2007

Guidelines to Defra's GHG conversion factors for company reporting

Annexes updated June 2007

Key

light blue	=	Data entry field
purple	=	Fixed factors used in calculations
yellow	=	Calculation results

Annex 1 - Fuel Conversion Factors

Last updated:	Jun-07

Table 1

Converting fuel types to CO_2				Net CV Basis [3]			Gross CV Basis [4]	
Fuel Type	Amount used per year	Units	x	kg CO_2 per unit	Total kg CO_2	x	kg CO_2 per unit	Total kg CO_2
Electricity	See Annex 3						See Annex 3	
Natural Gas		kWh	x	0.206		x	0.185	
		therms	x	6.023		x	5.421	
Gas Oil		tonnes	x	3190		x	3190	
		kWh	x	0.265		x	0.251	
		litres	x	2.674		x	2.674	
Diesel		tonnes	x	3164		x	3164	
		kWh	x	0.263		x	0.249	
		litres	x	2.630		x	2.630	
Petrol		tonnes	x	3135		x	3135	
		kWh	x	0.253		x	0.240	
		litres	x	2.315		x	2.315	
Fuel Oil		tonnes	x	3223		x	3223	
		kWh	x	0.281		x	0.267	
Burning Oil[1]		tonnes	x	3150		x	3150	
		kWh	x	0.258		x	0.245	
		litres	x	2.518		x	2.518	
Coal [2]		tonnes	x	2457		x	2457	
		kWh	x	0.346		x	0.329	
LPG		kWh	x	0.225		x	0.214	
		therms	x	6.608		x	6.277	
		litres	x	1.498		x	1.498	
Coking Coal		tonnes	x	2810		x	2810	
		kWh	x	0.349		x	0.332	
Aviation Spirit		tonnes	x	3128		x	3128	
		kWh	x	0.250		x	0.238	
		litres	x	2.233		x	2.233	
Aviation Turbine Fuel [1]		tonnes	x	3150		x	3150	
		kWh	x	0.258		x	0.245	
		litres	x	2.518		x	2.518	
Other Petroleum Gas		tonnes	x	2894		x	2894	
		kWh	x	0.217		x	0.206	
Naphtha		tonnes	x	3131		x	3131	
		kWh	x	0.249		x	0.237	
Lubricants		tonnes	x	3171		x	3171	
		kWh	x	0.263		x	0.250	
Petroleum Coke		tonnes	x	3410		x	3410	
		kWh	x	0.361		x	0.343	
Refinery Miscellaneous		kWh	x	0.259		x	0.246	
		therms	x	7.585		x	7.214	
Total					**0**			**0**

Sources

UK Greenhouse Gas Inventory for 2005 (AEA Energy & Environment)

Digest of UK Energy Statistics (DTI)

Notes

[1] Burning oil is also known as kerosene or paraffin used for heating systems. Aviation Turbine fuel is a similar kerosene fuel specifically refined to a higher quality for aviation.

[2] Average emission factor for coal used in sources other than power stations and domestic, i.e. industry sources including collieries, Iron & Steel, Autogeneration, Cement production, Lime production, Other industry, Miscellaneous, Public Sector, Stationary combustion - railways and Agriculture. Users who wish to use coal factors for types of coal used in specific industry applications should use the factors given in the UKETS.

[3] Emission factors calculated on a Net Calorific Value basis. Energy and emissions are currently calculated on a Gross Calorific Value basis in the UK, however it is anticipated that in the near future calculations will be moved to a Net Calorific Value basis, which is also consistent with the European Union Emission Trading Scheme (EUETS) for CO_2 emissions.

[4] Emission factors calculated on a Gross Calorific Value basis

Annex 2 - Combined Heat and Power - Imports and Exports

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If you use all the output of a Combined Heat and Power plant to meet the energy needs of your business, you need not attribute the emissions from the plant between the energy and heat output. You can therefore calculate the total plant emissions from the fuel used with the standard conversion factors at Annex 1.

If, however, you export energy or heat to another business (or import from another business), you will need to split the emissions between the energy and heat before calculating the appropriate proportion of emissions which should be deducted from (or added to) your company total.

Because it is typically roughly twice as efficient to generate heat from fossil fuels as it is to generate electricity, you can attribute the emissions from the CHP plant 1:2 and calculate emissions per kWh of heat or electricity produced by the CHP plant using the appropriate formula below:

Emissions (in kgCO2) per kWh electricity = $\frac{\text{twice total emissions (in kg}CO_2\text{)}}{\text{twice total electricity produced + total heat produced (in kWh)}}$

Emissions (in kgCO2) per kWh heat = $\frac{\text{total emissions (in kg}CO_2\text{)}}{\text{twice total electricity produced + total heat produced (in kWh)}}$

Calculate emissions per kWh electricity			
Total emissions (kg CO_2)	Total electricity produced	Total heat produced	kg CO_2/kWh elecricity

Calculate emissions per kWh heat			
Total emissions (kg CO_2)	Total electricity produced	Total heat produced	kg CO_2/kWh heat

Annex 3 - Electricity Conversion Factors from 1990 to 2005

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Table 2

Electricity conversion factors from 1990 to 2005			
Year	Amount used per year, kWh	kg CO_2 per kWh	Total kg CO_2
1990		0.77000	
1991		0.75000	
1992		0.70000	
1993		0.62000	
1994		0.61000	
1995		0.58000	
1996		0.56616	
1997		0.51935	
1998		0.51808	
1999		0.48291	
2000		0.51022	
2001		0.52581	
2002		0.50974	
2003		0.52628	
2004		0.52659	
2005		0.52657	
Rolling Average[5]		0.52300	
Long-term marginal factor[6]		0.43000	
Electricity from CHP[7]		0.29500	
Renewables[8]		0	
Total			**0**

Sources

Based on UK Greenhouse Gas Inventory for 2005 (AEA Energy & Environment) according to the amount of CO_2 emitted from major power stations per unit of electricity consumed from the DTI's Digest of UK Energy Statistics (DUKES) 2006 Table 5.6

Notes

The electricity conversion factors given are the average carbon dioxide emission from the UK national grid per kWh of electricity used at the point of final consumption. These factors include only carbon emissions at UK power stations and do not include emissions resulting from production and delivery of fuel to these power stations (i.e. from gas rigs, refineries and collieries, etc.).

[5] A rolling average of emission factors for the last 5 years for which data is available (2001-2005). This is to help reduce short-term annual variability with year on year comparisons for the purposes of these Guidelines. The rolling 5 year average factor is a suitable metric for calculating the carbon emissions of a company's electricity use. Emissions reductions from activities that bring about short term electricity savings (such as switching off lights ad computers a night, reducing air conditioning and heating use, etc.) can be calculated using this factor.

[6] The long-term marginal factor assumes that, over a long time period (a decade or more) avoided electricity use will displace generation at a new Combined Cycle Gas Turbine (CCGT) plant. Policies and measures that produce long-term reductions in electricity use should therefore use this factor to assess what carbon saving will result. When calculating emissions reductions based on long term investment decisions (for example, building zero carbon housing or business premises, investing in on-site renewables etc.) companies should use this factor. Carbon savings used for the purposes of Climate Change Agreements (CCAs) have historically been calculated using this factor, and it should continue to be used for this purpose.

[7] The conversion factor for electricity from CHP may be used only for the percentage of the electricity sourced from your supplier that has been produced from CHP meeting the 'Good Quality CHP' criterion of the CHPQA programme. If you use all the output of a Combined Heat and Power plant to meet the energy needs of your business, you need not attribute the emissions from the plant between the energy and heat output - please refer to Annex 2 for this calculation. Otherwise the regular electricity emission factor should be applied

[8] A zero conversion factor can only be applied if your company has entered into a renewables source contract with an energy supplier, that has acquired Climate Change Levy Exemption Certificates (LECs) for the electricity supplied to you as a non-domestic electricity consumer.

Annex 4 - Typical Process Emissions

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There are six main greenhouse gases that are produced as a by-product by industry:

Carbon Dioxide CO2
Methane CH4
Nitrous oxide N2O
Perfluorocarbons PFC
Sulphur Hexafluoride SF6
Hydrofluorocarbons HFC

Below is a table that highlights the gases that are likely to be produced by a variety of the industries in the UK that are most likely to have a significant impact on climate change.
The dark areas represent the gases that are likely to be produced.

Table 3

Process related emissions[9]							
Process		Emission					
		CO_2	CH_4	N_2O	PFC	SF_6	HFC
Mineral Products	Cement Production	■					
	Lime Production	■					
	Limestone Use[10]	■					
	Soda Ash Production and Use	■					
	Fletton Brick Manufacture[11]	■	■				
Chemical Industry	Ammonia	■	■				
	Nitric Acid			■			
	Adpic Acid			■			
	Urea			■			
	Carbides	■	■				
	Caprolactam			■			
	Petrochemicals		■				
Metal Production	Iron, Steel and Ferroalloys	■	■				
	Aluminium	■			■		
	Magnesium					■	■
	Other Metals	■					
Energy Industry	Coal mining		■				
	Solid fuel transformation	■					
	Oil production	■	■				
	Gas production and distribution	■	■				
	Venting and flaring from oil/gas production	■	■				
Other	Production of Halocarbons				■		■
	Use of Halocarbons and SF_6				■	■	■
	Organic waste management	■	■				

Sources

Greenhouse Gas Inventory Reference Manual, Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories (IPCC, 1997)

adapted for UK processes by netcen (now AEA Energy & Environment)

[9] These process related emissions refer to the types of processes that are used specifically in the UK. Process emissions might be slightly different for processes operated in other countries.

[10] For use of limestone in Flue Gas Desulphurisation (FGD) and processes such as those in the glass industry. Not all uses of limestone release CO_2.

[11] This is specific to Fletton brick manufacture at the mineral processing stage, a process that uses clay with high organic content. Other types of brick manufacturing in the UK do not release Greenhouse Gases during the processing stage

Annex 5 - Conversion Factors for Greenhouse Gas Process Emissions (including emissions from refrigerants and air conditioning systems)

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Table 4

Factors for Process Emissions				
Emission	Amount Emitted per Year in tonnes	x	Conversion Factor	Total kg CO_2 equivalent
CO_2		x	1,000	
Methane		x	21,000	
Nitrous Oxide		x	310,000	
HFC - 125		x	2,800,000	
HFC - 134		x	1,000,000	
HFC - 134a		x	1,300,000	
HFC - 143		x	300,000	
HFC - 143a		x	3,800,000	
HFC - 152a		x	140,000	
HFC - 227ea		x	2,900,000	
HFC - 23		x	11,700,000	
HFC - 236fa		x	6,300,000	
HFC - 245ca		x	560,000	
HFC - 32		x	650,000	
HFC - 41		x	150,000	
HFC - 43 - I0mee		x	1,300,000	
Perfluorobutane		x	7,000,000	
Perfluoromethane		x	6,500,000	
Perfluoropropane		x	7,000,000	
Perfluoropentane		x	7,500,000	
Perfluorocyclobutane		x	8,700,000	
Perfluoroethane		x	9,200,000	
Perfluorohexane		x	7,400,000	
SF_6		x	23,900,000	
Total				**0**

Sources

The conversion factors in the table above incorporate global warming potential (GWP) values published by the IPCC in its Second Assessment Report (Climate Change 1995. The Science of Climate Change. Contribution of Working Group I to the Second Assessment Report of the Intergovernmental Panel on Climate Change. (Eds. J.T Houghton et al). Published for the Intergovernmental Panel on Climate Change by Cambridge University Press 1996). Revised GWP values have since been published by the IPCC in the Third Assessment Report (2001) but current UNFCCC Guidelines on Reporting and Review, adopted before the publication of the Third Assessment Report, require emission estimates to be based on the GWPs in the IPCC Second Assessment Report.

Notes

Not all refrigerants in use are classified as greenhouse gases for the purposes of the Climate Change Programme (e.g. CFCs, HCFCs). GWP values for refrigerant HFC blends should be calculated on the basis of the percentage blend composition (e.g. the GWP for R404a that comprises is 44% HFC125, 52% HFC143a and 4% HFC134a is 2800x0.44 + 3800x0.52 + 1300x0.04 = 3260).

Annex 6 - Passenger Transport Conversion Tables

Last updated:	Jun-07

Table 5a

Standard road transport fuel conversion factors					
Fuel used	Total units used	Units	x	kg CO_2 per unit	Total kg CO_2
Petrol		litres		2.3154	
Diesel		litres		2.6304	
Compressed Natural Gas		kg		2.7278	
Liquid Petroleum gas		litres		1.4975	
Total					0

Sources

UK Greenhouse Gas Inventory for 2005 (produced for Defra by AEA Energy & Environment)

Digest of UK Energy Statistics (DTI)

Carbon factors for fuels (UKPIA, 2004)

Notes

Emission factors calculated on a Net Calorific Value basis. Energy and emissions are currently calculated on a Gross Calorific Value basis in the UK, however it is anticipated that in the near future calculations will be moved to a Net Calorific Value basis, which is also consistent with the European Union Emission Trading Scheme (EUETS) for CO_2 emissions

1 imperial gallon (UK) = 4.546 litres

Table 6a

Passenger Road Transport Conversion Factors: Petrol Cars					
Size of car	Total units travelled	Units	x	kg CO_2 per unit	Total kg CO_2
Small petrol car, up to 1.4 litre engine		miles	x	0.2947	
		km	x	0.1831	
Medium petrol car, from 1.4 - 2.0 litres		miles	x	0.3479	
		km	x	0.2162	
Large petrol cars, above 2.0 litres		miles	x	0.4770	
		km	x	0.2964	
Average petrol car		miles	x	0.3372	
		km	x	0.2095	
Total for petrol cars					0

Table 6b

Passenger Road Transport Conversion Factors: Diesel Cars					
Size of car	Total units travelled	Units	x	kg CO_2 per unit	Total kg CO_2
Small diesel car, up to 1.7 litre or under		miles	x	0.2425	
		km	x	0.1507	
Medium diesel car, from 1.7 to 2.0 litre		miles	x	0.3027	
		km	x	0.1881	
Large diesel car, over 2.0 litre		miles	x	0.4240	
		km	x	0.2635	
Average diesel car		miles	x	0.3197	
		km	x	0.1987	
Total for diesel cars					0

Table 6c

Passenger Road Transport Conversion Factors: Petrol Hybrid Cars					
Size of car	Total units travelled	Units	x	kg CO_2 per unit	Total kg CO_2
Medium petrol hybrid car		miles	x	0.2031	
		km	x	0.1262	
Large petrol hybrid car		miles	x	0.3604	
		km	x	0.2240	
Total for hybrid petrol cars					0

Table 6d

Passenger Road Transport Conversion Factors: Cars (unknown fuel)					
Size of car	Total units travelled	Units	x	kg CO_2 per unit	Total kg CO_2
Average car (unknown fuel)		miles	x	0.3340	
		km	x	0.2075	
Total for average cars					**0**

Sources: Revised factors developed by AEA Energy & Environment and agreed with DfT (2007)

Notes: These factors are estimated average values for the UK car fleet in 2005 travelling on average trips in the UK. They are calculated based on data from SMMT on new car CO_2 emissions from 1997 to 2005 combined with factors from TRL as functions of average speed of vehicle derived from test data under real world testing cycles and an uplift of 15% agreed with DfT to take into account further real-world driving effects on emissions relative to test-cycle based data.

The hybrid car factors are calculated based on data new car CO_2 emissions averaged accross the main 4 hybrid vehicles currently available on the market and an uplift of 15% agreed with DfT to take into account real-world driving effects on emissions relative to test-cycle based data.
Real world effects not covered in regular test cycles include use of accessories (air con, lights, heaters, etc), vehicle payload (only driver +25kg is considered in tests, no passengers or further luggage), poor maintenance (tyre under inflation, maladjusted tracking, etc), gradients (tests effectively assume a level road), weather, harsher driving style, etc.

More accurate calculation of emissions can be made using the actual fuel consumed, where available, and the emission factors in Table 5a. Alternatively if a figure for a specific car's fuel consumption (e.g. in miles per gallon, mpg) is known, then the CO_2 can be calculated from the total mileage and the Table 5a factors.

Table 7

Passenger Road Transport Conversion Factors: Motorcycles					
Size of motorcycle	Total units travelled	Units	x	kg CO_2 per unit	Total kg CO_2
Small petrol motorbike (mopeds/scooters up to 125cc)		miles	x	0.1173	
		km	x	0.0729	
Medium petrol motorbike (125-500cc)		miles	x	0.1511	
		km	x	0.0939	
Large petrol motorbike (over 500cc)		miles	x	0.2069	
		km	x	0.1286	
Average petrol motorbike (unknown engine size)		miles	x	0.1718	
		km	x	0.1067	
Total for motorcycles					**0**

Sources: Revised factors developed by AEA Energy & Environment and agreed with DfT (2007)

Notes: These factors are based on calculations of average emissions data by size category, based data reproduced from ACEM (European Motorcycle Manufacturers Association) – sourced from the European Commission's Joint Research Centre. The original data is available at:
http://www.acembike.org/motorcycles&society/pressreleases/MS3-Environment-LMercanti.pdf

More accurate calculation of emissions can be made using the actual fuel consumed, where available, and the emission factors in Table 5a. Alternatively if a figure for a specific motorbike's fuel consumption (e.g. in miles per gallon, mpg) is known, then the CO_2 can be calculated from the total mileage and the Table 5a factors.

Table 8

Bus and Rail Passenger Transport Conversion Factors					
Method of travel		Passenger kms travelled (pkm)	x	kg CO_2 per pkm	Total kg CO_2
Bus [12]			x	0.0891	
Rail	national rail [13]		x	0.0602	
	light rail [14]		x	0.0650	
	underground [15]		x	0.0526	
Total					**0**

Sources Department for Transport and AEA Energy & Environment, 2007

Notes

[12] The bus factors are calculated based on fleet average gCO2/km for all bus class and journey data from the UK Greenhouse Gas Inventory and an average load factor of 9.2 calculated using total bus vehicle km and passenger km from Transport Statistics Great Britain (TSGB).

[13] The national rail factor refers to an average emission per passenger kilometre for diesel and electric trains in 2005. The calculation of the factor is based on the total electricity and diesel consumed by the railways in 2005/06 from the DfT National Modelling Framework Environment Module, and DfT transport statistics on the total number of passenger kilometres for 2005/06. The factor for conversion of units of diesel and electricity into CO_2 are based on the factors in Table 1 for diesel and the 2005 grid electricity factor in Table 2.

[14] The light rail factors were based on an average of factors for the Docklands Light Rail (DLR) service, the Manchester Metrolink and the Croydon Tramlink. The factors for these light rail systems were based on annual electricity consumption and passenger km data provided by the network operators in 2005 (referring to consumption in 2003/04) and a CO_2 emission factor for electricity generation on the national grid from the UK Greenhouse Gas Inventory.

[15] The Underground rail factor is based on the Underground's annual electricity consumption and uses corresponding passenger km figures for the Underground from Transport Statistics Great Britain.

Table 9

Air Passenger Transport Conversion Factors							
Method of travel		Passenger kms travelled (pkm)	x	kg CO_2 per pkm [16]	x	km uplift factor [17]	Total kg CO_2
Air [18]	long haul international		x	0.1056	x	109%	
	short haul international		x	0.1304	x	109%	
	domestic		x	0.1580	x	109%	
Total							**0**

Source Department for Transport and AEA Energy & Environment, 2007

Notes These emissions factors are intended to be an aggregate representation of the typical emissions per passenger km from illustrative types of aircraft for the 3 types of air services. Actual emissions will vary significantly according to the type of aircraft in use, the load, cabin class, etc.

[16] The emission factors **do not** include additional impacts of Radiative Forcing (i.e. non-CO_2 climate change impacts) and are designed to be used in conjunction with great circle distances. The total climate impacts of aviation due to Radiative Forcing are estimated to be up to 2-4 times those of CO_2 alone, however the science of Radiative Forcing is currently uncertain.

[17] The 9% uplift factor comes from the IPCC Aviation and the global Atmosphere 8.2.2.3 , which states that 9-10% should be added to take into account non-direct routes (i.e. not along the straight line great circle distances between destinations) and delays/circling.

[18] The emissions factors are based on typical aircraft fuel burn over illustrative trip distances listed in the EMEP/CORINAIR Emissions Inventory Guidebook (EIG 2006) – available at the EEA website at: http://reports.eea.europa.eu/EMEPCORINAIR4/en/B851vs2.4.pdf

The long haul estimate is based on a flight length from the Guidebook of of 6482 km, short haul 1108km and domestic 463km. Actual flight distances do however vary significantly, as demonstrated in the examples in the following tables. Domestic flights are between UK airports, short haul international flights are typically to Europe, and long haul international flights are typically to non-European destinations.

Illustrative long haul flight distances

From London to:		
Area	***Airport***	***Distance (km)***
North Africa	Abu Simbel/Sharm El Sheikh, Egypt	3300
Southern Africa	Johannesburg/Pretoria, South Africa	9000
Middle East	Dubai, UAE	5500
North America	New York (JFK), USA	5600
North America	Los Angeles California, USA	8900
South America	Sao Paulo, Brazil	9400
Indian sub-continent	Bombay/Mumbai, India	7200
Far East	Hong Kong	9700
Australasia	Sydney, Australia	17000

Source Distances based on International Passenger Survey (Office for National Statistics) calculations using airport geographic information.

Illustrative short haul flight distances

From London to:		
Area	***Airport***	***Distance (km)***
Europe	Amsterdam Netherlands	400
Europe	Prague (Ruzyne) Czech Rep	1000
Europe	Malaga Spain	1700
Europe	Athens Greece	1500

Source Distances based on International Passenger Survey (Office for National Statistics) calculations using airport geographic information.

Annex 7 - Freight Transport Conversion Tables

Last updated:	Jun-05

Table 5b

Standard road transport fuel conversion factors

Fuel used	Total units used	Units	x	kg CO_2 per unit	Total kg CO_2
Petrol		litres		2.3154	
Diesel		litres		2.6304	
Compressed Natural Gas		kg		2.7278	
Liquid Petroleum gas		litres		1.4975	
Total					**0**

Sources

UK Greenhouse Gas Inventory for 2005 (produced for Defra by AEA Energy & Environment)

Digest of UK Energy Statistics (DTI)

Carbon factors for fuels (UKPIA, 2004)

Notes

Emission factors calculated on a Net Calorific Value basis. Energy and emissions are currently calculated on a Gross Calorific Value basis in the UK, however it is anticipated that in the near future calculations will be moved to a Net Calorific Value basis, which is also consistent with the European Union Emission Trading Scheme (EUETS) for CO_2 emissions

1 imperial gallon (UK) = 4.546 litres

Table 9

Diesel Freight Road Mileage Conversion Factors

Detailed work is continuing on establishing revised factors for this sector. Once this is complete the factors will be published

Table 10

Other freight transport mileage conversion factors

Detailed work is continuing on establishing revised factors for this sector. Once this is complete the factors will be published