane for the CFI ineligible additional waste calculated in accordance with subsection (6).

(5) The total amount of methane combusted from all waste in the project must be calculated:

(a) in accordance with section 4.9 (2);

(b) where Q_{com} is not capped in accordance with section 4.12.

(6) The amount of methane generated from the CFI ineligible additional waste must be calculated:

(a) by measuring the VS in accordance with section 5.3; and

(b) multiplying the VS by:

(i) the maximum methane producing capacity from VS in CFI ineligible additional waste (Bo), which is either taken from Schedule 2 or measured in accordance with section 5.5; and

(ii) the methane conversion factor (MCF), which is the portion of Bo that is achieved under temperature and treatment specifications.

Division 4.3 Calculations

Subdivision 4.3.1 Preliminary

4.6 General

(1) In this Part:

(a) all calculations are in respect of activities undertaken, or outcomes achieved, during the reporting period for the eligible offsets project;

(b) unless otherwise specified:

(i) a reference to a project is a reference to an eligible offsets project that meets the requirements of Part 2;

(ii) a reference to a biodigester or combustion device is a reference to a biodigester or combustion device used in the project;

(iii) all references to Parts, Divisions, sections, subsections, paragraphs and Equations are references to corresponding parts of this Determination.

(c) for all equations, unless otherwise specified:

(i) n = number of combustion devices; and

(ii) h denotes a combustion device.

(d) References to a factor or parameter prescribed in the NGER (Measurement) Determination or the NGER Regulations are, for the entire offsets reporting period, references to the NGER (Measurement) Determination or NGER Regulations in force at the time that the offsets report was required to be submitted.

Subdivision 4.3.2 Calculating the baseline

4.7 Calculating the baseline

(1) Baseline methane emissions must be calculated as follows:

$E_b = \gamma \times Q_b$	Equation 1.1

Where:

E_b = total methane emissions that would have occurred from the operation of all of the lagoons used in the project, as if the project did not occur, in tonnes of CO_2-e (t CO_2-e).

γ = the factor 6.784 x 10^{-4} x GWP_{CH_4}, which converts cubic metres of methane to tonnes of CO2-e at standard conditions.

Q_b = total volume of methane that would be emitted from the operation of the lagoons used in the project, as if the project did not occur, in cubic metres of methane (m^3 CH_4) at standard conditions.

(2) Q_b must be calculated as follows:

$Q_b = (VS_p \times Bo_p \times MCF_l) + (VS_e \times Bo_e \times MCF_l)$	Equation 1.2

Where:

Q_b = the total volume of methane that would be atmosphere emitted from the operation of the lagoons used in the project, as if the project did not occur, including that the lagoons were uncovered, in cubic metres of methane (m^3 CH_4) at standard conditions.

Note See subsection (4) for additional waste projects that include CFI ineligible additional waste.

VS_p = the quantity of volatile solids from piggery manure deposited into the biodigester, in kilograms, determined using the PigBal model.

Bo_p = 0.45, which is the maximum methane-producing capacity from volatile solids from piggery manure, in cubic metres of methane per kilogram of VS (m^3 CH_4/kg VS).

MCF_l = 0.9, which is the methane conversion factor that reflects the portion of Bo that is achieved under temperature and treatment specifications for anaerobic lagoons.

VS_e = the quantity of VS from each CFI eligible additional waste stream entering the project biodigester, in kilograms, measured in accordance with section 5.3.

Bo_e = the maximum methane-producing capacity from volatile solids from each CFI eligible additional waste stream, in cubic metres of methane per kilogram of VS (m^3 CH_4/kg VS), determined in accordance with subsection (3).

(3) Bo_e must be determined by:

(a) using the relevant factor prescribed in Schedule 1; or

(b) direct measurement in accordance with section 5.5.

(4) For additional waste projects that include CFI ineligible additional waste, Q_b must be determined by using:

(a) Method 1, outlined in subsection (5);

(b) Method 2, outlined in subsection (6); and

(c) Taking the lower value from Method 1 and Method 2.

Method 1

(5) For method 1—Q_b is calculated in accordance with Equation 1.2.

Method 2

(6) For method 2—Q_b is calculated as follows:

$Q_b = Q_{com} - (VS_{in} \times Bo_{in} \times MCF_l)$	Equation 1.3

Where:

Q_b = the total volume of methane that would be emitted from the operation of the lagoons used in the project, as if the project did not occur, including that the lagoons were uncovered, in cubic metres of methane (m^3 CH_4) at standard conditions.

Q_{com} = the volume of methane destroyed by combustion device h, in cubic metres (m^3), calculated in accordance with section 4.9 (2) and which has not been capped in accordance with section 4.12.

VS_{in} = the quantity of volatile solids from CFI ineligible waste entering the project biodigester in kilograms, and measured in accordance with section 5.2.

Bo_{in} = the maximum methane-producing capacity from the volatile solids from CFI ineligible waste, in units of cubic metres of methane per kilogram of volatile solids (m^3 CH_4/kg VS), determined in accordance with subsection (7).

MCF_l = 0.9, which is the methane conversion factor that reflects the portion of Bo that is achieved under temperature and treatment specifications for anaerobic lagoons.

(7) Bo_{in} must be determined, in accordance with the choice of a proponent, either:

(a) by using the value prescribed in Schedule 2; or

(b) by measuring the amount in accordance with section 5.5.

Subdivision 4.3.3 Calculating net greenhouse gas abatement

4.8 Calculating the net abatement (A)

Net abatement must be calculated as follows:

$A = (A_p - E_p)$	Equation 2.1

Where:

A = net greenhouse gas abatement due to the project, in tonnes of CO_2-e.

A_p = total quantity of emissions avoided as a consequence of the project, in tonnes of CO_2-e, calculated using Equation 2.2.

E_p = total emissions from activities undertaken for the purpose of the project, measured in tonnes of CO_2-e, calculated using Equation 3.1.

Subdivision 4.3.4 Calculating emissions avoided

4.9 Calculating greenhouse gas emissions avoided (A_p)

(1) Emissions avoided as a consequence of carrying out a project must be calculated as follows:

$A_p = \gamma \times Q_{com}$	Equation 2.2

Where:

A_p = the quantity of methane emissions avoided as a consequence of the project, in tonnes of CO_2-e (t CO_2-e).

γ = the factor $6.784 \times 10^{-4} \times GWP_{CH_4}$, which converts cubic metres of methane to tonnes of CO_2-e at standard conditions.

Q_{com} = the volume of methane destroyed by all combustion devices, in cubic metres (m^3), calculated using Equation 2.3.

(2) Q_{com} must be calculated as follows:

$Q_{com} = \sum_{h} \left(Q_{CH4,h} \times OE_h \right)$	Equation 2.3

Where:

Q_{com} = the volume of methane destroyed by combustion device h, in cubic metres (m^3) and capped in accordance with section 4.12.

$Q_{CH4,\ h}$ = the volume of methane sent to combustion device h, in cubic metres (m^3), determined in accordance with subsection (3).

OE_h = the average operation efficiency for device h determined in accordance with section 5.2.

(3) The volume of methane destroyed by a combustion device must be calculated:

(a) For standard projects—using Equation 2.4, where the volume of methane is $Q_{CH_4,h}$; or

(b) For additional waste projects—using Equation 2.5, where the volume of methane is $Q_{CH4\ CFI}$.

4.10 Calculating the volume of methane sent to a combustion device ($Q_{CH4,h}$) for a standard project

For standard projects, $Q_{CH4,\ h}$ must be calculated for each combustion device as follows:

$Q_{CH_4,h} = Q_{biogas,h} \times W_{CH_4}$	Equation 2.4

Where:

$Q_{CH4,\ h}$ = the volume of methane sent to combustion device h, in cubic metres (m^3), capped according to section 4.12.

$Q_{biogas, h}$ = the total volume of biogas sent to combustion device h, in cubic metres (m^3), measured in accordance with section 5.2 and adjusted to standard conditions.

W_{CH4} = the proportion of the volume of biogas that is methane, measured in accordance with section 5.7.

4.11 Calculating the volume of methane sent to a combustion device ($Q_{CH4,h}$) for an additional waste project

(1) For additional waste projects, the volume of methane sent to the combustion device must be calculated for each combustion device as follows:

$Q_{CH4\ CFI\ ,h} = R \times Q_{CH4,h}$	Equation 2.5

Where:

$Q_{CH4\ CFI\ ,h}$ = the volume of methane sent to the combustion device that is from CFI eligible additional waste, capped in accordance with section 4.12.

R = the proportion of the volume of methane sent to the combustion device that is from CFI eligible additional waste, calculated using Equation 2.6.

$Q_{CH4,h}$ = the volume of methane sent to combustion device h, in cubic metres (m^3), capped in accordance with section 4.12.

(2) R must be calculated as follows:

$R = \frac{Q_{CFI}}{(Q_{CFI} + Q_{in})}$	Equation 2.6

Where:

R = the proportion of the volume of methane sent to the combustion device that is from CFI eligible additional waste.

Q_{CFI} = the total volume of methane generated from piggery manure and CFI eligible additional waste, calculated using Equation 2.7.

Q_{in} = the volume of methane generated from CFI ineligible additional waste, calculated using Equation 2.8.

(3) Q_{CFI} must be calculated as follows:

$Q_{CFI} = (VS_p \times Bo_p) + (VS_e \times Bo_e)$	Equation 2.7

Where:

Q_{CFI} = the volume of methane sent to the combustion device h that is from CFI eligible additional waste, in cubic metres (m^3).

VS_p = the quantity of volatile solids from piggery manure entering the biodigester, in kilograms, determined using the PigBal model.

Bo_p = 0.45, which is the maximum methane-producing capacity from the volatile solids from piggery manure, in units of cubic metres of methane per kilogram of volatile solids (m^3 CH_4/kg VS).

VS_e = the quantity of volatile solids from CFI eligible additional waste entering the biodigester, in kilograms, measured in accordance with section 5.3.

Bo_e = the maximum methane-producing capacity from volatile solids from CFI eligible additional waste, in units of cubic metres of methane per kilogram of Volatile Solids (m^3 CH_4/kg VS), determined in accordance with subsection (4).

(4) Bo_e must be determined, in accordance with the choice of a proponent, either:

(a) by using the value prescribed in Schedule 1; or

(b) by measuring the amount in accordance with section 5.5.

(5) Q_{in} must be calculated as follows:

$Q_{in} = VS_{in} \times Bo_{in}$	Equation 2.8

Where:

Q_{in} = the volume of methane sent to the combustion device h that is from CFI ineligible additional waste, in cubic metres (m^3).

VS_{in} = the quantity of volatile solids from CFI ineligible additional waste entering the project biodigester in kilograms, and measured in accordance with section 5.2.

Bo_{in} = the maximum methane-producing capacity from the volatile solids from CFI ineligible additional waste, in units of cubic metres of methane per kilogram of volatile solids (m^3 CH_4/kg VS), determined in accordance with subsection (6).

(6) Bo_{in} must be determined, in accordance with the choice of a proponent, either:

(a) by using the value prescribed in Schedule 2; or

(b) by measuring the amount in accordance with section 5.5.

4.12 Capping the volume of methane

(1) Q_b (calculated using Equation 1.2 or in accordance with section 4.5) and Q_{com} (calculated using Equation 2.3) must be estimated over the same time period and at least once every 12 months.

(2) If the value of the volume of methane destroyed by all combustion devices ($\sum_{h=1}^{n} Q_{com,h}$) is greater than the value for baseline methane emissions (Q_b), the value for $\sum_{h=1}^{n} Q_{com,h}$ is, for the purposes of this Determination, deemed to be:

(a) for standard projects—Q_b in Equation 1.2; or

(b) for additional waste projects—the baseline determined in accordance with section 4.7 (4).

4.13 Quantity of emissions combusted in an internal combustion engine – optional verification methods

(1) This section applies if a project uses an internal combustion engine for electricity generation which is fed by methane generated by the project activity.

(2) If subsection (1) applies, a project proponent must, in accordance with Equation 2.3:

(a) measure the average operating efficiency of the internal combustion engine using section 5.5; and

(b) calculate the volume of methane combusted ($Q_{com,h}$), where h is the internal combustion engine.

(3) In addition to subsection (2), a project proponent may verify $Q_{com,h}$ by using the quantity of methane combusted by the internal combustion engine for electricity generation ($A_{com,ice}$). This may be calculated using Equation 2.9 and Equation 2.10.

Note To compare $Q_{com,h}$ with $A_{com,ice}$ for the purposes of subsection (3) the figure produced at (2) (b) will need to be multiplied by $6.784 \times 10^{-4} \times GWP_{CH_4}$ to obtain tonnes CO_2-e.

(4) $A_{com,ice}$ may be calculated using the following formula:

$A_{com,ice} = QE \times CH_4 \text{ conversion factor} \times GWP_{CH_4}$	Equation 2.9

Where:

$A_{com,ice}$ = amount of methane destroyed as a consequence of an internal combustion engine, in tonnes CO_2-e.

QE = energy content of the methane sent to the internal combustion engine, in gigajoules (GJ) calculated in accordance with Equation 2.10.

CH_4 conversion factor = 0.018.

GWP_{CH_4} = the global warming potential of methane as prescribed in the NGER Regulations.

(5) QE may be calculated using the following formula:

$QE = \frac{\text{Electricity produced} \times EC}{\text{Eff}}$	Equation 2.10

Where:

QE = quantity of energy produced as a result of methane combustion in the internal combustion engine, in gigajoules (GJ).

Electricity produced =	the total amount of electricity produced by the internal produced combustion engine (supplied to the grid or used on-site) in megawatt hours (MWh).
EC =	3.6, which is the energy in GJ per megawatt hours (MWh).
Eff =	electrical efficiency factor for the internal combustion engine for conversion of energy to electricity, expressed as a fraction, determined in accordance with subsection (6).

(6) Eff is either:

(a) the value prescribed by the manufacturer in the manufacturer's specifications for the equipment; or

(b) if there is no value prescribed by the manufacturer—0.36.

Subdivision 4.3.5 Calculating project emissions (E_p)

4.14 Calculating project emissions (E_p)

The total emissions from activities undertaken for the purpose of the project must be calculated as follows:

$E_p = E_{FE} + E_{TRAN} + E_{BCS} + E_{MMS} + E_{POST}$	Equation 3.1

Where:

E_P =	total emissions from the activities undertaken for the purpose of the project.
E_{FE} =	the total emissions from fuel and electricity used in the operation of the project, measured in tonnes of CO_2-e (t CO_2-e), and calculated in accordance with section 4.15.
E_{TRAN} =	total emissions from the transport of CFI eligible additional waste to the project site, calculated using Equation 3.4.
E_{BCS} =	total emissions from the engineered biodigester and biogas capture system, including any fugitive emissions, calculated using Equation 3.6.
E_{MMS} =	total emissions of methane from the uncontrolled anaerobic treatment of CFI eligible additional waste, calculated using Equation 3.17.
E_{POST} =	total emissions from the treatment of piggery manure and digestate from the engineered biodigester before it is applied to land, calculated using Equation 3.18.

Note As no credits may be received for CFI ineligible additional waste, emissions from the transport of CFI ineligible additional waste and emissions from the uncontrolled anaerobic treatment of CFI ineligible additional waste do not need to be included in calculations.

4.15 Calculating emissions from fuel and electricity (E_{FE})

Calculating emissions from fuel

(1) Emissions from fuel (E_f) must only be calculated where fuel is used to operate any of the following equipment used in the project:

(a) pre-treatment equipment;

(b) heating and mixing systems;

(c) gas capture and combustion devices; or

(d) post treatment equipment.

Calculating emissions from electricity

(2) Emissions from electricity (E_{elec}) must be calculated as follows:

(a) for the consumption of grid derived electricity that occurred between 1 July 2010 and 1 July 2012—in accordance with Equation 3.5; and

(b) where the project uses grid derived electricity after 1 July 2012—E_{elec} must be taken to be zero.

(3) Subject to subsections (1) and (2), E_{FE} must be calculated as follows:

$E_{FE} = (E_f + E_{elec})$	Equation 3.2

Where:

E_{FE} = the total emissions from fuel and electricity used in the operation of the project, measured in tonnes of CO_2-e (t CO_2-e).

E_f = the total emissions from fuel use, measured in tonnes of CO_2-e (t CO_2-e).

E_{elec} = the total emissions from consumption of grid-derived electricity, measured in tonnes of CO_2-e (t CO_2-e).

(4) Subject to subsection (1), E_f must be calculated as follows:

$E_f = \sum_{i=1}^{n} \sum_{j=1}^{N} E_{i,j} \times R$	Equation 3.3

Where:

E_f =	the total emissions from fuel use, in tonnes of CO_2-e (t CO_2-e).
j =	the greenhouse gas type (CO_2, N_2O, CH_4).
i =	the fuel type.
E_{ij} =	the emissions from fuel type (i) and greenhouse gas (j).
n =	the number of different fuel types (i).
N =	the number of different gas types (j) emitted (CO_2, CH_4 or N_2O).
R =	the proportion of the volume of methane that is from CFI eligible additional waste, determined in accordance with Equation 2.6.

(5) Subject to subsection (1), $E_{i,j}$ must be calculated as follows:

$E_{i,j} = \frac{Q_i \times EC_i \times EF_{ijoxec}}{1000}$	Equation 3.4

Where:

$E_{i,j}$ =	emissions of greenhouse gas type (j) released from the combustion of fuel type (i).
Q_i =	the quantity of fuel type (i), measured in appropriate units in accordance with Schedule 1 of the NGER (Measurement) Determination.
EC_i =	the energy content factor of fuel type (i) in gigajoules per kilolitre (GJ/kL), determined in accordance with subsection (6).
EF_{ijoxec} =	the emission factor for each gas type (j) and for fuel type (i) in kilograms of CO_2-e per gigajoule (kg CO_2-ee/GJ) as prescribed in the NGER (Measurement) Determination.

(6) To determine the value of EC_i, the following rules apply:

(a) where Q_i is measured in gigajoules—EC_i is 1;

(b) where Qi is not measured in gigajoules—EC_i is the value prescribed in the NGER (Measurement) Determination.

(7) Subject to subsection (2), E_{elec} must be calculated as follows:

$E_{elec} = Q_{elec} \times \frac{EF}{1000}$	Equation 3.5

Where:

E_{elec} = the total emissions from consumption of grid-derived electricity, in tonnes of CO_2-e (t CO_2-e).

Q_{elec} = the quantity of electricity purchased from the grid in kilowatt hours (kWh) in accordance with section 5.2.

EF = the scope 2 emissions factor for the relevant State, Territory or electricity grid where consumption occurs, as prescribed in Schedule 1 of the NGER (Measurement) Determination and measured in kg CO_2-e per kilowatt hour (kg CO_2-e /kWh).

(8) If Q_{elec} is measured in gigajoules, the quantity of kilowatt hours must be calculated by dividing the amount of gigajoules by 0.0036.

4.16 Calculating emissions from transport (E_{TRAN}) for additional waste projects

(1) This section applies where:

(a) the project is classified as an additional waste project; and

(b) waste transport operations have changed as a result of carrying out the project.

Note As no credits may be received for CFI ineligible additional waste, emissions from the transport of CFI ineligible additional waste do not need to be calculated.

(2) Subject to subsection (1), emissions from the transport of additional waste must be calculated as follows:

$E_{TRAN} = \sum_{i=1}^{n} \sum_{j=1}^{N} E_{ij}$	Equation 3.6

E_{TRAN} = the total emissions from the transport of additional waste.

i = the fuel type.

j = the greenhouse gas type (CO_2, CH_4 or N_2O).

n =	the number of different fuel types (i).
N =	the number of different gas types (j) emitted (CO_2, CH_4 or N_2O).
$E_{i,j}$ =	emissions of greenhouse gas type (j) released from the combustion of fuel type (i), calculated using Equation 3.7.

(3) E_{ij} must be calculated as follows:

$E_{ij} = \frac{Q_i \times EC_i \times EF_{ijoxec}}{1000}$	Equation 3.7

Where:

E_{ij} =	emissions of greenhouse gas type (j) released from the combustion of fuel type (i), in tonnes of CO_2-e (t CO_2-e).
Q_i =	the quantity of fuel type (i), in kilolitres (kL) or gigajoules (GJ), combusted for transport energy purposes.
EC_i =	the energy content factor of fuel type (i) in gigajoules per kilolitre (GJ/kL), determined in accordance with subsection (4).
EF_{ijoxec} =	the emission factor for each gas type (j) and for fuel type (i) in kilograms of CO_2-e per gigajoule (kg/GJ) as prescribed in the NGER (Measurement) Determination.

(4) To determine the value of EC_i, the following rules apply:

(a) where Q_i is measured in gigajoules—EC_i is 1;

(b) where Qi is not measured in gigajoules—EC_i is the value prescribed in the NGER (Measurement) Determination.

4.17 Calculating emissions from the biogas capture system (E_{BCS})

(1) Emissions from the engineered biodigester and biogas capture system resulting from venting events and incomplete combustion must be calculated as follows:

$E_{BCS} = (E_{Fug\ CH4} + E_{COM}) \times R$	Equation 3.8

Where:

E_{BCS} =	emissions from the engineered biodigester and biogas capture system resulting from venting events and incomplete combustion.
$E_{Fug\ CH4}$ =	the fugitive emissions of methane from venting events or sub-optimal flaring, calculated using Equation 3.9.
E_{COM} =	the emissions of methane and nitrous oxide from incomplete combustion in combustion devices, calculated using Equation 3.11.
R =	the proportion of the volume of methane that is from CFI eligible additional waste, determined in accordance with Equation 2.6.

(2) E_{FugCH4} must be calculated as follows:

$E_{Fug\ CH4} = \gamma \left[\sum_{h} \left(Q_{CH4,h} \times \left(\frac{1}{BCE} - OE_h \right) \right) + \sum_{q} Q_{CH\ 4\ Vent,q} \right]$	Equation 3.9

Where:

$E_{Fug\ CH4}$ =	the fugitive emissions of methane from venting events or sub-optimal flaring, in tonnes of CO_2-e.
γ =	the factor 6.784 x 10-4 x GWP_{CH_4}, which converts cubic metres of methane at standard conditions to tonnes of CO_2-e (t CO_2-e).
$Q_{CH4,h}$ =	the volume of methane sent to combustion device h in cubic metres (m^3), calculated using Equation 2.4 or Equation 2.5.
BCE =	0.98, which is the assumed methane collection efficiency of the biogas capture system.
OE_h =	the average operation efficiency for device h, expressed as a fraction, determined in accordance with section 5.2.
$Q_{CH4\ Vent,\ q}$ =	the volume of methane, in cubic metres (m^3), vented to the atmosphere due to a biogas capture system venting event calculated in accordance with subsection (4).

(3) $Q_{CH4\ Vent,\ q}$ must only be calculated where:

(a) a system failure or a system shutdown occurs; and

(b) as a result, methane is released into the atmosphere.

(4) For the purposes of subsection (3), if it can be demonstrated that biogas was not released into the atmosphere during a system shutdown, a project proponent may elect to not calculate $Q_{CH4\ Vent,\ q}$.

(5) Subject to subsection (4), $Q_{CH4\ Vent,\ q}$ must be calculated as follows:

$Q_{CH4\ Vent,\ q} = [MS_{BCS} + (F_{pw} \times t)] \times W_{CH4}$	Equation 3.10

Where:

$Q_{CH4\ Vent,\ q}$ =	the volume of methane, in cubic metres (m^3), released to the atmosphere due to a venting event, q.
MS_{BCS} =	the maximum biogas storage capacity of the biogas capture system, in cubic metres, determined in accordance with subsection (6).
F_{pw} =	the average total daily flow of biogas from the digester for the entire week prior to the venting event, in cubic metres per day (m^3/day).
t =	the number of days that the venting event is uncontrolled.
W_{CH4} =	the proportion of the volume of biogas that is methane, measured in accordance with section 5.7.

(6) MS_{BCS} is either:

(a) where there is a failure or shut down of all combustion devices, or where there is a failure of the storage systems that are upstream from the combustion device—the maximum biogas storage capacity of the biogas capture system; or

(b) where there is more than one combustion device and there is a failure of only one combustion device and the storage systems upstream of the combustion devices remain intact—zero.

4.18 Calculating emissions from combustion devices (E_{com})

(1) The total emissions from combustion of biogas must be calculated as follows:

$E_{COM} = \sum_j E_j$	Equation 3.11

Where:

E_{COM} = the total emissions of methane and nitrous oxide from incomplete combustion in combustion devices, in tonnes of CO_2-e (t CO_2-e).

j = the greenhouse gas type, which is either nitrous oxide or methane (N_2O, CH_4).

E_j = the emissions of greenhouse gas (j) from the combustion of biogas in tonnes of CO_2-e.

(2) E_j must be calculated as follows:

$E_j = \frac{Q_{com} \times EC \times EF_j}{1000}$	Equation 3.12

Where:

E_j = the emissions of greenhouse gas (j) from the combustion of biogas in tonnes of CO_2-e.

Q_{com} = the total volume of methane destroyed by all combustion devices measured in cubic metres (m^3) calculated using Equation 2.3.

EC = the energy content factor of biogas, in gigajoules per cubic metre (GJ/m^3) as prescribed in the NGER (Measurement) Determination.

EF_j = the technology based emission factor for the biogas for each greenhouse gas type (j), in kilograms of CO_2-e per gigajoule (kg CO_2-e/GJ) as prescribed in the NGER (Measurement) Determination.

4.19 Calculating emissions from manure management systems (E_{MMS})

(1) This section applies where:

(a) the project is classified as a standard project; or

(b) the project is classified as an additional waste project and the additional waste contains CFI eligible additional waste; and

(c) there has been uncontrolled anaerobic treatment of the waste at the site of livestock operations that contribute the waste to the engineered biodigester.

Note Additional waste projects that only add ineligible waste do not need to calculate and include E_{MMS}.

(2) For the purposes of subsection (1), if it can be demonstrated that there was no uncontrolled anaerobic treatment of waste at any of the livestock operation sites that contribute waste to the engineered biodigester, a project proponent may elect to not calculate E_{MMS}.

(3) Emissions of methane from the treatment of CFI eligible additional waste in manure management systems (E_{MMS}) is either:

(a) where paragraph (1) (a) applies—zero; or

(b) where paragraph (1) (b) and (c) apply—calculated using Equation 3.13.

(4) Subject to subsections (1) and (2), E_{MMS} must be calculated as follows:

$E_{MMS} = \gamma \times f \times [(VS_{p,un} \times Bo_p \times MCF_l) + (VS_{e,un} \times Bo_e \times MCF_l)]$	Equation 3.13

Where:

E_{MMS} =	emissions of methane from the uncontrolled anaerobic treatment of waste in manure management systems at the livestock operation(s) contributing waste to the engineered biodigester.
γ =	the factor $6.784 \times 10^{-4} \times GWP_{CH_4}$, which converts cubic metres of methane at standard conditions to tonnes of CO_2-e.
$VS_{p,\,un}$ =	the quantity of volatile solids from piggery manure that is treated in uncontrolled anaerobic process, in kilograms, determined using the Pigbal Model.
$Bo_{p,}$ =	0.45, which is the maximum methane-producing capacity from the volatile solids from the waste sent to an uncontrolled anaerobic treatment process, in units of cubic metres of methane per kilogram of volatile solids (m^3CH_4/kg VS).
MCF_{l} =	0.9, which is the methane conversion factor for treatment of waste in uncovered anaerobic lagoons.

f =	the proportion of the reporting period that the waste has been stored in an uncontrolled anaerobic lagoon.
$VS_{e,un}$ =	the quantity of volatile solids from each eligible waste stream that is treated in an uncontrolled anaerobic process, in kilograms.
$Bo_{e,}$ =	the maximum methane-producing capacity from the volatile solids from each eligible waste stream, in units of cubic metres of methane per kilogram of volatile solids (m^3 CH_4/kg VS), determined in accordance with subsection (5).

(5) Bo_e must be determined:

(a) by using the relevant factor prescribed in Schedule 1; or

(b) by carrying out sampling and analysis in accordance with section 5.5.

4.20 Calculating emissions from post treatment (E_{POST})

(1) Emissions from the post treatment of the digestate removed from the engineered biodigester must be calculated where:

(a) the digestate is treated in accordance with one of the treatment types prescribed in Schedule 4;

(b) the digestate is sent to a landfill; or

(c) the digestate is sent to an open lagoon.

(2) Where subsection (1) applies, E_{post} must be calculated as follows:

$E_{POST} = E_{LF} + E_{EFF} + E_{AER}$	Equation 3.14

Where:

E_{LF} =	emissions of methane from decomposition of digestate at a landfill, calculated using Equation 3.15.
E_{AER} =	emissions of methane and nitrous oxide from aerobic treatment of digestate, including stockpiling, calculated using Equation 3.17.

E_{EFF} = emissions of methane from engineered biodigester piggery manure in an open lagoon, as calculated using Equation 3.16.

(3) E_{LF} must be calculated as follows:

$E_{LF} = W_{D,\,LF} \times EF_{LF} \times (1 - C_{STATE}) \times R$	Equation 3.15

Where:

E_{LF} = emissions of methane from decomposition of digestate at a landfill, in units of tonnes CO_2-e.

$W_{D,\,LF}$ = the wet weight of the digestate sent to a landfill in the reporting period, measured in tonnes.

EF_{LF} = 0.3, which is the emission factor for the decay of digestate in a landfill, in tonnes CO_2-e per tonne of wet waste.

C_{STATE} = the capture rate, expressed as a fraction, for methane emissions at a landfill in each state, as prescribed in Schedule 3.

R = the proportion of the volume of methane that is from CFI eligible additional waste, determined in accordance with subsection (4).

(4) R is either:

(a) where a project is classified as a standard project—1; or

(b) where a project is classified as an additional waste project—calculated using Equation 2.6.

(5) E_{EFF} must be calculated as follows:

$E_{EFF} = \gamma \times VS_{EFF} \times Bo_{EFF} \times MCF_{EFF} \times R \times GWP_{CH_4}$	Equation 3.16

Where:

E_{EFF} =	emissions of methane from engineered biodigester piggery manure in an open lagoon, in units of tonnes of CO_2-e (t CO_2-e).
γ =	the factor 6.784 x 10^{-4} x GWP_{CH_4}, which converts cubic metres of methane at standard conditions to tonnes of CO_2-e (t CO_2-e).
VS_{EFF} =	the quantity of volatile solids in the piggery manure discharged from the engineered biodigester into the lagoon, in kilograms, measured in accordance with section 5.2.
Bo_{EFF} =	the maximum methane-producing capacity of the piggery manure from the engineered biodigester, in units of kilograms of methane per kilogram of volatile solids, determined in accordance with subsection (6).
MCF_{EFF} =	0.2, which is the methane conversion factor for the lagoon.
R =	the proportion of the volume of methane that is from CFI eligible additional waste, determined in accordance with subsection (7).

(6) B_{OEFF} is, in accordance with the choice of a proponent, either:

(a) measured in accordance with section 5.5; or

(b) 0.3 m^3CH_4/ kg VS.

(7) R is either:

(a) where a project is classified as a standard project—1

(b) where a project is classified as an additional waste project—calculated using Equation 2.6.

(8) E_{AER} must be calculated as follows:

$E_{AER} = W_{D,\,AER} \times EF_{AER} \times R$	Equation 3.17

Where:

E_{AER} =	the emissions of methane and nitrous oxide from aerobic treatment of digestate in tonnes of CO_2-e.
$W_{D,\,AER}$ =	the wet weight of digestate treated aerobically on-site or off-site for the reporting period, measured in tonnes.

EF_{AER} =	the emission factor for the aerobic treatment of digestate based on the risk that the treatment will produce emissions, as prescribed in Schedule 4.
R =	the proportion that is from CFI eligible additional waste, determined in accordance with subsection (9).

(9) R is either:

(a) where a project is classified as a standard project—1; or

(b) where a project is classified as an additional waste project—calculated using Equation 2.6.

Part 5 Monitoring, record-keeping and reporting requirements

Note See subsection 106(3) of the Act.

Division 5.1 General

5.1 General

For the purposes of subsection 106 (3) of the Act, a project proponent of an offsets project to which this Determination applies must comply with the monitoring, record-keeping and reporting requirements of this Part.

Division 5.2 Measuring requirements

5.2 Project measurement

A project proponent must measure the matters specified in the following table, in the manner and frequency specified, for the purposes of calculating baseline emissions and the net abatement amount.

Note Unless otherwise specified, terms used for calculating the baseline have the same meaning as the PigBal Model.

Parameter	Description	Unit	Measurement procedure	Measurement frequency
OEh	Average operation efficiency for device h	Expressed as a fraction	(1) Flare operation can be detected using temperature measurement. (2) Uptime must be represented by a number between zero and 1 where: (a) zero—represents a device that is not operating; and (b) 1—represents a device that is operating. (3) If a device was operational for 45 minutes of an hour the record for that hour and device must show a fraction of 0.75. (4) For flares: (a) if there is no record of the	Hourly records of combustion device uptime must be kept. The average uptime for each day should be summed to provide the average operation efficiency for the reporting period.

			temperature of the exhaust gas of the flare; or (b) if the recorded temperature is less than 500°C for any period exceeding 20 minutes in any particular hour, then it must be assumed that during that hour the flare operation efficiency is zero.	
pH levels			(1) pH levels must be measured using: (a) a calibrated pH meter; or (b) sampling and analysis in accordance with: (i) APHA Method 4500-H^+ or (ii) USEPA Method 9040C (iii) or an equivalent method. (2) samples in accordance with (1) (b) must be: (a) sampled on enough occasions to obtain a representative sample; and (b) free of bias so that any estimates are neither over nor under estimates of the true value; and (c) sampled immediately after additional waste is added; or (d) where additional waste is continuously added—sampled on a weekly basis.	Immediately after waste is added; or If additional waste is continuously added—sampled on a weekly basis
Pig numbers	This is the number of pigs in each	Number per class	From shed records.	Daily

	class housed in the shed.			
Feed used	Weight of each feed type	Kg of feed type	From delivery records. For each type of feed mix used, the weight delivered to the facility minus the stockpile remaining each year.	Daily
Pre-treatment screening	Presence or absence of screens: Yes/No	As prescribed in the PigBal workbook.	From shed maintenance records.	Recorded when added or removed.
Screen removal efficiency ***Note:*** Solids removal efficiency is required to be used in the Pigbal Model.	Solids and nutrient removal for different separation devices	Percentage	In accordance with the choice of a project proponent, either: (1) where no screens are installed, a value of zero for all removal percentages; or (2) the figure prescribed from the supplier of the separator unit appropriate for piggery waste; or (3) the highest value for the type of separation unit prescribed in Appendix A of the Effluent and Manure Management Database; or (4) measured, where the samples are: (a) taken on enough occasions to produce an unbiased, representative sample; and (b) representative of the piggery waste stream and the total solids concentrations at the project site; and (c) only be used for the piggery operation for which it was	For direct measurement, solids removal must be measured for a one week period for each season (four times per year) in accordance with the Effluent and Manure Management Database.

			intended to be representative.	
VS_e	Volatile solids of each eligible waste stream that is not from the project piggery operation but added to the project digester.	Kg	The standards and protocol for measurement as outlined at section 5.3.	In accordance with section 5.3.
Bo_e	Maximum methane producing capacity from the VS in eligible waste stream.	m^3 CH_4/kg VS	From Schedule 1 or measured in accordance section 5.5.	In accordance with section 5.5.
VS_{in}	Volatile solids of each ineligible waste stream added to project digester	Kg	In accordance with section 5.3.	In accordance with section 5.3.
Bo_{in}	Maximum methane producing capacity from VS in	m^3 CH_4/kg VS	From Schedule 2 or measured in accordance with section 5.5.	If measured — in accordance with section 5.5.

	CFI each ineligible waste stream			
Additional CFI eligible waste	Amount of CFI eligible additional waste—for each eligible waste stream that would have been treated in an anaerobic lagoon.	kL or kg	(1) The amount of waste received during the reporting period as evidenced by invoices; or (2) The amount of waste received during the reporting period as measured by an accepted industry measurement device calibrated to a measurement requirement; or (3) If devices mentioned in subsection (2) are absent—according to industry practice.	Daily
Additional CFI ineligible additional waste	Amount of CFI ineligible additional waste.	kL or kg	(1) The amount of waste received during the reporting period as evidenced by invoices; or (2) The amount of waste received during the reporting period as measured by an accepted industry measurement device calibrated to a measurement requirement; or (3) If devices mentioned in subsection (2) are absent—according to industry practice.	Daily
MS_{BCS}	Maximum storage capacity of the biogas capture system	Cubic metres	From installation and maintenance records.	Recorded when installations or upgrades to the physical equipment of the biogas capture system occur that would change the

				storage capacity of the biogas capture system.
F_{pw}	Average total flow of biogas from project digester for the week prior to a venting event.	Cubic metres	From records for $Q_{biogas.}$	Weekly
t	Number of days biogas is venting uncontrolled from the biogas capture system.	Days	From daily record.	Monthly
$Q_{biogas,h}$	Quantity of biogas sent to combustion device h.	m3	In accordance with section 5.6.	Continuous monitoring — an average value in a time interval not greater than 1 hour.
Fuel used Q_i	Quantity of fuel type (i) used for the operation of gas capture and combustion equipment.	For liquid fuels, measured in kL, or for gaseous fuels, measured in m^3 unless otherwise specified in the NGER (Measureme	(1) For each fuel used (diesel, LPG, etc) —the amount must be estimated as a proportion of totals for the project activities. (2) The estimation may be made from a reading from a meter or from invoices. (3) Manufacturer's specifications can be used to assist with these estimates for the gas capture and combustion component.	At least once during the reporting period

		nt) Determinatio n.		
Electricity used Q_{elec}	Quantity of electricity used for the operation of gas capture and combustion equipment	Kilowatt hours (kWh)	(1) Meter measuring the electricity used by equipment installed, the electricity usage is the value from that meter (2) Electricity used to operate the biogas capture and combustion equipment may be estimated as a proportion of the total electricity used on the property. (3) Project proponents must provide a justification for all estimates.	(1) If estimated from invoices—estimate from total electricity used for the reporting period. (2) If submeterin g is used—monthly.
Electricity produced	Quantity of electricity produced by methane combustion in the internal combustion engine generator.	MWh	(1) For electricity sent to the grid—meter data recording electricity sent to the grid; or (2) For electricity used on site—meter data recording electricity produced by the internal combustion engine generator (for electricity used on site). (3) The accuracy of the meter used must be equivalent of a revenue meter.	Total amount of electricity produced during the reporting period
Electrical Efficiency Factor (Eff)	The electrical efficiency factor of the internal combustion engine generator.	%	As specified by the manufacturer of the generator in the technical manual for the equipment or the default value of 36%.	Set value as per manufacturer's specification or default.

$W_{D,LF}$	Wet weight of digestate sent to landfill.	Tonnes	From daily record.	Daily.
VS_{EFF}	VS of piggery manure discharged from project biodigester into lagoon.	Kg	In accordance with section 5.4.	In accordance with section 5.4.
Bo_{EFF}	Maximum methane producing capacity of the effluent discharged from project biodigester.	Tonnes of methane per kilogram of VS	In accordance with section 5.5.	Annually.

5.3 Measuring volatile solids from additional waste before it enters the biodigester (VS)

Note See section 2.4 of this Determination.

(1) Volatile solids in additional waste must, in accordance with subsection (2), be measured:

(a) for each different waste stream—at least once before it is combined with piggery manure and enters a biodigester; and

(b) at least once every month following commencement of a project; and

(c) where there is a change to the process, being either a change to the type or order of engineered biodigester unit operations used in the process or the addition of one or more new waste types—at least once immediately after that change.

(2) Volatile solids must be measured by:

(a) collecting samples from composite amounts of waste sent to the project biodigester;

(b) collecting enough samples to produce a representative sample; and

(c) analysing those samples in accordance with the following:

(i) method 2540E of the American Public Health Association; or

(ii) an equivalent Australian or international standard.

5.4 Measuring volatile solids for waste discharged from the biodigester into a lagoon (VS_{EFF})

Note See section 4.20 of this Determination.

(1) Volatile solids in additional waste must, in accordance with subsection (2), be measured:

(a) at least once every month following commencement of a project; and

(b) where there is a change to the process, being either a change to the type or order of unit operations used in the process or the addition of one or more new waste types—at least once immediately after that change.

(2) Volatile solids must be measured by:

(a) collecting samples from composite of amounts of waste sent to the project biodigester;

(b) collecting enough samples to produce a representative sample; and

(c) analysing those samples in accordance with the following:

(i) method 2450E of the the methods of American Public Health Association ; or

(ii) an equivalent Australian or international standard.

5.5 Measuring the methane producing capacity for volatile solids for additional waste (Bo_e) (Bo_{in}) (Bo_{EFF})

Note See sections 4.7, 4.11, 4.19 and 4.20 of this Determination.

(1) This section applies if a project proponent elects to measure the methane producing capacity for:

(a) the volatile solids of additional waste streams (Bo_e and Bo_{in}); and

(b) the effluent discharged from a project biodigester into a storage lagoon (Bo_{EFF}).

Note This section is not required if a project proponent elects to use the relevant figure prescribed in Schedule 1 or Schedule 2.

(2) The methane producing capacity for Bo_e, Bo_{in} and Bo_{EFF} must be measured:

(a) annually for each waste type;

(b) by collecting samples on at least three separate occasions in accordance with the following standards:

(i) method 6211 (1998) or method 2720 (1997) of the American Public Health Association Method; or

(ii) an equivalent Australian or international standard; and

(c) by causing those samples to be:

(i) delivered to a laboratory within 24 hours of collection; and

(ii) analysed in a laboratory in triplicate.

(3) Methane composition must be measured in a laboratory throughout the Bo test, and the Bo must be reported as $m^3CH_4/kgVS$.

5.6 Measuring the quantity of biogas sent to a combustion device ($Q_{biogas,h}$)

(1) $Q_{biogas,\ h}$ must be measured in accordance with the following requirements:

(a) Gas flow must be measured:

(i) at the delivery location of the gaseous fuel;

(ii) using a gas volumetric flow meter that uses a continuous monitoring system; and

(iii) in cubic metres per hour (m^3 per hour).

(b) Subject to paragraph (b), gas flow must be measured using equipment that:

(i) is rated for use with a process gas/biogas/dirty stream;

(ii) is rated for use at the expected flow rate and pressure;

(iii) is designed for use in the anticipated operating temperature range; and

(iv) is to be accurate to +/- 5% for flow measurement.

(c) Gas flow must be continuously recorded and integrated using an integration device that is isolated from the flow computer in such a way that if the computer fails, the integration device will retain the last reading, or the previously stored information, that was on the computer immediately before the failure.

(d) All measurements must comply with the National Measurement Act.

5.7 Measuring the percentage of methane in biogas (W_{CH4})

(1) The percentage of methane in biogas (W_{CH_4}) must be measured using either:

(a) an online gas analyser; or

(b) analysis, taken from samples, at an accredited laboratory.

(2) Where subsection (1) (a) applies, the following requirements apply:

(a) paired values of the methane fraction of the gas and gas flow that are averaged for the same time interval must be used in the calculation of emission reductions; and

(b) measurement of the methane fraction must occur at the same time as flow measurement.

(3) Where subsection (1) (b) applies, the following requirements apply:

(a) gas composition samples must be taken at the delivery location of the gaseous fuel;

(b) gas composition samples must be taken on a regular basis, occurring no less than once per month;

(c) the sampling vessel must be set up to provide a time period for the instrument to stabilise and carry out initial checks in accordance with the instrument provided by the manufacturer; and

(d) there must be no leaks in the sampling train or between the sampling train and the instrument; and

(e) gas samples must be analysed using US EPA Method 3 gas chromatography or mass spectrometry.

5.8 Gas measurement error margins

(1) The measurement of gas pressures must be carried out using equipment that complies with the following accuracy and transmitter requirements:

(a) pressure <±0.25%; and

(b) differential pressure <±0.25%.

Division 5.3 Monitoring requirements

5.9 General

The project proponent must monitor and record the information specified in this Division.

5.10 Monitoring requirements

Frequency of recording Pigbal inputs

(1) A project proponent must monitor and record the following data, as set out in the PigBal Model, no less than once per week:

(a) herd data;

(b) herd performance data where this data is necessary in accordance with the conditions set out in the PigBal Manual;

(c) piggery feed usage data; and

(d) diet analysis.

Quality assurance and quality control

(2) All monitoring instruments must be:

(a) cleaned and inspected on a regular basis to ensure the equipment operates within an accuracy threshold of +/- 5%, with the activities performed and the "as found/as left" condition of the equipment documented;

(b) field checked for calibration accuracy, with the percentage drift documented, no earlier than two months before the end of the reporting period by a third-party technician:

(c) using an appropriate instrument or apparatus; or

(d) as per the manufacturer's guidance;

(e) calibrated by the manufacturer, or an accredited third-party calibration service, as per the manufacturer's guidance, or every 5 years, whichever occurs with greater frequency.

(3) Field checks of monitoring instruments must determine whether the instrument reads measurement within the accuracy threshold of +/-5%.

(4) If a field check of a monitoring instrument determines that its accuracy is outside of the accuracy threshold of +/-5% then the instrument must be calibrated by the manufacturer or an accredited third-party calibration service. The calibration must ensure that the instrument reads measurement within the accuracy threshold of +/-5%.

Division 5.4 Record-keeping requirements

5.11 General

The project proponent must make and keep records of the information specified in this Division.

5.12 Record keeping

Quality assurance plan

(1) The project proponent must, prior to submission of the first offsets report, prepare a quality assurance plan that:

(a) meets the operation, maintenance and equipment calibration requirements of the manufacturer or installer, or both, for the following equipment:

(i) the engineered biodigester;

(ii) the biogas capture system; and

(iii) the pre-treatment and post-treatment equipment;

(b) specifies how optimum performance will be maintained for the duration of the project; and

(c) specifies the parameters that will be monitored and the frequency of monitoring.

(2) The quality assurance plan must be kept in electronic form and in hard copy form.

General information

(3) The following information must be recorded and kept for general purposes:

(a) all receipts and specifications for the gas capture and combustion equipment;

(b) all maintenance records for the gas capture system, monitoring instruments and combustion devices;

(c) logs of operations of the gas capture system including notation of all shut-downs, start-ups, and process adjustments;

(d) all information relating to the operating efficiency of each device;

(e) evidence of corrective measures taken if monitoring instruments do not meet the accuracy threshold specified in section 5.10;

(f) independent audit reports;

(g) NATA certificates from the stack testing laboratory showing measured methane destruction efficiency where default values are not used;

(h) the quality assurance plan;

(i) diagrams showing the configuration of equipment and unit operations used in the project, including the change in practices between the baseline scenario and the project scenario and updated diagrams where changes to the configuration are made during the project.

Information for calculating the baseline

(4) The following information must be recorded and kept for calculating and verifying the baseline:

(a) pig number and classes

(b) type and quantity of feed;

(c) herd data;

(d) herd performance data where this data is necessary in accordance with the conditions set out in the PigBal Manual;

(e) piggery feed usage data;

(f) diet analysis;

(g) pre-screening of waste;

(h) type of engineered biodigester system;

(i) number of project biodigesters;

(j) engineered biodigester dimensions;

(k) maximum storage capacity of biogas capture system;

(l) climate data (within the meaning provided in the PigBal model);

(m) calculations of VS;

(n) duration of venting events;

(o) duration, cause and impact of abnormal operating conditions for project biodigesters; and

(p) additional waste entering the biodigester in the year prior to project commencement (by type and weight).

(q) the number of additional waste streams;

(r) the category of additional waste;

(s) percentage by volume of increase in biogas due to input into the digester of additional waste streams.

Combustion devices

(5) The following information must be recorded and kept in relation to combustion devices:

(a) combustion device information including the model, serial number, and calibration procedures for the device;

(b) combustion device monitoring data for each device, including records of device failure and time in operation below specification or at temperatures less than 500°C for any period of time exceeding 20 minutes in any particular hour;

(c) combustion device calibration data for each device; and

(d) results from combustion device operation efficiency measurement and testing for each device.

Monitoring equipment

(6) The following information must be kept in relation to monitoring instruments:

(a) gas flow meter information including the model, serial number and calibration procedures for the instrument; and

(b) gas flow meter calibration data for each flow meter.

Gas Composition

(7) The following information must be kept in relation to site determination of gas composition:

(a) if a gas analyser is used - gas analyser information including the model, serial number and calibration procedures for the instrument;

(b) gas analyser calibration data for each gas analyser; and

(c) gas quality data (including particulate content and humidity).

Direct and indirect measurement

(8) The following information must be kept in relation to direct and indirect measurement:

(a) additional waste entering the biodigester during the reporting period (weight and category of waste);

(b) records of any raw data and site observations relating to the gas capture and combustion system and parameters entered into the PigBal model;

(c) all values and calculations used in baseline calculations;

(d) all values and calculations used to calculate net greenhouse gas abatement;

(e) the methods of handling of digestate, including:

(i) the volume of digester effluent discharged into a lagoon in cubic metres (m^3) or kilolitres; and

(ii) the amounts of digestate, in wet weight measured in tonnes, that are:

(A) applied directly to land;

(B) sent to landfill; and

(C) treated aerobically.

(f) monthly and annual CO_2-e tonnage calculations;

(g) electronic recording of values of logged primary parameters for each measurement interval, for each meter. This includes:

(i) gas flow data for each flow meter;

(ii) temperature data from temperature measurement device for each device;

(iii) methane content of gas (% by volume) for each measurement (if default value not used) including date, time and location of measurement, notes of non-compliance to performance specifications, remedial actions taken to correct instrument;

(h) evidence of fuel use including invoices and receipts;

(i) evidence of grid-delivered electricity use including invoices, receipts and meter data; and

(j) where an internal combustion engine is used—evidence of the amount of electricity produced by the internal combustion engine generator.

Division 5.5 Offsets report requirements

5.13 Report requirements

(1) Project proponents must submit a report for each reporting period of the project.

Required information for all offsets reports

(2) Offsets reports must contain the following information:

(a) all calculation inputs for which a default or calculated value is not used including:

(i) data used in the Pigbal model;

(ii) feed usage data;

(iii) diet analysis;

(iv) pig numbers by class;

(v) volatile solids of each waste stream; and

(vi) all measured methane producing capacities.

(b) net greenhouse gas abatement number;

(c) independent audit report;

(d) quantity of methane generated under baseline conditions in tonnes of CO_2-e;

(e) total volume of methane sent to combustion devices, in cubic metres (sum of $Q_{CH_4,h}$);

(f) operating efficiencies for all combustion devices;

(g) total number of occasions when a combustion device fails or is shutdown and the duration of the failure or shutdown;

(h) total number of occasions when a combustion device operates at temperatures less than 500°C for a period exceeding 20 minutes in any particular hour.

(i) total amount of fuel and/or electricity used by the project, in kilolitres (kL), cubic metres (m^3), or kilowatt hours (kWh);

(j) electrical efficiency of (Eff) of the internal combustion engine generator;

(k) types of waste, including incidental waste in the case of a standard project, and eligible and ineligible waste types in the case of an additional waste project, treated in the digester;

(l) annual amount of each type of waste, including incidental waste, treated in the digester.

Additional requirements for the first offsets report

(3) In addition to the information prescribed in subsection (2), the first offsets report for a project must contain the quality assurance plan required in section 5.12.

Schedule 1—Categories of CFI eligible additional waste and attributable biogas methane generation rates

Number	Category	Maximum methane-producing capacity (m^3 CH_4/kgVS) (Bo)
1	Sheep manure	0.25
2	Rabbit manure	0.17
3	Feeder cattle liquid manure	0.22
4	Cow dung fresh	0.25
5	Horse dung	0.17
6	Poultry excrement, dry	0.28
7	Poultry excrement	0.33

Schedule 2—Categories of CFI ineligible additional waste and biogas methane generation rates

Number	Category	Maximum methane-producing capacity (m^3 CH_4/kgVS) (Bo)
1	Food waste, low fat	0.50
2	Food waste, high fat and grease trap waste	0.70
3	Ulva sp. Macroalgae (Saltwater)	0.10
4	Oedogonium sp. Macroalgae (freshwater)	0.16
5	Cladophora sp. Macroalgae (freshwater)	0.23
6	Microalgae Polyculture (freshwater)	0.20
7	Cabbage leaves	0.33
8	Maize Silage	0.30
9	Bakery waste	0.40
10	Cheese waste	0.61
11	Spent grains fresh (brewery)	0.33
12	Slaughter house waste	0.61
13	Press mud	0.22
14	Vegetable matter	0.34
15	Barley (cerial / corn)	0.39
16	Barley straw	0.30
17	Glycerin	0.37
18	Rye silage barley/wheat (low grain)	0.27

19	Freshly wilted grass	0.30
20	Grass silage	0.32
21	Green pruning (DM content very variable)	0.34
22	Wheat (cereals)	0.39
23	Wheat bran	0.29
24	Wheat chaff	0.30
25	Wheat straw	0.30
26	Winter peas (whole plant silage, mid-flowering)	0.27
27	Blood	0.48

Schedule 3—Methane capture rates for Australian States and Territories

State	Methane capture rate (C_{STATE})
ACT	0.47
NSW	0.24
NT	0.25
QLD	0.16
SA	0.28
TAS	0.33
VIC	0.32
WA	0.27

Schedule4—Emissions factors for the decay of digestate in landfill

Treatment Type	Treatment Risk	Emission Factor (EF_{AER})
(1) Digestate treated on-site in uncovered non-aerated static piles; or (2) Material treated off-site at an undocumented facility.	High	0.10
(3) Digestate treated on-site in aerated systems (turned windrows or aerated static piles); or (4) Material treated off-site at a centralised composting facility.	Medium	0.06
(5) Digestate treated on-site in an enclosed system (in-vessel) utilising a bio-filter or biogas scrubber.	Low	0.02
(6) Materials thermally dried upon separation from liquid effluent; (7) Materials used directly as animal bedding material; or (4) Digestate immediately blended as soil amendment.	Zero	0

Note

1. All legislative instruments and compilations are registered on the Federal Register of Legislative Instruments kept under the *Legislative Instruments Act 2003.* See http://www.frli.gov.au.