Methodology and Calculations

Carbon Neutral Client Carbon Calculator Technical Documentation

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Overview

Introduction

Objective

Carbon Neutral (CN) has developed two carbon calculators to its clients free of charge; an online calculator accessed on Carbon Neutral's website, and an offline Microsoft Excel-based calculator. These calculators estimate organisational and event greenhouse gas (GHG) emissions and global warming impact.

The purpose of this document is to outline the methodology, assumptions and references used by CN's Client Carbon Calculators to calculate and estimate GHG emissions in tonnes. An emission factor is a science-based estimated value for determining an amount of a GHG emitted for a given activity. Emission factors have been obtained from recognised third-party sources and have not been developed by CN. We acknowledge the hard work and dedication of the many individuals and organisations that have contributed to these emission factors; these calculators would not be available without them.

Our Client Carbon Calculators cover the most common and material GHG emission generating activities. However, please note an entity or event may be responsible for GHG emissions from activities not captured by these calculators. Our Client Carbon Calculators are designed to be indicative only and are not intended to replace a formal emissions audit.

How do Carbon Neutral's calculators work?

Our carbon calculators are user-friendly instruments that allow organisations and events to input a variety of activity data to estimate their GHG emissions. User information typically includes fuel, electricity and water consumption, business travel, staff commuting, working-from-home energy use, waste production, and freight use. Users can also input financial information for emission estimations of events, business consumables, purchased goods and services, and food consumption.

Our calculators use a comprehensive set of GHG emission resources, using what are called *emissions factors* to convert user inputted information into carbon emission estimates.

Carbon Neutral strives to ensure the reliability and accuracy of calculated results, using emission factors from credible sources and updating them as required.

The level of accuracy and efficacy of these calculators deeply relies on users' information exactitude and level of detail. Information can be edited, when necessary, to allow the user to rectify their inputs and compare with different data sets. The end result is a blended carbon inventory, made up of users' measurements and credible-based greenhouse gas estimations.

Boundaries

CN calculators are a product based on the Greenhouse Gas Protocol - GHGP (WRI, 2021). GHGP establishes comprehensive global standardized frameworks to measure and manage greenhouse gas (GHG) emissions from private and public sector operations, value chains and mitigation actions.

Therefore, CN calculators consider the following categories of footprint, as defined by the protocol.

1. Fleet (L) **or**
2. Fleet (km)
3. Energy (Stationary fuel use)
4. Fugitive emissions
5. Air travel
6. Waste
7. Water
8. Office consumables
9. Staff travel (light vehicles)
10. Staff travel (transport)
11. Freight
12. Events
13. Food

All categories above are accounted for per the GHGP's calculation guidance with the notable exception of Scope 3 categories such as capital goods, downstream products embodied emissions, franchises, and investments.

Primary Calculation Data

The calculator makes use of three data sets, where two of them are recording information of estimation of emission factors based on direct measurements and the last one is recording information on the inputs required for the production of products.

NGA Factors (AUS, GOV, 2021). Estimates are based on the IPCC classification system used to report Australia's greenhouse gas emission inventory to track Australia's progress towards its 2030 Paris target. These estimates are compiled using the global warming potentials from the IPCC 5th Assessment Report.

DBEIS EF (GOV, UK, 2021) These conversion factors allow organisations and individuals to calculate GHG emissions from a range of activities, including energy use, water consumption, waste disposal and recycling, and transport activities. For instance, a conversion factor can be used to calculate the amount of GHG emitted as a result of burning a particular quantity of oil in a heating boiler.

EPiC Database (Crawford, 2020) The scope of the EPiC coefficients includes the processes associated with the production of these materials and products, including raw materials supply, transport, and manufacturing. This scope is also referenced in the GHG Protocol as *cradle-to-gate*.

The EPiC database has been used to determine the carbon intensities of products and services, against one Australian dollar of final demand. Since EPiC Database's most current document is from 2019, Carbon Neutral adjusts for the current dollar value based on the Reserve Bank of Australia's inflation calculator from 2018/19 to 2020/21 (RBA, 2021).

Hybridisation

The data collection process often requires users to compile information that is not readily available. Failing to include the minimum inputs required to obtain a valid emissions estimation can lead to uncertainty values between 50% to 70% (WRI, 2021). Carbon Neutral therefore uses hybridised methods (combining three different sets of emission factors data) to reduce levels of uncertainty from calculators' user inputs also reducing data collection time constraints.

While NGAF and DBEIS enables the use of more specific data (i.e., estimate the footprint of litres of certain fuel being combusted or indirect emission associated with air distance travel), EPiC produces estimates based on cradle-to-gate product research. This combination result on a more comprehensive emissions estimation.

Specific Methodology Justification by category

1. Fleet (L)

The transport sector is third largest contributor to Australia's net greenhouse gas (GHG) emissions, accounting for 17.5 % in the year to March 2021. The Department of Agriculture, Water and the Environment has collected information on these emissions from sources within the energy industry. Factors for estimating emissions from energy use are taken from the Department of the Environment's NGAF August 2021 (AUS, GOV, 2021). CN calculators include Scope 1 and Scope 3 emissions, to ensure that the full impact of fuel use is included.

Liquid Fuel Formula

$$E_{ij} = \frac{Q_i \text{ x } EC_i \text{ x } EF_{ijoxec}}{1{,}000}$$

Where:

- E_{ij} is the emissions of gas type (j), (carbon dioxide, methane, or nitrous oxide) from gaseous fuel type (i) (CO_2-e tonnes).
- Q_i is the quantity of fuel type (i) (kilolitres or gigajoules) combusted for stationary energy purposes.
- EC_i is the energy content factor of fuel type (i) (gigajoules per kilolitre) for stationary energy purposes, according to Table 7 below. If Q_i is measured in gigajoules, then EC_i is 1.
- EF_{ijoxec} is the emission factor for each gas type (j) (which included the effect of an oxidation factor) for fuel type (i) (kilograms CO_2-e per gigajoule).

2. Fleet (km)

There are different ways to estimate fleet emissions. The previous title outlined in this paper describes the standard NGA method for estimation of emissions when liquid fuel is combusted. This section uses the same method and emission factors. This method differs from the previous one as it assists the user to estimate values of fuel consumption (L) when data is not readily available.

Fuel consumption is estimated in litres based on distance travelled and vehicle engine fuel efficiencies. Data on engine fuel efficiency is obtained from Green Vehicle Guide and Motor Vehicle Census, Australia (ABS, 2020; GVG, 2021). Once information on litres of fuel consumption is estimated, 1. Fleet (L) emission factors and formulas are applicable.

3. Energy

Electricity

The electricity sector is the largest contributor to Australia's net GHG emissions, accounting for 33.2 % in the year to March 2021. The Department of the Environment has collected information on these emissions from sources within the energy industry. Factors for estimating emissions from energy use are taken from the Department of the Environment's National Greenhouse Accounts Factors August 2021 (AUS, GOV, 2021). Carbon Neutral includes both Scope 2 and 3 emissions in its estimates, to ensure that the full impact of electricity use is included.

Indirect Electricity Use Formula

$$Y = Q \times \frac{EF}{1{,}000}$$

Where:

- ***Y*** is the scope 2 and/or scope 3 emissions measured in CO_2-e tonnes.
- ***Q*** is the quantity of electricity purchased (kilowatt hours).
- ***EF*** is the scope 2 and/or scope 3 emission factor, for the State, Territory, or electricity grid in which the consumption occurs (kg CO_2-e per kilowatt hour). If the electricity is not sourced from the main electricity grid the emission factor can be either provided by the supplier of the electricity or, if that factor is not available, the emission factor for the Northern Territory may be used.

Gas wood and Liquid fuel (stationary energy)

The stationary energy sector is second largest contributor to Australia's net GHG emissions, accounting for 20.2 % in the year to March 2021. The Department of the Environment has collected information on these emissions from sources within the energy industry. Factors for estimating emissions from energy use are taken from the NGA Factors August 2021 (AUS, GOV, 2021).

Carbon Neutral includes both Scope 1 and Scope 3 emissions to ensure that the full impact of stationary fuel is included. The relationship between gas GJ and gas kWh is also taken from the NGA Factors 2021. It is listed as 1 GJ = 278 kWh or 1 kWh = 3.6 MJ (Energy conversion factors Table 35).

Stationary Fuel Formula

$$E_{ij} = \frac{Q_i \times EC_i \times EF_{ijoxec}}{1{,}000}$$

Where:

- E_{ij} is the emissions of gas type (j), (carbon dioxide, methane, or nitrous oxide) from gaseous fuel type (i) (CO_2-e tonnes).
- Q_i is the quantity of fuel type (i) (cubic metres).
- EC_i is the energy content factor of fuel type (i) (gigajoules per cubic metre according to Table 2). If Q_i is measured in gigajoules, then EC_i is 1.
- EF_{ijoxec} is the emission factor for each gas type (j) (which included the effect of an oxidation factor) for fuel type (i) (kilograms CO_2-e per gigajoule of fuel type (i) according to Table 2 for Scope 1 emissions and Table 43 for Scope 3 emissions).

4. Fugitive Emissions

Fugitive emissions as a sector is considered a major contributor to Australia's net GHG emissions, accounting almost 10% in the year to March 2021. The Department of the Environment has collected information on these emissions from sources within the energy industry. Factors for estimating emissions from energy use are taken from the Department of the Environment's NGAF

August 2021 (AUS, GOV, 2021). CN calculators include Scope 1 and Scope 3 emissions, to ensure that the full impact of fuel use is included.

Fugitive emissions are based on the direct emissions from refrigerant leakage in air conditioners and refrigeration systems. The Global Warming Potential (GWP) is an index used to convert gases to a carbon dioxide equivalent (CO_2-e) by multiplying the quantity of the gas used or leaked by its GWP. Carbon Neutral use a range of sources to derive its GWP for all gases commercially available. The relative GWP for the different gas types are shown in are sourced from the NGAF as well as from DBEIS.

Carbon Neutral includes emissions associated with the use of all seven greenhouse gases required by the UNFCCC/Kyoto Protocol. These are: carbon dioxide, methane, nitrous oxide, hydrofluorocarbons, perfluorocarbons, sulphur hexafluoride and nitrogen trifluoride. In addition to these, emissions arising from optional greenhouse gases, including those GHGs currently regulated by the Montreal Protocol on Substances that Deplete the Ozone Layer can also be included.

Fugitive Emissions Formula

$$\mathrm{E_{jk}} = \mathrm{Stock_{jk}} * \mathrm{L_{jk}} * GWP$$

Where:

- E_{jk} is the emissions of HFC or SF_6, summed over each equipment type (tonnes CO_2-e).
- $Stock_{jk}$ is the stock of HFC or SF_6 contained in equipment, by equipment type (tonnes CO_2-e).
- L_{jk} is the default leakage rate by equipment type.
- ***GWP*** is the global warming potential

5. Air travel

For Air Travel emissions estimation, Carbon Neutral applies a methodology and emission factors based on the DBEIS (GOV, UK, 2021). The Well-To-Tank (WTT) conversion factors for air travel are included to report the upstream Scope 3 emissions associated with extraction, refining and transportation of the raw fuels before they are used to power the transport mode.

Carbon Neutral includes a Radiative Forcing Index (RFI) factor of 1.9 as recommended by DBEIS in the 2021 Government GHG Conversion Factors for Company Reporting. The IPCC has identified that aircraft emissions at altitude have a greater impact on the atmosphere due to other non-CO2 climate change effects from aviation (e.g. NOx, water vapour, contrails) and the RFI factors allows for the estimation of these other impacts.

Carbon Neutral also applies an uplift factor of 8% to account for non-direct routes (i.e. not along the straight line great circle distances between destinations) and delays/circling as suggested in the IPCC's report on Aviation and the Global Atmosphere (Section 8.2.2.3, p373)[1].

Emissions from air travel fuel use can fall in to two categories. Scope 1 emissions are the emissions directly associated with the fuel burn and Scope 3 emissions are the emissions

[1] IPCC – 1999, Aviation and the Global Atmosphere Special Report, Section 8.2.2.3 and UK Government GHG Conversion Factors for Company Reporting 2016

associated with the extraction, refining and transportation of the aviation fuel to the plane before take-off (WTT). Carbon Neutral utilises DBEIS emission factors for both.

6. Solid waste

Factors for estimating GHG emissions from solid waste are taken from the NGA Factors 2021. Emission factors per identifiable waste streams are shown in Table 12. Emissions estimates are most accurate when the weight of waste is used. Table 12 also lists the relevant conversion factors for volume to weight and emissions from various waste streams.

Solid Waste Formula

$$\text{GHG emissions (t } CO_2\text{-e)} = Q_i \times EF_i$$

Where:

- $\boldsymbol{Q_i}$ is the quantity of waste by type in tonnes (i).
- $\boldsymbol{EF_i}$ is the emission factor of waste type (i).

Where the waste is measured in volume and not in weight, the volume to weight conversion factor can be used to estimate the weight in tonnes. As this is an imperfect science, other variables may alter the volume to weight ratio.

7. Water

Estimation of emissions associated with water usage result from the product of the quantity of water used multiplied by the emission factor of the State, or territory where the water was use. Emission factors associated with the use of water and disposal of sewage are obtained from the Australian Bureau of Meteorology Department and the most recent National Performance Report 2019/20: Urban Water Utilities Dataset (BoM, 2020).

Emissions are based on data provided by water service utilities. For the cases where the National Performance Report does not provide total net greenhouse gas emissions per 1000 properties for (i.e., Darwin) the average Australian emission rate per 1,000 properties has been used.

8. Consumables

Office Consumables - Paper

Emissions from office paper use are based on EPA Victoria's Information Bulletin – Greenhouse Gas Emission Factors for Office Copy paper (EPA, Victoria, 2013). Emission estimation result from the product of the weight of type of paper multiplied by its specific emission factor.

Inks and other Chemicals

Emissions from the use of inks and other chemicals are determined by using sector emissions from the Input-Output tables of EPiC Database (Crawford, 2020). Emissions associated with the use of inks, degreasers, waxes, polishes, explosives, and other chemical products are captured by this activity.

Printing & Stationery

Emissions from the use of printing and stationery are determined by using sector emissions from the Input-Output tables of the EPiC Database (Crawford, 2020). Emissions associated with

the use of stationery, envelopes, diaries, printing, and services to printing are captured by this activity.

9. Staff Travel

Staff travel emissions estimation is based on the same assumptions made earlier on this paper for the Fleet (km) section.

10. Staff Travel – Other

Staff travel emissions estimation is based on the same assumptions made earlier on this paper on the Fleet (km) section. Additional emission factors are obtained by analysing 1931: Greenhouse gas inventory and management plan 2019-2020 Report (EPA, Victoria, 2020).

11. Freight

Freight good emissions estimations aim to account for the indirect emissions associated with transporting certain weight of goods for a given distance. The product of those two can be expressed in terms of weight per kilometre (tonne-km) of a good being transported. Freight emissions are then, the product of the tonne-km unit of transported good by the specific transport mode emission factor.

WTT conversion factors for freighting goods are included to report the upstream Scope 3 emissions associated with extraction, refining and transportation of the raw fuels before they are used to power the transport mode.

Emission factors for freight are sourced from the 9208.8 – Survey of Motor Vehicle Use, Australia, 12 months ended 30 June 2020 (ABS, 2020) and from the DBEIS (GOV, UK, 2021) which includes WTT emission factors.

Air Freight

Emissions factors for Air Freight are sourced from DBEIS (Freighting Goods). WTT emission factors are also sourced from DBEIS (WTT – delivery vehs & freight).

Sea Freight

Emissions factors for Sea Freight are sourced from DBEIS (Freighting Goods). WTT emission factors are also sourced from DBEIS (WTT – delivery vehs & freight). Emissions for sea freight are broken down into General Cargo Shipping and Container Shipping. With complexities associated to generalise the right figures for sizing sea freight, Carbon Neutral uses both General cargo and Container Shipping average emission factors.

Rail Freight

Emissions factors for Rail Freight are sourced from DBEIS (Freighting Goods). WTT emission factors are also sourced from DBEIS (WTT – delivery vehs & freight).

Road Freight

Road freight can be broken down into the following vehicle classes if this information is available to input into the calculator.

a. Where only distance is available or to calculate emissions from a particular distance of freighting goods, data of light commercial, rigid truck and articulated truck average figures are adapted to be used from the Australian Motor Survey of Vehicles Report (ABS,

2020). Once data on fuel usage is estimated, emission factor from section 1 (Fleet (L)) are applicable for road freight sourced from NGA Factors.

b. When distance and weight are available (tonne-km), emissions will then be estimated as the product of tonne-km of road freight goods multiplied by the specific emission factor of the type of road freight used. Emission factors for road freight are sourced from DBEIS (Freighting Goods). WTT emission factors are also sourced from DBEIS (WTT – delivery vehs & freight).

12. Events

Greenhouse gas emissions from events arise from activities such as energy used during hosting, accommodation and event preparation, fuel use associated with the transport of delegates, organisers and freight, the generation of waste and the use of materials.

Where only spend data is available, Carbon Neutral uses environmental flow coefficients from EPiC (Crawford, 2020) to account for greenhouse gases embodied within the manufacturing process of products and services.

The resulting estimation for GHG emissions are the product of the total cost of product or service multiplied by its correspondent emission factor.

Food and Drink

Emissions from meals, food and drink are based on the EPiC Database (Crawford, 2020). Meat and Meat product Manufacturing, Sugar and Confectionery Manufacturing, Processed Seafood Manufacturing, Dairy Product Manufacturing, Fruit and Vegetable Product Manufacturing, Grain Mill and Cereal Product Manufacturing, Bakery Product Manufacturing, Soft Drinks, Cordials and Syrup Manufacturing, Beer Manufacturing and Wine Manufacturing are Input/Output sectors included within these calculations.

Venue Hire, Accommodation, Giveaways

Emissions from Venue Hire, Giveaways and Accommodation are determined using EPiC Database. Accommodation, Rental and Hiring Services (except Real Estate) and Paper Stationery and Other Converted Paper Product Manufacturing are Input/output sectors included within these calculations.

Travel

The emissions from travel are made using the following assumptions.

- Local travel (car) emissions are based on vehicle efficiency of 11.1l/100km using gasoline (unleaded petrol). Trip length of 40km.
- Local travel (train) BITRE 2007 emissions intensity for average urban commute used. Trip length of 40km.
- Local travel (bus) BITRE 2007 emissions intensity for average urban commute used. Trip length of 40km.
- Interstate travel based on return trip from Brisbane to Melbourne flying economy emissions.
- Travel from Asia based on return flight from Kuala Lumpur to Sydney flying economy emissions
- Travel from Europe / America based on return flight from London to Melbourne (stopover Doha) flying economy

13. Food

Where only spend data is available, Carbon Neutral uses environmental flow coefficients from EPiC Database (Crawford, 2020) to account for greenhouse gases embodied within the manufacturing process of products and services.

Meat and Meat product Manufacturing, Sugar and Confectionery Manufacturing, Processed Seafood Manufacturing, Dairy Product Manufacturing, Fruit and Vegetable Product Manufacturing, Grain Mill and Cereal Product Manufacturing, Bakery Product Manufacturing, Soft Drinks, Cordials and Syrup Manufacturing, Beer Manufacturing and Wine Manufacturing are Input/Output sectors included within these calculations.

Cross-tool Methodology

Inflation

Out of the three sets of data, The EPiC database has been used to determine the carbon intensities of products and services, against one Australian dollar of final demand. Since EPiC Database's most current document is 2019, Carbon Neutral relies on adjustments for the current dollar value based on the Reserve Bank of Australia's inflation calculator from 2018/19 to 2020/21 (RBA, 2021). NGAF and DBEIS do not use expenditure-based figures and therefore, calculations on currency conversion are not necessary.

Glossary:

- CN – Carbon Neutral
- GHGP - Greenhouse Gas Protocol
- BoM – Bureau of Meteorology
- GHG – Greenhouse Gas
- NGA Factors – National Greenhouse Account Factors
- DBEIS – Department of Business, Energy & Industrial Strategy, UK
- EPIC – Environmental Performance in Construction
- WRI – World Resources Institute
- WTT – Well-To-Tank
- ABS – Australian Bureau of Statistics
- GVG – Green Vehicle Guide
- GWP – Global Warming Potential
- RFI – Radiative Forcing Index
- IPCC – Intergovernmental Panel on Climate Change

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