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# Conversion factors

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Energy and carbon conversions  
2013 update



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# Introduction

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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 2013.

## Conversion factors for energy units

From	to kWh
therms	29.31
Btu	$2.931 \times 10^{-4}$
MJ	0.2778
toe	$1.163 \times 10^4$

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

### Example

Conversion of 100,000 Btu to kWh:

$$\begin{aligned}
 100,000 \text{ Btu} &= 100,000 \times 2.931 \times 10^{-4} \text{ kWh} \\
 &= 29.31 \text{ kWh}
 \end{aligned}$$

### 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<sub>2</sub>e) per unit of fuel.

The use of fuels leads to emissions of carbon dioxide (CO<sub>2</sub>) and small quantities of other greenhouse gases – including methane (CH<sub>4</sub>) and nitrous oxide (N<sub>2</sub>O). For a given quantity of a gas, the equivalent quantity of CO<sub>2</sub> 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<sub>2</sub>e).

The greenhouse gas conversion factor comprises the effect of the CO<sub>2</sub>, CH<sub>4</sub> and N<sub>2</sub>O combined – this is quoted as kgCO<sub>2</sub>e per unit of fuel consumed.

The energy conversion factors given in this leaflet are quoted as total direct kgCO<sub>2</sub>e 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 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 2013 greenhouse gas conversion factors.



# Energy conversion factors

The factors given below are taken from Defra/DECC's GHG conversion factors for company reporting, published in June 2013.

*Table 1 Energy conversion factors*

Fuel	Units	kgCO <sub>2</sub> e per unit	Fuel	Units	kgCO <sub>2</sub> e per unit
Grid electricity <sup>1</sup>	kWh	0.44548	Burning oil	tonnes	3164.9
Renewable electricity <sup>2</sup>	See footnote 2	See footnote 2		kWh	0.24555
Natural gas <sup>3</sup>	kWh	0.18404	Diesel <sup>4</sup>	tonnes	3100.1
	therms	5.39421		kWh	0.24512
LPG	kWh	0.21452		litres	2.6008
	therms	6.28578	Petrol <sup>4</sup>	tonnes	3005.8
	litres	1.4929		kWh	0.23394
Gas oil	tonnes	3427.2		litres	2.2144
	kWh	0.27176	Industrial coal	tonnes	2339.1
	litres	2.9343		kWh	0.31304
Fuel oil	tonnes	3232.7	Wood pellets	tonnes	0
	kWh	0.26876		kWh	0

<sup>1</sup> This figure represents electricity generated (scope 2). Scope 3 emissions from transmission and distribution, and extraction, refining and transportation of primary fuels, should be reported separately.

<sup>2</sup> 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.

<sup>3</sup> Factors given for all fuels are on a gross calorific value (CV) basis, in common with most energy billing.

<sup>4</sup> Standard fuel bought from a local filling station (across the board forecourt fuel typically contains biofuel content).

# Passenger transport conversion factors

Table 2 Petrol and diesel cars

Car size	Units	kgCO <sub>2</sub> e per unit
Small up to 1.4 litre petrol	km	0.16192
	miles	0.260585
Medium 1.4-2.0 litre petrol	km	0.2049
	miles	0.329755
Large, over 2.0 litre petrol	km	0.29678
	miles	0.477621
Average petrol car	km	0.19811
	miles	0.318827

Car size	Units	kgCO <sub>2</sub> e per unit
Small, up to 1.7 litre diesel	km	0.14048
	miles	0.226081
Medium, 1.7-2.0 litre diesel	km	0.17475
	miles	0.281233
Large, over 2.0 litre diesel	km	0.22941
	miles	0.3692
Average diesel car	km	0.18322
	miles	0.294864

Table 3 Bus, rail and air<sup>3</sup> travel

Mode of transport	Units <sup>4</sup>	kgCO <sub>2</sub> e per unit
Regular taxi	vkm	0.20208
Average local bus	pkm	0.111621
Coach	pkm	0.02932
International rail (Eurostar)	pkm	0.01235
National rail	pkm	0.04904
Light rail and tram	pkm	0.06006
Underground	pkm	0.06361
Long haul international flight	pkm	0.119783
Short haul international flight	pkm	0.101768
Domestic flight	pkm	0.172757

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](#).



<sup>3</sup> The air travel emission factors include a distance uplift factor of 8%, to take into account non-direct routes and delays/circling. It does not include an uplift factor for radiative forcing.

<sup>4</sup> vkm stands for vehicle kilometres. The associated kgCO<sub>2</sub>e figure is based on the vehicle emissions per kilometre. pkm stands for passenger kilometres. The associated kgCO<sub>2</sub>e figures are calculated by taking the total emissions figure for the vehicle and dividing it by the average number of passengers.

# 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.<sup>5</sup>

*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 <sup>3</sup>
Natural gas	-	-	11.13

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

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Lines open 9am-5.30pm, Monday to Friday.

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