Calculations and Emission Factors

The CarbonNeutral Company works for organisations and individuals who want to tackle climate change. 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 everything we do to third party review. That includes - uniquely in our industry - an annual audit of our carbon accounts by PwC, a public register of carbon contracted here on our website, and an Independent Advisory Group. This is all part of our second-to-none quality assurance programme. See our website for details
http://www.carbonneutral.com/about-us/quality-assurance/

To help calculate carbon emissions we have developed our carbon calculators using information from a collection of sources, these will be specified in this document. Also, detailed will be how this tool caters for a global audience; emission factors, units of measurement, categories and labels. All our resulting units that measure emissions are based on the metric tonne, as per the standard for Carbon Market.

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

General Note:
Factors are provided in CO_2e (carbon dioxide equivalent), and include CO_2, CH_4 and N_2O, weighted according to their global warming potentials (GWP). The GWP of CH_4 is 21 and the GWP of N_2O is 310 (in accordance with DEFRA 2009).

Flights

There are two methods for calculating the emissions from flight activity; choosing airports, type of flight.

Choosing Airports
The first method uses the Airport locations and is more accurate as the emissions are based upon the actual distance flown. The airport choices offer 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 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).
2. The distance is multiplied by 1.09 to allow for take off, circling and non-direct routes. This is known as the uplift factor (DEFRA 2009).
3. The class of flight chosen which determines the emission factor to use for that distance; economy/premium economy / business / first. For shorter flights class is not applicable.

The above choices, determine the emission factor to use in our calculation.

The total emissions of carbon dioxide equivalent ($C0_2e$), (which includes carbon dioxide, methane (CH_4) and nitrous oxide (N_2O), converted to carbon dioxide equivalents and summed) per passenger kilometre* (these are the Air Passenger Transport Conversion Factors, provided by DEFRA, see below)

As per DEFRA:
http://www.defra.gov.uk/environment/business/reporting/pdf/20090928-guidelines-ghg-conversion-factors.pdf

The resulting amount is affected by the later customer options
4. Single / Return journey
5. The number of people travelling

NOTES
- We do not include the additional (non CO2) components of Radiative Forcing (point 10)
- We include an uplift factor of 9% to account for additional distance flown due to non-direct routes, delays and circling (point 11)
- Domestic flights have the emission factor of 0.17283 kgCO2e / p.km (DEFRA 2009)
- Short international are those greater than domestic but less than 3,700km in accordance DEFRA 2009 (point 12). The **short economy** class emission factor is 0.0946 kgCO2e / p.km, the **short business** class emission factor is 0.1419 kgCO2e / p.km
- Long international are those greater than 3,700 km in accordance with DEFRA 2009 (point 12). The **long economy** class emissions factor is 0.0827 kgCO2e / p.km. The **long business** class emissions factor is 0.2399 kgCO2e / p.km. The **long first** class emissions factor is 0.3309 kgCO2e / p.km

An example calculation would be:
Distance between London Heathrow (LHR) and New York JFK x 1.09 (uplift factor) = ***6,045 km***

*6,045km * 0.0827 kg carbon dioxide equivalent (CO2e) per passenger kilometre (economy- long haul) / 1000 (to convert from kg to tonnes) =* ***0.499 tCO2e***

*0.499 tCO2e * 1 (passenger) * 1 (one way) =* ***0.499 tCO2e***

Flight Type

The second method to calculate emissions from flights, is to pick the type / category.

This uses the average emission factor from DEFRA and typical distances stated in the EMEP/CORINAIR Emissions Inventory Guidebook (EIG 2007):
http://www.defra.gov.uk/environment/business/reporting/pdf/20090928-guidelines-ghg-conversion-factors.pdf

NOTES

- We have renamed 'domestic' to 'short haul'. Our tool is global and therefore the DEFRA term 'domestic' is confusing. A 'domestic' flight literally is one within a country's borders, whereas the distance of such can vary greatly.
- The emission factor for an average 'short haul' flights is 0.1728 kgCO2e / p.km. The distance of a typical 'short haul' flight is 463 km.
- We have renamed 'short-international' to 'medium haul'. Again, our tool is global and therefore the DEFRA terms are too UK orientated.
- The emission factor for an average 'medium haul' flight is 0.0992 kgCO2e / p.km. The distance of a typical 'medium haul' flight is 1108 km
- We have renamed 'long-international' to 'long haul'.
- The emission factor for a typical 'long haul' flight is 0.1133 kgCO2e / p.km. The distance of an average 'long haul' flight is 6482 km
- No uplift factor is applied to the specified distances.

An example calculation would be:
Average Distance of a Long Haul flight = ***6,482 km***

*6,482 * 0.1133 kg carbon dioxide equivalent (CO2e) per passenger kilometre (average long haul) / 1000 (to convert from kg to tonnes) =* ***0.7345 tCO2****e*

Vehicles

There are two methods for calculating the emissions from vehicles; vehicles database, vehicle type.

Vehicles Database
The first method allows the user to choose their actual vehicle make and model, which means the CO_2 emission factor used in the calculations is model specific and more accurate. CH_4 and N_2O default factors per km or mile are then added on (expressed in CO_2e).

Depending on the region specified there will be 2 different vehicles databases used. The default is the VCA Carfuel Database, UK Department of Transport. If the region specified is United States or Canada then the vehicles database will be the US EPA's Fuel Economy database - http://www.fueleconomy.gov/FEG/download.shtml

Best practice is to multiply the VCA fuel efficiency factors by an up-lift factor, to take into account real-world driving conditions (use of air conditioning, the effects on fuel economy of city traffic etc.) Therefore an up-lift of 15% is applied. The US EPA Fuel economy database states that it already reflects typical driving conditions.

An example calculation for the UK would be:
Vauxhaull – Astra MY2007 5 Dr Hatchback – 1.3CDTi 16V = 130 gCO2 / km
Yearly Useage = 20,000 km
*20,000 * 130*1.15 / 1000000 (convert g to tonnes) = 2.99 tCO2*
CH_4 and N_2O have then to be added in, to give total tCO_2e:
*(20,000*0.0003/1000)+(20,000*0.0018/1000) = 0.042 tCO_2e*
Total tCO_2e = 2.99 +0.042 = 3.03 tCO_2e

An example calculation for the US would be:
2009 Honda Accord, 2.4 litre, 4 cylinder, rear-wheel– average 25mpg. Yearly usage = 10,000 miles
10,000(1/25)*8.81/1000 (convert kg to tonnes) = 3.52 tCO_2*
CH_4 and N_2O have then to be added in, to give total tCO_2e.
(10,000 0.651/1000000) (convert g to tonnes) +(10,000* 9.92/1000000)= 0.106 tCO_2e.*
Total tCO_2e = 3.52 + 0.106 = 3.63 tCO_2e

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

Depending on the region specified there will be 2 different set of vehicles types. The default will be; average petrol, diesel and Hybrid, average Motorcycle, dual purpose 4x4 and Sports
http://www.defra.gov.uk/environment/business/reporting/pdf/20090928-guidelines-ghg-conversion-factors.pdf

If the region specified is United States or Canada then it will use categories derived from The GHG Protocol calculation tool *GHG emissions from transport or mobile sources (2005)*, available from http://www.ghgprotocol.org/calculation-tools/all-tools

and the EPA's *Climate leaders Greenhouse Gas Inventory Protocol Core Module Guidance – Optional emissions from commuting, business travel and product transport*, 2008. The vehicle type defaults will be average small, medium and large petrol cars, average hybrid, average motorcycle, station wagon and mid size pick-up.

NOTES

- The emission factor for an average petrol vehicle is 0.2078 kgCO2e /.km.
- The emission factor for an average diesel vehicle is 0.1983 kgCO2e / .km.
- The emission factor for a medium petrol hybrid vehicle is 0.1282 kgCO2e /.km.
- The emission factor for an average petrol motorcycle is 0.1186 kgCO2e / km.
- The emission factor for an average diesel dual purpose 4x4 is 0.2763kgCO2e /km.
- The emission factor for an average petrol Sports vehicle is 0.2575 kgCO2e / km.
- The US factor for an average small petrol car is 0.202 kgCO2e/km, 0.325 kgCO2e/mile
- The US factor for an average medium petrol car is 0.227 kgCO2e/km, 0.365 kgCO2e/mile
- The US factor for an average large petrol car is 0.274 kgCO2e/km, 0.441 kgCO2e/mile
- The US factor for an average hybrid car is 0.107 kgCO2e/km, 0.172 kgCO2e/mile
- The US factor for an average motorcycle is 0.106 kgCO2e/km, 0.17 kgCO2e/mile
- The US factor for a station wagon is 0.250 kgCO2e/km, 0.402 kgCO2e/mile
- The US factor for a mid size pick-up is 0.299 kgCO2e/km, 0.481kgCO2e/mile

An example UK calculation would be:
Petrol (average petrol car) = 0. 2078 *kgCOe2 / km*
Yearly Useage = 20,000 km
*20000 * 0.2078 / 1000 (convert kg to tonnes) = 4.156 tCO2e*

Household

Emissions from household energy and waste are calculated by entering the amount of energy consumed, and the waste created. By using consumption and not cost it is more accurate.

Figures that are entered for household consumption and waste must be over a specified period of time. The default here is monthly. The greenhouse gas emissions produced by household energy and waste are calculated over a period of one year.

The emission factor and units of measurement **entered** vary greatly in the household section, detailed in the table below:

	Electricity	Natural Gas	Heating Oil	LPG	Waste
UK	0.54418 kgCO2e/kWh	0.20417 kgCO2e/kWh	2.5442 kgCO2e/ltr	1.4968 kgCO2e/ltr	0.4662 kgCO2e / kg
US	0.561 kgCO2e/kWh	6.1659 kgCO2e/CCF	9.6308 kg CO2e/gallon	5.666 kg/gallon	0.1429 kgCO2e / lb
Asia	0.733 kgCO2e/kWh	0. 20417 kgCO2e/kWh	2.5442 kgCO2e/ltr	1.4968 kgCO2e/ltr	0.8421 kgCO2e / kg
Europe (EU)	0.356 kgCO2e/kWh	0.20417 kgCO2e/kWh	2.5442 kgCO2e/ltr	1.4968 kgCO2e/ltr	0.798 kg CO2e / kg
Singapore	0.537 kgCO2e/kWh	0.20417 kgCO2e/kWh	2.5442 kgCO2e/ltr	1.4968 kgCO2e/ltr	0.8421 kg CO2e/ kg
South Africa	0.848 kgCO2e/kWh	0.20417 kgCO2e/kWh	2.5442 kgCO2e/ltr	1.4968 kgCO2e/ltr	0.8421 kg CO2e/ kg

Sources:

UK Electricity	– DEFRA 2009, Grid Rolling Average
Int. Electricity	– IEA 2009
GAS	– All factors from DEFRA 2009. UK figures are on a gross CV basis, international figures are on a net CV basis.
Heating Oil	- DEFRA 2009, Burning Oil - For US / Canada I converted factor to apply toUS gallons 1 litre = 0.26417 US gallons
LPG	- DEFRA 2009 - For US / Canada I converted factor to apply to US gallons 1 litre = 0.26417 US gallons
Waste	- Default factors are

World default: Methane emitted from landfilled MSW: (derived from IPCC 2006, Smith et al 2001 and EPA 2008)	40.1	kgCH4/t waste
Europe default: Methane emitted from landfilled MSW: (derived from IPCC 2006 and Smith et al 2001)	38.0	kgCH4/t waste
US default: Methane emitted from landfilled MSW: (derived from IPCC 2006 and EPA 2008)	15.0	kgCH4/t waste
UK default: Methane emitted from landfilled MSW: (derived from IPCC 2006 and Smith et al 2001)	22.2	kgCH4/t waste
GWP of methane:	21 (DEFRA 2009)	

For US / Canada, converted to lbs of waste (0.315 / 2.205). Canada landfill emissions assumed to be the same as US.

An example calculation would be (UK):

3000 kWh per year electricity usage x 0.54418 kg carbon dioxide equivalent (CO2e) per kWh / 1000 = 1.633tCO2e
7500 kWh per year gas usage x 0.18396 kg carbon dioxide equivalent (CO2e) per kWh / 1000 = 1.379 tCO2e
1000 kg Waste per Year x 0.4662 kg carbon dioxide equivalent (CO2e) per kg waste / 1000 = 0.4662 tCO2e
Total = 3.478 tCO2e

Commuting

Commute is the carbon emissions associated with regular travel, generally this is too and from work. Distances are entered in general areas, for a chosen period of time and then the emissions calculated for a year.

The source of these factors are DEFRA:
http://www.defra.gov.uk/environment/business/reporting/pdf/20090928-guidelines-ghg-conversion-factors.pdf

NOTES

- When figures are entered daily we assume the commute occurs 239 days / year. 1 month holiday and a 5-day working week
- When figures are entered weekly we assume you commute 48 weeks of the year
- When figures are entered monthly we assume you commute 11 months of the year
- The emission factor for an average petrol vehicle is 0.2078 kgCO2e / km.
- The emission factor for an average petrol motorcycle is 0.1186 kgCO2e / km.
- The emission factor for national rail is 0.0611 kgCO2e / p.km.
- The emission factor for light rail and tram is 0.084 kgCO2e / p.km.
- The emission factor for an average bus is 0.1046 kgCO2e / p.km.
- The emission factor for London Underground is 0.0786 kgCO2e / p.km.
- The emission factor for a passenger Ferry is 0.1161 kgCO2e / p.km.

An example commute calculation would be:
4km on Bus / Coach x 0.1046 kg carbon dioxide equivalent(CO2e) =0.4184
12km on Tube / Subway x 0.0786 kg carbon dioxide equivalent (CO2e) = 0.9432
Total = 1.3616kg CO2e

I do this commute DAILY to work
x 239 / 1000 (convert to tonnes) = 0.325tCO2e