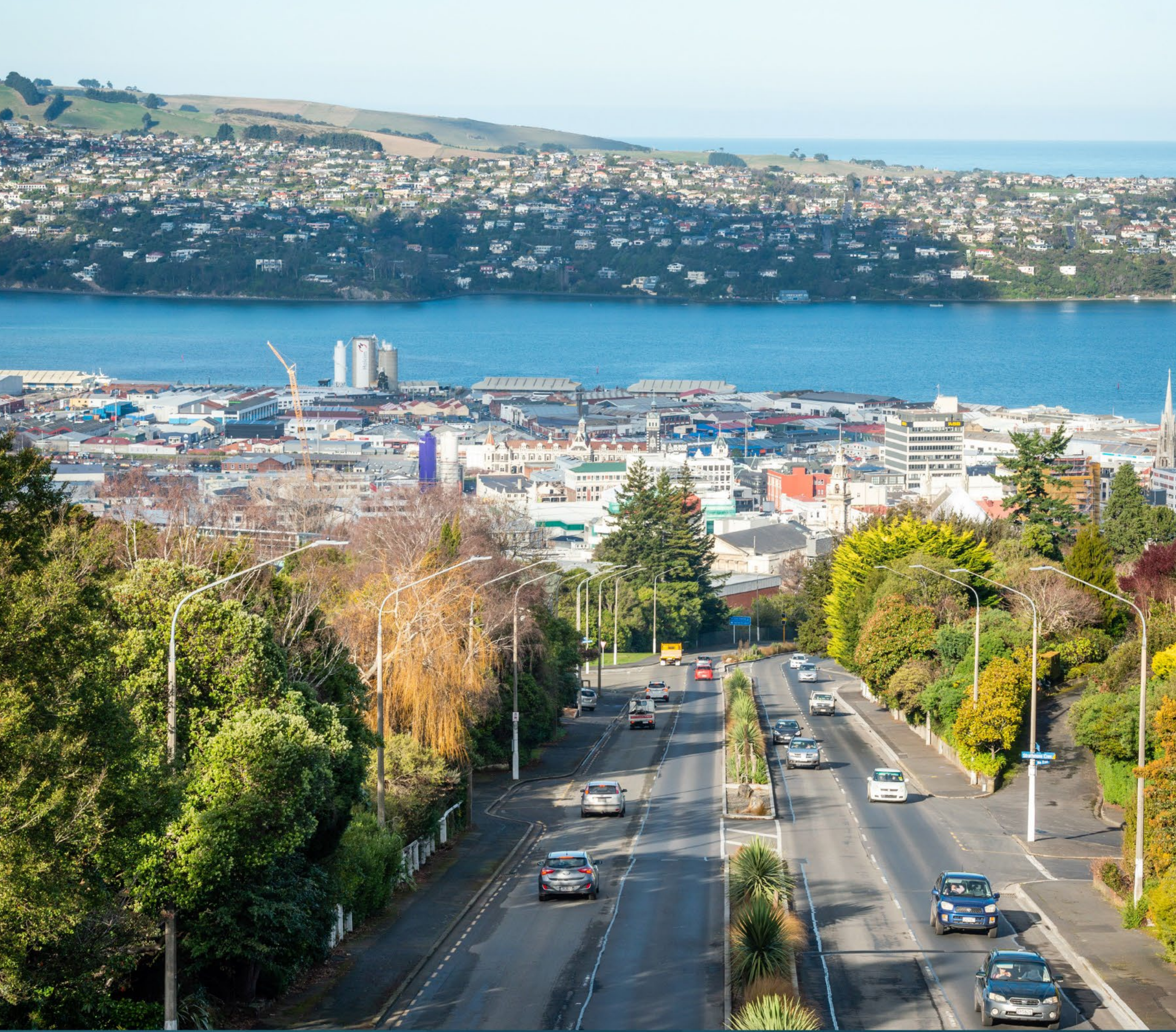

Measuring emissions: A guide for organisations

2022 quick guide

Ministry for the Environment
Manatū Mō Te Taiao

Te Kāwanatanga o Aotearoa
New Zealand Government

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Overview of changes since the previous update

This is the 12th version of the publication originally titled *Guidance for Voluntary Greenhouse Gas Reporting*. Previous versions can be accessed on the Ministry's website here.

There have been several updates since the last edition of the guidance in 2020.

- The emission factors in the fuel chapter have been updated to align with activity data from *New Zealand's Greenhouse Gas Inventory 1990-2020.*
- The purchased electricity, heat and steam emissions chapter now includes a time series for electricity and transmission and distribution losses from 2019 and 2020.
- The methodology in the indirect business emissions (working from home) chapter has been updated to align with international research on emissions calculation methodologies.
- The travel chapter includes updated emission factors for domestic air travel based on 2019 and 2020 data. Public transport emission factors for buses and rail services have been updated based on 2020 data. International air travel emission factors have been updated to align with the 2021 conversion factors from the United Kingdom Government Department for Business, Energy and Industrial Strategy (UK BEIS). Accommodation emission factors have been updated to align with the 2021 Cornell Hotel Sustainability Benchmarking Index.
- The freight transport emissions chapter includes an update to heavy trucks and rail based on 2020 data, and an update to international shipping factors based on the 2021 conversion factors from the UK BEIS.
- The materials and waste chapter now recommends users refer directly to the BRANZ CO2NSTRUCT Report and the EPD Australasia database for up-to-date emission factors for construction materials. The wastewater and waste emission factors have been updated to align with *New Zealand's Greenhouse Gas Inventory 1990-2020*.
- In the agriculture, forestry and other land use chapter the methodology and emission factors have been updated to align with *New Zealand's Greenhouse Gas Inventory 1990-2020.*

Impacts of the COVID-19 pandemic: Many organisations' emissions for 2020 have been significantly impacted by COVID-19, for example travel may have been reduced or levels of production reduced. ISO 14064-1:2018 allows a base year to be quantified using an average of several years. This may be an appropriate and representative approach for organisations that have begun measuring their emissions in 2020.

1 Introduction

1.1 Purpose of this guide

The Ministry for the Environment supports organisations taking climate action. We recognise there is strong interest from organisations across New Zealand to measure, report and reduce their emissions. We have prepared this guide to help you measure and report your organisation's greenhouse gas (GHG) emissions. Measuring and reporting emissions empowers organisations to manage and reduce emissions more effectively over time.

The guide aligns with and endorses the use of the GHG Protocol Corporate Accounting and Reporting Standard (referred to as the GHG Protocol throughout the rest of the document) and ISO 14064-1:2018 (see section 1.3). It sets out how to quantify and report GHG emissions and provides methods to apply emission factors to produce a GHG inventory (see section 2.4).

We update the guide regularly in line with international best practice and the New Zealand Government's Greenhouse Gas Inventory to provide new emission factors.

This quick guide is part of a suite of documents that comprise *Measuring emissions: a guide for organisations*, listed in figure 1.

Figure 1: Documents in *Measuring emissions: A guide for organisations*

Measuring emissions: a guide for organisations		
Quick guide	The go-to document explaining changes since the last update, how to produce an inventory, and what data you need to work out emissions from your activities	THIS DOCUMENT
Detailed guide	For users who need to know the data sources, methodologies, uncertainties and assumptions behind the emission factors for each emission source	
Emission factors summary	Quick look up tables providing the main emission factors for each emission source	
Emission factors workbook	As above but in Excel format across multiple tabs	
Emission factors flat file	Simple format for integration with software	
Interactive workbook	Use this spreadsheet to input your activity data, in order to work out your organisation's emissions and produce an inventory	
Example GHG inventory	Shows what a finished inventory might look like	
Example GHG report	Shows what a finished report might look like	

Feedback

We welcome your feedback on this update. Please email emissions-guide@mfe.govt.nz.

1.2 Important notes

The information in this guide is intended to help organisations that want to report their GHG emissions on a voluntary basis. This guide does not represent, or form part of, any mandatory reporting framework or scheme.

The emission factors and methods in this guide are for sources common to many New Zealand organisations and supports the recommended disclosure of GHG emissions consistent with the Climate-related Disclosures framework and the Carbon Neutral Government Programme (CNGP).

Climate-related disclosures

In October 2021, New Zealand became the first country to legislate mandatory climate risk reporting on the Task Force on Climate-related Financial Disclosures (TCFD) recommendations for large listed issuers, banks, investment managers and insurers. By December 2022, the External Reporting Board expects to release climate standards based on the TCFD recommendations for these entities to disclose against.[1]

The TCFD was set up by the Financial Stability Board to increase transparency, stability, and resilience in financial markets. The TCFD framework promotes consistent climate-related financial risk disclosures aligned with investors' needs and which supports organisations in understanding how to measure and report on their climate change risks and opportunities.

This guide and the emission factors and methods align with the TCFD recommendations for disclosure of GHG emissions.

The complete TCFD recommendations go beyond the scope of this guidance. For further guidance on these consult the TCFD website.[2]

Carbon Neutral Government Programme

The Carbon Neutral Government Programme (CNGP) was set up by the Government to accelerate the reduction of emissions within the public sector. The CNGP guidance document for public sector organisations contains information on measuring and reporting GHG emissions. It includes information on what sources of GHG emissions organisations need to collect, standards to follow, methods for calculating emissions, the required information to report, who to report to, and by when.

For further guidance on this consult the CNGP website[3] or contact cngp@mfe.govt.nz.

This guide, and the emission factors and methods, are not appropriate for a full life-cycle assessment or product carbon footprinting. The factors presented in this guide only include direct emissions from activities, and do not include all sources of emissions required for a full life-cycle assessment. If you want to do a full life-cycle assessment, we recommend using life-cycle assessment software tools.

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1 External Reporting Board Climate-related Disclosures accessed via: https://www.xrb.govt.nz/standards/climate-related-disclosures/

2 Task Force on Climate-related Financial Disclosures accessed via: www.fsb-tcfd.org/

3 Carbon Neural Government Programme accessed via: https://environment.govt.nz/what-government-is-doing/key-initiatives/carbon-neutral-government-programme/

Measuring your organisation's emissions is the first step in the journey to reducing your emissions. Developing and implementing a reduction plan is the next important step. The New Zealand Government's emissions reduction plan will be published in mid-2022. The emissions reduction plan is not intended to be guidance for how organisations should create their own emission reduction plans.

It is best practice to reduce emissions as much as possible before offsetting – see the Ministry's Interim guidance for voluntary climate change mitigation.

This guide recognises and supports the Government's ambition of a NetZero by 2050 target, and the many organisations that have already set, or are looking to set, ambitious emission reduction targets aligned with science. The External Reporting Board guidance which is currently being developed will include the need for disclosure of GHG metrics and targets.

The measuring emissions guide supports New Zealand organisations to measure and report their greenhouse gas emissions; however, this information is not appropriate for use in an emissions trading scheme. Organisations required to participate in the New Zealand Emissions Trading Scheme (NZ ETS) need to comply with the scheme-specific reporting requirements. The NZ ETS regulations determine which emission factors and methods to use to calculate and report emissions.

Users seeking guidance on preparing a regional inventory should refer to the GHG Protocol for Community-scale Greenhouse Gas Emission Inventories.

If emission factors relevant to your organisation are not included in Measuring emissions: A guide for organisations, we suggest using alternatives such as those published by the UK government: www.gov.uk/government/publications/greenhouse-gas-reporting-conversion-factors-2021.

When using emission factors from other sources, it is important to consider factors such as:

- the geographic context – ideally the data should reflect the country or region that the emissions calculation is associated with
- the time period it applies to – ideally the data should reflect the time period that the emissions calculation is associated with
- the age of emission factor – ideally emission factors should be based on methods and data published less than 5-10 years ago
- coverage – are the emission factors combustion based or life cycle
- global warming potential (GWP) values – are they based on the Intergovernmental Panel on Climate Change (IPCC) fourth assessment report (AR4) or fifth assessment report (AR5)
- whether suitable supplier specific emissions factors are available rather than national average factors.

This guide covers the following greenhouse gases: carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), sulphur hexafluoride (SF_6) and nitrogen trifluoride (NF_3)[4] and other gases (eg, Montreal Protocol refrigerant gases or medical gases).

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4 The *GHG Protocol* added NF_3 in 2013 as a requirement and ISO 14064-1 included NF_3 in 2018. This is consistent with the national inventory.

GHGs can trap differing amounts of heat in the atmosphere, meaning they have different relative impacts on climate change. These are known as global warming potentials (GWPs).[5] To enable a meaningful comparison between the seven gas types, GHG emissions are commonly expressed as carbon dioxide equivalent or CO_2-e. This is used throughout the guide. For further information about GWPs, please see the *Detailed guide*.

The change from AR4 to AR5 GWPs may cause a significant change in some organisation's inventories, including those who use large quantities of refrigerants. For those that see reductions in their footprints, it would be misleading to interpret this as a true reduction, and the focus should remain on reducing the use of these refrigerants or switching to more climate friendly alternatives. It may be necessary to restate previous inventories based on updated global warming potentials.

From 2023, the rest of this guidance will be updated to align with AR5 GWPs as we enter the reporting period for the Paris Agreement. Additional guidance will be provided at the next update about how to transition to the new global warming potentials, and as to how the Sixth Assessment Report may impact this.

1.3 Standards to follow

We recommend following ISO 14064-1:2018 and the GHG Protocol Corporate Accounting and Reporting Standard. We wrote this guide to align with both. Depending on your intended final use and users, we recommend downloading the relevant following standards and using them in tandem with this guidance:

- ISO 14064-1:2018[6] is shorter and more direct than the GHG Protocol. A PDF copy can be purchased.
- The GHG Protocol[7] gives more description and context around what to do to produce an inventory. It is free to download. The Corporate Value Chain (Scope 3) Accounting and Reporting Standards are also available which allow companies to assess their entire value chain emissions impact and identify where to focus reduction activities.

Both standards give comprehensive guidance on the core issues of GHG monitoring and reporting at an organisational level, including:

- principles of monitoring and reporting
- setting organisational boundaries
- setting reporting boundaries
- establishing a base year
- managing the quality of a GHG inventory
- content of a GHG report.

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5 We use the 2007 IPCC GWPs to ensure consistency with the national inventory. These can be found in the *IPCC AR4 Climate Change 2007: The physical science basis* accessed via: www.ipcc.ch/site/assets/uploads/2018/05/ar4_wg1_full_report-1.pdf

6 Published by the International Organization for Standardization. This standard is closely based on the *GHG Protocol*.

7 Developed jointly by the World Resources Institute (WRI) and the World Business Council for Sustainable Development (WBCSD).

1.3.1 How emission sources are categorised

The GHG Protocol places GHG emission sources into Scope 1, Scope 2 and Scope 3 activities.

- Scope 1: Direct emissions from sources owned or controlled by the organisation (ie, within the organisational boundary). For example, emissions from combustion of fuel in vehicles owned or controlled by the organisation.
- Scope 2: Indirect emissions from the generation of purchased energy (in the form of electricity, heat or steam) that the organisation uses.
- Scope 3: Other indirect emissions occurring because of the activities of the organisation but generated from sources it does not own or control (eg, air travel).

ISO 14064-1:2018 categorises emissions as direct or indirect sources. This is to manage double counting of emissions (such as between an electricity generator's direct emissions associated with generation, and the indirect emissions linked to the user of that electricity). The terminology of 'Categories' is used in ISO 14064-1:2018, replacing the use of 'Scopes'.

The GHG Protocol Corporate Value Chain (Scope 3) Accounting and Reporting Standard goes into more detail, allowing companies to assess their entire value chain emissions impact and identify where to focus reduction activities. Users should be aware that in this standard, Scope 3 is broken down into 15 'Categories'. These should not be confused with the Categories outlined in ISO 14064-1:2018. The Corporate Value Chain standard goes beyond the scope of this guidance.

Table 1 lists the scopes according to the type of emission, and the source categories.

Table 1: Emissions by scope and source category

Scopes used in the GHG Protocol	Categories used in ISO 14064-1:2018	Direct/indirect emissions and removals	Source
Scope 1	Category 1	Direct GHG emissions and removals	Fuel
			Refrigerant and medical gases*
			Agriculture, forestry and other land uses
Scope 2	Category 2	Indirect GHG emissions from imported energy	Purchased energy
Scope 3	Category 3	Indirect GHG emissions from transportation	Business travel
			Employee commute (travel)
			Freight transport
			Refrigerant use (from chilled transport or air conditioner)
			Working from home
	Category 4	Indirect GHG emissions from products an organisation uses	Transmission and distribution losses
			Water supply and wastewater
			Materials and waste
	Category 5	Indirect GHG emissions (use of products from the organisation)	
	Category 6	Indirect GHG emissions (other sources)	

Note: Depending on your organisation's reporting and financial boundaries, some emission sources may be either Scope 1 or Scope 3.

* Emissions inventories, in line with the GHG Protocol, report only Kyoto Protocol gases under direct (Scope 1) emissions. All non-Kyoto gases, such as the Montreal Protocol refrigerant gases or medical gases, should be reported separately as 'other gases'. However, ISO 14064-1:2018 requires all relevant direct (Scope 1) emissions to be reported, in line with the *Interactive workbook.*

Currently for direct emissions, ISO 14064-1:2018 requires that organisations report emissions by GHG as well as in carbon dioxide equivalents (CO_2-e). Example calculations in this guide do so. For more information see the *Detailed guide*, *Emission factors workbook* and *Interactive workbook*.

2 How to quantify and report GHG emissions

To quantify and report GHG emissions, organisations need data about their activities (eg, quantity of fuel used). They can then convert this into information about their emissions (measured in tonnes of CO_2-e) using emission factors.

An emission factor allows you to estimate emissions from a unit of activity data (eg, litres of fuel used). The factors are set out in the *summary of emission factors* and the *Emission factors workbook*.

A GHG inventory contains all applicable emissions for an organisation within a defined boundary during a set period. The inventory is key to measuring emissions.

A GHG report (see section 2.3) provides context about the organisation, as well as analysis and progress. The report is key to communicating GHG-related information to its intended users.

Organisations that wish to be in line with ISO 14064-1:2018 should be aware that the standard has specific requirements about what to include in the inventory and report.

You may opt to verify the GHG inventory or report against the measurement standards (see section 3). Although optional, this can give confidence that the inventory is accurate and complete, so organisations can effectively manage and reduce their emissions.

2.1 Step by step

To prepare an inventory:

1. Select the boundaries (organisational and reporting[8]) and measurement period (ie, calendar or financial year) you will report against for your organisation, based on the intended uses of the inventory.
2. Collect activity data on each emission source within the boundaries for that period.
3. Multiply the quantity used by the appropriate emission factor in a spreadsheet. See the 2019 *Example GHG Inventory*.
4. Produce a GHG report, if applicable. See section 2.3 and the 2019 *Example GHG Report*.

If this is your first inventory, you can use it as a base year for measuring the change in emissions over time (as long as the scope and boundaries represent your usual operations, and that comparable reporting is used in future years). ISO 14064-1:2018 also allows a base year to be quantified using an average of several years. Due to Covid-19 this may be an appropriate and representative approach for organisations that have commenced measuring their emissions in 2020 and 2021.

To ensure the representativeness of your base year GHG inventory, it is good practice to undertake a base year review and recalculation procedure to account for any significant changes that may have occurred since. Examples of such changes may result from:

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[8] See Glossary for definitions.

- a structural change in your reporting or organisational boundary
- a change in calculation methodologies or emission factors, or
- the discovery of an error or cumulative errors in your activity data.

Any base year recalculations should be documented in subsequent inventories.

If the change to a factor is material and could result in a +/- 5% change in an organisations published GHG inventory then recalculation and re-publishing of the inventory is required. In the cases where historic emission factors have changed it is suggested these figures are provided in the document itself or made available elsewhere.

For some organisations, certain GHG emissions may form less than 1 per cent of the inventory. These are known as *de minimis*[9] and may be excluded from the total inventory, provided that the total of excluded emissions does not exceed the materiality threshold. For example, if using a materiality threshold of 5 per cent, the total of all emission sources excluded as *de minimis* must not exceed 5 per cent of the inventory. Typically, an organisation estimates any emissions considered *de minimis* using simplified methods to justify the classification. It is important these are transparently documented and justified. You only need to re-estimate excluded emissions in subsequent years if the assumptions change.

Note however, if the user is needing to report into a particular programme or satisfy an intended use or user, they may decide to include *de minimis* activities.

2.2 Using the emission factors

Emission factors rely on historical data. This version of the guidance is based on *New Zealand's Greenhouse Gas Inventory 1990–2020* as this was the latest complete set of data available. In some cases where more recent data was available, we used it; this is clearly stated in the documents.

If you use the *Interactive Workbook*, input your activity data and the emission factors will be applied automatically. If you do not use the Interactive Workbook, example calculations are provided throughout chapter four to demonstrate how to use the emission factors.[10]

Organisations can choose to report on a calendar or financial year basis. The period determines which historical factors to use.

Calendar year: Use the latest published emission factors. For example, if you are reporting emissions for the 2021 calendar year, use this 2022 guide, which largely relies on 2019 and 2020 data.

Financial year: Use the guide that the greatest portion of your data falls within. For example, if you are reporting for the 2020/21 financial year, use this 2022 guide. For a July to June reporting year, apply the more recent set of factors.

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9 See Glossary for definition.

10 Note that the emission factors in the example calculations within this document, the Emission factors summary and the Emission factors workbook are rounded. In the Interactive Workbook and Emission Factors Flat File they are not. For this reason, you may notice small discrepancies between the answers in the example calculations and the answers provided in the Interactive Workbook.

The emission factors in this guide are:

- default factors, used in the absence of better organisation- or industry-specific information
- consistent with the reporting requirements of ISO 14064-1:2018 and the *GHG Protocol*
- aligned with *New Zealand's Greenhouse Gas Inventory 1990–2020*. This also means we use the 2007 IPCC GWPs to ensure consistency.

See the *Detailed guide* for further information.

2.3 Producing a GHG report

A full GHG report gives context to the GHG inventory by including information about the organisation, comparing annual inventories, discussing significant changes to emissions, listing excluded emissions, and stating the methods and references for the calculations.

A GHG REPORT

To compile a full GHG report, organisations should include:

- a description of the organisation
- the person or entity responsible for the report
- a description of the inventory boundaries
  - organisational boundary
  - reporting boundary
  - measurement period
- the chosen base year (initial measurement period for comparing annual results)
- emissions (and removals where appropriate)
- for all seven GHGs separately in metric tonnes CO_2-e
- emissions separated by scope
  - total Scope 1 and 2 emissions
  - specified Scope 3 emissions
- emissions from biologically sequestered carbon reported separately from the scopes
- a time series of emissions results from base year to present year
- significant emissions changes, including in the context of triggering any base year recalculations
- the methodologies for calculating emissions, and references to key data sources
- impacts of uncertainty on the inventory
- any specific exclusions of sources, facilities or operations.

View an example reporting template on the GHG Protocol Corporate Standard webpage.

3 Verification

Verification[11] gives confidence about the inventory and report. If you intend to publicly release the inventory, we recommend it is independently verified to confirm that calculations are accurate, the inventory is complete and you have followed the correct methodologies.

3.1 Who should verify my inventory?

If you opt for verification, we recommend using verifiers who:

- are independent
- hold accreditation or certification from a suitable professional organisation (for example a professional recognition from NZICA, a carbon auditor certification from Carbon and Energy Professionals New Zealand, or organisations accredited to ISO 14065 standard)
- have experience with emissions inventories
- understand ISO 14064, ISAE (NZ) 3410, and the GHG Protocol
- have effective internal peer review and quality control processes.

Organisations may choose to use an accredited body to help them assess a verifier. For example, accreditation under the ISO 14065 standard confirms that verifiers are suitably qualified and enables them to certify an inventory as being prepared in accordance with ISO 14064-1:2018.

In New Zealand, the Joint Accreditation System of Australia and New Zealand (JAS-ANZ) issues accreditations and publishes a list of accredited bodies on its website.[12]

ISAE (NZ) 3410 deals with assurance engagements to report on an entity's GHG statement. It is free to download.

[11] See Glossary for definition.

[12] View accredited bodies on the JAS-ANZ Register at www.jas-anz.org/accredited-bodies/all

4 Calculating emissions by source category

The following sections aim to help organisations produce a GHG inventory. The Detailed guide has information about category changes. For more information see the *Detailed guide*, *2019 Example GHG Inventory* and *Interactive workbook*.

4.1 Fuel

The fuel category comprises stationary combustion and transport. It also includes the use of biofuels, and the transmission and distribution losses for reticulated natural gas.

In line with the reporting requirements of ISO 14064-1:2018 and the GHG Protocol, we provide emission factors for direct (Scope 1) sources to allow separate carbon dioxide, methane and nitrous oxide calculations.

Organisations typically report their fuel emissions using activity data on the amount of fuel used during the reporting period.

4.1.1 Stationary combustion

Stationary combustion fuels are burnt in a fixed unit or asset, such as a boiler. To calculate these emissions, collect data on the quantity of fuel used (ie, volume in litres or weight in kilograms) during the reporting period and multiply this by the emission factor for each GHG.

Quantified units of fuel weight or volume (commonly in litres) are preferable.

STATIONARY COMBUSTION: EXAMPLE CALCULATION

An organisation uses 1400 kg of LPG to heat an office building in the reporting year.

CO_2 emissions	= 1,400 × 3.02	= 4,228 kg CO_2
CH_4 emissions	= 1,400 × 0.00594	= 8.32 kg CO_2-e
N_2O emissions	= 1,400 × 0.00142	= 1.99 kg CO_2-e
Total CO_2-e emissions	= 1,400 × 3.03	= 4,242 kg CO_2-e

Note: Numbers may not add due to rounding.

4.1.2 Transport fuels

Transport fuels are used in an engine to move a vehicle. To calculate transport fuel emissions, collect data on the quantity of fuel used (ie, litres or gigajoules/GJ) and multiply this by the emission factors for each GHG.

Quantified units of fuel weight or volume (commonly in litres) are preferable.

TRANSPORT FUELS: EXAMPLE CALCULATION

An organisation has 15 petrol vehicles. They use a total of 40,000 litres of regular petrol (default) in the reporting year.

CO_2 emissions	= 40,000 × 2.35	= 94,000 kg CO_2
CH_4 emissions	= 40,000 × 0.0276	= 1,104 kg CO_2-e
N_2O emissions	= 40,000 × 0.0797	= 3,188 kg CO_2-e
Total CO_2-e emissions	= 40,000 × 2.46	= 98,400 kg CO_2-e

Note: Numbers may not add due to rounding.

4.1.3 If no fuel data is available

If your records only state kilometres travelled, and you do not have information on fuel use, see section 4.5 Travel. Factors such as individual vehicle fuel efficiency and driving efficiency mean that kilometre-based estimates of carbon dioxide equivalent emissions are less accurate than calculating emissions based on fuel-use data. Therefore, only use the emission factors based on distance travelled if you have no information on fuel use.

Calculating transport fuel based on dollars spent is less accurate and should only be applied to taxis. See section 4.5.1 Passenger vehicles.

Travel emissions are indirect (Scope 3) if you do not directly own or control the vehicles used for travel. If you own or have an operating lease for the vehicle, these emissions are direct (Scope 1) and should be accounted for in transport fuels (see section 4.1.2).

4.1.4 Biofuels and biomass emission factors

This category gives emission factors for bioethanol and biodiesel and wood emission sources. For more information about biofuels, see the *Detailed guide*.

The carbon dioxide emitted from the combustion of biofuels and biomass (including wood) is biogenic, meaning it equates to the carbon dioxide absorbed by the feedstock during its lifespan. This means we treat the carbon dioxide portion of the combustion emissions of biofuels as carbon neutral. However, organisations should still report the carbon dioxide released through biofuel and biomass combustion. Calculate these emissions in the same way as the direct emissions. Then, instead of including them in the emissions total, list them separately from the other scopes.[13] This ensures the organisation is transparent about all potential sources of carbon dioxide from its activities.

To calculate biofuel emissions, collect data on the quantity of fuel used (litres) and multiply this by the emission factors for each gas.

[13] Calculation Tool for Direct Emissions from Stationary Combustion, accessed via: https://ghgprotocol.org/sites/default/files/Stationary_Combustion_Guidance_final_1.pdf

BIOFUELS: EXAMPLE CALCULATION

An organisation uses 100 per cent biofuel in five vehicles. They use 7000 litres of biodiesel in the reporting year.

CO_2 emissions	= 7,000 × 2.45	= 17,150 kg CO_2 (reported separately)
CH_4 emissions	= 7,000 × 0.000104	= 0.728 kg CO_2-e
N_2O emissions	= 7,000 × 0.0000208	= 0.146 kg CO_2-e
Total CO_2-e emissions	= 7,000 × 0.000125	= 0.875 kg CO_2-e (reported as Scope/Category 1)

Note: Numbers may not add due to rounding.

An organisation wants to report on its Scope 1 fuel emissions (in kg CO_2-e/litre) from a specific biodiesel blend of 10 per cent. It is known that:

mineral diesel conversion factor	= 2.69 kg CO_2-e/litre
biodiesel conversion factor	= 0.000125 kg CO_2-e/litre

Therefore, 10 per cent biodiesel blend conversion factor =

(10% × 0.000125) + [(1-10%) × 2.69] = 2.42 kg CO_2-e/litre biofuel blend

4.1.5 Transmission and distribution losses for reticulated gases

Reticulated gases are delivered via a piped gas system. Users should be aware what type of reticulated gas they are receiving: natural gas or liquefied petroleum gas (LPG).

Reticulated LPG is supplied in Canterbury and Otago only (natural gas is not available in the South Island). LPG does not contain any methane so fugitive emissions (ie, leaks) of methane do not occur.

To calculate the emissions from transmission and distribution losses, collect data on the quantity of natural gas used in the unit expressed in the emission factor tables and multiply this by the emission factors for each gas.

RETICULATED GAS: EXAMPLE CALCULATION

An organisation uses 800 gigajoules of distributed natural gas in the reporting period.

CO_2 emissions	= 800 × 0.00	= 0 kg CO_2
CH_4 emissions	= 800 × 3.212	= 2,569.6 kg CO_2-e
N_2O emissions	= 800 × 0.00	= 0 kg CO_2-e
Total CO_2-e emissions	= 800 × 3.212	= 2,569.6 kg CO_2-e

Note: Numbers may not add due to rounding.

4.2 Refrigerant and other gases use

4.2.1 Refrigerant use

GHG emissions from HFCs are associated with unintentional leaks and spills from refrigeration units, air conditioners and heat pumps. Quantities of HFCs in a GHG inventory may be small, but HFCs have very high GWPs so emissions from this source may be material. Refrigerant gases come under the Montreal and Kyoto protocols. You can find more information in the *Detailed guide*.

Calculate emissions from refrigerants based on estimated leakage from equipment. The equipment maintenance service provider can typically provide the actual amounts used to top up equipment (ie, to replace what has leaked). There are three approaches to estimate HFC leakage from equipment, depending on data available. See the *Detailed guide* (chapter 4 and appendix B) for further information on methods B and C.

If you consider it likely that emissions from refrigerant equipment and leakage is a significant proportion of your total emissions (ie, more than 5 per cent), you should include them in your GHG inventory. You may need to carry out a screening test to determine if this is a material source.

If you own or control the refrigeration units, emissions from refrigeration are direct (Scope 1). If the unit is leased, they are indirect (Scope 3).

To calculate the emissions from refrigerant use, collect data on the quantity of refrigerant used to top up equipment and multiply this by the emission factors. If this data is not available, please see the *Detailed guide* for alternative methods.

REFRIGERANT USE: EXAMPLE CALCULATIONS

Method A: Top-up

Chiller unit: During the 2020 calendar year, a service technician confirmed a top-up of 6 kg of HFC-134a (AR4 GWP = 1,430) in December 2020. The technician also confirmed that when last serviced at the end of December 2019, no top-ups were needed. So, we assume the 6 kg of gas was lost during calendar year 2020.

So, for the 2020 inventory:

6 kg HFC-134a × 1,430 = 8,580 kg CO_2-e

Air conditioning unit: During the 2020 calendar year, a service technician confirmed a top-up of 6 kg of HFC-143a (AR4 GWP = 4,470) in July 2020. The technician also confirmed that when last serviced at the end of July 2019, no top-ups were needed. So, we assume all the gas was lost at an even rate during the 12 months between service visits, and six of those months sit in the 2020 measurement period.

6 kg /12 months = 0.5 kg per month

So, for the 2020 calendar year inventory, 0.5 × 6 months = 3 kg. Emissions calculate as:

3 kg HFC-143a × 4,470 = 13,410 kg CO_2-e

4.2.2 Medical gases use

This section covers emissions from medical gases. Anaesthetic medical gases can be a significant source of direct (Scope 1) emissions in hospitals. The most accurate way to calculate emissions from medical gases is based on consumption data.

To calculate medical gas emissions, collect consumption data for each medical gas used by the organisation, and multiply this by the GWP for each gas.

Medical gases are supplied in bottles or cylinders. If only the volume of the gas is known, an additional calculation to calculate the mass of the gas is required to estimate emissions. This should be done by multiplying the volume (L) of gas by its density (g/mL or kg/L).

MEDICAL GAS USE: EXAMPLE CALCULATION

An organisation uses 5 bottles of Isoflurane (HCFE-235da2, AR4 GWP = 350) in the reporting period. Each bottle holds 0.3 kg of Isoflurane. Its direct (Scope 1) emissions are:

5 bottles x 0.3 kg	= 1.5 kg	
Total CO_2-e emissions	= 1.5 × 350	= 525 kg CO_2-e

An organisation uses 5 bottles 250 mL bottles of Isoflurane (HCFE-235da2, AR4 GWP = 350) in the reporting period. The density of Isoflurane is 1.49 g/mL. Its direct (Scope 1) emissions are:

5 bottles x 250 mL x 1.49/ 1000	= 1.86 kg	
Total CO_2-e emissions	= 1.86 × 350	= 651 kg CO_2-e

Note: Numbers may not add due to rounding.

4.3 Purchased electricity, heat and steam

Purchased energy, in the form of electricity, heat or steam, is an indirect (Scope 2) emission. This section also includes transmission and distribution losses for purchased electricity, which is an indirect (Scope 3) source.

4.3.1 Indirect emissions from purchased electricity from New Zealand grid

This guide applies to electricity purchased from a supplier that sources electricity from the national grid (ie, purchased electricity consumed by end users). It does not cover on-site, self-generated electricity.

The grid-average emission factor best reflects the carbon dioxide equivalent emissions associated with the generation of a unit of electricity purchased from the national grid in New Zealand in 2020. We recommend the use of the emissions factors in table 10 for all electricity purchased from the national grid, apart from when the market-based method is being used.

We calculate purchased electricity emission factors on a calendar-year basis and based on the average grid mix of generation types for the calendar year. The emission factor accounts for the emissions from fuel combustion at thermal power stations and fugitive emissions from the generation of geothermal electricity. Thermal electricity is generated by burning fossil fuels.

The emission factor for purchased grid-average electricity does not include transmission and distribution losses. We provide a separate average emission factor for this as an indirect (Scope 3) emission source in section 4.3.2.

To calculate the emissions from purchased electricity, collect data on the quantity of electricity used during the period in kilowatt hours (kWh) and multiply this by the emission factor for each gas.

PURCHASED ELECTRICITY: EXAMPLE CALCULATION

An organisation uses 800,000 kWh of electricity in the 2020 reporting period. Its indirect (Scope 2) emissions from electricity are:

CO_2 emissions	= 800,000 × 0.117	= 93,600 kg CO_2
CH_4 emissions	= 800,000 × 0.0028	= 2,240 kg CO_2-e
N_2O emissions	= 800,000 × 0.0002	= 160 kg CO_2-e
Total CO_2-e emissions	= 93,600 + 2,240 + 160	= 96,000 kg CO_2-e

Note: Numbers may not add due to rounding.

4.3.2 Transmission and distribution losses for electricity

Additional electricity must be generated to make up for that lost in the transmission and distribution network. This emission factor accounts for that extra generation. Under the *GHG Protocol*, end users should report emissions from electricity consumed due to transmission and distribution losses as an indirect (Scope 3) source.

To calculate the emissions from transmission and distribution losses for purchased electricity, collect data on the kWh of electricity used in the reporting period and multiply this by the emission factor for each gas.

TRANSMISSION AND DISTRIBUTION LOSSES: EXAMPLE CALCULATION

An organisation uses 800,000 kWh of electricity in the 2020 reporting period. Its indirect (Scope 3) emissions from transmission and distribution losses for purchased electricity are:

CO_2 emissions	= 800,000 × 0.0107	= 8,560 kg CO_2
CH_4 emissions	= 800,000 × 0.0003	= 240 kg CO_2-e
N_2O emissions	= 800,000 × 0.000021	= 16.8 kg CO_2-e
Total CO_2-e emissions	= 8,560 + 240 + 16.8	= 8,816.8 kg CO_2-e

Note: Numbers may not add due to rounding.

4.3.3 Imported heat and steam

Organisations that have a specific heat or steam external energy source (such as a district heating scheme) can calculate emissions using an emission factor specific to that scheme. This should be available from the owner of the external source.

4.3.4 Geothermal energy

Organisations that have their own geothermal energy source can calculate emissions separately using a unique emission factor. Depending on the composition of the steam coming from the borehole, there may or may not be emissions associated with this energy type.

4.4 Indirect business-related emission factors

This section provides three emission factors, which incorporate typical emission sources associated with the activities of employees working from home. These emission factors can be used by employers to estimate the indirect (Scope 3) emissions associated with staff working from home. The three emission factors for working from home are:

- Working from home – Default
- Working from home – Without heating
- Working from home – With heating.

All three emission factors have been developed based on typical uses of the following emissions sources by staff members working from home; a laptop plus monitor, lighting and optionally heating. The default factor assumes heating is run for five months of the year and could be used where more granular data on the actual use of home heating is not available. The default factor does not account for different heater sizes or for different heating fuels (eg, gas, solid fuels). Future updates to the guidance will explore regional averages for heating type and duration.

Note the Working from home – With heating factor should only be used when heating is additional to what would normally be used. In other words, when the heater is being used over and above the normal home heating use. Noting this factor assumes six hours of heating per day. More information on the emission factors and the assumptions used for their derivation is outlined in section 6.2 of the *Detailed guide*.

To account for the emissions produced by employees commuting between their homes and their worksites, refer to Travel emissions in section 4.5.

To calculate the emissions for an employee working from home, collect information on the number of days staff have worked from home during the reporting period.

WORKING FROM HOME: EXAMPLE CALCULATION

An organisation has 20 employees and knows through an employee survey or some other means, that on a given day 12 employees were working from home. Of these, eight used heating each day and four did not use heating. This same daily data was collected over a month and summed as either with or without heating.

Its indirect (Scope 3) emissions from working at home for a given month are:

With heating = 168 employee days

CO_2 emissions	= 168 × 0.94	= 157.9 kg CO_2
CH_4 emissions	= 168 × 0.037	= 6.29 kg CO_2-e
N_2O emissions	= 168 × 0.0013	= 0.23 kg CO_2-e
Total CO_2-e emissions	= 1,380 × 0.979	= 164.50 kg CO_2-e

WORKING FROM HOME: EXAMPLE CALCULATION		
Without heating = 84 employee days		
CO_2 emissions	= 84 × 0.064	= 5.37 kg CO_2
CH_4 emissions	= 84 × 0.0025	= 0.21 kg CO_2-e
N_2O emissions	= 184 × 0.00009	= 0.008 kg CO_2-e
Total CO_2-e emissions	= 1,380 × 0.067	= 5.59 kg CO_2-e

Note: Numbers may not add due to rounding.

4.5 Travel

Travel emissions result from travel associated with (and generally paid for by) the organisation. We provide factors for private and rental vehicles, taxis, public transport, air travel and accommodation.

Travel emissions are indirect (Scope 3) if you do not directly own or control the vehicles used for travel. If you own or have an operating lease for the vehicle, these emissions are direct (Scope 1) and should be accounted for in transport fuels (see section 4.1.2).

4.5.1 Passenger vehicles

This section covers emissions from private vehicle mileage claims, rental vehicles and taxi travel.

Organisations should gather the data on passenger vehicles with as much detail as possible, including age of the vehicle, engine size, fuel type and kilometres travelled. If information is not available, we provide conservative defaults to allow for over- rather than underestimation.

If fuel use data is available, see section 4.1.2 on transport fuels.

If fuel use data is not available, collect data on the kilometres travelled by vehicle type, and multiply this by the emission factors based on distance travelled for each GHG.

PASSENGER VEHICLES: EXAMPLE CALCULATION

An organisation has 15 petrol vehicles. They use 40,000 litres of regular petrol in the reporting period.

CO_2 emissions	= 40,000 × 2.35	= 94,000 kg CO_2
CH_4 emissions	= 40,000 × 0.0276	= 1,104 kg CO_2-e
N_2O emissions	= 40,000 × 0.0797	= 3,188 kg CO_2-e
Total CO_2-e emissions	= 40,000 × 2.45	= 98,000 kg CO_2-e

An organisation owns three pre-2010 petrol hybrid vehicles. They are all between 1600 and 2000 cc and travel a total of 37,800 km in the reporting period.

CO_2 emissions	= 37,800 × 0.173	= 6,539 kg CO_2
CH_4 emissions	= 37,800 × 0.002	= 76 kg CO_2-e
N_2O emissions	= 37,800 × 0.006	= 227 kg CO_2-e
Total CO_2-e emissions	= 37,800 × 0.181	= 6,842 kg CO_2-e

PASSENGER VEHICLES: EXAMPLE CALCULATION

An organisation uses petrol rental cars to travel 12,000 km in 2018. It also spends $18,000 on taxi travel.

Total CO_2-e emissions from rental cars = 12,000 × 0.211 = 2,532 kg CO_2-e

Total CO_2-e emissions from taxi travel = $18,000 × 0.07 = 1,260 kg CO_2-e

Note: Numbers may not add due to rounding.

4.5.2 Public transport passenger

Passenger transport is for passenger travel on buses and trains. The unit used for these emission sources are passenger kilometres (pkm).

PASSENGER BUS: EXAMPLE CALCULATION

An employee takes a return trip on an electric Wellington bus from the CBD to the airport (9.4 km each way). This happens five times in the reporting year

Passenger kilometres travelled = 2 trips × 9.4 km x 5 times = 94 pkm

CO_2 emissions = 94 x 0.012 = 1.128 kg CO_2

CH_4 emissions = 94 x 0.0004 = 0.038 kg CO_2-e

N_2O emissions = 94 x 0.00002 = 0.002 kg CO_2-e

Total CO_2-e emissions from passenger public travel = 94 x 0.024 = 2.3 kg CO_2-e

4.5.3 Public transport vehicles

Public transport emissions include those from buses and trains. Air travel is in a separate section below. No data is currently available on ferries.

To calculate emissions, collect data on the type of bus used (if available) and distance travelled, and multiply this by the emission factors for each gas

DIESEL BUS: EXAMPLE CALCULATION

An organisation charters a diesel bus (<7,500 kg) to travel 500 km. The emissions would be:

CO_2 emissions = 500 x 0.557 = 278.5 kg CO_2

CH_4 emissions = 500 x 0.001 = 0.5 kg CO_2-e

N_2O emissions = 500 x 0.009 = 4.5 kg CO_2-e

Total CO_2-e emissions from bus travel = 500 km x 0.567 = 283.5 kg CO_2-e

This result is for the entire bus.

4.5.4 Air travel (domestic and international)

This section provides emission factors from 2016, 2019 and 2020. Domestic air travel is a common source of indirect (Scope 3) emissions for many New Zealand organisations.

To calculate emissions for air travel, collect information on passengers flying, their departure airport and destination airport, and if practical, the size of the plane. For international travel, note the class of travel if possible. Calculate distances using online calculators such as www.airmilescalculator.com. Multiply the number of passengers by the distance travelled to obtain the pkm. Collect data on the pkm by class in the reporting period.

Domestic air travel: Emission factors should only be used for flights within New Zealand. Domestic air travel cannot be broken down by travelling class, but emission factors are provided based on the aircraft size: large, medium or small aircraft. For the purpose of this guide, a jet is a large aircraft (ie, an Airbus A320), a medium aircraft has between 50 and 70 seats (ie, regional services on an ATR 72 or Dash 8-300) and a small aircraft has less than 50 seats. If the aircraft type is unknown, we recommend using the national average.

To report domestic travel in other countries, see international travel.

International travel: To report international air travel emissions could use the International Civil Aviation Organisation (ICAO) calculator.[14] This considers aircraft types and load factors for specific airline routes. It does not apply a radiative forcing multiplier or distance uplift factor[15] to account for delays/circling and non-direct routes. To account for these, multiply the output by 1.9 to account for radiative forcing and 1.09 to account for the distance uplift factor. For more information see section 6.4 of the *Detailed guide*.

We also recommend using the emission factors in the guide. International travel is divided by class of travel. Emissions vary by class because they are based on the number of people on a flight. Business-class passengers use more space and facilities than economy travellers. If everyone flew business class, fewer people could fit on the flight and therefore emissions per person would be higher.

Multipliers or other corrections may be applied to account for the global warming potential (GWP) of emissions arising from aircraft transport at altitude (jet aircraft). We provide air travel emission factors with and without a radiative forcing multiplier applied. Radiative forcing helps account for the wider climate effects of aviation, including water vapour and indirect GHGs. This is an area of active research aiming to express the relationship between emissions and the climate warming effects of aviation, but there is yet to be consensus on this aspect. If multipliers are applied, organisations should disclose the specific factor used and produce comparable reporting. Therefore, avoid reporting with air travel conversion factors in one year and without in another year, as this may skew the interpretation of your reporting.

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[14] International Civil Aviation Organisation Calculator, available at: www.icao.int/environmental-protection/CarbonOffset/Pages/default.aspx

[15] See Glossary for definition.

AIR TRAVEL: EXAMPLE CALCULATION

An organisation flies an employee on a return flight from Christchurch to Wellington (304 km each way). This happens five times in the reporting year on an aircraft of unknown size. The national average emission factor with radiative forcing is used.

Passenger kilometres travelled = (2 × 304) × 5 = 3,040 pkm

Total CO_2-e emissions from domestic air travel = 0.306 x 3,040 = 929.92 kg CO_2-e

An organisation makes five flights from Auckland to Shanghai (9,346 km each way). On the first trip, two people flew return to Shanghai on the same flight in economy class. On the second trip, three people flew return to Shanghai and the cabin classes were not recorded. Long-haul (>3700 km) emission factors including the indirect effects of non-CO_2 emissions are used.

For the two people who travel economy class:

Passenger kilometres travelled	= (2 × 9,346) × 2	= 37,384 pkm
Their CO_2-e emissions from air travel	= 37,384 × 0.148	= 5,532 kg CO_2-e

For the three people with unknown travel classes:

Passenger kilometres travelled	= (3 × 9,346) × 2	= 56,076 pkm
Their CO_2-e emissions from air travel	= 56,076 × 0.193	= 10,822 kg CO_2-e

Total CO_2-e emissions from international air travel	= 5,532 + 10,822	= 16,354 kg CO_2-e
Total CO_2-e with distance uplift	= 16,354 × 1.09	= 17,825 kg CO_2-e

Note: Numbers may not add due to rounding.

4.5.5 Helicopters

To calculate emissions from helicopters, collect the type of helicopter and the hours spent flying. If the fuel use is known, refer to the Fuel section for a more accurate representation of emissions.

HELICOPTER: EXAMPLE CALCULATION

An agricultural operation used a Eurocopter AS 350B Squirrel to apply topdressing and other spraying activities. They could not obtain data on the amount of fuel used but had recorded 10 flying hours over a given year.

CO_2 emissions	= 10 × 463.998	= 4,639.98 kg CO_2
CH_4 emissions	= 10 × 3.2647	= 32.647 kg CO_2-e
N_2O emissions	= 10 × 12.923	= 129.23 kg CO_2-e
Total CO_2-e emissions	= 10 × 480.185	= 4,801.85 kg CO_2-e

Note: Numbers may not add due to rounding.

4.5.6 Accommodation

To calculate emissions from accommodation during business trips, collect data on the number of rooms booked, the number of nights and the country visited.

ACCOMMODATION: EXAMPLE CALCULATION

An organisation sends six people to a conference in Australia. They book three rooms for four nights.

3 rooms × 4 nights = 12

Total CO_2-e emissions from the hotel stay = 12 × 38.9 = 466.8 kg CO_2-e

4.6 Freight transport

Emissions from freight transport are indirect (Scope 3) for businesses freighting goods through a third party. We provide emission factors for freighting goods, in tonne kilometres (tkm), and for the actual freight vehicles (in km). The emission factors include freighting goods via road, rail, domestic coastal shipping, international shipping and air freight. We also provide emission factors (in km) for road light commercial vehicles and heavy goods vehicles.

4.6.1 Road freight

If you use freight vehicles, you can calculate the emissions from the kilometres travelled by that vehicle (sorted by age, engine size and fuel type).

For freighting goods emissions, you need to know the weight in tonnes of the goods freighted, and the distance in kilometres travelled.

Downstream and upstream transportation and distribution can also be considered. Refer to the *GHG Protocol Corporate Accounting and Reporting Standard*.

4.6.2 Rail freight

Calculate the weight of goods freighted (tonnes) and multiply this by the kilometres travelled.

4.6.3 Air freight

Organisations should collect data on the weight (tonnes) of goods freighted by air, and the distance travelled (kilometres).

4.6.4 Coastal and international shipping freight

Organisations can calculate emissions for both coastal shipping in New Zealand and international shipping. The international shipping emission factors consider the ship types that visit New Zealand.

Collect data on the weight (tonnes) of goods freighted, and the distance (kilometres) travelled. For each journey, multiply the total weight by the total distance travelled. See the Detailed guide for more example calculations.

MULTIPLE FREIGHT MODES: EXAMPLE CALCULATION

A company sends 300 kg of its product to a customer. It travels by road freight (All trucks) 50 km to the port, then 500 km by coastal shipping (container freight) to another domestic port. It is then loaded onto rail to its destination 250 km from the port.

Road freight emissions:

0.3 tonnes × 50 km	= 15 tkm
15 tkm × 0.135	= 2.03 kg CO_2-e

Coastal shipping emissions:

0.3 tonnes × 500km	= 150 tkm
150 tkm × 0.046	= 6.9 kg CO_2-e

Rail freight emissions:

0.3 tonnes × 250km	= 75 tkm
75 tkm × 0.027	= 2.1 kg CO_2-e

Total freight emissions:

2.03 + 6.9 + 2.1	= 11 kg CO_2-e

Note: Numbers may not add due to rounding.

4.7 Water supply and wastewater treatment

Emissions result from energy use in water supply and wastewater treatment plants. Some plants also generate emissions when treating organic matter. We calculated the emission factors using data from Water NZ and *New Zealand Greenhouse Gas Inventory 1990–2020*. Emissions from the supply of water and wastewater treatment are indirect GHG emissions (Scope 3) if the organisation does not own or control the facilities.

4.7.1 Water supply

Users should collect data on cubic metres (m^3) of water used if it is available. If it is not, apply the per capita emission factor. This is based on an average of water consumed by one person per year and is less accurate.

WATER SUPPLY: EXAMPLE CALCULATION

An organisation's assets have water meters. Throughout the reporting year they use 1000 m^3 of water.

CO_2 emissions	= 1,000 × 0.030	= 30 kg CO_2
CH_4 emissions	= 1,000 × 0.0014	= 1.4 kg CO_2-e
N_2O emissions	= 1,000 × 0.00003	= 0.03 kg CO_2-e
Total CO_2-e emissions	= 1,000 × 0.031	= 31 kg CO_2-e

Note: Numbers may not add due to rounding.

4.7.2 Wastewater

We converted energy use (kWh) to GHG emissions and added these to the treatment process emissions to give the total emissions from wastewater treatment in New Zealand. We provide emission factors for centralised wastewater treatment plants, septic tanks and specific manufacturing industries that produce wastewater that is particularly high in biological oxygen demand (BOD): meat, poultry, pulp and paper, wine, and dairy.

Collect data on the amount of water supplied, similar to measuring water supply emissions. Septic tank calculations require the number of people using the septic tank during that reporting year. Industrial users in the above categories should use the specific emission factors provided.

WASTEWATER: EXAMPLE CALCULATION

During the reporting period an organisation uses 100 m^3 of water in its offices. They assume that all water is also sent to be treated. This organisation also owns a winery that crushed 10 tonnes of grapes during the reporting period.

The office wastewater is domestic, therefore:

CO_2 emissions	= 100 × 0.077	= 7.7 kg CO_2
CH_4 emissions	= 100 × 0.167	= 16.7 kg CO_2-e
N_2O emissions	= 100 × 0.235	= 23.5 kg CO_2-e
Total CO_2-e emissions	= 100 × 0.480	= 48.0 kg CO_2-e

The winery wastewater is industrial wastewater (wine), therefore:

CO_2 emissions	= n/a	
CH_4 emissions	= 10 × 5.173	= 51.73 kg CO_2-e
N_2O emissions	= n/a	
Total CO_2-e emissions	= 10 × 5.173	= 51.73 kg CO_2-e

The total wastewater emissions are:

48.0 + 51.73	= 99.73 kg CO_2-e

Note: Numbers may not add due to rounding.

4.8 Materials and waste

4.8.1 Construction materials

Construction materials emissions are based on best-available New Zealand data for three core materials: concrete, steel and aluminium. BRANZ[16] provide the emission conversion factors for the emission sources, in their 2021 CO_2NSTRUCT dataset.[17] These emissions are indirect (Scope 3) if the organisation does not own or control the facilities making the materials.

We recommend that users refer directly to the free CO_2NSTRUCT tool for emission factors for construction materials. The tool provides embodied carbon and energy values for building

16 BRANZ Ltd, www.branz.co.nz

17 BRANZ CO_2NSTRUCT, www.branz.co.nz/co2nstruct\

materials including concrete, glass, timber, and metals, as well as products such as bathroom and kitchen fittings.

Users should also check EPD Australasia[18] for any interim updates to emission factors.

These emissions are indirect (Scope 3) if the organisation does not own or control the facilities making the materials.

Users should collect data on the quantity of construction materials used (kg).

4.8.2 Waste disposal

This section will help organisations calculate emissions from waste sent to a landfill. It does not include emissions from other waste processes (eg, recycling).

To calculate waste emissions, you need to know the type of landfill and the composition of the waste (if possible).

Knowing the type of landfill ensures that methane is appropriately counted. Organic waste produces significant amounts of methane as it decomposes. Some landfills have systems to collect and destroy this gas before it can reach the atmosphere (you can find which landfills have these systems in the *Detailed guide's* appendix A). By selecting the appropriate emissions factor the emissions inventory will account for if the landfill gas is destroyed.[19]

If the type of landfill is unknown, use the emission factor for 'without gas recovery', which will give a more conservative estimate.

Knowing the composition and weight (in kg) of waste allows you to accurately quantify GHG emissions. Use the known weight of waste to calculate a more accurate emissions footprint.

If the waste composition is unknown, you can select 'general waste' or 'office waste'. 'General waste' assumes the waste matches the national composition average for mixed municipal waste. 'Office waste' should be used by office-based organisations as it reflects their higher proportion of organic matter (eg, paper and food).

WASTE DISPOSAL: EXAMPLE CALCULATION

A hotel produces waste in its kitchen, guest rooms and garden. They send it to the regional landfill, which is known to have landfill gas recovery.

If the waste comprises 150 kg food waste, 50 kg general waste from guest rooms and 60 kg of garden waste, the hotel calculates emissions as follows:

Food waste	= 150 × 0.602	= 90.3 kg CO_2-e
General waste	= 50 × 0.207	= 10.3 kg CO_2-e
Garden waste	= 60 × 0.492	= 29.5 kg CO_2-e
Total waste emissions	= 90.3 + 10.3 + 29.5	= 130.2 kg CO_2-e

Note: Numbers may not add due to rounding.

[18] https://epd-australasia.com/

[19] When methane is recovered and flared or combusted for energy, the carbon dioxide emitted from the combustion process is regarded as part of the natural carbon cycle.

4.9 Agriculture, forestry and other land use

This category covers emissions produced by land use, land-use change and forestry (LULUCF), enteric fermentation of livestock, manure management and fertiliser use. Including these sources is in line with *New Zealand's Greenhouse Gas Inventory 1990–2020*.

Emissions from agriculture, forestry and land use are produced in several ways.

- Methane is a by-product of digestion in ruminants such as cattle and sheep, which nationally are the largest sources of methane in this sector.
- Storing and treating manure, and spreading it onto pasture, produces methane and nitrous oxide.
- Losses from manure that is simply deposited in paddocks, which is distinct from losses from agricultural soils.
- Applying nitrogen (urea sourced or synthetic) fertiliser onto land produces nitrous oxide and carbon dioxide emissions.
- Applying lime and dolomite fertilisers results in carbon dioxide emissions.
- Land use can result in removals (growing forests remove carbon dioxide from the atmosphere) or emissions (harvesting and deforestation).

If an organisation directly owns and manages livestock, these are direct GHG emissions (Scope 1). LULUCF emissions are reported separately from direct and indirect GHG emissions (Scope 1, 2 and 3).

Alternative tools such as the Ministry's Agricultural Emissions Calculator, Overseer[FM], or the B+LNZ GHG calculator can estimate the GHG emissions from agricultural processes. It is up to the user to assess the appropriateness of emission factors when comparing those from the guide with those from alternative tools.

4.9.1 Land use, land-use change and forestry (LULUCF)

GHG emissions from vegetation and soils that are due to human activities are reported in the LULUCF sector. This guide provides emission factors related to forest growth, forest harvest and deforestation only. The term LULUCF is used for consistency with the national inventory.

The LULUCF sector is responsible for both emitting GHG to the atmosphere (emissions ie, through harvesting and deforestation) and removing GHG from the atmosphere (removals ie, through vegetation growth and increasing organic carbon stored in soils). Most emissions reported in the LULUCF sector are due to forestry activities, such as harvesting in production forests. Most removals are due to forest growth. When emissions exceed removals, LULUCF is a 'net source' and emissions are positive. When removals exceed emissions, LULUCF is a 'net sink' and emissions are negative.

In line with ISO 14064-1:2018 and the GHG Protocol, organisations should consider LULUCF emissions if they have forested land within their measurement boundary, or own land that has been deforested for timber or other reasons during the measurement period.

Organisations with LULUCF emissions should calculate and report these separately from direct and indirect GHG emissions (Scope 1, 2 and 3). In the case that LULUCF is a net sink however (ie, net emissions are negative), you should subtract the total from the other emissions – a practice known as offsetting.

In New Zealand, most LULUCF emissions and removals reported at the national scale result from forestry. This guide provides methods for estimating carbon stock changes that occur in forest vegetation. The emission factors provided in this guide are New Zealand-specific emission factors, derived from national averages.

Land-use definitions and further details on the LULUCF sector can be found in the *Detailed guide*.

To calculate LULUCF emissions and removals, you need activity data on each forest type (planted, tall natural or regenerating natural – see section 10.2.3 in the *Detailed guide* for definitions), the area harvested (in hectares, ha) and any changes to forested land within the organisational boundary for the measurement period.

Sources for this information could include:

5. Corporate or farm records for enterprises and organisations.
6. Geospatial analysis of the property or region.
7. The LUCAS Land Use Map[20] can provide area by vegetation type at 1990, 2008, 2012 and 2016. It requires geospatial expertise to analyse and extract the data by region. This is free to use and supports users in monitoring changes in their own land management practices.
8. The New Zealand Land Cover Database (LCDB)[21] provides multi-temporal land cover. It requires geospatial expertise to analyse and extract the data for sub-national analysis.

LAND USE, LAND-USE CHANGE AND FORESTRY: EXAMPLE CALCULATION

Example one (using Approach One for Planted Forest):

An organisation owns four ha of land. three ha are planted forest (*Pinus radiata*) and one ha is pre-1990 regenerating natural forest. During the reporting year the organisation harvested the planted forest for timber.

Three ha of planted forest (*Pinus radiata*) were harvested, therefore:

CO_2 emissions = 3 × 1,027,286 = 3,081,858 kg CO_2

The removals (expressed as a negative) of the regenerating pre-1990 natural forest are:

CO_2 removals = 1 × -1,567 = -1,567 kg CO_2

Therefore, total net CO_2-e emissions = 3,081,858 – 1,567 = 3,080,291 kg CO_2-e.

Example two (using Approach Two for Planted Forest):

An organisation owns 40 ha of land: 10 ha are planted forest (Other softwoods) below the long-term average age (< 28 years since time of planting), 20 ha are planted forest (*Pinus radiata*) above the long-term average age (> 22 years since time of planting), and a further 10 ha of planted forest (*Pinus radiata*) were deforested during the reporting year.

The removals (expressed as negative) for the 10 ha of planted forest (Other softwoods) below the long-term average age (< 28 years) are:

CO_2 removals = 10 × -29,453 = -294,530 kg CO_2-e

[20] Land Use Carbon Analysis System (LUCAS) Land Use Map available at https://data.mfe.govt.nz/

[21] LCDB available at https://lris.scinfo.org.nz/layer/48423-lcdb-v41-land-cover-database-version-41-mainland-new-zealand/

LAND USE, LAND-USE CHANGE AND FORESTRY: EXAMPLE CALCULATION

The removals (expressed as a negative) for the 20 ha of planted forest (*Pinus radiata*) above the long-term average (> 22 years):

CO_2 removals	= 20 × 0	= 0 kg CO_2e

The emissions for the 10 ha of planted forest (*Pinus radiata*) that were deforested:

CO_2 emissions	= 10 × 1,027,286	= 10,272,860 kg CO_2-e

Therefore, total net CO_2-e emissions = 10,272,860 – 294,530 – 0 = 9,978,330 kg CO_2-e.

Note: Negative emissions are a carbon sink.

4.9.2 Enteric fermentation

Enteric fermentation is the process by which ruminant animals produce methane through digesting feed. We provide emission factors for dairy cattle, non-dairy cattle, sheep, deer, swine, goats, horses, alpaca, mules & asses, and poultry.

To calculate these emissions, collect data on the number and type of livestock as at 30 June during the measurement period (regardless of whether it is a calendar or financial year – see the *Detailed guide* section 11.3.1 for more information).

ENTERIC FERMENTATION: EXAMPLE CALCULATION

An organisation owns 2,400 sheep and 210 dairy cows on 30 June during the reporting period. They graze on land owned by the organisation.

CO_2 emissions	= 0
CH_4 emissions	= (2,400 × 318) + (210 × 2,264) = kg CO_2-e
N_2O emissions	= 0
Total CO_2-e emissions	= 1,238,640 kg CO_2-e

Note: Numbers may not add due to rounding.

4.9.3 Manure management

Manure management refers to the process of managing the excretion of livestock, particularly when they are not on paddocks. Manure storage and treatment produces GHG emissions. We provide emission factors for dairy cattle, non-dairy cattle, sheep, deer, swine, goats, horses, alpaca, mules & asses and poultry.

To calculate these emissions, collect data on the number and type of livestock as at 30 June during the measurement period (regardless of whether it is a calendar or financial year – see the *Detailed guide* section 11.3.2 for more information).

MANURE MANAGEMENT: EXAMPLE CALCULATION

An organisation owns 2,400 sheep and 210 dairy cows on 30 June during the reporting period.

CO_2 emissions	= 0	
CH_4 emissions	= (2,400 × 3,53) + (210 × 238)	= 58,452 kg CO_2-e
N_2O emissions	= (2,400 × 0) + (210 × 14.4)	= 3,204 kg CO_2-e
Total CO_2-e emissions	= 61,656 kg CO_2-e	

Note: Numbers may not add due to rounding.

4.9.4 Fertiliser use

Fertilisers produce GHG emissions when applied to land as they break down. We provide emission factors for the following fertiliser types:

- non-urea nitrogen
- urea nitrogen, not coated with urease inhibitor
- urea nitrogen, coated with urease inhibitor
- limestone
- dolomite

Organisations should collect data on quantity (in kg) of fertiliser used in the reporting period by type.

FERTILISER USE: EXAMPLE CALCULATION

An organisation uses 80 kg of dolomite and 50 kg of nitrogen from non-urea nitrogen fertiliser in the reporting year.

CO_2 emissions	= (80 × 0.477) + (50 × 0)	= 38.2 kg CO_2-e
CH_4 emissions	= (80 × 0) + (50 × 0)	= 0 kg CO_2-e
N_2O emissions	= (80 × 0) + (50 × 5.4)	= 270 kg CO_2-e
Total CO_2-e emissions	= 308 kg CO_2-e	

Note: Numbers may not add due to rounding.

4.9.5 Agricultural soils

Agricultural soils emit nitrous oxide due to the addition of nitrogen to soils through manure, dung and urine. We provide emission factors for dairy cattle, non-dairy cattle, sheep, deer, swine, goats, horses, alpaca, mules & asses, and poultry.

Organisations should collect data on the number and type of livestock they had as at 30 June during the measurement period.

AGRICULTURAL SOILS: EXAMPLE CALCULATION

An organisation owns 2400 sheep and 210 dairy cows on 30 June during the reporting period. They graze on land owned by the organisation.

CO_2 emissions	= n/a	
CH_4 emissions	= n/a	
N_2O emissions	= (2400 × 36.3) + (210 × 468)	= 185,400 kg CO_2-e
Total CO_2-e emissions	= 185,400 kg CO_2-e	

Note: Numbers may not add due to rounding.

Glossary

Activity data	Data on the magnitude of human activity resulting in emissions or removals taking place during a given period.
Base year	The first year in the reporting series.
Biodiesel	A type of biofuel similar to diesel that is made from natural elements such as plants, vegetables, and reusable materials.
Bioethanol	A type of biofuel similar to ethanol that is made from natural elements such as plants, vegetables, and reusable materials.
Biofuels	Any fuel derived from biomass.
BOD	Biological oxygen demand, the amount of dissolved oxygen needed by micro-organisms to break down biological organic matter in water.
Biologically sequestered carbon	The removal of carbon dioxide from the atmosphere and captured by plants and micro-organisms.
Carbon sink	A natural or artificial process that removes carbon from the atmosphere.
CH_4	Methane.
CO_2	Carbon dioxide.
CO_2-e	Carbon dioxide equivalent.
De minimis	An issue that is insignificant to a GHG inventory, usually <1% of an organisation's total inventory for an individual emission source. Often there is a limit to the number of emission sources that can be excluded as *de minimis.*
Deforestation	The clearing of forest land that is then converted to a non-forest land use.
EECA	Energy Efficiency and Conservation Authority.
Emission factor	A coefficient that quantifies the emissions or removals of a gas per unit activity.
Enteric fermentation	The process by which ruminant animals digest feed and produce methane.
Forest land	Land containing tree species that will reach a height of at least 5 meters, with a canopy cover of at least 30% and be of at least 1 hectare in size.
Fugitive emissions	The emission of gases from pressurised equipment due to leaks or unintended releases of gases, usually from industrial activities.
GHG	Greenhouse gas.
GHG inventory	A quantification of an organisation's greenhouse gas sources, sinks, emissions and removals.
GHG Protocol	The *Greenhouse Gas Protocol Accounting and Reporting Standard* provides guidance for organisations preparing a GHG inventory.
GHG report	A standalone report to communicate an organisations GHG-related information to intended users.
GJ	Gigajoule (unit of measure, one billion joules).
GWP	Global warming potential, a factor describing the radiative forcing impact of one mass-based unit of a given GHG relative to an equivalent unit of carbon dioxide over a given period (typically 100 years).
HFC	Hydrofluorocarbon, an alternative refrigerant gas that minimises damage to the ozone hole.

ISO 14064-1:2018	International Organization for Standardization standard on greenhouse gases - Part 1: Specification with guidance at the organization level for quantification and reporting greenhouse gas emissions and removals.
JAS-ANZ	Joint Accreditation System of Australia and New Zealand.
LPG	Liquefied petroleum gas.
LULUCF	Land use, land-use change and forestry.
Materiality	To be considered as having significance to an organisation.
National inventory	*New Zealand's Greenhouse Gas Inventory 1990–2018.*
NF_3	Nitrogen trifluoride.
N_2O	Nitrous oxide.
NZ ETS	New Zealand Emissions Trading Scheme.
Organisational boundary	The boundary of the organisation as it applies to measurement of GHG emissions. This typically aligns with legal and/or organisational structure; a financial boundary must be drawn within this too.
OVERSEER	A New Zealand software platform that enables farmers and growers to estimate and improve nutrient use on farms.
PFC	Perfluorocarbon. A common type of refrigerant.
pkm	Passenger-kilometre (unit of measure for transport).
Radiative forcing	The difference between solar energy absorbed by the Earth and that radiated back to space. Human activity has impacts which alter radiative forcing.
Refrigerants	A substance or mixture used in a heat pump and refrigeration unit or air conditioner.
Removals	Withdrawal of a GHG from the atmosphere by GHG sinks.
Reporting boundary	The grouping of emission sources included within the organisational boundary, including direct and indirect emission sources. It includes choosing which indirect emission sources to report.
Reticulated gas	A piped gas system to deliver a gas such as LPG or natural gas to a consumer.
Scope	Emission sources are categorised by scope to manage risks and impacts of double counting. There are three scopes in greenhouse gas reporting: Scope 1 (direct emissions), Scope 2 (energy indirect emissions) and Scope 3 (other indirect emissions).
SF_6	Sulphur hexafluoride.
Stationary combustion fuel	Fuel used in an unmoving engine, eg, a power plant or boiler.
tkm	Tonne-kilometre (unit of measure for freight).
Unique emission factor	A value given to an activity based on how emissions intensive it is. Experienced professionals must verify a unique emission factor. See Climate Change (Unique Emissions Factors) Regulations 2009 for further information.
Uplift factor	Applied to take into account the combined 'real-world' effects on fuel consumption (such as non-direct flight paths).
TCFD	Task Force on Climate-related Financial Disclosures.