Department for Environment, Food and Rural Affairs

Guidelines to Defra's Greenhouse Gas Conversion Factors for Company Reporting

June 2008

What are Greenhouse Gas Conversion Factors?

These conversion factors allow companies and individuals to calculate greenhouse gas (GHG) emissions from a range of activities, including energy use and transport activities

Who should use these factors?

These factors are publicly available for use by anyone in the United Kingdom. We do not recommend that they are used by organisations or individuals overseas as the conversion factors are specific to the UK.

What should I use these factors for?

For voluntary estimating and reporting GHG emissions. This might be in a Company Report, a project plan or simply for your own use.

What should I *not* use these factors for?

These factors are not for use with mandatory or legal reporting. For reporting emissions under the EU Emissions Trading Scheme see here. For reporting emissions under Climate Change Agreements see here. For reporting emissions under the new Carbon reduction commitment, see here. Policymakers in National, Regional and Local Government should consult the document *Greenhouse Gas Policy Evaluation and Appraisal in Government Departments*

What about my personal carbon footprint?

Individuals who wish to calculate their carbon footprint from their day-to-day activity may be interested in the Governments Act on CO_2 carbon calculator.

What is my company's carbon footprint?

The Carbon Trust provides more information about carbon footprinting for companies at www.carbontrust.co.uk/footprinting.

This includes a carbon footprint calculator for organisations, which uses the factors contained in this document. Visit http://www.carbontrust.co.uk/carboncalculator

How should my company report GHG emissions?

GHGs can be measured by recording emissions at source by continuous emissions monitoring or by estimating the amount emitted using activity data (such as the amount of fuel used) and applying a conversion factors (e.g. calorific values, emission factors, oxidation factors). For instance, a conversion factor can be used to calculate the amount of CO2 emitted as a result of burning a particular quantity of oil in a heating boiler. It is recommended that UK companies not already reporting for regulatory purposes use Defra's Guidelines for Environmental Reporting, as presented here. The Conversion factors given here will assist you in implementing these Guidelines.

Which Conversion Factors to use

- To calculate emissions from the use of *Fuels* see **Annex 1**
- To calculate emissions from *Combined Heat and Power* (CHP) see **Annex 2**
- To calculate emissions from the use of *Electricity* see **Annex 3**
- To understand which industrial processes lead to GHG emissions see **Annex 4**
- *Global warming potentials* of commonly used GHGs are given in **Annex 5**
- To calculate emissions associated with *passenger transport* see **Annex 6**
- To calculate emissions associated *freight transport* see **Annex 7**

Units

All emissions factors are given in units of kg (kilograms) of carbon dioxide (CO_2) equivalent. GHG emissions are sometimes quoted in figures of mass of *Carbon equivalent*, rather than *carbon dioxide equivalent*. To convert carbon equivalents into carbon dioxide equivalents, multiply by 44/12

To convert emissions of gases other than carbon dioxide to carbon dioxide equivalent units, see **Annex 5**

Missing factors, and additional guidance

If you require GHG conversion factors that you cannot find here, or this guidance is unclear, or you have additional questions, we would very much like to hear from you. Please send us an email at Environmentalreporting@defra.gsi.gov.uk We cannot undertake to provide all the conversion factors you might need, but please provide a rationale for your request and we will assess your needs accordingly

Annex 1 – Converting from fuel use to carbon dioxide emissions

How to use this Annex

1. Identify the amount of fuel used

2. Identify the units. Are you measuring fuel use in terms of mass, volume or energy?

3. If you are measuring fuel use in terms of *energy* is your unit of measurement *net energy* or *gross energy* (in the event that this is unclear you should contact your fuel supplier)

4. Identify the appropriate conversion factor that matches the unit you are using. If you cannot find a factor for that unit, the following gives guidance on converting between different units of mass, volume and energy

5. Multiply the amount of fuel used by the conversion factor to get total emissions (kg CO_2). The excel spreadsheet does this automatically following your entry the amount of fuel used into the appropriate box.

Notes : Fuel types

Some fuel types may be known by different names. Burning oil is also known as kerosene or paraffin used for heating systems. Aviation Turbine fuel is a similar kerosene fuel, but specifically refined to a higher quality for aviation.

Notes : Coal

The factor given is the 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.

Notes : Electricity

See **Annex 3** to calculate emissions from electricity use

Data source

Digest of UK Energy statistics

The relevant conversion factors can be found in the pdf document at
http://www.defra.gov.uk/environment/business/envrp/conversion-factors.htm

Annex 2 – Combined Heat and Power (CHP)

How to use this Annex

If you use all the output of a Combined Heat and Power plant to meet the energy needs of your business, there is no reason to attribute the emissions from the plant between the electricity and heat output, since you are responsible for both. You can therefore calculate the total plant emissions from the fuel used with the standard conversion factors at Annex 1.

If the *heat user* and the *electricity user* are different individuals/installations, carbon dioxide emissions should be calculated as per Annex I (i.e. calculate fuel consumption then apply the appropriate conversion factor for that fuel) and then divided between the *heat user* and the *electricity user.*

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:

$$\text{Emissions (in } kgCO_2\text{) } \textit{electricity} = \frac{\textit{twice} \text{ total emissions (in kgCO2) * electricity produced (kWh)}}{\text{twice total electricity produced + total heat produced (in kWh)}}$$

$$\text{Emissions (in } kgCO_2\text{) } \textit{heat} = \frac{\text{total emissions (in kgCO2) * heat produced (kWh)}}{\text{twice total electricity produced + total heat produced (in kWh)}}$$

I buy my electricity from a producer/plant that I know is CHP. Which factor should I use?

If you purchase electricity from a CHP plant, the appropriate emissions factor for electricity use is given in Annex 3, under *Electricity from CHP*.

The relevant conversion factors can be found in the pdf document at http://www.defra.gov.uk/environment/business/envrp/conversion-factors.htm

Annex 3 – Converting from *UK grid* electricity use to carbon dioxide emissions

How to use this Annex

To calculate emissions of carbon dioxide associated with *use of UK grid electricity*

1. Identify the amount electricity used, in units of kWh

2. Multiply this value by the conversion factor *UK grid electricity use*

How are the factors calculated?

The electricity conversion factors given represent the average carbon dioxide emission from the UK national grid per kWh of electricity used at the point of final consumption (i.e. transmission and distribution losses are included). These factors include only carbon dioxide 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.).

This factor changes from year to year, as the fuel mix consumed in UK power stations changes. Because these annual changes can be large (the factor depends very heavily on the relative prices of coal and natural gas), and to assist companies with year to year comparability, the factor presented is the *average* of the grid Conversion factor over the last 5 years. This factor is updated annually.

I generate my electricity onsite. How do I calculate emissions from this?

If you generate renewable electricity on-site, and *do not* sell Renewable Obligation Certificates (ROCs) or Levy Exemption Certifications (LECs) to a third party, this electricity should be rated as **zero emission.** 'Renewable electricity' in this context should be considered any form of generation that does not emit carbon dioxide, or generation of electricity for renewable biomass.

If you generate renewable electricity on-site, and *do* sell Renewable Obligation Certificates (ROCs) or Levy Exemption Certifications (LECs) to a third party, emissions should be calculated as per *UK Grid electricity use.*

How should I report the carbon emissions from my use of green tariffs?

This is a complicated issue. Electricity suppliers already have a legal obligation to produce a certain amount of their electricity from renewable sources through Renewables Obligation Certificates (ROCs) and other Government schemes.

This means that existing evidence suggests that green tariffs deliver insignificant additional carbon savings from renewable energy. You may wish to speak to your supplier about whether your tariff results in additional renewable energy being generated beyond the legal minimum

After considering the evidence on this issue, Defra has decided to revise this best practice Guidance.

For the **2008-9 reporting year,** we recommend that best practice will be for businesses to use the grid average electricity quotient. This fits with wider policy, such as the upcoming Carbon Reduction Commitment and is consistent on how Government reports its own carbon emissions.

However, we do recognise that some existing and future green tariffs may well deliver broader environmental benefits and may have the potential to deliver these carbon benefits in the long term. Following the outcome of Ofgem's consultation on proposals for revised guidance to suppliers on green tariffs, Defra will consult on how any broader environmental benefits, possible long term carbon benefits and any genuinely additional carbon benefits of green tariffs could be treated in the Defra voluntary reporting guidelines. We would welcome your ideas for how to do this.

In anticipation of this change, for the **2007-8 reporting year**, best practice for voluntary reporting is for you to make clear the basis on which green electricity is being valued. We would suggest you do this by either:

- Applying a grid average electricity quotient, in which case we recommend that you should **footnote this to explain that you are using a green tariff** to reflect your broader commitment to the environment**.**

Or,

- 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, you may **continue to zero rate this, but we recommend that you footnote this to say that you have applied a zero emission rating resulting from a green tariff.**

Why does the government use a *smaller* electricity factor for calculating the impact of carbon dioxide saving policies?

The Government uses a factor of 0.43 kgCO_2 per kWh when appraising policies that *reduce electricity consumption or encourage the use of renewable electricity*

This is because in the long run the carbon dioxide saved by policies which reduce electricity corresponds to the fossil fuel plant that would otherwise have been constructed if the policies had not been in place. It is not the same as the plant switched on or off in real time as a response to real time variations electricity consumption, because the long run marginal effect (which this factor captures) is a function of decisions about plant construction.

Analysts assume that, as demand for electricity is reduced, the first plant to reduce output is a Combined Cycle Gas Turbine (CCGT) power station. This type of power station emits 0.43 kg CO_2 per kWh electricity produced. Therefore the impact of *economy wide* emissions savings (such as UK energy

efficiency policy or increased renewable generation) is to reduce emissions by 0.43 kg CO_2 per kWh electricity saved.

It is important to note that the government use this factor to calculate the carbon dioxide emissions *savings* (or *avoided emissions*) rather than *emissions*. The Government does *not* use this factor to report carbon dioxide emissions, nor does it use this factor, in any way, in calculating emissions in the UK GHG inventory.

This factor will be reviewed in the event that the predicted future mix of UK power stations changes.

> Companies and individuals should not use this factor for reporting emissions from electricity use or savings they have made from reducing electricity consumption. They should use the factor *UK grid electricity use*

Data source

Based on UK Greenhouse Gas Inventory for 2005 (AEA Energy & Environment) according to the amount of CO_2 emitted from major power stations from Digest of UK Energy statistics (DUKES)

The relevant conversion factors can be found in the pdf document at http://www.defra.gov.uk/environment/business/envrp/conversion-factors.htm

Annex 4 – Typical Process Emissions

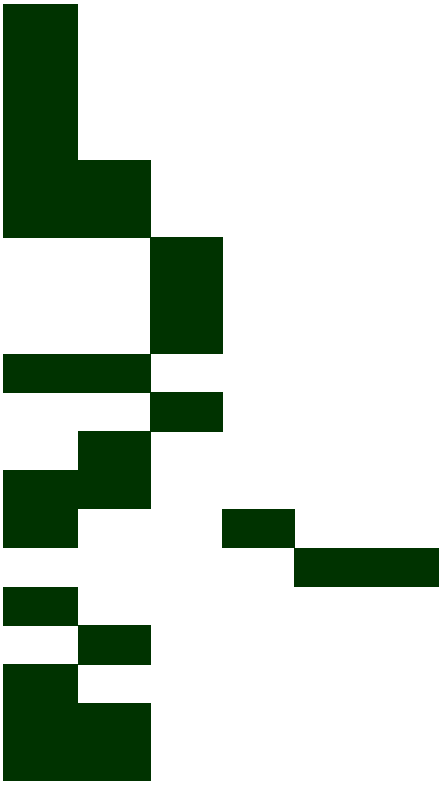
How to use this Annex

The Kyoto protocol seeks to reduce emissions of the following six greenhouse gases.

Carbon Dioxide (CO_2)
Methane (CH_4)
Nitrous oxide (N_2O)
Perfluorocarbons (PFC)
Sulphur Hexafluoride (SF_6)
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.

Process		Gas released CO2 CH4 N2O PFC SF6 HFC
Mineral Products	Cement Production	
	Lime Production	
	Limestone Use[1]	
	Soda Ash Production and Use	
	Fletton Brick Manufacture[2]	
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	

[1] 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.

[2] 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

	Venting and flaring from oil/gas production	[redacted]	
Other	Production of Halocarbons		[redacted]
	Use of Halocarbons and SF6		
	Organic waste management	[redacted]	

Notes

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.

Data Source

Greenhouse Gas Inventory Reference Manual, Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories (IPCC, 1997) adapted for UK Processes by AEA Energy and Environment

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

How to use this Annex

Global Warming Potentials (GWPs) are used to compare the relative impact of the emission of equivalent masses of different GHGs. For example, it is estimated that the emission of 1 kilogram of methane will have the same warming impact[3] as 21 kilograms of carbon dioxide. Therefore the GWP of methane is 21. The GWP of carbon dioxide is, by definition, 1.

The conversion factors in the table above incorporate (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, 1996)*.

Revised GWP values have since been published by the IPCC in the Fourth Assessment Report (2007) but current UNFCCC Guidelines on Reporting and Review, adopted before the publication of the Fourth Assessment Report, require emission estimates to be based on the GWPs in the IPCC Second Assessment Report.

Notes : CFCs and HCFCs

Not all refrigerants in use are classified as greenhouse gases for the purposes of the UNFCCC and Kyoto Protocol (e.g. CFCs, HCFCs). These gases are controlled under the Montreal Protocol and as such GWP values are not listed here

Notes : Mixed/Blended gases

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 [2800 x 0.44] + [3800 x 0.52] + [1300 x 0.04] = 3260).

The relevant conversion factors can be found in the pdf document at http://www.defra.gov.uk/environment/business/envrp/conversion-factors.htm

[3] Over the period of one century. The length of time a GWP is referenced to is important. 100 year GWPs were adopted for use under the UNFCCC and Kyoto Protocol.

Annex 6 – Passenger Transport Conversion Tables

How to use this Annex

Emissions can be calculated *either* from fuel use (See Table 5) or from *distance* travelled (other tables). For public transport (Tables 10 and 11) emissions are presented per passenger, rather than per vehicle. Therefore enter *passenger kilometres travelled* to calculate emissions (e.g. if one person travels 500km, then *passenger kilometres travelled* are 500. If three people travel the same distance *passenger kilometres travelled* are 1500.)

Simply multiply activity (either fuel used, kilometres travelled or passenger kilometres travelled) by the appropriate conversion factor. An excel spreadsheet is provided for ease of use.

How were these factors calculated?

Defra have produced a document *Passenger transport emissions factors : Methodology paper* that explains the derivation of these factors in detail.

Data sources

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

Digest of UK Energy statistics (DUKES)

The relevant conversion factors can be found in the pdf document at http://www.defra.gov.uk/environment/business/envrp/conversion-factors.htm

Annex 7 – Freight Transport Conversion Tables

How to use this Annex

If you know how much of a particular fuel type is consumed, emissions can be calculated using **Table 5.**

Table 12a gives emissions for distance travelled for vans and small trucks

Table 12b gives emissions *per tonne freight carried* for vans and small trucks. Emission factors for vans in tonne km were calculated from the emission factors per vehicle km provided in Table 8 (Annex 6) and an average load factor of 50%. The average cargo capacity was taken to be 0.5 tonnes for vans up to 1.25 tonnes gross vehicle weight, and 2 tonnes for vans up to 3.5 tonnes gross vehicle weight.

Table 13a gives emissions *per vehicle kilometre travelled* for a range of HGV sizes with a range of different loads. Use this table if you know the distance the *vehicle* has travelled. If you do not know the load capacity of your vehicle, apply the *UK average load* which is given for a range of vehicle classes.

Table 13b gives emissions *per tonne kilometre travelled* for a range of HGV sizes with a range of different loads. Use this table if you know the distance the *freight* has travelled and what the *mass* (in tonnes) of the freight was.

Table 14 gives emissions factors for *tonne kilometres* of freight for *shipping*, *rail,* and *air freight*

The relevant conversion factors can be found in the pdf document at http://www.defra.gov.uk/environment/business/envrp/conversion-factors.htm