Carbon Farming (Capture and Combustion of Methane in Landfill Gas from Legacy Waste) Methodology Determination 2012

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 7 August 2012

MARK DREYFUS
Parliamentary Secretary for Climate Change and Energy Efficiency

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Part 1 Preliminary

1.1 Name of Methodology Determination

This Methodology Determination is the *Carbon Farming (Capture and Combustion of Methane in Landfill Gas from Legacy Waste) Methodology Determination 2012*.

1.2 Commencement

This Methodology Determination is taken to commence on 1 July 2010.

1.3 Application

(1) This Methodology Determination applies to the following types of landfill legacy emissions avoidance projects:

(a) transitioning Greenhouse Friendly projects;

(b) transitioning GGAS projects; and

(c) projects that involve the following activities:

(i) installing, on or after 1 July 2010, a landfill gas extraction system; and

(ii) collecting gas emitted from legacy waste from the landfill facility; and

(iii) combusting the methane component of the gas using a combustion device to chemically convert it to carbon dioxide (CO_2).

(2) To avoid confusion, 'installing a landfill gas extraction system' does not include the reinstallation, or replacement of, upgrades to or modifications of an existing system, where such systems were installed prior to 1 July 2010. A project under this Methodology Determination that is not a transitioning project must include the installation of a new system, in entirety, where no system has previously been installed.

1.4 Definitions

Act means the *Carbon Credits (Carbon Farming Initiative) Act 2011*.

biogas means the gas generated from anaerobic decomposition of biological material.

CO_2-e means carbon dioxide equivalent.

combustion device means a device which destroys methane in landfill gas emissions by combusting it in a flare or an internal combustion engine.

flare means:

(a) *open flare* – a device whereby gas is burned in or at an open air tip with or without any auxiliary fuel assistance; or

(b) *enclosed flare* – a device whereby 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.

GGAS means the New South Wales Government's Greenhouse Gas Reduction Scheme and the Australian Capital Territory Government's Greenhouse Gas Abatement Scheme.

Greenhouse Friendly means the program known as the Greenhouse Friendly™ initiative and administered by the Commonwealth Government.

Guidelines for calculating regulatory baselines means the *Guidelines for Calculating Regulatory Baselines for Legacy Waste Landfill Methane Projects* developed by the Department of Climate Change and Energy Efficiency, as they exist from time to time, and which are available from the Department's website at www.climatechange.gov.au/cfi

greenhouse gas assessment boundary **–** see section 3.2 of this Methodology Determination.

landfill gas extraction system means a system to collect and destroy methane emitted from legacy waste at a landfill facility.

legacy waste means solid waste containing biodegradable organic matter accepted by a landfill facility before 1 July 2012**.**

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

NGER (Measurement) Determination means the applicable determination made under subsection 10 (3) of the *National Greenhouse and Energy Reporting Act 2007* 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.

Scope 2 emissions has the meaning given by paragraph 2.23 (2) (b) of the *NGER Regulations*.

transitioning Greenhouse Friendly project means a landfill legacy emissions avoidance project that was accredited and remained eligible to generate credits under Greenhouse Friendly until the program closed on 30 June 2010 and has not been accredited under GGAS since that time.

transitioning GGAS project means a landfill legacy emissions avoidance project that was accredited and remained eligible to generate abatement certificates under GGAS until the scheme closed on 1 July 2012.

Note: Several other words and expressions used in this Methodology Determination have the meaning given by section 5 of the Act, for example:

- baseline;
- carbon dioxide equivalence;
- eligible offsets project;
- emission;
- greenhouse gas;
- landfill facility;

- landfill legacy emissions avoidance project;
- methodology determination;
- National Inventory Report;
- offsets project;
- offsets report;
- project;
- project area;
- project proponent;
- reporting period.

Part 2 Requirements that must be met for an offsets project to be an eligible offsets project

2.1 Requirements that must be met for an offsets project to be an eligible offsets project

(1) For paragraph 106 (1) (b) of the Act, this section sets out requirements that must be met for an offsets project to which this Methodology Determination applies to be an eligible offsets project.

(2) The project must be one of the following types of landfill legacy emissions avoidance projects:

(a) transitioning Greenhouse Friendly projects;

(b) transitioning GGAS projects; and

(c) projects that involve the following activities:

(i) installing, on or after 1 July 2010, a landfill gas extraction system; and

(ii) collecting gas emitted from legacy waste from the landfill facility; and

(iii) combusting the methane component of the gas using a combustion device to chemically convert it to carbon dioxide (CO_2).

(3) The project must relate to the capture and combustion of emissions from legacy waste only.

(4) To avoid confusion, 'installing a landfill gas extraction system' does not include the reinstallation, or replacement of, upgrades to or modifications of an existing system, where such systems were installed prior to 1 July 2010. A project under this Methodology Determination that is not a transitioning project must include the installation of a new system, in entirety, where no system has previously been installed.

(5) The proportion of methane that is required to be captured or destroyed to meet regulatory requirements must be calculated in accordance with the *Guidelines for calculating regulatory baselines.*

Part 3 Calculating the carbon dioxide equivalent net abatement amount for a project in relation to a reporting period

Division 3.1 Preliminary

3.1 General

(1) In this Part:

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

Example: in Equation 2 (calculation of avoided methane emissions), $Q_{com,h}$ is the volume of methane generated by legacy waste that was destroyed in the landfill gas extraction system during the reporting period.

(b) *n* = number of combustion devices; and

h denotes a combustion device.

(2) If a calculation in Division 3.2 refers to a factor or parameter prescribed in the *NGER (Measurement) Determination* or the *NGER Regulations*, the person carrying out the calculations must apply, to the entire offsets reporting period, the *NGER (Measurement) Determination* or the *NGER Regulations* in force at the time that the offsets report was submitted or was required to be submitted, whichever occurs first.

(3) The data used in the calculations set out in Division 3.2 must comply with the data collection requirements set out in Division 3.3.

3.2 Greenhouse gas assessment boundary

The following greenhouse gases from the following activities must be taken into account when making calculations under this Part in respect of each of the following kinds of activities within the project. No other gases may be taken into account.

Table of gases accounted for in the abatement calculations

Project activity	***Greenhouse gas***
Electricity consumption	Carbon dioxide (CO_2)
	Methane (CH_4)
	Nitrous oxide (N_2O)
Supplemental fuel use	Carbon dioxide (CO_2)
	Methane (CH_4)
	Nitrous oxide (N_2O)
Electricity generation	Methane (CH_4)

Project activity	*Greenhouse gas*
	Nitrous oxide (N_2O)
Gas flare	Methane (CH_4)
	Nitrous oxide (N_2O)

3.3 Calculating the baseline for the offsets project

(1) For paragraph 106 (4) (f) of the Act, the baseline for a project is the methane that would have been emitted from the landfill facility in the absence of the project, which is determined by subtracting the quantity of methane generated by legacy waste that is required to be captured and destroyed to meet regulatory requirements (A_{reg}) from the total methane generated by legacy waste that otherwise would have been emitted.

Note: A_{reg} *is defined in section 3.10.*

(2) The proportion of methane that is required to be captured or destroyed to meet regulatory requirements must be calculated in accordance with the *Guidelines for calculating regulatory baselines*.

Division 3.2 Calculations

Subdivision 3.2.1 Calculating the carbon dioxide equivalent net abatement amount (**A**)

3.4 Carbon dioxide equivalent net abatement amount (**A**)

For paragraph 106 (1) (c) of the Act, the carbon dioxide equivalent net abatement amount for an offsets project to which this Methodology Determination applies for a reporting period is taken, for the purposes of the Act, to be the amount calculated using the following formula:

$\mathbf{A} = (\mathbf{A_p} - \mathbf{Y_p})$	**Equation 1**

where:

A = the net abatement amount for an offsets project to which this Methodology Determination applies for a reporting period, in tonnes of CO_2-e.

$\mathbf{A_p}$ = quantity of methane emissions avoided as a consequence of the project, in tonnes of CO_2-e, calculated in accordance with section 3.5 of this Methodology Determination.

$\mathbf{Y_p}$ = emissions from fuel and grid-delivered electricity used to operate the landfill gas extraction system for the purposes of the project, in tonnes of CO_2-e, calculated in accordance with section 3.11 of this Methodology Determination.

Subdivision 3.2.2 Calculating avoided emissions (A_p)

3.5 Avoided emissions (A_p)

Subject to section 3.8 of this Methodology Determination, the quantity of emissions avoided as a consequence of the project (A_p) is to be calculated using the following formula:

$$\mathbf{A_p} = \left[\left(\boldsymbol{\gamma} \sum_{\mathbf{h=1}}^{\mathbf{n}} \mathbf{Q_{com,h}}\right) - \mathbf{A_{reg}}\right] \times (\mathbf{1 - OF}) - \mathbf{E_{com}}$$	**Equation 2**

where:

$\mathbf{A_p}$ = quantity of emissions avoided as a consequence of the project, in tonnes of CO_2-e.

$\boldsymbol{\gamma}$ = the factor converting cubic metres of methane at standard conditions to tonnes of CO_2-e as prescribed in Part 5.2 of the *NGER (Measurement) Determination*.

$\mathbf{Q_{com,h}}$ = volume of methane generated by legacy waste destroyed by combustion device h, in cubic metres, calculated in accordance with section 3.6 of this Methodology Determination.

$\mathbf{A_{reg}}$ = quantity of methane generated by legacy waste destroyed under baseline conditions, due to regulatory requirements, in tonnes of CO_2-e, calculated in accordance with section 3.10 of this Methodology Determination.

OF = oxidation factor for near surface methane in a landfill as prescribed in Part 5.2 of the *NGER (Measurement) Determination*.

$\mathbf{E_{com}}$ = quantity of methane and nitrous oxide emissions released from combustion devices in the landfill facility, in tonnes of CO_2-e, calculated in accordance with section 3.7 of this Methodology Determination.

3.6 Volume of methane generated from legacy waste destroyed by a combustion device ($Q_{com,h}$)

(1) Subject to section 3.8 of this Methodology Determination, the volume of methane generated by legacy waste destroyed by combustion device h, in cubic metres, ($Q_{com,h}$) is to be calculated using the following formula:

$$\mathbf{Q_{com,h}} = \mathbf{Q_{sent,h}} \times \mathbf{DE_h} \times \mathbf{L_p}$$	**Equation 3**

where:

$\mathbf{Q_{com,h}}$ = volume of methane generated by legacy waste destroyed by combustion device h, in cubic metres.

$\mathbf{Q_{sent,h}}$ = volume of methane sent to combustion device h, in cubic metres, calculated in accordance with subsections 3.6 (2) or 3.6 (3) of this Methodology Determination.

$\mathbf{DE_h}$ = methane destruction efficiency for combustion device h, expressed as a fraction. If the combustion device is an open flare, a default value of 0.98 must be used. Otherwise, either a default value of 0.98 may be used or the methane destruction efficiency of the device may be measured in accordance with section 3.14 of this Methodology Determination. If the device is a flare and the flare is not operational, DE_h is zero.

$\mathbf{L_p}$= proportion of methane generated by legacy waste, calculated in accordance with section 3.9 of this Methodology Determination.

Note: If the combustion device is an internal combustion engine the project proponent may elect to calculate the volume of methane destroyed using $Q_{com,h}$. *Alternatively the proponent may elect to calculate the quantity of methane destroyed by the internal combustion engine in accordance with section 3.8 of this Methodology Determination.*

Note: Section 3.18 of this Methodology Determination sets out the circumstances in which a flare is taken not to be operational.

(2) Unless subsection 3.6 (3) applies, the volume of methane sent to the combustion device h ($Q_{sent,h}$) is to be calculated using the following formula:

$\mathbf{Q_{sent,h} = Q_{lfg,h} \times W_{CH_4}}$	**Equation 4a**

where:

$\mathbf{Q_{sent,h}}$ = volume of methane sent to combustion device h, in cubic metres.

$\mathbf{Q_{lfg,h}}$ = volume of landfill gas sent to combustion device h, in cubic metres, measured in accordance with section 3.15 of this Methodology Determination.

$\mathbf{W_{CH_4}}$ = the average methane fraction of the landfill gas, calculated using either a default value of 0.5, or measured in accordance with section 3.14 of this Methodology Determination.

(3) If the energy content of landfill gas is calculated in gigajoules (GJ) from the measured flow rate and methane fraction of the landfill gas by a flow computer, and all measured parameters are corrected to standard conditions, $Q_{sent,h}$ may be calculated by reference to the landfill gas energy content reported by the computer using the following formula:

$\mathbf{Q_{sent,h} = E_{lfg} \times \frac{1}{EC_{biogas}}}$	**Equation 4b**

where:

$\mathbf{Q_{sent,h}}$ = volume of methane sent to combustion device h, in cubic metres.

$\mathbf{E_{lfg}}$ = the value, calculated by a flow computer, of the energy content of methane in the landfill gas, in gigajoules (GJ).

$\mathbf{EC_{biogas}}$ = the energy content factor for landfill biogas that is captured for combustion as prescribed in Schedule 1, Part 2 of the *NGER (Measurement) Determination*.

3.7 Emissions from combustion devices (E_{com})

(1) The quantity of methane and nitrous oxide emissions released from combustion devices used in the project, in tonnes of CO_2-e, (E_{com}) is to be calculated using the following formula:

$\mathbf{E_{com} = E_{rel,CH_4} + E_{N_2O}}$	**Equation 5**

where:

$\mathbf{E_{com}}$ = quantity of methane emissions and nitrous oxide emissions released from all combustion devices, in tonnes of CO_2-e.

$\mathbf{E_{rel,CH_4}}$ = quantity of methane emissions released from all combustion devices, in tonnes of CO_2-e, calculated in accordance with subsection 3.7 (2) of this Methodology Determination.

$\mathbf{E_{N_2O}}$ = quantity of nitrous oxide emissions released as a result of all combustion devices, in tonnes of CO_2-e, calculated in accordance with subsection 3.7 (5) of this Methodology Determination.

(2) Subject to subsection 3.7 (3), $E_{rel\ CH_4}$ is to be calculated using the following formula:

$\mathbf{E_{rel,CH_4} = \gamma \sum_{h=1}^{n} Q_{rel,h} \times OF}$	**Equation 6**

where:

$\mathbf{E_{rel,CH_4}}$ = quantity of methane emissions from legacy waste released from all combustion devices, in tonnes of CO_2-e.

$\boldsymbol{\gamma}$ = the factor converting cubic metres of methane at standard conditions to tonnes of CO_2-e as prescribed in Part 5.2 of the *NGER (Measurement) Determination*.

$\mathbf{Q_{rel,h}}$ = volume of methane generated by legacy waste not destroyed by combustion device h, in cubic metres, calculated in accordance with subsection 3.7 (4) of this Methodology Determination.

OF = oxidation factor for near surface methane in a landfill as prescribed in Part 5.2 of the *NGER (Measurement) Determination*.

(3) If section 3.8 applies, E_{rel,CH_4} is to be calculated using the following formula:

$\mathbf{E_{rel,CH_4}} = \left[\left(\boldsymbol{\gamma} \sum_{\mathbf{h=1}}^{\mathbf{n}} \mathbf{Q_{rel,h}}\right) + \left(\left(\sum_{\mathbf{h=1}}^{\mathbf{n}} \mathbf{QE_h} \times (\mathbf{1} - \mathbf{DE_h})\right) \times \mathbf{CH_4\ factor} \times \mathbf{GWP_{CH_4}} \times \mathbf{L_p}\right)\right] \times \mathbf{OF}$	**Equation 6(a)**

where:

$\mathbf{E_{rel,CH_4}}$ = quantity of methane emissions from legacy waste released from all combustion devices, in tonnes of CO_2-e.

$\boldsymbol{\gamma}$ = the factor converting cubic metres of methane at standard conditions to tonnes of CO_2-e as prescribed in Part 5.2 of the *NGER (Measurement) Determination*.

$\mathbf{Q_{rel,h}}$ = volume of methane generated by legacy waste not destroyed by combustion device h, in cubic metres, calculated in accordance with subsection 3.7 (4) of this Methodology Determination.

$\mathbf{QE_h}$ = energy content of the methane sent to the internal combustion engine, h, in gigajoules (GJ), calculated in accordance with subsection 3.8 (6) of this Methodology Determination.

$\mathbf{DE_h}$ = methane destruction efficiency for combustion device h, expressed as a fraction. If the device is an internal combustion engine h, the default value is 0.98 or the methane destruction efficiency of the device can be determined in accordance with section 3.14 of this Methodology Determination.

$\mathbf{CH_4}$ **factor** = conversion factor to convert gigajoules to tonnes of methane = 0.018

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

OF = oxidation factor for near surface methane in a landfill as prescribed in Part 5.2 of the *NGER (Measurement) Determination*.

Note: If an internal combustion engine is the only type of combustion device used, then the value for $\left(\gamma \sum_{h=1}^{n} Q_{rel,h}\right)$ *will be zero.*

(4) $Q_{rel,h}$ is to be calculated using the following formula:

$\mathbf{Q_{rel,h} = Q_{sent,h} \times L_p - Q_{com,h}}$	**Equation 7**

where:

$Q_{rel,h}$ = volume of methane generated from legacy waste not destroyed by combustion device h, in cubic metres.

$Q_{sent,h}$ = has the same value as it has for the purposes of section 3.6 of this Methodology Determination.

L_p = proportion of methane generated by legacy waste, calculated in accordance with section 3.9 of this Methodology Determination.

$Q_{com,h}$ = has the same value as it has for the purposes of section 3.6 of this Methodology Determination.

(5) Subject to subsection 3.7 (6), E_{N_2O} is to be calculated using the following formula:

$\mathbf{E_{N_2O} = \sum_{h=1}^{n} Q_{sent,h} \times EC_{biogas} \times \frac{EF_{N_2O}}{1000} \times L_p}$	**Equation 8**

where:

E_{N_2O} = quantity of nitrous oxide emissions released from legacy waste as a result of methane destruction processes from all combustion devices, in tonnes of CO_2-e.

$Q_{sent,h}$ = has the same value as it has for the purposes of section 3.6 of this Methodology Determination.

EC_{biogas} = the energy content factor for landfill biogas that is captured for combustion as prescribed in Schedule 1, Part 2 of the *NGER (Measurement) Determination*.

EF_{N_2O} = the emission factor for nitrous oxide (N_2O) from landfill that is captured for combustion as prescribed in Schedule 1, Part 2 of the *NGER (Measurement) Determination*.

L_p = proportion of methane generated by legacy waste, calculated in accordance with section 3.9 of this Methodology Determination.

(6) If section 3.8 applies, E_{N_2O} is to be calculated using the following formula:

$$\mathbf{E_{N_2O}} = \left(\left(\sum_{\mathbf{h=1}}^{\mathbf{n}} \mathbf{Q_{sent,h}} \times \mathbf{EC_{biogas}}\right) + \sum_{\mathbf{h=1}}^{\mathbf{n}} \mathbf{QE_h}\right) \times \frac{\mathbf{EF_{N_2O}}}{\mathbf{1000}} \times \mathbf{L_p}$$	**Equation 8(a)**

where:

$\mathbf{E_{N_2O}}$ = quantity of nitrous oxide emissions released from legacy waste as a result of methane destruction processes from all combustion devices, in tonnes of CO_2-e.

$\mathbf{Q_{sent,h}}$ = has the same value as it has for the purposes of section 3.6 of this Methodology Determination.

$\mathbf{L_p}$ = proportion of methane generated by legacy waste, calculated in accordance with section 3.9 of this Methodology Determination.

$\mathbf{EC_{biogas}}$ = the energy content factor for landfill biogas that is captured for combustion as prescribed in Schedule 1, Part 2 of the *NGER (Measurement) Determination*.

$\mathbf{QE_h}$ = energy content of the methane sent to the internal combustion engine, h, in gigajoules (GJ), calculated in accordance with subsection 3.8 (6) of this Methodology Determination.

$\mathbf{L_p}$= proportion of methane generated by legacy waste, calculated in accordance with section 3.9 of this Methodology Determination.

$\mathbf{EF_{N_2O}}$ = the emission factor for nitrous oxide (N_2O) from landfill biogas that is captured for combustion as prescribed in Schedule 1, Part 2 of the *NGER (Measurement) Determination*.

Note: If internal combustion engines are the only type of combustion device used, then the value for $\left(\gamma \sum_{h=1}^{n} Q_{sent,h} \times EC_{biogas}\right)$ *is zero.*

3.8 Quantity of methane combusted in an internal combustion engine - optional calculations

(1) This section applies if:

(a) the landfill gas extraction system used in an offsets project to which this Methodology Determination applies includes an internal combustion engine for electricity generation; and

(b) the project proponent elects to calculate the quantity of methane destroyed by an internal combustion engine ($A_{com,ice}$) based on the amount of electricity produced by an internal combustion engine generator (Ep_h) measured in megawatt hours.

Calculation of quantity of methane destroyed $A_{com,ice}$

(2) If the conditions specified in subsection 3.8 (1) of this Methodology Determination apply, then the quantity of methane destroyed in an internal combustion engine $A_{com,ice}$ may be calculated using the formula set out in subsections 3.8 (5) and (6) of this Methodology Determination.

(3) If the conditions specified in subsection 3.8 (1) (b) apply then the formula in subsections 3.6 (1) and (2) of this Methodology Determination must not be used to calculate the quantity of methane destroyed in an internal combustion engine.

Alternative Calculation for A_p

(4) If the conditions specified in subsection 3.8 (1) of this Methodology Determination apply, and $A_{com,ice}$ is calculated in accordance with subsections 3.8 (5) and (6), then A_p is to be calculated using the following formula:

$\mathbf{A_p} = \left[\left(\boldsymbol{\gamma} \sum_{\mathbf{h=1}}^{\mathbf{n}} \mathbf{Q_{com,h}}\right) + \mathbf{A_{com,ice}} - \mathbf{A_{reg}}\right] \times (\mathbf{1} - \mathbf{OF}) - \mathbf{E_{com}}$	**Equation 2(a)**

where:

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

γ = the factor converting cubic metres of methane at standard conditions to tonnes of CO_2-e as prescribed in Part 5.2 of the *NGER (Measurement) Determination*.

$Q_{com,h}$ = volume of methane destroyed by combustion device h, in cubic metres, calculated in accordance with section 3.6 of this Methodology Determination.

$A_{com,ice}$ = quantity of methane destroyed as a consequence of combustion in an internal combustion engine, in tonnes CO_2-e, calculated in accordance with subsection 3.8 (5) of this Methodology Determination.

A_{reg} = quantity of methane destroyed under baseline conditions, due to regulatory requirements, in tonnes of CO_2-e, calculated in accordance with section 3.10 of this Methodology Determination.

OF = oxidation factor for near surface methane in a landfill as prescribed in Part 5.2 of the *NGER (Measurement) Determination.*

E_{com} = quantity of methane and nitrous oxide emissions released from combustion devices in the landfill facility, in tonnes of CO_2-e, calculated in accordance with section 3.7 of this Methodology Determination.

Note: If an internal combustion engine is the only type of combustion device used, then the value for $\left(\gamma \sum_{h=1}^{n} Q_{com,h}\right)$ *is zero.*

(5) $A_{com,ice}$ is to be calculated using the following formula:

$\mathbf{A_{com,ice}} = \left(\sum_{h=1}^{n} \mathbf{QE_h} \times \mathbf{DE_h}\right) \times \mathbf{CH_4\ factor} \times \mathbf{GWP_{CH_4}} \times \mathbf{L_p}$	**Equation 9**

where:

$\mathbf{A_{com,ice}}$ = quantity of methane generated by legacy waste destroyed as a consequence of combustion in an internal combustion engine, in tonnes of CO_2-e.

$\mathbf{QE_h}$= energy content of the methane sent to the internal combustion engine, h, in gigajoules (GJ), calculated in accordance with subsection 3.8 (6) of this Methodology Determination.

$\mathbf{DE_h}$ = methane destruction efficiency for combustion device h, expressed as a fraction. If the device is an internal combustion engine h, the default value is 0.98 or the methane destruction efficiency of the device can be determined in accordance with section 3.14 of this Methodology Determination.

$\mathbf{CH_4\ factor}$ = methane conversion factor, to convert gigajoules to tonnes of methane = 0.018.

$\mathbf{GWP_{CH_4}}$= global warming potential of methane as prescribed in Regulation 2.02 of the *NGER Regulations.*

$\mathbf{L_p}$ = proportion of methane generated from legacy waste, calculated in accordance with section 3.9 of this Methodology Determination.

(6) QE_h is to be calculated using the following formula:

$\mathbf{QE_h} = \frac{\mathbf{Ep_h} \times \mathbf{E_{GJ}}}{\mathbf{Eff}}$	**Equation 10**

where:

$\mathbf{QE_h}$ = energy content of the methane sent to the internal combustion engine, h, in gigajoules (GJ).

$\mathbf{Ep_h}$= amount of electricity (supplied to the grid or used on-site) produced by internal combustion engine, h, as a result of combustion of methane in MWh.

$\mathbf{E_{GJ}}$ = Energy in GJ per MWh = 3.6.

Eff = Electrical efficiency factor (as a fraction) for the internal combustion engine as per the manufacturer's specifications for the equipment. If there is no value specified by the manufacturer, a default value of 0.36 must be used.

3.9 Proportion of methane generated from legacy waste (L_p)

(1) On or before 30 June 2012, $L_p = 1$.

(2) After 30 June 2012:

(a) if it can be demonstrated under a method prescribed in the *NGER (Measurement) Determination* that all methane captured is generated from legacy waste, $L_p = 1$.

(b) otherwise, subject to subsection 3.9 (3), L_p is to be calculated using the following formula:

$$\mathbf{L_p} = \frac{\mathbf{M_{lw}}}{\mathbf{M_{lw}} + \mathbf{M_{plw}}}$$	**Equation 11**

where:

$\mathbf{L_p}$ = the proportion of methane generated from legacy waste.

$\mathbf{M_{lw}}$ = the quantity of methane generated by legacy waste during that part of the reporting period that is after 30 June 2012, in tonnes of CO_2-e, calculated using a method prescribed in Divisions 5.2.2 to 5.2.4 of the *NGER (Measurement) Determination*.

$\mathbf{M_{plw}}$ = the quantity of methane generated by non-legacy waste during that part of the reporting period that is after 30 June 2012, in tonnes of CO_2-e, calculated using a method specified in Divisions 5.2.2 to 5.2.4 of the *NGER (Measurement) Determination.*

(3) If the landfill facility is required to report greenhouse gas emissions under the *National Greenhouse and Energy Reporting Act 2007*, M_{lw} and M_{plw} must be calculated using the data submitted in the facility's report under that Act.

3.10 Quantity of methane destroyed under baseline conditions, due to regulatory requirements (A_{reg})

(1) Subject to subsection 3.10 (2), the quantity of methane destroyed under baseline conditions, due to regulatory requirements (A_{reg}), is to be calculated using the following formula:

$$\mathbf{A_{reg}} = \left(\boldsymbol{\gamma} \sum_{\mathbf{h=1}}^{\mathbf{n}} \mathbf{Q_{com,h}} \right) \times \mathbf{R_P}$$	**Equation 12**

where:

$\mathbf{A_{reg}}$ = the quantity of methane destroyed under baseline conditions, due to regulatory requirements in tonnes CO_2-e.

$\boldsymbol{\gamma}$ = the factor converting cubic metres of methane at standard conditions to tonnes of CO_2-e as prescribed in Part 5.2 of the *NGER (Measurement) Determination*.

$\mathbf{Q_{com,h}}$ = calculated in accordance with section 3.6 of this Methodology Determination.

$\mathbf{R_P}$ = the proportion of methane that is required to be captured or destroyed to meet regulatory requirements, calculated in accordance with the *Guidelines for calculating regulatory baselines*, and equal to:

(a) zero, for transitioning Greenhouse Friendly projects;

(b) 0.24, for transitioning GGAS projects; and

(c) the number calculated in accordance with the *Guidelines for calculating regulatory baselines* for all other projects.

(2) If the conditions specified in subsection 3.8 (1) apply and $A_{com,ice}$ is calculated in accordance with subsection 3.8 (4), then A_{reg} is to be calculated using the following formula:

$\mathbf{A_{reg}} = \left[\left(\boldsymbol{\gamma} \sum_{\mathbf{h=1}}^{\mathbf{n}} \mathbf{Q_{com,h}}\right) + \mathbf{A_{com,ice}}\right] \times \mathbf{R_P}$	**Equation 12(a)**

where:

$\mathbf{A_{reg}}$ = the quantity of methane destroyed under baseline conditions, due to regulatory requirements in tonnes CO_2-e.

$\boldsymbol{\gamma}$ = the factor converting cubic metres of methane at standard conditions to tonnes of CO_2-e as prescribed in Part 5.2 of the *NGER (Measurement) Determination*.

$\mathbf{Q_{com,h}}$ = calculated in accordance with section 3.6 of this Methodology Determination.

$\mathbf{A_{com,ice}}$ = calculated in accordance with subsection 3.8 (5) of this Methodology Determination.

$\mathbf{R_P}$ = has the same meaning as in subsection 3.10 (1) of this Methodology Determination.

Subdivision 3.2.3 Calculating emissions from fuel and grid-delivered electricity used to operate the landfill gas extraction system used in the project ($\mathbf{Y_p}$)

3.11 Emissions from fuel and grid-delivered electricity used to operate the landfill gas extraction system used in the project (Y_p)

(1) Subject to subsection 3.11 (4) of this Methodology Determination, the emissions from fuel and grid-delivered electricity used to operate the landfill gas extraction system used in an offsets project to which this Methodology Determination applies (Y_p) is to be calculated using the following formula:

$\mathbf{Y_p = Y_t - Y_{reg}}$	**Equation 13**

where:

$\mathbf{Y_p}$ = emissions from fuel and grid-delivered electricity used to operate the landfill gas extraction system to capture and destroy methane generated from legacy waste as a result of the project, in tonnes of CO_2-e.

$\mathbf{Y_t}$ = total emissions from fuel and grid-delivered electricity used to operate the landfill gas extraction system, in tonnes of CO_2-e, calculated in accordance with subsection 3.11 (2) of this Methodology Determination.

$\mathbf{Y_{reg}}$ = emissions from fuel and grid-delivered electricity used to operate the landfill gas extraction system to meet regulatory requirements, in tonnes of CO_2-e, calculated in accordance with subsection 3.11 (3) of this Methodology Determination.

(2) The total emissions from fuel and grid-delivered electricity used to operate the landfill gas extraction system (Y_t), is to be calculated using the following formula:

$\mathbf{Y_t = (E_f + E_{elec}) \times L_p}$	**Equation 14**

where:

$\mathbf{Y_t}$ = total emissions from fuel and grid-delivered electricity used to operate the landfill gas extraction system, in tonnes of CO_2-e.

$\mathbf{E_f}$ = total emissions from fuel used (including supplemental natural gas) to operate the landfill gas extraction system, in tonnes of CO_2-e, calculated in accordance with section 3.12 of this Methodology Determination.

$\mathbf{E_{elec}}$ = total emissions from consumption of purchased electricity used to operate the landfill gas extraction system, in tonnes of CO_2-e, calculated in accordance with section 3.13 of this Methodology Determination.

$\mathbf{L_p}$ = proportion of methane generated from legacy waste, calculated in accordance with section 3.9 of this Methodology Determination.

(3) The emissions from fuel and grid-delivered electricity used to operate the landfill gas extraction system to meet regulatory requirements (Y_{reg}), is to be calculated using the following formula:

$\mathbf{Y_{reg} = Y_t \times R_P}$	**Equation 15**

where:

Y_{reg} = the emissions from fuel and grid-delivered electricity used to operate the landfill gas extraction system to meet regulatory requirements, in tonnes of CO_2-e.

Y_t = has the same meaning as in subsection 3.11 (2) of this Methodology Determination.

R_P = has the same meaning as in subsection 3.10 (1) of this Methodology Determination.

(4) In this section, all calculations of emissions from fuel and electricity use must be calculated using the energy content and emission factors set out in Schedule 1 to the *NGER (Measurement) Determination*.

3.12 Total emissions from fuel used to operate the landfill gas extraction system (Ef)

(1) Total emissions from fuel used (including supplemental natural gas) to operate the landfill gas extraction system (Ef) is to be calculated using the following formula:

$\mathbf{Ef} = \sum_{i=1}^{n} \sum_{j=1}^{N} \mathbf{E_{ij}}$	**Equation 16**

where:

Ef = total emissions from fuel used (including supplemental natural gas) to operate the landfill gas extraction system, in tonnes of CO_2-e

i = fuel type

j = gas type (CO_2, N_2O, CH_4)

n = number of fuel types

N = number of gas types

E_{ij}= emissions from fuel type (i) of greenhouse gas (j) in tonnes of CO_2-e, calculated in accordance with subsection 3.12 (2) of this Methodology Determination.

(2) E_{ij} is to be calculated for each fuel type (i) and each greenhouse gas (j) (i.e. CO_2, N_2O, CH_4), using the following formula:

$\mathbf{E_{ij} = \frac{Q_i \times EC_i \times EF_{ijoxec}}{1000}}$	**Equation 17**

where:

$\mathbf{E_{ij}}$ = emissions from fuel type (i) of greenhouse gas (j) in tonnes of CO_2-e.

$\mathbf{Q_i}$ = quantity of fuel type (i), measured in cubic metres, kilolitres or gigajoules.

$\mathbf{EC_i}$ = energy content factor of fuel type (i) (gigajoules per kilolitre or gigajoules per cubic metres), calculated using the relevant energy content factor prescribed in Schedule 1 to the *NGER (Measurement) Determination*.

$\mathbf{EF_{ijoxec}}$ = emission factor for each gas type (j) (which includes the effect of an oxidation factor) for fuel type (i) (in kilograms of CO_2-e per gigajoule), calculated using the relevant emission factor prescribed in Schedule 1 of the *NGER (Measurement) Determination*.

Note: If Q_i is measured in gigajoules, then EC_i is not required

3.13 Total emissions from the consumption of purchased electricity (E_{elec})

Total emissions from the consumption of purchased electricity used to operate the landfill gas extraction system (E_{elec}) is to be calculated using the following formula:

$\mathbf{E_{elec} = Q_{elec} \times \frac{EF}{1000}}$	**Equation 18**

where:

$\mathbf{E_{elec}}$ = total emissions from consumption of purchased electricity used to operate the landfill gas extraction system, in tonnes of CO_2-e.

$\mathbf{Q_{elec}}$ = quantity of electricity purchased from the electricity grid (kilowatt hours). If Q_{elec} is measured in gigajoules, the quantity of kilowatt hours must be calculated by dividing the amount of gigajoules by the conversion factor of 0.0036.

EF = the scope 2 emissions factor for the State, Territory or electricity grid in which consumption occurs as prescribed in Part 6 of Schedule 1 of the *NGER (Measurement) Determination*, in kg CO_2-e per kilowatt hour.

Division 3.3 Data collection

3.14 Measurement procedures and measurement frequency

The data collection method for deriving a parameter included in column 1 of the following table must comply with the corresponding measurement procedure and measurement frequency set out in columns 4 and 5 of the following table:

Parameter	Description	Unit	Measurement Procedure	Measurement Frequency
$Q_{sent,h}$	Quantity of landfill gas sent to a combustion device (h)	m^3	Measured by a flow meter, corrected to standard conditions. Data to be aggregated monthly and yearly	Continuous (average value in a time interval not greater than 24 hours must be used in the calculations of emissions reductions).
DE_h	Methane destruction efficiency for device h	%	*Open Flares:* - Default: 98% (factor of 0.98) *Enclosed Flares:* - Measured efficiency: Duplicate compliance testing, measured every 6 months, by a NATA accredited emission stack testing company, using a method based on US EPA Method 18 - Default: 98% (factor of 0.98) *Internal combustion engine:* - Measured efficiency: Duplicate compliance testing, measured every 6 months, by a NATA accredited emission stack testing company, using a method based on US EPA Method 18 - Default: 98% (factor of 0.98)	Every 6 months, if using measured efficiency by a testing company.

Parameter	Description	Unit	Measurement Procedure	Measurement Frequency
$\mathbf{W_{CH_4}}$	Methane fraction in the landfill gas	m^3CH_4 / m^3 landfill gas	Measured using a continuous gas analyser Measurement must be made on a consistent basis (either wet or dry) Measurement of methane fraction must be made on a consistent basis with flow measurement (wet or dry). See section 3.15 If there is no continuous gas analyser, the default of 50% (factor of 0.50) is to be used	Continuous (average value in a time interval not greater than 24 hours must be used in the calculations of emissions reductions). Values must be paired to flow rate measurement so that measurements are contiguous.
Electricity (Q_{elec})	Quantity of electricity used for abatement activity	Kilowatt hours	Measured using the relevant meter and sub-meter measuring the electricity used by equipment installed: the electricity usage is the value from that meter Estimated from the invoiced amount of electricity supplied to the landfill where the cost per unit of energy is known	If read from a meter or sub-meter, record monthly If estimated from invoices, estimate from total electricity used for the reporting period.
Fuel used (Q_i)	Quantity of fuel used for abatement activity	For liquid fuels, measured in kilolitres, or for gaseous fuels, measured in m^3 unless otherwise specified in the *NGER (Measurement) Determination*	For each fuel used the amount must be estimated as a proportion of totals for the facility. The estimation can be made from a reading from a meter or from invoices Manufacturer's specifications must be used to estimate the proportion of totals for the facility	Estimate from total amount of fuel used at least once per reporting period.

Parameter	Description	Unit	Measurement Procedure	Measurement Frequency
$\mathbf{Ep_h}$	Quantity of electricity produced by methane combustion in internal combustion engine generator (h)	MWh	Meter data, recording electricity sent to the grid; or meter data recording electricity sent out from internal combustion engine generator (if electricity is used onsite) The accuracy of the meter used must be equivalent to a revenue meter	Amount of electricity sent out from the internal combustion engine generator 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 specifications for the equipment (with reference to Australian Standard AS 4594.1 or equivalent) or the default value of 36% (factor of 0.36)	A set value as per manufacturer's specification or the default.

3.15 Volumetric measurement — Quantity of landfill gas ($Q_{lfg,h}$) and methane fraction (W_{CH_4})

The following requirements must be complied with when measuring $\mathbf{Q_{lfg,h}}$ and $\mathbf{W_{CH_4}}$:

(a) measurements must comply with the units of measurement required by or under the *National Measurement Act 1960*;

(b) appropriate measuring equipment must be employed to provide volumetric measurement in cubic metres corrected to standard conditions (temperature and pressure);

(c) volumetric flow rate must be measured as cubic metres per hour;

(d) the volumetric measurement must be calculated using a flow computer that measures and analyses flow signals and gas composition of the gaseous fuel captured for combustion from the landfill at the point of consumption;

(e) the maximum uncertainty of gas flow measurement of the flow device or flow meter must not be greater than ±5%;

(f) the measuring equipment must ensure that landfill gas volumes (in cubic metres) are corrected to standard conditions (temperature and pressure). The data must be accumulated over a time interval of not greater than 24 hours;

(g) the volumetric flow rate and gas composition data must be continuously recorded;

(h) the accumulated data from the previous time interval must be retained by a device separate from the flow computer so that the data can be retrieved in the event that the flow computer fails;

(i) if the proponent is using a continuous gas analyser to determine the methane fraction in the landfill gas, the equipment must continuously acquire data using a flow computer to calculate landfill gas flow and the methane fraction of the landfill gas;

(j) the volumetric flow rate and gas composition data must be accumulated over a time interval of not greater than 24 hours;

(k) paired values of the volumetric flow rate and gas composition data must be used in the calculations.

Example: methane fraction of landfill gas averaged over time interval "x" must be used with landfill gas flow which is averaged over the same time interval "x".

3.16 Flow computer requirements

If measuring equipment uses a flow computer, the flow computer must record the instantaneous values for all primary measurement inputs and must also record the following outputs:

(a) instantaneous volumetric flow corrected to standard conditions; and

(b) cumulative volumetric flow corrected to standard conditions.

3.17 Gas composition

For the analysis of landfill gas composition, landfill gas must be analysed in accordance with one of the following standards, or with a standard that is equivalent to a standard set out below:

(a) ASTM D 1945 – 03;

(b) ASTM d 1946 – 90 (2006);

(c) ISO 6974

i. Part 1 (2000);

ii. Part 2 (2001);

iii. Part 3 (2000);

iv. Part 4 (2000);

v. Part 5 (2000);

vi. Part 6 (2002).

(d) GPA 2145 – 03; or

(e) GPA 2261 – 00.

3.18 Operation of flares

(1) The destruction efficiency of a flare is contingent upon it being operational. Flare operation can be detected using either temperature measurement or a UV detection sensor coupled to a flare management system.

(2) If flare operation is detected using temperature measurement, then the flare is taken not to be operational and the destruction efficiency taken to be zero in any particular hour if there is no record of the temperature of the exhaust gas of the flare or the recorded temperature is less than 500°C for any period exceeding 20 minutes in that hour.

(3) Project proponents must document which type of flare and which approach to determining DE_h is used. If using a default value, the flare must be operated in accordance with the manufacturer's specifications.

Part 4 Monitoring, record-keeping and reporting requirements

Division 4.1 General

4.1 Application

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

Division 4.2 Monitoring requirements

4.2 Project monitoring

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

(a) Pressure <±0.25%;

(b) Differential Pressure <±0.25%;

(c) Temperature <±0.50%.

4.3 Quality assurance and quality control

(1) Monitoring instruments must be inspected, cleaned and calibrated on a regular basis.

(2) All gas flow meters and continuous methane analysers must be:

(a) cleaned and inspected as required to ensure the equipment reads measurement 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 percent drift documented, no earlier than two months before the end of the reporting period by a third-party technician:

(i) using an appropriate instrument or apparatus; or

(ii) as per the manufacturer's guidance; and

(c) 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) The requirements of 4.3 (2) (b) do not apply if the requirements of 4.3 (2) (c) are completed within two months of the end of the reporting period.

(4) Field checks of monitoring instruments must determine whether the instrument reads measurement within the accuracy threshold of ±5%.

(5) 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 4.3 Record-keeping requirements

4.4 Records that must be kept

(1) The project proponent must make and keep records of the information specified in this section as follows:

General information

(a) copies of all relevant landfill licences, including their conditions;

(b) copies of Landfill Environment Management Plans where these relate to the landfill gas extraction system requirements;

(c) copies of all relevant regulations or associated documents, used in estimating the proportion of methane generated from the landfill that is required to be captured and destroyed to meet regulatory requirements;

(d) all maintenance records relevant to the landfill gas extraction system, monitoring equipment and combustion devices (for each device);

(e) logs of operations of the landfill gas extraction system including notation of all shut-downs, start-ups, process adjustments;

(f) corrective measures taken if instruments do not meet performance specifications;

(g) independent audit records and results;

(h) NATA certificates from stack testing laboratory/ies as evidence of measured methane destruction efficiency (for each device, if relevant);

(i) if relevant, the date of a report under section 19 or section 22G of the *National Greenhouse and Energy Reporting Act 2007* and the factors and parameters used in that report, as prescribed in the *NGER (Measurement) Determination* or *NGER Regulations*;

Combustion device information

(j) information about the model, serial number and calibration procedures for each combustion device;

(k) all data produced in relation to the monitoring of each combustion device, including flare temperatures for each device;

(l) all data relevant to the calibration of each combustion device;

(m) all results from combustion device destruction efficiency testing, for each device, if relevant.

Monitoring device information

(n) information about the model, serial number and calibration procedures for the landfill gas flow meter;

(o) information about the model, serial number and calibration procedures for the landfill gas analyser;

(p) for each flow meter, all landfill gas flow meter calibration data;

(q) for each gas analyser, all landfill gas analyser calibration data;

(r) gas quality data, including particulate content and humidity;

Data required on the direct and indirect measurement

(s) all values and calculations used in the equations set out in Part 3;

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

(u) electronic recording of values of logged primary parameters (as set out in sections 3.14 and 3.15) for each measurement interval, for each meter. This includes:

(i) landfill gas flow data for each measurement (for each flow meter);

(ii) methane content of landfill gas (% by volume) for each measurement noting the date, time and location of measurement, notes of non-compliance to performance specifications and remedial actions taken to correct instrument;

(iii) temperature data from temperature measurement device (for each device) or record of flare operation if UV detection system is used;

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

(w) evidence of grid-delivered electricity use (including invoices and receipts);

(x) evidence of the amount of electricity sent out from the internal combustion engine generator (if using equation 2 (a)); and

Legacy waste proportion data

(y) all data inputs for the calculation of the quantity of methane generated from legacy waste and the quantity of methane generated from post legacy waste in accordance with Part 5.2 of the *NGER (Measurement) Determination*, including the weight of landfill in relation to each waste mix type.

Division 4.4 Offsets report requirements

4.5 Information that must be included in an offsets report

(1) The following information is required to be included in the first offsets report for a project to which this Methodology Determination applies:

(a) carbon dioxide equivalent net abatement amount for the project;

(b) the proportion of methane generated from the landfill that is required to be captured and destroyed to meet regulatory requirements (A_{reg});

(c) justification for the proportion of methane generated from the landfill that is required to be captured and destroyed to meet regulatory requirements;

(d) if applicable, the total volume of methane sent to combustion devices, in cubic metres (sum of $Q_{sent,h}$) and total volume of methane destroyed by combustion devices, in cubic metres (sum of $Q_{com,h}$);

(e) if applicable, the quantity of methane destroyed as a consequence of an internal combustion engine, in tonnes CO_2-e ($A_{com,ice}$);

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

(g) destruction efficiency of each combustion device (DE_h);

(h) electrical efficiency (Eff) of the internal combustion engine generator (with reference to Australian Standard AS 4594.1 or equivalent);

Note: Australian standards are available from the government website at www.standards.org.au

(i) if applicable, the date of a report required under section 19 or section 22G of the *National Greenhouse and Energy Reporting Act 2007* and the factors and parameters used in that report, as prescribed in the *NGER (Measurement) Determination* or *NGER Regulations*.

4.6 Subsequent reporting periods

(1) The following information is required to be included in the second and subsequent offsets reports:

(a) carbon dioxide equivalent net abatement amount for the project;

(b) the proportion of methane generated from the landfill that is required to be captured and destroyed to meet regulatory requirements;

(c) if applicable, the total volume of methane sent to combustion devices, in cubic metres (sum of $Q_{sent,h}$) and total volume of methane destroyed by combustion devices, in cubic metres (sum of $Q_{com,h}$);

(d) if applicable, the quantity of methane destroyed as a consequence of an internal combustion engine, in tonnes CO_2-e ($A_{com,ice}$);

(e) total amount of fuel and electricity used by the project, in kilolitres, cubic metres or kilowatt hours;

(f) destruction efficiencies of combustion devices;

(g) electrical efficiency (Eff) of the internal combustion engine generator (with reference to Australian Standard AS 4594.1 or equivalent);

Note: Australian standards are available from the government website at www.standards.org.au

(h) if applicable, the date of a report under section 19 or section 22G of the *National Greenhouse and Energy Reporting Act 2007* and the factors and parameters used in that report, as prescribed in the *NGER (Measurement) Determination* or *NGER Regulations*.