Australian Capital Territory

Climate Change and Greenhouse Gas Reduction (Greenhouse Gas Emissions Measurement Method) Determination 2024

Disallowable instrument DI2024-311

made under the

Climate Change and Greenhouse Gas Reduction Act 2010, s 11 (Measuring greenhouse gas emissions—determinations)

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1 Name of instrument

This instrument is the *Climate Change and Greenhouse Gas Reduction (Greenhouse Gas Emissions Measurement Method) Determination 2024*.

2 Commencement

This instrument commences on the day after its notification day.

3 Determination of method for measuring greenhouse gas emissions

I determine the method for measuring the amount of greenhouse gas emissions in the ACT as set out in schedule 1.

Note The greenhouse gas emissions measurement method is used, under the Act, s 12 by an independent entity to prepare a report for the Minister about greenhouse gas emissions in the ACT for each financial year.

4 Revocation

This instrument revokes the *Climate Change and Greenhouse Gas Reduction (Greenhouse Gas Emissions Measurement Method) Determination 2023* (DI2023-273).

Suzanne Orr MLA
Minister for Climate Change, Environment, Energy and Water
27 November 2024

Schedule 1
(see s 3)

1. Objects of the determination
This determination sets out the method for the measurement of greenhouse gas emissions arising from sources, or attributable to activities, located within the geographic boundary of the Australian Capital Territory (ACT).

2. Application of the determination
The method determined in this instrument must be used to measure the amount of greenhouse gas emissions in the ACT for the year (the annual emissions amount) for inclusion in the annual report prepared by an independent entity as required under section 12 of the *Climate Change and Greenhouse Gas Reduction Act 2010* (the Act).

3. Greenhouse gas emissions covered
The emissions covered by this determination are:

- Scope 1 emissions from:
  - fuel combustion
  - fugitive emissions from fuels
  - industrial processes
  - agriculture
  - land use, land use change and forestry
  - waste.
- Scope 2 emissions from electricity consumption in the ACT, adjusted for scope 3 electricity transmission and distribution losses.

4. Definitions
In this Determination:

carbon dioxide equivalence or ***CO_2-e***, means the amount of greenhouse gas multiplied by its specific global warming potential.

dry wood means wood that:

a) has a moisture content of 20% or less if the moisture content is calculated on a wet basis; and
b) is combusted to produce heat.

emission factors refer to the kilograms of carbon dioxide equivalent emitted per unit of activity.

energy content factor, for a fuel, means gigajoules of energy per unit of the fuel measured as a gross calorific value.

fugitive emissions means the release of emissions that occur during the extraction, processing and delivery of fossil fuels.

global warming potential refers to an index (on a 100 year time horizon) representing the combined effect of the differing times greenhouse gases remain in the atmosphere and their relative effectiveness in absorbing outgoing infrared radiation.

GreenPower means renewable energy purchased in accordance with the Australian Government's GreenPower program.

Large-scale Generation Certificate (LGC) – see the *Renewable Energy (Electricity) Act 2000* (Cwlth), section 5.

scope 1 emissions refer to the emission of greenhouse gases directly resulting from an activity, or series of activities (including ancillary activities).

scope 2 emissions refer to the emission of greenhouse gases that occurs outside the ACT as a consequence of using grid-supplied electricity, heating and/or cooling within the ACT.

scope 3 emissions refer to the emission of greenhouse gases not included as a scope 1 or scope 2 emission that occur outside the ACT as a result of activities within the jurisdiction due to use of goods and services. Scope 3 emissions include electricity transmission and distribution losses.

5. Method for calculating emissions from stationary energy

The method for calculating the emissions from stationary energy will be made using the equations presented below:

5.1 Electricity

The calculation of Scope 2 emissions attributable to consumption of electricity by ACT consumers using the market-based method is particularly complex because of the many different sources of zero emission electricity for which ACT consumers are paying and because of the interaction between the physical and the financial transactions in the National Electricity Market (NEM). Relating to this latter point, the calculation relies on the propositions that the ACT is part of the NSW region of the NEM, that the NSW region exchanges electrical energy with Victoria and Queensland through the relevant interconnectors, that interconnector flows are sourced from the marginal source of generation in each region, and that the marginal source in all three regions is coal fired generation.

In order to make the steps in the calculation somewhat easier to follow, the method is structured in four parts.

The first part calculates the quantity of zero emission electricity (electricity supplied by renewable generators) being paid for by ACT electricity consumers other than renewable electricity being supplied by generators through the ACT Government's reverse auction processes. This includes the following components:

- the ACT share of national Large Renewable Energy Target scheme generation,
- GreenPower purchases by ACT consumers,

- rooftop photovoltaic (PV) generation from systems under 200 kilowatts (kW), and
- the ACT share of "old" (pre- Renewable Energy Target (RET)) hydro generation (mainly from the Snowy Hydro power stations) forming part of the generation supplying the NSW pool of the NEM.

The second part calculates quantity of electricity considered to be renewable through the voluntary surrender of Large-scale Generation Certificates (LGCs) generated under the ACT Government's reverse auction process.

The third part calculates residual electricity by subtracting the sum of all renewable electricity (part one and two above) from the total electricity input to the ACT network.

The fourth part calculates emissions by multiplying residual electricity by the national residual mix factor (RMF) for scope 2 emissions as published by the latest Australian National Greenhouse Accounts Factors.

5.1.1 Calculate total renewable electrical energy being paid for by ACT electricity consumers

5.1.1.1 Large-scale Renewable Energy Target (LRET) purchases

$S_1 = \alpha_i \times (\beta_i + \gamma_i)$
Where,

S_1 = Total LRET purchases (MWh)
α_i = Renewable power percentage
β_i = Total electricity supplied to residential customers;
γ_i = Total electricity supplied to non-residential and other customers.

Data sources:
α_i - Clean Energy Regulator www.cleanenergyregulator.gov.au/
β_i, γ_i - Evoenergy (a component of the annual Regulatory Information Notice (RIN) submission to the Australian Energy Regulator (AER))

5.1.1.2 GreenPower

The ACT may also count Greenpower purchases in the ACT towards total renewable electricity at the discretion of the Minister.

$$S_2 = \sum_i \delta_i$$

Where,

S_2 = Total GreenPower sales in the ACT (MWh)
$\sum_i \delta_i$ = Sum of Quarterly GreenPower Sales in the ACT (MWh)

Data sources:

$\sum_i \delta_i$ = National GreenPowerTM Accreditation Program. Annual Compliance Audit and National GreenPower Accreditation Program Status Report. www.greenpower.gov.au/about-greenpower/audits-and-reports/annual-audits.

5.1.1.3 Rooftop PV

$$S_3 = \sum_i \varepsilon_i$$

Where,

S_3= Total Rooftop PV output (MWh)
$\sum_i \varepsilon_i$ = Sum of metered output (MWh) in the year of all PV installations with capacity less than 200 kW in the following categories:

- supplied with ACT feed in tariff (f.i.t.)
- supplied under gross metering but without f.i.t.
- supplied under net metering.

Data sources:

$\sum_i \varepsilon_i$ - As advised by Evoenergy in regular reports to the ACT Government, Environment, Planning and Sustainable Development Directorate

5.1.1.4 Below Baseline NSW region NEM renewable generation

$$S_4 = \frac{\sum_{m=1}^{5} G_m}{5} \times \left(\frac{1}{n} \ x \sum_{t=1}^{n} x_i \right)$$

Where,

1 = Inventory year − 4;
2 = Inventory year − 3;
3 = Inventory year − 2;
4 = Inventory year − 1;
5 = Inventory year.

Where,

n = the number of inventory years from 2012-13 to the current inventory year;

x_i = the ACT's percentage share of below baseline NSW region NEM renewable generation as calculated for the relevant inventory year.

and

For each of the following Stations: Hume, Blowering, Guthega, Tumut 1, Tumut 2, Tumut 3 (net of pump energy input)[i]:

$$G_m = \sum_{n=1}^{6}\left(Min\left(ES_n, \left(\frac{\omega_n + \varphi_n}{2}\right)\right)\right)$$

Where,

For each of the following Stations:
1 = Hume;
2 = Blowering;
3 = Guthega;
4 = Tumut 1;
5 = Tumut 2;
6 = Tumut 3 (net of pump energy input);
$Min\left(ES_n, \left(\frac{\omega_n+\varphi_n}{2}\right)\right)$ = the lesser of:

- ES_n = electrical energy sent out in the inventory year, and
- $\frac{\omega_n+\varphi_n}{2}$ = the simple average of the RET Baseline in the calendar year covering the first half of the reporting year and the calendar year covering the second half of the reporting year.

ED = Electrical energy supplied by TransGrid to Evoenergy;
ND_{NSW} = Total NSW region Native demand;
NG_{NSW}= NSW region Small Non-scheduled Generation;
TL_{NSW} = NSW region transmission losses.

5.1.1.5 Total renewable electrical energy being paid for by ACT electricity consumers

$$S_{renew} = \sum_{n=1}^{4} S_n$$

Where,

S_{renew} = Total renewable electricity being paid for by ACT electricity consumers (MWh)
S_1 = Total LRET purchases (MWh)
S_2 = Total GreenPower sales in the ACT (MWh)
S_3 = Total Rooftop PV output (MWh)
S_4 = Below Baseline NSW region NEM renewable generation (MWh)

5.1.2 Calculate the renewable electricity associated with the voluntary surrender of LGCs

$RE_{lgc} = N_{lgc}$

Where,

RE_{lgc} = Renewable electricity associated with voluntary surrender of LGCs (MWh)

N_{lgc} = Total number of LGCs voluntarily surrendered by the ACT Government through the Clean Energy Regulator registry (1 LGC = 1 MWh)

5.1.3 Calculate the residual electricity

$E_{res} = E_{tot} – S_{renew} – RE_{lgc}$

Where,

E_{res} = Residual electricity (MWh), i.e., from other than identified renewable sources.

E_{tot} = Total electricity input to the ACT network (MWh)

S_{renew} = Total renewable electricity being paid for by ACT electricity consumers (MWh) (as per 5.1.1.5)

RE_{lgc} = Renewable electricity associated with voluntary surrender of LGCs (MWh) (as per 5.1.2)

5.1.4 *Calculate total Scope 2 emissions attributable to electricity consumed in the ACT*

$E_{elec} = E_{res}\ x\ RMF$

Where,

E_{elec} = Scope 2 emissions of electricity consumed in the ACT (t CO_2-e)

E_{res} = Residual electricity (MWh) (as per 5.1.3)

RMF = Scope 2 Residual Mix Factors (national) (kg CO_2-e/kWh)

Data sources:

RMF- The most recent published edition of the Australian National Greenhouse Accounts Factors

5.2 Stationary fossil fuel gas (Natural gas) combustion

Annual emissions are calculated using the following equation:

$E_{NG} = (Q_{NG} - Q_{TC})\ x\ EF_{NG} / 1000$

Where:

E_{NG} is emissions from fossil fuel gas (natural gas) combustion in tonnes of CO_2-e.

Q_{NG} is the total amount of fossil fuel gas (natural gas) consumed by end users in the ACT, in gigajoules.

Q_{TC} is the amount of fossil fuel gas (natural gas) used by the Transport Canberra bus fleet, in gigajoules.

EF_{NG} is the Scope 1 emission factor for combustion of fossil fuel gas (natural gas) distributed in a pipeline in kilograms of CO_2-e per gigajoule.

Data sources:

Q_{NG} - Evoenergy

Q_{TC} - ACT Government

EF_{NG} - The most recent published edition of the Australian National Greenhouse Accounts Factors.

5.3 LPG stationary combustion

Annual emissions are calculated using the following equation:

$$E_{LPG} = Q_{LPG} \times 1.96 \times EF_{LPG} / 1000$$

Where:

E_{LPG} is emissions from LPG stationary combustion expressed in tonnes of CO_2-e.

Q_{LPG} is the consumption of LPG for stationary combustion expressed in tonnes.

1.96 is for converting Q_{LPG} from tonnes to kilolitres.

EF_{LPG} is the Scope 1 emissions factor for LPG in kilograms of CO_2-e per kilolitre.

Data sources:

Q_{LPG} - Total bulk and bottled sales of LPG to ACT consumers; data to be collected from LPG suppliers

EF_{LPG} - The most recent published edition of the Australian National Greenhouse Accounts Factors.

5.4 Heating oil

$$E_{HO} = E_{IW} + (Q_{HO} \times EF_{HO})/1000$$

Where:

E_{HO} is emissions from heating oil consumption expressed in tonnes of CO_2-e.

E_{IW} is annual Scope 1 emissions in tonnes of CO_2-e from combustion of heating oil by Icon Water, as included in the annual report by the business under the National Greenhouse and Energy Reporting Scheme (NGERS).

Q_{HO} is the consumption of heating oil in the ACT by users other than Icon Water in kilo litres (if any).

EF_{HO} is the Scope 1 emissions factor for heating oil in kilograms of CO_2-e per kilolitre.

Data sources:

E_{IW}- Icon Water

Q_{HO} - Total sales of fuel oil to ACT consumers; data to be collected by a survey of users/and/or suppliers.

EF_{HO} - The most recent published edition of the Australian National Greenhouse Accounts Factors.

5.5 Wood-fuel

Annual emissions are calculated using the following equation:

$E_{WF} = Q_{WF} \times EC_{WF} \times EF_{WF} / 1000$

Where:

E_{WF} is emissions from wood fuel consumption expressed in tonnes of CO_2-e.
Q_{WF} is the consumption of dry wood expressed in tonnes.
EC_{WF} is the energy content factor for dry wood expressed in gigajoules per tonne.
EF_{WF} is the Scope 1 emissions factor for dry wood in kilograms of CO_2-e per gigajoule.

Data sources:

Q_{WF} - The most recent available ACT government *Firewood Sales* report
EC_{WF} and EF_{WF} - The most recent published edition of the Australian National Greenhouse Accounts Factors.

5.6 Fugitive emissions: Fossil fuel gas (natural gas) distribution

Annual emissions are calculated using the following equation:

$E_{fug} = UAG \times EF \times (C_{CO2} + C_{CH4}) / 1000$

Where:

E_{fug} is the fugitive emissions from the ACT fossil fuel gas distribution network in tonnes CO_2-e.
UAG is the quantity of unaccounted for gas in the ACT gas distribution network in the inventory year, derived as the difference between total gas receipts and total network, expressed in gigajoules.
EF is the Emissions Fraction that represents the fraction of gas that is unaccounted for and released as emissions (and not arising from other issues such as measurement error).
C_{CO2} is the composition factor for CO_2 in gas supplied to the ACT, in tonnes CO_2-e per terajoule.
C_{CH4} is the composition factor for methane in gas supplied to the ACT, in tonnes CO_2-e per terajoule.

Data sources:

UAG - Evoenergy (to be derived using total gas receipts and total gas network data)
C_{CO2}, C_{CH4}, *EF* - National Greenhouse and Energy Reporting (Measurement) Determination 2008

6. Method for calculating emissions from transport

6.1 Ground transport

Annual emissions are calculated using the following equation:

$E_{Trans} = (\Sigma (QP_i \times ECP_i \times EFP_i) + (Q_{TC} \text{ x } EF_{NG}) / 1000$

Where:

E_{Trans} is emissions from consumption of road transport fuels in tonnes of CO_2-e.

QP_i is the consumption of road transport fuel type i, where i is LPG, petrol, diesel, in kilolitres.

ECP_i is the energy content factor for road transport fuel type i, in gigajoules per kilolitre.

EFP_i is the Scope 1 emissions factor for road transport fuel type i, in kilograms of CO_2-e per gigajoule.

Q_{TC} is fossil fuel gas (natural gas) used by the Transport Canberra bus fleet, in gigajoule.

EF_{NG} is the Scope 1 emission factor for fossil fuel gas (natural gas) combustion in kilograms of CO_2-e per gigajoule.

Data sources:

QP_i : The Fuel Survey undertaken by the Environment, Planning and Sustainable Development Directorate

ECP_i , EFP_i , EF_{NG} : The most recent published edition of the Australian National Greenhouse Accounts Factors.

Q_{TC} : ACT Government

6.2 Aviation

Emissions from aviation are calculated in accordance with the GHG Protocol guidance for cities and account for emissions that occur within the jurisdiction. All emissions associated with the landing and take-off (LTO) cycle (including taxi-out, take-off, climb, descent, land and taxi-in) are taken as a proxy for aviation emissions that occur within the ACT boundary. It is assumed that all cruising altitude emissions occur outside of the ACT. Annual emissions from regular public transport air service movements are calculated using ACERT calculator (ACERT_7.2338_ACI_Public) using the following equation:

$$E_{av} = \sum LTO_{a,e} F_{a,e,m} E_{e,m} / 1000$$

Where:

E_{av} is emissions from fuel combustion in aviation that occurs within the ACT boundary (assumed to be LTO emissions), in tonnes of CO_2-e.

$LTO_{a,e}$ is number of LTO cycles for aircraft type a and engine type e.

$F_{a,e,m}$ is fuel consumption per LTO cycle for aircraft type a with engine type e in mode m (taxi out, take-off, climb out, descend, land, taxi-in) [in kilo litres].

$E_{e,m}$ is emission factor for fuel consumption (in kg CO2-e per kilo litre).

Data sources:

$LTO_{a,e}$: Canberra Airport

$F_{a,e,m}$, $E_{e,m}$: Airport Canbon and Emissions Reporting Tool (ACERT_7.2338_ACI_Public)

Emissions from light aircrafts, other than regular public transport, are estimated using AVGAS fuel sales activity data and emissions factors for AVGAS.

7. Method for calculating emissions from industrial processes and product use

7.1 Product uses as substitutes for ozone depleting substances

Annual emissions are calculated using the following equation:

$$E_{ind} = \sum_{p=1}^{n} \frac{(D \times N_p \times RC_p \times LR_p \times EF_p)}{1000} + \sum_{v=1}^{n} (N_v \times EF_v) + E_{comm}$$

Where:

E_{ind} is emissions resulting from industrial process in tonnes of CO_2-e.

D is number of residential dwellings in the ACT.

N_p is the average number of product type p per residential dwelling. For the purposes of this equation, product types include refrigerators and air-conditioning units only.

RC_p is the average refrigerant charge in kilograms per product type p.

LR_p is the annual refrigerant leakage rate as percentage (of charge) for product type p.

EF_p is the emission factor averaged for refrigerant types used in product type p. For the purposes of this equation, it is assumed that all product types use refrigerant types R134a and R410a in equal proportion.

N_v is the number of vehicles of type v in the ACT. For the purposes of this equation, vehicle types include light vehicles and heavy vehicles.

EF_v is the emission factor for vehicle type v in tonnes of CO_2-e. It is calculated based on national data.

E_{comm} is emissions resulting from commercial/industrial processes in tonnes CO_2-e.

Data sources:

D	ABS ‘Household and Family Projections’ at: www.abs.gov.au
N_p	ABS 2014 ‘ 4602.0.55.001 - Environmental Issues: Energy Use and Conservation, Mar 2014’ at www.abs.gov.au; 2021 RBS_OutputTablesV1.9.2-AU.xlsx tab Energy.NG.EndUse-State, assumed
RC_p	Final Draft (iges.or.jp); RRA 61847 Domestic AC Refrigerant Recovery Project – Article reformat_AW2.indd (refrigerantreclaim.com.au)
LR_p	Australian National Greenhouse Accounts Factors (dcceew.gov.au)
EF_p	Australian National Greenhouse Accounts Factors (dcceew.gov.au)
N_v	ACT Government (motor vehicles registration data)
EF_v	Derived from National Inventory Report 2021, Volume 2 (dcceew.gov.au)
E_{comm}	ACT data provided by the Clean Energy Regulator

8. Method for calculating emissions from agriculture

Emissions from agriculture will be the sum of emissions from three sources - enteric fermentation, manure management, and agricultural soils. Emissions from enteric fermentation and manure management will be calculated based on the latest available activity data (livestock numbers) reported each year in the Australian National Greenhouse Accounts. The year concerned will normally be one to two years prior to the year for which the ACT inventory is being compiled. Estimates reported for the ACT by the National Greenhouse Gas Inventory will be used for the emissions from agricultural soils.

The following equation will be used to calculate emissions from agriculture:

$$\mathrm{E}_{ag} = \sum_{l=1}^{n} \left(N_l \times EF_{efl}\right)/1000 + \sum_{l=1}^{n} (N_l \times EF_{mml})/1000 + E_{as}$$

Where:

E_{ag} is emissions from agriculture in tonnes of CO_2-e.

N_l is the number of livestock type l in the ACT.

EF_{efl} is the emission factor for enteric fermentation for livestock type l. This is methane in kilograms multiplied by its GWP.

EF_{mml} is the emission factor for manure management for livestock type l. This is methane in kilograms multiplied by its GWP.

E_{as} is emissions from agricultural soils in tonnes of CO_2-e, as reported by the National Greenhouse Gas Inventory for the ACT.

9. Method for calculating emissions from land use, land-use change and forestry

ACT Land-use, land-use change and forestry (LULUCF) emissions are the value for the ACT for total emissions from LULUCF, emissions source category 4 under the 2006 IPCC Guidelines, which are contained in the most recent National Greenhouse Accounts compiled by the Department of Climate Change, Energy, the Environment and Water. To date, there has been a time lag in national reporting on annual greenhouse gas inventories, generally of around 18-24 months. To address this, ACT LULUCF emissions for the financial year will be calculated as the average of the three most recent ACT LULUCF emissions results reported in the National Greenhouse Accounts. These data will be updated annually, using the National Greenhouse Accounts to update emissions for reported years and update the three-year rolling average.

10. Method for calculating emissions from waste

10.1 Methane released from landfills

10.1.1 Introductory explanation of methodology

The calculations below follow the IPCC (and thus the NGERS) method for estimating emissions from landfills. Various constants and defaults have been used consistent with the current usage in the NGERS method. The output can be achieved by inserting the relevant data into the NGERS solid waste calculator.

The model for decomposition works by creating a record of landfill stock levels of waste in various types for which decomposition is well understood (e.g. food; paper and cardboard; etc.), and then assessing how much of that stock will decompose to create landfill gas in a given year. The overall amount of degradable organic carbon (DOC) is calculated for each waste type as it enters the landfill. The amount of this that subsequently degrades to produce landfill gas is termed decomposable degradable organic carbon (DDOC) and this stock amount is tallied year on year, accounting for degradation, for each waste type.

10.1.2 Methodology in detail

Methane released from landfills (other than from flaring of methane) in the inventory year is calculated by the following equation:

$$Ej = [CH_4{*} - \gamma (Q_{cap} + Q_{flared} + Q_{tr})] \times (1 - OF)$$

where:

Ej is the emissions of methane released by the landfill during the year measured in CO_2-e tonnes.

CH_4^* is the estimated quantity of methane in landfill gas generated by the landfill during the year and measured in CO_2-e tonnes.

γ is the factor $6.784 \times 10^{-4} \times 25$ converting cubic metres of methane at standard conditions to CO_2-e tonnes.

Q_{cap} is the quantity of methane in landfill gas captured for combustion from the landfill during the year and measured in cubic metres.

Q_{flared} is the quantity of methane in landfill gas flared from the landfill during the year and measured in cubic metres.

Q_{tr} is the quantity of methane in landfill gas (if any) transferred out of the landfill during the year and measured in cubic metres.

OF is the oxidation factor (0.1) for near surface methane in the landfill.

The estimation of CH_4* takes account of the following factors:

(a) the tonnage of total solid waste disposed of in the landfill in previous years, as set out in Table 1;
(b) the tonnage of total solid waste disposed of in the landfill in the inventory year;
(c) the composition of the solid waste disposed of in the landfill during the year estimated in the categories municipal solid waste (MSW), commercial and industrial waste (C&I), and construction and demolition (C&D) as in Table 1.
(d) the proportions in each of the three categories of the different types of degradable waste, (actual data if available or default values as given in the NGERS solid waste calculator);
(e) the degradable organic carbon content of each of the types of degradable waste disposed of in the landfill by waste type, as set out in Table **2**2;

(f) the opening stock of degradable organic carbon in the solid waste at the landfill at the start of the first reporting period (financial year 1975) for the landfill is zero;
(g) methane generation constants (*k values*) for the solid waste at the landfill as per Table **3**3;
(h) the fraction of degradable organic carbon dissimilated (DOC_F) estimated in accordance with
Table **4**4;
(i) the methane correction factor for aerobic decomposition is 1;

The quantity of methane generated by the landfill is calculated by the following equation:

$$CH_4{*} = (\Delta C_{ost} + \Delta C_{at}) \times F \times 1.336 \times 28$$

where:

$CH_4{*}$ is the quantity of methane generated by the landfill measured in CO_2-e tonnes

F is the fraction of methane generated in landfill gas and is 0.5.

1.336 is the factor to convert a mass of carbon to a mass of methane

28 is the 100-year Global Warming potential (GWP) of methane, which converts tonnes of methane to tonnes of carbon dioxide equivalent

ΔC_{ost} is the change in the quantity of the opening stock of decomposable degradable organic carbon derived from the sum of all waste mix types located in the landfill during the reporting year, measured in tonnes, lost through decomposition, and estimated by the following equation:

$$\Delta \mathrm{C}_{\mathrm{ost}} = \sum_i \mathrm{C}_{\mathrm{osit}} \times (1\text{-}e^{\,--ki})$$

where:

C_{osit} is the quantity of decomposable degradable organic carbon accumulated in the landfill at the beginning of the reporting year from all waste mix types deposited in all prior years, measured in tonnes and equals:

$$C_{osit} = C_{csit-1}$$

where:

C_{csit-1} is the closing stock of decomposable degradable organic carbon accumulated in the landfill in the year immediately preceding the reporting year from all waste mix types defined above, measured in tonnes and equals:

$$C_{csit} = C_{osit} - \Delta C_{osit} + C_{ait} - \Delta C_{ait}$$

and

k_i is the methane generation constant for each waste mix type as specified in Table 3.

and:

ΔC_{at} is the change in the quantity of decomposable degradable organic carbon derived from the sum of all waste mix types deposited at the landfill during the reporting year, measured in tonnes, lost through decomposition, and equals:

$$\Delta C_{at} = \sum_i C_{ait} \times [1 - e^{-ki \times (13 - M)/12}]$$

where:

C_{ait} is the quantity of degradable organic carbon in all waste mix types deposited at the landfill during the year concerned, measured in tonnes and is equal to:

$$C_{ait} = (Q_{it} \times DOC_i \times DOC_{fi} \times MCF)$$

where:

Q_{it} is the quantity of each waste mix type deposited at the landfill during the year concerned, measured in tonnes.

DOC_i is the fraction of the degradable organic carbon content in each waste type, as specified in Table 2 of the solid waste for all waste mix types defined above and deposited at the landfill.

DOC_{fi} is the fraction of decomposable degradable organic carbon for each waste mix types as specified in Table 4.

MCF is the methane correction factor for aerobic decomposition for the facility during the reporting year and is equal to 1.

and where:

i is the waste type.

t is the reporting year.

M is the number of months before commencement of methane generation at the landfill (here zero) plus seven.

Σ_i is the sum for all waste mix types.

Table 1: Waste deposition baseline for emissions model

Financial Year	MSW	C&I	C&D	Total waste
1975	20,896	14,105	17,239	52,239
1976	26,790	18,083	22,102	66,975
1977	32,677	22,057	26,959	81,693
1978	38,556	26,026	31,809	96,391
1979	44,345	29,933	36,585	110,862
1980	50,421	34,034	41,597	126,052
1981	56,613	38,214	46,706	141,533
1982	63,556	42,900	52,434	158,890
1983	70,901	47,858	58,494	177,254
1984	78,593	53,050	64,839	196,482
1985	86,629	58,474	71,469	216,572
1986	95,424	64,411	78,725	238,560
1987	104,205	70,338	85,969	260,513
1988	113,336	76,502	93,502	283,341
1989	121,752	82,182	100,445	304,379
1990	135,618	91,542	111,885	339,045
1991	125,331	84,599	103,398	313,328
1992	124,123	83,783	102,402	310,308
1993	122,128	82,437	100,756	305,321
1994	166,319	112,265	137,213	415,798
1995	108,822	73,455	89,778	272,054
1996	100,827	68,058	83,182	252,068
1997	95,192	64,255	78,534	237,981
1998	95,890	64,726	79,110	239,726
1999	101,074	68,225	83,386	252,686
2000	103,634	69,953	85,498	259,084
2001	89,690	60,541	73,994	224,225
2002	88,866	63,161	68,302	220,328
2003	84,207	62,810	60,049	207,067
2004	85,440	66,685	56,265	208,390
2005	84,484	68,813	51,099	204,396
2006	80,130	67,951	44,232	192,313
2007	82,919	73,047	41,459	197,425
2008	87,937	80,320	39,468	207,725
2009	88,297	98,150	27,522	213,969
2010	86,753	103,058	38,895	228,706
2011	88,946	127,881	51,261	268,088
2012	89,373	139,784	88,686	317,842
2013	94,863	130,859	29,370	255,092
2014	102,852	114,275	21,178	238,305
2015	111,156	111,542	21,095	**243,793**
2016	119,701	109,007	90,601	**319,310**

2017	122,102	108,496	280,693	**511,291**
2018	118,258	117,269	105,404	**340,931**
2019	119,039	103,278	33,959	**256,276**
2020	121,238	92,877	48,215	**262,330**
2021	133,997	98,186	24,186	**256,369**
2022	134,011	83,404	15,117	**232,532**
2023	124,766	85,205	10,028	**219,999**
2024	125,623	50,899	11,427	**187,949**

Table 2: Waste mix types DOC values [Source: National Greenhouse and Energy Reporting (Measurement) Determination 2008]

Waste mix type	Degradable organic carbon value
Food	0.15
Paper and cardboard	0.40
Garden and green	0.20
Wood and wood waste	0.43
Textiles	0.24
Sludge	0.05
Nappies	0.24
Rubber and Leather	0.39
Inert waste	0.00
Alternative waste treatment residue	0.08

Table 3: Waste type k values [Source: National Greenhouse and Energy Reporting (Measurement) Determination 2008]

Waste mix type	k values
Food	0.06
Paper and cardboard	0.04
Garden and Green	0.05
Wood	0.02
Textiles	0.04
Sludge	0.06
Nappies	0.04
Rubber and Leather	0.04
Alternative waste treatment residue	0.04

Table 4: Fraction of DOC dissimilated (DOC_F) [Source: National Greenhouse and Energy Reporting (Measurement) Determination 2008]

Waste mix type	DOCF value
Food	0.84
Paper and cardboard	0.49
Garden and green	0.47
Wood	0.23
Textiles	0.5
Sludge	0.5
Nappies	0.5
Rubber and leather	0.5
Inert waste	0.0
Alternative waste treatment residues	0.5

10.2 Biological treatment of solid waste

Methane and nitrous oxide released from the composting of biomass materials in an un-enclosed composting facility is calculated by the following equation

$$Ej = (M \times EFj) - R$$

where:

EF_j is the emission factor for each gas type (***j***), being methane or nitrous oxide, released from the composting process measured in tonnes of CO_2-e per tonne of waste processed, having the following values:

For the gas type methane 0.019

For the gas type nitrous oxide 0.029

E_j is the emissions of the gas type (j), being methane or nitrous oxide, released from the landfill during the year from the composting process measured in CO_2-e tonnes.

M is the mass of biomass materials treated by composting during the year measured in tonnes of waste.

R is:

(a) for the gas type methane—the total amount of methane recovered during the year at the site from the composting of biomass materials measured in tonnes of CO_2-e; or

(b) for the gas type nitrous oxide—zero.

10.3 Wastewater treatment and discharge

Annual emissions from nitrous oxide and methane emissions arising from wastewater treatment by Icon Water, as included in the annual report by the business under the National Greenhouse and Energy Reporting Scheme (NGERS).

Data source: Icon Water