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End-user GHG emissions from energy

Reallocation of emissions from energy industries to end users 2005–2009

European Environment Agency

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Summary

The objective of this report[1] is to help improve the understanding of past greenhouse gas (GHG) emission trends in the energy sector from the demand or end-user side. To do this, the report develops a methodology to redistributes emissions from energy industries to the final users (by sector) of that energy. This reallocation is done on the basis of Eurostat's energy balances and GHG inventories for the energy sector as reported to the United Nations Framework Convention on Climate Change (UNFCCC), for the period 2005–2009.

Background

The European Union (EU), as a party to the United Nations Framework Convention on Climate Change (UNFCCC), reports annually on GHG inventories for the year t–2 and within the area covered by its Member States. The European Environment Agency (EEA) is responsible for the compilation of the EU's GHG inventory to UNFCCC. Trends in GHG emissions have traditionally be explained based on the sectorial classification used in UNFCCC reporting. This internationally-agreed reporting system requires Annex I Parties to estimate and report GHG emissions using UNFCCC Guidelines and IPCC methods. Data are reviewed annually and are the basis for assessing progress towards GHG emission targets.

GHG emissions for the energy sector consist of two main blocks: energy combustion and fugitive emissions[2]. For reporting purposes, the main combustion categories are: energy industries, manufacturing and construction, residential, commercial and agriculture/fishing/forestry. This means that, for example, emissions from the transformation of primary fuels in thermal stations to deliver heat and electricity to the residential sector are reported under energy industries, whereas emissions from the burning of coal in a stove by a household would be reported as part of emissions from the residential sector. The official sectoral breakdown based on UNFCCC provides no information on emissions from energy industries by end user.

This report develops a methodology to reallocate emissions from the energy transformation sector to the final users of energy. These end-users are allocated a share of emissions from energy industries. For the purpose of this report, emissions from the energy transformation industries (and fugitives) which are reallocated to end users are termed 'indirect emissions'. This is different from the meaning of 'indirect emissions' in relation to GHG inventories covering CO_2 from the oxidation of CH_4, CO and NMVOC in the atmosphere. Emissions resulting from combustion activities as reported to UNFCCC are termed 'direct emissions'.

In essence, the end-user methodology splits direct and indirect GHG emissions by reallocating all GHG emissions from energy transformation industries to end users using final energy flows. End-use emissions allow a better understanding of the underpinning trends from the demand side by linking final energy use and greenhouse gas emissions. This is useful from a different policy perspective, as for example, policies to improve the insulation of residential buildings could reduce both direct and

[1] The present summary and the main report published alongside this summary are available from http://www.eea.europa.eu/publications/end-use-energy-emissions/

[2] Fugitive emissions are releases of GHG gases from anthropogenic activities that arise from the exploration, production, processing, transmission, distribution and storage of fuels. Combustion emissions are included here if they do not support a productive activity (e.g., flaring of natural gases at oil and gas production facilities).

indirect emissions. Moreover, the method also highlights the relative importance and emission effects of trade in energy flows between EU countries.

Box 1 Policy context

The EU Climate and Energy package adopted by the European Council on 6 April 2009 represents the EU's response to limiting the rise in global average temperature to no more than 2 ºC above pre-industrial levels. European Union leaders also agreed to the so-called '20-20-20' climate and energy targets:

i. A reduction in EU GHG emissions of at least 20% below 1990 levels

ii. 20% of EU energy consumption to come from renewable resources

iii. 20% reduction in primary energy use compared with projected levels, to be achieved by improving energy efficiency

All sectors of the economy must contribute to the EU's objective of reducing GHG emissions by 20 % compared to 1990 by 2020. A single EU-wide cap on emission allowances under the EU Emissions Trading Scheme (ETS) will apply from 2013 and the number of allowances will be reduced by 21 % in 2020 compared to 2005. Emissions from sectors not covered by the EU ETS will be governed by the EU Effort Sharing Decision (ESD), where Member States agreed to binding national targets to reduce the EU's overall emissions from non-ETS sectors by 10 % by 2020 compared to 2005. The non-trading sectors represent about 60 % of total GHG emissions in the EU-27 and broadly include 'direct' emissions from households and services, as well as emissions from transport, waste and agriculture. Direct emissions from energy transformation industries are by and large regulated by the EU ETS.

Furthermore, EU governments should reduce emissions in sectors subject to national targets under the ESD, as opposed to sectors where reductions are by and large market driven (EU ETS). As with Kyoto, meeting the 2020 national targets set out in the EU Climate and Energy Package will by and large be determined by how countries reduce emissions in the non-trading sectors. Under the Kyoto Protocol, the EU-15 took on a common commitment to reduce emissions by 8 % between 2008 and 2012 compared to emissions in the base year. When Member States set national emission caps for installations under the EU ETS for the period 2008–2012, they allocated part of their Kyoto emission budget (Kyoto Assigned Amounts) to the EU ETS and fixed the overall contribution of EU ETS sectors towards reaching Kyoto national targets.

The end-user approach provides additional information on the effect of energy demand or sectoral policies on GHG emissions that can be helpful in the context of the ESD. For example, more district heating from combined heat and power (CHP), replacing old stoves in households, or higher demand for electric-powered vehicles, may drive emissions from non-trading sectors (where there are national targets) to trading sectors (governed by carbon prices). Thus, the end-user approach to GHG emissions can also help policy makers target GHG emission reductions more effectively.

It should be noted that the end-user method is not directly linked to monitoring of progress towards targets. It is rather a tool to help understand the links between energy use and emissions at a more disaggregated level, including the emission effects from energy trade between EU countries.

Main findings

Notwithstanding differences between energy statistics and activity data, the reallocation of emissions from energy transformation to end-users is done on the basis of Eurostat's energy balances and

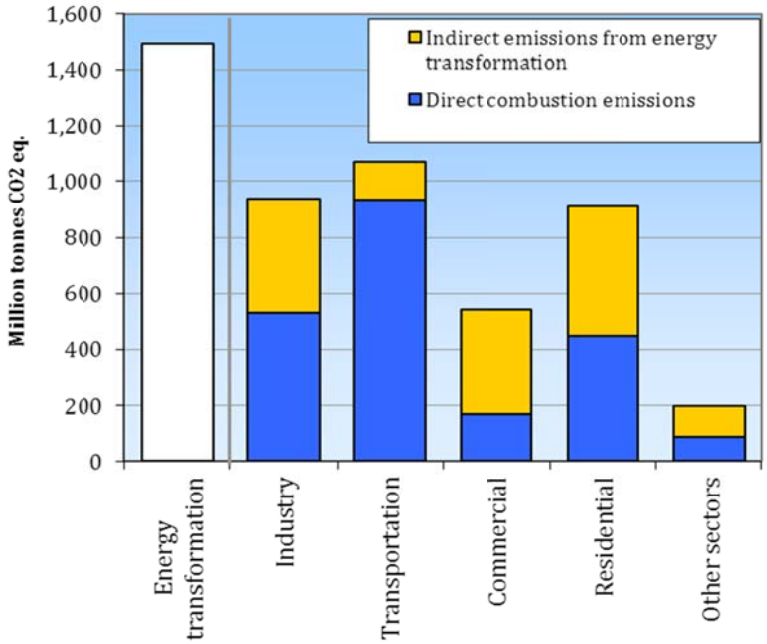
UNFCCC greenhouse gas emissions from the energy sector. One key objective from this exercise is to better analyse the link between GHGs emissions as reported to the UNFCCC and the final energy demand driving the source of emissions.

As explained above, the model to estimate end-use emissions 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 broadly include direct combustion emissions from residential and commercial buildings, as well as transportation (excluding electric trains). Thus, while direct emissions from households, for example, are generally excluded from the EU ETS the indirect emissions from the electricity and heat supplied to households fall within the scope of the EU ETS.

Results by end use for 2009

Figure ES.1 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 GHG 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 ES.1 End-use greenhouse gas emissions from energy use in EU-27 in 2009

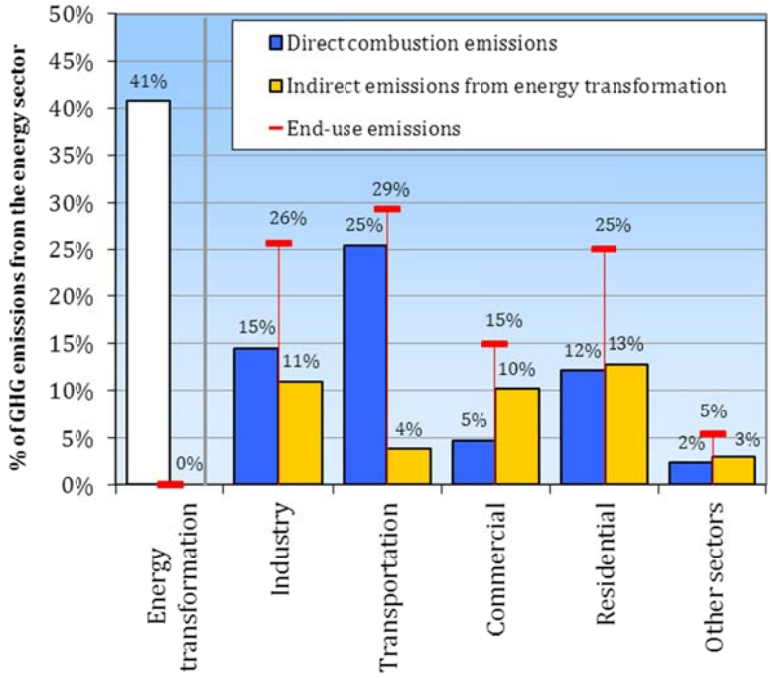


Note: The sum of direct and indirect emissions equals end-use emissions. The total indirect emissions allocated to end-users in a country can be smaller than the direct emissions from fuel transformation in that country if some of the indirect emissions are allocated to exports and international bunkers. The indirect emissions allocated to end users including exports and bunkers equals the direct emissions from fuel transformation plus the indirect emissions associated with energy imported from other countries. The indirect emissions arising from energy supplied from countries outside the EU are assumed to be zero. 'Other sectors' include emissions from agriculture, forestry and fishing as well as the net (indirect) emissions from energy trade. The emissions shown in the chart are only representative of the EU as a whole. Country-specific data are available in the main report.

Source: EEA, 2011

Figure ES.2 presents the same information in an alternative way, and in relation to total energy-related greenhouse gas emissions in 2009. The height of the line in each sector (in red) is the sum of direct and indirect greenhouse gas emissions in that sector.

Figure ES.2 End-use greenhouse gas emissions from energy use in EU-27 in 2009



Note: The sum of direct and indirect emissions equals end-use emissions. The total indirect emissions allocated to end users in a country can be smaller than the direct emissions from fuel transformation in that country if some of the indirect emissions are allocated to exports and international bunkers. The indirect emissions allocated to end users including exports and bunkers equals the direct emissions from fuel transformation plus the indirect emissions associated with energy imported from other countries. The indirect emissions arising from energy supplied from countries outside the EU are assumed to be zero. 'Other sectors' include emissions from agriculture, forestry and fishing as well as the net (indirect) emissions from energy trade. The shares shown in the chart are only representative of the EU as a whole. Country-specific data are available in the main report.

Source: EEA, 2011

Energy industries and fugitive emissions accounted for 41% of energy-related GHG emissions in the EU-27 in 2009. 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. This is by and large because of the electricity supplied by thermal stations to these two sectors. The remaining difference is accounted for by distributed heat from district heating and combined heat and power plants. In transport, particularly, direct emissions account for the bulk of emissions in the sector, with a significantly lower share of indirect emissions from petroleum refining and electricity for railways, for example. 'Other sectors' include the indirect emissions from imports and exports of energy between countries (e.g. electricity trade). For some EU member states there is a larger effect, which highlights the relative importance of trade in energy flows in these countries. These effects can also vary significantly from year to year.

Figures ES.1 and ES.2 portray the emission's shares across sectors from the final demand side in one point in time, i.e. 2009. It should be stressed these shares only apply to the EU as a whole and very different pictures emerge for different countries. This shows for example that the vast majority of

transport emissions (with the exception of electric railways) are by and large direct emissions which are covered by the ESD.

The dynamics of how end-use emissions evolve over time are even more relevant. The progressive development of electric vehicles should result in a redistribution of the emission shares in transport across the EU ETS and the ESD. GHG emission savings will depend on whether transport demand continues growing, outpacing any environmental benefits, and whether the fuel mix for electricity generation is more carbon friendly than combustion engines using mainly diesel and/or gasoline. Improvements in the efficiency of electricity transformation should also contribute to further emissions reductions.

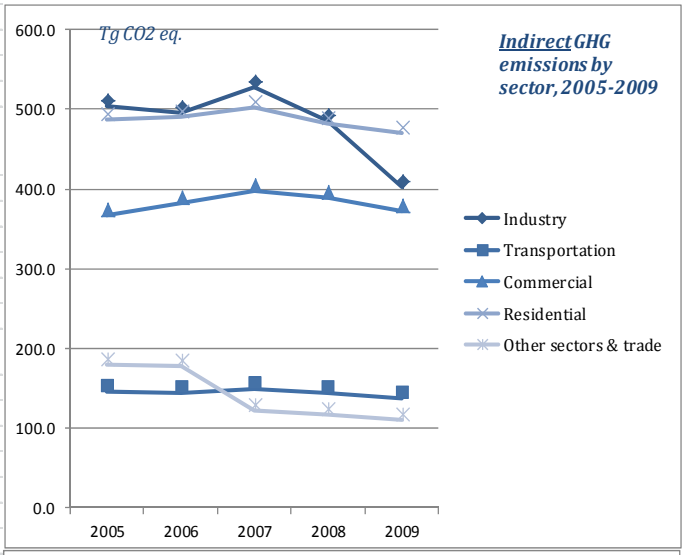
How have end-use emissions changed between 2005 and 2009?

Figure ES.3 (top) shows the evolution of indirect GHG emissions, estimated by reallocating GHG emissions from energy industries and fugitives. Figure ES.3 (middle) shows the trends in direct GHG emissions as reported to UNFCCC, while excluding emissions from the energy transformation sector. Figure ES.3 (bottom) shows total energy-related GHG emissions, including both indirect and direct emissions from the charts above.

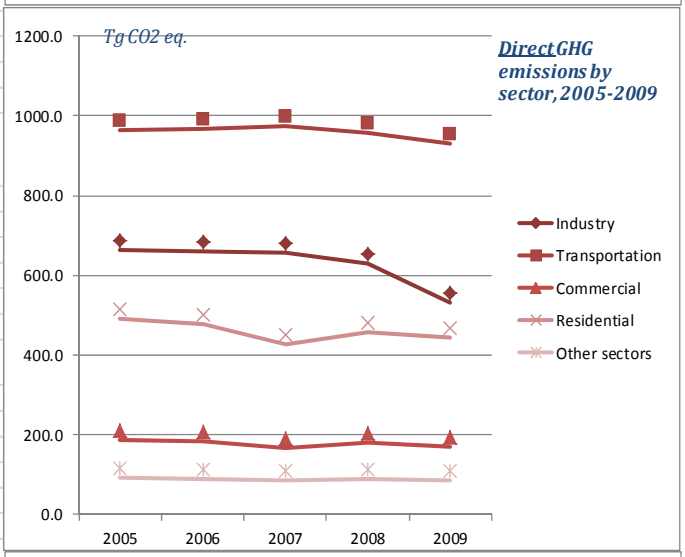
All the main sectors reduced their GHG emissions in 2009 (Figure ES.3). Clearly, GHG emissions fell in the transformation sector (energy industries, including fugitives). On an end-use basis, GHG emission reductions in industry accounted for two thirds (30% indirect and 36% direct) of all energy-related GHG emission reductions in 2009. Emissions for sectors which are part of the EU ETS declined more than the so-called non-trading sectors. Most of the biggest industrial installations are part of the EU ETS and the stark contraction in gross value added in industry during 2009 appears to have led to a sharp reduction in final energy demand and emissions in the sector (combustion, but also process-related). Emissions fell particularly for manufacturing industries and construction, as well as for key industrial processes, such as iron and steel and cement production. The 2009 energy balances and the verified 2009 emissions from the EU ETS published last year also confirm significantly lower energy use and lower emissions in all industrial sectors. There was also a marked decline in real energy and carbon prices which has to be seen in the context of lower final energy demand and the 2009 economic recession.

After industry, transport was the sector contributing most to the reduction in GHG emissions in 2009, particularly road transport. Gasoline emissions continued their downward trend, whereas diesel emissions fell for the second time since 1990. Along with the start of economic recession in the second half of 2008 and the whole of 2009, this could have triggered a fall in freight transport demand. Part of this reduction in emissions on an end-use basis was accounted for by lower (electric) rail transport demand and lower emissions from refining of oil products in 2009.

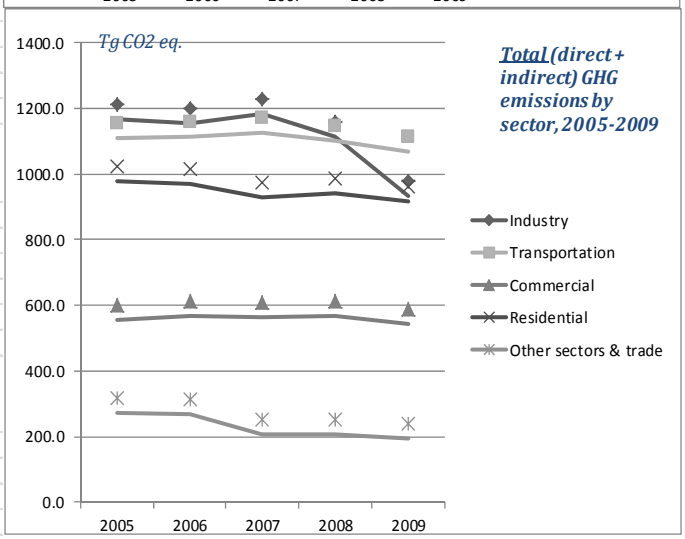
Figure ES.3 Trends in direct and indirect GHG emissions by end-use sector in EU-27, 2005-2009



Sector	Contribution to the total reduction in energy-related emissions, 2008/2009
	Indirect emissions
Industry	30.3%
Transportation	2.5%
Commercial	5.9%
Residential	4.9%
Other sectors & trade	3.0%
Indirect emissions (all sectors)	*46.5%*



Sector	Contribution to the total reduction in energy-related emissions, 2008/2009
	Direct emissions
Industry	35.5%
Transportation	9.6%
Commercial	3.0%
Residential	4.6%
Other sectors	0.8%
Direct emissions (all sectors)	*53.5%*



Sector	% of the total absolute reduction in energy-related emissions, 2008/2009
	Total emissions
Industry	65.8%
Transportation	12.1%
Commercial	8.9%
Residential	9.4%
Other sectors & trade	3.8%
Total direct and indirect emissions (all sectors) in Tg CO2 eq.	*-274*

The year 2009 also saw GHG emission reductions in households (and services) despite the colder winter. There was an increase in the number of 'heating degree days' in most European countries (an indicator of household demand for heating) compared to 2008. Eurostat's energy balances confirm a significant increase in derived heat (and also in electricity demand) in EU-27 households during 2009. However, this increase has been more than offset by lower use of fuel in non-distributed heat in the residential sector, particularly liquid fuels. As a result, household emissions fell in 2009 even though the winter was on average colder than 2008.

While tracking indirect emissions from energy transformation industries is not directly suited to monitoring overall GHG emission targets, the method to reallocate indirect emissions to the end users can help increase the transparency of how reductions in energy use in households and other sectors affect overall emissions reductions at the level of that sector (direct and indirect). In this way, Member States could better assess which additional policies/measures may be needed to reduce emissions in these sectors to meet their overall emission targets. These additional measures could for example include specific sectoral policies as well as overall improvements in energy efficiency, carbon intensity and higher shares of renewables, to mention but a few.

How were end-use emissions calculated?

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 GHG 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 compare GHG inventory emissions directly with final energy consumption from the energy balances[3].

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

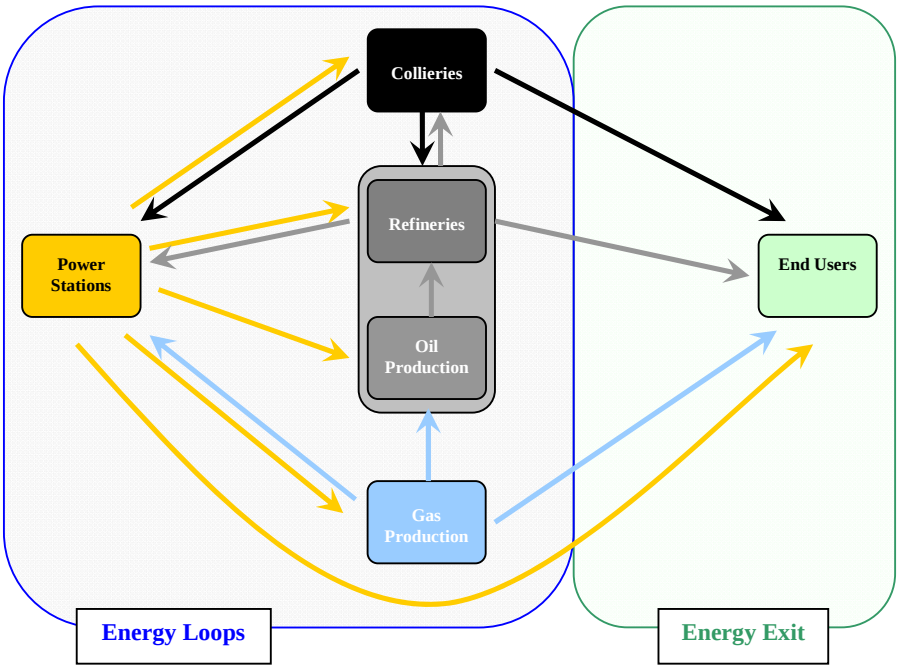
Refineries, the coal industry and the gas production industry are supplied with a small part of the public electricity produced. The refineries supply oil to the power stations and the coal industry. The

[3] 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, GHG 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).

[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 GHG emissions in the UK. In addition, the model has been used to improve the analysis of energy efficiency and GHG emissions in the Devolved Administrations of the UK by taking account of electricity transfers between the Devolved Administrations.

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 ES.4 below.

Figure ES.4 Energy Flows in the End-User Model



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 greenhouse gas inventory of the European Union - an annual submission of national greenhouse gas inventories of Annex I Parties under the UNFCCC and the Kyoto Protocol, which the EEA compiles on behalf of the European Commission. The second data source is the annual energy balances reported to Eurostat under the Energy Statistics Regulation In both cases there are well established QA/QC processes to ensure the highest possible quality of the emissions and energy estimates, respectively. Differences remain between both sets of data: between fuel/activity data in GHG inventories and energy data in the energy balances, for example. 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 and/or practices. The treatment of non-energy use, particularly in industrial sectors, can be a source of inconsistencies between the energy balances and national GHG inventories.

The end-user approach is internally consistent at EU level as all emissions from energy producing industries are reallocated to the final users using the energy balances as the distributing tool. The starting point is the emissions (EEA GHG data viewer) which are then reallocated using energy flows in the energy balance (Eurostat). The allocation of indirect emissions depends on the fuel mix in the

energy balance. This means emission factors are not an input to the model but can be derived from the model.

The end-user model also takes into account energy trade flows between EU countries to allocate emissions to the final users. This is because electricity, oil products, natural gas and solid fuels produced in one country may be exported to other countries. Thus, the net exported indirect emissions by Member State may be different from zero for countries with significant energy trade flows with other countries. The indirect emissions allocated to end users including exports and bunkers equals the direct emissions from fuel transformation plus the indirect emissions associated with energy imported from other countries.

A country can both import and export fuels and the implied emissions factors for imports and exports are not generally the same because of different fuel mixes across countries. To guarantee the internal consistency in the model, the redistribution of indirect emissions across EU countries is based on the fuel mix of the exporting country. For example, if country A exports electricity to country B, then country B is allocated a fraction of country A's emissions based on the fuel mix in country A. Also, indirect emissions from refining oil products in one country would be allocated to end users in other countries in proportion to the energy content of the fuel supplied. Thus, the derived emission factors for the allocation of indirect emission to the end users in the importing country are based on the exporting country fuel mix and transformation efficiency. See Chapters 2 and 3 in the main report for more information.

Planned improvements and additional information

An update of this EEA technical report is planned for 2012. The report will include a refined description of GHG emission trends from the demand side as well as a number of flow charts to map primary energy flows by fuel on the one hand and GHG emissions on the other.

The geographical scope will also be extended to cover all EEA member countries including Iceland, Liechtenstein, Norway, Switzerland and Turkey.

Finally, the same allocation principles applied to CO_2 will be tested for NOx and SOx emissions.

For more information:

Annual EU greenhouse gas inventory 1990–2009 and inventory report 2011

http://www.eea.europa.eu/publications/european-union-greenhouse-gas-inventory-2011/

EEA GHG data viewer

http://dataservice.eea.europa.eu/PivotApp/pivot.aspx?pivotid=475

EEA Climate publications

http://www.eea.europa.eu/themes/climate/publications

Eurostat energy balances

http://epp.eurostat.ec.europa.eu/portal/page/portal/energy/data/database

1 Introduction

National governments throughout Europe calculate emission inventories for the greenhouse gases carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), sulphur hexafluoride (SF_6), hydrofluorocarbons (HFCs) and perfluorocarbons (PFCs) for their countries classified by activity. The classifications include, for example, electrical power generation, combustion in various industrial sectors, road traffic emissions and domestic combustion. The inventories provide estimates of the direct emissions emitted from sources associated with each sector. Thus the direct emissions from power stations are allocated to the electricity industry.

Most of the activities identified in the inventories consume electricity and/or refined oil products, gas or solid fuels. The demand for these energy sources results in emissions from the energy transformation industries. It is useful for governments to be able to reallocate these emissions to end users in order to understand the effect of the activities of the end users on the emissions from the energy transformation industries. Here, the end users include domestic activities, industrial activities, transport activities, commercial activities and agriculture. The emissions reallocated from the energy transformation industries are termed indirect emissions[5].

The end-user approach is internally consistent at EU level as all emissions from energy producing industries are reallocated to the final users using the energy balances as the distributing tool. The starting point is the emissions (EEA GHG data viewer) which are then reallocated using energy flows in the energy balance (Eurostat).

This report describes the application of a method to reallocate the emissions from energy transformation industries to end users. It presents the results of the application of the method to emissions from the EU Member states. The method is based on the United Kingdom End User Model. We demonstrated the application of the method to the EU Member States for the year 2008 in our previous report to the Topic Centre. This report presents the results of the application of the method for each of the years 2005-2009.

In concept, for one country, the end user model developed for this work reallocates combustion emissions from the energy transformation industries (Public Electricity and Heat Production, Petroleum Refining, and the Manufacture of Solid Fuels and other Energy Industries) to the *end users*.

Refineries, the coal industry and other energy industries are supplied with a small part of the public electricity and heat supply. The refineries supply oil to the power stations and other energy industries. 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 the 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

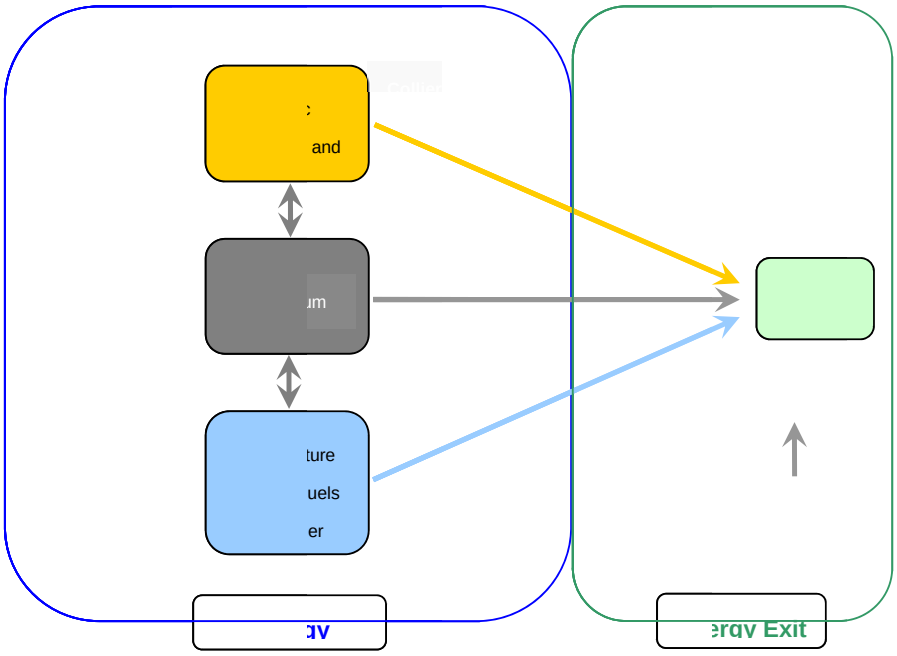
[5] For the purpose of this report, emissions from the energy transformation industries (and fugitives) which are reallocated to end users are termed 'indirect emissions'. This is different from the meaning of 'indirect emissions' in relation to GHG inventories covering CO2 from the oxidation of CH4, CO and NMVOC in the atmosphere. Emissions resulting from combustion activities as reported to UNFCCC are termed 'direct emissions'

reallocated. These feedback loops are illustrated conceptually in Figure 1 below and described in Chapter 2.

Fugitive emissions are reallocated in a similar way, and the approach to reallocation is described in Chapter 3.

In practice the electricity and fuels are transferred between EU Member States. The end user model takes account of transfers, although these transfers are not shown in Figure 1.

Figure 1 Energy Flows in End User Model



Section 2 of the report describes how we applied the model to combustion emissions of carbon dioxide, methane and nitrous oxide from the energy industries. Section 3 of the report describes how we applied the model to fugitive emissions of carbon dioxide, methane and nitrous oxide from the fuel supply industries. The results are presented as tables in Section 4 for the European Union as a whole for total greenhouse gases as carbon dioxide equivalents. A separate Excel spreadsheet tool has been developed to allow the user to prepare similar results tables for each of the EU Member States for total greenhouse gases, carbon dioxide, methane and nitrous oxide.

2 Energy industry emissions from combustion activities

2.1 Introduction

European Union Member States report greenhouse gas emissions under the Intergovernmental Panel on Climate Change (IPCC) Common Reporting Framework (CRF). Fuel combustion emissions for the energy industries are reported under category 1A1 which comprises:

1A1a: Public Electricity and Heat Production

1A1b: Petroleum Refining

1A1c: Manufacture of Solid Fuels and other Energy Industries

The European Environment Agency is responsible for the compilation of the EU GHG inventory which is submitted by the European Commission on behalf of the EU every year to UNFCCC. The EEA GHG data viewer contains data on greenhouse gas emissions and removals, sent by countries to UNFCCC and the EU Greenhouse Gas Monitoring Mechanism (EU Member States)[6]. The current data set contains national emissions of carbon dioxide, methane and nitrous oxide from the 1A1a-c sectors for years up to 2009. This section describes the reallocation of these emissions to end user sectors for the years 2005-2009.

We reallocated the greenhouse gas emissions to end users on the basis of net energy statistics provided by the Eurostat database[7]. Eurostat is responsible for collecting the energy balances of EU Member States according to the 2009 EU Energy Statistics Regulation (ESR). Please note we have not used the national energy balances of the individual Member States, but those reported to Eurostat under the ESR. The following end user categories were identified from the supply, transformation and consumption tables within the database:

- Iron and steel (includes blast furnaces)
- Non-Ferrous Metals
- Chemical and Petrochemical
- Non-Metallic Minerals
- Mining and Quarrying
- Food and Tobacco
- Textile and Leather
- Paper, Pulp and Print
- Transport Equipment
- Machinery
- Wood and Wood Products
- Construction
- Non-specified (Industry)
- Non energy use in industry
- Rail
- Road

[6] http://www.eea.europa.eu/data-and-maps/data/national-emissions-reported-to-the-unfccc-and-to-the-eu-greenhouse-gas-monitoring-mechanism-5 and, http://dataservice.eea.europa.eu/PivotApp/pivot.aspx?pivotid=475

[7] http://epp.eurostat.ec.europa.eu/portal/page/portal/energy/data/database

- International aviation
- Domestic aviation
- Domestic Navigation
- Consumption in Pipeline transport
- Non-specified (Transport)
- Non energy use in transport
- Households
- Fisheries
- Agriculture
- Services
- Other sectors
- Non energy use in other sectors
- Bunkers

The supply, transformation and consumption tables also provided details of total exports of energy from each country. Additional tables in the database provide details of exports broken down by country of destination.

2.2 Public Electricity and Heat Production

The IPCC Greenhouse Gas Inventory Reporting Instructions[8] define Sector 1A1a as follows:

> Sum of emissions from public electricity generation, public combined heat and power generation and public heat plants. Public utilities are defined as those undertakings whose primary activity is to supply the public. They may be in public or private ownership. Emissions from own on-site use of fuel should be included. Emissions from autoproducers (undertakings which generate electricity/heat wholly or partly for their own use, as an activity which supports their primary activity) should be assigned to the sector where they were generated and not under 1A1a. Autoproducers may be in public or private ownership.

The Eurostat database provides separate tables for the supply, transformation and consumption of electricity and heat. Combined heat and power plants (CHP) produce both electricity and heat. Various countries may allocate the fuel consumed to heat production or electricity production in different ways. For this study, we have followed the default methodology for apportioning fuel input in a CHP plant given in the Eurostat questionnaire guidance. The method implies that the fuel input (and consequently greenhouse gas emission) is divided between electricity and heat in proportion to their shares in the output. We have therefore simply added the supply, transformation and consumption statistics for electricity and heat.

The consumption data for industry (including the refinery, solid fuel manufacture and other energy industries) includes the consumption of electricity and heat generated by autoproducers. We estimated the electricity and heat consumed in each industry from public sources from:

$$C_{pi} = C_i - \frac{C_i}{\sum_i C_i} A$$

[8] IPCC Greenhouse Gas Inventory Reporting Instructions Revised 1996 IPCC Guidelines for National Greenhouse gas Inventories: volume 1.

where C_{pi} is the electricity and heat consumed in industry, i from public sources;

C_i is the electricity and heat consumed in industry, i from autoproducers and public sources;

A is the supply of electricity and heat from autoproducers.

We assumed that non-industrial sources did not consume electricity and heat from autoproducers. We allocated consumption in mines and patent fuel/briquetting plants, coke-oven and gasworks plant and oil and gas extraction to the solid fuel manufacture and other energy industries sector. Electricity and heat supplied for own use for public electricity and heat production was not considered to be part of the total consumption. We considered the nuclear industry to be part of the public electricity supply industry.

We then calculated the total public electricity and heat consumed as the sum of consumption by industrial and non-industrial sources in the country and exports. We then calculated fraction, f_j, of public heat and electricity supplied to each sector, j, (refining, solid fuel manufacture and other energy industries, industry and non-industry, and exports) in proportion to the energy consumed:

$$f_j = \frac{C_{pj}}{\sum_j C_{pj}}$$

2.3 Petroleum refining

The IPCC Greenhouse Gas Inventory Reporting Instructions[9] define Sector 1A1b as follows:

> All combustion activities supporting the refining of petroleum products. Does not include evaporative emissions, which should be reported separately under 1A3 or 1B2.

The Eurostat database provides separate tables for the supply, transformation and consumption of petroleum products and feedstocks. A refinery feedstock is a processed oil destined for further processing (e.g. straight run fuel oil or vacuum gas oil) excluding blending. With further processing, it will be transformed into one or more components and/or finished products. This definition also covers returns from the petrochemical industry to the refining industry (e.g. pyrolysis gasoline, C4 fractions, gasoil and fuel oil fractions). We summed the net heat content of the feedstocks and petroleum products to calculate the total transformed in the energy industries or otherwise consumed.

The Eurostat database provides details of exports of petroleum products and feedstocks to individual countries in mass units (k tonnes). The tables for supply, transformation and consumption on the other hand give total exports in units of both net heat content (TJ) and mass units. We derived country-specific net calorific values (net TJ/k tonne) from the total export data and applied these factors to convert the detailed export data to the net heat content basis.

The consumption data for industry (including the refinery, solid fuel manufacture and other energy industries) does not include the fuel used by autoproducers to generate electricity. We estimated the fuel consumed in each industry for autogeneration from:

$$A_i = \frac{C_i}{\sum_i C_i} A$$

[9] IPCC Greenhouse Gas Inventory Reporting Instructions Revised 1996 IPCC Guidelines for National Greenhouse gas Inventories: volume 1.

where C_{pi} is the electricity and heat consumed in industry, i from public sources;

C_i is the electricity and heat consumed in industry, i from autoproducers and public sources;

A is the fuel supplied to autoproducers.

We assumed that non-industrial sources did not consume electricity and heat from autoproducers. We allocated fuel consumption and transformation input for mines and patent fuel/briquetting plants, coke-oven and gasworks plant and oil and gas extraction to the solid fuel manufacture and other energy industries sector. We allocated fuel consumption in electricity generating plants and the transformation input to public thermal power stations and district heating plants to the public electricity and heat production sector.

We then calculated the total petroleum products and feedstocks consumed as the sum of consumption and transformation inputs by industrial and non-industrial sources in the country and exports. Finally, we calculated the fraction, f_j, of petroleum products and feedstocks supplied to each sector, j, (public electricity and heat, solid fuel manufacture and other energy industries, industry and non-industry, and exports) in proportion to the energy consumed or transformed:

$$f_j = \frac{B_j}{\sum_j B_j}$$

where

B_j is quantity of petroleum products and feedstocks supplied to each sector (consumption and transformation input plus autoproduction input)

2.4 Solid fuel manufacturing and other energy industries

The IPCC Greenhouse Gas Inventory Reporting Instructions[10] define Sector 1A1c as follows:

> Combustion emissions from fuel use during the manufacture of secondary and tertiary products from solid fuels including the production of charcoal. Emissions from own on-site fuel use should be included.
>
> The emissions from the manufacture of solid fuels comprise emissions arising from fuel combustion for the production of coke, brown coal briquettes and patent fuel.
>
> The emissions from other energy industries comprise combustion emissions arising from the energy-producing industries own (on-site) energy use not mentioned above. This includes the emissions from own-energy use in coal mining and oil and gas extraction. Combustion emissions from pipeline transport should be reported under category 1A3e (other transportation).

The Eurostat database provides separate tables for the supply, transformation and consumption of solid fuels, crude oil and gas. We summed the net heat content of the solid fuels, crude oil and gas to calculate the totals transformed in the energy industries or otherwise consumed.

The Eurostat database does not provide details of exports of solid fuels broken down by country of destination as a single fuel category. Instead, it provides details of exports by country of destination separately for hard coal, hard coke, brown coal (lignite) and brown coal briquettes. The Eurostat

[10] IPCC Greenhouse Gas Inventory Reporting Instructions Revised 1996 IPCC Guidelines for National Greenhouse gas Inventories: volume 1.

database provides details of exports of these products to individual countries in mass units (k tonnes). The tables for supply, transformation and consumption, on the other hand, give total exports in units of both net heat content (TJ) and mass units. We derived product-specific and country-specific net calorific values (net TJ/k tonne) from the total export data and applied these factors to convert the detailed export data to the net heat content basis. We then summed the export flows to give total exports of solid fuels by country of destination.

The consumption data for industry (including the refinery, solid fuel manufacture and other energy industries) does not include the fuel used by autoproducers to generate electricity. We estimated the fuel consumed in each industry for autogeneration from:

$$A_i = \frac{C_i}{\sum_i C_i} A$$

where C_{pi} is the electricity and heat consumed in industry, i from public sources;

C_i is the electricity and heat consumed in industry, i from autoproducers and public sources;

A is the solid fuel supplied to autoproducers.

We assumed that non-industrial sources did not consume electricity and heat from autoproducers. We allocated fuel consumption and transformation input for mines and patent fuel/briquetting plants, coke-oven and gasworks plant and oil and gas extraction to the solid fuel manufacture and other energy industries sector. We allocated fuel consumption in electricity generating plants and the transformation input to public thermal power stations and district heating plants to the public electricity and heat production sector.

We allocated solid fuel transformation inputs to blast furnaces to the iron and steel industry. Blast furnaces produce blast furnace gas, which is used as a source of energy within the steel works. The output of blast furnace gas was subtracted from the energy consumption in the steel industry in order to avoid double counting.

We then calculated the solid fuel and other energy sources consumed as the sum of consumption and transformation inputs by industrial and non-industrial sources in the country and exports. Finally, we calculated the fraction, f_j, of solid fuels and other energy supplied to each sector, j, (public electricity and heat, refinery, industry and non-industry, and exports) in proportion to the energy consumed or transformed:

$$f_j = \frac{B_j}{\sum_j B_j}$$

where

B_j is quantity of solid fuels and other energy industry products supplied to each sector (consumption and transformation input plus autoproduction input)

2.5 The reallocation of emissions

The emissions of greenhouse gases were reallocated to end users according to a conceptual model based on the UK End User model. In this case, there are 27 countries of the European Union and 3 energy supply industry categories:

- Public electricity and heat production
- Petroleum refining
- Solid fuel manufacture and other energy industries

The aim of the first stage of the reallocation is to reallocate the emissions to the 27 x 3 = 81 energy supply industries, taking account of the transfers of energy between the industries. The reallocation is carried out by solving the set of simultaneous equations:

$$S_i - \sum_{j \neq i} f_{ij} S_j = D_i$$

where S_i is the total direct and indirect emission from energy source ,i ;

D_i is the direct emission from energy source, i;

f_{ij} is the fraction of the total emission from energy source, j, attributed to energy source i

The factors f_{ij} make up an 81 x 81 matrix. Fig.1 shows the basic structure of the matrix comprising 9 sub-matrices A-I.

Sub-matrix A is a 27 x 27 matrix of factors representing the fraction of emissions supplied from the electricity and heat production industry in each country to the electricity and heat production industries in the other countries of the European Union. The off-diagonal elements equal $-f_{ij}$ and were calculated as described in Section 2.2. The diagonal elements equal 1.

Sub-matrix D is a 27 x 27 matrix of factors representing the fraction of emissions supplied from the electricity and heat production industry in each country to the petroleum industries in each country of the European Union. The off-diagonal elements are equal to zero: it is thus assumed that there is no direct reallocation between the electricity industry in one country and the refinery industry in another country. The diagonal elements represent the fraction allocated to the refinery industry from the electricity industry in the same country: they equal $-f_{ij}$ and were calculated as described in Section 2.2.

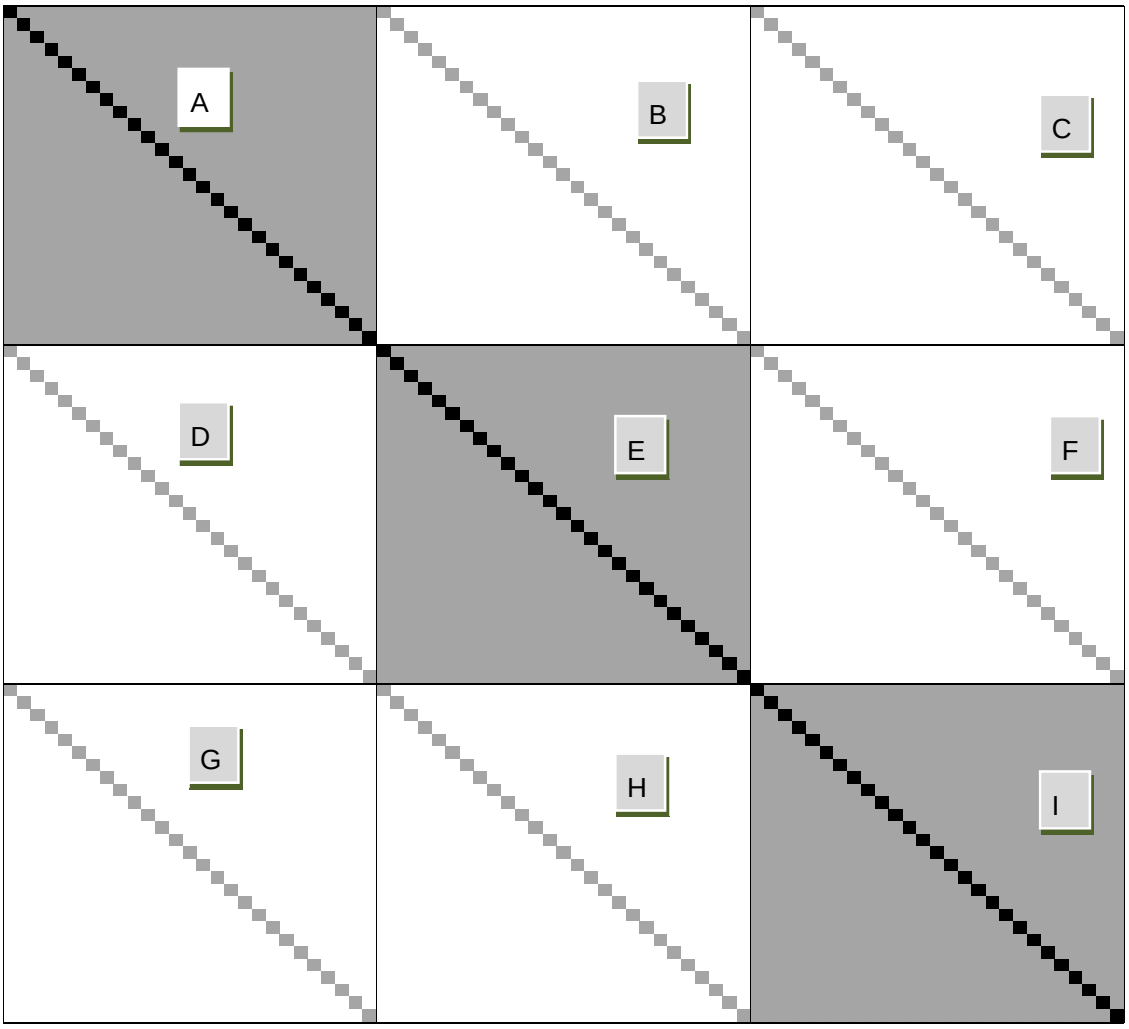
Sub-matrix G is a 27 x 27 matrix of factors representing the fraction of emissions supplied from the electricity and heat production industry in each country to the solid fuel manufacturing and other energy industries in each country of the European Union. The structure is similar to that of sub-matrix D.

Sub-matrix E is a 27 x 27 matrix of factors representing the fraction of emissions supplied from the refinery industry in each country to the refinery industries in the other countries of the European Union. The off-diagonal elements equal $-f_{ij}$ and were calculated as described in Section 2.3. The diagonal elements equal 1.

Sub-matrix I is a 27 x 27 matrix of factors representing the fraction of emissions supplied from the solid fuel manufacturing and other energy industries in each country to the solid fuel manufacturing and other energy industries in the other countries of the European Union. The off-diagonal elements equal $-f_{ij}$ and are and were calculated as described in Section 2.4. The diagonal elements equal 1.

The remaining sub-matrices have a structure similar to sub-matrix D.

Figure 1: Basic structure of the allocation matrix



We solved the simultaneous equations for the 81 unknowns, S_i by Gaussian elimination. We then calculated implied emission factors for each energy source category in each country:

$$e_i = \frac{S_i}{T_i}$$

where T_i is the total energy supplied by the country energy source to end users, other energy sources and exports.

The reallocated emission for each of the end user sectors was then calculated as the product of the implied emission factor and the energy supplied to the end user from the energy supply industry.

2.6 Treatment of the non-energy use of fuels

The Eurostat energy statistics database contains data on the energy contents of products supplied by the energy industries (e.g. refineries) which are not used to provide energy. For example, some of the

fuels supplied to an economy can be used for non-energy purposes (e.g. bitumen in road construction) or as raw materials for the manufacture of products such as plastics (i.e. feedstocks). In some cases, the carbon in these fuels is oxidised to CO_2 within the non-energy process; in other cases, the carbon is stored for long periods of time. The use of these products is referred to as non-energy use.

The database contains information about the non-energy use of fuels in three of the end use sectors (industry, transportation, and other sectors). The end user model allocates the emissions used by the energy industries to produce these products to the end use sector.

3 Fugitive emissions from fuels

3.1 Introduction

Fugitive emissions from fuels are reported under category 1B which comprises:

1B1: Solid fuels

1B2: Oil and natural gas

As with energy industries described above, the EEA dataset[11] contains national emissions of carbon dioxide, methane and nitrous oxide from the 1B1 and 1B2 sectors for years up to 2009. This section describes the reallocation of these emissions to end user sectors for the years 2005-2009.

We reallocated the greenhouse gas emissions to end users on the basis of net energy statistics (supply, transformation and consumption and exports by destination country) provided by the Eurostat database[12]following similar methods to those described in Chapter 2.

Solid fuels, oil and gas are used in the production of electricity and heat by public utilities. The electricity and heat is then supplied to the end users. Our analysis thus included three energy supply industry categories:

- Public electricity and heat production
- Solid fuel production and distribution
- Oil and natural gas production and distribution.

3.2 Public electricity and heat production

We calculated the fractions of public heat and electricity supplied to consumers as described in **Chapter 2**. However, in this case, consumption in mines, patent fuel/briquetting plants, coke-oven and gas-works plants was attributed to the solid fuel production industry while consumption for oil and gas extraction, oil and gas pipelines and refineries was allocated to the oil and natural gas production industry.

3.3 Solid fuel production and distribution

The IPCC Greenhouse Gas Inventory Reporting Instructions[13] define Sector 1B1 as follows:

> Total release of methane (and other greenhouse gases) during coal mining and post mining activities. Combustion emissions from colliery methane recovered and used should be excluded here and reported under fuel combustion emissions.

Sector 1B1 includes fugitive emissions arising during the manufacture of secondary and tertiary products (e.g. coke-oven gas and gasworks gas) from solid fuels.

[11] http://www.eea.europa.eu/data-and-maps/data/national-emissions-reported-to-the-unfccc-and-to-the-eu-greenhouse-gas-monitoring-mechanism-5

[12] http://epp.eurostat.ec.europa.eu/portal/page/portal/energy/data/database

[13] IPCC Greenhouse Gas Inventory Reporting Instructions Revised 1996 IPCC Guidelines for National Greenhouse gas Inventories: volume 1.

The Eurostat database provides separate tables for the supply, transformation and consumption of solid fuels, coke-oven gas and gasworks gas. We summed the net heat content of the solid fuels, coke-oven gas and gasworks gas to calculate the totals transformed in the energy industries or otherwise consumed.

We calculated the fractions of solid fuel products supplied to consumers as described in Chapter 2. However, in this case, consumption for oil and gas extraction, oil and gas pipelines and refineries was allocated to the oil and natural gas production industry.

3.4 Oil and gas production

The IPCC Greenhouse Gas Inventory Reporting Instructions[14] define Sector 1B2 as follows:

> Total fugitive emissions from oil and gas activities. Fugitive emissions may arise from equipment exhaust (non combustion), leakages, upsets and mishaps at any point in the chain of production through to final use. Note also that emissions from flaring are included (the combustion is considered a non-productive activity).

The Eurostat database provides separate tables for the supply, transformation and consumption of petroleum products, feedstocks, crude oil and natural gas. We summed the net heat content of the petroleum products, feedstocks, crude oil and natural gas to calculate the total transformed in the energy industries or otherwise consumed.

We calculated the fractions of solid fuel products supplied to consumers as described in Chapter 2. However, in this case, consumption for oil and gas extraction, oil and gas pipelines and refineries was allocated to the oil and natural gas production industry.

[14] IPCC Greenhouse Gas Inventory Reporting Instructions Revised 1996 IPCC Guidelines for National Greenhouse gas Inventories: volume 1.

4 Summary of results

4.1 Introduction

This section presents the results of the analysis for the European Union as a whole for total greenhouse gases. The results are presented as tables and charts. We have prepared an Excel spreadsheet tool that allows the user to prepare similar tables and charts for individual EU Member States for total greenhouse gases and for carbon dioxide, methane and nitrous oxide as individual greenhouse gases.

4.2 Direct emissions

Table 1 lists the direct emissions of total greenhouse gases from all Member States for the years 2005-2009 by sector. The data were extracted directly from the European Environment Agency's GHG data viewer. The data show a steady reduction in greenhouse gas emissions from the Energy sector as a whole during the period

4.3 End user emission balance

Table 2 provides a summary of the end user emission balance for 2009. The first column lists the main emission sectors. Box 1 shows the UNFCCC source categories and energy statistic consumer sectors corresponding to these main energy sectors[15].

The aim of the end user analysis is to transfer the direct emissions from the energy transformation sector to the end user sectors in the EU. Column 2 shows the direct emissions from the energy transformation sectors: these include both the combustion emissions (1A1) and fugitive emissions (1B).Column 2 also lists the direct emissions from the end user sectors.

Column 3 lists the indirect emissions transferred from the energy transformation sector to the end user sectors by the end user analysis[16]. Note that the sum of the indirect emissions transferred to end users or exports in this column equals the direct emissions from the energy transformation sector in column 2. Column 3 also includes indirect emissions imported and exported between Member States. The net exported indirect emission (intra EU imports+exports) is zero for the whole of the EU. However, the net exported indirect emission may not be zero for individual countries- for example, a country importing the bulk of its electricity from other countries within the EU.

[15] Bunkers in the emission balance of Table 2 relates to the emissions allocated to the fuel supplied to international marine bunkers. The emissions (direct and indirect) from domestic navigation are included in the transportation sector in Table 2. Table 1 shows the direct emissions from domestic navigation (1A3d). Tables A1-A7in the Appendix shows the indirect emissions allocated to domestic navigation. Moreover, the model allocates refinery emissions to domestic and international aviation in proportion to the energy content of the fuel supplied. Transportation in the emissions balance Table 2 includes the indirect emissions allocated to total domestic and international aviation. Tables A1-A7 in the Appendix shows the indirect emissions allocated to domestic navigation and international aviation separately.

[16] There is a category named 1b0. Fugitive emissions occur during the production of solid and liquid fuels (IPCC categories 1B1 and 1 B2). The fuels are supplied to end users in the transport, industrial and domestic sectors. The analysis therefore reallocates part of the fugitive emissions to these end users. However, some of the fuel is supplied to the electricity and heat generating industry, which is not an end user. The indirect fugitive emissions allocated to the electricity industry must be further reallocated to users in proportion to the electricity and heat supplied. The indirect emissions category 1B0 is the fugitive emission allocated to end users in proportion to the heat and electricity supplied.

Column 10 lists the total end user emissions (direct + indirect) calculated as the sum of columns 2 and 3. Note that the sum of these emissions equals the sum of the direct emissions in column 2.

Columns 4-9 list the end user emissions associated with each of the UNFCCC energy transformation sectors:

1A1a: Public Electricity and Heat Production

1A1b: Petroleum Refining

1A1c: Manufacture of Solid Fuels and other Energy Industries

1B1: Solid fuels

1B2: Oil and natural gas

Column 7 includes an additional source sector (here designated 1B0) which corresponds to the fugitive emissions from solid fuel and oil and natural gas production allocated to end users as the result of the consumption of fuels in the production of heat and electricity.

Table 2 also shows the direct and indirect emissions as a percentage of the total direct emission in the energy sector.

Appendix 1 provides more detailed sectoral data for the indirect emissions presented in columns 3-9.

Figure 2 shows a bar chart representing the data given in Table 2. Indirect emissions, particularly those associated with the use of heat and electricity (1A1a), make up a substantial part of the emissions from the industry, residential and commercial sectors. The refinery sector (1A1b) makes the largest contribution to indirect transportation emissions. Figure 3 shows a bar chart representing the data given in Table 2 as percentages of the direct energy sector emissions. Indirect emissions exceed the direct emissions from the residential and commercial sectors.

Box 1: Correspondence between end user sectors

Main end user sector	UNFCCC source categories	Energy statistics categories
Industry	1.A.2. Manufacturing Industries and Construction	Iron and steel Non-Ferrous Metals Chemical and Petrochemical Non-Metallic Minerals Mining and Quarrying Food and Tobacco Textile and Leather Paper, Pulp and Print Transport Equipment Machinery Wood and Wood Products Construction Non-specified (Industry) Non energy use in industry
Transportation	1.A.3. Transport	Rail Road International aviation Domestic aviation Domestic Navigation Consumption in Pipeline transport Non-specified (Transport) Non energy use in transport
Commercial	1.A.4.A. Commercial/Institutional	Services
Residential	1.A.4.B. Residential	Households
Other sectors	1.A.4.C. Agriculture/Forestry/Fisheries 1.A.5. Other (Not elsewhere specified)	Fisheries Agriculture Other sectors Non energy other sectors

4.4 Trends in indirect and direct emissions

Table 3 shows the emissions from the EU for the years 2005-2009. Row 1 shows the total direct emissions from the energy sector (1A plus 1B). Rows 2-4 show the direct combustion emissions from the energy sector as a whole (1A), direct combustion emissions from the energy transformation sector (1A1) and direct fugitive emissions (1B). The direct emissions from fuel transformation (1A1 plus 1B, row 5) are then allocated to end users (row 7). Part of the end user emission is exported from the EU: row 8 shows the indirect emissions allocated to end users within the EU. Row 6 shows the direct emissions from the end user sectors: row 10 is then the sum of the direct emissions from the end user sectors and the indirect emissions in the country. The row 10 emissions are slightly smaller than the total direct emissions from the energy sector (row 1) because part of the emission is exported outside the EU.

The Table 3 chart (Figure 4) shows the trend in the:

- Direct emissions from fuel transformation (row 5)
- Direct emissions from end user sectors (row 6)
- Indirect emission allocated to end users in country (row 9)
- Direct and indirect emission allocated to end users in country (row 10)

Each of these emissions has fallen steadily over the period 2005-2009, with the total direct and indirect emissions allocated to end users in the EU falling by 10.5% over the period.

Table 4 (Figure 5) shows the trends in indirect emissions by sector.

The indirect emissions associated with the "other sectors" fell sharply between 2006 and 2007. This reduction arises because of changes to the energy statistics for Germany. The indirect emissions for the "other sectors" for other countries do not decrease substantially between 2006 and 2007 in the same way.

Table 5 (Figure 6) shows the trends in direct emissions by sector

Table 6 (Figure 7) shows the trends in total indirect plus direct emissions by sector.

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Table 1: Direct greenhouse emissions by sector						
Country:	EU					
Greenhouse gases	Units:	Tg, CO2 equivalent				
Sector		Year				
		2005	2006	2007	2008	2009
Total emissions (sectors 1-7, excluding 5. LULUCF)		5148.8	5128.9	5071.3	4969.1	4614.5
1. Energy		4084.5	4073.4	4010.4	3934.1	3659.8
1.A. Fuel Combustion - Sectoral Approach		3990.1	3981.5	3922.4	3848.1	3578.4
1.A.1. Energy Industries		1592.1	1599.5	1610.8	1535.2	1412.3
1.A.1.A. Public Electricity and Heat Production		1384.2	1396.9	1404.7	1333.2	1229.6
1.A.1.B. Petroleum Refining		137.8	134.4	134.9	136.2	127.9
1.A.1.C. Manufacture of Solid Fuels and Other Energy Industries		70.1	68.3	71.2	65.7	54.9
1.A.2. Manufacturing Industries and Construction		663.2	661.3	656.2	629.3	531.8
1.A.2.A. Iron and Steel		118.0	119.4	119.3	112.0	81.1
1.A.2.B. Non-Ferrous Metals		11.0	11.3	10.7	10.6	9.0
1.A.2.C. Chemicals		87.2	83.7	81.2	80.6	74.3
1.A.2.D. Pulp, Paper and Print		31.1	31.0	30.0	27.7	25.1
1.A.2.E. Food Processing, Beverages and Tobacco		43.4	42.7	40.3	38.9	35.6
1.A.2.F. Other		372.4	373.2	374.6	359.5	306.8
1.A.3. Transport		963.0	968.1	975.4	958.5	932.1
1.A.3.A. Civil Aviation		19.1	19.2	19.5	18.7	17.6
1.A.3.B. Road Transportation		907.0	911.9	918.7	902.8	878.4
1.A.3.C. Railways		8.1	8.0	8.3	8.0	7.5
1.A.3.D. Navigation		18.7	18.7	19.1	18.7	19.2
1.A.3.E. Other Transportation		10.0	10.3	9.8	10.3	9.5
1.A.4. Other Sectors		761.1	742.7	670.4	715.5	693.2
1.A.4.A. Commercial/Institutional		186.2	183.5	167.2	179.3	171.2
1.A.4.B. Residential		491.9	479.4	426.6	457.9	445.3
1.A.4.C. Agriculture/Forestry/Fisheries		83.0	79.7	76.6	78.3	76.8
1.A.5. Other (Not elsewhere specified)		10.8	10.0	9.7	9.5	8.9
1.A.5.A. Stationary		3.3	3.0	2.8	2.9	2.5
1.A.5.B. Mobile		7.5	7.0	6.9	6.6	6.4
1.B. Fugitive Emissions from Fuels		94.4	91.8	88.0	86.0	81.3
1.B.1. Solid Fuels		32.3	31.0	27.7	27.3	24.4
1.B.2. Oil and Natural Gas		62.2	60.9	60.3	58.7	57.0

Table 2: End-user emission balance, 2009

Country: EU

Greenhouse gases **Units:** Tg, CO_2 equivalent

		Indirect emissions from energy transformation							
Sector	**Direct**	**total**	**1a1a**	**1a1b**	**1a1c**	**1b0**	**1b1**	**1b2**	**End-use emissions (all)**
Energy transformation	1493.7								
Industry	531.8	403.3	337.8	31.6	10.4	6.7	4.5	12.2	935.1
Transportation	932.1	138.2	27.9	91.6	0.2	0.6	0.0	18.0	1070.3
Commercial	171.2	372.8	354.6	5.0	2.9	6.8	0.2	3.3	544.0
Residential	445.3	469.6	431.0	11.1	8.9	9.3	1.1	8.2	914.9
Other sectors	85.7	40.4	33.1	4.3	0.9	0.5	0.2	1.4	126.1
total end user sector	2166.1	1424.3	1184.4	143.6	23.4	23.9	6.0	43.0	
imports from EU		-141.0	-81.4	-38.7	-7.1	-1.7	-2.4	-9.6	-141.0
exports to EU		141.0	81.4	38.7	7.1	1.7	2.4	9.6	141.0
exports from EU		57.8	23.2	25.4	2.3	0.6	0.2	6.1	57.8
bunkers		11.6	0.0	10.1	0.0	0.0	0.0	1.5	11.6
total	3659.8	1493.6	1207.5	179.1	25.7	24.5	6.2	50.5	3659.7

As percentage of total direct emissions

		Indirect emissions from energy transformation							
Sector	**Direct**	**total**	**1a1a**	**1a1b**	**1a1c**	**1b0**	**1b1**	**1b2**	**End-use emissions**
Energy transformation	41%								0%
Industry	15%	11%	9%	1%	0%	0%	0%	0%	26%
Transportation	25%	4%	1%	3%	0%	0%	0%	0%	29%
Commercial	5%	10%	10%	0%	0%	0%	0%	0%	15%
Residential	12%	13%	12%	0%	0%	0%	0%	0%	25%
Other sectors	2%	1%	1%	0%	0%	0%	0%	0%	3%
total end user sector	59%	39%	32%	4%	1%	1%	0%	1%	
imports from EU		-4%	-2%	-1%	0%	0%	0%	0%	-4%
exports to EU		4%	2%	1%	0%	0%	0%	0%	4%
exports from EU		2%	1%	1%	0%	0%	0%	0%	2%
bunkers		0%	0%	0%	0%	0%	0%	0%	0%
total	100%	41%	33%	5%	1%	1%	0%	1%	100%

Figure 2: Direct and indirect emissions by end user, 2009

Country: **EU**

Greenhouse gases **Units:** **Tg, CO_2 equivalent**

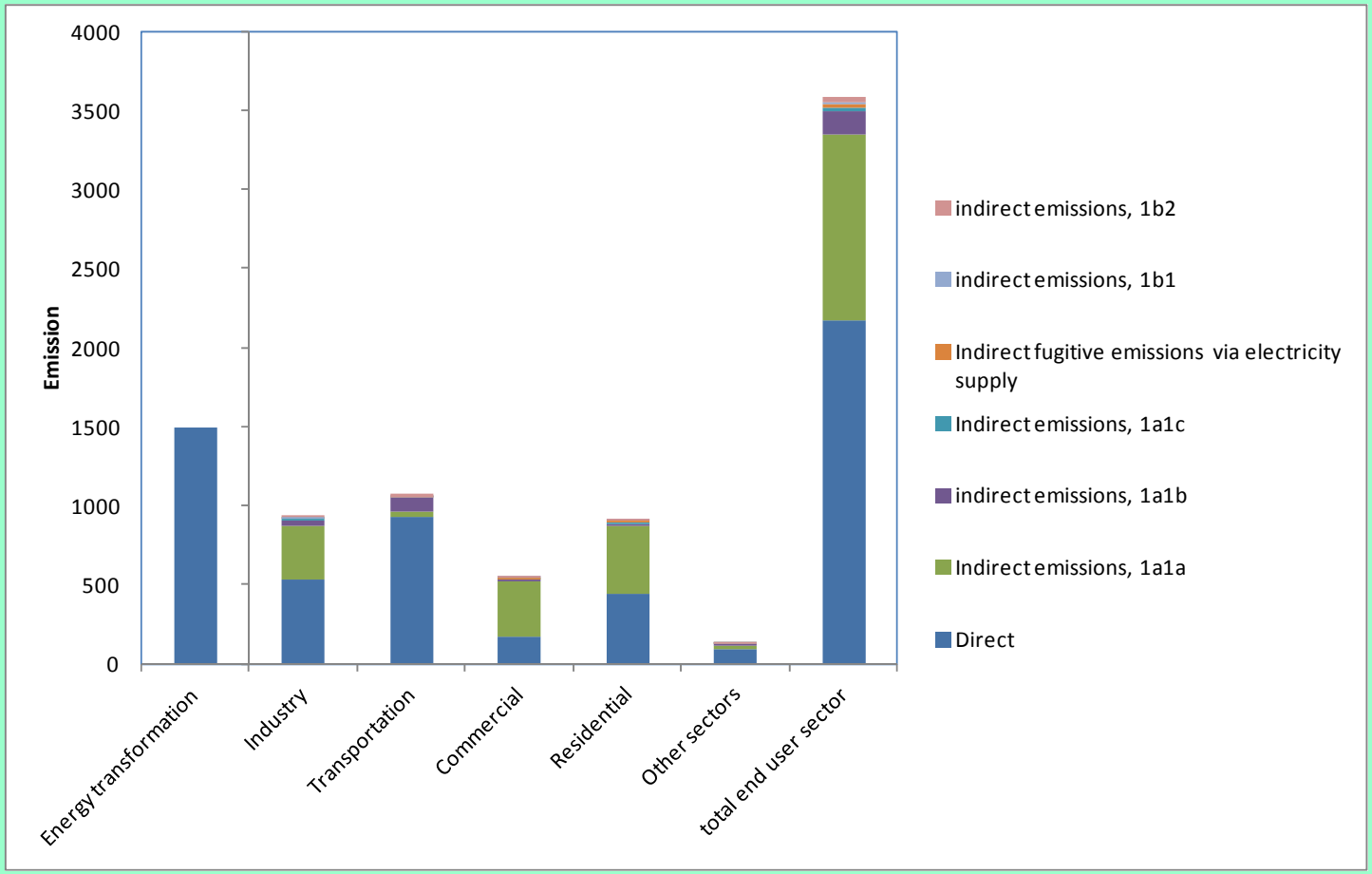


Figure 3: Direct and indirect emissions by end user as percentage of total energy-related emissions, 2009

Country: **EU**

Greenhouse gases

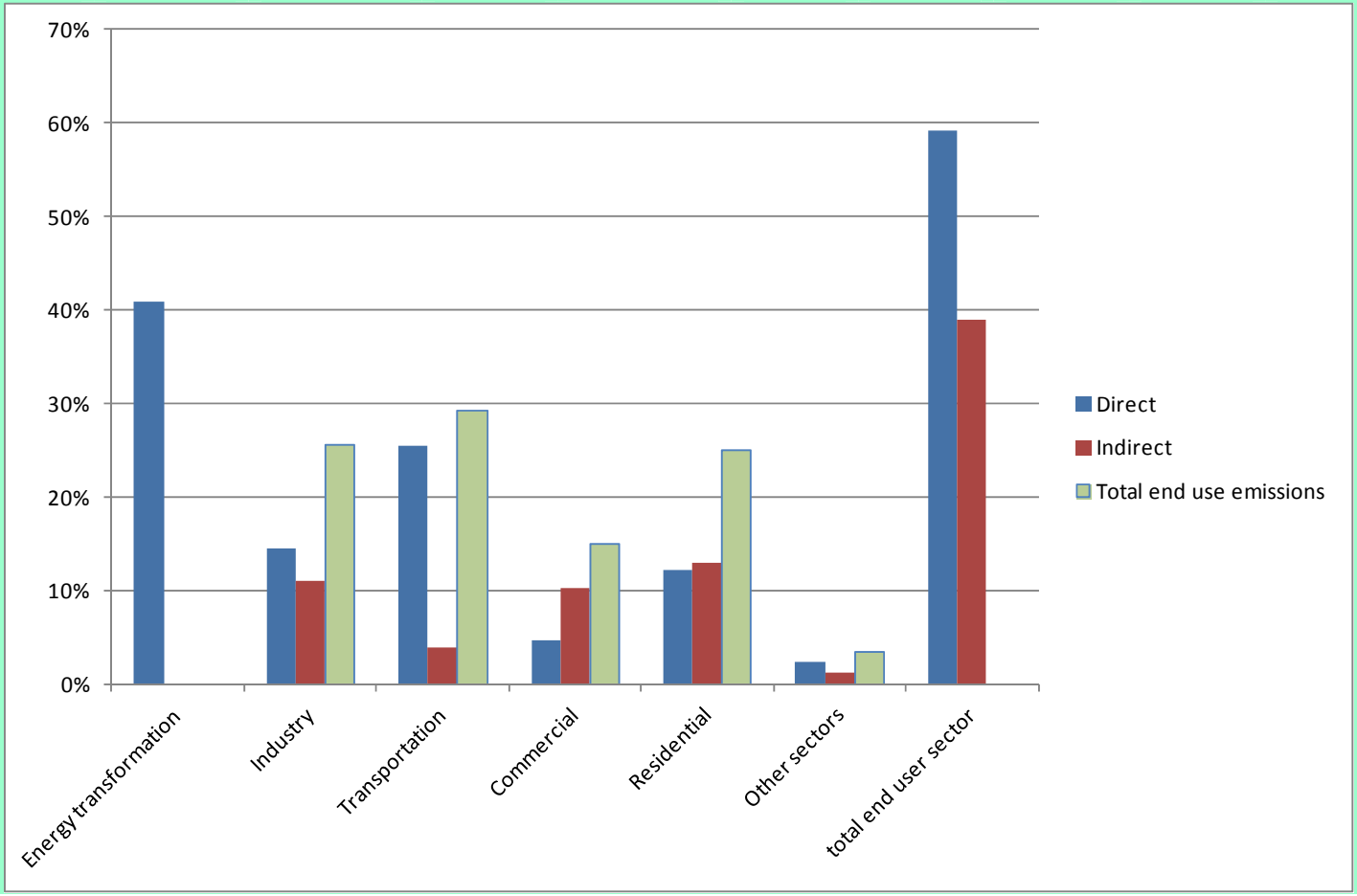


Table 3; Figure 4: Trends in indirect and direct emissions

Country: EU

Greenhouse gases **Units:** Tg, CO_2 equivalent

	2005	2006	2007	2008	2009
1. Energy	4084.5	4073.4	4010.4	3934.1	3659.8
1.A. Fuel Combustion - Sectoral Approach	3990.1	3981.5	3922.4	3848.1	3578.4
1.A.1. Energy Industries	1592.1	1599.5	1610.8	1535.2	1412.3
1.B. Fugitive Emissions from Fuels	94.4	91.8	88.0	86.0	81.3
Direct emissions from fuel transformation	1686.5	1691.4	1698.8	1621.2	1493.7
End user sectors, direct emission	2398.0	2382.0	2311.7	2312.9	2166.1
Total emission allocated to end users	1686.5	1691.4	1698.8	1621.2	1493.6
Indirect emission allocated to end users in country	1614.5	1621.1	1620.8	1546.8	1424.3
Direct and indirect emission allocated to end users in country	4012.5	4003.1	3932.5	3859.7	3590.4

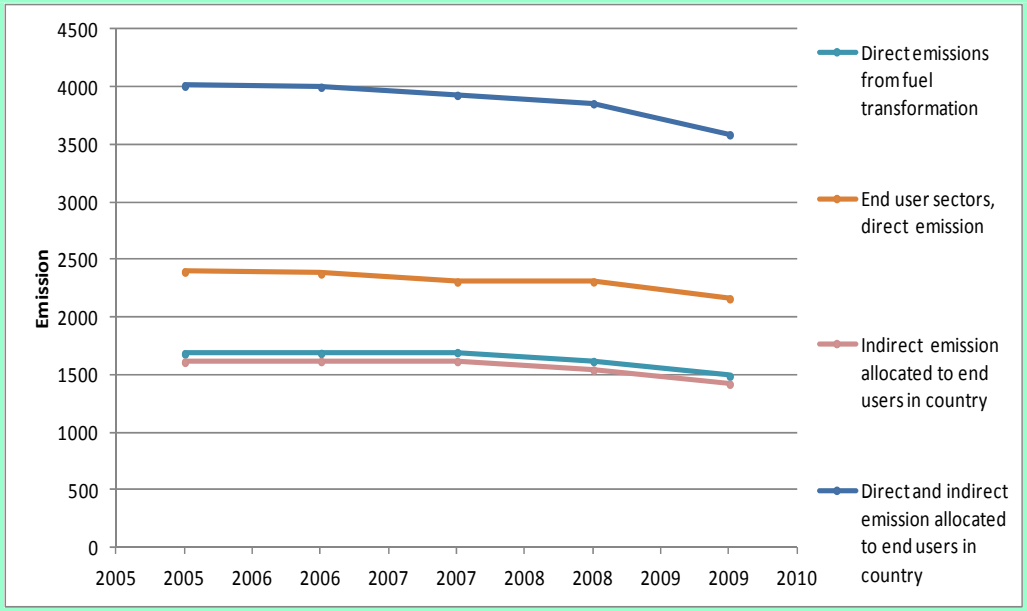


Table 4; Figure 5: Trends in indirect emissions by sector

Country: EU

Greenhouse gases **Units:** Tg, CO_2 equivalent

	Year				
	2005	**2006**	**2007**	**2008**	**2009**
Industry	504.1	495.1	527.0	486.3	403.3
Transportation	146.5	144.6	149.1	145.0	138.2
Commercial	367.7	382.6	397.9	388.9	372.8
Residential	487.7	491.4	503.1	483.0	469.6
Other sectors	108.5	107.4	43.6	43.7	40.4

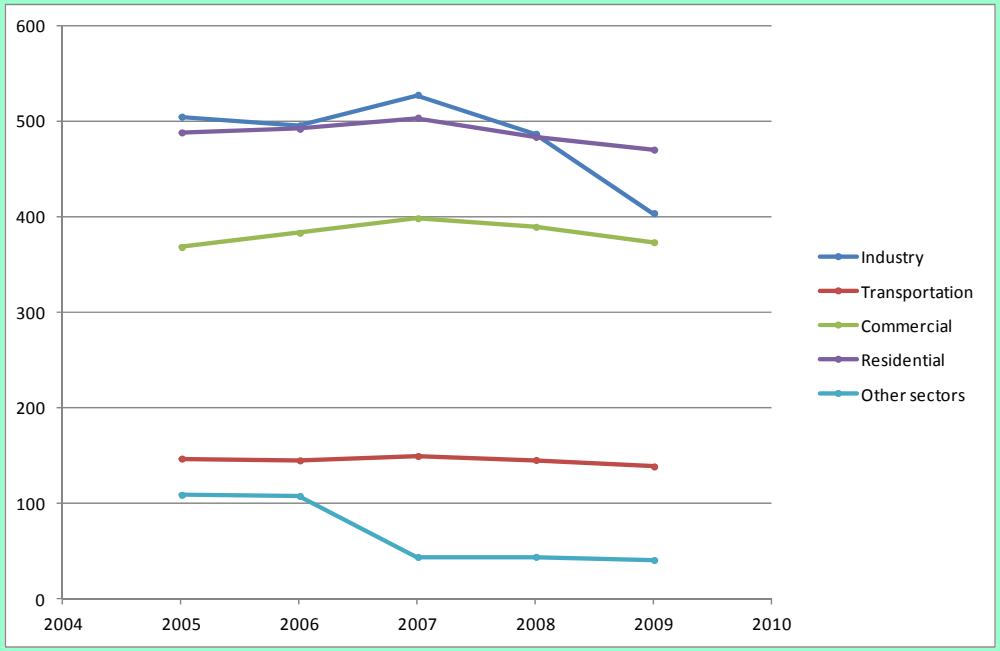


Table 5; Figure 6: Trends in direct emissions by sector

Country: EU

Greenhouse gases **Units:** Tg, CO2 equivalent

	Year				
	2005	**2006**	**2007**	**2008**	**2009**
Industry	663.2	661.3	656.2	629.3	531.8
Transportation	963.0	968.1	975.4	958.5	932.1
Commercial	186.2	183.5	167.2	179.3	171.2
Residential	491.9	479.4	426.6	457.9	445.3
Other sectors	93.7	89.7	86.2	87.9	85.7

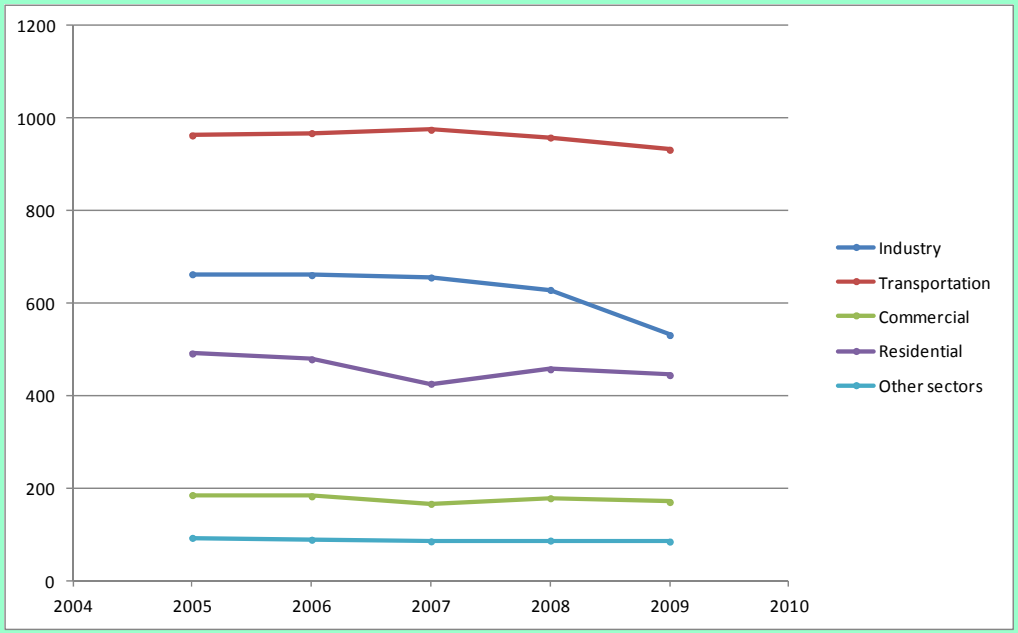
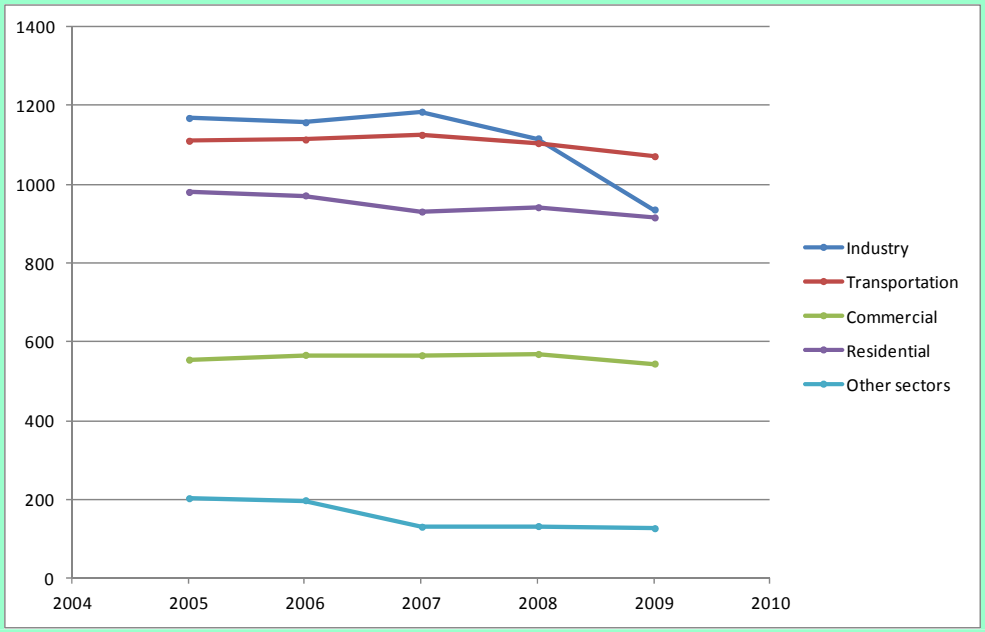


Table 6; Figure 7: Trends in total (indirect + direct) emissions by sector

Country: EU

Greenhouse gases **Units:** Tg, CO_2 equivalent

	Year				
	2005	**2006**	**2007**	**2008**	**2009**
Industry	1167.3	1156.4	1183.3	1115.6	935.1
Transportation	1109.4	1112.7	1124.5	1103.5	1070.3
Commercial	553.9	566.1	565.1	568.3	544.0
Residential	979.6	970.9	929.8	940.8	914.9
Other sectors	202.2	197.1	129.8	131.5	126.1



Appendix 1 – Indirect emissions allocated to end user sectors in the European Union

Table A1: Total indirect emissions allocated to end user sectors					
Country: EU					
Greenhouse gases	Units: Tg, CO2 equivalent				
	2005	2006	2007	2008	2009
Direct emissions, D	1686.5	1691.4	1698.8	1621.2	1493.7
Total emission allocated to end users	1686.5	1691.4	1698.8	1621.2	1493.6
Total emission allocated to end users in country	1614.5	1621.1	1620.8	1546.8	1424.3
Iron and steel	57.9	58.5	62.4	57.1	43.0
Non-Ferrous Metals	29.7	27.2	31.4	27.6	20.7
Chemical and Petrochemical	95.0	91.4	111.7	101.0	88.4
Non-Metallic Minerals	37.5	36.8	39.0	35.6	29.1
Mining and Quarrying	7.0	7.0	7.2	6.7	5.5
Food and Tobacco	42.0	39.7	44.0	40.4	37.2
Textile and Leather	13.8	12.5	12.7	11.1	8.3
Paper, Pulp and Print	41.4	42.3	46.9	43.0	37.4
Transport Equipment	18.6	18.7	23.6	22.0	18.3
Machinery	35.8	35.9	37.9	36.9	29.1
Wood and Wood Products	9.2	9.2	10.3	10.1	8.9
Construction	6.6	6.8	7.0	6.7	6.2
Non-specified (Industry)	79.0	79.1	62.0	58.1	44.1
Non energy use in industry	30.6	30.1	30.9	29.9	27.0
Rail	24.7	23.5	24.0	22.7	21.3
Road	94.2	93.9	97.5	94.6	91.7
International aviation	12.4	12.4	13.1	13.1	12.1
Domestic aviation	2.4	2.4	2.6	2.5	2.2
Domestic Navigation	2.0	2.1	2.0	2.0	1.8
Consumption in Pipeline transport	1.0	1.0	1.0	1.0	0.9
Non-specified (Transport)	8.8	8.3	8.1	8.3	7.5
Non energy use in transport	0.9	0.8	0.9	0.8	0.6
Households	487.7	491.4	503.1	483.0	469.6
Fisheries	0.4	0.4	0.3	0.4	0.3
Agriculture	33.2	32.0	31.6	31.9	29.7
Services	367.7	382.6	397.9	388.9	372.8
Other sectors	74.6	74.7	11.3	11.1	10.2
Non energy other sectors	0.3	0.3	0.3	0.2	0.2
Exports from EU	60.0	57.5	64.8	61.4	57.8
Bunkers	12.0	12.8	13.1	13.0	11.6
Exports to EU	164.0	166.7	160.7	147.2	141.0
Imports from EU	-164.0	-166.7	-160.7	-147.2	-141.0

Table A2: Indirect emissions from public heat and electricity combustion allocated to end user sectors

Country: EU

Greenhouse gases **Units:** Tg, CO2 equivalent

Sector	Year				
	2005	2006	2007	2008	2009
Iron and steel	45.6	46.3	50.4	46.4	35.5
Non-Ferrous Metals	27.9	25.5	29.7	26.1	19.6
Chemical and Petrochemical	85.5	82.7	102.6	92.4	81.2
Non-Metallic Minerals	29.1	28.8	31.1	28.0	22.9
Mining and Quarrying	6.4	6.4	6.7	6.1	5.0
Food and Tobacco	37.1	35.3	39.5	36.2	33.5
Textile and Leather	12.5	11.2	11.5	10.1	7.5
Paper, Pulp and Print	38.2	39.2	43.9	40.3	35.0
Transport Equipment	17.3	17.3	22.2	20.8	17.3
Machinery	32.3	32.6	34.6	33.7	26.6
Wood and Wood Products	8.5	8.6	9.7	9.5	8.4
Construction	5.0	5.2	5.6	5.2	4.8
Non-specified (Industry)	73.3	73.9	57.4	53.7	40.5
Non energy use in industry	0.0	0.0	0.0	0.0	0.0
Rail	23.2	22.1	22.5	21.3	20.0
Road	0.0	0.0	0.0	0.0	0.0
International aviation	0.0	0.0	0.0	0.0	0.0
Domestic aviation	0.0	0.0	0.0	0.0	0.0
Domestic Navigation	0.0	0.0	0.0	0.0	0.0
Consumption in Pipeline transport	0.7	0.7	0.7	0.6	0.6
Non-specified (Transport)	8.6	8.1	7.9	8.1	7.3
Non energy use in transport	0.0	0.0	0.0	0.0	0.0
Households	441.9	447.6	463.5	442.2	431.0
Fisheries	0.1	0.1	0.1	0.1	0.1
Agriculture	26.3	25.8	25.6	26.0	24.0
Services	347.5	362.7	379.7	369.7	354.6
Other sectors	71.9	72.2	9.9	9.8	9.0
Non energy other sectors	0.0	0.0	0.0	0.0	0.0
Exports from EU	25.2	23.9	27.4	25.1	23.2
Bunkers	0.0	0.0	0.0	0.0	0.0
Exports to EU	97.9	99.6	96.0	83.2	81.4
Imports from EU	0.0	0.0	0.0	0.0	0.0

Table A3: Indirect emissions from refinery combustion allocated to end user sectors

Country: EU

Greenhouse gases **Units:** Tg, CO2 equivalent

Sector	Year				
	2005	2006	2007	2008	2009
Iron and steel	1.0	0.9	1.1	0.9	0.7
Non-Ferrous Metals	0.4	0.4	0.4	0.3	0.2
Chemical and Petrochemical	2.3	2.1	2.4	2.2	1.6
Non-Metallic Minerals	3.5	3.3	3.2	3.1	2.6
Mining and Quarrying	0.2	0.2	0.2	0.2	0.2
Food and Tobacco	1.3	1.2	1.2	1.2	0.9
Textile and Leather	0.4	0.3	0.3	0.3	0.2
Paper, Pulp and Print	0.7	0.6	0.6	0.6	0.5
Transport Equipment	0.3	0.2	0.2	0.2	0.1
Machinery	1.0	0.9	0.8	0.8	0.6
Wood and Wood Products	0.2	0.2	0.1	0.1	0.1
Construction	1.0	1.0	0.8	0.8	0.8
Non-specified (Industry)	2.3	2.1	2.1	2.0	1.7
Non energy use in industry	23.7	23.5	24.0	23.4	21.3
Rail	0.8	0.8	0.8	0.8	0.7
Road	79.3	78.9	82.2	79.7	76.5
International aviation	10.6	10.6	11.1	11.3	10.3
Domestic aviation	2.1	2.1	2.2	2.1	1.9
Domestic Navigation	1.8	1.9	1.8	1.8	1.6
Consumption in Pipeline transport	0.0	0.0	0.0	0.0	0.0
Non-specified (Transport)	0.0	0.0	0.0	0.0	0.0
Non energy use in transport	0.8	0.7	0.8	0.6	0.5
Households	14.1	13.4	10.8	12.3	11.1
Fisheries	0.2	0.2	0.2	0.3	0.2
Agriculture	4.8	4.2	4.2	4.0	3.8
Services	5.8	5.5	4.8	5.5	5.0
Other sectors	0.3	0.2	0.2	0.2	0.1
Non energy other sectors	0.2	0.2	0.2	0.2	0.1
Exports from EU	25.0	24.0	27.5	26.8	25.4
Bunkers	10.6	11.2	11.5	11.5	10.1
Exports to EU	40.8	42.0	40.4	41.9	38.7
Imports from EU	-40.8	-42.0	-40.4	-41.9	-38.7

Table A4: Indirect emissions from other energy industry combustion allocated to end user sectors

Country: EU

Greenhouse gases **Units:** Tg, CO2 equivalent

Sector	Year				
	2005	2006	2007	2008	2009
Iron and steel	4.6	4.6	4.9	4.2	2.7
Non-Ferrous Metals	0.4	0.4	0.4	0.4	0.3
Chemical and Petrochemical	2.3	2.1	2.1	2.0	1.7
Non-Metallic Minerals	1.9	1.8	2.1	1.8	1.4
Mining and Quarrying	0.1	0.1	0.1	0.1	0.1
Food and Tobacco	1.3	1.2	1.3	1.2	1.1
Textile and Leather	0.4	0.3	0.3	0.3	0.2
Paper, Pulp and Print	1.0	0.9	0.9	0.9	0.7
Transport Equipment	0.4	0.4	0.4	0.3	0.3
Machinery	0.9	0.9	0.9	0.9	0.6
Wood and Wood Products	0.1	0.1	0.1	0.1	0.1
Construction	0.1	0.1	0.1	0.1	0.1
Non-specified (Industry)	0.9	0.8	0.7	0.7	0.5
Non energy use in industry	1.2	1.0	1.2	1.1	0.8
Rail	0.0	0.0	0.0	0.0	0.0
Road	0.0	0.1	0.1	0.1	0.1
International aviation	0.0	0.0	0.0	0.0	0.0
Domestic aviation	0.0	0.0	0.0	0.0	0.0
Domestic Navigation	0.0	0.0	0.0	0.0	0.0
Consumption in Pipeline transport	0.2	0.1	0.2	0.2	0.1
Non-specified (Transport)	0.0	0.0	0.0	0.0	0.0
Non energy use in transport	0.0	0.0	0.0	0.0	0.0
Households	10.7	10.2	10.2	9.9	8.9
Fisheries	0.0	0.0	0.0	0.0	0.0
Agriculture	0.4	0.4	0.4	0.4	0.3
Services	3.4	3.4	3.3	3.3	2.9
Other sectors	0.5	0.6	0.6	0.5	0.5
Non energy other sectors	0.0	0.0	0.0	0.0	0.0
Exports from EU	2.7	2.5	2.7	2.3	2.3
Bunkers	0.0	0.0	0.0	0.0	0.0
Exports to EU	9.1	8.7	8.7	7.7	7.1
Imports from EU	-9.1	-8.7	-8.7	-7.7	-7.1

Table A5: Indirect fugitive emissions allocated to end user sectors via public heat and electricity production

Country: EU

Greenhouse gases **Units:** Tg, CO2 equivalent

Sector	Year				
	2005	2006	2007	2008	2009
Iron and steel	1.2	1.2	1.2	1.1	0.8
Non-Ferrous Metals	0.6	0.5	0.5	0.5	0.4
Chemical and Petrochemical	1.9	1.9	2.0	1.9	1.6
Non-Metallic Minerals	0.7	0.7	0.7	0.6	0.5
Mining and Quarrying	0.2	0.1	0.1	0.1	0.1
Food and Tobacco	0.8	0.7	0.7	0.7	0.6
Textile and Leather	0.3	0.2	0.2	0.2	0.2
Paper, Pulp and Print	0.7	0.7	0.6	0.6	0.5
Transport Equipment	0.4	0.4	0.4	0.4	0.3
Machinery	0.7	0.7	0.7	0.7	0.6
Wood and Wood Products	0.2	0.2	0.2	0.2	0.2
Construction	0.1	0.1	0.1	0.1	0.1
Non-specified (Industry)	1.4	1.2	0.9	0.9	0.7
Non energy use in industry	0.0	0.0	0.0	0.0	0.0
Rail	0.5	0.5	0.4	0.4	0.4
Road	0.0	0.0	0.0	0.0	0.0
International aviation	0.0	0.0	0.0	0.0	0.0
Domestic aviation	0.0	0.0	0.0	0.0	0.0
Domestic Navigation	0.0	0.0	0.0	0.0	0.0
Consumption in Pipeline transport	0.0	0.0	0.0	0.0	0.0
Non-specified (Transport)	0.2	0.2	0.2	0.2	0.2
Non energy use in transport	0.0	0.0	0.0	0.0	0.0
Households	10.6	10.2	9.7	9.4	9.3
Fisheries	0.0	0.0	0.0	0.0	0.0
Agriculture	0.5	0.5	0.4	0.5	0.4
Services	7.3	7.2	6.9	7.0	6.8
Other sectors	1.2	1.1	0.1	0.1	0.1
Non energy other sectors	0.0	0.0	0.0	0.0	0.0
Exports from EU	0.6	0.6	0.7	0.7	0.6
Bunkers	0.0	0.0	0.0	0.0	0.0
Exports to EU	2.6	2.4	2.1	1.8	1.7
Imports from EU	-2.6	-2.4	-2.1	-1.8	-1.7

Table A6: Indirect fugitive emissions from solid fuel production allocated to end user sectors

Country: EU

Greenhouse gases **Units:** Tg, CO2 equivalent

Sector	Year				
	2005	2006	2007	2008	2009
Iron and steel	4.5	4.3	3.8	3.6	2.6
Non-Ferrous Metals	0.2	0.1	0.1	0.1	0.1
Chemical and Petrochemical	0.8	0.7	0.6	0.6	0.6
Non-Metallic Minerals	0.6	0.6	0.6	0.6	0.5
Mining and Quarrying	0.0	0.0	0.0	0.0	0.0
Food and Tobacco	0.3	0.3	0.2	0.2	0.2
Textile and Leather	0.1	0.1	0.0	0.0	0.0
Paper, Pulp and Print	0.3	0.2	0.2	0.2	0.2
Transport Equipment	0.1	0.1	0.1	0.1	0.1
Machinery	0.2	0.2	0.1	0.1	0.1
Wood and Wood Products	0.0	0.0	0.0	0.0	0.0
Construction	0.0	0.0	0.0	0.0	0.0
Non-specified (Industry)	0.3	0.3	0.2	0.2	0.1
Non energy use in industry	0.0	0.0	0.0	0.0	0.0
Rail	0.0	0.0	0.0	0.0	0.0
Road	0.0	0.0	0.0	0.0	0.0
International aviation	0.0	0.0	0.0	0.0	0.0
Domestic aviation	0.0	0.0	0.0	0.0	0.0
Domestic Navigation	0.0	0.0	0.0	0.0	0.0
Consumption in Pipeline transport	0.0	0.0	0.0	0.0	0.0
Non-specified (Transport)	0.0	0.0	0.0	0.0	0.0
Non energy use in transport	0.0	0.0	0.0	0.0	0.0
Households	1.1	1.2	1.0	1.1	1.1
Fisheries	0.0	0.0	0.0	0.0	0.0
Agriculture	0.2	0.2	0.1	0.2	0.2
Services	0.2	0.2	0.2	0.2	0.2
Other sectors	0.0	0.0	0.0	0.0	0.0
Non energy other sectors	0.0	0.0	0.0	0.0	0.0
Exports from EU	0.3	0.3	0.2	0.2	0.2
Bunkers	0.0	0.0	0.0	0.0	0.0
Exports to EU	3.5	3.6	3.0	2.9	2.4
Imports from EU	-3.5	-3.6	-3.0	-2.9	-2.4

Table A7: Indirect fugitive emissions from oil and natural gas production allocated to end user sectors

Country: EU

Greenhouse gases **Units:** Tg, CO2 equivalent

Sector	Year				
	2005	2006	2007	2008	2009
Iron and steel	1.0	1.1	1.0	0.9	0.7
Non-Ferrous Metals	0.3	0.2	0.2	0.2	0.2
Chemical and Petrochemical	2.2	2.0	1.9	1.9	1.7
Non-Metallic Minerals	1.7	1.6	1.5	1.4	1.2
Mining and Quarrying	0.1	0.1	0.1	0.1	0.1
Food and Tobacco	1.1	1.0	1.0	1.0	0.9
Textile and Leather	0.3	0.3	0.3	0.2	0.2
Paper, Pulp and Print	0.6	0.6	0.6	0.5	0.5
Transport Equipment	0.3	0.3	0.3	0.2	0.2
Machinery	0.7	0.7	0.7	0.6	0.6
Wood and Wood Products	0.1	0.1	0.1	0.1	0.1
Construction	0.3	0.4	0.4	0.4	0.3
Non-specified (Industry)	0.9	0.7	0.7	0.7	0.6
Non energy use in industry	5.7	5.6	5.7	5.4	4.9
Rail	0.2	0.2	0.2	0.2	0.2
Road	14.9	14.9	15.3	14.8	15.1
International aviation	1.8	1.8	1.9	1.9	1.8
Domestic aviation	0.3	0.3	0.4	0.4	0.3
Domestic Navigation	0.3	0.3	0.3	0.3	0.2
Consumption in Pipeline transport	0.1	0.1	0.1	0.1	0.1
Non-specified (Transport)	0.0	0.0	0.0	0.0	0.0
Non energy use in transport	0.1	0.1	0.1	0.1	0.1
Households	9.3	8.8	8.0	8.0	8.2
Fisheries	0.0	0.0	0.0	0.0	0.0
Agriculture	1.1	1.0	0.9	0.9	0.9
Services	3.5	3.6	3.1	3.2	3.3
Other sectors	0.5	0.5	0.5	0.5	0.4
Non energy other sectors	0.1	0.0	0.0	0.0	0.0
Exports from EU	6.3	6.2	6.3	6.3	6.1
Bunkers	1.4	1.5	1.6	1.6	1.5
Exports to EU	10.2	10.4	10.3	9.8	9.6
Imports from EU	-10.2	-10.4	-10.3	-9.8	-9.6

Appendix 2 – GHG emissions allocated to end user sectors in EU Member States

Figure A2.1 Trends in direct and indirect GHG emissions by end use sector in Belgium, 2005-2009

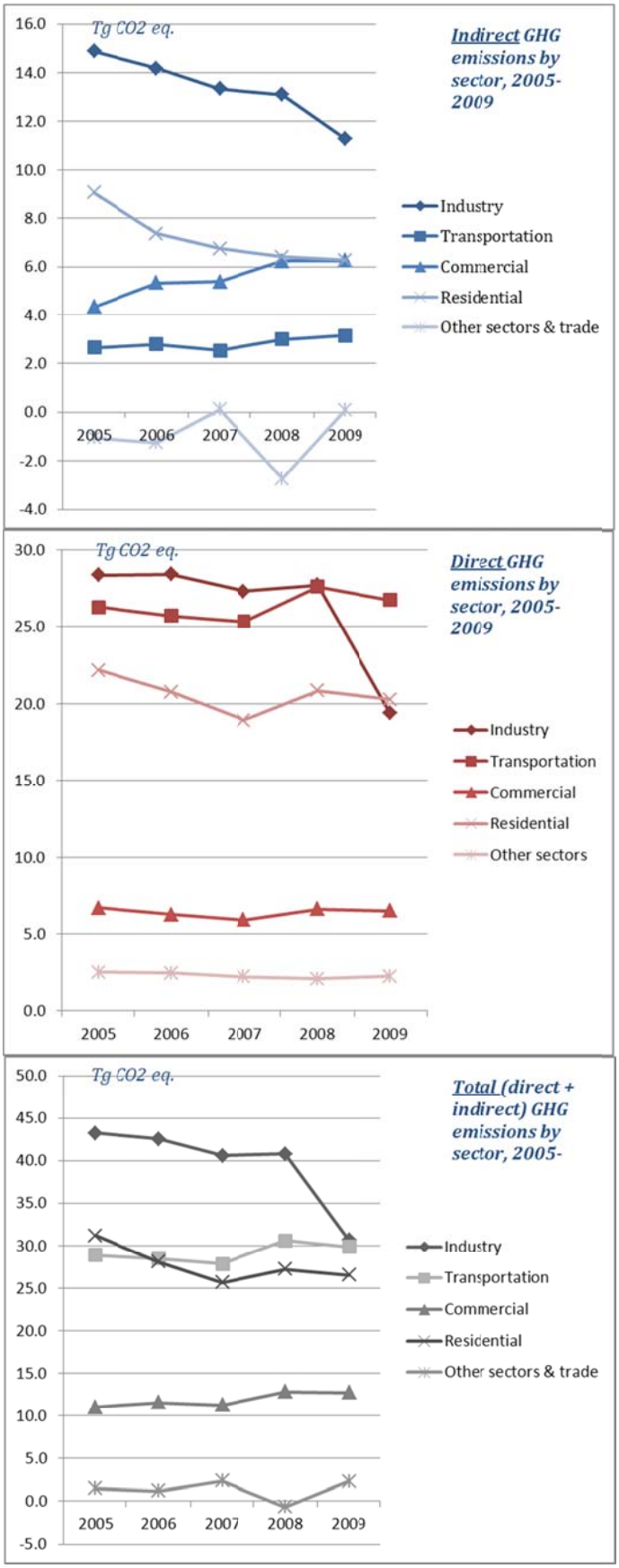
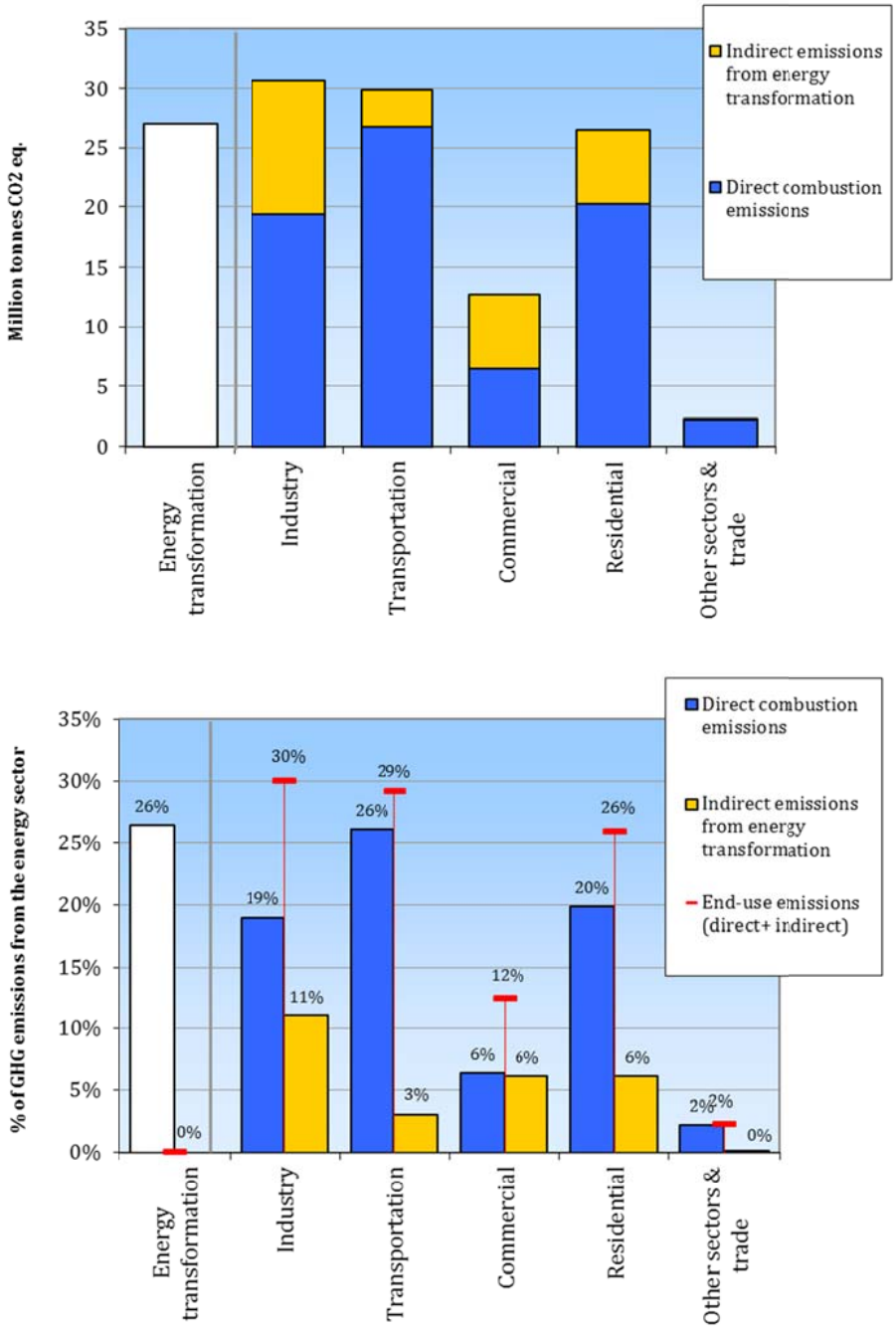


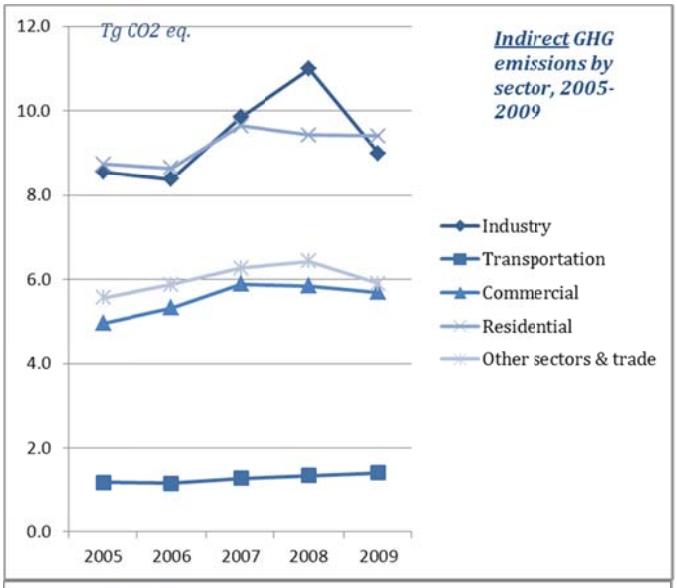
Figure A2.2 Direct and indirect GHG emissions by end use sector in Belgium in 2009

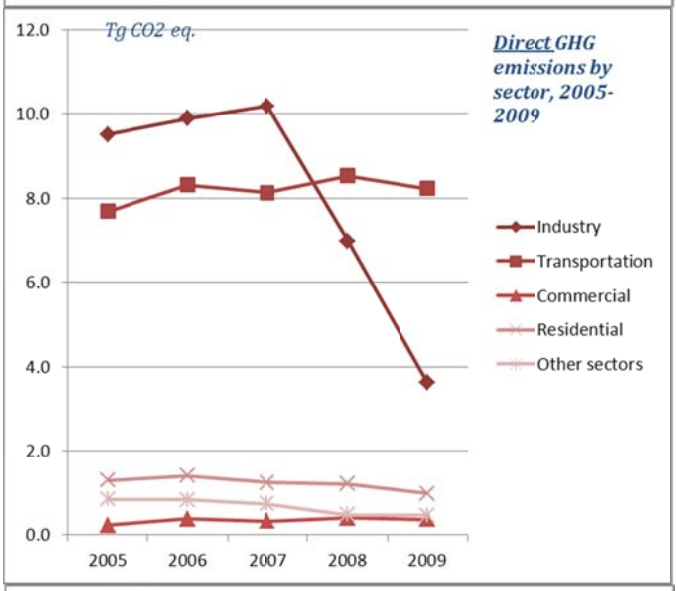


Note: The sum of direct and indirect emissions equals end-use emissions. The total indirect emissions allocated to end-users in a country can be smaller than the direct emissions from fuel transformation in that country if some of the indirect emissions are allocated to exports and international bunkers. The indirect emissions allocated to end users including exports and bunkers equals the direct emissions from fuel transformation plus the indirect emissions associated with energy imported from other countries. The indirect emissions arising from energy supplied from countries outside the EU are assumed to be zero. 'Other sectors' include emissions from agriculture, forestry and fishing as well as the net (indirect) emissions from energy trade.

Source: EEA, 2011

Figure A2.3 Trends in direct and indirect GHG emissions by end use sector in Bulgaria, 2005-2009





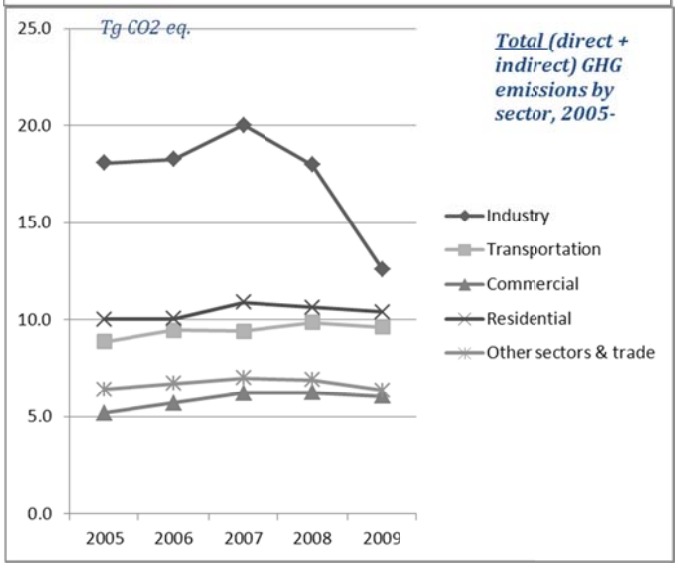
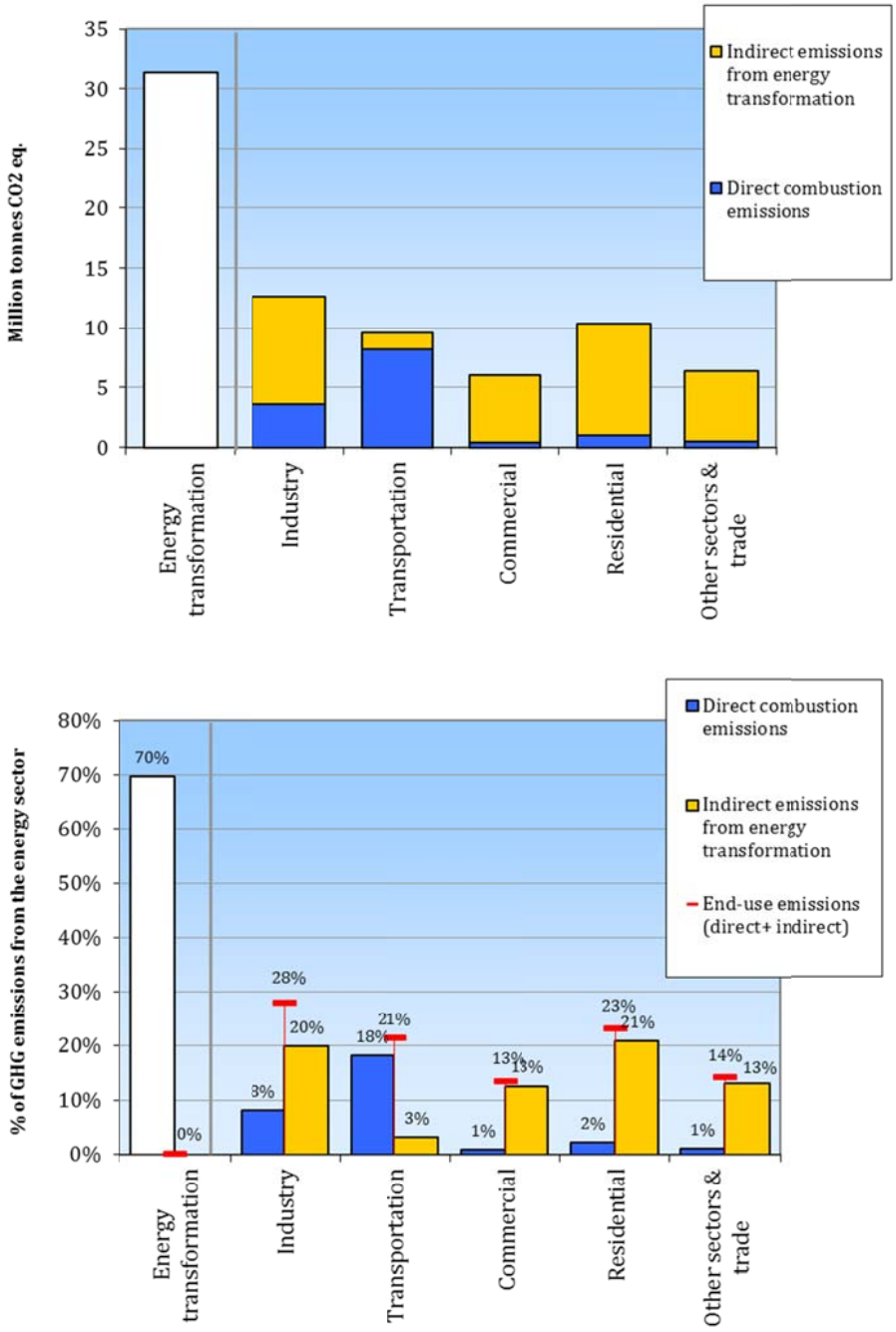


Figure A2.4 Direct and indirect GHG emissions by end use sector in Bulgaria in 2009



Note: The sum of direct and indirect emissions equals end-use emissions. The total indirect emissions allocated to end-users in a country can be smaller than the direct emissions from fuel transformation in that country if some of the indirect emissions are allocated to exports and international bunkers. The indirect emissions allocated to end users including exports and bunkers equals the direct emissions from fuel transformation plus the indirect emissions associated with energy imported from other countries. The indirect emissions arising from energy supplied from countries outside the EU are assumed to be zero. 'Other sectors' include emissions from agriculture, forestry and fishing as well as the net (indirect) emissions from energy trade.

Source: EEA, 2011

Figure A2.5 Trends in direct and indirect GHG emissions by end use sector in Czech Republic, 2005-2009

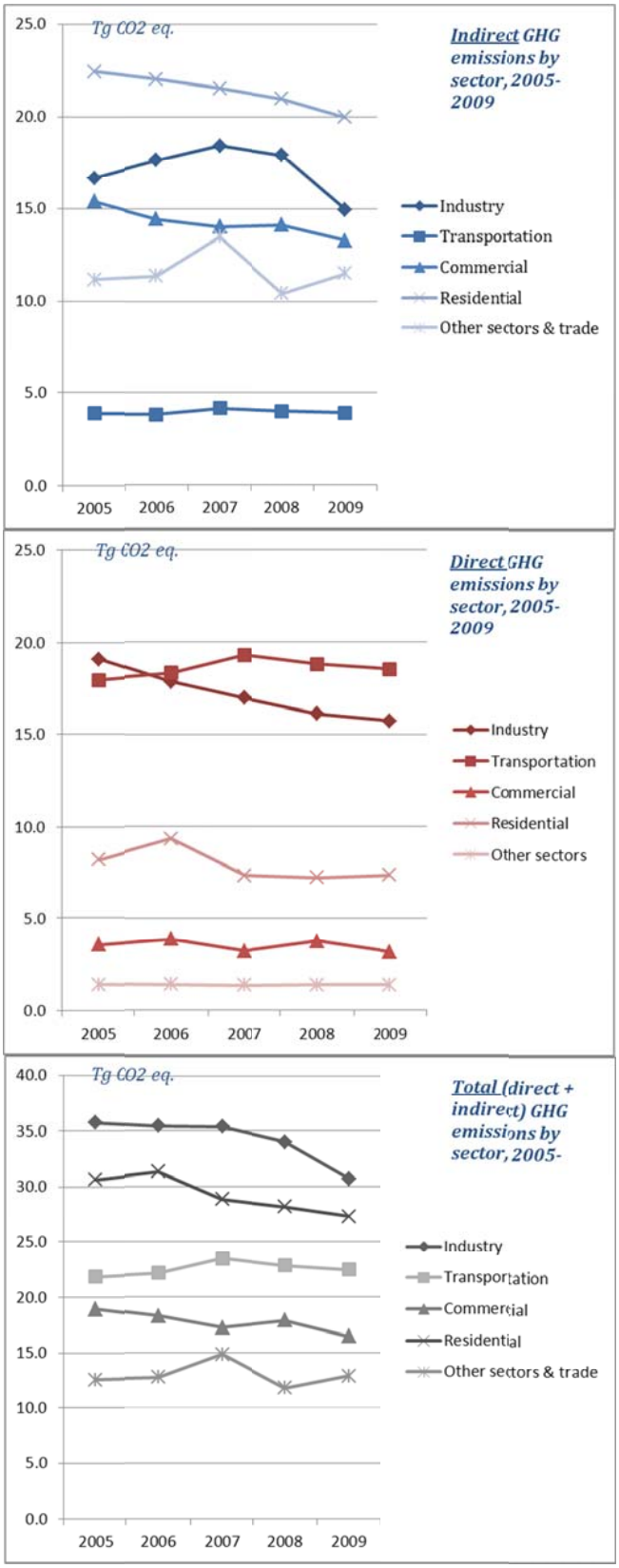
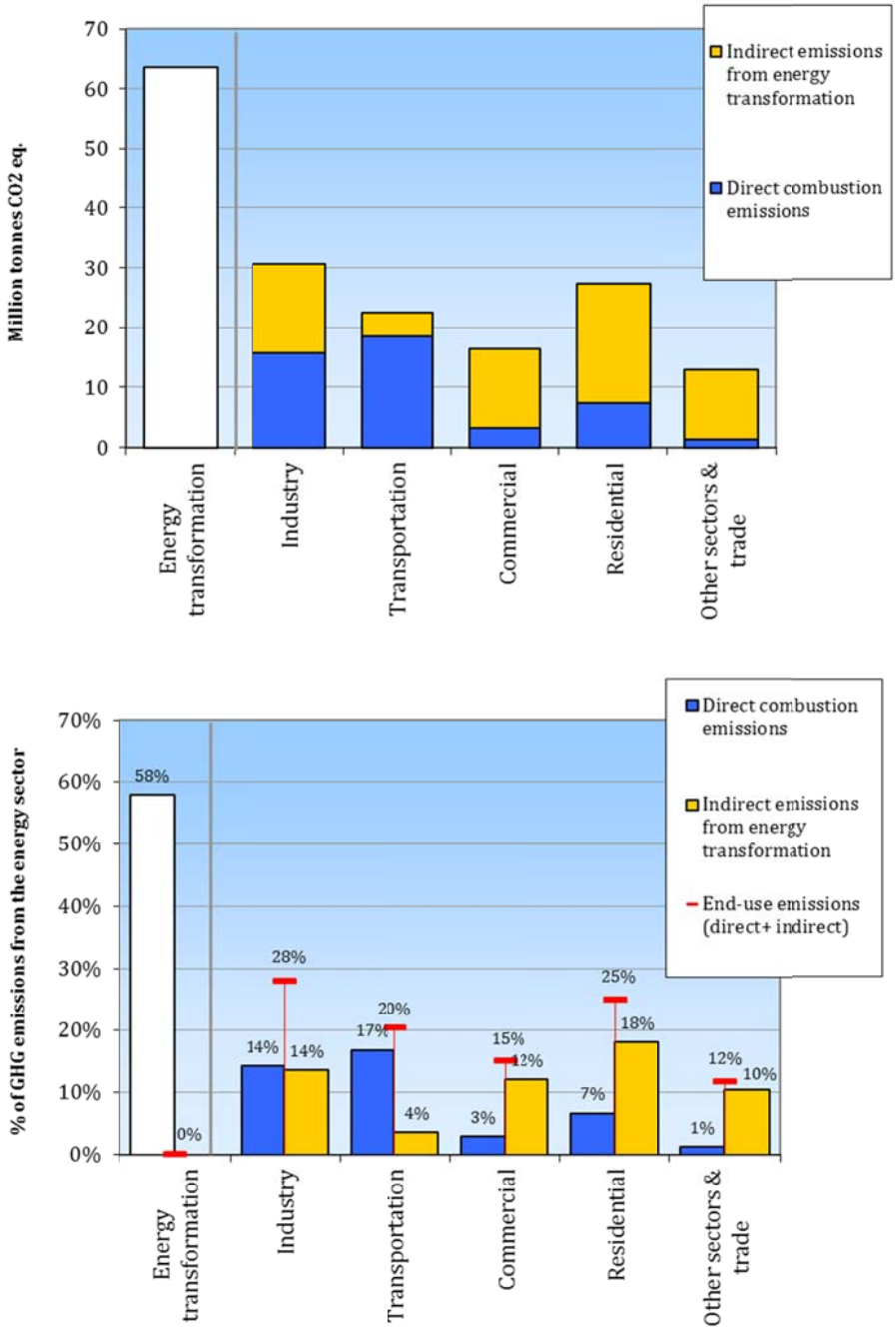


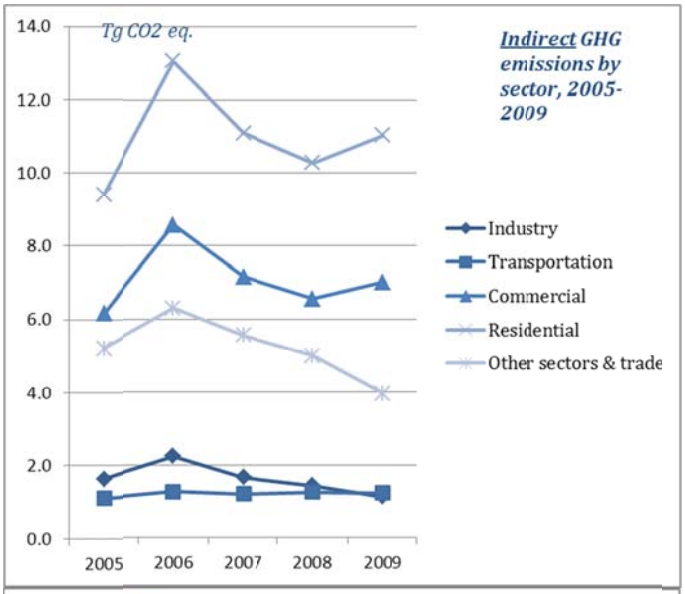
Figure A2.6 Direct and indirect GHG emissions by end use sector in Czech Republic in 2009

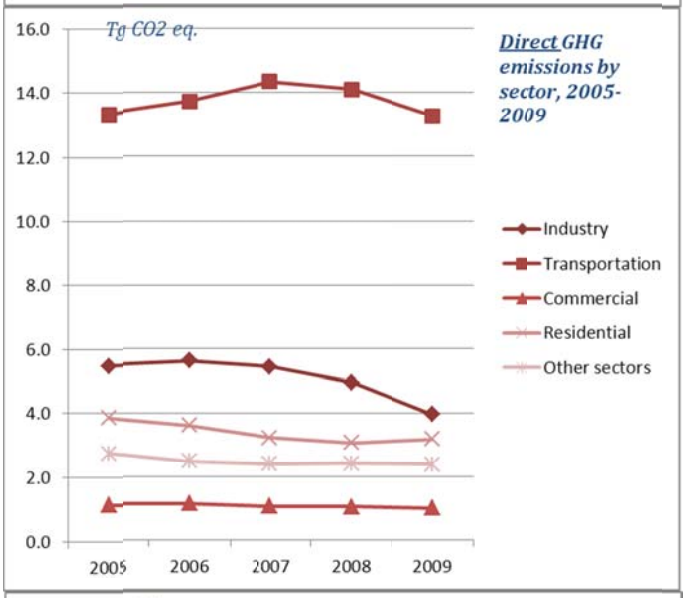


Note: The sum of direct and indirect emissions equals end-use emissions. The total indirect emissions allocated to end-users in a country can be smaller than the direct emissions from fuel transformation in that country if some of the indirect emissions are allocated to exports and international bunkers. The indirect emissions allocated to end users including exports and bunkers equals the direct emissions from fuel transformation plus the indirect emissions associated with energy imported from other countries. The indirect emissions arising from energy supplied from countries outside the EU are assumed to be zero. 'Other sectors' include emissions from agriculture, forestry and fishing as well as the net (indirect) emissions from energy trade.

Source: EEA, 2011

Figure A2.7 Trends in direct and indirect GHG emissions by end use sector in Denmark, 2005-2009





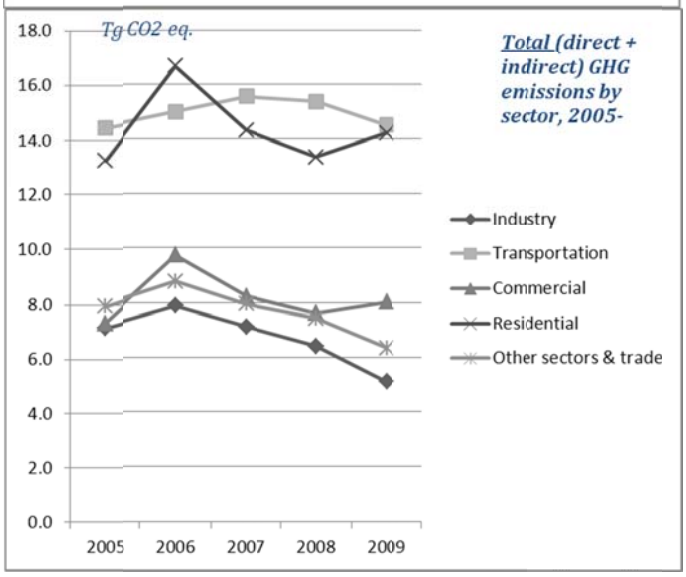
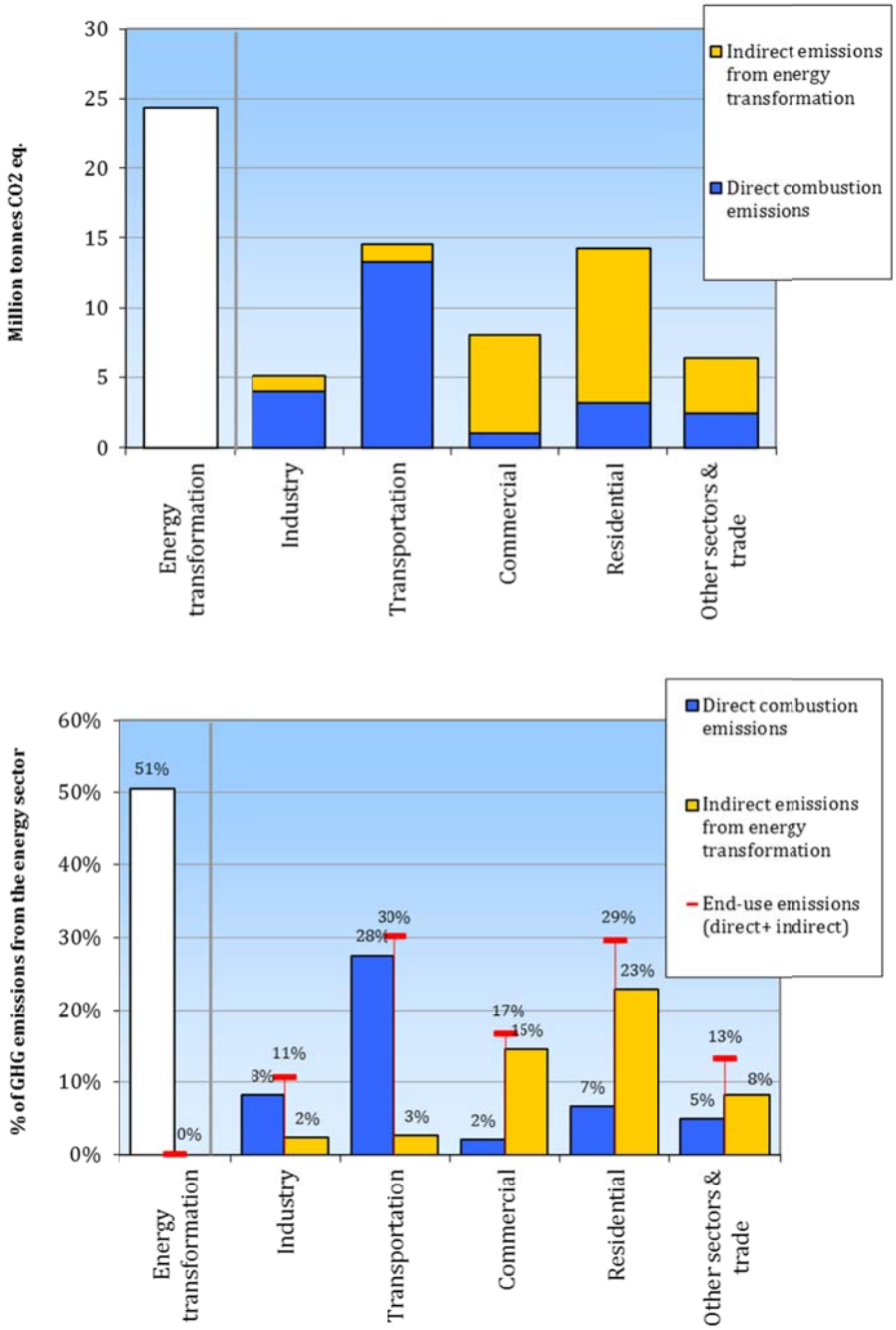


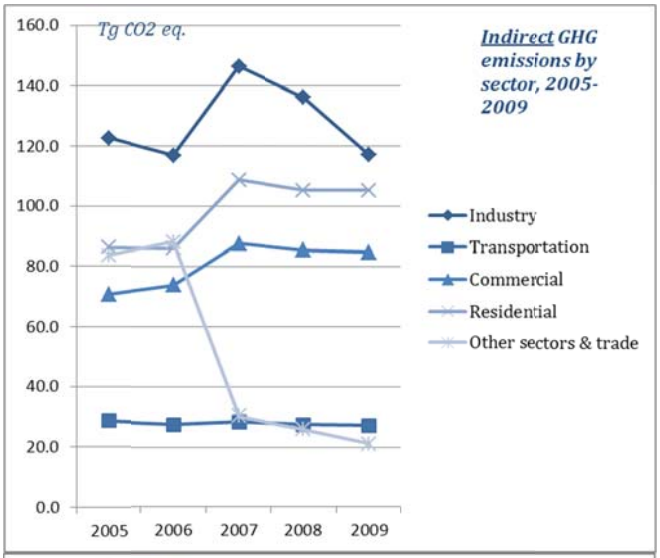
Figure A2.8 Direct and indirect GHG emissions by end use sector in Denmark in 2009

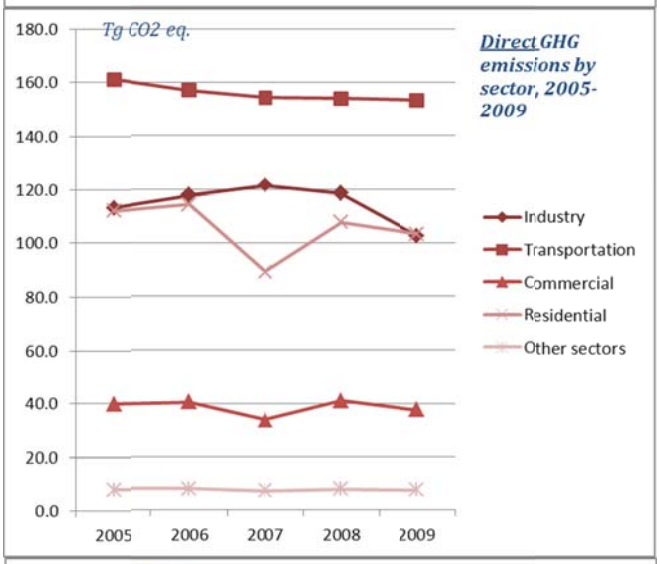


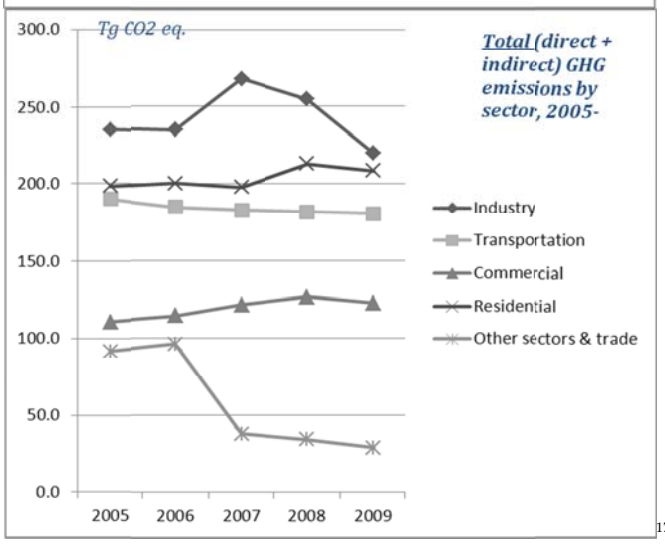
Note: The sum of direct and indirect emissions equals end-use emissions. The total indirect emissions allocated to end-users in a country can be smaller than the direct emissions from fuel transformation in that country if some of the indirect emissions are allocated to exports and international bunkers. The indirect emissions allocated to end users including exports and bunkers equals the direct emissions from fuel transformation plus the indirect emissions associated with energy imported from other countries. The indirect emissions arising from energy supplied from countries outside the EU are assumed to be zero. 'Other sectors' include emissions from agriculture, forestry and fishing as well as the net (indirect) emissions from energy trade.

Source: EEA, 2011

Figure A2.9 Trends in direct and indirect GHG emissions by end use sector in Germany, 2005-2009



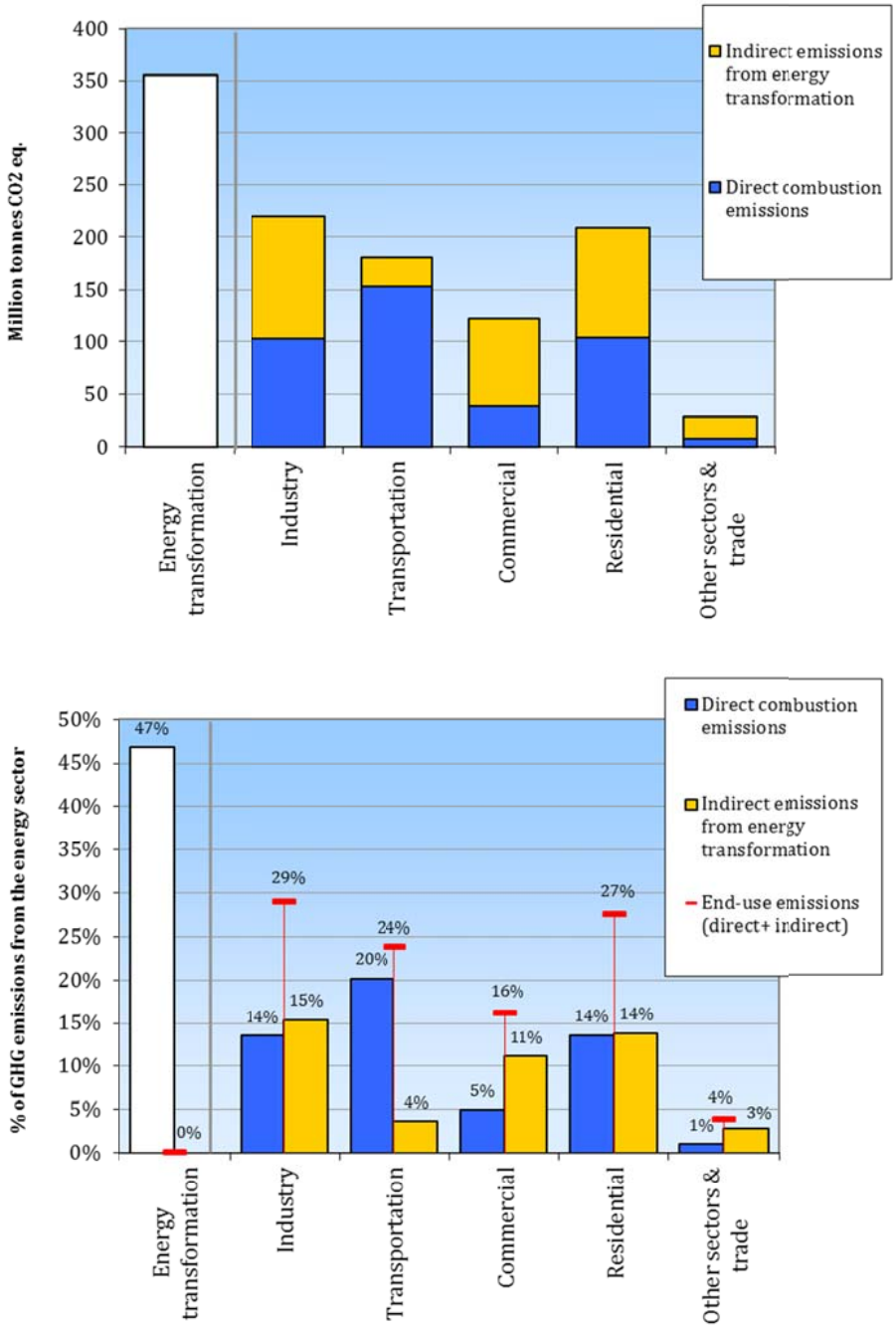




[17]

[17] The indirect emissions associated with the "other sectors" fell sharply between 2006 and 2007. This reduction arises because of changes to the energy statistics for Germany.

Figure A2.10 Direct and indirect GHG emissions by end use sector in Germany in 2009



Note: The sum of direct and indirect emissions equals end-use emissions. The total indirect emissions allocated to end-users in a country can be smaller than the direct emissions from fuel transformation in that country if some of the indirect emissions are allocated to exports and international bunkers. The indirect emissions allocated to end users including exports and bunkers equals the direct emissions from fuel transformation plus the indirect emissions associated with energy imported from other countries. The indirect emissions arising from energy supplied from countries outside the EU are assumed to be zero. 'Other sectors' include emissions from agriculture, forestry and fishing as well as the net (indirect) emissions from energy trade.

Source: EEA, 2011

Figure A2.11 Trends in direct and indirect GHG emissions by end use sector in Estonia, 2005-2009

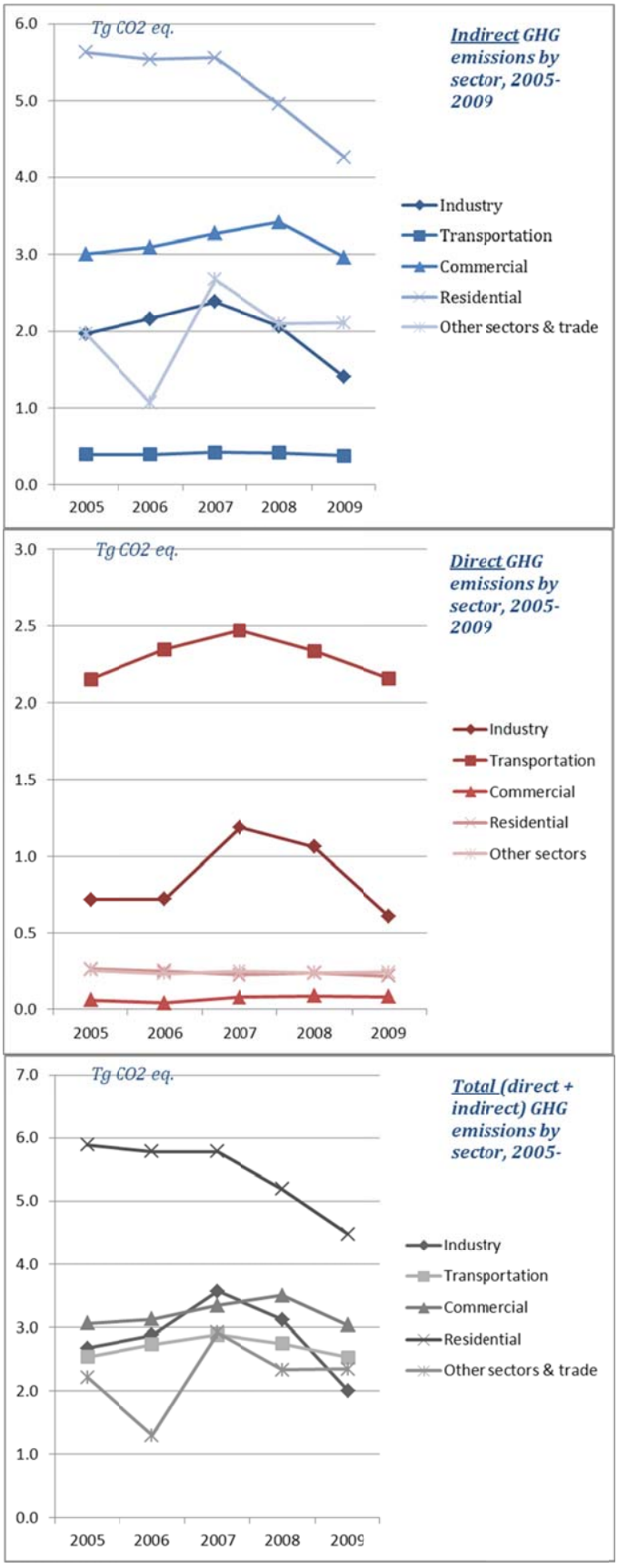
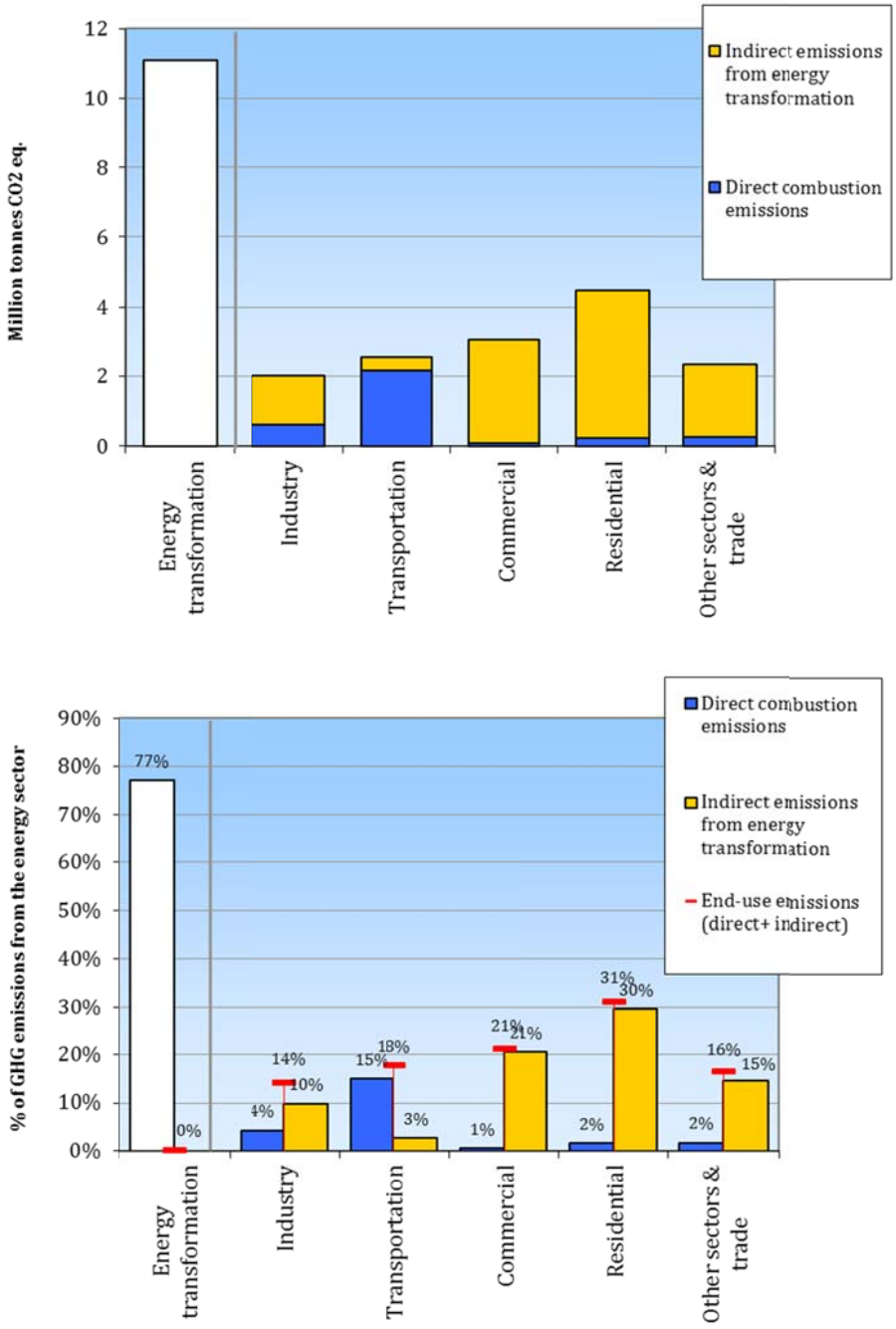


Figure A2.12 Direct and indirect GHG emissions by end use sector in Estonia in 2009



Note: The sum of direct and indirect emissions equals end-use emissions. The total indirect emissions allocated to end-users in a country can be smaller than the direct emissions from fuel transformation in that country if some of the indirect emissions are allocated to exports and international bunkers. The indirect emissions allocated to end users including exports and bunkers equals the direct emissions from fuel transformation plus the indirect emissions associated with energy imported from other countries. The indirect emissions arising from energy supplied from countries outside the EU are assumed to be zero. 'Other sectors' include emissions from agriculture, forestry and fishing as well as the net (indirect) emissions from energy trade.

Source: EEA, 2011

Figure A2.13 Trends in direct and indirect GHG emissions by end use sector in Ireland, 2005-2009

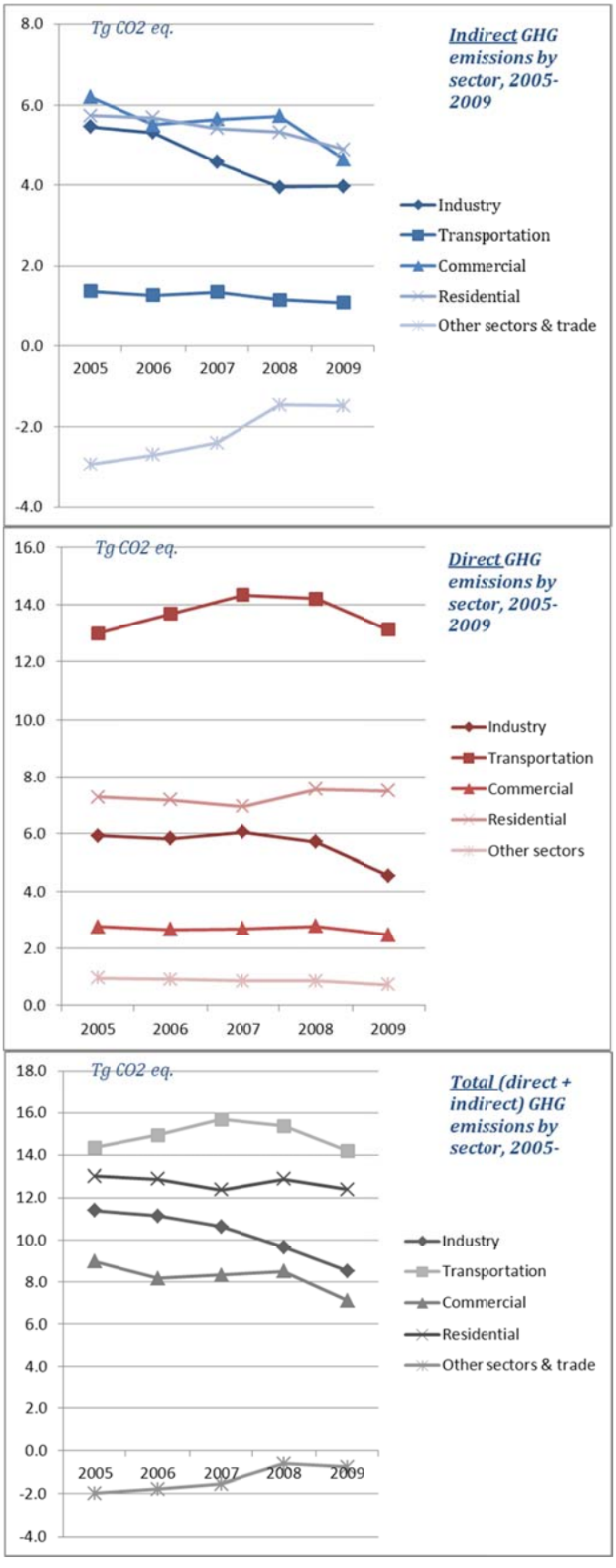
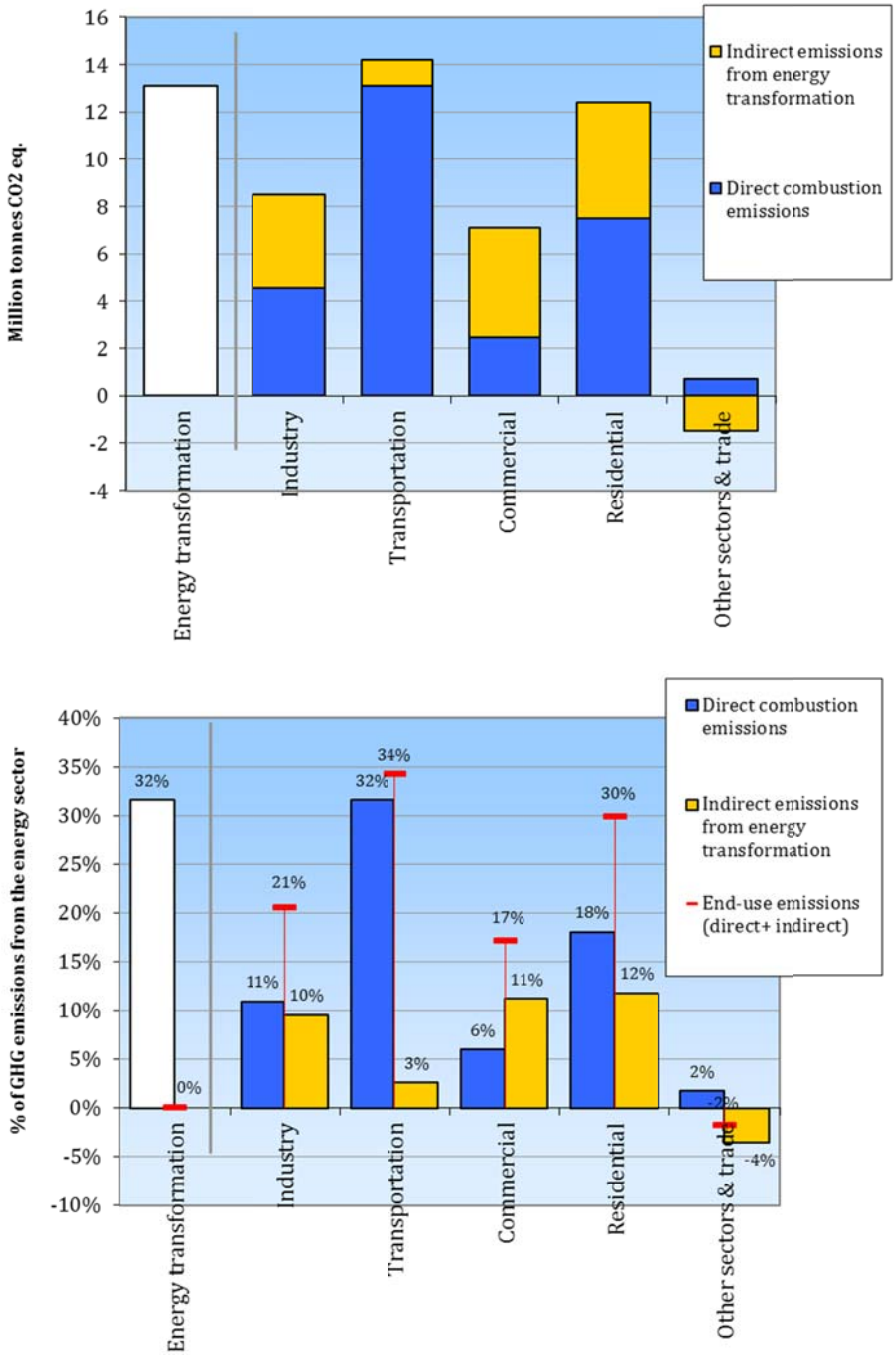


Figure A2.14 Direct and indirect GHG emissions by end use sector in Ireland in 2009



Note: The sum of direct and indirect emissions equals end-use emissions. The total indirect emissions allocated to end-users in a country can be smaller than the direct emissions from fuel transformation in that country if some of the indirect emissions are allocated to exports and international bunkers. The indirect emissions allocated to end users including exports and bunkers equals the direct emissions from fuel transformation plus the indirect emissions associated with energy imported from other countries. The indirect emissions arising from energy supplied from countries outside the EU are assumed to be zero. 'Other sectors' include emissions from agriculture, forestry and fishing as well as the net (indirect) emissions from energy trade.

Source: EEA, 2011

Figure A2.15 Trends in direct and indirect GHG emissions by end use sector in Greece, 2005-2009

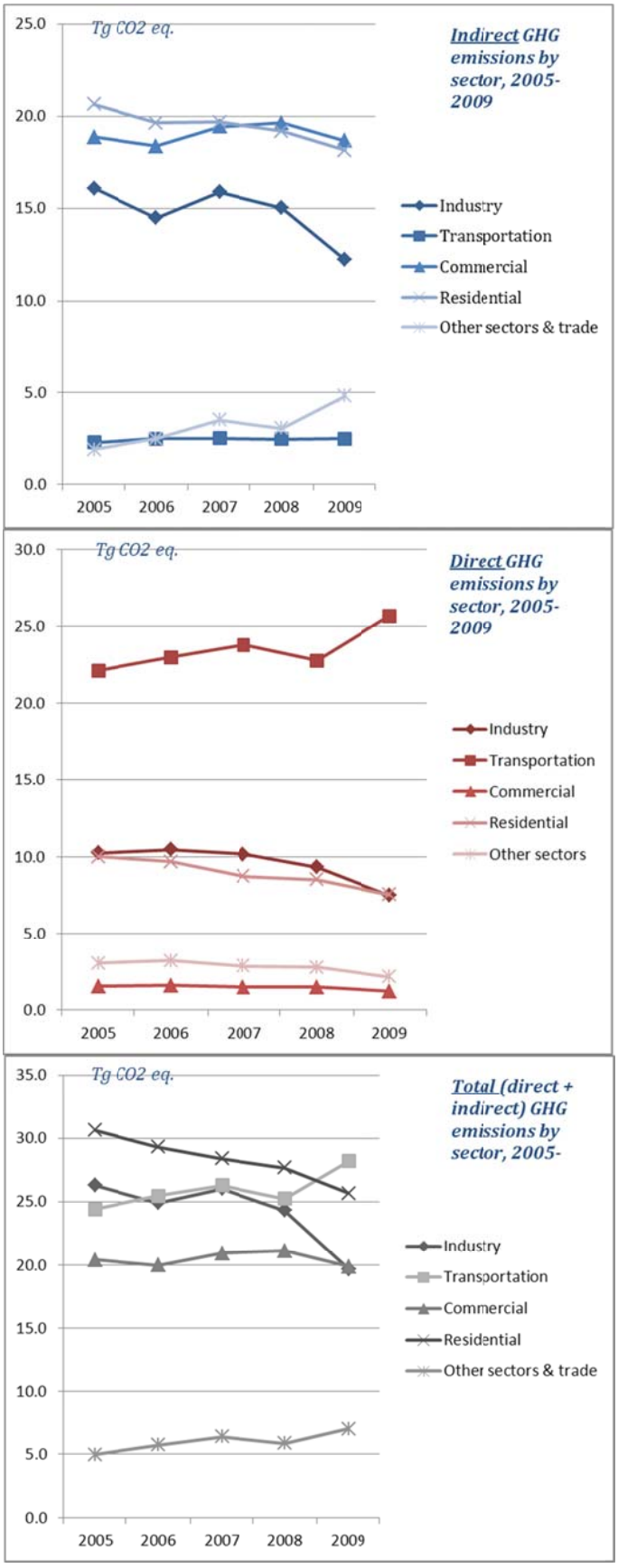
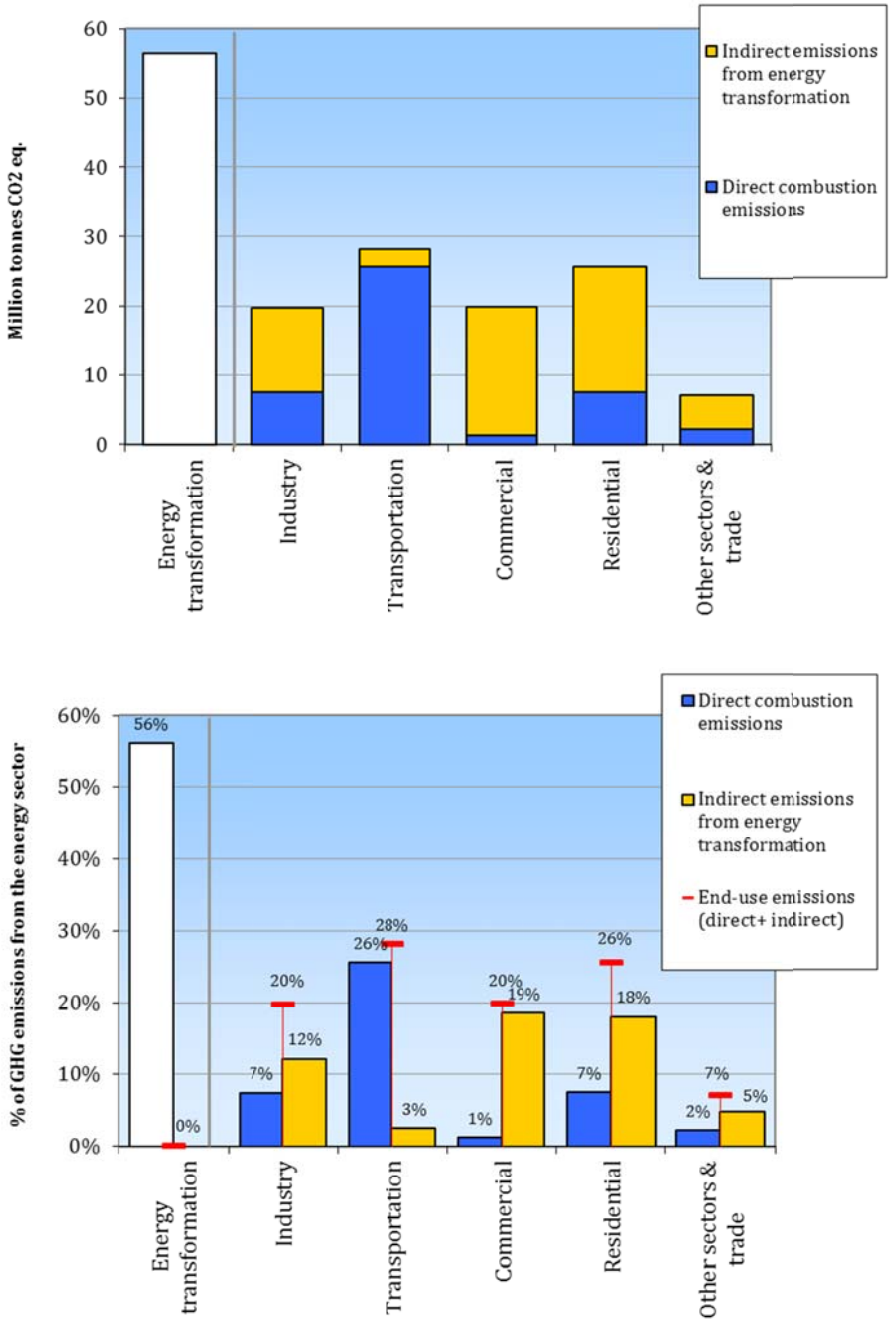


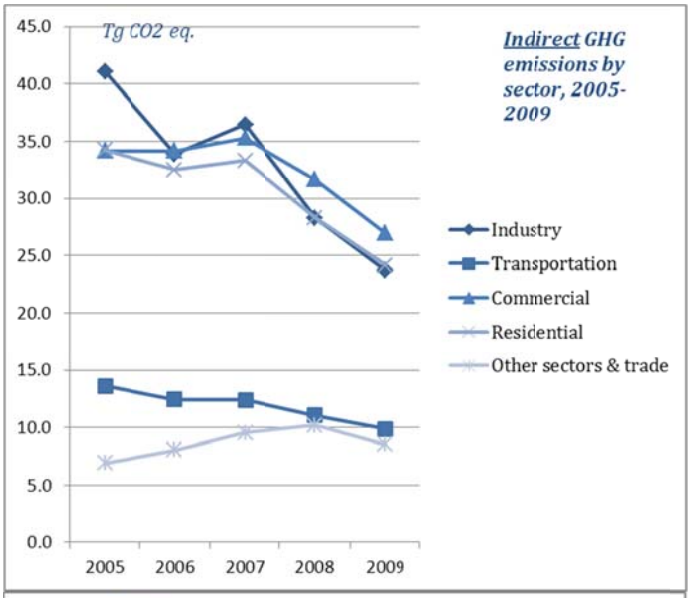
Figure A2.16 Direct and indirect GHG emissions by end use sector in Greece in 2009

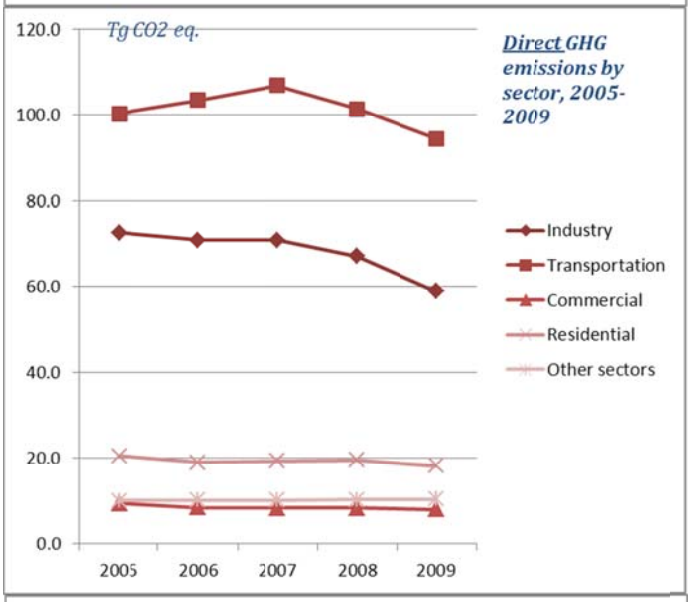


Note: The sum of direct and indirect emissions equals end-use emissions. The total indirect emissions allocated to end-users in a country can be smaller than the direct emissions from fuel transformation in that country if some of the indirect emissions are allocated to exports and international bunkers. The indirect emissions allocated to end users including exports and bunkers equals the direct emissions from fuel transformation plus the indirect emissions associated with energy imported from other countries. The indirect emissions arising from energy supplied from countries outside the EU are assumed to be zero. 'Other sectors' include emissions from agriculture, forestry and fishing as well as the net (indirect) emissions from energy trade.

Source: EEA, 2011

Figure A2.17 Trends in direct and indirect GHG emissions by end use sector in Spain, 2005-2009





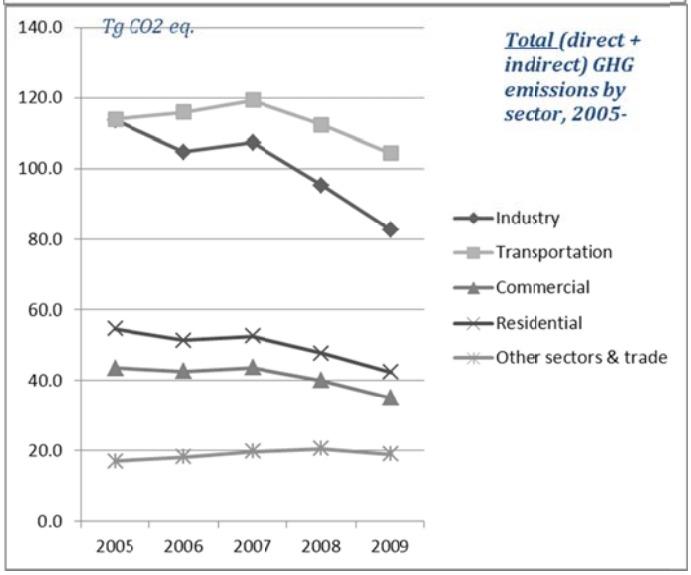
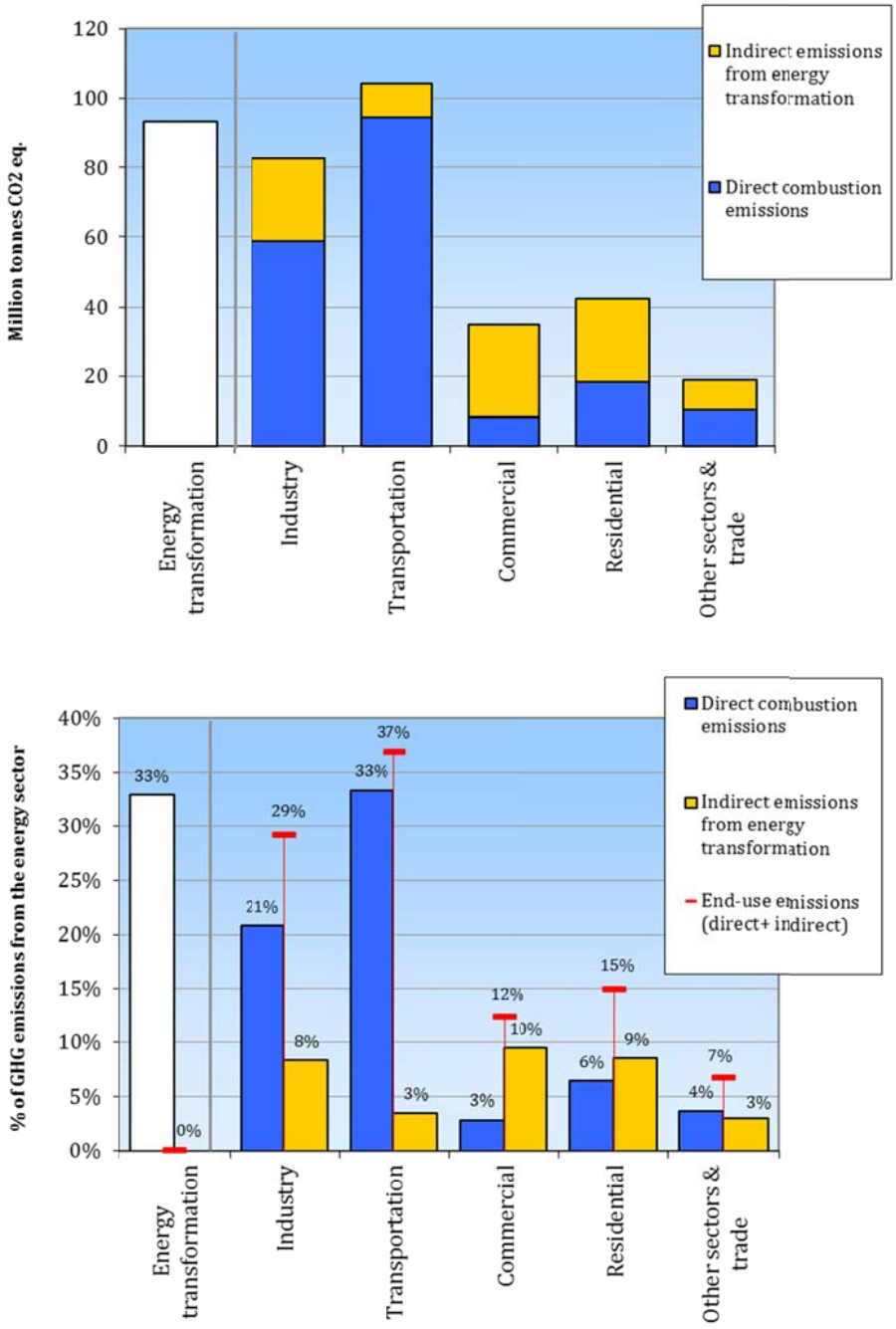


Figure A2.18 Direct and indirect GHG emissions by end use sector in Spain in 2009



Note: The sum of direct and indirect emissions equals end-use emissions. The total indirect emissions allocated to end-users in a country can be smaller than the direct emissions from fuel transformation in that country if some of the indirect emissions are allocated to exports and international bunkers. The indirect emissions allocated to end users including exports and bunkers equals the direct emissions from fuel transformation plus the indirect emissions associated with energy imported from other countries. The indirect emissions arising from energy supplied from countries outside the EU are assumed to be zero. 'Other sectors' include emissions from agriculture, forestry and fishing as well as the net (indirect) emissions from energy trade.

Source: EEA, 2011

Figure A2.19 Trends in direct and indirect GHG emissions by end use sector in France, 2005-2009

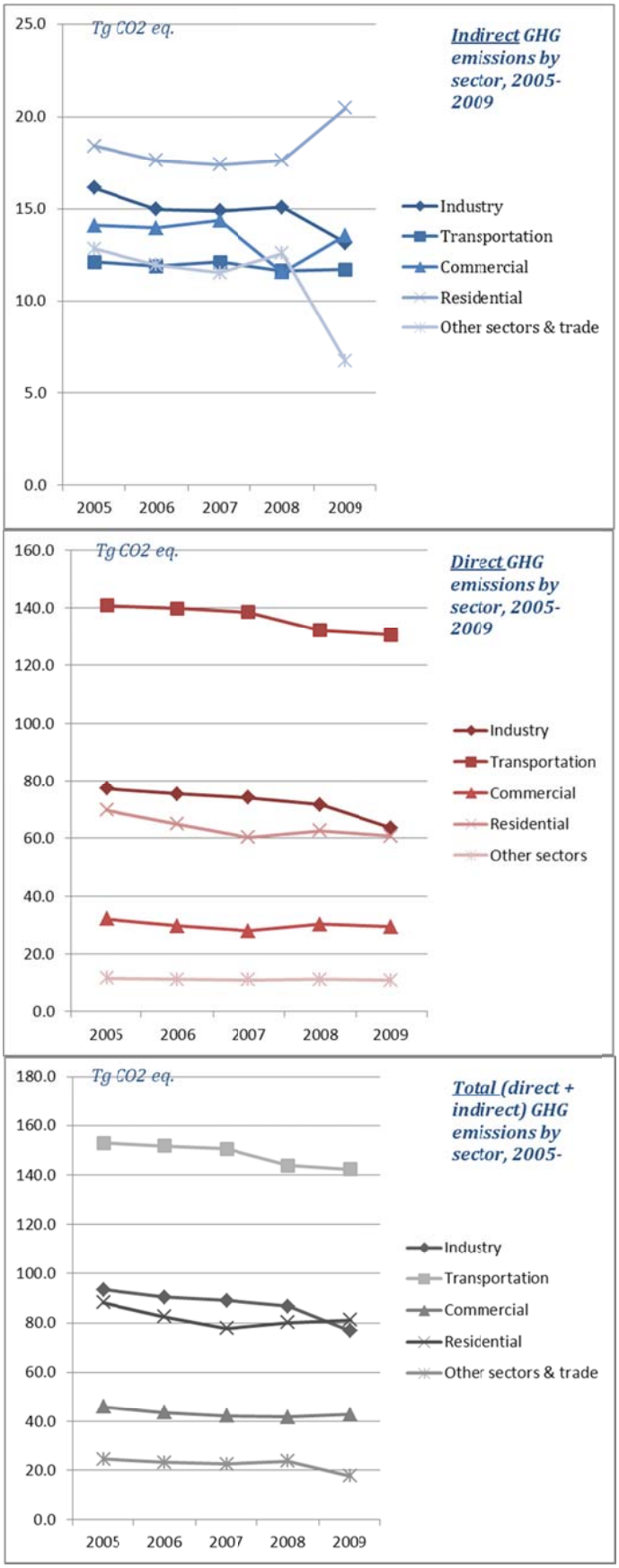
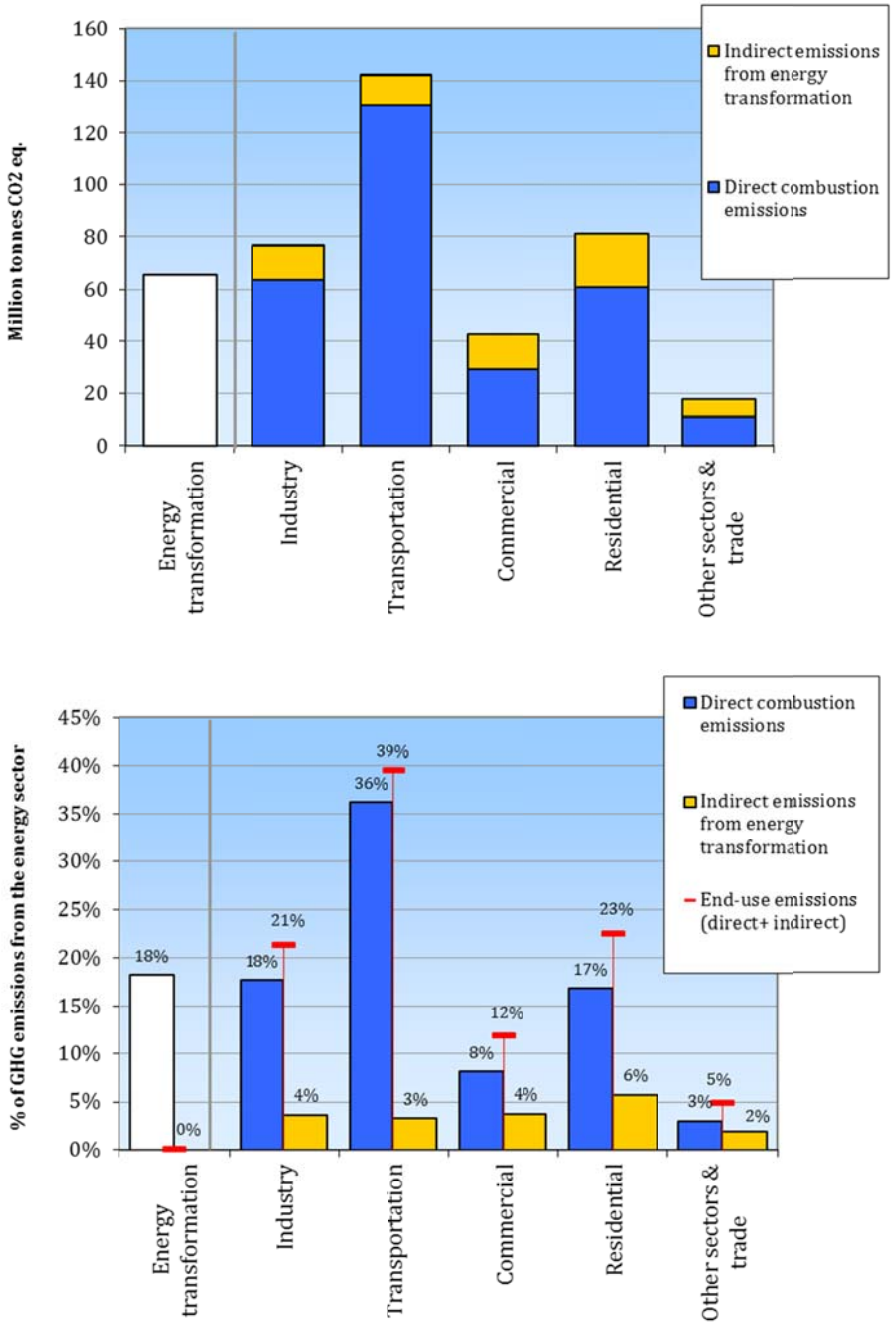


Figure A2.20 Direct and indirect GHG emissions by end use sector in France in 2009



Note: The sum of direct and indirect emissions equals end-use emissions. The total indirect emissions allocated to end-users in a country can be smaller than the direct emissions from fuel transformation in that country if some of the indirect emissions are allocated to exports and international bunkers. The indirect emissions allocated to end users including exports and bunkers equals the direct emissions from fuel transformation plus the indirect emissions associated with energy imported from other countries. The indirect emissions arising from energy supplied from countries outside the EU are assumed to be zero. 'Other sectors' include emissions from agriculture, forestry and fishing as well as the net (indirect) emissions from energy trade.

Source: EEA, 2011

Figure A2.21 Trends in direct and indirect GHG emissions by end use sector in Italy, 2005-2009

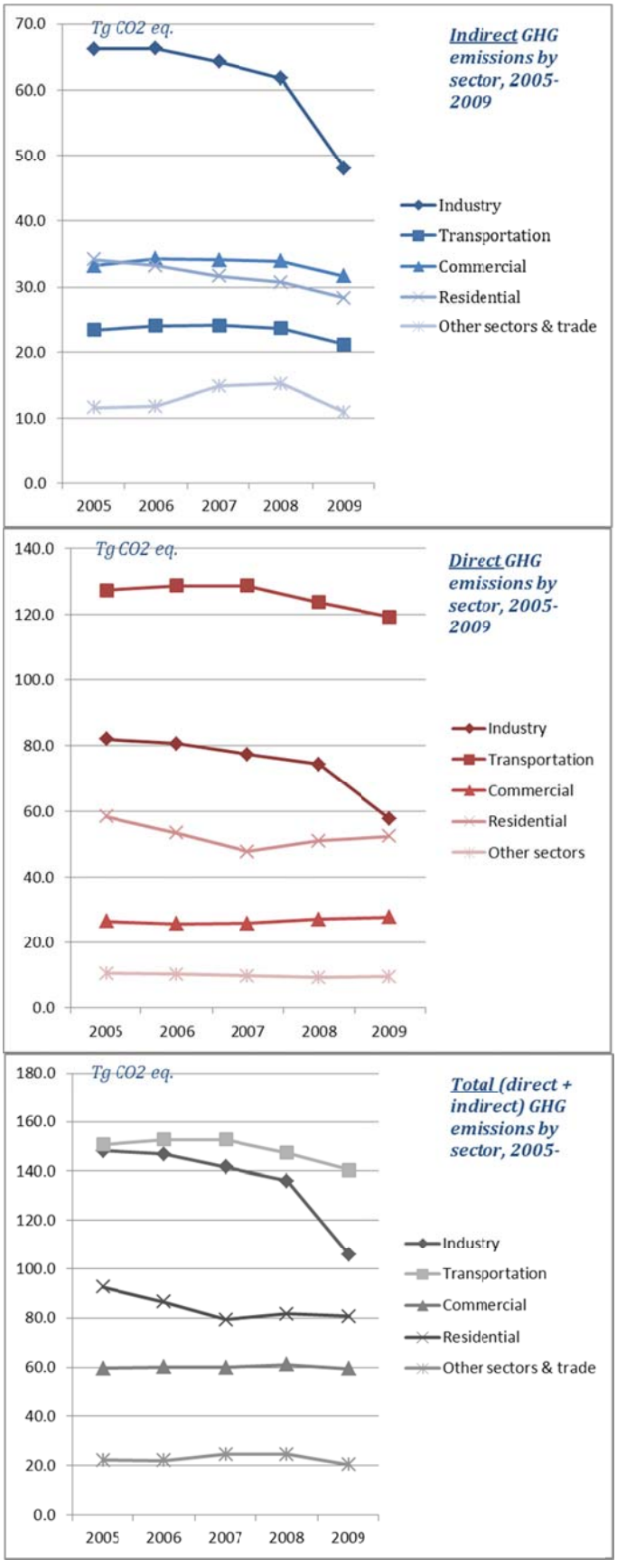
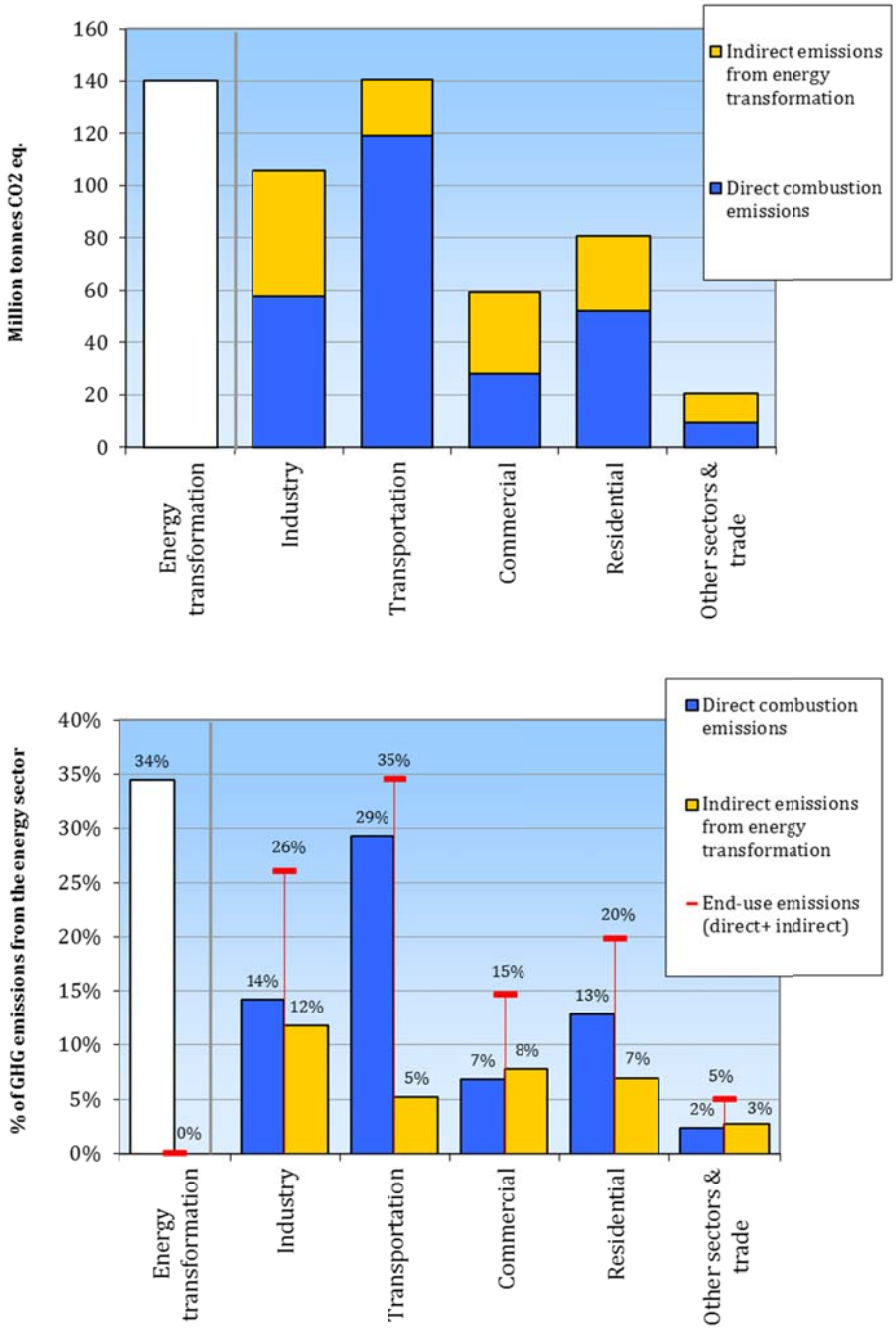


Figure A2.22 Direct and indirect GHG emissions by end use sector in Italy in 2009



Note: The sum of direct and indirect emissions equals end-use emissions. The total indirect emissions allocated to end-users in a country can be smaller than the direct emissions from fuel transformation in that country if some of the indirect emissions are allocated to exports and international bunkers. The indirect emissions allocated to end users including exports and bunkers equals the direct emissions from fuel transformation plus the indirect emissions associated with energy imported from other countries. The indirect emissions arising from energy supplied from countries outside the EU are assumed to be zero. 'Other sectors' include emissions from agriculture, forestry and fishing as well as the net (indirect) emissions from energy trade.

Source: EEA, 2011

Figure A2.23 Trends in direct and indirect GHG emissions by end use sector in Cyprus, 2005-2009

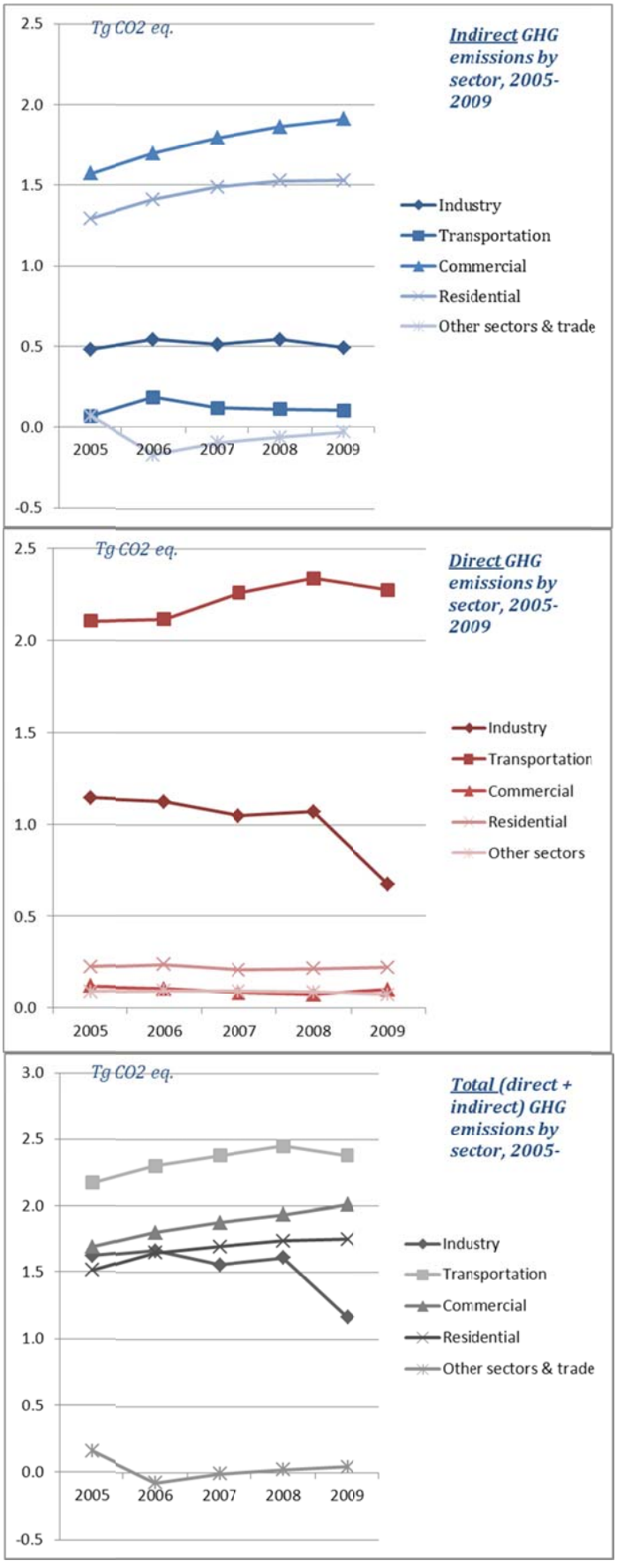
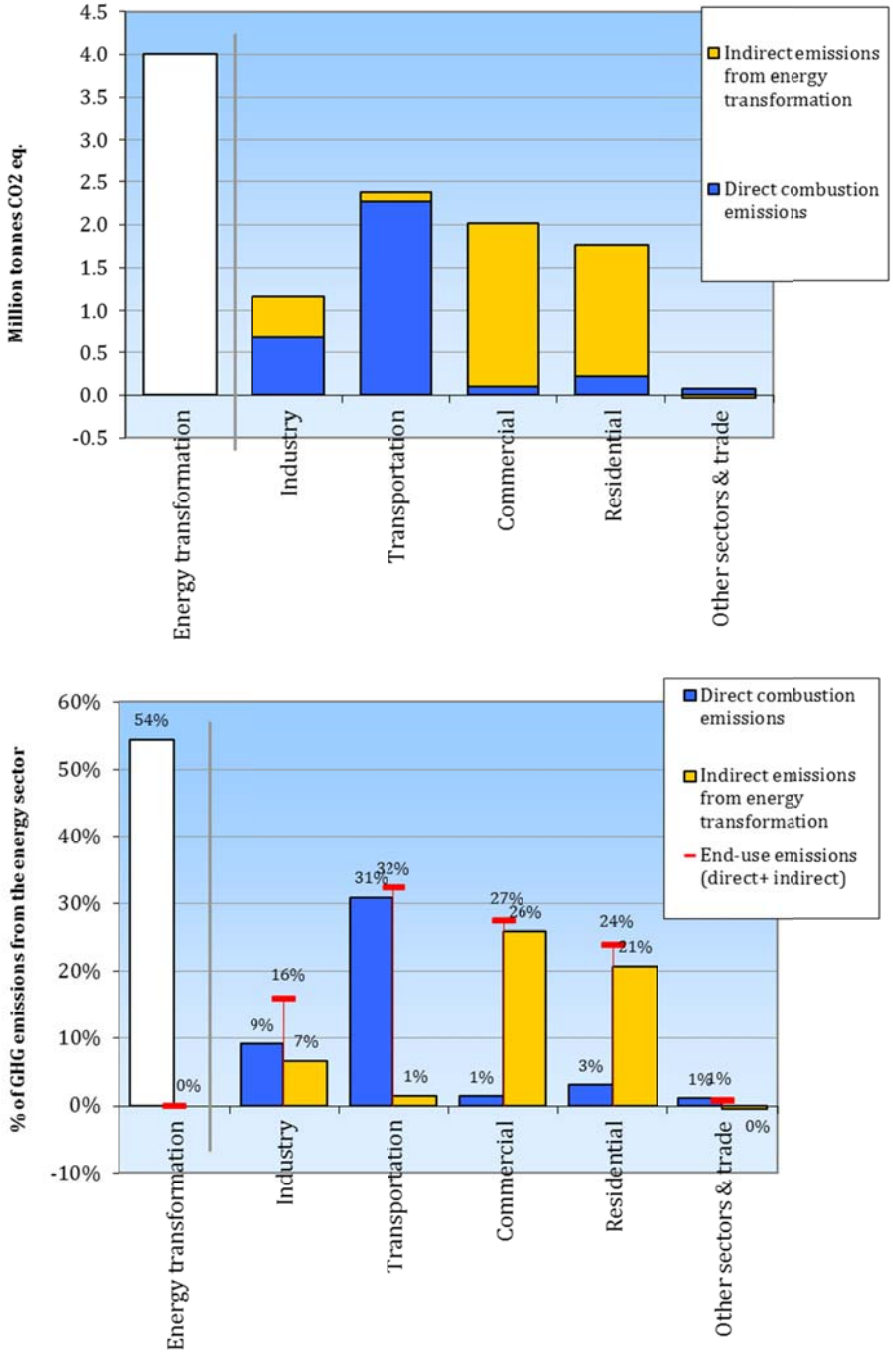


Figure A2.24 Direct and indirect GHG emissions by end use sector in Cyprus in 2009



Note: The sum of direct and indirect emissions equals end-use emissions. The total indirect emissions allocated to end-users in a country can be smaller than the direct emissions from fuel transformation in that country if some of the indirect emissions are allocated to exports and international bunkers. The indirect emissions allocated to end users including exports and bunkers equals the direct emissions from fuel transformation plus the indirect emissions associated with energy imported from other countries. The indirect emissions arising from energy supplied from countries outside the EU are assumed to be zero. 'Other sectors' include emissions from agriculture, forestry and fishing as well as the net (indirect) emissions from energy trade.

Source: EEA, 2011

Figure A2.25 Trends in direct and indirect GHG emissions by end use sector in Latvia, 2005-2009

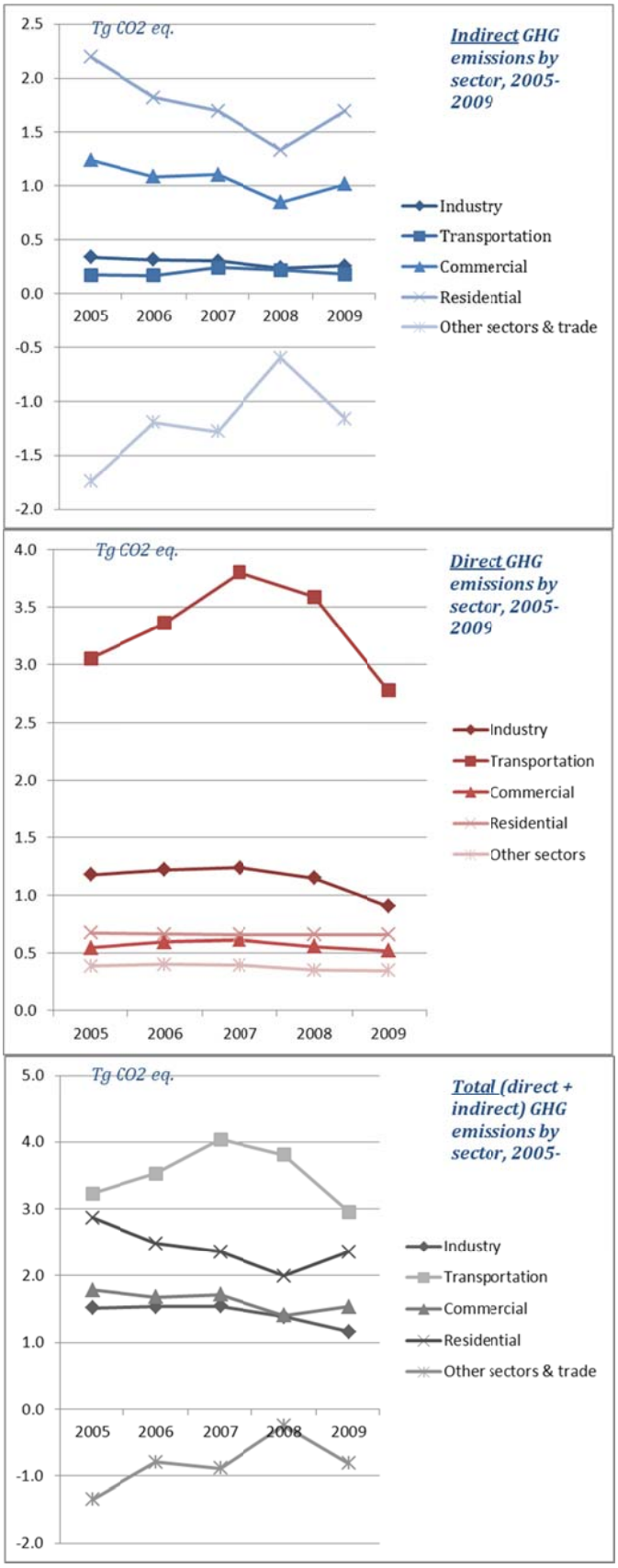
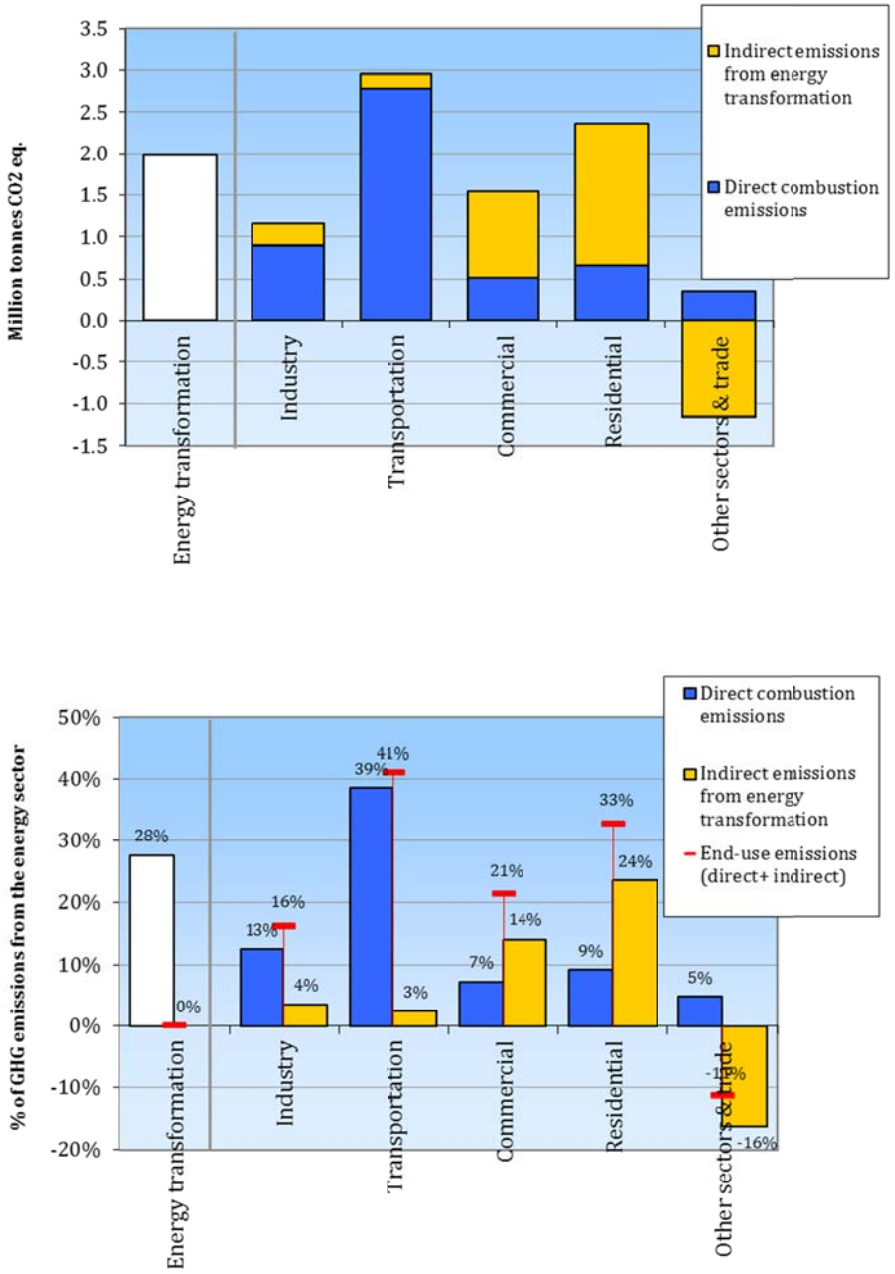


Figure A2.26 Direct and indirect GHG emissions by end use sector in Latvia in 2009



Note: The sum of direct and indirect emissions equals end-use emissions. The total indirect emissions allocated to end-users in a country can be smaller than the direct emissions from fuel transformation in that country if some of the indirect emissions are allocated to exports and international bunkers. The indirect emissions allocated to end users including exports and bunkers equals the direct emissions from fuel transformation plus the indirect emissions associated with energy imported from other countries. The indirect emissions arising from energy supplied from countries outside the EU are assumed to be zero. 'Other sectors' include emissions from agriculture, forestry and fishing as well as the net (indirect) emissions from energy trade.

Source: EEA, 2011

Figure A2.27 Trends in direct and indirect GHG emissions by end use sector in Lithuania, 2005-2009

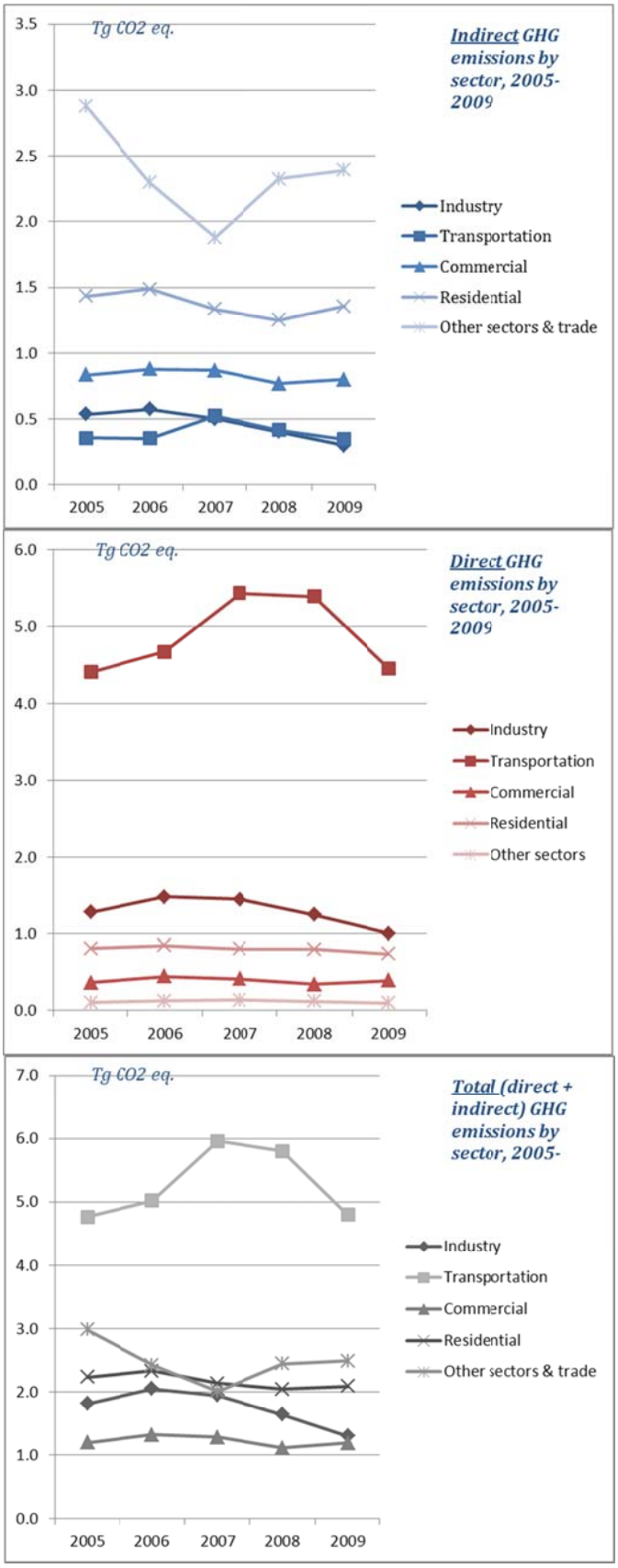
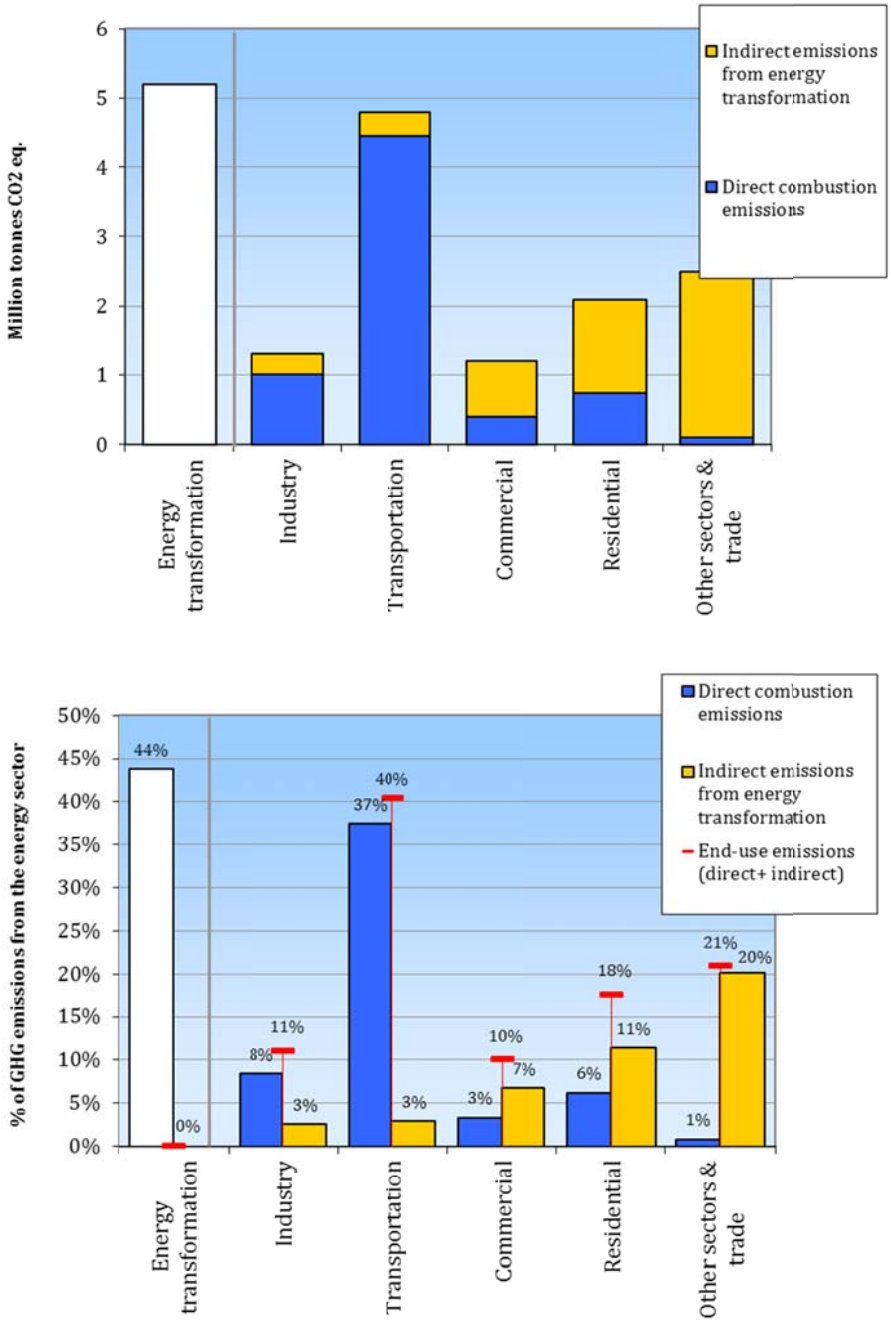


Figure A2.28 Direct and indirect GHG emissions by end use sector in Lithuania in 2009



Note: The sum of direct and indirect emissions equals end-use emissions. The total indirect emissions allocated to end-users in a country can be smaller than the direct emissions from fuel transformation in that country if some of the indirect emissions are allocated to exports and international bunkers. The indirect emissions allocated to end users including exports and bunkers equals the direct emissions from fuel transformation plus the indirect emissions associated with energy imported from other countries. The indirect emissions arising from energy supplied from countries outside the EU are assumed to be zero. 'Other sectors' include emissions from agriculture, forestry and fishing as well as the net (indirect) emissions from energy trade.

Source: EEA, 2011

Figure A2.29 Trends in direct and indirect GHG emissions by end use sector in Luxembourg, 2005-2009

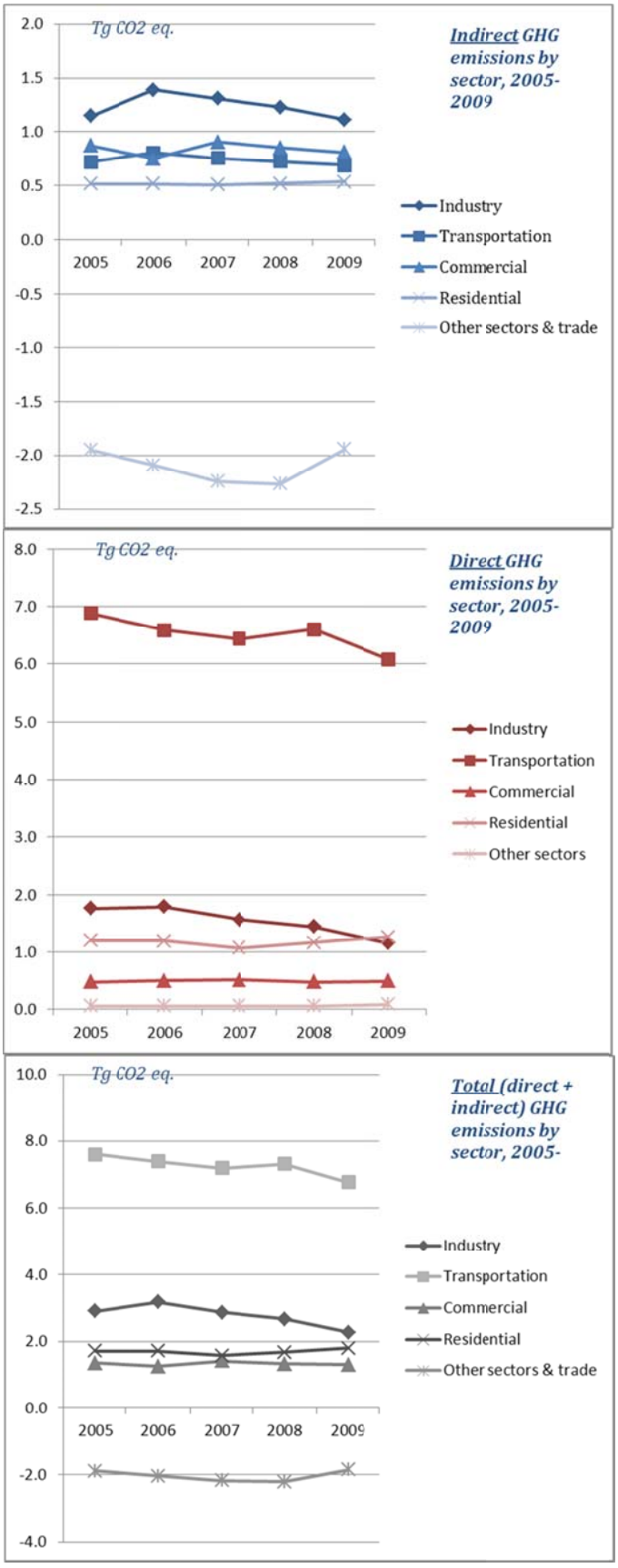
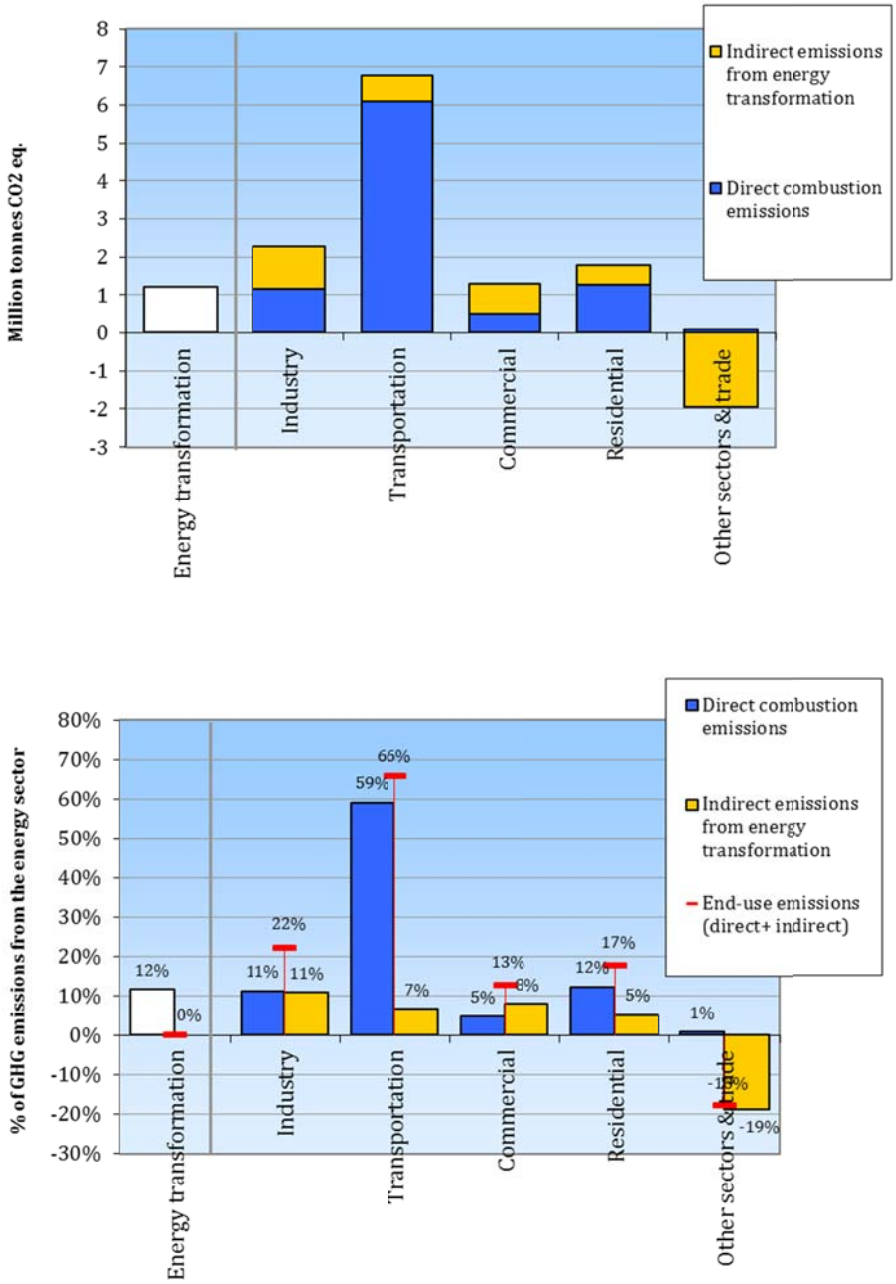


Figure A2.30 Direct and indirect GHG emissions by end use sector in Luxembourg in 2009



Note: The sum of direct and indirect emissions equals end-use emissions. The total indirect emissions allocated to end-users in a country can be smaller than the direct emissions from fuel transformation in that country if some of the indirect emissions are allocated to exports and international bunkers. The indirect emissions allocated to end users including exports and bunkers equals the direct emissions from fuel transformation plus the indirect emissions associated with energy imported from other countries. The indirect emissions arising from energy supplied from countries outside the EU are assumed to be zero. 'Other sectors' include emissions from agriculture, forestry and fishing as well as the net (indirect) emissions from energy trade.

Source: EEA, 2011

Figure A2.31 Trends in direct and indirect GHG emissions by end use sector in Hungary, 2005-2009

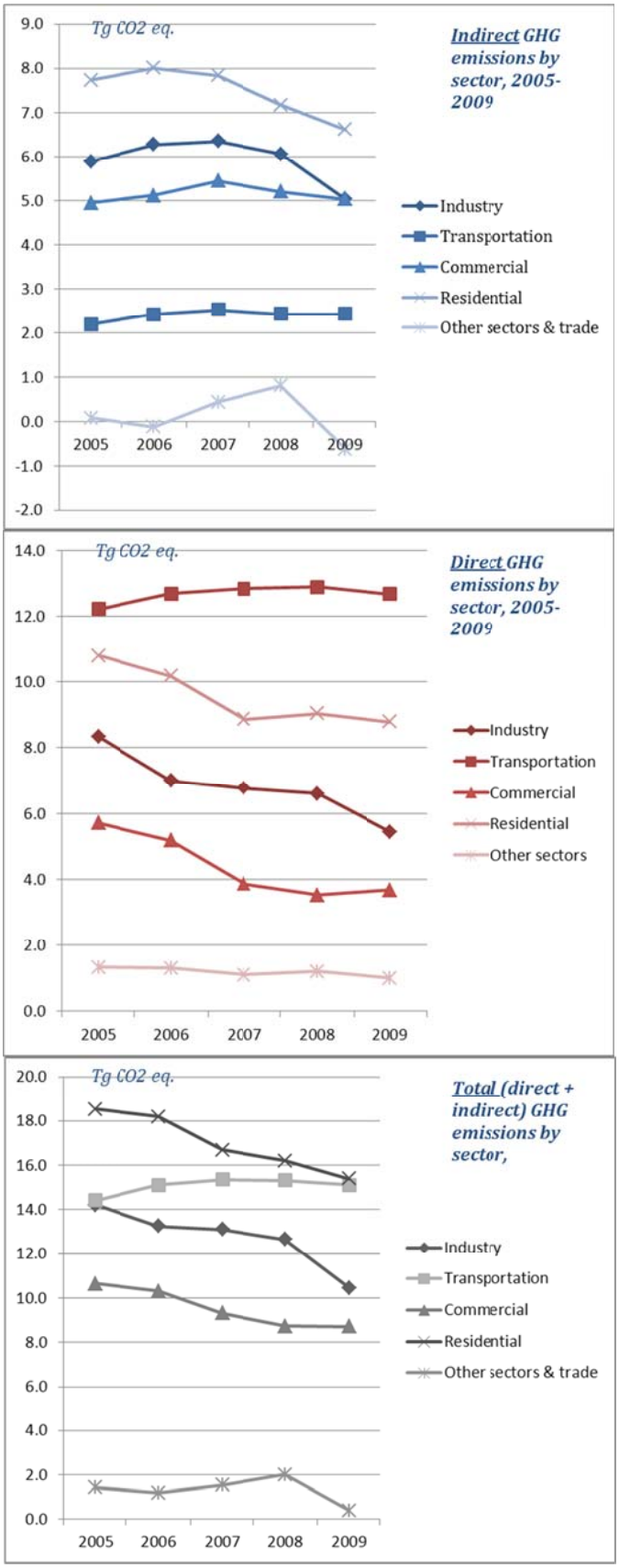
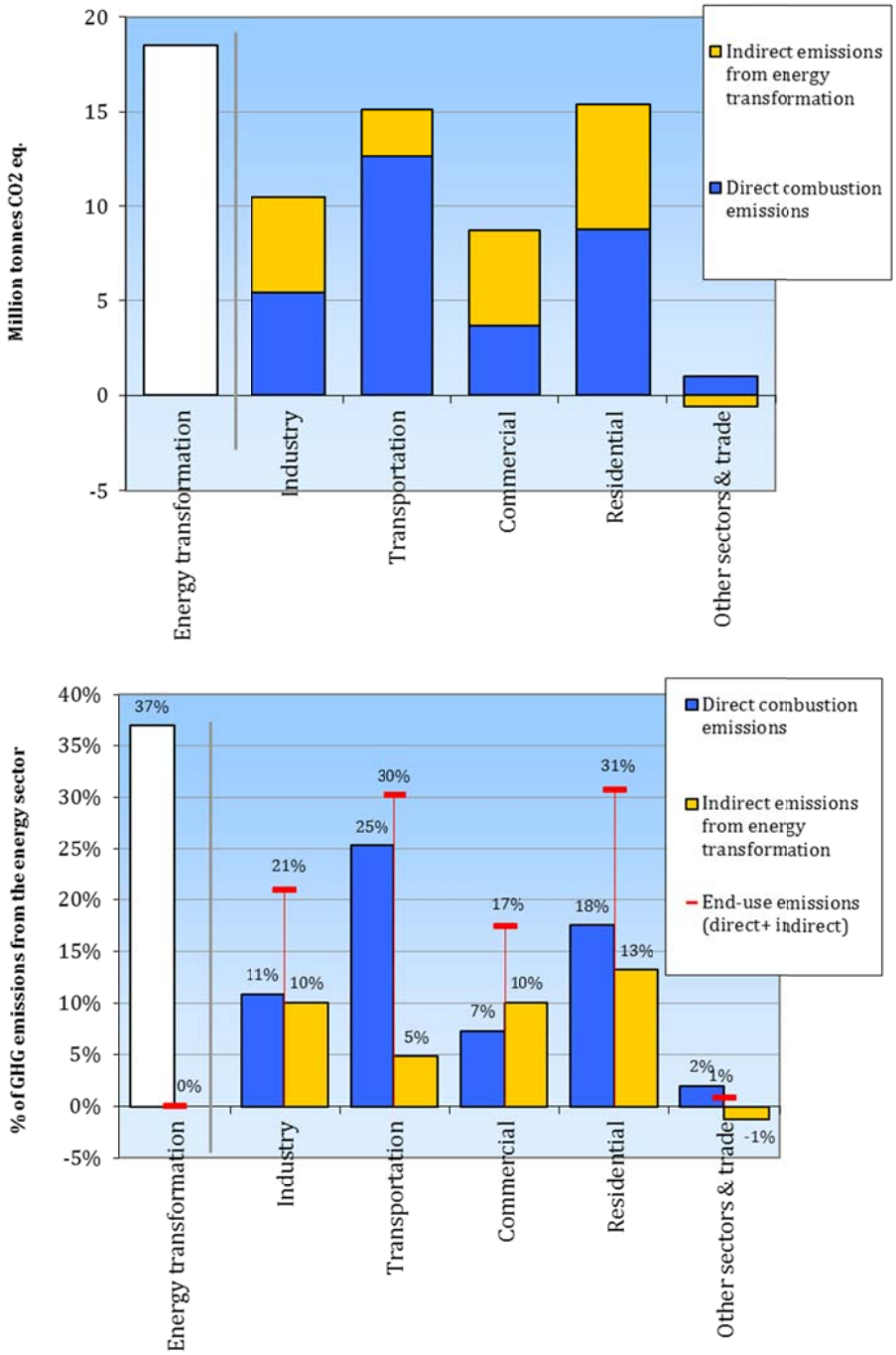


Figure A2.32 Direct and indirect GHG emissions by end use sector in Hungary in 2009



Note: The sum of direct and indirect emissions equals end-use emissions. The total indirect emissions allocated to end-users in a country can be smaller than the direct emissions from fuel transformation in that country if some of the indirect emissions are allocated to exports and international bunkers. The indirect emissions allocated to end users including exports and bunkers equals the direct emissions from fuel transformation plus the indirect emissions associated with energy imported from other countries. The indirect emissions arising from energy supplied from countries outside the EU are assumed to be zero. 'Other sectors' include emissions from agriculture, forestry and fishing as well as the net (indirect) emissions from energy trade.

Source: EEA, 2011

Figure A2.33 Trends in direct and indirect GHG emissions by end use sector in Malta, 2005-2009

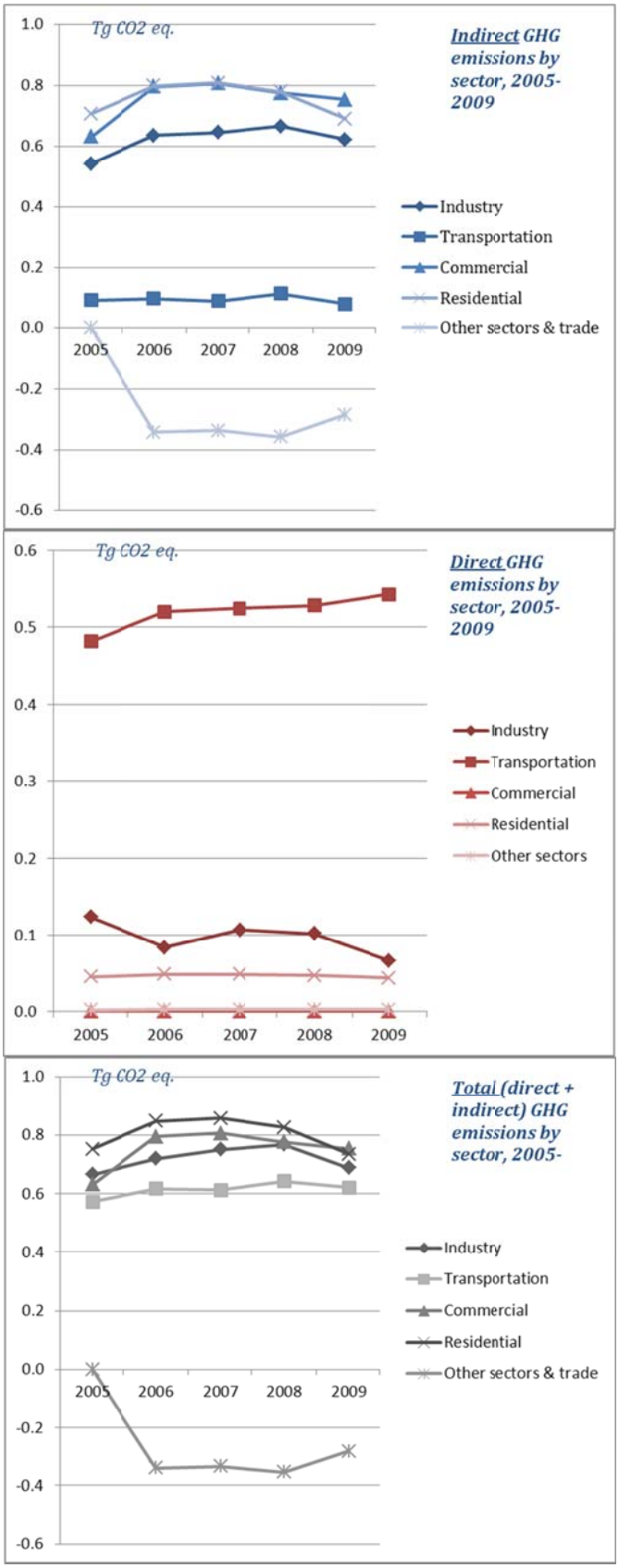
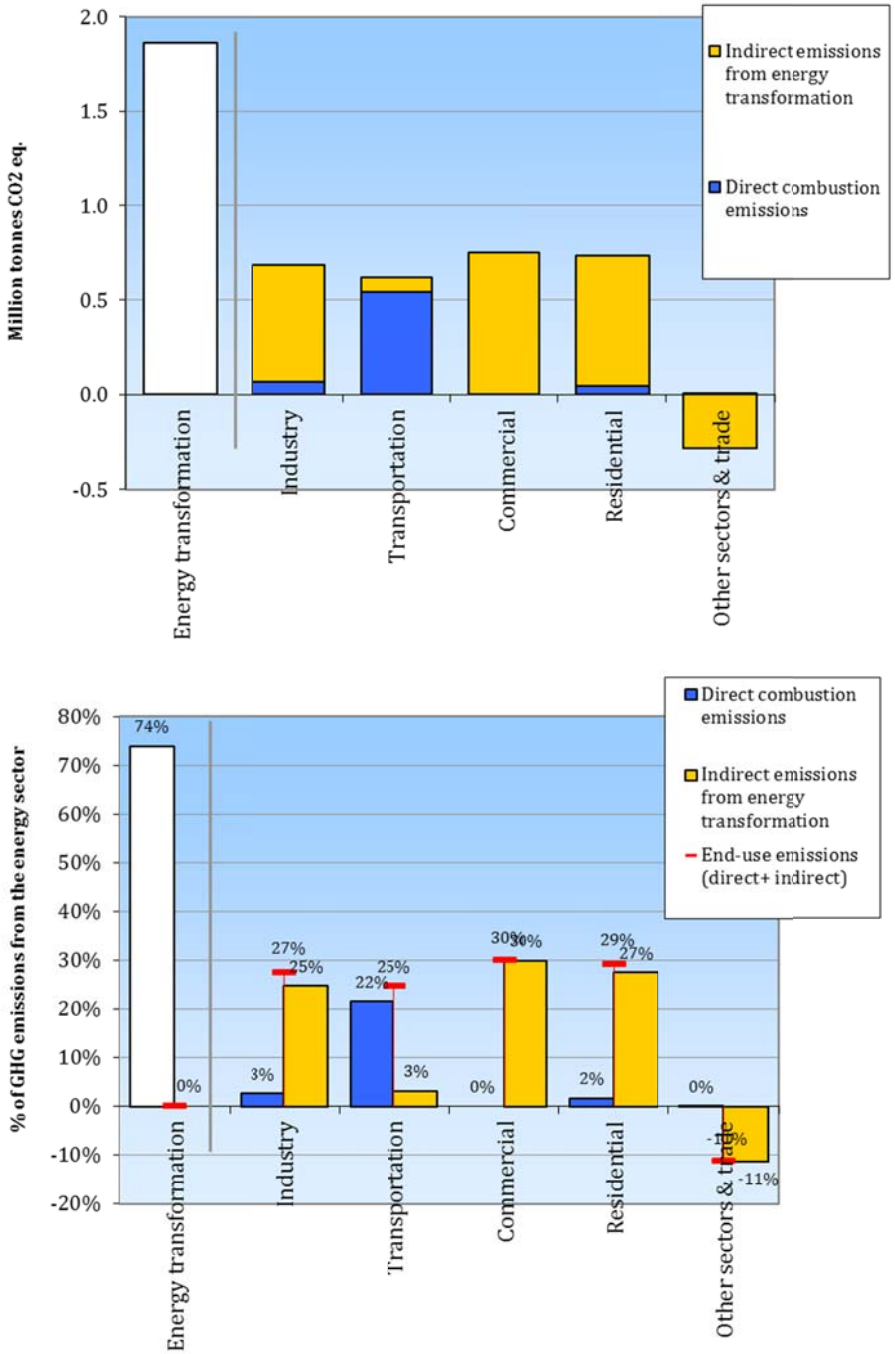


Figure A2.34 Direct and indirect GHG emissions by end use sector in Malta in 2009



Note: The sum of direct and indirect emissions equals end-use emissions. The total indirect emissions allocated to end-users in a country can be smaller than the direct emissions from fuel transformation in that country if some of the indirect emissions are allocated to exports and international bunkers. The indirect emissions allocated to end users including exports and bunkers equals the direct emissions from fuel transformation plus the indirect emissions associated with energy imported from other countries. The indirect emissions arising from energy supplied from countries outside the EU are assumed to be zero. 'Other sectors' include emissions from agriculture, forestry and fishing as well as the net (indirect) emissions from energy trade.

Source: EEA, 2011

Figure A2.35 Trends in direct and indirect GHG emissions by end use sector in Netherlands, 2005-2009

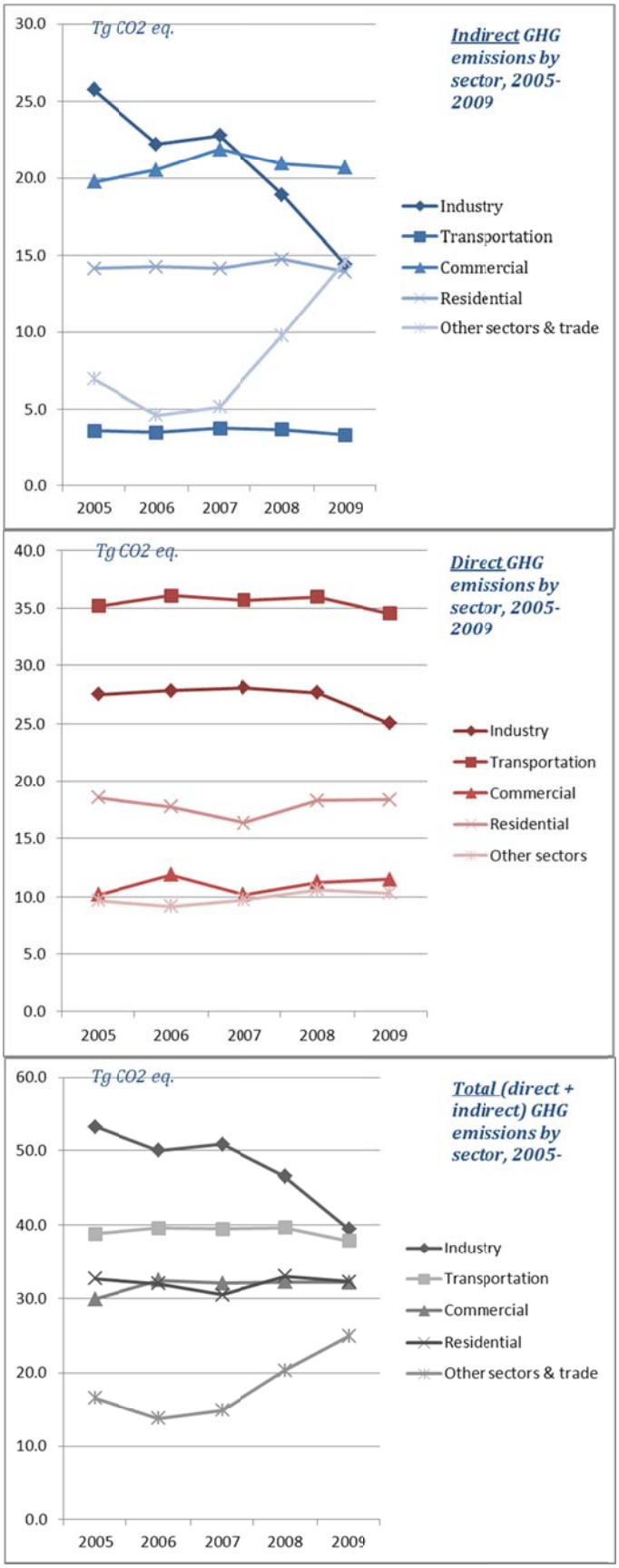
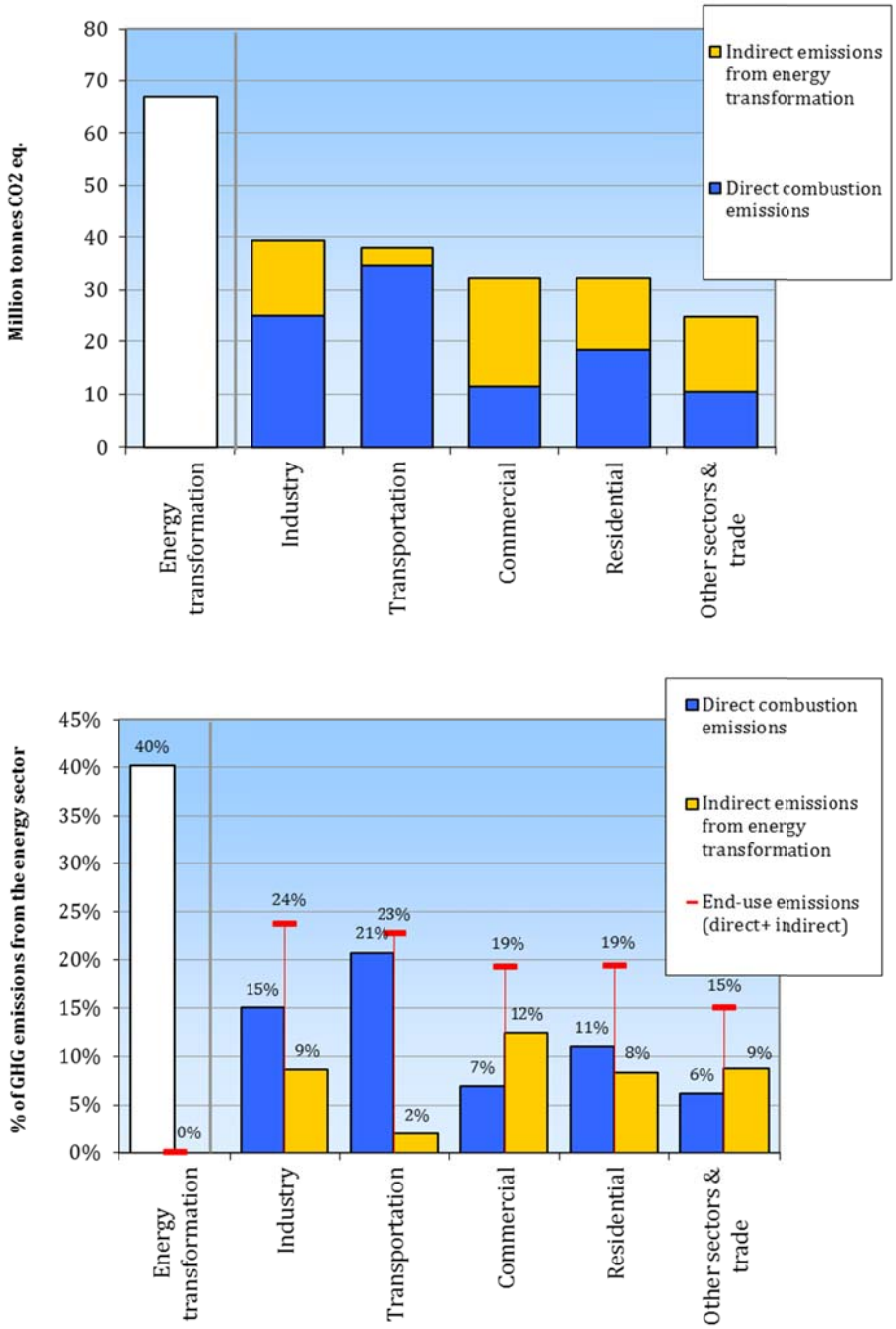


Figure A2.36 Direct and indirect GHG emissions by end use sector in Netherlands in 2009



Note: The sum of direct and indirect emissions equals end-use emissions. The total indirect emissions allocated to end-users in a country can be smaller than the direct emissions from fuel transformation in that country if some of the indirect emissions are allocated to exports and international bunkers. The indirect emissions allocated to end users including exports and bunkers equals the direct emissions from fuel transformation plus the indirect emissions associated with energy imported from other countries. The indirect emissions arising from energy supplied from countries outside the EU are assumed to be zero. 'Other sectors' include emissions from agriculture, forestry and fishing as well as the net (indirect) emissions from energy trade.

Source: EEA, 2011

Figure A2.37 Trends in direct and indirect GHG emissions by end use sector in Austria, 2005-2009

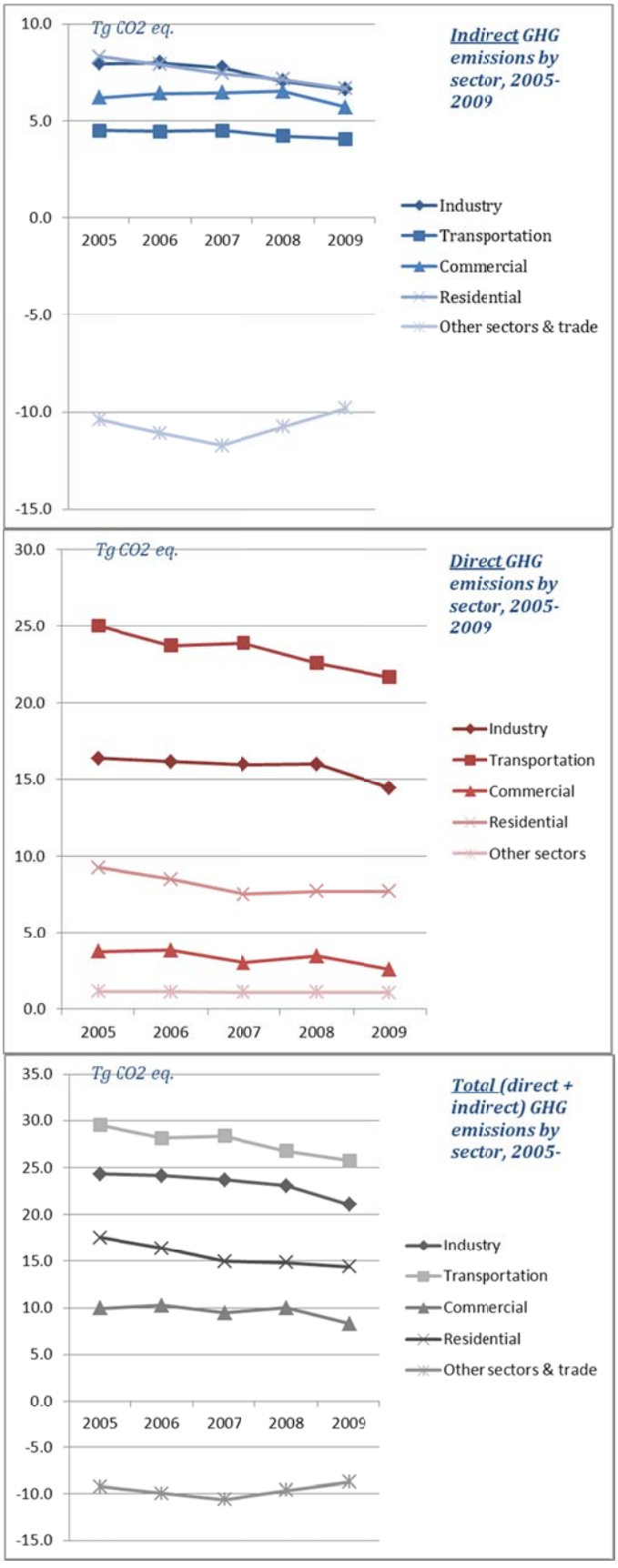
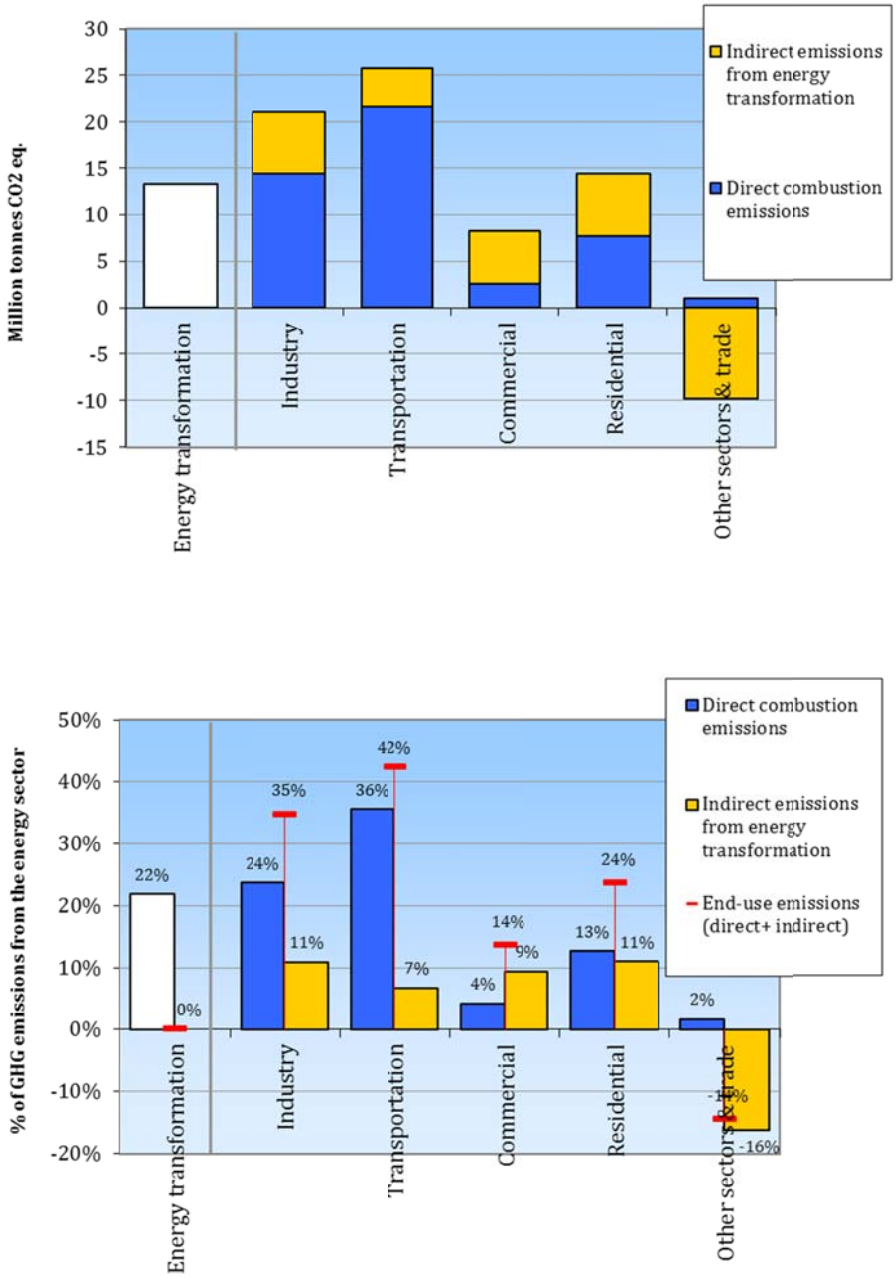


Figure A2.38 Direct and indirect GHG emissions by end use sector in Austria in 2009



Note: The sum of direct and indirect emissions equals end-use emissions. The total indirect emissions allocated to end-users in a country can be smaller than the direct emissions from fuel transformation in that country if some of the indirect emissions are allocated to exports and international bunkers. The indirect emissions allocated to end users including exports and bunkers equals the direct emissions from fuel transformation plus the indirect emissions associated with energy imported from other countries. The indirect emissions arising from energy supplied from countries outside the EU are assumed to be zero. 'Other sectors' include emissions from agriculture, forestry and fishing as well as the net (indirect) emissions from energy trade.

Source: EEA, 2011

Figure A2.39 Trends in direct and indirect GHG emissions by end use sector in Poland, 2005-2009

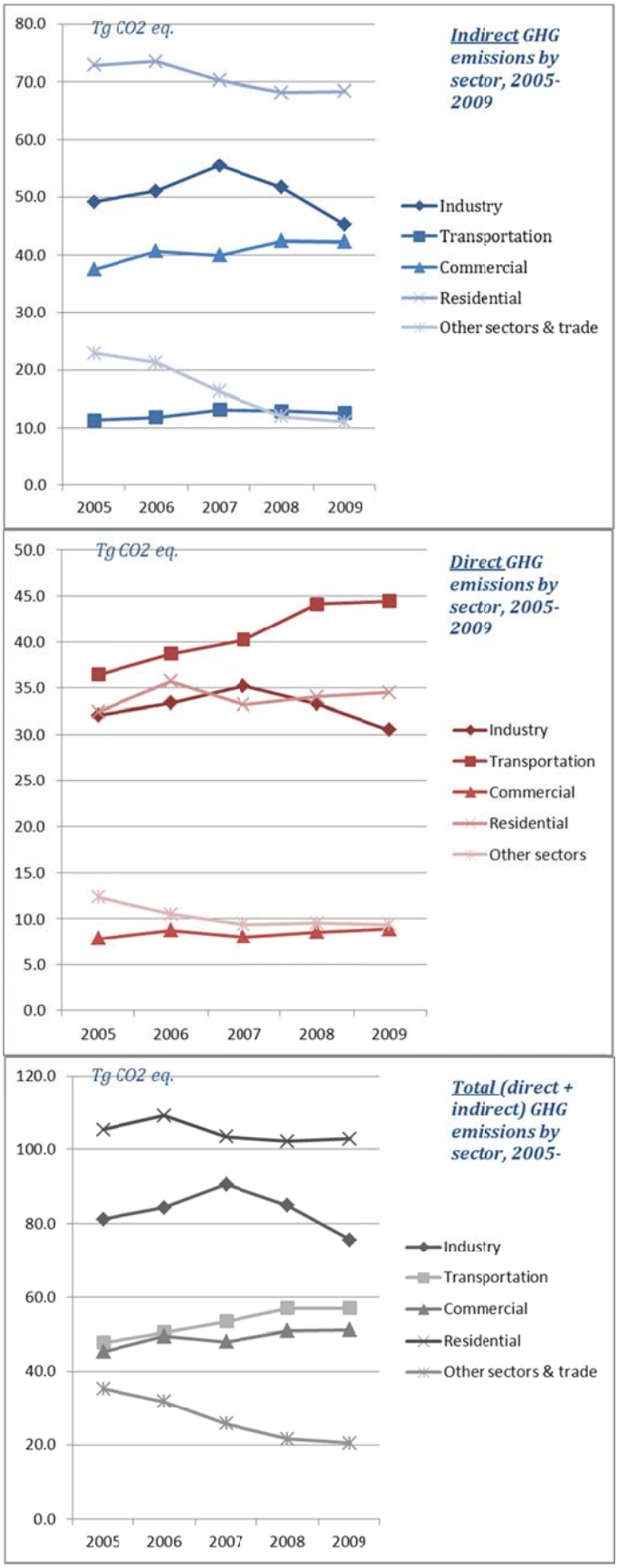
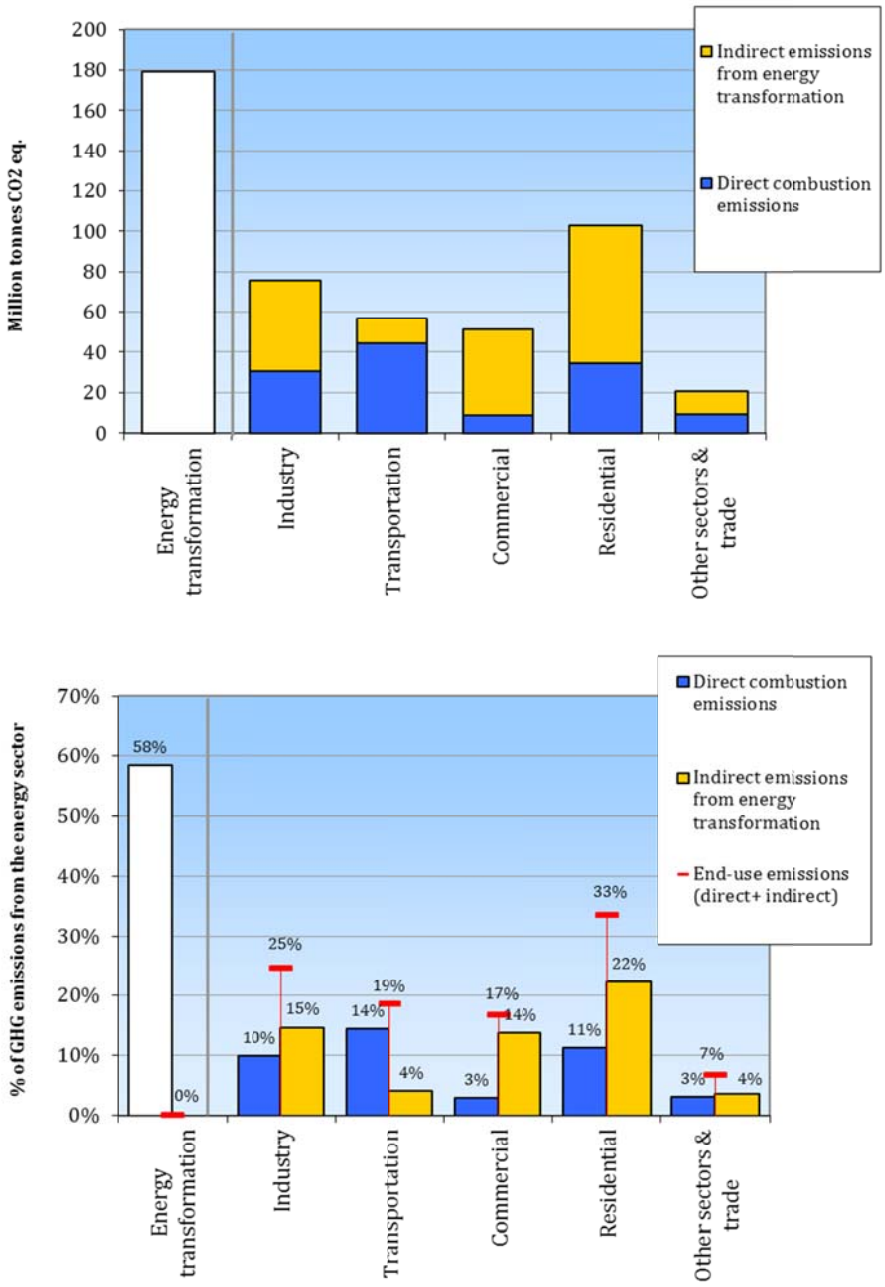


Figure A2.40 Direct and indirect GHG emissions by end use sector in Poland[18] in 2009



Note: The sum of direct and indirect emissions equals end-use emissions. The total indirect emissions allocated to end-users in a country can be smaller than the direct emissions from fuel transformation in that country if some of the indirect emissions are allocated to exports and international bunkers. The indirect emissions allocated to end users including exports and bunkers equals the direct emissions from fuel transformation plus the indirect emissions associated with energy imported from other countries. The indirect emissions arising from energy supplied from countries outside the EU are assumed to be zero. 'Other sectors' include emissions from agriculture, forestry and fishing as well as the net (indirect) emissions from energy trade.

Source: EEA, 2011

[18] Other methodological issues which could influence the end-use allocation in Poland are that part of the direct emissions from CRF sector 1.A.2.a (manufacturing industries and construction) are reallocated to CRF sector 2 (industrial processes). This is because emissions from fuel consumption in metallurgy processes (i.e. blast furnace process, sinter plants and basic oxygen furnace process) are reported under sector 2. Moreover, a share of the emissions from coke production (based on the input/output C balance in the coke production process) that could be recognized as fugitive emission from the transformation of solid fuels are reported under CRF sector 2.C.1 (iron and steel production).

Figure A2.41 Trends in direct and indirect GHG emissions by end use sector in Portugal, 2005-2009

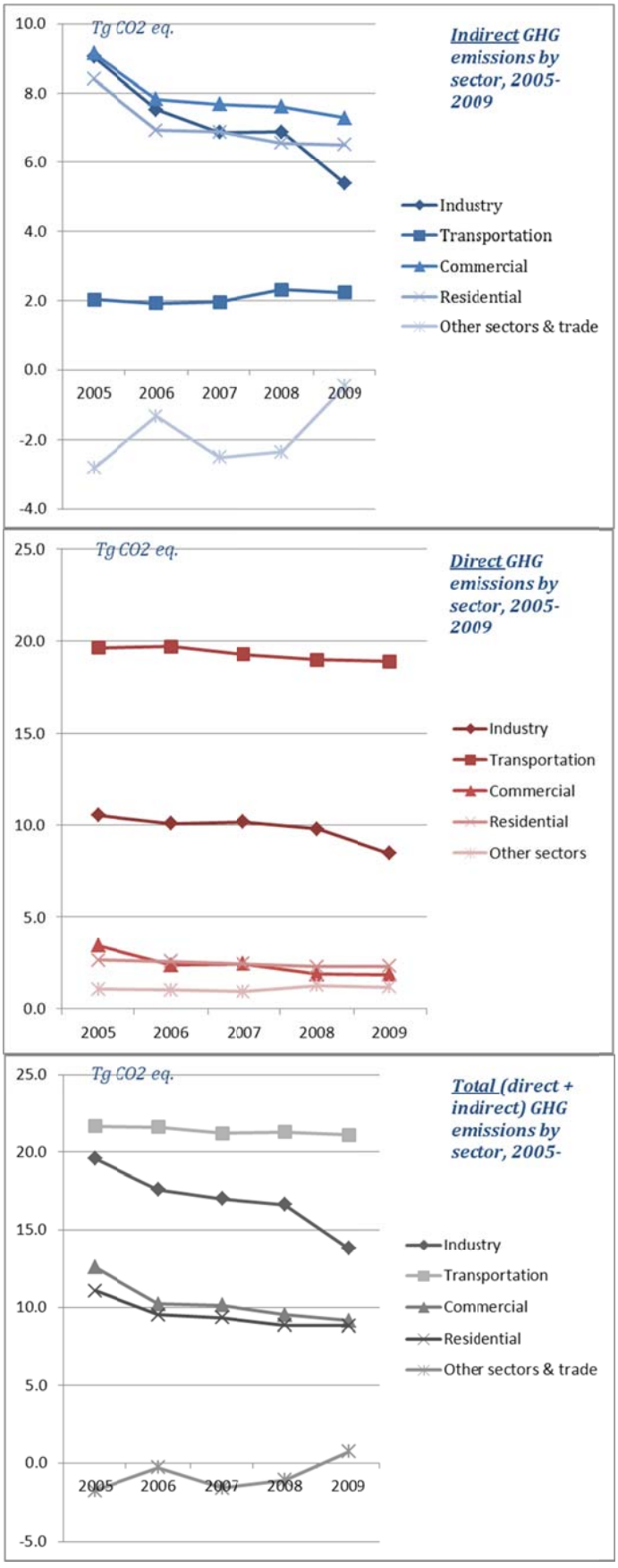
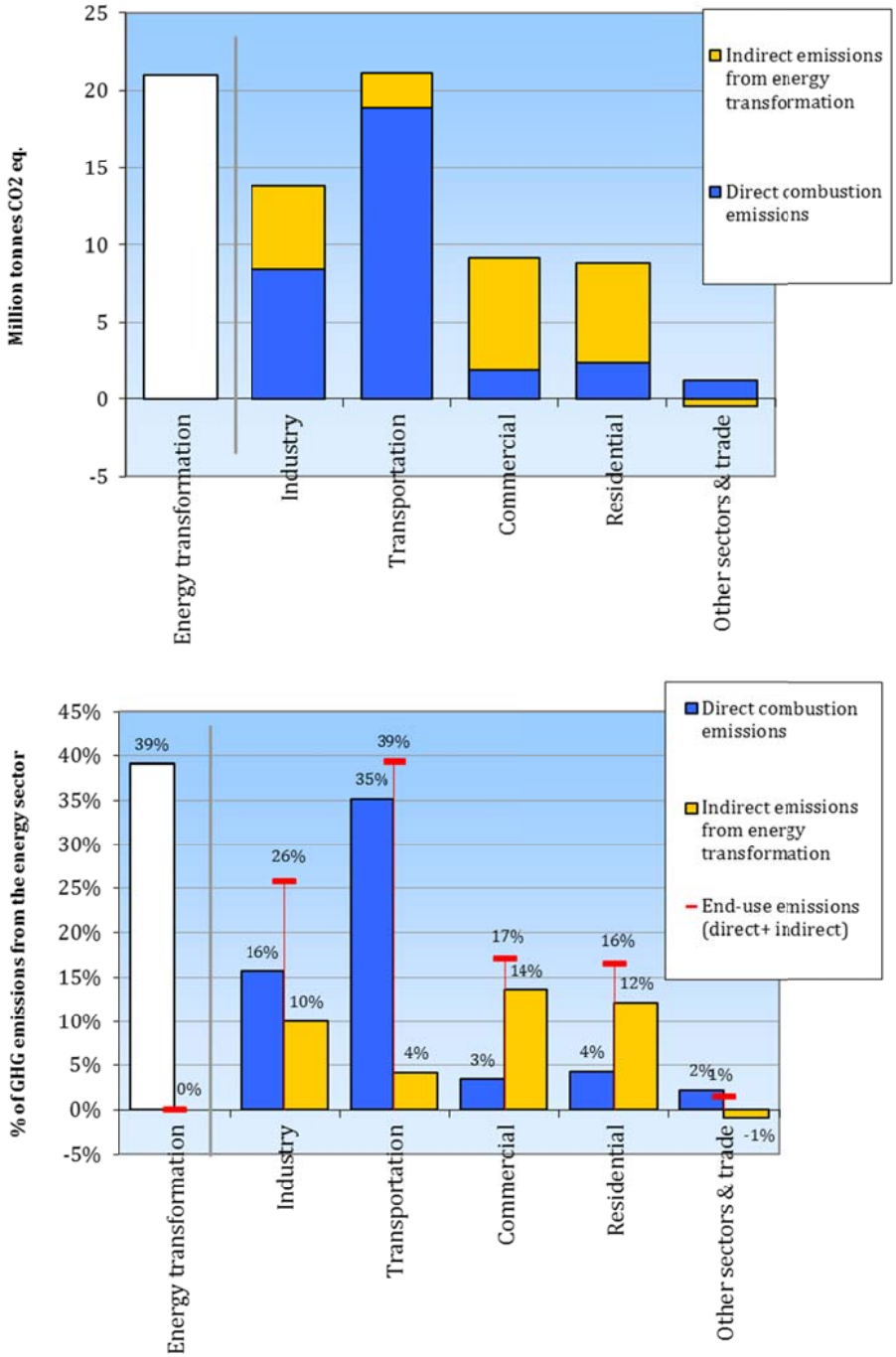


Figure A2.42 Direct and indirect GHG emissions by end use sector in Portugal in 2009



Note: The sum of direct and indirect emissions equals end-use emissions. The total indirect emissions allocated to end-users in a country can be smaller than the direct emissions from fuel transformation in that country if some of the indirect emissions are allocated to exports and international bunkers. The indirect emissions allocated to end users including exports and bunkers equals the direct emissions from fuel transformation plus the indirect emissions associated with energy imported from other countries. The indirect emissions arising from energy supplied from countries outside the EU are assumed to be zero. 'Other sectors' include emissions from agriculture, forestry and fishing as well as the net (indirect) emissions from energy trade.

Source: EEA, 2011

Figure A2.43 Trends in direct and indirect GHG emissions by end use sector in Romania, 2005-2009

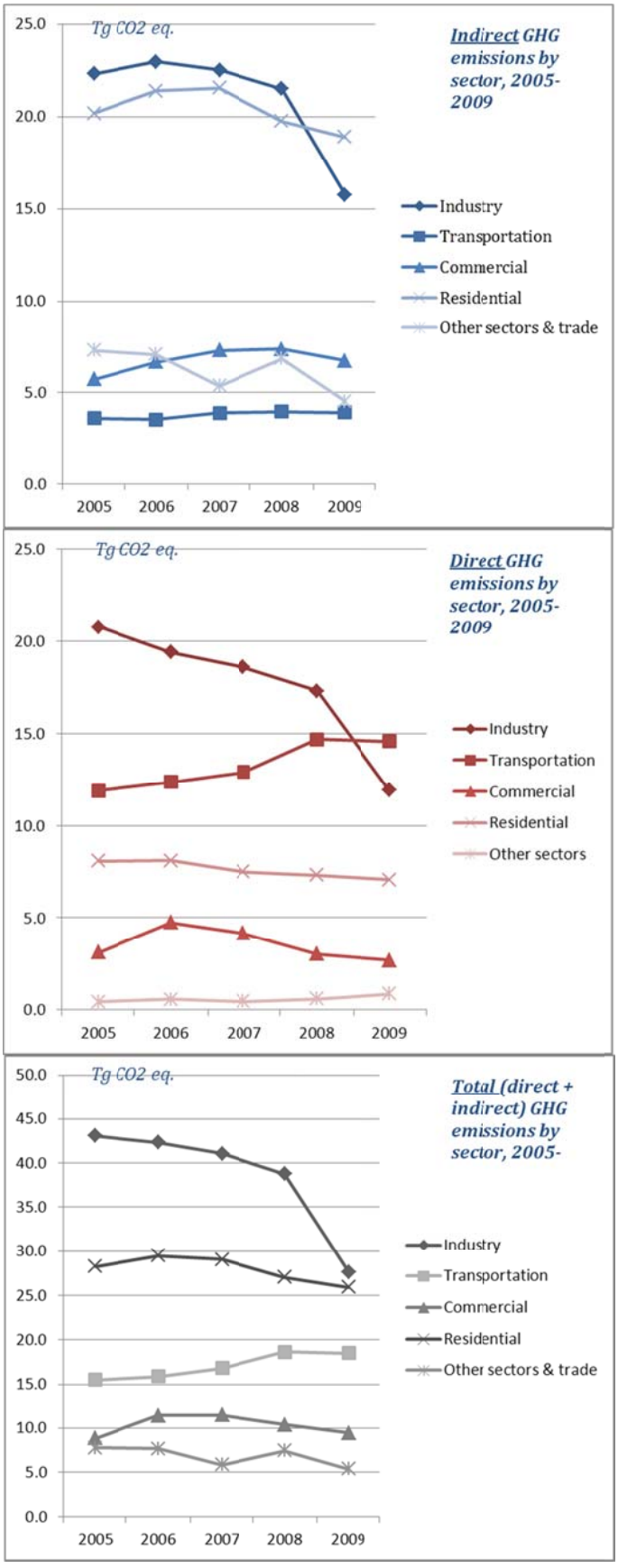
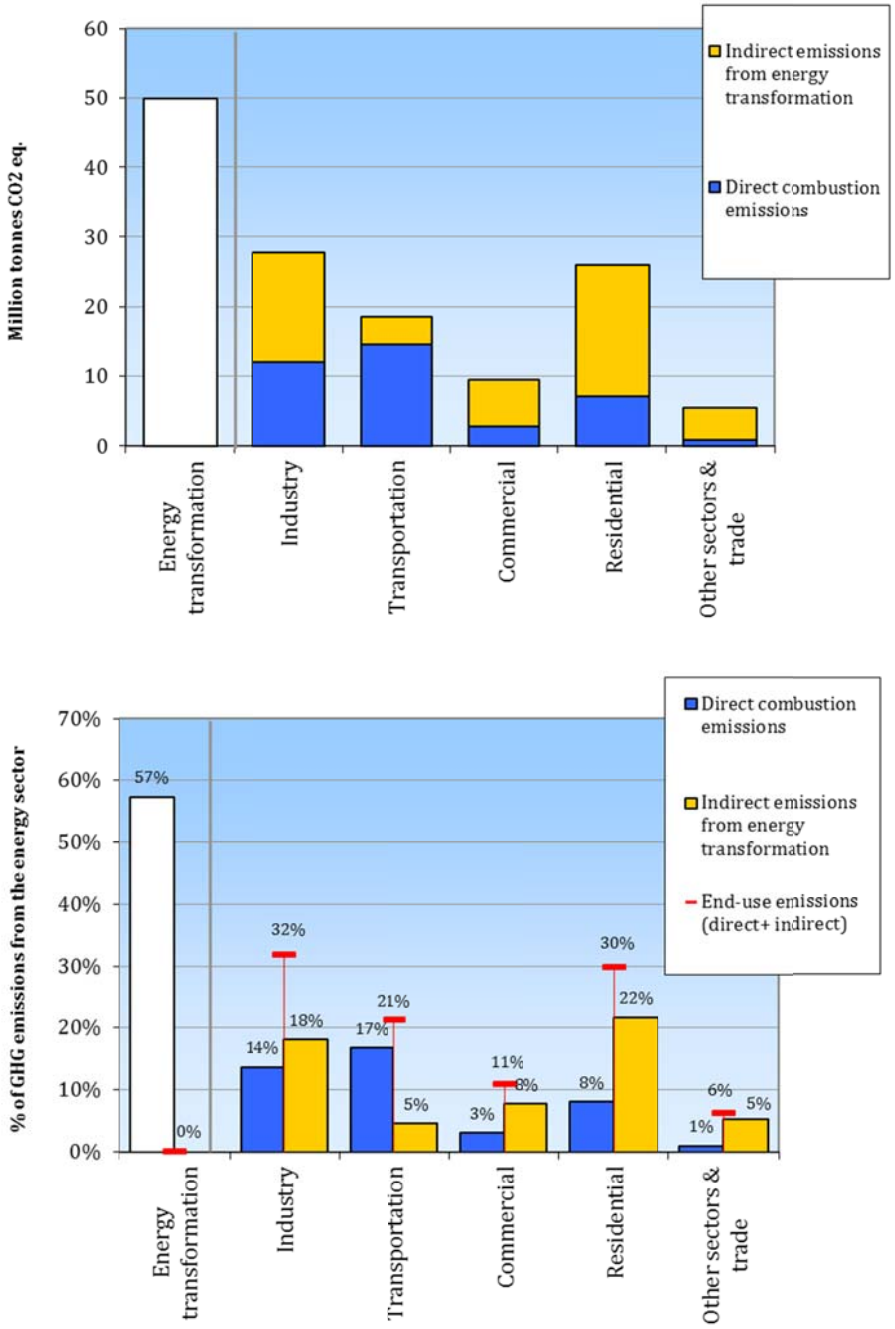


Figure A2.44 Direct and indirect GHG emissions by end use sector in Romania in 2009



Note: The sum of direct and indirect emissions equals end-use emissions. The total indirect emissions allocated to end-users in a country can be smaller than the direct emissions from fuel transformation in that country if some of the indirect emissions are allocated to exports and international bunkers. The indirect emissions allocated to end users including exports and bunkers equals the direct emissions from fuel transformation plus the indirect emissions associated with energy imported from other countries. The indirect emissions arising from energy supplied from countries outside the EU are assumed to be zero. 'Other sectors' include emissions from agriculture, forestry and fishing as well as the net (indirect) emissions from energy trade.

Source: EEA, 2011

Figure A2.45 Trends in direct and indirect GHG emissions by end use sector in Slovenia, 2005-2009

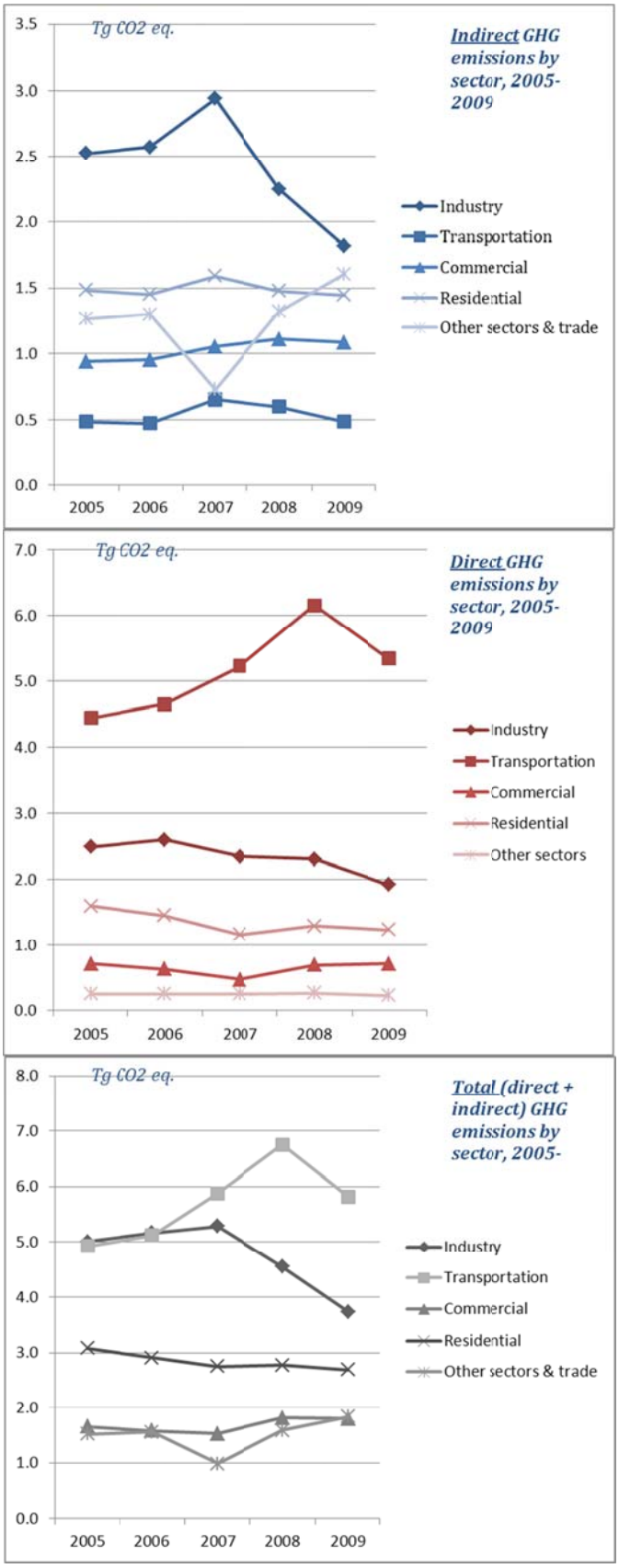
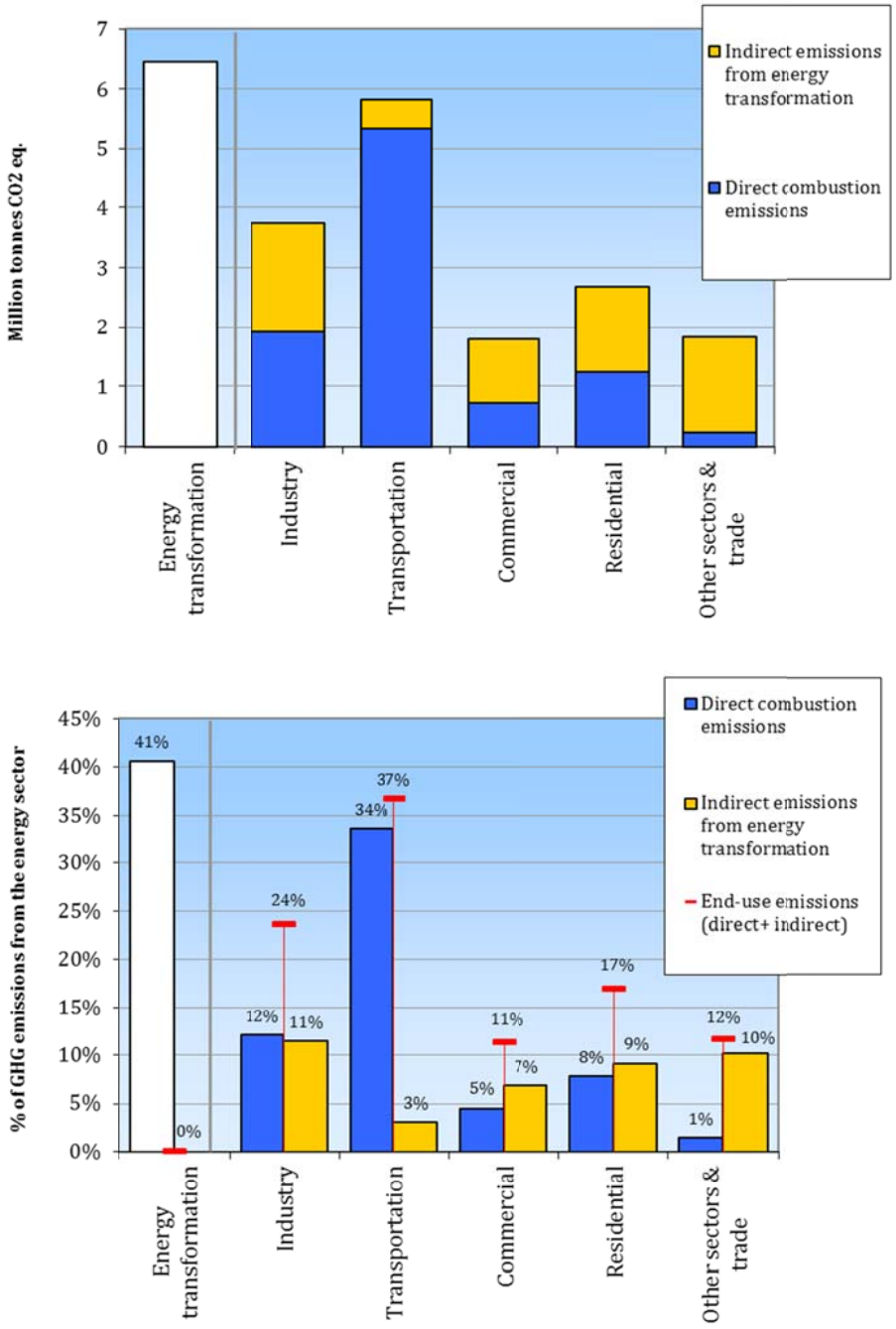


Figure A2.46 Direct and indirect GHG emissions by end use sector in Slovenia in 2009



Note: The sum of direct and indirect emissions equals end-use emissions. The total indirect emissions allocated to end-users in a country can be smaller than the direct emissions from fuel transformation in that country if some of the indirect emissions are allocated to exports and international bunkers. The indirect emissions allocated to end users including exports and bunkers equals the direct emissions from fuel transformation plus the indirect emissions associated with energy imported from other countries. The indirect emissions arising from energy supplied from countries outside the EU are assumed to be zero. 'Other sectors' include emissions from agriculture, forestry and fishing as well as the net (indirect) emissions from energy trade.

Source: EEA, 2011

Figure A2.47 Trends in direct and indirect GHG emissions by end use sector in Slovakia, 2005-2009

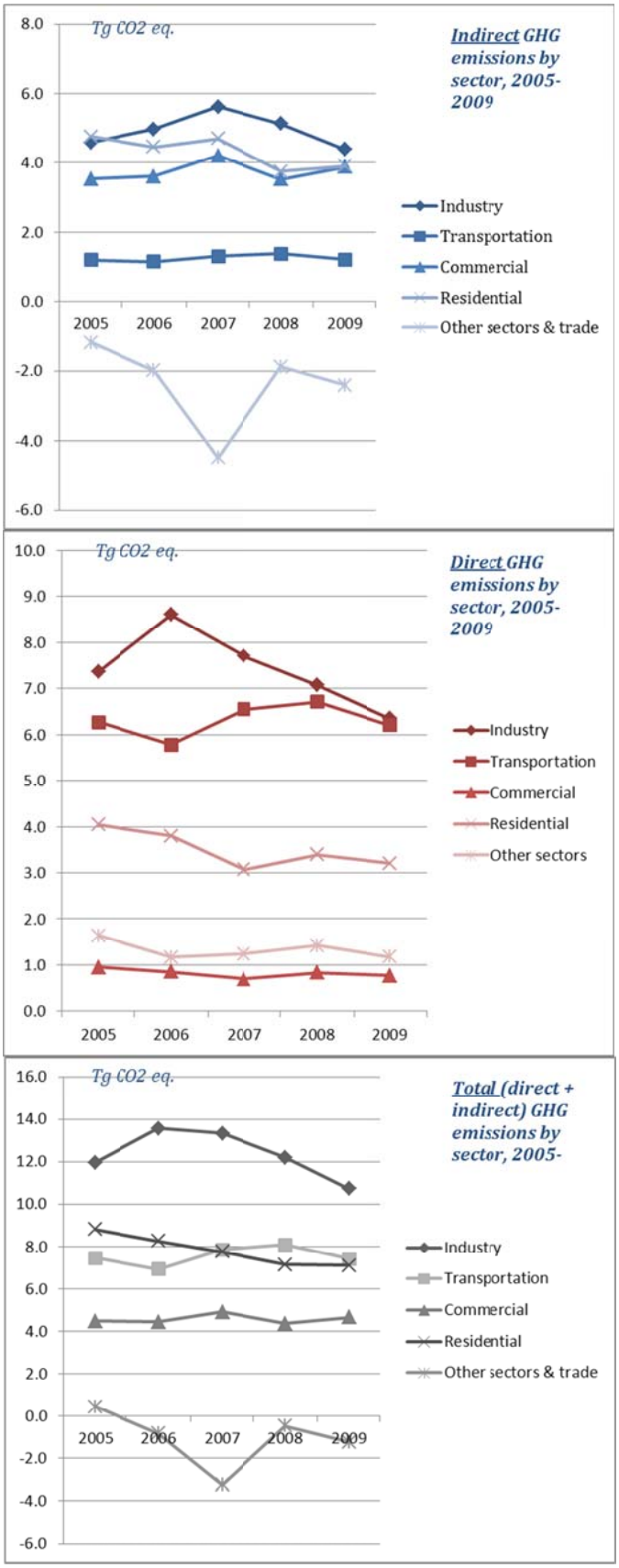
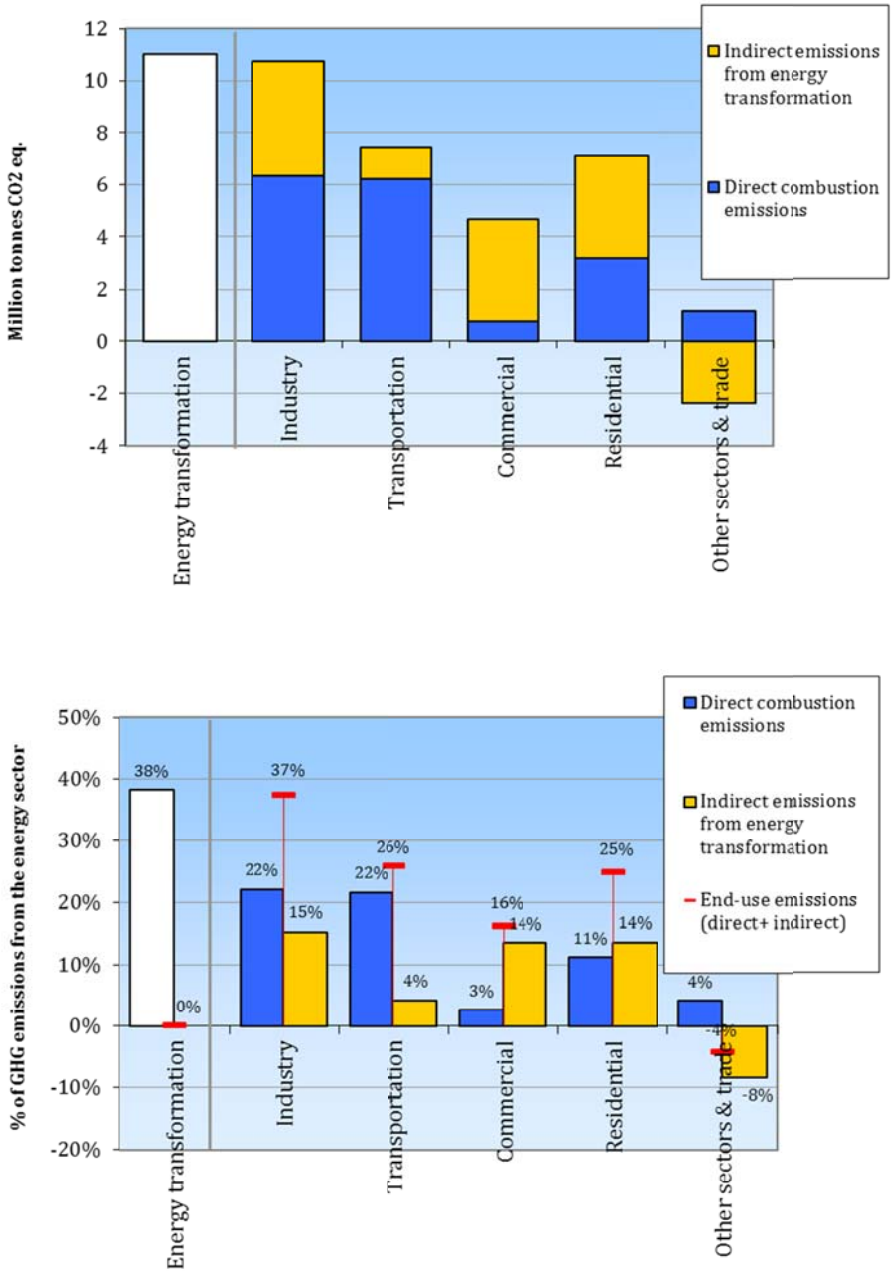


Figure A2.48 Direct and indirect GHG emissions by end use sector in Slovakia in 2009



Note: The sum of direct and indirect emissions equals end-use emissions. The total indirect emissions allocated to end-users in a country can be smaller than the direct emissions from fuel transformation in that country if some of the indirect emissions are allocated to exports and international bunkers. The indirect emissions allocated to end users including exports and bunkers equals the direct emissions from fuel transformation plus the indirect emissions associated with energy imported from other countries. The indirect emissions arising from energy supplied from countries outside the EU are assumed to be zero. 'Other sectors' include emissions from agriculture, forestry and fishing as well as the net (indirect) emissions from energy trade.

Source: EEA, 2011

Figure A2.49 Trends in direct and indirect GHG emissions by end use sector in Finland, 2005-2009

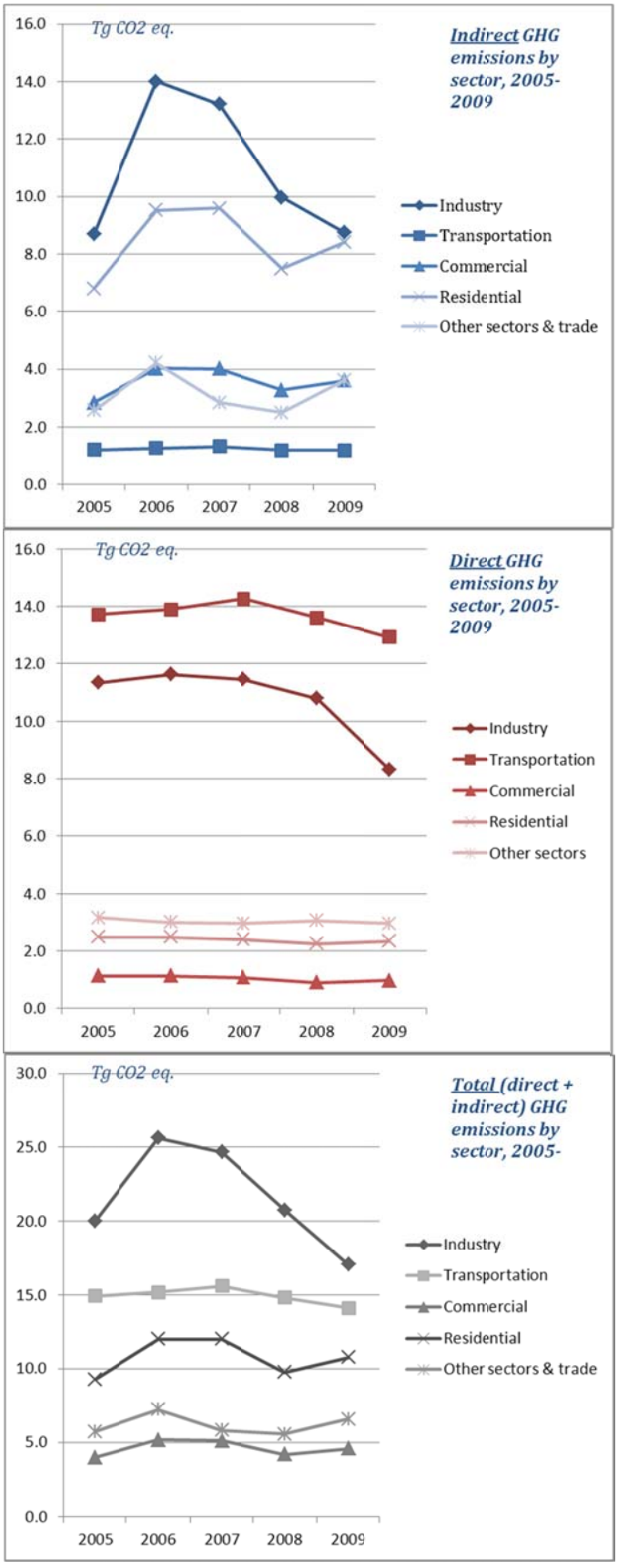
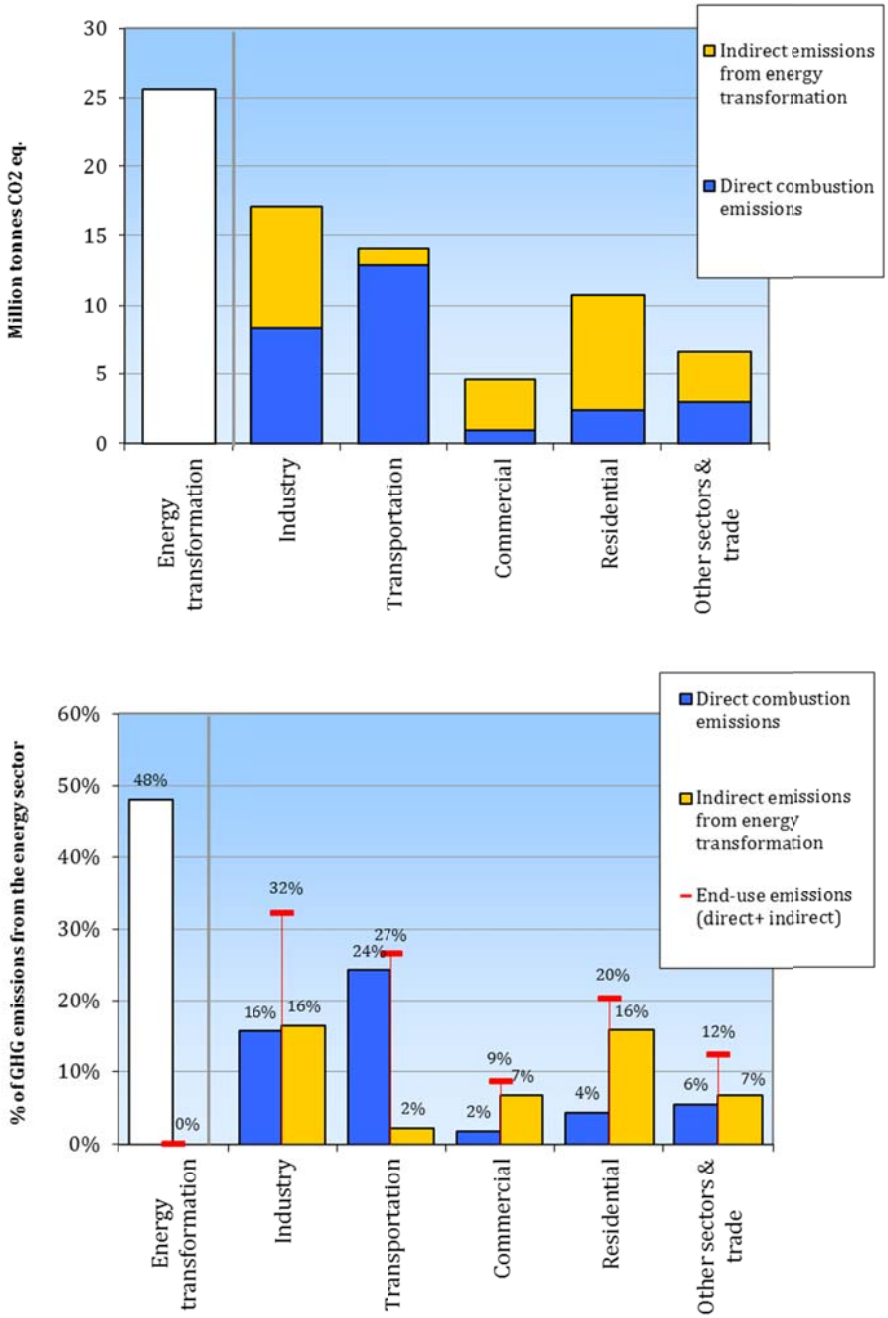


Figure A2.50 Direct and indirect GHG emissions by end use sector in Finland in 2009



Note: The sum of direct and indirect emissions equals end-use emissions. The total indirect emissions allocated to end-users in a country can be smaller than the direct emissions from fuel transformation in that country if some of the indirect emissions are allocated to exports and international bunkers. The indirect emissions allocated to end users including exports and bunkers equals the direct emissions from fuel transformation plus the indirect emissions associated with energy imported from other countries. The indirect emissions arising from energy supplied from countries outside the EU are assumed to be zero. 'Other sectors' include emissions from agriculture, forestry and fishing as well as the net (indirect) emissions from energy trade.

Source: EEA, 2011

Figure A2.51 Trends in direct and indirect GHG emissions by end use sector in Sweden, 2005-2009

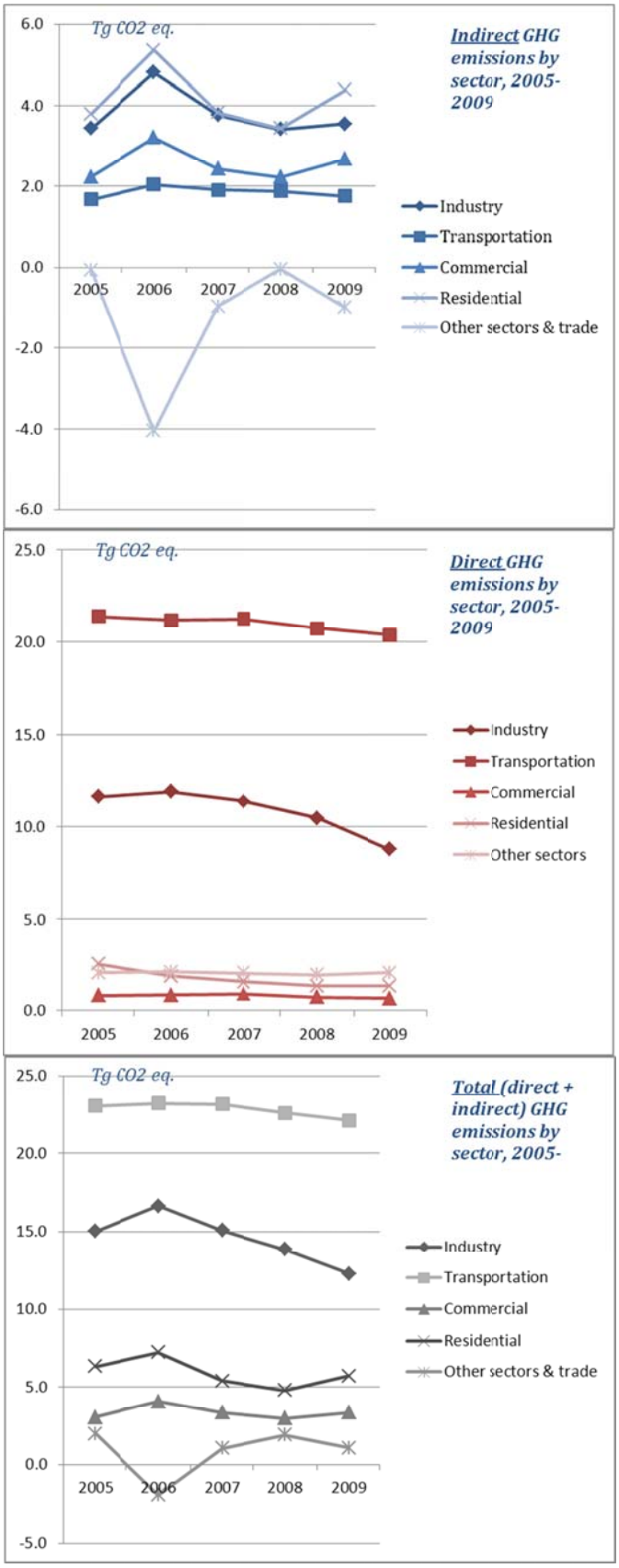
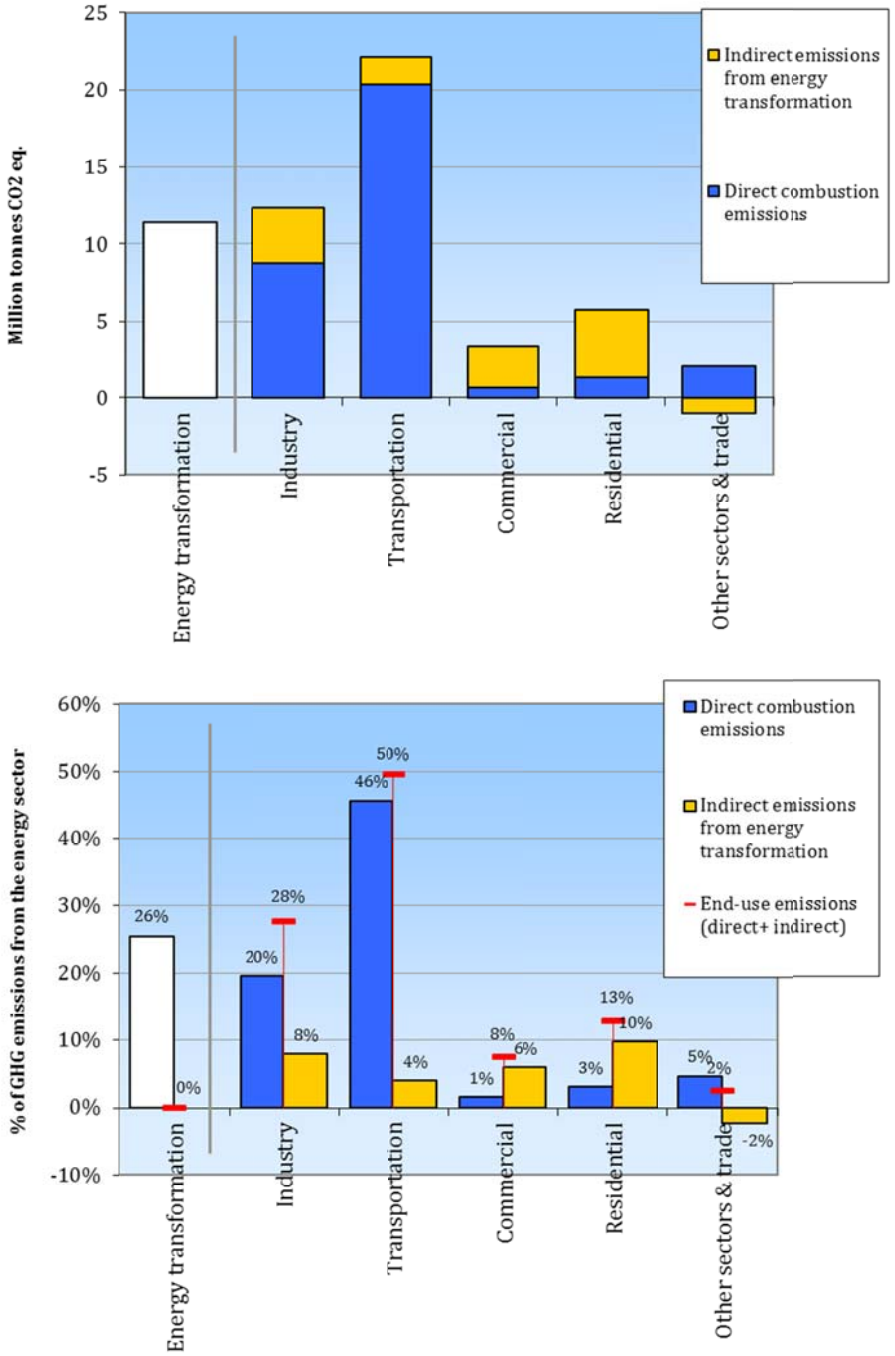


Figure A2.52 Direct and indirect GHG emissions by end use sector in Sweden in 2009



Note: The sum of direct and indirect emissions equals end-use emissions. The total indirect emissions allocated to end-users in a country can be smaller than the direct emissions from fuel transformation in that country if some of the indirect emissions are allocated to exports and international bunkers. The indirect emissions allocated to end users including exports and bunkers equals the direct emissions from fuel transformation plus the indirect emissions associated with energy imported from other countries. The indirect emissions arising from energy supplied from countries outside the EU are assumed to be zero. 'Other sectors' include emissions from agriculture, forestry and fishing as well as the net (indirect) emissions from energy trade.

Source: EEA, 2011

Figure A2.53 Trends in direct and indirect GHG emissions by end use sector in United Kingdom, 2005-2009

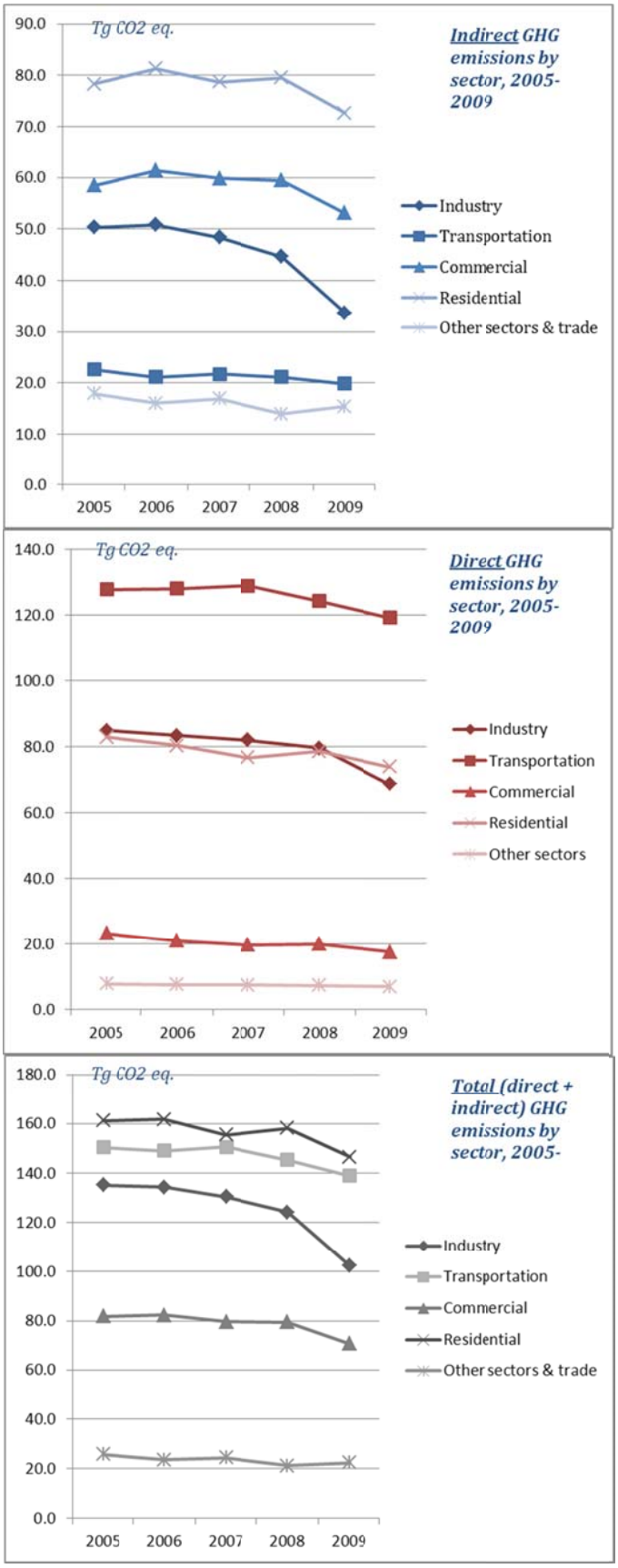
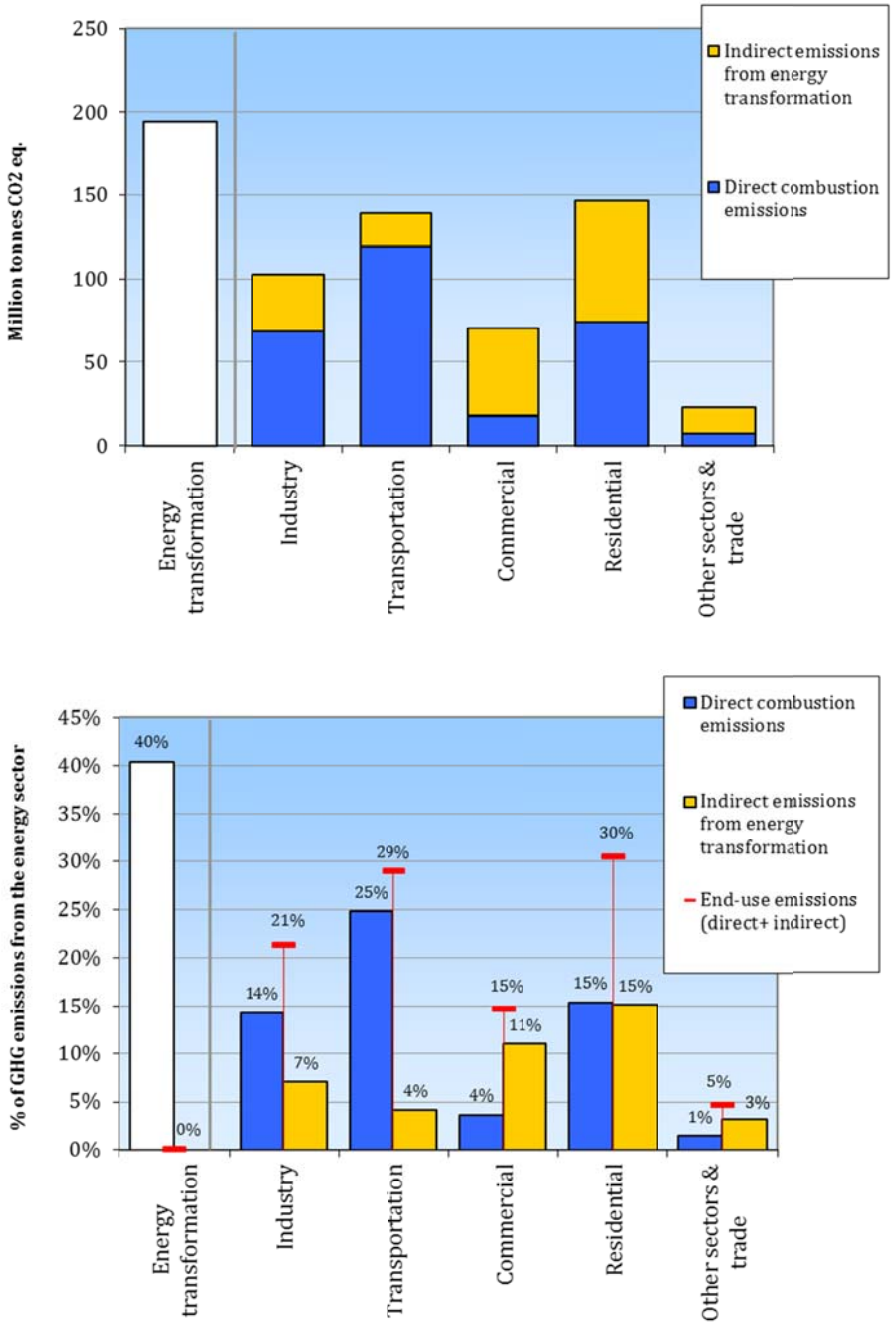


Figure A2.54 Direct and indirect GHG emissions by end use sector in United Kingdom in 2009



Note: The sum of direct and indirect emissions equals end-use emissions. The total indirect emissions allocated to end-users in a country can be smaller than the direct emissions from fuel transformation in that country if some of the indirect emissions are allocated to exports and international bunkers. The indirect emissions allocated to end users including exports and bunkers equals the direct emissions from fuel transformation plus the indirect emissions associated with energy imported from other countries. The indirect emissions arising from energy supplied from countries outside the EU are assumed to be zero. 'Other sectors' include emissions from agriculture, forestry and fishing as well as the net (indirect) emissions from energy trade.

Source: EEA, 2011

Figure A2.55 Trends in direct and indirect GHG emissions by end use sector in EU-27, 2005-2009

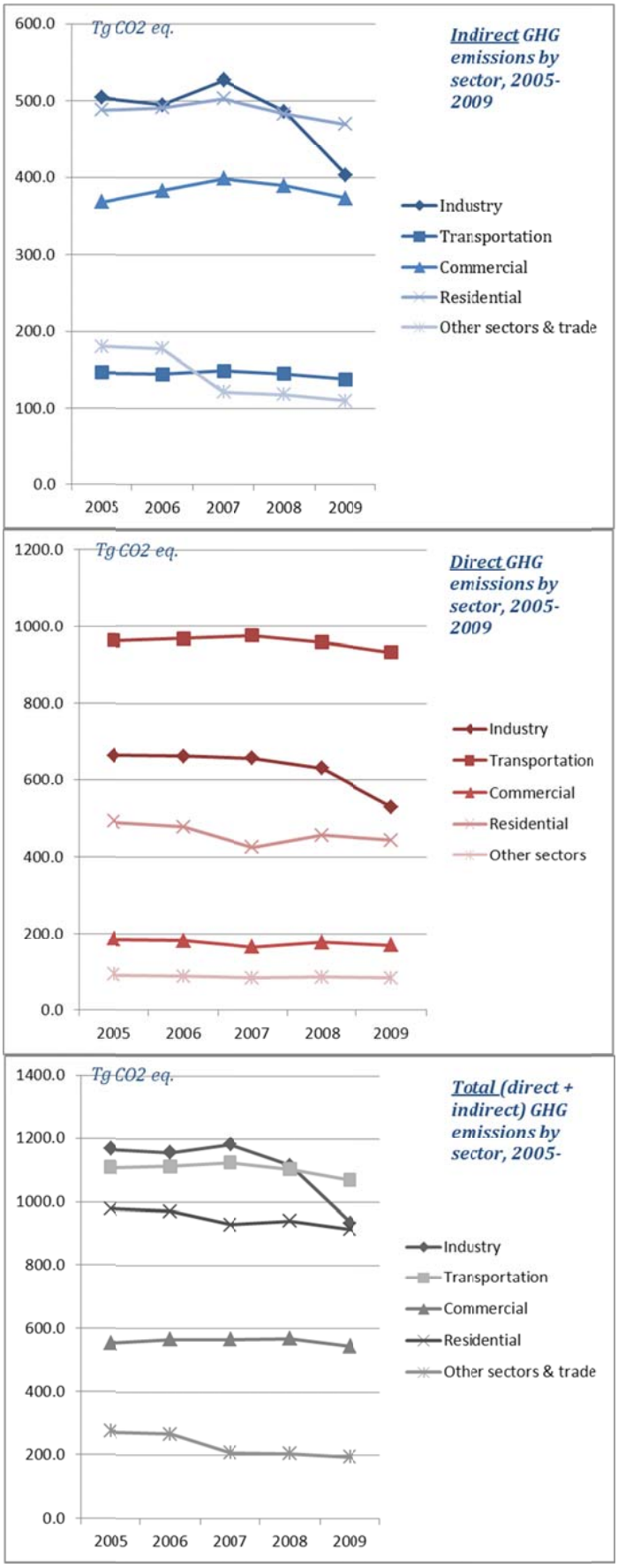
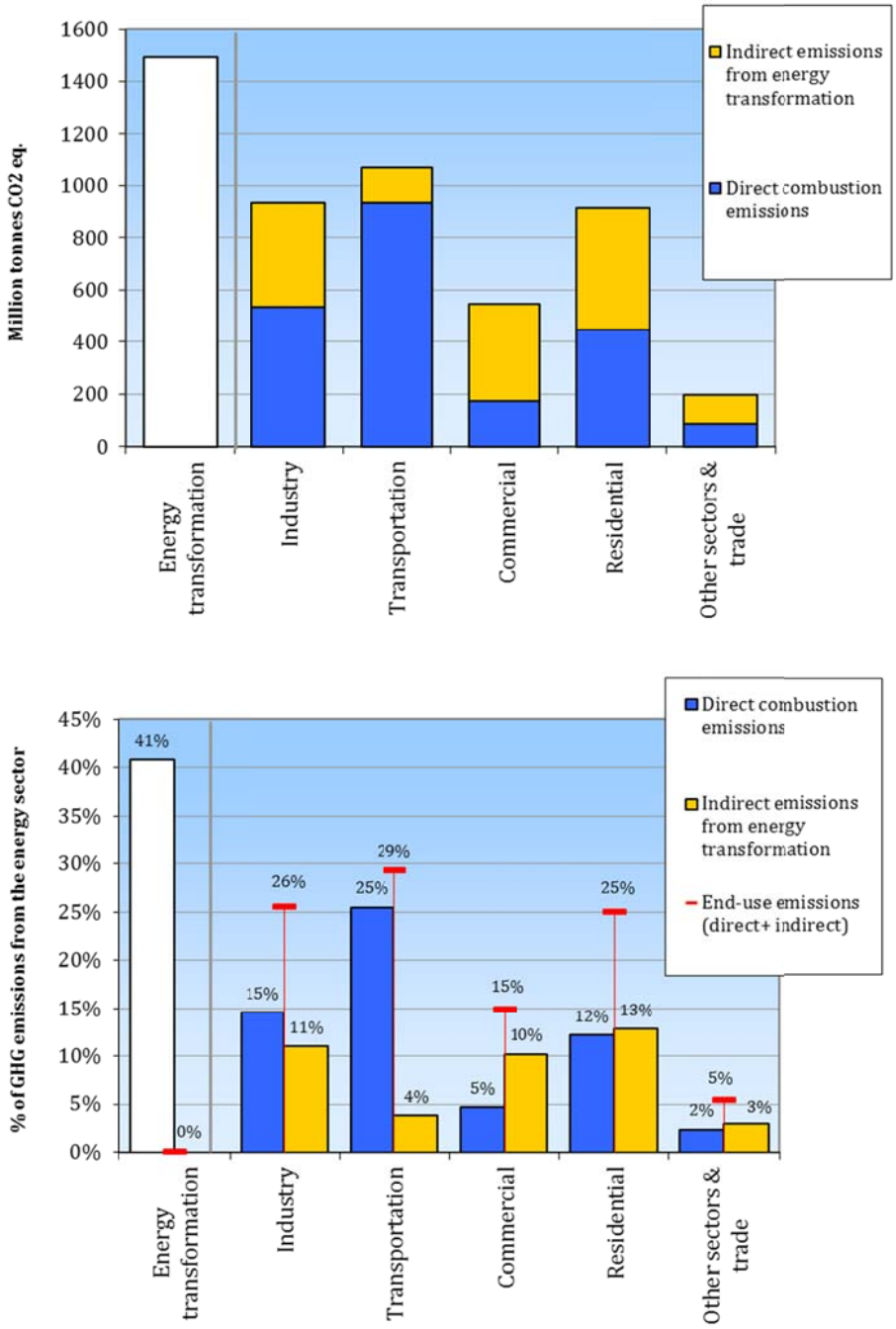


Figure A2.56 Direct and indirect GHG emissions by end use sector in EU-27 in 2009



Note: The sum of direct and indirect emissions equals end-use emissions. The total indirect emissions allocated to end-users in a country can be smaller than the direct emissions from fuel transformation in that country if some of the indirect emissions are allocated to exports and international bunkers. The indirect emissions allocated to end users including exports and bunkers equals the direct emissions from fuel transformation plus the indirect emissions associated with energy imported from other countries. The indirect emissions arising from energy supplied from countries outside the EU are assumed to be zero. 'Other sectors' include emissions from agriculture, forestry and fishing as well as the net (indirect) emissions from energy trade.

Source: EEA, 2011