

Calculations and Emission Factors

The CarbonNeutral Company works for organisations and individuals who want to reduce their carbon footprint. Our core services are carbon consulting and carbon offsetting – both designed to help reduce CO₂ emissions, and deliver commercial, personal and environmental benefit.

We care about the integrity of the way we operate, and subject what we do to third party review. That includes an annual audit of our carbon accounts by PwC and an Advisory Forum as part of our robust quality assurance programme. See our website for details:

<http://www.carbonneutral.com/about-us/quality-assurance/>

We have developed our carbon calculators using information from a variety of trusted sources, which will be specified in this document.

Also, detailed: how the calculator caters for a global audience; emission factors; units of measurement; categories and labels. All results of calculations are presented in metric tonnes, as per the standard for Carbon Market.

If you have any queries regarding the calculations which are not answered below please email us at paypal@carbonneutral.com.

General Note:

- Except where stated, factors are provided in CO₂e (carbon dioxide equivalent), and include CO₂, CH₄ and N₂O, weighted according to their global warming potentials (GWP).
- The GWP of CH₄ is 21 and the GWP of N₂O is 310 (in accordance with DEFRA 2012).
- References to “DEFRA 2012” relate to “Greenhouse gas conversion factors for company reporting – 2012 guidelines, 30th May 2012”, which can be found here: <http://www.defra.gov.uk/publications/2012/05/30/pb13773-2012-ghg-conversion/>

Calculating emissions from Flights

There are two methods for calculating the emissions from flight activity:

1. Choosing airport pairs
- or*
2. Selecting the type of flight.

Method 1 - Choosing Airports

The first method uses the Airport locations and allows the emissions to be based upon the actual distance flown. The airport choices include most of the main international and popular airports. However, it is not a full listing.

The following factors are taken into account:

1. The total distance - This is calculated using the 2 specified airport locations (based on the 'Great Circle' method of calculating distances, where the distance is the shortest between any two points on the surface of a sphere).

The distance is multiplied by 1.09 to allow for take-off, circling and non-direct routes. This is known as the uplift factor.

2. The class of flight (i.e. economy, first, business) - This determines the emission factor to use for that distance. Where emissions factors for that class do not exist, the most appropriate factor is used. For example, on short haul flights, DEFRA does not supply class specific emissions factors.

The above criteria determine the emission factor to use in our calculation. The emissions factor, provided by DEFRA 2013, allows for calculation of total emissions "per passenger kilometre". The emission factor includes carbon dioxide and methane (CH₄) & Nitrous Oxide (N₂O) converted to carbon dioxide equivalents and summed together. The emissions factor applied is defined in the Notes section below.

The following variables also affect the final calculation:

- Whether it is a single or return journey
- The number of people travelling

NOTES

- We do not include the additional (non CO₂) components of Radiative Forcing
- Emissions Factors provided by DEFRA 2013 include a "Domestic" classification, which is unhelpful when applied globally (due to different countries having such widely varying sizes). As a result, our calculator uses "short", "medium" and "long"-haul classifications to allow it to be applicable globally. Details below:

Flight classifications within the calculator:

Category	Applicable DEFRA category	Flight distance
Short haul	Domestic	Less than 785km ¹
Medium haul	Short-haul international	Between 785km and 3,700km inclusive
Long haul	Long-haul international	Flights greater than 3,700km

Emissions factors used by the calculator:

	Economy	Business	First
Short Haul	0.17271		
Medium Haul	0.09695	0.14541	
Long Haul	0.08740	0.25349	0.34964

All emissions factors are kgCO₂e “per passenger km”.

EXAMPLE

An example calculation would be:

Return Economy flight between London Heathrow (LHR) and New York JFK for 3 people

Distance between airports * 1.09 (uplift factor) = **6,045 km** = Long Haul

6,045km * 0.08740 kg carbon dioxide equivalent (CO₂e) per passenger km = 528.33kgCO₂e= **0.528333**

tCO₂e per passenger flight

0.528333tCO₂e * 3 (passengers) * 2 (Outbound and Return flight) = **3.17 tCO₂e**

Method 2 - Flight Type

This method involves selecting the Type of flight, rather than a specific airport pair. This uses the average emission factor and distances provided by DEFRA 2013.

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	DEFRA Category	Assumed flight distance	Emissions Factor applied
Short haul	Domestic	463 km	0.17271
Medium haul	Short-haul international	1108 km	0.10173
Long haul	Long-haul international	6482 km	0.11974

- No uplift factor is applied to the specified distances.

¹ The 785km figure is based on the midpoint that DEFRA have used for calculating ‘domestic’ and ‘short international’ factors, i.e. 463km and 1108km).

EXAMPLE

An example calculation would be:

Average Distance of a Long Haul flight = **6,482 km**

$6,482 * 0.11974 \text{ kg carbon dioxide equivalent (CO}_2\text{e) per passenger km} = 776 \text{ kgCO}_2\text{e} = \mathbf{0.78 \text{ tCO}_2\text{e}}$

Calculating Emissions from driving

There are two methods for calculating the emissions from vehicles:

1. Using a vehicles database
or
2. Selecting a generic vehicle type.

Method 1 - Using a Vehicles Database

The first method allows the user to choose a specific vehicle make and model. This means the CO₂ emission factor used in the calculation is model specific and more accurate.

Depending on the region specified there will be 2 different vehicles databases used.

Region	Database
Default	VCA Carfuel Database, UK Department of Transport
United States or Canada	US EPA's Fuel Economy database - http://www.fueleconomy.gov/FEG/download.shtml

Best practice, as defined by DEFRA 2012, states that manufacturer data on average fuel consumption should be uplifted by 15% to take into account "further real-world driving effects on emissions relative to test-cycle based data". This uplift is applied when using this method.

EXAMPLES

UK Example

Vauxhaull – Aqila MY2010 1.3CDTi 5 Door MPV = 120 gCO₂ / km

Yearly Useage = 20,000 km

$20,000 * 120 = 2,400,000 \text{ gCO}_2\text{e}$

$2,400,000 \text{ gCO}_2\text{e} * 15\% \text{ uplift} = 2,760,000 \text{ gCO}_2\text{e} \rightarrow 2.76 \text{ tCO}_2\text{e}$

US Example

Honda Accord 2dr coupe, 2.4 Manual (M5) Front Wheel Dr, Req Gas = 25mpg

Yearly usage = 10,000 miles

$10,000 * (1/25) * 8.81 = 3,524,000 \text{ gCO}_2\text{e}$

$3,524,000 \text{ gCO}_2\text{e} * 15\% \text{ uplift} = 4,052,600 \text{ gCO}_2\text{e} \rightarrow 4.0526\text{tCO}_2\text{e}$

Method 2 - Vehicle Type

The second method to calculate a vehicle's emissions is to pick the type of vehicle.

Depending on the region specified the selection of vehicle types may change. The emissions factors for the specified region and vehicle type are as follows:

Vehicle Type	Default Region	United States or Canada
Petrol	0.24234 kgCO ₂ e/km	0.2367 ghCO ₂ e/km or 0.3809 kgCO ₂ e/mile
Diesel	0.22428 kgCO ₂ e/km	0.2687 kgCO ₂ e/km or 0.4325 kgCO ₂ e/mile
Hybrid	0.16170 kgCO ₂ e/km	0.1421 kgCO ₂ e/km or 0.2287 kgCO ₂ e/mile
Motorcycle	0.14238 kgCO ₂ e/km	0.1298 kgCO ₂ e/km or 0.2089kgCO ₂ e/mile
4x4	0.31529 kgCO ₂ e/km	0.31529 kgCO ₂ e/km or 0.5074kgCO ₂ e/mile
Sports	0.29024 kgCO ₂ e/km	0.29024 kgCO ₂ e/km or 0.467115kg/mile

SOURCES

- For the “Default” region, emissions factors are provided by DEFRA 2012, as are the United States or Canada emissions factors for 4x4 or Sports vehicles. Should region specific factors for those vehicle types become available, those factors will be implemented.
- For the “United States” and “Canada” region emissions factors for Petrol, Diesel, Hybrid, & Motorcycle are derived from the <http://emissionfactors.com/> service provided by Ecometrica

EXAMPLE

An example UK calculation would be:

Average UK petrol car driven 20,000km

Petrol (average petrol car) = 0.24234 kgCO₂e / km

*20,000km * 0.24234 kgCO₂e / km= 4,846.8kgCO₂e → **4.9142 tCO₂e***

Calculating annual household emissions

Emissions from household energy and waste are calculated by entering the amount of energy consumed, and the waste created.

Figures that are entered for household consumption and waste must relate to a specified period of time (the default being monthly). The greenhouse gas emissions produced by household energy and waste are then calculated for a period of one year.

The emission factor and units of measurement vary greatly in the household section, detailed in the table below (emissions factor derivations stated below):

	Electricity	Natural Gas	Heating Oil	LPG	Waste
UK	0.58982 kgCO ₂ e/kWh	0.22674 kgCO ₂ e/kWh	3.0714 kgCO ₂ e/ltr	1.7244 kgCO ₂ e/ltr	0.4662 kgCO ₂ e/kg
US Canada	0.65849 kgCO ₂ e/kWh	6.349222 kgCO ₂ e/CCF	11.6266 CO ₂ e/gallon	6.5276 kg/gallon	0.1450 kgCO ₂ e/lb
Asia	0.78213 kgCO ₂ e/kWh	0.22674 kgCO ₂ e/kWh	3.0714 kgCO ₂ e/ltr	1.7244 kgCO ₂ e/ltr	0.8421 kgCO ₂ e/kg
Europe (EU)	0.43650 kgCO ₂ e/kWh	0.22674 kgCO ₂ e/kWh	3.0714 kgCO ₂ e/ltr	1.7244 kgCO ₂ e/ltr	0.8421 kgCO ₂ e/kg
Singapore	0.63575 kgCO ₂ e/kWh	0.22674 kgCO ₂ e/kWh	3.0714 kgCO ₂ e/ltr	1.7244 kgCO ₂ e/ltr	0.8421 kgCO ₂ e/kg
South Africa	1.10196 kgCO ₂ e/kWh	0.22674 kgCO ₂ e/kWh	3.0714 kgCO ₂ e/ltr	1.7244 kgCO ₂ e/ltr	0.8421 kgCO ₂ e/kg

NOTES

- All emissions factors (excepting waste) source – DEFRA 2012

Electricity The emissions factor for Asia is an average of People's Republic of China (0.92105), Chinese Taipei (0.77051), Hong Kong (0.96825), India (1.42260), Indonesia (0.95300), Japan (0.51416), DPR of Korea (0.59018), Malaysia (0.73159), Pakistan (0.62163), Philippines (0.61308), Singapore (0.63575), Thailand (0.64370)

Waste Factors developed by Ecometrica, based on Default emission factors derived from IPCC 2006, Smith et al 2001 and EPA 2008

Region	Methane emitted from landfilled Municipal solid waste (kg CH ₄ /t)
Default	40.1
Non-UK Europe	38
US	15
UK	22.2

US/Canada factors are derived from DEFRA 2012 converted from metric to imperial US units

- 1 litre = 0.26417 US gallons

- 1 kg = 2.205 pounds

EXAMPLE

UK Household emissions:

3000 kWh per year electricity usage * 0.58982 kg carbon dioxide equivalent (CO₂e) per kWh
= 1,769 kgCO₂e → 1.781 tCO₂e

7500 kWh per year gas usage x 0.22674 kg carbon dioxide equivalent (CO₂e) per kWh / 1000
= 1,701 kgCO₂e → 1.701 tCO₂e

1000 kg Waste per Year * 0.4662 kg carbon dioxide equivalent (CO₂e) per kg waste = 466.2
kgCO₂e → 0.4662 tCO₂e

Total = 3.9482 tCO₂e

Calculating emissions from commuting

This section calculates the emissions related to commuting (travelling to and from work). The distance travelled by each transport type over a particular period (daily, weekly, monthly, annually) is entered. The results are then calculated to give total annual emissions.

Emissions factors are from DEFRA 2012

Mode of transportation	Defra Emissions Factor	Emissions Factor value
Car	Average petrol car	0.24234 kgCO ₂ e per km
Motorcycle	Average petrol motorbike	0.14238 kgCO ₂ e per km
Train	National rail	0.06715 kgCO ₂ e per km
Light Rail / Tram	Light rail and tram	0.07659 kgCO ₂ e per km
Bus / Coach	Average local bus	0.13552 kgCO ₂ e per km
Tube / Subway	London Underground	0.08154 kgCO ₂ e per km
Ferry	Ferry- Average	0.13788 kgCO ₂ e per km

NOTES

- When daily figures are entered we assume you commute occurs 239 days / year. (5 day working week with 4 week's holiday)
- When weekly figures are entered we assume you commute 48 weeks of the year
- When monthly figures are entered we assume you commute 11 months of the year

EXAMPLE

4km on Bus / Coach x 0.13552 kg carbon dioxide equivalent(CO₂e) =0.54208 kgCO₂e

12km on Tube / Subway x 0.08154kg carbon dioxide equivalent (CO₂e) = 0.97848 kgCO₂e

Total = 1.52056 kgCO₂e

Daily commute 239 times in 1 year

1.52056 kgCO₂e / day x 239 days = 363.4 kgCO₂e → 0.3634 tCO₂e