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# Conversion factors

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Energy and carbon conversions  
2016 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](#) in 2016.

## Conversion factors for energy units

From	to kWh
therms	29.307
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:

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

### 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 2016 greenhouse gas conversion factors.



# Energy conversion factors

The factors given below are taken from Defra's greenhouse gas conversion factors for company reporting, published in September 2016.

Table 1 Energy conversion factors

[Download editable spreadsheet](#)

Fuel <sup>1</sup>	Units	kgCO <sub>2</sub> e per unit
Grid electricity <sup>2</sup>	kWh	0.41205
Renewable electricity <sup>3</sup>	See footnote 3	See footnote 3
Natural gas	kWh	0.183997
	therms	5.39241
	cubic meters	2.024
LPG	kWh	0.214577
	therms	6.28864
	litres	1.50502
Gas oil	tonnes	3,475.821
	kWh	0.27631
	litres	2.96572
Fuel oil	tonnes	3,225.108
	kWh	0.26782

Fuel <sup>1</sup>	Units	kgCO <sub>2</sub> e per unit
Burning oil	tonnes	3,165.398
	kWh	0.24666
Diesel <sup>4</sup>	tonnes	3,108.5
	kWh	0.24592
	litres	2.61163
Petrol <sup>4</sup>	tonnes	2,993.6
	kWh	0.23324
	litres	2.19697
Industrial coal	tonnes	2,417.464
	kWh	0.32235
Wood pellets <sup>5</sup>	tonnes	55.53515
	kWh	0.01307

<sup>1</sup> Factors given for all fuels are on a gross calorific value (CV) basis, in common with most energy billing.

<sup>2</sup> This figure represents electricity generated (scope 2 under the location-based method). Scope 3 emissions should be reported separately.

<sup>3</sup> For electricity purchased on a 'green tariff', the grid electricity factor above should be used to report under the location-based method of the GHG Protocol Corporate Standard. The Standard requires organisations to also report scope 2 emissions using the market-based method. The relevant factor under this method will be specific to the product supplied by a given electricity supplier.

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

<sup>5</sup> Conversion factors include the emissions of methane and nitrous oxide that occur during combustion.

# Passenger transport conversion factors

Table 2 Petrol and diesel cars

[Download editable spreadsheet](#)

Car size	Units	kgCO <sub>2</sub> e per unit
Small up to 1.4 litre petrol	km	0.16027
	miles	0.25794
Medium 1.4-2.0 litre petrol	km	0.20033
	miles	0.32241
Large, over 2.0 litre petrol	km	0.29461
	miles	0.47414
Average petrol car	km	0.19184
	miles	0.30875

Car size	Units	kgCO <sub>2</sub> e per unit
Small, up to 1.7 litre diesel	km	0.14675
	miles	0.23618
Medium, 1.7-2.0 litre diesel	km	0.17741
	miles	0.28551
Large, over 2.0 litre diesel	km	0.22473
	miles	0.36166
Average diesel car	km	0.18307
	miles	0.29461

Table 3 Bus, rail and air<sup>6</sup> travel[Download editable spreadsheet](#)

Mode of transport	Units <sup>7</sup>	kgCO <sub>2</sub> e per unit
Regular taxi	pkm	0.16286
Average local bus	pkm	0.10172
Coach	pkm	0.02867
International rail (Eurostar)	pkm	0.01214
National rail	pkm	0.04885
Light rail and tram	pkm	0.05363
Underground	pkm	0.05789
Long haul international flight to/from UK	pkm	0.02038
Long haul international flight to/from non-UK	pkm	0.01904
Short haul international flight to/from UK	pkm	0.01791
Domestic flight	pkm	0.02963

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 [gov.uk](https://www.gov.uk).



<sup>6</sup> The air travel emission factors include a distance uplift factor of 8%, to take into account non-direct routes and delays/circling and also includes an uplift factor for radiative forcing. Department for Transport data on passenger cabin class split by flight length (domestic, short haul, long haul) is now used to give better average passenger emissions for each flight length.

<sup>7</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 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.

Table 4 Gross calorific values for solid fuels

Solid fuels	kWh/tonne
Coal (industrial)	7,500
Wood pellets	4,650
Straw	4,378

Table 5 Gross calorific values for liquid fuels

[Download editable spreadsheet](#)

Liquid fuels	kWh/tonne	litres/tonne	kWh/litre
Fuel oil	12,042	1,014	11.876
LPG	13,710	1,955	7.0126
Diesel	12,684	1,192	10.641
Gas oil	12,579	1,172	10.733
Burning oil	12,833	1,250	10.266
Petrol	13,095	1,368	9.5727

Table 6 Gross calorific values for gaseous fuels

[Download editable spreadsheet](#)

Gaseous fuels	kWh/tonne	litres/tonne	kWh/m <sup>3</sup>
Natural gas	14,760	1,338,912.134	11.024

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➡ [www.carbontrust.com/carbonfootprintguide](http://www.carbontrust.com/carbonfootprintguide)

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# The Carbon Trust also offers:

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➤ [www.carbontrust.com/greenbusiness](http://www.carbontrust.com/greenbusiness)

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The Carbon Trust:

- Advises businesses, governments and the public sector on opportunities in a sustainable, low carbon world.
- Measures and certifies the environmental footprint of organisations, products and services.
- Helps develop and deploy low carbon technologies and solutions, from energy efficiency to renewable power.

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