



TECHNICAL WHITEPAPER · VERSION 1.0 · 28 SEPTEMBER 2026

Carbon footprint methodology

How the Coffset calculators turn everyday activities into kilograms of CO₂e: the formula, the emission factors and their sources, the boundaries, and the uncertainty behind every result.

Version

1.0, first versioned release

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Owner

Coffset OÜ, Tallinn, Estonia

Next review

Within 12 months, or on new factor releases



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Summary. Coffset estimates emissions as *activity × emission factor*, using published factors from the IPCC, the UK government (DEFRA), the IEA, national grid operators, the US EPA, the FAO and the Carbon Trust. Results are expressed in CO₂e using IPCC AR6 100-year global warming potentials and shown with an uncertainty band (about ±15% for activity-based estimates, ±30% for spend-based ones). The calculators are screening tools, not audited greenhouse-gas inventories.

Document control

This whitepaper is versioned. Every change to the method or to the factors produces a new version, recorded below.

Document	Coffset carbon footprint methodology, technical whitepaper
Version	1.0
Publication date	28 September 2026
Publisher	Coffset OÜ, Lõõtsa 5, 11415 Tallinn, Estonia (registry code 17306246)
Methodology review	Agustin, Engineer, PMP, PfMP (last web review: March 2026)
Applies to	Lifestyle, trip, event and business calculators on coffset.org, in all languages
Web versions	coffset.org/methodology and coffset.org/sources
Contact	hello@coffset.org

Versioning rules

- **Minor version** (1.0 → 1.1): new factor releases, added regions or categories, corrections that don't change the method.
- **Major version** (1.x → 2.0): changes to the calculation method, the boundaries or the treatment of greenhouse gases.
- Every version keeps the previous one available on request, so past results can be traced to the factors in force at the time.

Changelog

VERSION	DATE	CHANGES
1.0	28 Sep 2026	First versioned release. Consolidates the methodology page (reviewed March 2026) and the data-sources page into one document; adds document control, units for each published factor table, definitions of the personal and business boundaries, and the improvement plan in section 10.
Pre-1.0	2025 – Mar 2026	Methodology published as web pages without version numbers.

Purpose and scope

The calculators give individuals, event organisers and small businesses a fast, transparent first estimate of their emissions, so they can see where to reduce and, if they choose, how much to compensate.

What is estimated

CALCULATOR	COVERS	RESULT
Lifestyle	Home energy, transport, food, shopping and waste	Monthly footprint per household, with per-person share
Trip or holiday	Flights, road, rail, ferries and cruises, accommodation	Footprint of the trip
Event	Attendee travel, venue energy, catering	Footprint of the event
Business (beta)	Scope 1, Scope 2 and selected Scope 3 categories	Monthly company footprint

Standards and frameworks referenced

- **GHG Protocol** Corporate Standard and Scope 2 Guidance: scope definitions and the location-based method for electricity.
- **IPCC Sixth Assessment Report (AR6)**: global warming potentials.
- **UK Government GHG Conversion Factors (DEFRA)**: transport, fuels and several activity factors.
- **ISO 14064-1** (organisations) and **ISO 14067** (products) as reference frameworks. Offset results are not verified to either standard.

Who this document is for

Customers who want to understand their result, business buyers doing due diligence, partners, auditors and researchers. It describes the method as implemented on offset.org on the publication date.

Calculation framework

Every result is the sum of individual activities, each multiplied by the most specific emission factor available for that activity and location.

$$E = \sum (A_i \times EF_i)$$

where **E** is the footprint in kg CO₂e, **A_i** is the quantity of activity *i* (kWh, passenger-km, nights, kg, items or spend), and **EF_i** is the emission factor for that activity, in kg CO₂e per unit.

Four steps

STEP	WHAT HAPPENS
1. Input capture	The user answers in a conversation with the AI assistant or in a form without AI. The assistant extracts activity type, quantity, distance, duration and location, and asks follow-up questions when an answer is ambiguous. In form mode, answers stay in the browser until the user saves them.
2. Factor selection	The factor is chosen from the factor database by activity and, where available, by country or region (for example, the national electricity grid).
3. Calculation	Each activity quantity is multiplied by its factor. Units are harmonised before multiplication.
4. Aggregation and reporting	Results are summed and grouped by category (and by scope for businesses), and shown with an uncertainty band and comparisons with averages.

Worked examples

250 kWh × 0.420 kg CO₂e/kWh = 105 kg CO₂e

A month of household electricity in Germany (grid factor, Appendix A).

2 kg × 27.0 kg CO₂e/kg = 54 kg CO₂e

Two kilograms of beef (FAO lifecycle factor, Appendix A).

3 nights × 25 kg CO₂e/night = 75 kg CO₂e

Three nights in a mid-range hotel (Carbon Trust factor, Appendix A).

The role of AI

The AI assistant (a Google Gemini model, reached through Vercel AI Gateway) interprets natural-language answers and asks clarifying questions. It does not invent emission factors: every number in a result comes from the factor database and the arithmetic above. Users can review the extracted activities before saving, and the form mode offers the same calculation without AI.

Greenhouse gases and GWP

All results are expressed in carbon dioxide equivalent (CO₂e), so that different gases can be added up and compared.

CO₂e converts each greenhouse gas into the amount of CO₂ that would cause the same warming over 100 years, using the global warming potentials (GWP₁₀₀) of the IPCC Sixth Assessment Report:

GAS	GWP ₁₀₀ (AR6)
Carbon dioxide (CO ₂)	1
Methane (CH ₄)	27.9
Nitrous oxide (N ₂ O)	273

Most published factors are already expressed in CO₂e. Where a source reports gases separately, they are converted with the values above.

Activities and emission factors

Factors come from public, citable sources. The most specific factor available is always preferred: national over regional, regional over global, activity-based over spend-based.

CATEGORY	MAIN SOURCES	UNIT
Electricity	National grid operators and statistics offices, IEA, Eurostat, US EPA eGRID (27 regions in Appendix A)	kg CO ₂ e per kWh
Heating fuels	DEFRA conversion factors; IEA for electric heating	kg CO ₂ e per kWh
Road, rail, bus, ferry	DEFRA 2024 conversion factors, by fuel type and vehicle size	kg CO ₂ e per km or passenger-km
Flights	DEFRA 2024, by haul and cabin class, including radiative forcing (section 6)	kg CO ₂ e per passenger-km
Accommodation	Carbon Trust hotel and accommodation footprinting	kg CO ₂ e per night
Food and diet	FAO lifecycle database; diet profiles based on an IPCC AR6 meta-analysis	kg CO ₂ e per kg of food
Goods	US EPA Supply Chain factors and DEFRA	kg CO ₂ e per item or per unit of spend
Waste and water	US EPA, DEFRA, Water Footprint Network	kg CO ₂ e per kg of waste or volume of water

Selection rules

- **Location first.** Electricity and heating use the factor of the user's country, and state or grid region where available (for example, California, Texas and New York in the US).
- **Activity over spend.** Physical quantities (kWh, km, kg) are preferred. Spend-based factors are used only when no physical quantity is available, and carry a wider uncertainty band.
- **One factor per activity.** Factors are never stacked: an uplift already included in a factor is not applied again.
- **Published values.** The factors in force are published at coffset.org/sources; Appendix A reproduces the tables with their units.

Aviation

Flying warms the climate through more than the CO₂ from jet fuel. Coffset includes those effects, because leaving them out understates aviation by about half.

Distance and allocation

- **Distance.** Great-circle distance between the airports of each leg, including return legs and connections.
- **Haul.** Short-haul and long-haul factors differ, because take-off and landing weigh more on short flights.
- **Cabin class.** Premium seats take more space on the aircraft, so they are allocated a larger share of the flight's emissions.
- **Passengers.** Results are per passenger and multiplied by the number of travellers.

Non-CO₂ effects

Contrails, nitrogen oxides and induced cirrus clouds add to the warming effect of aviation. Coffset uses DEFRA's radiative-forcing uplift (about 1.9×), which is already built into the per-kilometre factors rather than applied on top. The science of non-CO₂ effects is still developing, and methods differ between calculators; results from other tools that report only CO₂ from fuel will be roughly half as high.

Note for v1.1. The aviation table currently shown on coffset.org/sources (ICAO-based values with a separate multiplier) does not yet mirror the DEFRA factors applied by the calculator. Version 1.1 will publish the exact per-kilometre factors in use and retire the separate table (section 10).

Boundaries and attribution

What is inside each footprint, and how shared emissions are divided.

Personal footprints

Direct energy use at home and in transport, plus estimated lifecycle emissions of diet, goods and waste. Home energy is a whole-dwelling figure and is never duplicated per occupant; diet, shopping and waste scale with the number of people. When household size is known, the per-person share is shown, because published national averages (for example, the EU average of about 6.3 t per person per year used in comparisons) are per capita.

Business footprints

SCOPE	INCLUDED
Scope 1	Fuel burned on site and in owned or controlled vehicles; relevant process and refrigerant emissions where reported.
Scope 2	Purchased electricity, heat and cooling, location-based (grid average of the country or region).
Scope 3	Category 1 (purchased goods and services), 4 (upstream transport), 6 (business travel) and 7 (employee commuting). Other categories are outside the boundary.

Under the GHG Protocol Scope 2 Guidance, a company that buys contractual renewable electricity (guarantees of origin, RECs or a PPA) should report a market-based figure *alongside* the location-based one, not instead of it. The Coffset calculator reports the location-based figure only.

Uncertainty and data quality

Every result is the centre of a range. Showing a single number to the kilogram would suggest a precision that screening estimates cannot deliver.

ESTIMATE TYPE	INDICATIVE BAND
Activity-based (kWh, km, kg, nights)	±15%
Spend-based (supply-chain estimates)	±30%

The narrower band for activity data reflects the use of country-level grid factors, real great-circle flight distances and the quantities entered by the user rather than global averages. The band is displayed with each result.

Main sources of uncertainty

- **Input quality:** estimated rather than measured quantities (for example, "about 10,000 km a year").
- **Averages:** a national grid or vehicle-class factor may differ from the user's actual supplier or car.
- **Factor age:** factors are updated periodically and can lag behind real changes, such as a fast-decarbonising grid.
- **Interpretation:** the AI may misread an ambiguous answer; users can review the extracted activities before saving.

Data quality principles

- Public, citable sources only; each factor records its source and year.
- Annual review against new DEFRA, IEA and EPA releases.
- Corrections are logged in the changelog with the version in which they apply.

Limitations and appropriate use

Coffset results are screening estimates for awareness, reduction planning and voluntary compensation.

Appropriate uses

- Understanding where emissions come from
- Prioritising reductions
- Sizing a voluntary purchase of carbon credits
- A first, documented estimate for a small business

Not appropriate for

- Regulatory disclosures (CSRD/ESRS) or audited inventories
- ISO 14064 or ISO 14067 verification
- Product-level environmental claims
- Claims of carbon or climate neutrality

Relationship to carbon credits

A calculation can be used to decide how many kilograms of CO₂e to compensate. Buying credits funds certified climate projects; it does not reduce the footprint itself and does not make a person, product or company carbon neutral. Coffset recommends reducing first and treating credits as a complement. The credit portfolio is described in Coffset's portfolio and credit-quality policy.

Planned improvements

The following improvements are planned for version 1.1 (target: Q4 2026). Each will be recorded in the changelog when released.

#	IMPROVEMENT	WHY
1	Publish the per-kilometre aviation factors used by the calculator (DEFRA, with radiative forcing) and retire the separate ICAO-based table and multiplier on /sources.	One aviation method, stated once.
2	Move all factors to the latest annual DEFRA and IEA releases, and show the release year per factor.	Factor currency.
3	Show the unit of every factor on /sources, including diet profiles, water, waste and events.	Unambiguous reuse of the tables.
4	Generate the example tables and presets on the calculator pages from the same factor module used for calculations.	Examples always match the factors.
5	Document how the $\pm 15\%$ and $\pm 30\%$ bands are derived.	Reproducible uncertainty.
6	Offer a market-based Scope 2 figure for businesses with contractual renewable electricity, shown alongside the location-based figure.	GHG Protocol Scope 2 Guidance.

Appendix A: Emission factor tables

Factors as applied by the calculators and published on coffset.org/sources on 28 September 2026. Values in kg CO₂e per unit shown.

A.1 Electricity (location-based grid factors)

REGION	KG CO ₂ E PER KWH	SOURCE	REGION	KG CO ₂ E PER KWH	SOURCE
Global average	0.475	IEA 2023	US – New York	0.295	NYISO 2023
EU average	0.351	Eurostat 2023	Canada	0.128	Statistics Canada 2023
Germany	0.420	German Federal Network Agency 2023	Mexico	0.510	IEA 2023
France	0.059	RTE France 2023	Argentina	0.320	CAMMESA 2023
United Kingdom	0.257	UK National Grid 2023	Brazil	0.085	ONS Brazil 2023
Italy	0.429	Terna 2023	Colombia	0.250	ISA Colombia 2023
Spain	0.274	Red Eléctrica 2023	Chile	0.310	CDEC-SING 2023
Sweden	0.033	Swedish Energy Agency 2023	Australia	0.680	AEMO 2023
Norway	0.013	Statnett 2023	New Zealand	0.230	Transpower NZ 2023
Poland	0.780	PSE 2023	Japan	0.670	Japan Energy Conservation Center 2023
Czech Republic	0.527	ČEPS 2023	China	0.570	China Electricity Council 2023
United States (national)	0.386	US EPA eGRID 2023	India	0.730	Central Electricity Authority 2023
US – California	0.165	CAISO 2023	Singapore	0.520	Energy Market Authority 2023
US – Texas	0.458	ERCOT 2023			

A.2 Heating

FUEL OR SYSTEM	KG CO ₂ E/KWH
Natural gas DEFRA 2023	0.185
Heating oil DEFRA 2023	0.310
Coal DEFRA 2023	0.420
Wood (unsustainably sourced) DEFRA 2023	0.340
Wood pellets (sustainable) DEFRA 2023	0.020
Heat pump DEFRA 2023	0.160
Electric heating (global average grid) IEA 2023	0.475

A.4 Food (selection)

FOOD	KG CO ₂ E/KG
Lamb	39.0
Beef	27.0
Pork	12.1
Salmon	12.0
Turkey	10.2
Cod	8.5
Tuna	8.2
Chicken	6.9
Cheese	6.6
Milk	1.9

Source: FAO lifecycle database 2023. The full list covers 21 food types.

A.3 Accommodation

TYPE	KG CO ₂ E/NIGHT
Luxury hotel	50
Upscale hotel	35
Mid-range hotel	25
Budget hotel	15
Resort	60
Holiday home	22
Rented apartment	18
Rented shared room	12
Hostel	8
Camping	2

Source: Carbon Trust 2023.

A.5 Goods (selection)

ITEM	KG CO ₂ E/ITEM
New clothing item	7
Second-hand clothing item	0.5
Smartphone	100
Tablet	120
Laptop	300
Wooden furniture item	25
Plastic furniture item	45
Book	1.2

Sources: US EPA Supply Chain factors 2023; DEFRA 2023 for second-hand clothing.

Appendix B: References

- GHG Protocol, Corporate Accounting and Reporting Standard; Scope 2 Guidance; Corporate Value Chain (Scope 3) Standard. ghgprotocol.org
- IPCC, Sixth Assessment Report, Working Group I, Chapter 7 (global warming potentials). ipcc.ch/report/ar6/wg1
- UK Government, Greenhouse gas reporting: conversion factors (DEFRA/DESNZ), 2023 and 2024 releases. gov.uk/government/collections/government-conversion-factors-for-company-reporting
- US EPA, GHG Emission Factors Hub; eGRID; Supply Chain GHG Emission Factors. epa.gov/climateleadership/ghg-emission-factors-hub
- International Energy Agency, emission factors and energy statistics. iea.org/data-and-statistics
- Eurostat, energy statistics. ec.europa.eu/eurostat
- FAO, lifecycle assessment data for food and agriculture. fao.org
- Carbon Trust, footprinting guidance for accommodation and events. carbontrust.com
- National grid operators and energy agencies listed in Appendix A.1.
- ISO 14064-1:2018, organisational GHG inventories; ISO 14067:2018, carbon footprint of products.
- Our World in Data, CO₂ and greenhouse gas emissions. ourworldindata.org/co2-and-greenhouse-gas-emissions



Questions or corrections?

Write to hello@coffset.org. Accepted corrections are recorded in the changelog of the next version.