

Appendix 3: Methods Used for Calculating End User Emissions

Introduction

Emissions of GHGs reported under international conventions are typically on a “by source” basis. This means that the emissions are allocated to the source sector at the point of their release. For example, emissions from refining oils are allocated to the refineries, and emissions from the combustion of fuel in vehicles are allocated to the relevant transport sector.

This section of the report presents emissions on an “end user” basis. In this case, all emissions associated with energy supply (e.g. power generation, coal mining, oil and gas extraction, refineries) are allocated to the final users of the energy. In the above example, the emissions from the refineries would be reallocated to all oil users, including within the transport sector. Therefore, the main usefulness of end user emission inventories is to present a more representative picture of emissions due to consumption, rather than production. End user inventories are needed in order to reflect the full impact of energy efficiency policies as they show the emissions associated with sector consumption of all fuels, including emissions associated with electricity use.

The scope of the emissions allocated within these Devolved Administration (DA) end user inventories is bounded by the definition of the “UK” emissions, as applied in the main DA by source inventories. The sum of the DA end user emissions equals the sum of the DA by source emissions. GHG emissions associated with fuel imports (e.g. electricity imported from the EU and consumed in the UK) are not reported within these data. However, the emissions of GHGs associated with the refining of fuels that are subsequently exported are included in these DA inventories, as the emissions are produced at source within the UK energy supply industry. An example of this is for international aviation and shipping; whilst the greenhouse gas (GHG) emissions from the direct use of petroleum fuels in those “memo item” sources are excluded from the end user inventories, the emissions associated with the supply of fuels to those sectors (i.e. upstream oil extraction and refinery emissions within the UK) are included in the DA end user inventories.

End User Methodology

The method for calculating UK emissions on an end user basis is described in Annex 13 of the National Inventory Report (Webb et al., 2013). The calculation uses an iterative approach, carried out in a database. As an overview, the approach is summarised in the three steps below:

1. Emissions are calculated for each sector for each fuel.
2. Emissions from fuel and electricity producers are then distributed to those sectors that use the fuel according to the energy content of the fuel they use (these sectors can include other fuel producers).
3. By this stage in the calculation, emissions from final users will have increased and those from fuel and electricity producers will have decreased. The sum of emissions from fuel producers and power stations in a particular year as a percentage of the total emissions is then calculated.

If this percentage, for any year, exceeds a predetermined value (e.g. 1% or 0.01%) the process continues at Step 2. If this percentage matches or is less than the predetermined value, the calculation is finished.

Convergence of this iterative approach is likely, as the fuel flows to the final users are much greater than fuel flows amongst the fuel producers. This calculation results in a table of emissions for the UK on an end user basis. Emissions from the energy supply sector are decreased to a very small number, and emissions within the end user sectors are increased.

DA end user estimates are then calculated by disaggregating the UK level estimates, in the same way as the DA source inventories are produced. The estimates for direct fuel use in the end use sectors, and emissions from energy supply, are therefore consistent with the DA source inventories.

In order to allocate the energy supply emissions to all sources, additional estimates have been required for the disaggregation of electricity use, and for the exports¹ category. Table A3.1 summarises the data used to derive DA estimates for sector-specific electricity use and exports. Note that the 2011 electricity data for Northern Ireland was not made available in time for this analysis.

Table A3.1 Summary of DA Data used to Derive Sector Estimates for Electricity Use and Exports

Assumptions for Electricity and Exports		
Source Name	Activity Name	Description
Public sector	Electricity	Northern Ireland public sector electricity use for 2003 onwards is taken from the Public Sector Energy Campaign dataset (DFPNI 2012), whilst the DA share of GB activity is derived from analysis of the Inter-Departmental Business Register for 2003 onwards. The 1990 estimates for all DAs are based on economic indicators from previous studies using the REEIO model.
Miscellaneous industrial/commercial	Electricity	The DA share of UK activity is derived from analysis of the Inter-Departmental Business Register for 2003 onwards, whereas the 1990 estimates are based on economic indicators from previous studies using the REEIO model.
Domestic	Electricity	Country-specific domestic electricity use in GWh, is taken from analysis within DECC Energy Trends December 2012 (for 2008 to 2011), December 2011 for 2007, December 2010 for 2006, December 2009 for 2005, December 2008 for 2003 and 2004, and from REEIO analysis for 1990. Scotland 1990 data are estimated by back-casting reported trends in domestic electricity use from the Scottish Housing Condition Survey. England, Wales and Northern Ireland data retain the % share from the REEIO analysis. No Northern Ireland data were available in the December 2012 Energy Trends, however, so the Northern Ireland % share of UK domestic electricity in 2010 has been used to estimate 2011 data.
Iron and steel - combustion plant, and Blast Furnaces	Electricity	Country-specific electricity use data for 2003 onwards is derived from ISSB regional energy statistics, and 1990 electricity use is estimated from ISSB regional production statistics.
Railways	Electricity	The DfT Rail Emission Model indicates that there are no electrified lines in Wales or Northern Ireland, and has revised the data also for England and Scotland.
Gas production	Electricity	Overall gas throughput through each of the Low Pressure Distribution Zones, from the gas network operators.
Refineries - combustion	Electricity	Carbon dioxide emissions from refineries are used to estimate the DA share of UK sector electricity consumption.

¹ Exports refers to the emissions associated with the production of fuel or electricity which is then exported from the UK, or used as fuels for international aviation or shipping.

Assumptions for Electricity and Exports		
Source Name	Activity Name	Description
Collieries - combustion	Electricity	Regional coal production data are used to estimate the DA share of UK electricity use by collieries
Exports	Electricity	DA data on electricity exports are published within the periodic DECC publication "Energy Trends". However, we note that the data published are the "net" import-export balance and the actual data on electricity exports from England and Northern Ireland have been obtained through personal communication with the DECC energy statistics team in 2012. (Personal communication: Hemingway, 2013)
Other industrial combustion	Electricity	For 2003 onwards, the "other industry" estimate of DA electricity use is derived by difference using the DECC Energy Trends DA totals for electricity sales and the estimates for other sectors. The 1990 estimates are calculated by difference, using 1989 regional electricity sales data scaled to 1990 UK electricity totals.
Non-ferrous metals (combustion)	Electricity	Electricity use estimates by DA are based on analysis of the DA share of the economic sector from the Inter-Departmental Business Register for 2010, with the 2010 DA split applied across all years.
Chemicals (combustion)	Electricity	Electricity use estimates by DA are based on analysis of the DA share of the economic sector from the Inter-Departmental Business Register for 2010, with the 2010 DA split applied across all years.
Pulp, paper and print (combustion)	Electricity	Electricity use estimates by DA are based on analysis of the DA share of the economic sector from the Inter-Departmental Business Register for 2010, with the 2010 DA split applied across all years.
Food, drink and tobacco	Electricity	Electricity use estimates by DA are based on analysis of the DA share of the economic sector from the Inter-Departmental Business Register for 2010, with the 2010 DA split applied across all years.
Agriculture - stationary combustion	Electricity	For Northern Ireland, estimated electricity use is based on DETI (2010) ² which provides electricity use estimates for the sector in 2005; the estimates for other years in Northern Ireland have been scaled on the UK sector electricity trends. For GB, employment on Agricultural Holdings data is used to estimate the DA share of GB sector electricity use for all years.
Exports	ATF, Burning Oil, DERV, Fuel Oil, Gas Oil, Petrol	In each year, the DA share of carbon dioxide emissions from refineries is used as an indicator of DA oil exports.
Exports	Coke	Regional data on coal consumed in coke ovens from ISSB statistics, DUKES, and WDig Hist Stats are used to estimate the DA share of coke exports.
Exports	SSF	Regional data on SSF production, based on reported or estimated annual plant production by site are used to estimate the DA share of SSF exports.

Revisions to End User Inventory Data and Methodology

The DA end user method has been updated since the 1990-2010 DA GHG inventory report, with data and method improvements to further develop the DA end user estimates, to build upon new information and data. There have therefore been recalculations of the end user estimates as a result of these data and method updates. The key differences in the approach used for the DA end user calculation this year compared with last year are summarised below. This includes both changes to the methods used, and improvements to the data:

- Revisions to the total DA electricity sales data are evident for recent years within DECC Energy Trends December 2012. The England/Wales split of electricity use has been revised

² http://www.detini.gov.uk/business_opportunities_and_challenges_arising_from_carbon_emissions_targets_interim_report.pdf

by the Department of Energy and Climate Change (DECC), with slightly higher estimates for the electricity sales in England since 2009, and lower estimates for electricity use in Wales. Electricity sales data for Northern Ireland have been increased by 5% in 2009, leading to higher end user estimates for Northern Ireland than in previous inventory estimates, with smaller revisions to the 2010 data;

- The driver used to estimate the rail sector use of electricity has been revised based on new analysis of the Rail Emission Model, which has identified that there are no electrified lines in Wales or Northern Ireland, and has revised the data also for England and Scotland. This revision affects the distribution of the rail sector end user emissions, but has not impact on the overall DA end user emission estimates, as the method for the other industry sector aligns the total DA sales with those published in DECC Energy Trends 2012;
- Electricity estimates for the public sector in 2010 were revised based on new data from the Northern Ireland Public Sector Energy Campaign;
- Electricity estimates for the gas supply industry were revised to utilise a new dataset acquired from the UK gas network operators on the overall gas throughput through each of the Low Pressure Distribution Zones, which are regionally allocated. There is a complete time series of actual (i.e. not weather-corrected) gas throughout from 2007 onwards, and this is regarded as a better indicator for the electricity use in the industry within the UK than the previous analysis which used emissions data from combustion processes at gas terminals for 2003 onwards. The previous analysis has been retained for 1990 estimates in this sector, based on REEIO model analysis of the gas supply sector GVA across the DAs, and the DA share interpolated between 1990 and 2007.

End User Analysis by National Communication Sector

Analysis of the outputs from the updated DA end user model is presented below, with details provided for the National Communication sectors where the end user approach has the greatest impact compared to the by source inventories. More detail is provided within each of the DA chapters of this report.

Note that the application of UK-wide factors to derive end user emission estimates for electricity consumption in the UK has a notable impact on the re-distribution of power sector emissions from the by source inventory dataset, and affects the comparisons with overall DA source emissions. For example, the power sector emissions in Scotland in the by source inventory are lower per unit GWh generated than the rest of the UK, but a UK-wide factor is applied to all UK electricity consumption. This leads to an oddity in the comparison of by source and end user emissions, as Scotland in 2011 is a net exporter of electricity, but a net importer of electricity-related emissions in the end user model.

Business

The business sector includes industrial and commercial energy use sources, in addition to a number of non-energy sources such as the use of fluorinated gases. Across the UK in 2011 the end user estimates for the business sector are 196% that reported in the by source inventories, i.e. almost double the emissions are allocated to the business sector once the upstream energy processing emissions are allocated on to the users of refined fuels and electricity. This doubling of emissions on an end user basis increases the significance of the sector in the overall inventory; in 2011 in the by source inventory the business sector represents 16% of national GHG emissions, but on an end user

basis this increases to 32%, highlighting the importance of the sector for energy efficiency policy implementation.

The high percentage increase in the end users data compared to the by source data indicates the large contribution of the electricity component in the DA end user estimates. The use of electricity for heating, lighting and operating equipment has a marked effect on the emissions attributed to this sector, when compared to the emissions in the by source inventories which only include estimates from direct fuel use in the sector.

Residential Sector

The residential sector includes emissions from domestic fuel combustion and electricity use, in addition to smaller emissions from the breakdown of consumer products, accidental vehicle fires, and HFC emissions from the use of aerosols and metered dose inhalers. The non-fuel combustion sources are unchanged between the by source and end user approaches.

In 2011 the UK end user estimates for the residential sector are 188% that reported in the by source inventories, due to the additional emissions allocated from the upstream energy process sectors to deliver the refined fuels and electricity that are consumed in the sector. The percentage increase in the end users emissions data compared to the by source data is predominantly due to the additional contribution of the electricity component in the DA end user estimates, although emissions associated with the extraction and processing of solid and petroleum fuels will also contribute.

Similar to the business sector above, much higher emissions on an end user basis increases the significance of the residential sector in the overall inventory; in 2011 in the by source inventory the residential sector represents 13% of national GHG emissions, but on an end user basis this increases to 24%, highlighting the importance of the residential sector for energy efficiency policy implementation.

The domestic sector estimates of electricity use in 1990 for each DA are based on sales data from regional electricity companies for 1989, scaled to the 1990 UK domestic electricity use total, with the Scottish estimates derived (as noted above) from Scottish Housing Condition Survey data. In addition, the sub-national energy statistics published by DECC for recent years within the periodic publication Energy Trends, provides domestic sector estimates of electricity use for each DA. Therefore, these sector estimates are associated with lower uncertainty than many of the other sectors.

Public Sector

This sector contains emissions from the combustion of fuel, and electricity use, within the public sector. The percentage increase in the end users data compared to the by source data for the public sector is 223%, similar to that reported for the business sector and for the same reasons, i.e. the high use of electricity as a fuel in the sector to provide heating, lighting cooking etc. Despite the large increase, the sector as a whole remains a modest overall contributor to the national inventory totals: even on an end user basis, in 2011 the UK public sector only represents 2.9% of the national GHG emissions total.

Transport

The transport category includes all emissions from road transport, rail (including stationary sources), national navigation and coastal shipping, domestic aviation, military aviation and coastal shipping.

In many end user sectors, the fuel mix within each DA will vary and hence the impact of the end users approach will also vary quite markedly as the additional emissions associated with different fuel groups combine to derive the total end user estimate. In the transport sector, however, the majority of the fuels used are derived from petroleum processing (with the exception being combustion in the rail sector), and hence the effects of the end user method can be seen in isolation for the petroleum sector. The end user estimates in recent years are a steady 13-16% higher than the by source estimates, reflecting the additional emissions from upstream oil extraction and the oil refining sector.

Other Sectors

Emissions from the Land Use, Land Use Change and Forestry (LULUCF) and Waste Management sectors are unchanged between the by source and end user approaches, since there are no emissions from energy use allocated to these sources.

The end user increment within the Industrial Process sector is limited to the use of fuels in ammonia production (feedstock use of natural gas), and iron and steel (where emissions are allocated to process use, rather than combustion).

For Agriculture, the increase in emissions using the end user approach is limited to the emissions from energy use within the sector.

Summary of End User Data for Wales “Electricity Only” Emissions

The allocation of emissions from electricity use in the end user DA inventories is of specific interest for the reporting of progress against GHG reduction targets for the Welsh Government; the Climate Change Strategy for Wales (2010) has established emission reduction targets that address the scope of devolved powers for the Welsh Government, and this requires analysis of the impact of the operation of the UK electricity supply grid. Therefore we present here a summary of the end user emissions that are allocated from the use of electricity in Wales during 2006 to 2011, as the Welsh Government targets use a baseline from 2006 onwards. Note that these data exclude the by source emission estimates and also the component of the end user dataset that relates to the use of solid fuels, natural gas and petroleum fuels.

Table A3.2 Wales End User Electricity Only Emissions, 2006-2011, MtCO₂e

NC Category	2006	2007	2008	2009	2010	2011
Agriculture	0.30	0.30	0.30	0.27	0.28	0.26
Business	6.57	6.36	6.18	5.19	5.35	5.11
Energy Supply	0.00	0.00	0.00	0.00	0.00	0.00
Exports	0.00	0.00	0.00	0.00	0.00	0.00
Industrial Process	0.01	0.01	0.01	0.01	0.01	0.01
Public	0.49	0.51	0.50	0.45	0.44	0.41
Residential	3.36	3.14	3.05	2.81	2.84	2.58
Transport	0.00	0.00	0.00	0.00	0.00	0.00
Wales Total	10.72	10.30	10.03	8.72	8.93	8.36

As outlined in the methodology text above, the main revisions to the Wales end user data stem from revisions to the electricity sales data published by DECC within Energy Trends; total electricity sales for Wales in 2009 and 2010 were revised by DECC in the December 2012 Energy Trends publication, leading to lower emission estimates than reported in the end user inventory for Wales published in September 2012 (i.e. the 1990-2010 DA GHGI dataset).