

Delivered Energy Emission Factors for 2003

Matt Batey and Christine Pout
December 2005

This note presents delivered energy emission factors for 2003 which update the revised 2001 emission factors for SAP presented in an earlier note "CO₂ Emission Figures for Policy Analysis" produced in July 2005. The note also presents historical annual emissions factors for delivered grid electricity and assesses the extent to which the inclusion of transport emissions for oil, LPG and solid fuels would increase these delivered energy emission factors. This work was funded by DEFRA's Global Atmosphere Division.

Delivered energy emission factors based on 2003 data

The main sources of data for this exercise 2003 combustion only emission factors which are produced by NETCEN¹ and data on energy use in energy transformation and energy production in 2003 from the 2005 Digest of UK Energy Statistics². Where the later was used to calculate emissions arising from production overheads³. The general approach and methodology has already been explained the earlier note "CO₂ Emission Figures for Policy Analysis".

Both the revised 2001 and 2003 delivered energy emission factors are shown below:

| UK Carbon Dioxide Emission Factors (kgCO₂/kWh) | 2003 | 2001 |
|--|-------------|-------------|
| electricity from grid ⁴ | 0.43 | 0.43 |
| mains gas | 0.191 | 0.194 |
| LPG | 0.235 | 0.234 |
| bottled LPG | 0.235 | 0.234 |
| heating oil | 0.265 | 0.265 |
| house coal | 0.298 | 0.291 |
| non-domestic coal | 0.284 | 0.300 |
| anthracite | 0.317 | 0.317 |
| manufactured smokeless fuel | 0.343 | 0.392 |
| dual fuel appliance (mineral and wood) | 0.187 | 0.187 |
| electricity displaced from grid | 0.568 | 0.568 |

¹ UK Greenhouse Gas Inventory, 1990-2003, SL Baggott et al, September 2005, NETCEN, DEFRA - www.naei.org.uk/emissions/greenhouse_2003.php?

² Digest of UK Energy Statistics 2005: Table 1.2 Aggregate Energy Balance 2003, DTI, National Statistics, The Stationary Office, London

³ Where these production overheads exclude transportation for fossil fuels

⁴ The factor used for SAP is the one recommended in DEFRA's guidelines for company reporting on greenhouse gas emissions (www.defra.gov.uk/environment/business/envrp/gas/index.htm) The emission factor for electricity was changed slightly from the previous guidelines (July 2005) to come into line with calculations for the Climate Change Levy Agreements and future requirements for Emissions Trading. It is now based on the (then) projected fuel mix for the grid 1998-2000.

The 2003 emission factor for natural gas is significantly lower than the revised 2001 factor, this is because of a reduction in the NETCEN combustion only emission factor rather than any change in the production overhead emissions. The 2003 emission factors for coal have also changed. For house coal the combustion only emission factor has increased, resulting in a higher emission factor of 0.298kgCO₂/kWh, whilst the combustion only emission factor for non-domestic coal has decreased reducing the emission factor 0.300 to 0.284kgCO₂/kWh.

The LPG factor proposed by LPGA of 0.237kgCO₂/kWh, based on the inclusion of distribution emissions from the 1997 Lewis MEET study⁵, as detailed below, includes emissions arising from transport and delivery, which is not the case with other fuels. The factor calculated excluding the distribution figure and based on 2003 data is 0.235kgCO₂/kWh. Including a separate estimate of transport emissions alone (see below), the figure rises to 0.236kgCO₂/kWh.

The production overhead for coke and manufactured smokeless fuels is made up of two components energy used during manufacture plus fugitive emissions arising directly from the transformation process. For the 2001 data a mass balance approach was used to calculate the latter. However, this approach gave a negative carbon emission for 2003 so an alternative approach was used.

The revised approach used here is to use the figure for fugitive emissions from solid fuel transformation from the UK Greenhouse Gas Emissions Inventory⁶ for 2003 and dividing it by the combined total 2003 production of coke products and manufactured solid fuels. This gives a production emission factor of 0.005 kgCO₂/kWh for solid fuels giving an overall emission factor for solid manufactured fuels of 0.343 kgCO₂/kWh.

Inclusion of fuel transport emissions

The delivered fossil fuel emission factors presented above do not include emissions associated with transporting the fuel to point of use⁷. This section provides some initial estimates of the transport emission overheads arising from heating oil, coal and LPG used in buildings.

A 1997 study conducted by AEA Technology assessed the transport related emissions associated with various transport fuels, including oil and LPG. Although the calculations are based on data ranging from 1985 to 1995 and relate to fuels used for transport rather than by buildings they should nevertheless provide a first estimate of the transport emissions overhead for oil and LPG relating to buildings. In addition a small desktop study was undertaken to generate provisional transport emissions

⁵ Fuel and energy production emission factors Dr C A Lewis MEET Project: Methodologies for Estimating Air pollutant Emissions from Transport, Task No. 3.4, Deliverable No. 20, Contract No. ST-96-SC.204, 1997.

⁶ UK Greenhouse Gas Inventory, 1990-2003, SL Baggott et al, September 2005, NETCEN, DEFRA

⁷ Although for renewables fuels an allowance for transport emissions is included in the SAP emission factors.

estimates specifically for building related fuel consumption. The data available for this study was limited, collected from web-based sources or personal estimates by companies involved in the fuel distribution business and the results should therefore be treated with some caution. The estimates for the various fuels are described below.

Oil

The 2005 oil data provided by F Peart & Sons Ltd, estimated an average delivery of 150,000l of oil per week and an average distance covered of 1000miles per week for an individual tanker. This data gave a transport emission factor for oil (mainly heating oil) of 0.55g/kWh energy produced, based on standard conversions of oil weight to energy and HGV emissions.

However this has a negligible effect on the overall emission factor using the existing calculations, remaining at 0.265kgCO₂/kWh.

Coal

Delivery data for domestic coal, by 50kg bags, was not available from the 1997 study, only an emission factor of 0.0029kgCO₂/kWh for large-scale delivery to power stations.

2005 data was based on two company sources, CPL Distribution Ltd and Cawley Bros Haulage. The transport emission factor for coal were significant at 0.0032kgCO₂/kWh, although this figure is based on a number of assumptions, and so should be treated with particular caution. However the figure is only a little higher than the large delivery figure from the 1997 study, which would reflect a lower efficiency of transporting smaller loads to multiple destinations.

LPG (Bulk)

LPG emissions calculated in the 2005 survey are, unlike oil, markedly lower than those reported in the 1997 Lewis-MEET study. However, the latter figures also include emissions due to electricity used in the compression phase prior to distribution from the terminal and not directly attributable to transport. This is already taken into account in the production emission factor which is applied to all oil products.

Including transport emissions and an upstream production emission factor the delivered energy emission factor for 2003 is 0.236 kgCO₂/kWh. Without emissions associated with transport, this figure is reduced to 0.235 kgCO₂/kWh.

LPG (Bottled)

As above regarding the 1997 figures but otherwise a slightly higher factor than bulk deliveries, due to a lower carriage capacity and greater overall container weight, hence proportionally more fuel is burnt to carry the same amount of fuel.

The transport overhead emission factors from the desk based study (2005) and the 1997 report are compared below:

| Transport Emission Factors (kgCO₂/kWh) | | | | | |
|--|----------------|------------------|---------------------|----------------|------------------|
| | Oil | LPG(Bulk) | LPG(Bottled) | Coal | Biodiesel |
| 1997 | 0.00043 | 0.00227 | - | - | - |
| 2005 | 0.00055 | 0.00048 | 0.00061 | 0.00319 | |
| 1997 for electricity | 0.0006 | - | - | 0.0029 | 0.0055 |

The following table compares delivered energy emission factors with and without the transport overheads included.

Emission factors including transport emissions

| | 2003 Inc. Transport | 2003 |
|--|----------------------------|-------------|
| electricity from grid | 0.43 | 0.43 |
| mains gas | 0.191 | 0.191 |
| LPG | 0.236 | 0.235 |
| bottled LPG | 0.236 | 0.235 |
| heating oil | 0.265 | 0.265 |
| house coal | 0.301 | 0.298 |
| non-domestic coal | 0.287 | 0.284 |
| anthracite | 0.317 | 0.317 |
| manufactured smokeless fuel | 0.343 | 0.343 |
| dual fuel appliance (mineral and wood) | 0.187 | 0.187 |
| electricity displaced from grid | 0.568 | 0.568 |

This preliminary study would seem to indicate that emissions from transporting heating oil, LPG and solid fossil fuels are small in relative to the total emission burden. However, for bulky fuels and/or where distribution distances are long transportation emissions may be more significant

Historical Energy Emission Factors for Electricity 1970 – 2003

The average emission factor for grid electricity of 0.43 kgCO₂/kWh used in SAP is the one recommended in the DEFRA guidelines for company reporting on greenhouse gas emissions. This figure is now based on the (then) projected fuel mix for the grid 1998-2000, where previously it was calculation of the average emissions between 2005-2010 based recent DTI projections

The actual average delivered energy emission factors for years to 2004 are presented here for comparison. Although the overwhelming trend downward, In recent years there has been a small increases due to relative increases in coal use for electricity generation against a levelling off and slight fall in natural gas use brought about by higher gas prices relative to coal.

The 2003 figure for UK grid electricity is in fact 0.543kgCO₂/kWh. The slightly rising trend since 1999 is shown in the table below and the long-term trend illustrated in the following graph.

| year | kgCO ₂ /kWh |
|------|------------------------|
| 1970 | 1.07 |
| 1971 | 1.04 |
| 1972 | 1.02 |
| 1973 | 1.01 |
| 1974 | 0.97 |
| 1975 | 0.98 |
| 1976 | 0.95 |
| 1977 | 0.95 |
| 1978 | 0.91 |
| 1979 | 0.95 |
| 1980 | 0.94 |
| 1981 | 0.93 |
| 1982 | 0.89 |
| 1983 | 0.87 |
| 1984 | 0.83 |
| 1985 | 0.83 |
| 1986 | 0.82 |
| 1987 | 0.81 |
| 1988 | 0.77 |
| 1989 | 0.75 |
| 1990 | 0.77 |
| 1991 | 0.72 |
| 1992 | 0.68 |
| 1993 | 0.61 |
| 1994 | 0.59 |
| 1995 | 0.55 |
| 1996 | 0.51 |
| 1997 | 0.51 |
| 1998 | 0.52 |
| 1999 | 0.48 |
| 2000 | 0.52 |
| 2001 | 0.54 |
| 2002 | 0.52 |
| 2003 | 0.54 |
| 2004 | 0.53 |

