CARBON TRUST

Conversion factors

Energy and carbon conversions
2011 update

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Introduction

This leaflet provides a number of useful conversion factors to help you calculate energy consumption in common units and to work out the greenhouse gas emissions associated with energy use.

Calculating your energy use and carbon emissions can be useful for monitoring energy use internally within a business, and also for public reporting of energy consumption and carbon emissions.

This updated version is based on data published by **Defra/DECC** in 2011.

Conversion factors for energy units

From	to kWh
therms	29.31
Btu	2.931×10^{-4}
MJ	0.2778
toe	1.163×10^{4}
kcal	1.163×10^{-3}

Btu = British thermal unit;
MJ = Megajoule;
toe = tonnes of equivalent oil;
Kcal = kilo calorie

Example

Conversion of 100,000 Btu to kWh:

100,000 Btu = 100,000 x 2.931 X 10^{-4} kWh

= 29.31kWh

Common prefixes

The following prefixes are used for multiples of joules, watts and watt-hours:

Kilo (k) = 10^3; mega (M) = 10^6; giga (G) = 10^9; tera (T) = 10^{12}; peta (P) = 10^{15}

Greenhouse gas conversions

The energy conversion factors given in this leaflet are quoted as kilograms carbon dioxide equivalent ($kgCO_2e$) per unit of fuel.

The use of fuels leads to emissions of carbon dioxide (CO_2) and small quantities of other greenhouse gases – including methane (CH_4) and nitrous oxide (N_2O). For a given quantity of a gas, the equivalent quantity of CO_2 that would be needed to give the same greenhouse effect can be calculated using its 'global warming potential'. This quantity is quoted in units of kilograms carbon dioxide equivalent ($kgCO_2e$).

The greenhouse gas conversion factor comprises the effect of the CO_2, CH_4 and N_2O combined – this is quoted as $kgCO_2e$ per unit of fuel consumed.

The energy conversion factors given in this leaflet are quoted as total direct $kgCO_2e$ per unit of fuel. Direct emissions are those emitted at the point of use of a fuel – or at the point of generation for electricity.

The factors in this guide do not (with the exception of Biomass) account for indirect emissions, for example emissions associated with the extraction of natural gas, refining of oil etc. For conversion factors that include indirect emissions see the Defra/DECC 2011 greenhouse gas conversion factors.

Note that biomass fuels are quoted as total direct and indirect $kgCO_2$ per unit of fuel (as the direct emissions are negligible).

Energy conversion factors

The factors given below are taken from Defra/DECC's GHG conversion factors for company reporting, published in August 2011.

Table 1 *Energy conversion factors*

Fuel	Units	$kgCO_2e$ per unit
Grid electricity[1]	kWh	0.5246
Renewable electricity[2]	See footnote 2	See footnote 2
Natural gas	kWh	0.1836
	therms	5.3808
LPG	kWh	0.2147
	therms	6.2915
	litres	1.4918
Gas oil	tonnes	3528
	kWh	0.27857
	litres	3.0595
Fuel oil	tonnes	3228
	kWh	0.2674
Burning oil	tonnes	3165
	kWh	0.2468
Diesel	tonnes	3188
	kWh	0.2517
	litres	2.6676
Petrol	tonnes	3149
	kWh	0.2407
	litres	2.3117
Industrial coal	tonnes	2383
	kWh	0.3325
Wood pellets	tonnes	183.9
	kWh	0.039

[1] This figure represents electricity consumed, i.e. electricity used at the point of final consumption. Because the fuel mix consumed in UK power stations changes from year to year, the figure is presented as a five year rolling average.
[2] For electricity purchased on a 'green tariff' the grid electricity factor above should generally be used. This factor incorporates UK renewable generation within it. For electricity generated on-site using renewable energy, a factor of zero may be used, as long as the energy source is backed by Renewable Energy Guarantee of Origin (REGO) certificates.

Passenger transport conversion factors

Table 2 *Petrol and diesel cars*

Car size	Units	$kgCO_2e$ per unit
Small up to 1.4 litre petrol	km	0.1711
	miles	0.2754
Medium 1.4-2.0 litre petrol	km	0.2121
	miles	0.3413
Large, over 2.0 litre petrol	km	0.2991
	miles	0.4813
Average petrol car	km	0.2086
	miles	0.3358

Car size	Units	$kgCO_2e$ per unit
Small, up to 1.7 litre diesel	km	0.1450
	miles	0.2334
Medium, 1.7-2.0 litre diesel	km	0.181
	miles	0.2912
Large, over 2.0 litre diesel	km	0.2433
	miles	0.3915
Average diesel car	km	0.1935
	miles	0.3115

Table 3 ***Bus, rail and air[3] travel***

Mode of transport	Units[4]	$kgCO_2e$ per unit
Regular taxi	vkm	0.2121
Average local bus	pkm	0.1488
Coach	pkm	0.0306
International rail (Eurostar)	pkm	0.0151
National rail	pkm	0.0565
Light rail and tram	pkm	0.0715
Underground	pkm	0.0736
Long haul international flight	pkm	0.1115
Short haul international flight	pkm	0.09684
Domestic flight	pkm	0.1648

The conversion factors presented here are just a sample of those published by Defra. For a more comprehensive set of factors, and full guidance notes for their use, visit **Defra's website.**

[3] The air travel emission factors do not include non-CO_2 climate change impacts such as Radiative Forcing. However, a 109% uplift factor has been built into the emission factors to take into account non-direct routes and delays/circling.
[4] vkm stands for vehicle kilometres. The associated $kgCO_2e$ figure is based on the vehicle emissions per kilometre. pkm stands for passenger kilometres. The associated $kgCO_2e$ figures are calculated by taking the total emissions figure for the vehicle, plane or train and dividing it by the number of passengers travelling.

Heat content of fuels

The default gross calorific values given below can be used when fuel-specific values are not available from your energy supplier. Gross values include the energy needed to evaporate the water in the fuel, and that formed during the combustion process. In the tables below we provide the gross values, in line with those usually provided by the energy suppliers in the UK. Net values exclude this energy.[5]

Table 4 ***Gross calorific values for solid fuels***

Solid fuels	kWh/tonne
Coal (weighted average)	7,500
Industrial wood	3,806
Short rotation coppice	3,084
Straw	4,389

Table 5 ***Gross calorific values for liquid fuels***

Liquid fuels	kWh/tonne	litres/tonne	kWh/litre
Fuel oil	12,029	1,024	12
LPG	13,668	1,968	7
Gas/diesel oil	12,584	1,153	11
Burning oil	12,834	1,245	10
Petrol	12,807	1,362	9

Table 6 ***Gross calorific values for gaseous fuels***

Gaseous fuels	kWh/tonne	litres/tonne	kWh/m^3
Natural gas	-	-	11.13

[5] Net calorific values can be found in Annex 11: Fuel Properties – **2011 Guidelines to Defra / DECC's GHG Conversion Factors for Company Reporting**

Go online to get more

The Carbon Trust provides a range of tools, services and information to help you implement energy and carbon saving measures, no matter what your level of experience.

Carbon Footprint Calculator – Our online calculator will help you calculate your organisation's carbon emissions.

➘ **www.carbontrust.co.uk/carboncalculator**

Cut Carbon, Cut Costs – This tool gives you an introduction to energy saving and helps you create a personalised action plan for your site, estimating the cost and carbon savings you could make in your workplace.

➘ **www.carbontrust.co.uk/onlinetraining**

Energy Saving Plan – The Carbon Trust Advice Line can work with you to understand your organisation's energy usage and to help identify specific opportunities for your business to save money and cut carbon. You will then be provided with a free Energy Saving Plan report. Call today on 0800 0852005 and ask one of our advisors how an Energy Saving Plan could help you.

Case Studies – Our case studies show that it's often easier and less expensive than you might think to bring about real change.

➘ **www.carbontrust.co.uk/casestudies**

Publications – We have a library of free publications detailing energy saving techniques for a range of sectors and technologies.

➘ **www.carbontrust.co.uk/publications**

The Carbon Trust also offers:

Energy Efficiency Financing– Investing in energy efficient equipment makes sound business and environmental sense, especially with the easy, affordable and flexible Energy Efficiency Financing scheme brought to you by Carbon Trust Implementation and Siemens Financial Services.
To find out more visit:

➘ **www.energyefficiencyfinancing.co.uk**

Carbon Reduction Label – This is managed by the Carbon Trust Footprinting Company, which was set up by the Carbon Trust in 2007. Any product that has had its carbon footprint calculated and verified by an accredited verifier can have the label on its packaging or marketing material. It shows the total greenhouse gas emissions arising from every stage of the product's life cycle, including production, transportation, preparation, use and disposal. Find out more at:

➘ **www.carbon-label.com**

Carbon Trust Standard – Focused on reduction, it is awarded to organisations that measure, manage and reduce their carbon footprint. It is managed by the Carbon Trust Standard Company, which was set up by the Carbon Trust in June 2008. Find out more at:

➘ **www.carbontruststandard.com**

Need further help?

Call our Advice Line on 0800 085 2005

Our experts offer independent, authoritative advice.
Lines open 8.30am-5.30pm, Monday to Friday.

The Carbon Trust is a not-for-profit company with the mission to accelerate the move to a low carbon economy. We provide specialist support to business and the public sector to help cut carbon emissions, save energy and commercialise low carbon technologies. By stimulating low carbon action we contribute to key UK goals of lower carbon emissions, the development of low carbon businesses, increased energy security and associated jobs.

We help to cut carbon emissions now by:

- providing specialist advice and finance to help organisations cut carbon
- setting standards for carbon reduction.

We reduce potential future carbon emissions by:

- opening markets for low carbon technologies
- leading industry collaborations to commercialise technologies
- investing in early-stage low carbon companies.

www.carbontrust.co.uk
0800 085 2005

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