



Climate Neutral Group's methodology on carbon footprinting

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This document describes the approach of Climate Neutral Group (CNG) on choosing emission factors and how we work with them.

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1 What is an emission factor?

An emission factor is a coefficient which allows to convert *activity data* from an emission source into greenhouse gas (GHG) emissions. The emission factor is expressed as kg CO₂eq per unit of activity data.

To calculate the carbon footprint, the activity data needs to be multiplied with an emission factor for the corresponding emission source.

Example

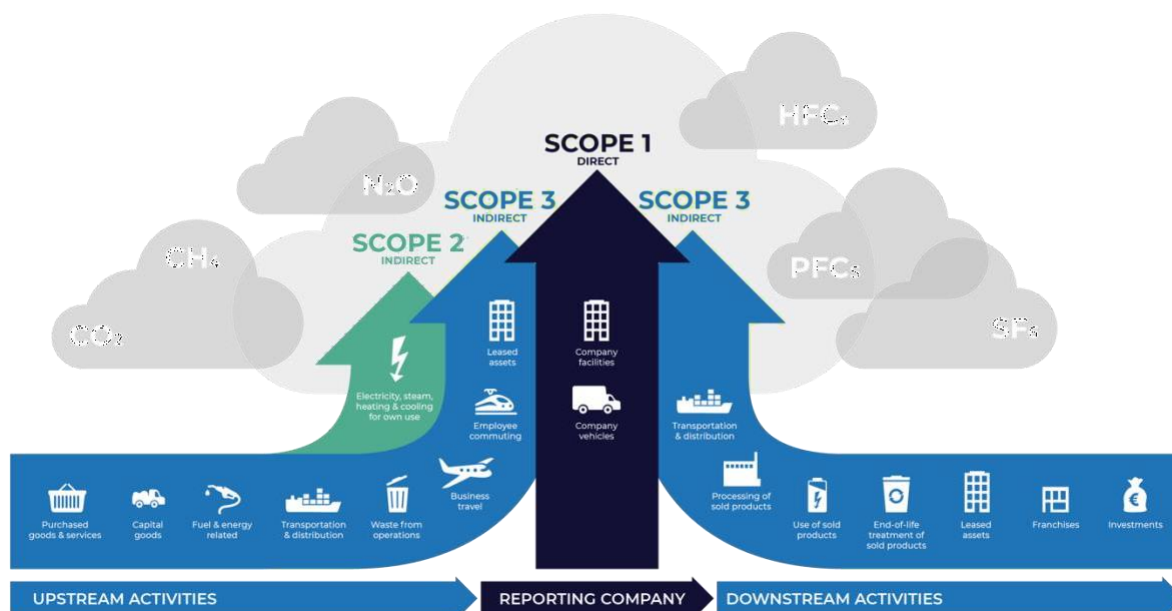
The emission sources to produce a product are Dutch grey electricity and natural gas. The activity data is 1 kWh of electricity and 2 m³ of gas.

The emission factor for Dutch grey electricity is 0,523 kg CO₂eq per kWh.

The emission factor for Dutch natural gas is 2,085 kg CO₂eq per m³.

The carbon footprint to produce this product is 1 kWh multiplied by 0,523 kg CO₂eq per kWh plus 2 m³ multiplied by 2,085 kg CO₂eq per m³.

To ensure high-quality carbon footprints, CNG follows a consistent and transparent approach in collecting activity data and choosing the source of emission factors.

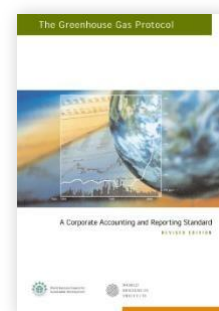


2 Emission factor sources

Climate Neutral Group works in line with our [Climate Neutral Certified Standard](#). The Annex 3a of the Standard - the Database with Permitted Emission Factor Sources & Secondary Data Sources - contains a list of reliable sources for emission factors. This list comprises international and/or commercial databases such as [Ecoinvent](#), [Agri-Footprint](#) or the [World Food LCA Database \(WFLDB\)](#) where CNG has access to. On the other hand, there are public national databases such as [CO₂emissiefactoren.nl](#) from the Dutch Government or [BEIS](#) from the UK government (formerly Defra).

In case a source is not listed, it can be added. However, it should be reviewed on transparency, completeness, and applicability by CNG. The [databases from Greenhouse Gas Protocol](#) could be considered when collecting data for inventories.

Be aware that the number of sources should be limited as much as possible for one footprint calculation to safeguard consistency.



3 Global Warming Potential (GWP)

The emission factors Climate Neutral Group uses do not only account for CO₂ emissions but also for other GHG emissions such as Methane (CH₄) and Nitrous oxide (N₂O). The Kyoto agreement identified four types of GHGs: Carbon Dioxide (CO₂), Methane (CH₄), Nitrous oxide (N₂O) and Fluorinated gases (HFCs, PFCs, NF₃, SF₆).

Each of the GHGs have a different impact on global warming, meaning how much they warm up the earth and how long they remain in the atmosphere. The so-called Global Warming Potential (GWP) is calculated as the warming potential over a given period of time (100 years is standard practice) of 1kg of a gas relative to 1kg of CO₂, expressed as CO₂ equivalent (CO₂e).

The GWP of each GHG is determined by the [Intergovernmental Panel on Climate Change](#) (IPCC), which prepares comprehensive Assessment Reports about knowledge on climate change, its causes, potential impacts and response options. Between 1990 and 2023, the IPCC published six assessment reports which have been reviewed and updated. The main emission factors sources used by CNG use the following IPCC assessment reports: [Fourth Assessment Report \(AR4\)](#) (2007), [Fifth Assessment Report \(AR5\)](#) (2014) and [Sixth Assessment Report \(AR6\)](#) (2021).

Below you can find the different GWP values determined for CO₂, CH₄ and N₂O across the Assessment Reports AR4, AR5 and AR6.

Substance	GWP (AR4)	GWP (AR5)	GWP (AR6)
Carbon dioxide (CO ₂)	1 CO ₂ e	1 CO ₂ e	1 CO ₂ e
Methane (CH ₄)	25 CO ₂ e	28 CO ₂ e	27,9 CO ₂ e
Nitrous oxide (N ₂ O)	298 CO ₂ e	265 CO ₂ e	273 CO ₂ e

It is a recommendation from the GHG protocol to use the latest GWP published values. However, there is a difference in the Assessment Reports used across emission factor sources. DEFRA uses AR5 since 2021 and it started using AR6 from 2023 onwards. CO₂-emissiefactoren uses both AR4 and AR5, being AR4 mostly used for refrigerant emission factors. Simapro and Ecoinvent use the latest assessment report, IPCC 2021 – AR6.

Database	GWP (AR4)	GWP (AR5)	GWP (AR6)
DEFRA		✓ Since 2021	✓ From 2023
CO ₂ -emissiefactoren	✓ Refrigerant EF	✓ General EF	
Simapro			✓
Ecoinvent			✓

4 Choosing the right emission factor

Our consultants at Climate Neutral Group are trained to pay careful attention to all relevant aspects of choosing the right emission factors. For each footprint calculation we analyse credible data sources and choose the most applicable emission factor for the year in which the emission occurred. International standards, such as the Greenhouse Gas Protocol or ISO 14064-1 and 14067, describe requirements for accurate carbon footprint calculations. However, they do not specify emission factors as they are regularly updated. We closely monitor all current developments and research regarding emission factors and base our choice on the following criteria (derived from the product life cycle accounting and reporting standard):

- **Technological representativeness:** The degree to which the data reflects the actual technology(ies) used.
- **Temporal representation:** The degree to which the data reflects the actual time (e.g., year) or age of the activity.
- **Geographical representation:** The degree to which the data reflects the actual geographic location of the activity (e.g., country or site).
- **Completeness:** The degree to which the data are statistically representative of the relevant activity. Completeness includes the percentage of locations for which data is available and used out of the total number that relate to a specific activity. Completeness also addresses seasonal and other normal fluctuations in data.
- **Reliability:** The degree to which the sources, data collection methods and verification procedures used to obtain the data are dependable. a carbon footprint for 2018, we use data (as close as possible) derived from the same year.

Representativeness to the process in terms of:

Score	Technology	Time	Geography	Completeness	Reliability
Very good	Data generated using the same technology	Data with less than 3 years of difference	Data from the same area	Data from all relevant process sites over an adequate period to even out normal fluctuations	Verified data based on measurements
Good	Data generated using a similar but different technology	Data with less than 6 years of difference	Data from a similar area	Data from more than 50 percent of sites for an adequate period to even out normal fluctuations	Verified data partly based on assumptions or non-verified data based on measurements
Fair	Data generated using a different technology	Data with less than 10 years of difference	Data from a different area	Data from less than 50 percent of sites for an adequate period to even out normal fluctuations or from more than 50 percent of sites but for a shorter time	Non-verified data partly based on assumptions or a qualified estimate (e.g., by sector expert)
Poor	Data where technology is unknown	Data with more than 10 years of difference or the age of the data are unknown	Data from an area that is unknown	Data from less than 50 percent of sites for shorter period or representativeness is unknown	Non-qualified estimate

Source: Greenhouse Gas protocol - Product Life Cycle Accounting and Reporting Standard, table 8.2.

5 Types of emission factors

5.1 Emission factors for green electricity

Emission factors for green electricity are in any case lower than the emission factors for grey electricity or the average emission factor for a country. This applies for both self-generated electricity (through e.g., solar panels) as well as for most green energy certificates, so-called Guarantees of Origin (GoOs). However, the emission factors are not consequentially zero. Electricity from biomass can originate from many types and the emission factor is highly dependent on the biomass used and its origin. Emission factors for biomass (including GoOs) are therefore also not equal to zero but based on the specific type of biomass used.

In addition, Climate Neutral Group does not recognise GoOs originating from hydropower in Scandinavia (incl. Iceland). Hydropower in these countries exists for a long time already and is therefore of no benefit to the European energy transition.

Below, you can find an overview of our approach to emission factors from GoOs:

Guarantees of Origin	Emission factor
Hydropower from Iceland, Norway, Sweden, Finland, Denmark	Emission factor for grey electricity from the country in which the electricity is used
Wind and solar from any European country	Emission factor equals zero
Biomass from any European country	Emission factor for the specific type of biomass used

5.2 Emission factors for passenger flights

Depending on the available data, CNG uses three different methods to calculate emissions for passenger flights. All calculation methods include a standard request for information. The results are expressed in CO₂ equivalents.

1) CNG's Flight Carbon Calculator

Since February 2021, Climate Neutral Group has its own flight carbon calculator available (FCC). The calculator uses special databases that can provide accurate, flight-specific calculations. This method is based on calculating the fuel consumption for a specific flight segment and converting it into CO₂ emissions using a standard conversion factor (3.16 tons CO₂/ton aviation fuel according to [ICAO](#), the International Civil Aviation Organisation from the UN). FCC calculates the CO₂ emissions of a flight with increasing accuracy, depending on available input data and on aircraft type and class level. The following input data is essential: [IATA airport codes](#), flight class, airline codes and aircraft type (equipment code). The calculation is based, among other things, on the following input fields: flight duration, aircraft type and age, airline and seat configuration, and passenger load factor.

Scientists are yet to reach a consensus on the global warming effects of radiative forcing (flying at high altitudes). This uncertainty has led to a range of radiative forcing indexes (RFIs)¹ being used from 1.9 to 5. The UK's BEIS standard had opted for the lowest within this range. Following new insights suggesting that flying at higher altitudes may also have cooling effects under certain weather conditions, BEIS has recently lowered its RFI to 1.7. Climate Neutral Group will be following this adjustment from January 2024. However, for clients that wish to have an alternative RFI, we can accommodate other RFIs for their emissions calculations.

¹ The Radiative Forcing Index (RFI) is the ratio of total radiative forcing to that from CO₂ emissions alone. It is used as a measure of the importance of aircraft-induced climate change. ([Source: IPCC archive](#))

2) CNG's distance-based flight calculator

In case not all necessary data for the FCC is known, CNG uses a flight calculator with a distance-based method. It calculates the flight emissions based on the distance flown, [UK-BEIS emission factors](#), the RFI, and flight class (if known). The distance flown is corrected for 'detour flights' to land at the right airport. This detour factor is maximised, according to ICAO. As in the FCC, an RFI is included as a standard, which can be adjusted if necessary. The Well to Tank (WtT) and Tank to Wheel (TtW) factors are included in the relevant parameters of the calculation.

Due to the COVID-19 pandemic in 2020 a reduced load factor has led to an increase in emissions per passenger. This is reflected in an increase of the emission factors from UK_BEIS of up to 35% for 2023. The emission factors are calculated retroactively based on the information of previous years. This is why the effect is visible only in later years than the actual pandemic. We can assume that this is a short-term effect.

5.3 Emission factors for 'green gas'

The term 'green gas' can be interpreted in different ways. CNG considers gas as 'green' only if it comes from renewable sources, also called biogas. This is released, for example, during the fermentation of organic waste, maize, or manure. In this case we also use a lower emission factor. However, green gas for heating is still very limited.

As a company, you can choose to compensate for your gas consumption, also called offsetting. Often, this is referred to as 'green' but factually, it concerns CO₂ credits/offsets from projects not related to green gas, meaning that this gas has not necessarily been generated from renewable sources. CNG therefore does not calculate with a lower emission factor in this case but with the one for natural gas. The offset credits count only for the compensation of emissions.

5.4 Emission factors from primary sources

It is encouraged to use primary data if available. For example, in case your supplier has calculated a carbon footprint for a product that you buy, it is recommended to use this information instead of emission factors from secondary databases. If this is an Environmental Product Declaration (EPD), the footprint has been reviewed and thus, is credible. In any other case, please keep in mind to review the footprint on the GHG footprinting principles described below.

6 Updating emission factors

CNG uses the most recent emission factors. Updates occur at the beginning of each year and will remain the same during that entire year (apart from exceptions due to insights with significant impact). This rule mostly applies to the emission factors derived from national databases, such as [CO₂emissiefactoren.nl](#) or [BEIS](#). Emission factors from international databases, such as [Ecoinvent](#), may not change every year and therefore, should be reviewed at least every 3 years.

Annual updates based on [CO₂emissiefactoren.nl](#) will also be translated to our CO₂ Management Systems (Route Zero and SmartTrackers).

7 GHG footprinting principles

When building a carbon footprint, we take the following aspects into account, based on the GHG Protocol principles:

- Accuracy: are uncertainties reduced as far as possible?
- Relevance: do the emissions included represent the GHG of the organisation or product?
- Consistency: are methods, boundaries and approaches used consistent so that they allow comparison of emissions over assets and time?
- Completeness: are all emission sources and activities accounted for in the footprint?

- Transparency: are the data sources, assumptions, and sub-calculations transparent?

We rely on the following sources:

- [GHG Accounting and Reporting Principles](#) of the World Resources Institute
- [GHG protocol Product Life Cycle Accounting and Reporting Standard](#)

8 List of activity data

Annex 1: List of Mandatory and Optional GHG Emission Sources on page 27 of the [Climate Neutral Certification Standard](#) provides a list of activity data (or usage data) that should in any case be considered when calculating the footprint of an organisation, product or service. This list is based on the GHG Protocol.