European Environment Agency

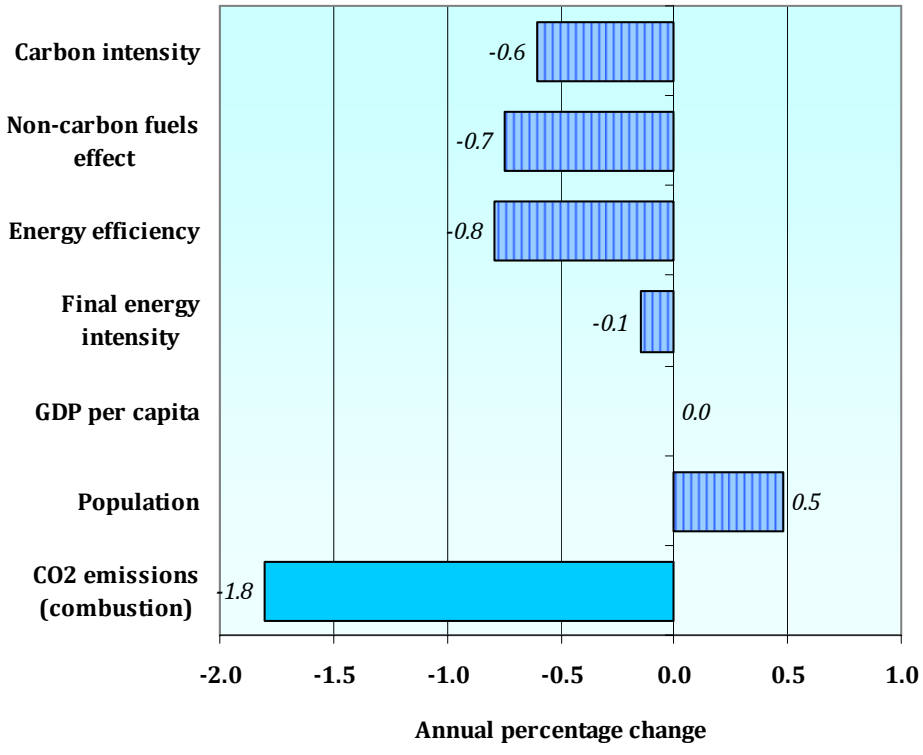
Allocation of energy-related greenhouse gas emissions by end use in 2008

This paper presents a snapshot of EU-27 energy-related greenhouse gas emissions by end-use economic sector. The allocation is done on the basis of Eurostat's energy balances and greenhouse gas emissions from the energy sector as included in the 2010 EU greenhouse gas inventory to UNFCCC. A fully-fledged EEA technical report spelling out the methodology and results at country level will be published in November/December 2011 *http://www.eea.europa.eu/themes/climate/publications*

Background

In 2010, the EEA published a short analysis paper underpinning the results from the 2010 EU greenhouse gas inventory to UNFCCC. The note entitled 'Why did greenhouse gas emissions fall in the EU in 2008?' briefly analysed the major factors that accounted for reduced CO_2 emissions in the EU-27 between 2007 and 2008. Some of these factors are also shown in figure 1 below.

Figure 1 Percentage change in factors contributing to energy-related CO_2 emissions in EU-27in 2008

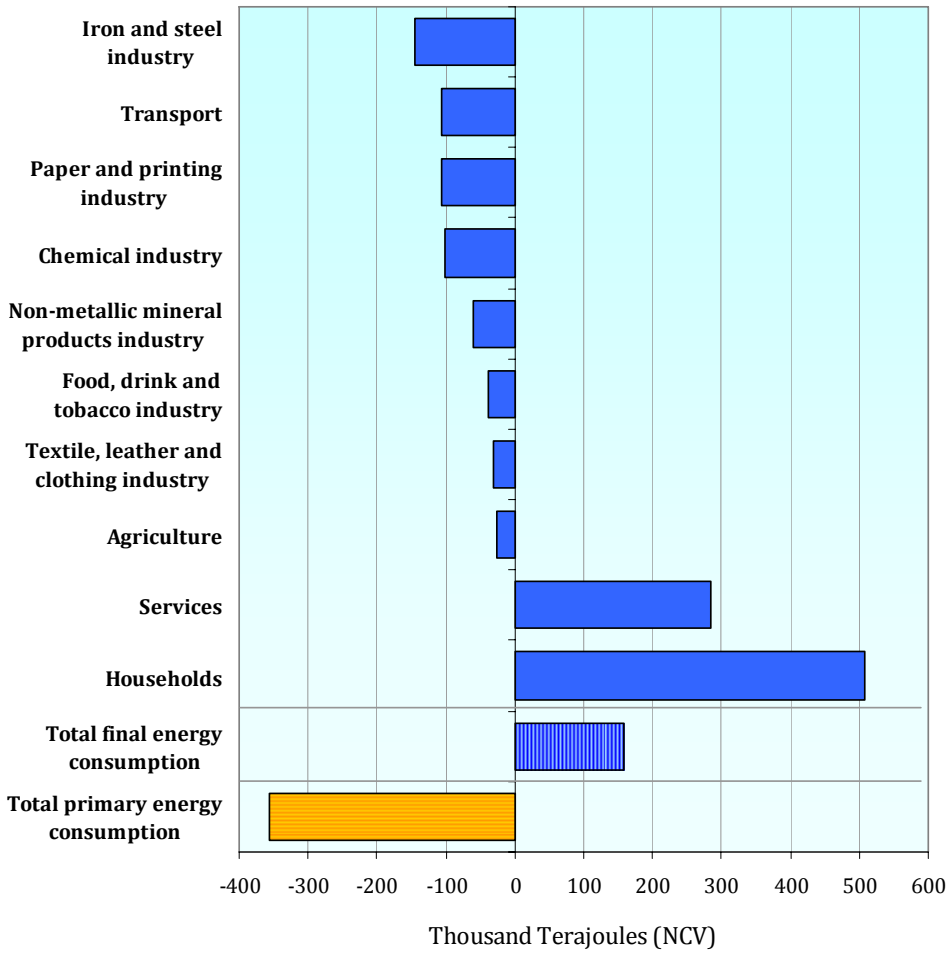


Note: The chart shows the estimated contributions of the various factors that have affected CO_2 emissions from energy production and consumption in the EU-27. This approach is often used to portray the primary forces driving emissions. The explanatory factors should not be seen as fundamental factors in themselves nor should they be seen as independent of each other.

Source: EEA (greenhouse gas emissions); Eurostat (population and energy balances); European Commission Ameco database (GDP).

Primary energy consumption decreased in the EU-27 in 2008, whereas final energy consumption available to the end users increased[1]. This was due to increased use of non-combustible renewables and improvements in the efficiency of energy transformation, which led to lower energy losses as less input of primary energy was required per output of final energy. Figure 2 below shows the change in final energy consumption by sector between 2007 and 2008. Final energy only increased in the residential/household and commercial/services sectors.

Figure 2 Final energy consumption by main sector in EU-27, change 2007–2008



Source: Eurostat energy balances

But how does this translate into emissions? There is no perfect match between the sectoral classification used in GHG inventories submitted to UNFCCC and the energy balances because of different reporting requirements. Energy industries (CRF 1A1) and fugitive emissions (CRF 1B) could be thought of as the equivalent of the transformation sector in the energy balances. However, the greenhouse gas inventory does not allocate emissions from energy industries to the end users of the final energy (households, transport, agriculture, industry and services). In the energy balances, primary energy is transformed (combustion or by mechanical means) to useful energy (e.g. heat, electricity and gasoline/diesel) which is then allocated to these sectors. Thus, one should not

[1] Not all primary energy is available to the end users of energy such as industry, transport, households, services and agriculture. This is because various losses occur within the energy system to transform primary energy (e.g. coal and lignite, natural gas and crude oil) into useful energy (i.e. heat, electricity, gasoline etc). In addition to transformation losses there are additional losses related to the distribution of the energy, and the consumption of energy by the energy-production sector itself. In the case of non-combustible renewables such as wind, hydro (without pumping) or photovoltaics, mechanical energy is used to transform primary energy into useful energy.

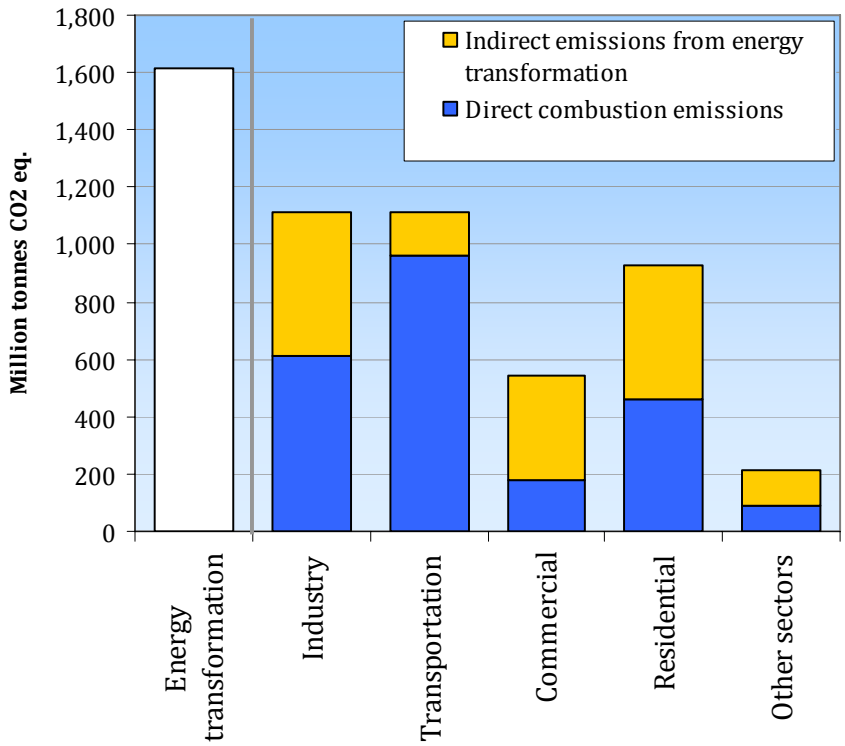
compare directly greenhouse gas inventory emissions with final energy consumption from the energy balances[2].

Preliminary results for 2008

In 2010 the EEA performed an internal study to estimate energy-related greenhouse gas emissions by end use economic sector at EU level. The end-use approach considers demand-side effects to redistribute emissions from energy industries to the final users of energy. The reallocation is done on the basis of Eurostat's energy balances and UNFCCC greenhouse gas emissions from the energy sector. One key objective from this exercise is to better analyse the link between greenhouse gas emissions as reported to the UNFCCC and the final energy demand driving the source of emissions.

The model is restricted to the energy sector as defined for reporting purposes under UNFCCC (i.e. energy combustion and fugitive emissions). Much of the sector is regulated by the EU ETS (e.g. combustion installations). The 'energy' subsectors which are outside the scope of the EU ETS include direct combustion emissions from residential and commercial buildings, as well as transportation (excluding electric trains). Thus, while direct emissions from e.g. households are excluded from the EU ETS the indirect emissions from the electricity and heat supplied to households fall within the scope of the EU ETS.

Figure 3 End use greenhouse gas emissions in the energy sector in EU-27 in 2008



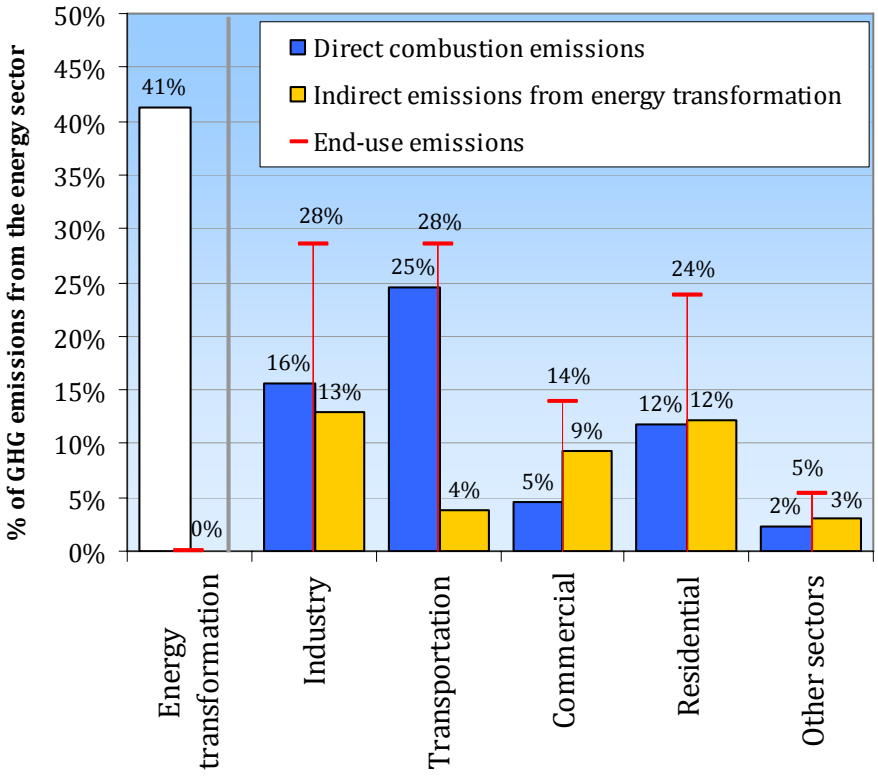
Source: EEA

[2] To give one example, the electricity and heat used by households and services which is reported as final energy consumption in the energy balances also include the energy supplied/distributed from conventional thermal stations. Under UNFCCC reporting, greenhouse gas emissions from households and services are estimated from direct combustion activities and exclude indirect emissions from energy transformation industries. The same is true for other energy-consuming sectors such as industry, agriculture and transportation. Emissions arising from the transformation of primary fuels in thermal power stations to produce heat and electricity for the final users of energy (e.g. households, services, transportation, industry and agriculture) are reported under public electricity and heat production. Other energy transformation industries include petroleum refining, coal mining, and oil and gas extraction. Fugitive emissions are also linked to the production, processing, transmission, storage and use of fuels (e.g. flaring of natural gases at oil and gas production).

Figure 3 shows the indirect emissions from energy transformation and the direct combustion emissions by main energy-consuming sector in million tonnes of CO_2 equivalent. The heights of the bars depict the total end-use greenhouse gas emissions in that sector. Energy transformation on the left side of the chart is shown in white colour to reflect all emissions (including fugitives) are allocated to the end use sectors.

Figure 4 presents the same information in an alternative way, and in relation to total energy-related greenhouse gas emissions in 2008. The height of the line in each sector (in red) is the sum of direct and indirect greenhouse gas emissions in that sector.

Figure 4 End use greenhouse gas emissions in the energy sector in EU-27 in 2008



Note: The sum of direct and indirect emissions equals end-use emissions. For industry and transportation differences are due to rounding.

Source: EEA

Energy industries and fugitive emissions accounted for 41% of energy-related greenhouse gas emissions in the EU-27 in 2008. In the commercial and residential sectors indirect emissions from heat and electricity generation in thermal stations are larger than the direct (inventory) combustion emissions attributed to these sectors. In transport, particularly, direct emissions account for the bulk of emissions in the sector, with a significantly lower share of indirect emissions from e.g. petroleum refining and electricity for railways.

The end-use approach to account for emissions is useful for policy purposes. For instance, under the EU's Climate Change and Energy Package[3], national governments will need to

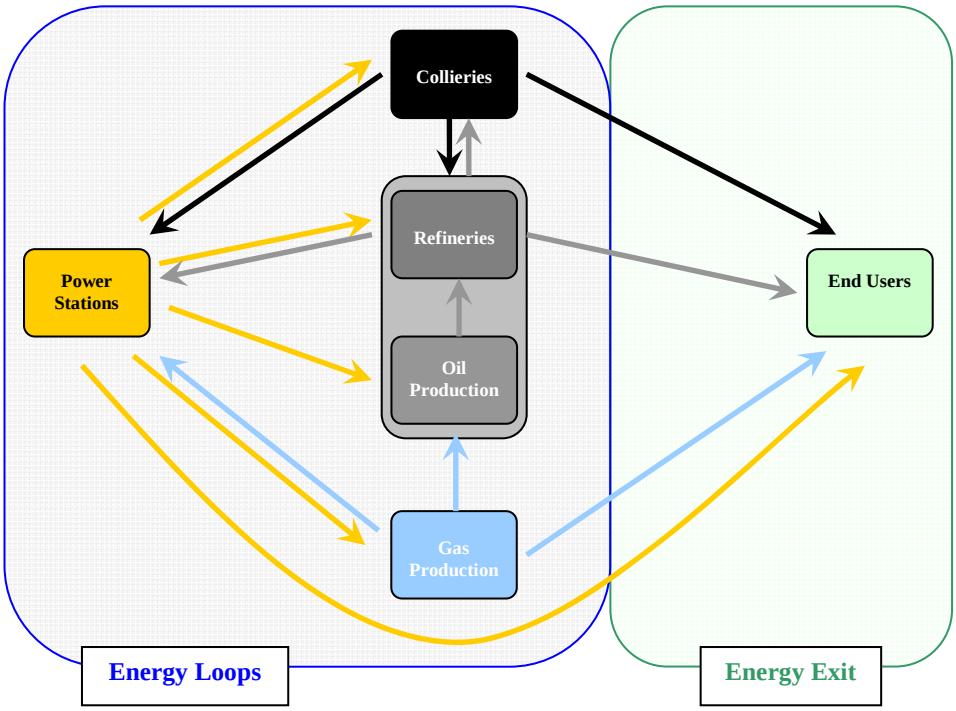
[3] The European Union's Climate Action and Renewable Energy package http://ec.europa.eu/clima/policies/package/index_en.htm was adopted by the European Council on 6 April 2009. The Package represents the EU's response to limiting the rise in global average temperature to no more than 2 ºC above pre-industrial levels. To achieve this, EU Member States agreed to reduce total EU GHG emissions by 20% compared to 1990 by

reduce emissions in sectors subject to national targets under the Effort Sharing Decision, as opposed to sectors where reductions are by and large market-driven (EU ETS). So the role of demand-side policies and measures in the non-trading sectors will be critical. For example, more district heating from CHP plants or higher demand for rail transport, may drive emissions from non-trading sectors (where there are national targets) to trading sectors (governed by carbon prices). These are just a few examples of the policy relevance of understanding the demand side of greenhouse gas emissions. The success of national policy responses would benefit from better information on whether the source of emissions falls under the EU ETS or whether national targets under the EU's Effort Sharing Decision are applicable.

Notes: the conceptual model

The conceptual model to reallocate emissions from energy transformation industries to the end users is based on the UK end user model[4].

Figure 5 Energy Flows in the End User Model



The model reallocates emissions from the energy transformation industries (power stations, refineries, coal mining, solid smokeless fuel production, gas production and town gas production) to the end users. The reallocation of emissions in the model is done on the basis of the energy balances reported to Eurostat under the Energy Statistics Regulation

2020. Both trading (EU Emissions Trading Scheme) and non-trading sectors (EU Effort Sharing Decision) will contribute to the 20% objective. Minimising overall reduction costs to reach the 20% objective implies a reduction of 21% compared to 2005 by 2020 for the trading sectors and a reduction of approximately 10 % compared to 2005 by 2020 for the non-trading sectors. There are country-specific national targets for the latter. The non-trading sectors broadly include direct emissions from households and services, as well as emissions from transport, waste and agriculture. The coverage of the non-trading sectors currently represents about 60 % of total greenhouse gas emissions in EU-27.

[4] The UK end user model has been used by policy makers in the United Kingdom to understand the interactions between the energy transformation industries and their effect on greenhouse gas emissions in the UK. In addition, the model has been used to improve the analysis of energy efficiency and greenhouse gas emissions in the Devolved Administrations of the UK by taking account of electricity transfers between the Devolved Administrations.

and greenhouse gas emissions from the energy sector as reported to the UNFCCC[5] Refineries, the coal industry and the gas production industry are supplied with a small part of the public electricity produced. The refineries supply oil to the power stations and the coal industry. The coal industry supplies coal to the power stations. The gas industry supplies gas to the power stations. Carbon dioxide and other greenhouse gases are emitted by each of these source categories. Each of the source sectors thus produces both direct and indirect emissions. It is not possible to allocate emissions directly from all producers to their end users, and the reallocation of emissions thus requires the development of a conceptual model that takes account of feedback loops between energy producers. In this way, all the emissions from the energy producers, including heat production are reallocated. These feedback loops are illustrated in Figure 5 above.

For more information

An EEA technical report spelling out the methodology and results at country level will be published in November/December 2011
http://www.eea.europa.eu/themes/climate/publications

[5] There are two streams of data used in the allocation of energy-related greenhouse gas emissions to the end users. The first one is the annual submissions of national greenhouse gas inventories of Annex I Parties under the UNFCCC and the Kyoto Protocol. The EEA compiles the greenhouse gas inventory of the European Union on behalf of the European Commission http://www.eea.europa.eu/publications/european-union-greenhouse-gas-inventory-2010 The second data source is the annual energy balances reported to Eurostat under the Energy Statistics Regulation http://epp.eurostat.ec.europa.eu/portal/page/portal/energy/data/main_tables In both cases there are well established QA/QC processes to ensure the highest possible quality of the emissions and energy estimates, respectively. There remain differences between both sets of data: i.e. fuel/activity data in greenhouse gas inventories and energy data in the energy balances. However, under the Energy Statistics Regulation, EU Member States are expected to ensure a high degree of consistency between the energy balances reported to Eurostat and the activity data reported under the UNFCCC. The main mismatch occurs at a more detailed sectoral level due to different reporting requirements.