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End-user GHG emissions from energy

Reallocation of emissions from energy industries to end users 2005–2010

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 redistribute 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 2005–2010.

Background

The European Union (EU), as a party to the UNFCCC, reports annually on GHG inventories for the year t–2 (i.e. two years after the reference year) 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 the UNFCCC. Trends in GHG emissions have traditionally been explained based on the sectorial classification used in UNFCCC reporting. This internationally-agreed reporting system requires Annex I Parties to estimate and report (territorial) GHG emissions using UNFCCC Guidelines and Intergovernmental Panel on Climate Change (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 presents 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 carbon dioxide (CO_2) from the oxidation of methane (CH_4), carbon monoxide (CO) and *non-methane volatile organic compounds* (NMVOCs) 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 GHG 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 indirect

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

[2] Fugitive emissions are releases of GHGs from anthropogenic activities such as 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).

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 the call to limit the rise in global average temperature to no more than 2 °C above pre-industrial levels. EU 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 the Kyoto Protocol, 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 Protocol 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.

The end-user approach also provides information on the GHG effect of cross-border trading of energy flows, such as electricity. These energy-trade effects can be very large in some countries, and can also vary significantly from year to year.

Although the focus of this report is on GHG emissions, polices to mitigate climate change can help reduce air pollution, and policies to improve air quality can also help reduce GHG emissions. There can be both synergies and trade-offs. The end-user methodology allows a better understanding of

both GHG emission and air pollution trends in the energy sector from the end-user side that can be helpful in the context of combined climate and air pollution policies.

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.

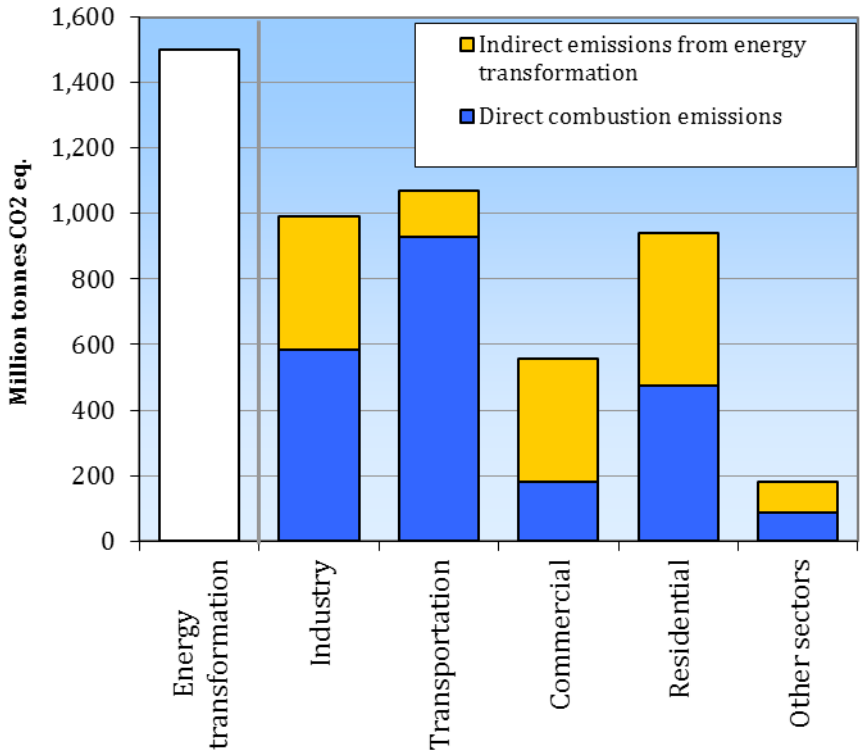
Notwithstanding differences between energy statistics and activity data, the reallocation of emissions from energy transformation to end-users is done on the basis of Eurostat's energy balances and UNFCCC GHG emissions from the energy sector. One key objective from this exercise is to better analyse 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 indirect emissions from the electricity and heat supplied to households fall within the scope of the EU ETS.

Results by end use for 2010

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 to reflect that all emissions (including fugitives) are allocated to the end-use sectors.

Figure ES.1 End-use GHG emissions from energy use in EU-27 in 2010

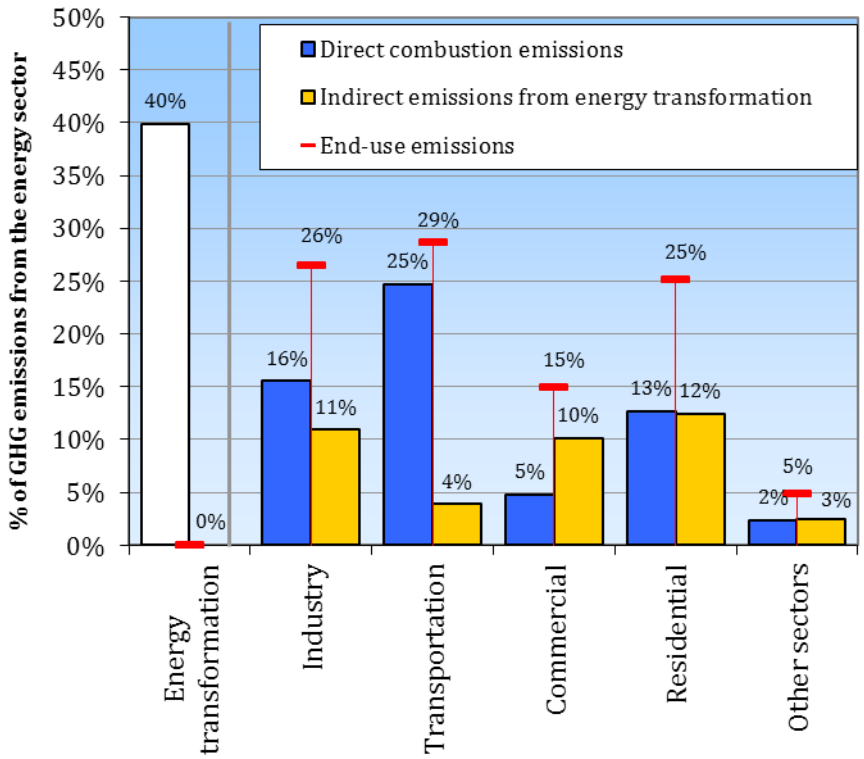


Note: The sum of direct and indirect emissions equals end-use emissions. The total indirect emissions allocated to end users in a country can be smaller than the direct emissions from fuel transformation in that country if some of the indirect emissions are allocated to exports and international bunkers. The indirect emissions allocated to end users including exports and bunkers equal 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' includes 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 Annex 2 of the main report.

Source: EEA, 2012

Figure ES.2 presents the same information in an alternative way, and in relation to total energy-related GHG emissions in 2010. The height of the line in each sector (in red) is the sum of direct and indirect GHG emissions in that sector.

Figure ES.2 End-use GHG emissions from energy use in EU-27 in 2010



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 equal 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' includes 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 Annex 2 of the main report.

Source: EEA, 2012

Energy industries and fugitive emissions accounted for 40% of energy-related GHG emissions in the EU-27 in 2010. 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 CHP 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 at one point in time, i.e. 2010. 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 GHG emissions changed between 2009 and 2010?

Total GHG emissions (excluding land use, land-use change and forestry (LULUCF)) in the EU increased in 2010 after five consecutive years of emission reductions, starting in 2004. With the exception of road transportation, all the main sectors increased their GHG emissions in 2010. Energy combustion (i.e. the production and consumption of energy by all sectors, including transport) accounted for over 90 % of the net increase in EU GHG emissions in 2010.

The increase in emissions in 2010 was partly driven by the economic recovery from the 2009 recession in many European countries, which had itself caused substantial emission reductions in 2008 and 2009 in all Member States. In 2010 the winter was also colder than in the previous year, leading to increased demand for heating and higher emissions from the residential and commercial sectors. The continued strong increase in renewable energy use and the improved carbon intensity of fossil fuels — underpinned by strong gas consumption — prevented the increase in GHG emissions from being higher.

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.

In 2010, GHG emissions increased in the transformation sector (energy industries, including fugitives), and particularly in heat and electricity production. Emissions from gas and coal more than offset lower emissions from liquid fuels in the sector. The use of biomass for heat and power also increased strongly in 2010 and continued the upward trend observed since 1990.

On an end-use basis, GHG emission increases in industry accounted for about half (40% direct and 10% indirect) of all energy-related GHG emission increases in 2010. Within industry, the bulk of the increase in emissions was accounted for by the iron and steel sector, driven by higher industrial activity and an increase in crude steel production. GHG inventories for 2010, the 2010 energy balances and the verified 2010 emissions from the EU ETS published last year all confirm significantly higher energy use and emissions in industry — predominantly in iron and steel. Overall the sectors covered by the EU ETS increased their emissions more in 2010 than the non-trading sectors (i.e. those outside the EU ETS). Most of the biggest industrial installations are part of the EU ETS and higher industrial

activity during 2010, after the strong contraction in 2009, appears to have led to a sharper increase in final energy demand and emissions in these sectors.

The second largest contributor to higher emissions in the EU on an end-user basis in 2010 was the residential sector, accounting for about 39 % (35 % direct and 4 % indirect) of all energy-related GHG emission increases in 2010. The winter in Europe in 2010 was colder than in 2009, resulting in greater household demand for heating and higher GHG emissions. Part of this heating is supplied via distributed systems from district heating and CHP thermal stations. The primary energy to generate distributed heat (mainly from coal and gas) is reported under 'public electricity and heat production' in GHG inventories, which generally falls under the EU ETS. Eurostat's energy balances confirm a very significant increase in derived heat in EU-27 households during 2010. Higher final electricity consumption of the residential sector also explains why emissions increased significantly compared to 2009. The other part of the heating consists of non-distributed heat, which is generated directly by households. Non-distributed heat (mainly from gas and biomass) is reported under the residential sector in GHG inventories. More than two thirds of the increase in direct emissions from households in 2010 was accounted for by higher gas use.

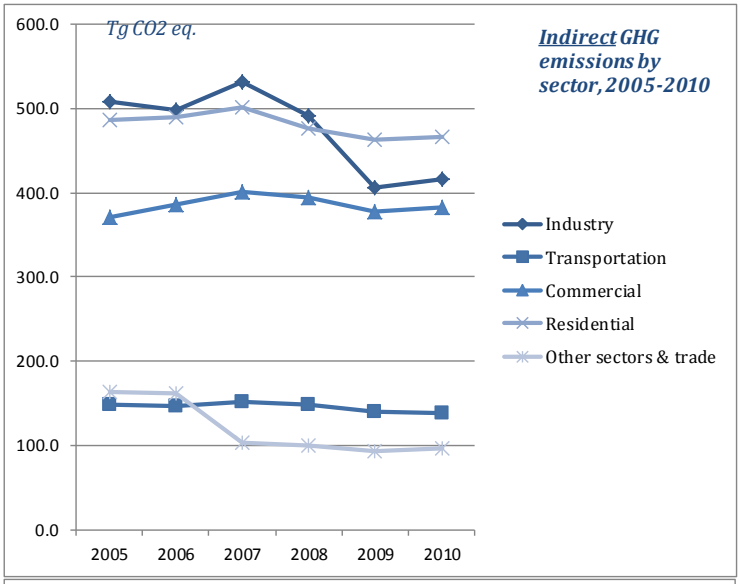
End-user emissions in the commercial sector accounted for 13 % of the total increase in energy-related GHG emissions in 2010 — split roughly the same between indirect and direct emissions. As with the residential sector, higher heat demand due to the colder winter and increased electricity consumption explain the increase in emissions in this sector in 2010.

GHG emissions did fall in some sectors between 2009 and 2010. Road transport emissions continued to decline in 2010 due to lower gasoline emissions. This was despite the recovery in diesel emissions after two consecutive years of decline. To a lesser extent, increased use of biofuels, lower emissions from refining of oil products for transportation, and lower indirect emissions from electric railways also contributed to the lower road transport emissions in 2010.

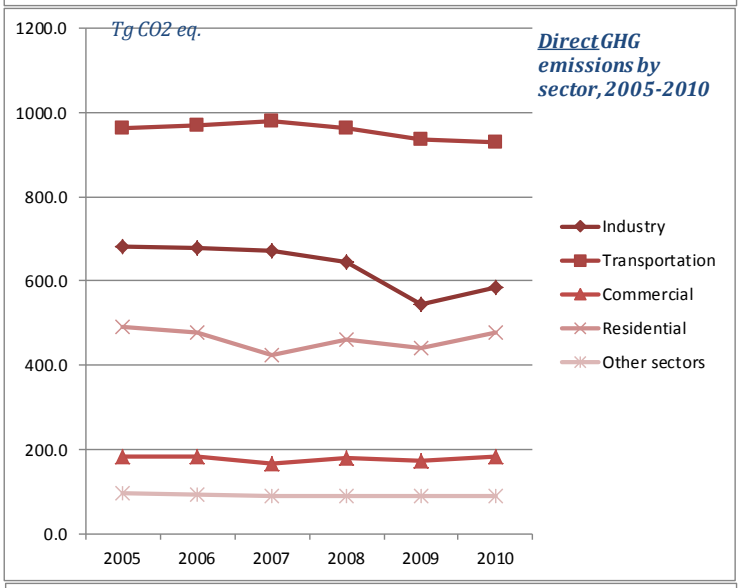
Figure ES.3 Trends in direct and indirect GHG emissions by end-use sector in EU-27, 2005-2010

EU

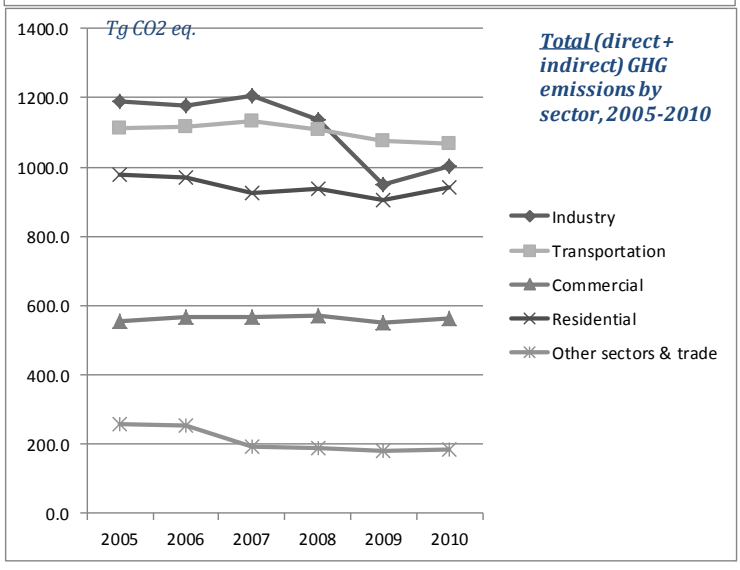
Trends in direct and indirect GHG emissions by end use sector, 2005-2010



Sector	Contribution to the total increase in energy-related emissions, 2009/2010
	Indirect emissions
Industry	10.4%
Transportation	-1.9%
Commercial	5.7%
Residential	4.0%
Other sectors & trade	3.2%
Indirect emissions (all sectors)	21.3%



Sector	Contribution to the total increase in energy-related emissions, 2009/2010
	Direct emissions
Industry	40.3%
Transportation	-4.6%
Commercial	7.5%
Residential	34.7%
Other sectors	0.8%
Direct emissions (all sectors)	78.7%



Sector	% of the total absolute increase in energy-related emissions, 2009/2010
	Total emissions
Industry	50.7%
Transportation	-6.6%
Commercial	13.1%
Residential	38.7%
Other sectors & trade	4.0%
Total direct and indirect emissions (all sectors) in Tg CO2 eq.	102

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.

End-use air pollutant emissions: SO_x and NO_x

Emissions of nitrogen oxides (NOx) and sulphur oxides (SOx) influence climate change indirectly. NOx is a precursor substance for ground-level ozone which is itself a GHG. SOx emissions can contribute to forming microscopic particles (aerosols), which can reflect sunlight back out into space and also affect cloud formation. Both NOx and SOx are reported at an aggregate level to the UNFCCC annually as part of the Parties' official GHG submissions. In addition, emissions from these substances are reported to the United Nations Economic Commission for Europe (UNECE) Convention on Long-range Transboundary Air Pollution (LRTAP) and to the EU's National Emission Ceilings Directive. Most NOx emissions are direct emissions from the transportation sector, whereas most SOx emissions are indirect emissions from energy industries. As with GHG, the same end-user methodology has been applied to NOx and SOx and the results are shown in Annex 4 of the main report.

How were end-use emissions calculated?

There is no perfect match between the sectoral classification used in GHG inventories submitted to the UNFCCC and the energy balances because of different reporting requirements. Energy industries (CRF 1.A.1) and fugitive emissions (CRF 1.B) 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 (by combustion or mechanical means) to useful energy (e.g. heat, electricity or 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

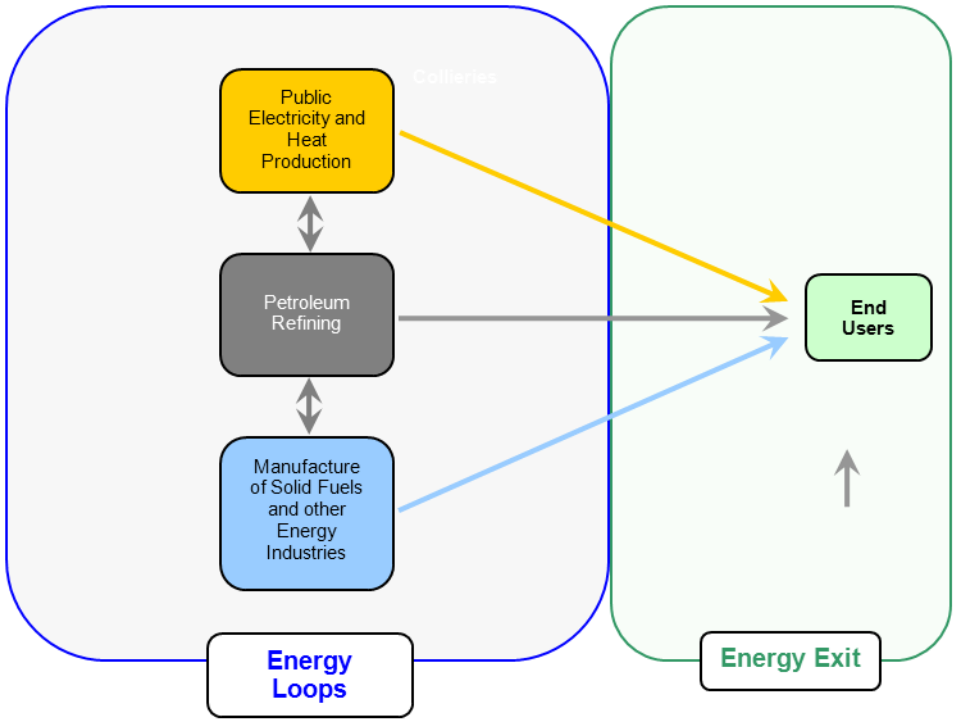
[3] To give one example: the electricity and heat used by households and services which are reported as final energy consumption in the energy balances also include the energy supplied/distributed from conventional thermal stations. Under UNFCCC reporting, GHG emissions from households and services are 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 facilities).

[4] The UK end-user model has been used by policy makers in the United Kingdom (UK) 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.

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 coal industry supplies coal to the power stations. The gas industry supplies gas to the power stations. CO2 and other GHGs 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.

Figure ES.4 Energy flows in the end-user model

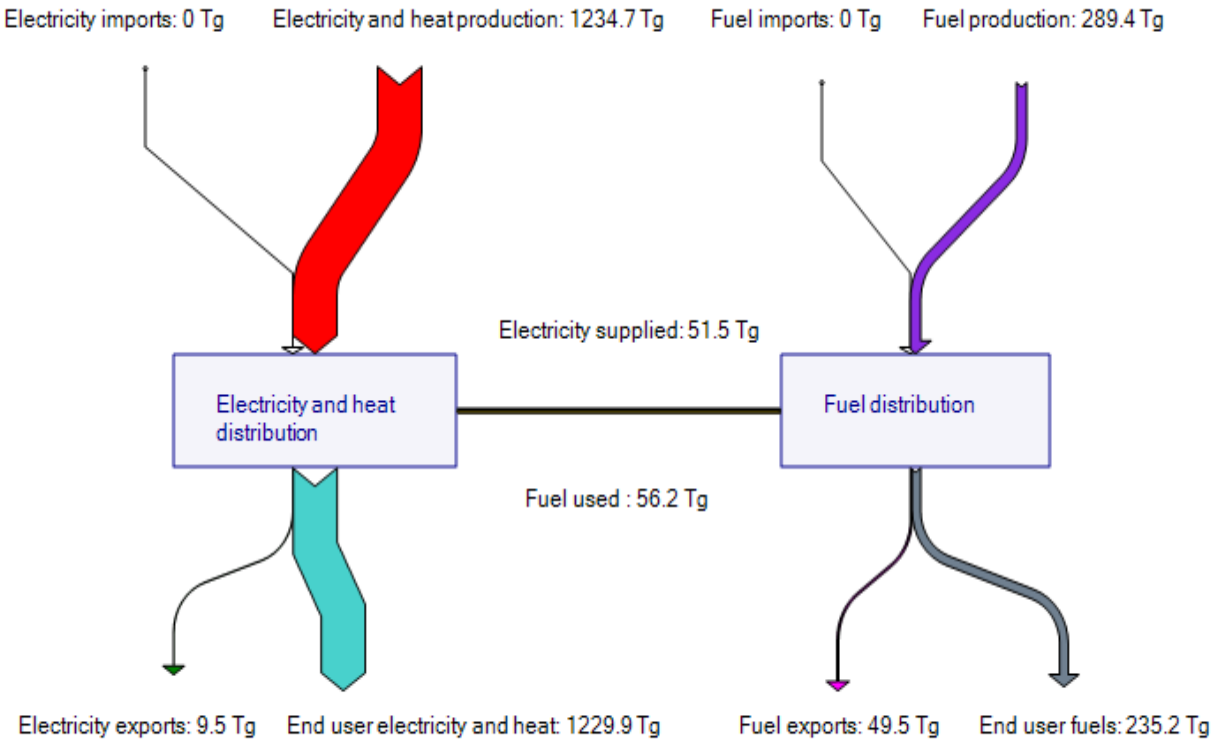


There are two streams of data used in the allocation of energy-related GHG emissions to end users. The first one is the GHG inventory of the EU — an annual submission of national GHG inventories of Annex I Parties under the UNFCCC and the Kyoto Protocol, which the EEA compiles on behalf of the European 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 emissions factors are not an input to the model but can be derived from the model.

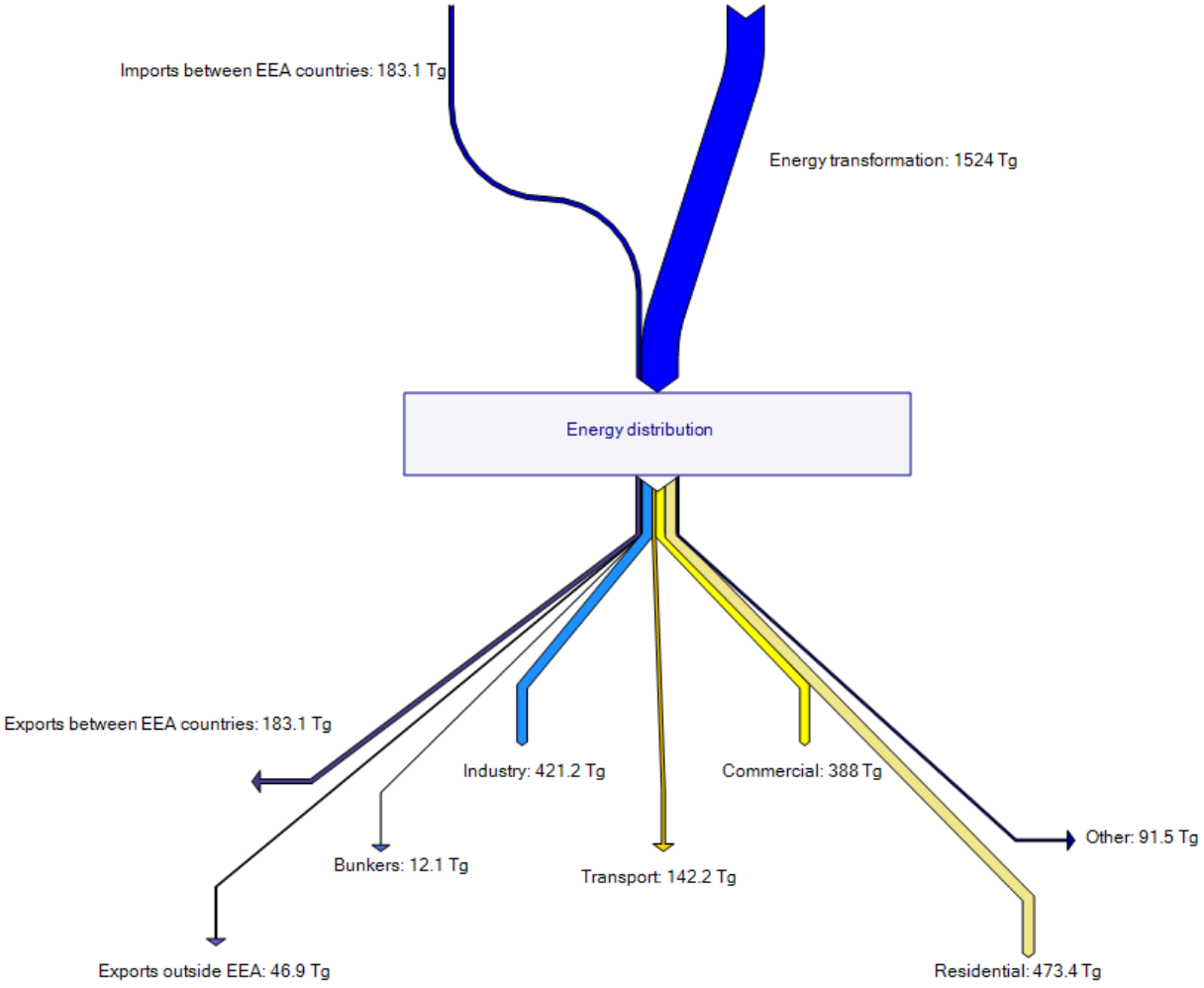
Figure ES.5 and ES.6 show the results of the end-user methodology for the EEA member countries[5]. Details by country are shown in Annex 3 of the main report. Figure ES.5 shows the GHG emissions associated with energy flows within the energy transformation sector. Figure ES.6 shows the 'indirect' GHG emissions associated with the distribution of energy flows to the end-user sectors.

Figure ES.5 Direct GHG emissions from energy transformation in EEA member countries, 2010



[5] EEA member countries include the 27 Member States of the EU, the four members of the European Free Trade Association (EFTA) and Turkey. GHG data were not available for Turkey at the time of production of this report. Eurostat's energy balances are not available for Iceland or Liechtenstein. Therefore, the EEA aggregate referred to in this report includes the EU-27 Member States, plus Norway and Switzerland.

Figure ES.6 Indirect GHG emissions from energy distribution by end user sector in EEA member countries, 2010



The end-user model also takes into account energy trade flows between 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 country 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 equal 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 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 emissions 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.

For more information:

Annual European Union greenhouse gas inventory 1990–2010 and inventory report 2012

http://www.eea.europa.eu/publications/european-union-greenhouse-gas-inventory-2012

EEA greenhouse gas - data viewer

http://www.eea.europa.eu/pressroom/data-and-maps/data/data-viewers/greenhouse-gases-viewer

EEA Climate change 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 to methodology

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[6].

The methodology has been applied to the available EEA member countries (i.e. EEA-area)[7]. The end-user approach is internally consistent within the chosen geographical scope (i.e. EEA area) 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 plus Norway and Switzerland. 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 2009 in the previous EEA technical report published in 2011. This report presents the results of the application of the method for each of the years 2005-2010.

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*.

Other inventories allocate emissions in different ways.

- National inventories allocate all the emissions to the source sectors
- This end user method allocates the emissions from the energy industries to end user sectors on the basis of energy flows

[6] 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'

[7] EEA member countries include the 27 Member States of the European Union, the 4 members of EFTA and Turkey. GHG data were not available for Turkey at the time of production of this report. Eurostat's energy balances are not available for Iceland or Liechtenstein. Therefore, the EEA aggregate referred to in this report includes the EU-27 member states, plus Norway and Switzerland.

- Various carbon accounting methods estimate the carbon dioxide emitted in the production of goods and services. For example, input-output tables derived from the national accounts can be used as the basis for allocating emissions from the energy and industrial sectors between products and services on a monetary basis[8].

This report does not describe the production of the national inventories or carbon accounting methods.

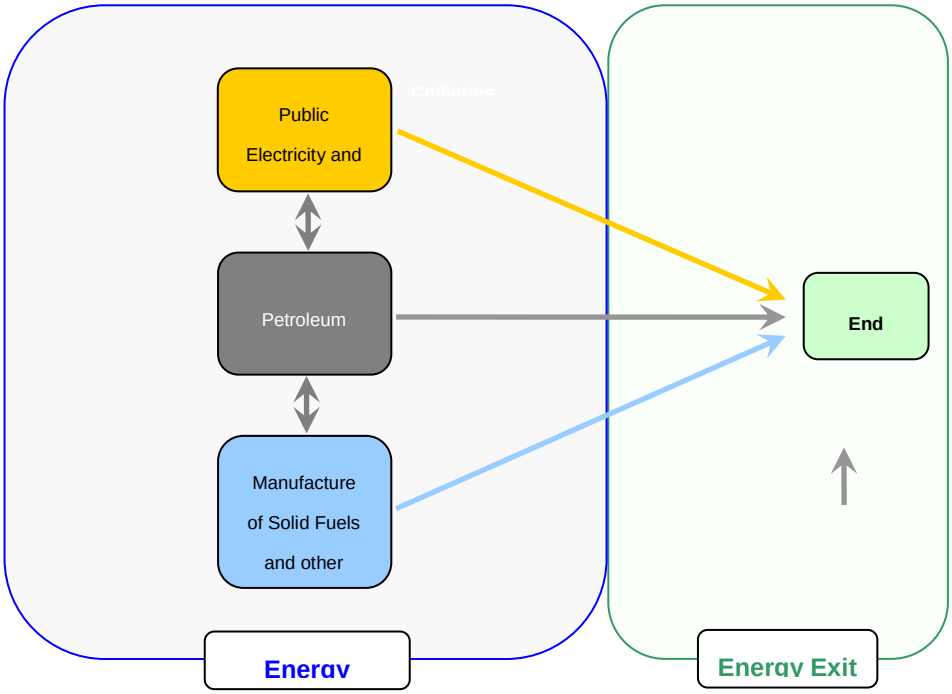
Refineries, the coal industry and other energy industries are supplied with a small part of the public electricity and heat supply. The refineries supply oil to the power stations and other energy industries. The coal industry supplies coal to the power stations. The gas industry supplies gas to the 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 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 countries. The end user model takes account of transfers, although these transfers are not shown in Figure 1.

[8] Air emissions accounts are a statistical information system that combines air emissions data and economic data from national accounts. In order to produce air emissions accounts, the emissions data are reorganized according to a breakdown by economic activity, as used within national accounts (based on the statistical classification of economic activities, NACE). All this data can be combined in the form of Environmentally Extended Input-Output Tables for the purpose of integrated environmental-economic analysis and modelling. More information on air emission accounts can be found from Eurostat's website http://epp.eurostat.ec.europa.eu/statistics_explained/index.php/Air_emissions_accounts_statistics It should be noted that the 'final consumers' in national economic accounts (government, households and exports) are also different from the 'end-users' describe in this report (households, services, industry, transportation and other sectors). The methodological approaches are similar in design: in the former, national accounts (based on monetary flows) are used to redistribute emissions to the final consumers; in the latter, energy balances (in common energy units) are used to redistribute emissions to the end-users. Both approaches add value from very different perspectives. In air emission accounts, emissions are allocated to the economic activity responsible for producing them; unlike national emissions inventories, where the boundary for measuring the extent of emissions is (usually) the territorial border.

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.

2 Methodology: Energy industry emissions from combustion activities

2.1 Introduction

European Union Member States, Norway and Switzerland 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)[9]. The current data set contains national emissions of carbon dioxide, methane and nitrous oxide from the 1A1a-c sectors for years up to 2010. This section describes the reallocation of these emissions to end user sectors for the years 2005-2010.

European Union Member States, Norway, Switzerland and Turkey report oxides of nitrogen and sulphur dioxide emissions under the Convention on Long Range Transport of Air pollutants. The data are available from the EEA[10]. The data were extracted in NFR09 format, which corresponds very closely with the IPCC CRF format. Domestic and international aircraft cruise emissions and international maritime navigation were excluded from the national totals. We reallocated mobile emissions from industry, construction and commercial/institutional uses to the CRF category for other transport emissions (1 a 3 e) in order to provide consistency between the two data sets.

The UNFCCC greenhouse gas inventory excludes the emissions of carbon dioxide from biomass combustion. The end user analysis also excludes these emissions. Emissions of other pollutants from biomass combustion are included in the UNFCCC and CLRTAP inventories; and in the end user inventories. Some biomass is used as fuel in public electricity and heat production: however, the analysis does not distinguish between the biomass and non-biomass electricity supplied in each country. However, a country with a high proportion of electricity and heat derived from biomass will have a relatively low emission of carbon dioxide per unit of electricity supplied.

We reallocated the emissions to end users on the basis of net energy statistics provided by the Eurostat database[11]. 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

[9] 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

[10] http://www.eea.europa.eu/data-and-maps/data/national-emissions-reported-to-the-convention-on-long-range-transboundary-air-pollution-lrtap-convention-6

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

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
- 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[12] 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

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

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:

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

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 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:

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

2.3 Petroleum refining

The IPCC Greenhouse Gas Inventory Reporting Instructions[13] 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

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

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:

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

where 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:

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

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[14] 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 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:

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

where 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.

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

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:

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

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.

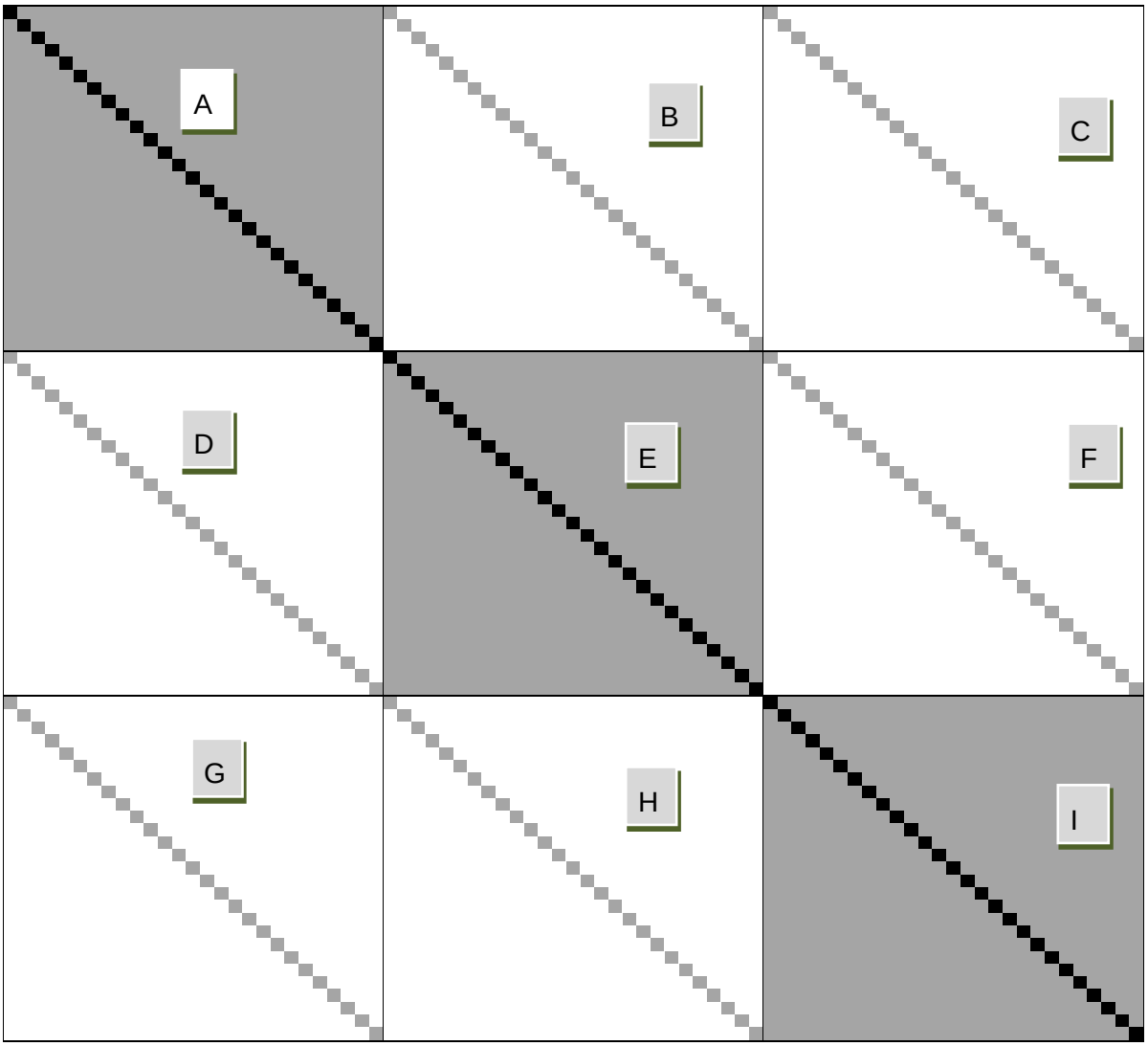
Sub-matrix G is a 27 x 27 matrix of factors representing the fraction of emissions supplied from the electricity and heat production industry in each country to the solid fuel manufacturing and other energy industries in each country of the European Union. The structure is similar to that of sub-matrix 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 (generated) by the energy industries to produce these products to the end use sector.

2.7 Uncertainties

The end user analysis uses emission estimates for each country taken from the European Environment Agency European dataset. The European Environment Agency European dataset contains data on greenhouse gas emissions and removals, sent by countries to UNFCCC and the EU Greenhouse Gas Monitoring Mechanism (EU Member States, Norway and Switzerland). It also contains data on oxides of nitrogen and sulphur dioxide emissions reported under the Convention on Long Range Transport of Air Pollutants. The end user analysis allocates all the combustion emissions associated with public electricity and heat production, petroleum refining, solid fuel manufacturing and other energy industries to end users. Thus a 1% uncertainty in the emissions from public electricity and heat production in the EEA European dataset produces a 1% uncertainty in the total emissions resulting from this activity attributed to all the end users.

The end user analysis attributes the annual emissions from the energy industries to all users in proportion to the annual energy supplied. This is a fundamental assumption of the method. There are other possible methods of attribution, for example on the monetary value of the energy supplied to different customers: these will produce different results.

The method allocates emissions from energy industries to users in proportion to the energy supplied based on data report by countries to Eurostat. Uncertainties in the data supplied will be propagated through the end user analysis. The end user analysis takes account of the energy flows between energy industries and so the calculation of how the uncertainties are propagated is not straightforward. To a first approximation, the uncertainty in the emissions from the public electricity and heat production attributed to a specific end user class may be estimated from:

$$U=\sqrt{(U\_e\text{^}2+U\_a\text{^}2\ )}$$

where Ue is the uncertainty in the emissions from public electricity and heat production and Ua is the uncertainty in the energy used by the end user class. For example, if the uncertainty in the emissions from public electricity and heat production was 3% and the uncertainty in the energy used by a particular end user sector was 4% then the uncertainty in the emissions attributed to the end user sector would be 5%.

The method allocates the electricity and heat produced by autoproducers between industries in proportion to the total electricity and heat supplied by each industry. This assumption is reasonable, but introduces additional uncertainty in the overall analysis.

3 Methodology: 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[15] contains national emissions of carbon dioxide, methane and nitrous oxide from the 1B1 and 1B2 sectors for years up to 2010. This section describes the reallocation of these emissions to end user sectors for the years 2005-2010.

European Union Member States, Norway, Switzerland and Turkey report oxides of nitrogen and sulphur dioxide emissions under the Convention on Long Range Transport of Air pollutants. The data are available from the EEA[16]. The data were extracted in NFR09 format, which corresponds very closely with the IPCC CRF format.

We reallocated the 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[17]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[18] define Sector 1B1 as follows:

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

[16] http://www.eea.europa.eu/data-and-maps/data/national-emissions-reported-to-the-convention-on-long-range-transboundary-air-pollution-lrtap-convention-6

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

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

> 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.

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[19] 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.

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

4 Summary of results: main tables

This section presents the results of the analysis for the European Union, Norway and Switzerland 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.

4.1 Direct emissions

Table 1 lists the direct emissions of total greenhouse gases from all EU Member States, Norway and Switzerland for the years 2005-2010 by sector. The data were extracted directly from the European Environment Agency's GHG data viewer[20]. The data show a steady reduction in greenhouse gas emissions from the Energy sector as a whole during the period

4.2 End user emission balance

Table 2 provides a summary of the end user emission balance for 2010. 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[21].

The aim of the end user analysis is to transfer the direct emissions from the energy transformation sector to the end user sectors, or to exports and international marine bunkers. 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[22]. 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, Norway and Switzerland, imports & exports) is zero for the whole of the EEA area. However, the net exported indirect emission may not be zero for

[20] EEA member countries include the 27 Member States of the European Union, the 4 members of EFTA and Turkey. GHG data were not available for Turkey at the time of production of this report. Eurostat's energy balances are not available for Iceland or Liechtenstein. Therefore, the EEA aggregate referred to in this report includes the EU-27 member states, plus Norway and Switzerland.

[21] 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.

[22] 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.

individual countries- for example, a country importing the bulk of its electricity from other countries within the EEA areas.

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.

Appendix 2 shows trends in GHG emissions allocated to end user sectors by individual country in 2010. Appendix 3 shows the direct GHG emissions from energy transformation and the indirect GHG emissions from energy distribution by end user for each individual country in 2010. Finally Appendix 4 shows trends in nitrogen oxide and sulphur dioxide allocated to the end-user sectors for the EU-27 as a whole.

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

4.3 Trends in indirect and direct emissions

Table 3 shows the emissions from the EEA areas for the years 2005-2010. 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 EEA area: row 8 shows the indirect emissions allocated to end users within the EEA area. 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 EEA area.

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 2005-2010, with the total direct and indirect emissions allocated to end users in the EEA areas falling by 7.5% 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 emissions of gas from emission sectors

Country:	EU+CH+NO					
Greenhouse gases	Units:	Tg, CO2 equivalent				
Sector	Year					
	2005	2006	2007	2008	2009	2010
Total emissions (sectors 1-7, excluding 5. LULUCF)	5256.9	5239.9	5186.5	5082.0	4713.8	4829.0
1. Energy	4175.7	4167.6	4104.6	4025.9	3742.3	3847.8
1.A. Fuel Combustion - Sectoral Approach	4081.8	4077.4	4017.6	3941.4	3662.4	3768.2
1.A.1. Energy Industries	1604.1	1614.2	1623.3	1546.5	1421.6	1444.4
1.A.1.A. Public Electricity and Heat Production	1373.4	1387.2	1395.9	1320.6	1219.3	1234.7
1.A.1.B. Petroleum Refining	143.8	142.1	143.1	144.3	134.2	135.9
1.A.1.C. Manufacture of Solid Fuels and Other Energy Industries	86.9	84.8	84.3	81.6	68.1	73.9
1.A.2. Manufacturing Industries and Construction	691.5	689.8	682.9	653.8	552.7	594.5
1.A.2.A. Iron and Steel	145.8	147.3	152.8	141.5	102.1	123.3
1.A.2.B. Non-Ferrous Metals	14.0	14.2	13.2	12.8	11.3	12.3
1.A.2.C. Chemicals	115.0	112.8	106.4	107.9	96.1	101.4
1.A.2.D. Pulp, Paper and Print	36.7	36.3	34.8	32.5	29.0	31.7
1.A.2.E. Food Processing, Beverages and Tobacco	51.3	49.8	46.8	45.2	41.4	43.7
1.A.2.F. Other	328.6	329.4	328.9	313.8	272.7	282.0
1.A.3. Transport	994.0	1001.1	1011.7	993.2	966.3	962.3
1.A.3.A. Civil Aviation	20.0	20.1	20.7	20.2	19.0	18.6
1.A.3.B. Road Transportation	932.9	939.4	949.2	931.7	907.1	902.8
1.A.3.C. Railways	8.2	8.1	8.4	8.1	7.5	7.4
1.A.3.D. Navigation	20.7	20.8	21.2	20.6	21.1	21.6
1.A.3.E. Other Transportation	12.1	12.7	12.2	12.6	11.7	11.8
1.A.4. Other Sectors	779.5	760.9	687.6	736.2	711.3	757.0
1.A.4.A. Commercial/Institutional	189.3	187.5	172.3	183.9	179.0	186.9
1.A.4.B. Residential	504.3	490.8	436.5	471.1	452.1	488.5
1.A.4.C. Agriculture/Forestry/Fisheries	85.9	82.6	78.8	81.3	80.2	81.5
1.A.5. Other (Not elsewhere specified)	12.7	11.4	12.1	11.7	10.5	10.0
1.A.5.A. Stationary	4.8	3.8	4.0	4.0	3.0	3.1
1.A.5.B. Mobile	7.8	7.6	8.0	7.7	7.4	6.9
1.B. Fugitive Emissions from Fuels	94.0	90.2	87.0	84.5	79.9	79.6
1.B.1. Solid Fuels	29.6	27.8	24.0	23.5	20.8	20.7
1.B.2. Oil and Natural Gas	64.3	62.4	63.0	61.0	59.1	58.9

Table 2: End-user emission balance, 2010

Country: EU+CH+NO

Greenhouse gases — Units: Tg, CO_2 equivalent

	Sector	Direct	Indirect emissions from energy transformation: total	1a1a	1a1b	1a1c	1b0	1b1	1b2	End-use emissions Direct+ indirect)
	Energy transformation	1524.0								
End users	Industry	594.5	421.2	349.2	34.3	14.0	6.2	4.6	13.0	1015.7
	Transportation	962.3	142.2	25.1	98.6	0.2	0.4	0.0	17.8	1104.5
	Commercial	186.9	388.0	368.7	5.4	3.9	6.4	0.2	3.5	575.0
	Residential	488.5	473.4	432.5	12.0	11.3	8.1	1.2	8.4	961.9
	Other sectors	91.5	40.2	32.9	4.8	0.7	0.5	0.2	1.2	131.7
	total end user sector	2323.7	1465.0	1208.3	155.1	30.0	21.6	6.1	43.9	
	imports from EEA countries		-183.1	-99.9	-44.4	-20.7	-1.8	-2.7	-13.6	-183.1
	exports to EEA countries		183.1	99.9	44.4	20.7	1.8	2.7	13.6	183.1
	exports from EEA countries		46.9	9.2	28.0	3.2	0.3	0.2	6.1	46.9
	bunkers		12.1	0.0	10.6	0.0	0.0	0.0	1.5	12.1
	Total	3847.8	1524.0	1217.5	193.7	33.2	21.9	6.2	51.5	3847.8

As percentage of total direct emissions

	Sector	Direct	Indirect emissions from energy transformation: total	1a1a	1a1b	1a1c	1b0	1b1	1b2	End-use emissions
	Energy transformation	40%								0%
End users	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	13%	12%	11%	0%	0%	0%	0%	0%	25%
	Other sectors	2%	1%	1%	0%	0%	0%	0%	0%	3%
	total end user sector	60%	38%	31%	4%	1%	1%	0%	1%	
	imports from EEA countries		-5%	-3%	-1%	-1%	0%	0%	0%	-5%
	exports to EEA countries		5%	3%	1%	1%	0%	0%	0%	5%
	exports from EEA countries		1%	0%	1%	0%	0%	0%	0%	1%
	bunkers		0%	0%	0%	0%	0%	0%	0%	0%
	Total	100%	40%	32%	5%	1%	1%	0%	1%	100%

Figure 2: Direct and indirect emissions by end user, 2010

Country: EU+CH+NO

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

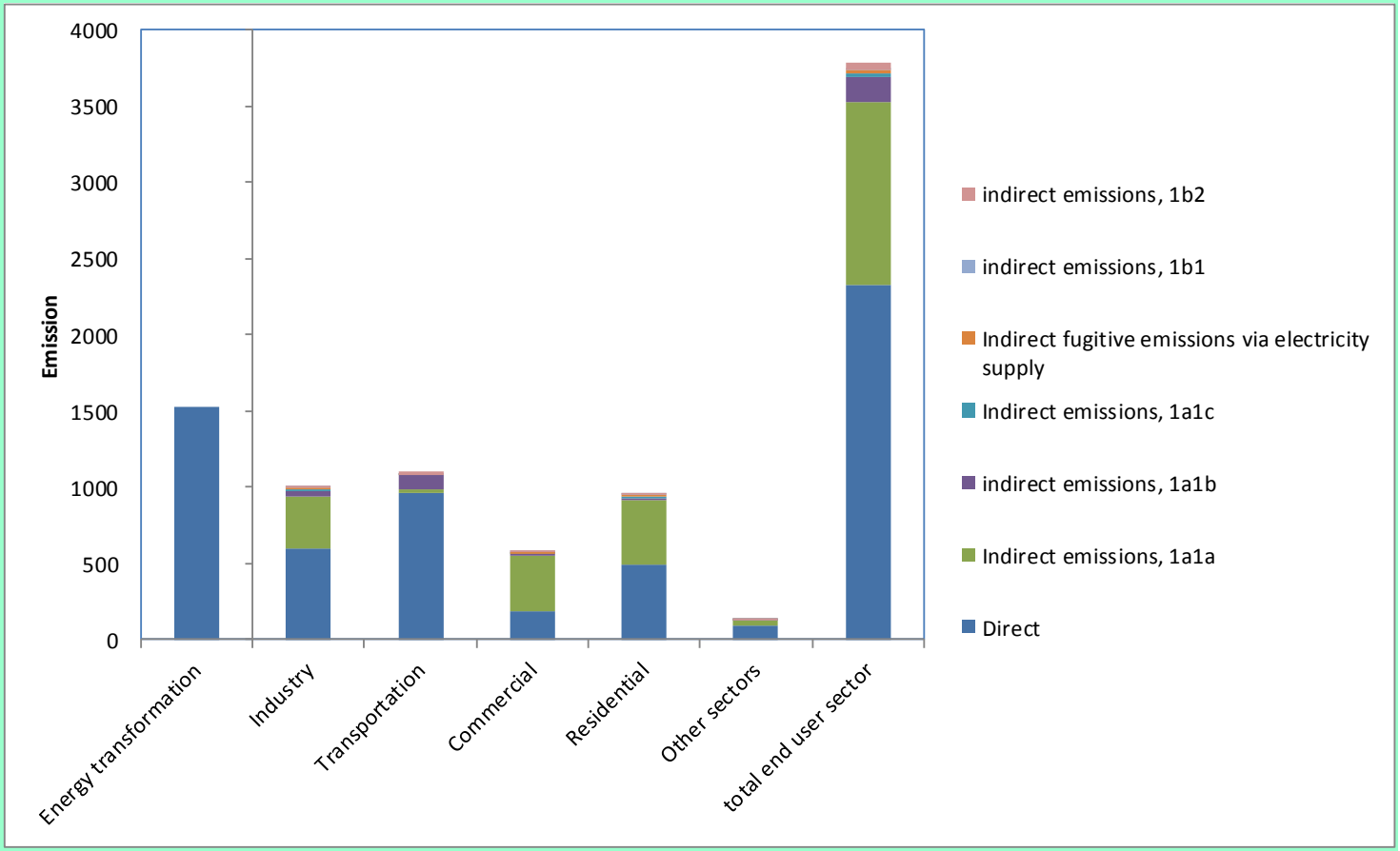


Figure 3: Direct and indirect emissions by end user as percentage of direct energy sector emissions, 2010

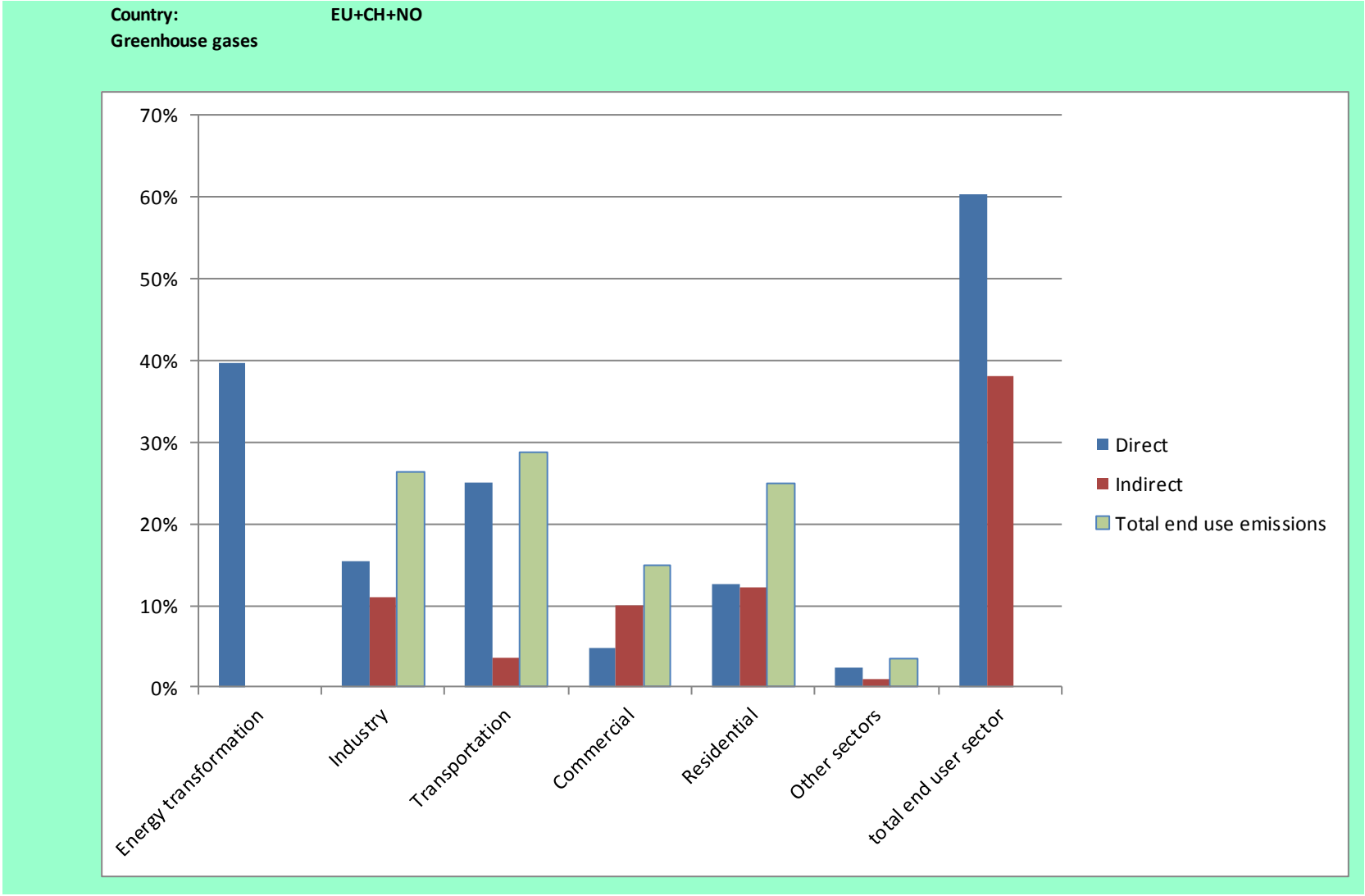


Fig.4s: Sankey diagram of greenhouse gas emissions associated with energy flows (e!Sankey 3.0 Pro)

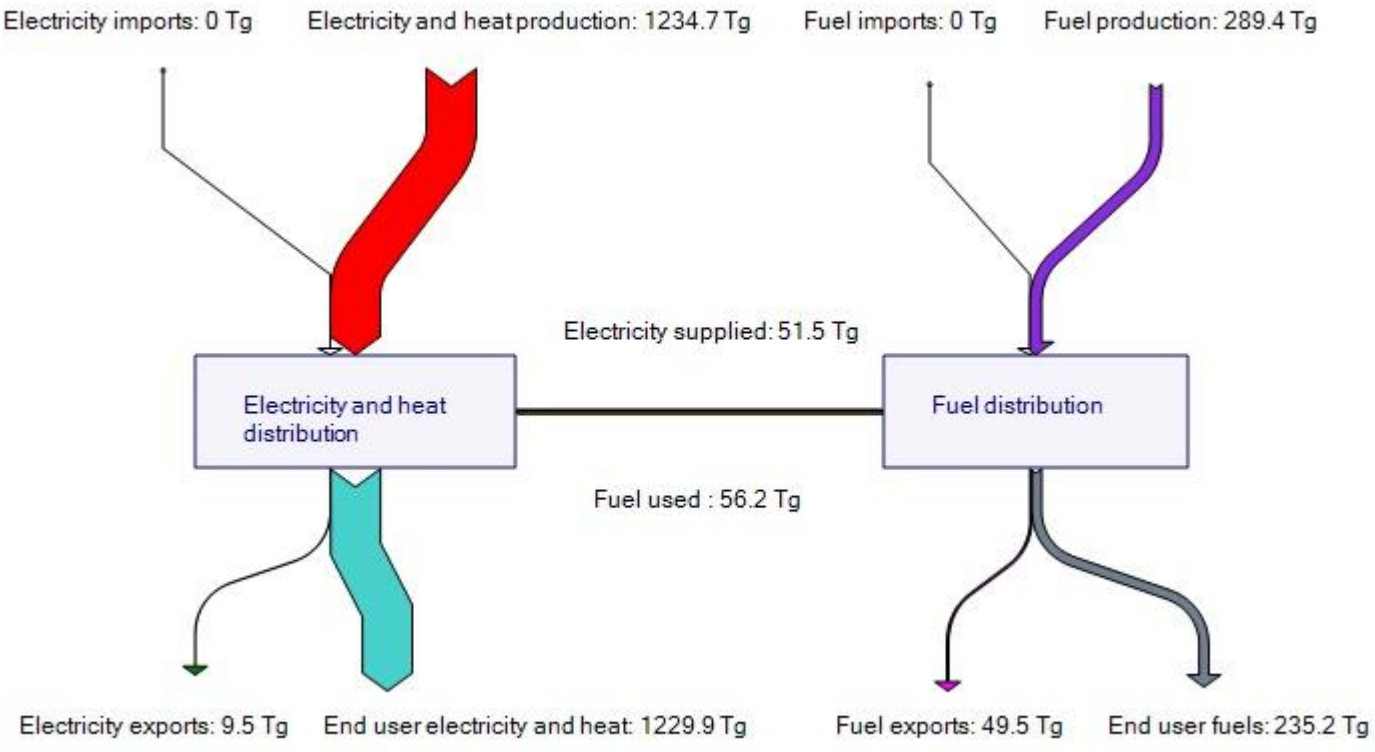


Table 3; Figure 4: Trends in indirect and direct emissions

Country:	EU+CH+NO					
Greenhouse gases	Units:	Tg, CO2 equivalent				
	2005	2006	2007	2008	2009	2010
1. Energy	4175.7	4167.6	4104.6	4025.9	3742.3	3847.8
1.A. Fuel Combustion - Sectoral Approach	4081.8	4077.4	4017.6	3941.4	3662.4	3768.2
1.A.1. Energy Industries	1604.1	1614.2	1623.3	1546.5	1421.6	1444.4
1.B. Fugitive Emissions from Fuels	94.0	90.2	87.0	84.5	79.9	79.6
Direct emissions from fuel transformation	1698.1	1704.3	1710.3	1631.0	1501.5	1524.0
End user sectors, direct emission	2477.7	2463.3	2394.3	2394.9	2240.8	2323.7
Total emission allocated to end users	1698.1	1704.3	1710.3	1631.0	1501.5	1524.0
Indirect emission allocated to end users in country	1641.1	1647.3	1645.8	1569.9	1445.1	1465.0
Direct and indirect emission allocated to end users in country	4118.8	4110.6	4040.1	3964.7	3685.9	3788.8

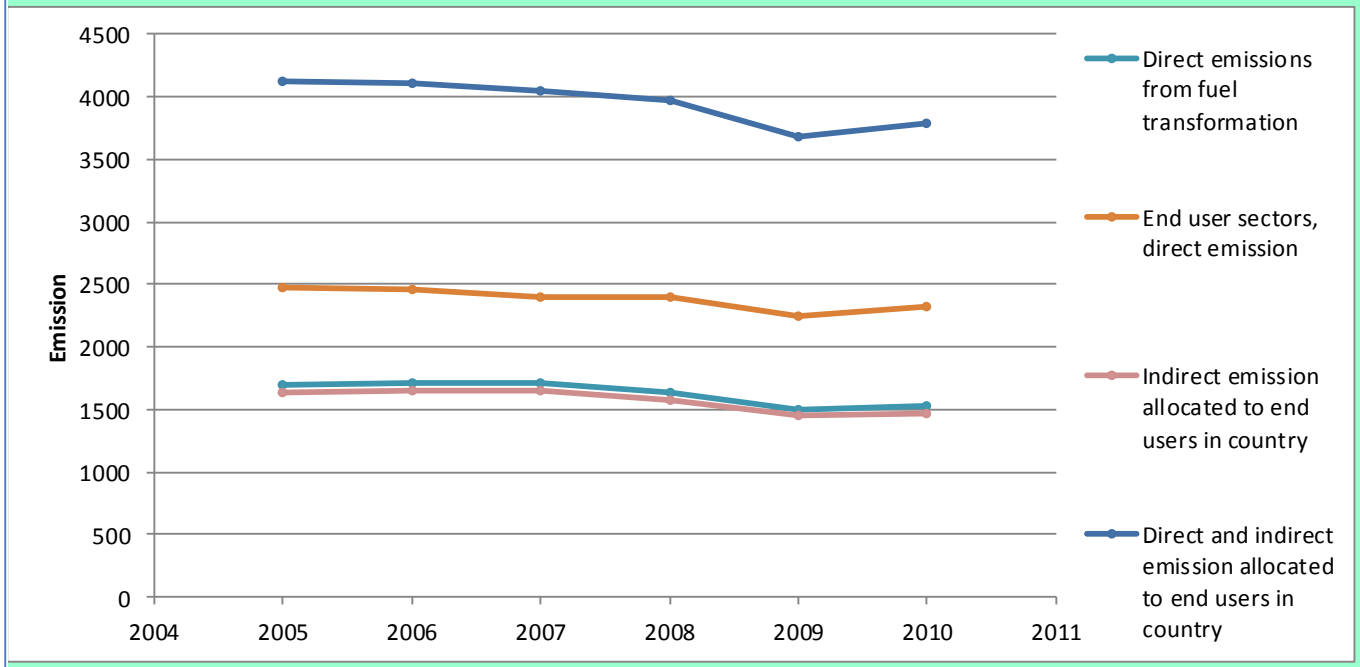


Table 4; Figure 5: Trends in indirect emissions by sector

Country:	EU+CH+NO					
Greenhouse gases	Units:	Tg, CO2 equivalent				
		Year				
	2005	2006	2007	2008	2009	2010
Industry	512.4	502.5	535.6	495.6	409.6	421.2
Transportation	152.1	151.0	155.5	152.0	144.5	142.2
Commercial	374.9	389.4	404.6	397.7	381.4	388.0
Residential	491.9	495.6	505.8	481.0	468.3	473.4
Other sectors	109.9	108.7	44.2	43.6	41.4	40.2

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

Country:	EU+CH+NO					
Greenhouse gases		Units:	Tg, CO2 equivalent			
			Year			
	2005	2006	2007	2008	2009	2010
Industry	691.5	689.8	682.9	653.8	552.7	594.5
Transportation	994.0	1001.1	1011.7	993.2	966.3	962.3
Commercial	189.3	187.5	172.3	183.9	179.0	186.9
Residential	504.3	490.8	436.5	471.1	452.1	488.5
Other sectors	98.5	94.1	90.9	93.0	90.7	91.5

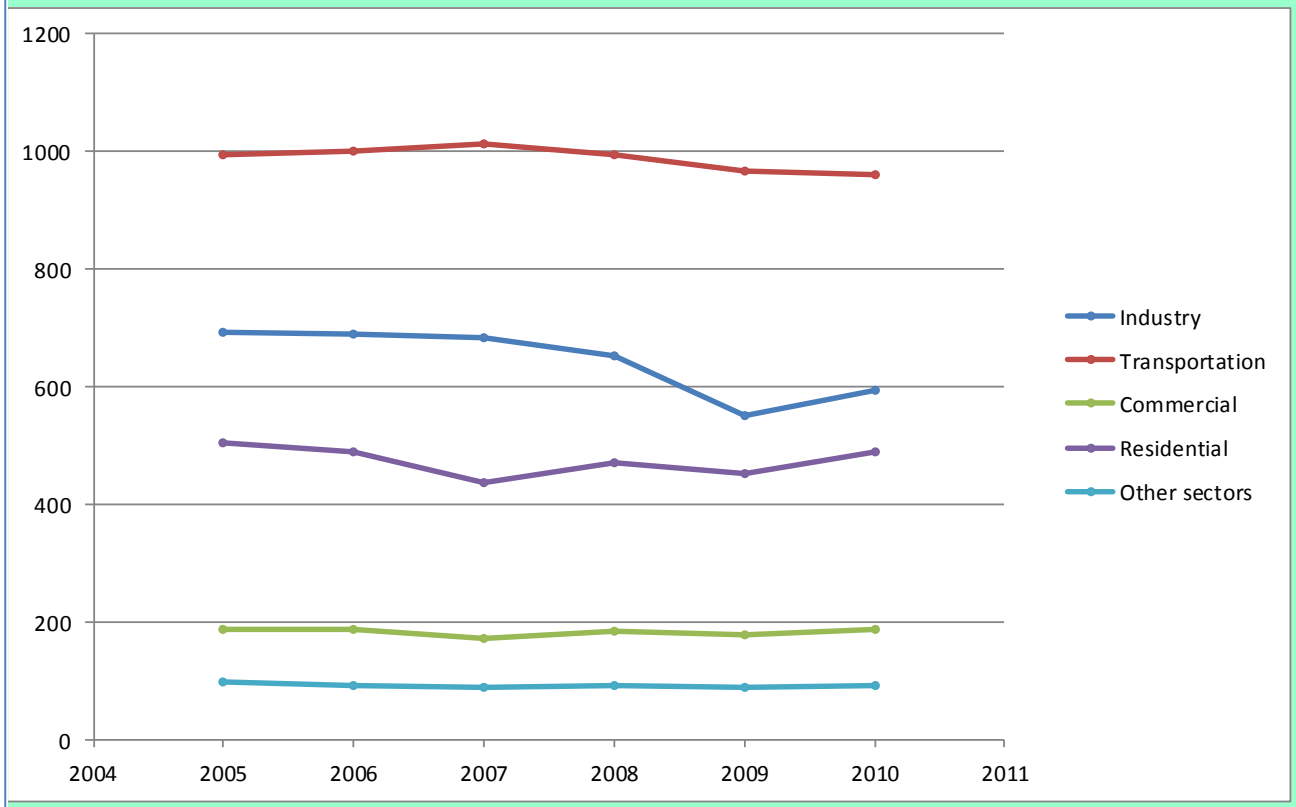
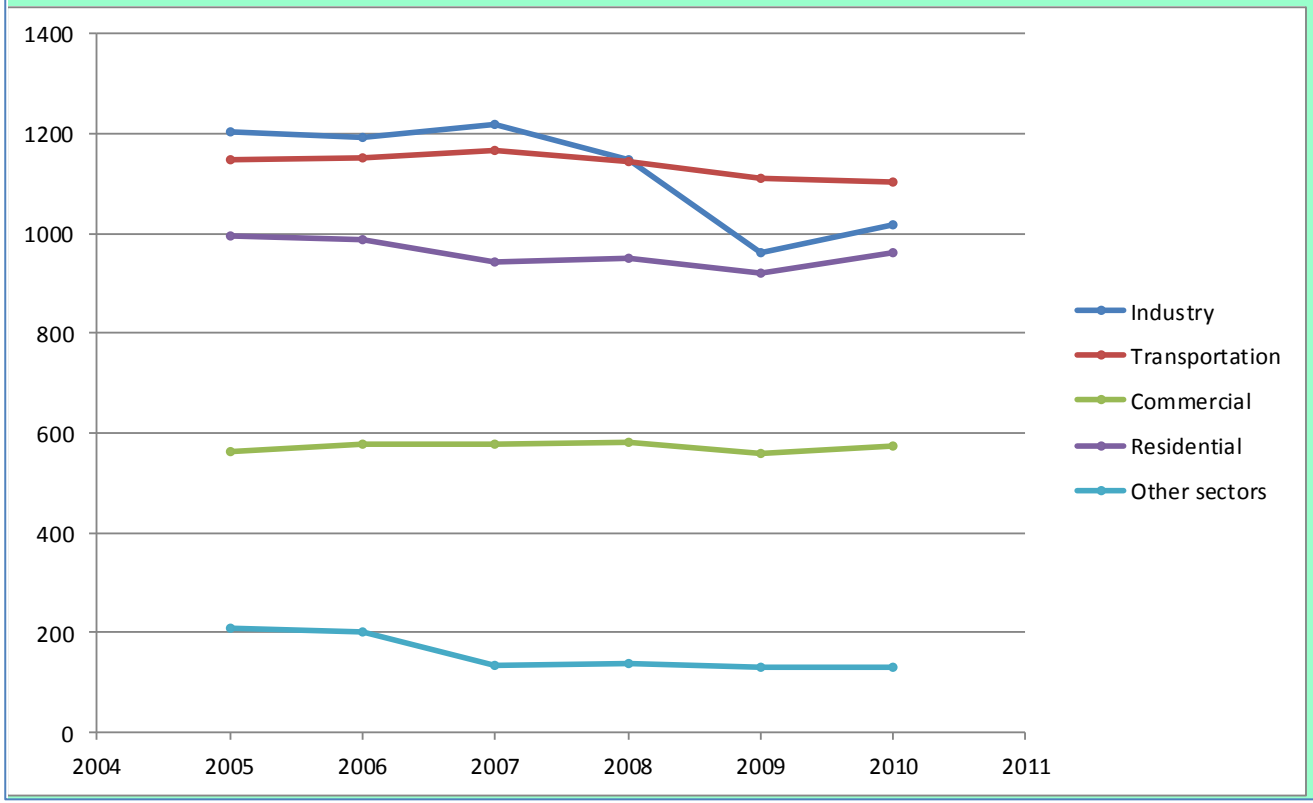


Table 6; Figure 7: Trends in total (indirect + direct) emissions by sector

Country:	EU+CH+NO					
Greenhouse gases		Units:	Tg, CO2 equivalent			
			Year			
	2005	2006	2007	2008	2009	2010
Industry	1203.9	1192.4	1218.5	1149.4	962.3	1015.7
Transportation	1146.1	1152.1	1167.2	1145.1	1110.8	1104.5
Commercial	564.2	576.9	577.0	581.5	560.4	575.0
Residential	996.2	986.4	942.3	952.1	920.4	961.9
Other sectors	208.5	202.8	135.1	136.6	132.1	131.7



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+CH+NO

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

	2005	2006	2007	2008	2009	2010
Direct emissions, D	1698.1	1704.3	1710.3	1631.0	1501.5	1524.0
Total emission allocated to end users	1698.1	1704.3	1710.3	1631.0	1501.5	1524.0
Total emission allocated to end users in country	1641.1	1647.3	1645.8	1569.9	1445.1	1465.0
Iron and steel	58.5	59.0	62.6	57.2	42.1	45.5
Non-Ferrous Metals	30.2	27.8	32.1	28.2	21.6	23.5
Chemical and Petrochemical	95.9	92.1	112.5	102.6	88.9	90.1
Non-Metallic Minerals	38.1	37.2	39.6	36.2	28.9	28.1
Mining and Quarrying	7.0	7.0	7.3	6.7	5.5	6.3
Food and Tobacco	42.3	40.2	44.6	41.2	37.9	36.9
Textile and Leather	14.0	12.6	12.8	11.2	8.3	8.3
Paper, Pulp and Print	42.3	43.4	48.3	44.5	38.7	40.1
Transport Equipment	18.7	18.7	23.7	22.2	18.3	19.2
Machinery	36.4	36.4	38.5	37.9	29.9	41.5
Wood and Wood Products	9.1	9.2	10.2	9.9	8.5	8.5
Construction	6.6	7.0	7.1	6.8	6.3	5.9
Non-specified (Industry)	80.7	79.9	63.2	59.0	45.7	37.4
Non energy use in industry	32.6	32.3	33.1	31.8	28.9	29.8
Rail	26.0	24.7	25.2	23.8	22.2	21.9
Road	100.7	100.7	104.5	102.3	98.6	97.4
International aviation	13.8	14.1	14.8	15.0	13.9	13.5
Domestic aviation	2.2	2.2	2.4	2.3	2.0	2.0
Domestic Navigation	2.2	2.4	2.2	2.3	2.0	2.0
Consumption in Pipeline transport	1.0	1.0	1.0	0.9	0.8	0.8
Non-specified (Transport)	5.3	5.0	4.6	4.5	4.2	4.1
Non energy use in transport	1.0	0.9	0.9	0.8	0.7	0.7
Households	491.9	495.6	505.8	481.0	468.3	473.4
Fisheries	0.4	0.4	0.4	0.5	0.4	0.4
Agriculture	33.7	32.5	32.0	32.3	30.0	29.2
Services	374.9	389.4	404.6	397.7	381.4	388.0
Other sectors	75.4	75.6	11.6	10.6	10.8	10.5
Non energy other sectors	0.4	0.3	0.3	0.3	0.2	0.2
Exports from EEA countries	44.2	43.5	50.6	47.4	44.1	46.9
Bunkers	12.7	13.5	13.9	13.8	12.3	12.1
Exports to EEA countries	207.6	207.7	204.6	190.5	182.0	183.1
Imports from EEA countries	-207.6	-207.7	-204.6	-190.5	-182.0	-183.1

Table A9: Indirect emissions from public heat and electricity combustion allocated to end user sectors

Country: EU+CH+NO

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

Sector	Year					
	2005	2006	2007	2008	2009	2010
Iron and steel	44.9	45.8	50.0	45.9	34.2	36.3
Non-Ferrous Metals	28.3	26.1	30.4	26.7	20.3	22.1
Chemical and Petrochemical	85.9	82.9	103.2	93.8	81.5	82.4
Non-Metallic Minerals	29.1	28.7	31.2	28.1	22.6	21.8
Mining and Quarrying	6.4	6.4	6.7	6.2	5.0	5.8
Food and Tobacco	37.1	35.6	39.9	36.6	33.9	33.0
Textile and Leather	12.5	11.2	11.6	10.1	7.5	7.5
Paper, Pulp and Print	38.9	40.1	45.1	41.5	36.2	37.5
Transport Equipment	17.3	17.3	22.2	20.9	17.2	18.0
Machinery	32.7	32.9	35.1	34.6	27.3	38.5
Wood and Wood Products	8.5	8.5	9.6	9.4	8.0	8.0
Construction	4.9	5.1	5.5	5.3	4.9	4.5
Non-specified (Industry)	74.8	74.4	58.4	54.5	41.8	33.6
Non energy use in industry	0.0	0.0	0.0	0.0	0.0	0.0
Rail	24.5	23.3	23.6	22.3	20.9	20.6
Road	0.0	0.0	0.0	0.0	0.0	0.0
International aviation	0.0	0.0	0.0	0.0	0.0	0.0
Domestic aviation	0.0	0.0	0.0	0.0	0.0	0.0
Domestic Navigation	0.0	0.0	0.0	0.0	0.0	0.0
Consumption in Pipeline transport	0.7	0.7	0.7	0.6	0.6	0.6
Non-specified (Transport)	5.1	4.9	4.5	4.4	4.0	4.0
Non energy use in transport	0.0	0.0	0.0	0.0	0.0	0.0
Households	443.4	449.4	464.4	438.1	427.9	432.5
Fisheries	0.1	0.1	0.1	0.1	0.1	0.1
Agriculture	26.5	26.0	25.7	26.0	24.0	23.3
Services	354.0	369.0	385.9	377.8	362.5	368.7
Other sectors	72.3	72.7	9.8	8.9	9.4	9.5
Non energy other sectors	0.0	0.0	0.0	0.0	0.0	0.0
Exports from EEA countries	10.6	10.8	13.4	12.2	10.5	9.2
Bunkers	0.0	0.0	0.0	0.0	0.0	0.0
Exports to EEA countries	117.0	116.2	115.2	100.0	97.9	99.9
Imports from EEA countries	-117.0	-116.2	-115.2	-100.0	-97.9	-99.9

Table A10: Indirect emissions from refinery combustion allocated to end user sectors

Country: EU+CH+NO

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

Sector	Year					
	2005	2006	2007	2008	2009	2010
Iron and steel	1.2	1.2	1.1	1.0	0.7	0.7
Non-Ferrous Metals	0.4	0.4	0.4	0.3	0.3	0.3
Chemical and Petrochemical	2.6	2.4	2.6	2.2	1.8	1.6
Non-Metallic Minerals	3.8	3.7	3.5	3.5	2.7	2.6
Mining and Quarrying	0.3	0.2	0.2	0.3	0.2	0.2
Food and Tobacco	1.5	1.4	1.3	1.3	1.0	0.9
Textile and Leather	0.4	0.4	0.4	0.3	0.2	0.2
Paper, Pulp and Print	0.7	0.7	0.7	0.6	0.5	0.4
Transport Equipment	0.3	0.3	0.2	0.2	0.2	0.2
Machinery	1.1	1.0	0.9	0.9	0.7	0.7
Wood and Wood Products	0.2	0.2	0.2	0.1	0.1	0.1
Construction	1.2	1.2	1.0	0.9	0.8	0.8
Non-specified (Industry)	2.3	2.2	2.2	1.9	1.8	1.7
Non energy use in industry	25.5	25.5	26.0	25.1	23.0	23.8
Rail	0.9	0.8	0.9	0.9	0.8	0.8
Road	85.3	85.5	88.6	86.9	82.9	82.3
International aviation	11.8	12.1	12.7	12.9	11.9	11.5
Domestic aviation	1.9	1.9	2.0	2.0	1.7	1.7
Domestic Navigation	1.9	2.1	1.9	2.0	1.8	1.7
Consumption in Pipeline transport	0.0	0.0	0.0	0.0	0.0	0.0
Non-specified (Transport)	0.0	0.0	0.0	0.0	0.0	0.0
Non energy use in transport	0.8	0.8	0.8	0.7	0.6	0.6
Households	15.8	15.0	12.1	13.7	12.4	12.0
Fisheries	0.3	0.3	0.3	0.3	0.3	0.3
Agriculture	5.1	4.5	4.4	4.4	4.1	4.1
Services	6.3	6.0	5.2	6.0	5.5	5.4
Other sectors	0.6	0.4	0.5	0.4	0.3	0.3
Non energy other sectors	0.3	0.2	0.2	0.2	0.2	0.1
Exports from EEA countries	23.2	22.8	26.7	25.8	24.2	28.0
Bunkers	11.2	11.9	12.2	12.1	10.7	10.6
Exports to EEA countries	49.5	50.8	48.3	50.8	46.6	44.4
Imports from EEA countries	-49.5	-50.8	-48.3	-50.8	-46.6	-44.4

Table A11: Indirect emissions from other energy industry combustion allocated to end user sectors

Country: EU+CH+NO

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

Sector	Year					
	2005	2006	2007	2008	2009	2010
Iron and steel	5.3	5.3	5.5	4.8	3.1	3.9
Non-Ferrous Metals	0.5	0.4	0.5	0.4	0.3	0.4
Chemical and Petrochemical	2.7	2.5	2.4	2.4	2.0	2.3
Non-Metallic Minerals	2.1	2.0	2.2	2.0	1.5	1.6
Mining and Quarrying	0.1	0.1	0.1	0.1	0.1	0.1
Food and Tobacco	1.5	1.4	1.4	1.4	1.2	1.4
Textile and Leather	0.4	0.4	0.3	0.3	0.2	0.2
Paper, Pulp and Print	1.1	1.1	1.0	1.0	0.8	0.9
Transport Equipment	0.4	0.4	0.4	0.4	0.3	0.4
Machinery	1.0	1.0	1.0	1.0	0.7	0.9
Wood and Wood Products	0.1	0.1	0.1	0.1	0.1	0.1
Construction	0.1	0.1	0.1	0.1	0.1	0.1
Non-specified (Industry)	1.0	1.0	0.8	0.8	0.6	0.6
Non energy use in industry	1.4	1.2	1.3	1.2	0.9	1.0
Rail	0.0	0.0	0.0	0.0	0.0	0.0
Road	0.1	0.1	0.1	0.1	0.1	0.1
International aviation	0.0	0.0	0.0	0.0	0.0	0.0
Domestic aviation	0.0	0.0	0.0	0.0	0.0	0.0
Domestic Navigation	0.0	0.0	0.0	0.0	0.0	0.0
Consumption in Pipeline transport	0.1	0.1	0.2	0.2	0.1	0.1
Non-specified (Transport)	0.0	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	0.0
Households	12.0	11.6	11.2	11.3	10.2	11.3
Fisheries	0.0	0.0	0.0	0.0	0.0	0.0
Agriculture	0.4	0.4	0.4	0.4	0.4	0.4
Services	3.8	3.8	3.6	3.7	3.4	3.9
Other sectors	0.7	0.7	0.7	0.6	0.5	0.3
Non energy other sectors	0.0	0.0	0.0	0.0	0.0	0.0
Exports from EEA countries	4.0	3.7	3.7	3.1	3.2	3.2
Bunkers	0.0	0.0	0.0	0.0	0.0	0.0
Exports to EEA countries	20.2	20.0	19.9	20.1	19.4	20.7
Imports from EEA countries	-20.2	-20.0	-19.9	-20.1	-19.4	-20.7

Table A12: Indirect fugitive emissions allocated to end user sectors via public heat and electricity production

Country: EU+CH+NO

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

Sector	Year					
	2005	2006	2007	2008	2009	2010
Iron and steel	1.1	1.1	1.1	1.0	0.7	0.7
Non-Ferrous Metals	0.6	0.5	0.5	0.5	0.4	0.4
Chemical and Petrochemical	1.8	1.7	1.8	1.7	1.5	1.4
Non-Metallic Minerals	0.6	0.6	0.6	0.6	0.5	0.4
Mining and Quarrying	0.1	0.1	0.1	0.1	0.1	0.1
Food and Tobacco	0.8	0.7	0.7	0.7	0.6	0.6
Textile and Leather	0.3	0.2	0.2	0.2	0.2	0.2
Paper, Pulp and Print	0.7	0.6	0.6	0.6	0.5	0.5
Transport Equipment	0.4	0.4	0.4	0.4	0.3	0.3
Machinery	0.7	0.7	0.7	0.7	0.5	0.7
Wood and Wood Products	0.2	0.2	0.2	0.2	0.2	0.1
Construction	0.1	0.1	0.1	0.1	0.1	0.1
Non-specified (Industry)	1.4	1.2	0.9	0.9	0.7	0.6
Non energy use in industry	0.0	0.0	0.0	0.0	0.0	0.0
Rail	0.5	0.5	0.4	0.4	0.4	0.3
Road	0.0	0.0	0.0	0.0	0.0	0.0
International aviation	0.0	0.0	0.0	0.0	0.0	0.0
Domestic aviation	0.0	0.0	0.0	0.0	0.0	0.0
Domestic Navigation	0.0	0.0	0.0	0.0	0.0	0.0
Consumption in Pipeline transport	0.0	0.0	0.0	0.0	0.0	0.0
Non-specified (Transport)	0.1	0.1	0.1	0.1	0.1	0.1
Non energy use in transport	0.0	0.0	0.0	0.0	0.0	0.0
Households	10.0	9.4	8.8	8.5	8.3	8.1
Fisheries	0.0	0.0	0.0	0.0	0.0	0.0
Agriculture	0.5	0.5	0.4	0.4	0.4	0.4
Services	7.1	6.8	6.5	6.7	6.4	6.4
Other sectors	1.2	1.1	0.1	0.1	0.1	0.1
Non energy other sectors	0.0	0.0	0.0	0.0	0.0	0.0
Exports from EEA countries	0.3	0.4	0.4	0.3	0.3	0.3
Bunkers	0.0	0.0	0.0	0.0	0.0	0.0
Exports to EEA countries	2.7	2.4	2.2	1.9	1.8	1.8
Imports from EEA countries	-2.7	-2.4	-2.2	-1.9	-1.8	-1.8

Table A13: Indirect fugitive emissions from solid fuel production allocated to end user sectors

Country: EU+CH+NO

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

Sector	Year					
	2005	2006	2007	2008	2009	2010
Iron and steel	4.7	4.3	3.6	3.4	2.5	2.8
Non-Ferrous Metals	0.1	0.1	0.1	0.1	0.1	0.1
Chemical and Petrochemical	0.7	0.6	0.5	0.6	0.5	0.5
Non-Metallic Minerals	0.6	0.5	0.6	0.5	0.4	0.4
Mining and Quarrying	0.0	0.0	0.0	0.0	0.0	0.0
Food and Tobacco	0.3	0.2	0.2	0.2	0.2	0.2
Textile and Leather	0.1	0.0	0.0	0.0	0.0	0.0
Paper, Pulp and Print	0.2	0.2	0.2	0.2	0.2	0.1
Transport Equipment	0.1	0.1	0.1	0.1	0.1	0.1
Machinery	0.1	0.1	0.1	0.1	0.1	0.1
Wood and Wood Products	0.0	0.0	0.0	0.0	0.0	0.0
Construction	0.0	0.0	0.0	0.0	0.0	0.0
Non-specified (Industry)	0.3	0.3	0.2	0.2	0.1	0.1
Non energy use in industry	0.0	0.0	0.0	0.0	0.0	0.0
Rail	0.0	0.0	0.0	0.0	0.0	0.0
Road	0.0	0.0	0.0	0.0	0.0	0.0
International aviation	0.0	0.0	0.0	0.0	0.0	0.0
Domestic aviation	0.0	0.0	0.0	0.0	0.0	0.0
Domestic Navigation	0.0	0.0	0.0	0.0	0.0	0.0
Consumption in Pipeline transport	0.0	0.0	0.0	0.0	0.0	0.0
Non-specified (Transport)	0.0	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	0.0
Households	1.1	1.1	1.0	1.1	1.1	1.2
Fisheries	0.0	0.0	0.0	0.0	0.0	0.0
Agriculture	0.2	0.2	0.1	0.2	0.1	0.2
Services	0.2	0.2	0.1	0.2	0.2	0.2
Other sectors	0.0	0.0	0.0	0.0	0.0	0.0
Non energy other sectors	0.0	0.0	0.0	0.0	0.0	0.0
Exports from EEA countries	0.2	0.3	0.2	0.1	0.2	0.2
Bunkers	0.0	0.0	0.0	0.0	0.0	0.0
Exports to EEA countries	3.4	3.5	3.0	2.8	2.4	2.7
Imports from EEA countries	-3.4	-3.5	-3.0	-2.8	-2.4	-2.7

Table A14: Indirect fugitive emissions from oil and natural gas production allocated to end user sectors

Country: EU+CH+NO

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

Sector	Year					
	2005	2006	2007	2008	2009	2010
Iron and steel	1.3	1.3	1.3	1.1	0.8	0.9
Non-Ferrous Metals	0.3	0.3	0.3	0.2	0.2	0.2
Chemical and Petrochemical	2.2	2.0	2.0	2.0	1.7	1.8
Non-Metallic Minerals	1.8	1.6	1.5	1.5	1.2	1.2
Mining and Quarrying	0.1	0.1	0.1	0.1	0.1	0.1
Food and Tobacco	1.2	1.0	1.1	1.0	1.0	1.0
Textile and Leather	0.3	0.3	0.3	0.2	0.2	0.2
Paper, Pulp and Print	0.7	0.6	0.6	0.6	0.5	0.6
Transport Equipment	0.3	0.3	0.3	0.2	0.2	0.2
Machinery	0.8	0.7	0.7	0.7	0.6	0.6
Wood and Wood Products	0.1	0.1	0.1	0.1	0.1	0.1
Construction	0.3	0.4	0.3	0.4	0.3	0.3
Non-specified (Industry)	0.9	0.8	0.7	0.7	0.6	0.6
Non energy use in industry	5.7	5.6	5.8	5.4	5.1	5.0
Rail	0.2	0.2	0.2	0.2	0.2	0.2
Road	15.3	15.2	15.8	15.3	15.6	15.0
International aviation	2.0	2.0	2.1	2.1	2.0	1.9
Domestic aviation	0.3	0.3	0.3	0.3	0.3	0.3
Domestic Navigation	0.3	0.3	0.3	0.3	0.3	0.3
Consumption in Pipeline transport	0.1	0.1	0.1	0.1	0.1	0.1
Non-specified (Transport)	0.0	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	0.1
Households	9.6	9.1	8.3	8.4	8.5	8.4
Fisheries	0.0	0.0	0.0	0.0	0.0	0.0
Agriculture	1.1	1.0	0.9	0.9	0.9	0.9
Services	3.5	3.6	3.2	3.3	3.4	3.5
Other sectors	0.6	0.5	0.5	0.5	0.4	0.2
Non energy other sectors	0.1	0.0	0.0	0.0	0.0	0.0
Exports from EEA countries	5.8	5.7	6.2	5.9	5.8	6.1
Bunkers	1.5	1.6	1.7	1.6	1.6	1.5
Exports to EEA countries	14.8	14.7	16.0	14.9	13.9	13.6
Imports from EEA countries	-14.8	-14.7	-16.0	-14.9	-13.9	-13.6

Appendix 2 – Trends in GHG emissions allocated to end user sectors in EU Member States and other EEA member countries

Figure A2.1 Trends in direct and indirect GHG emissions by end use sector in Belgium, 2005-2010

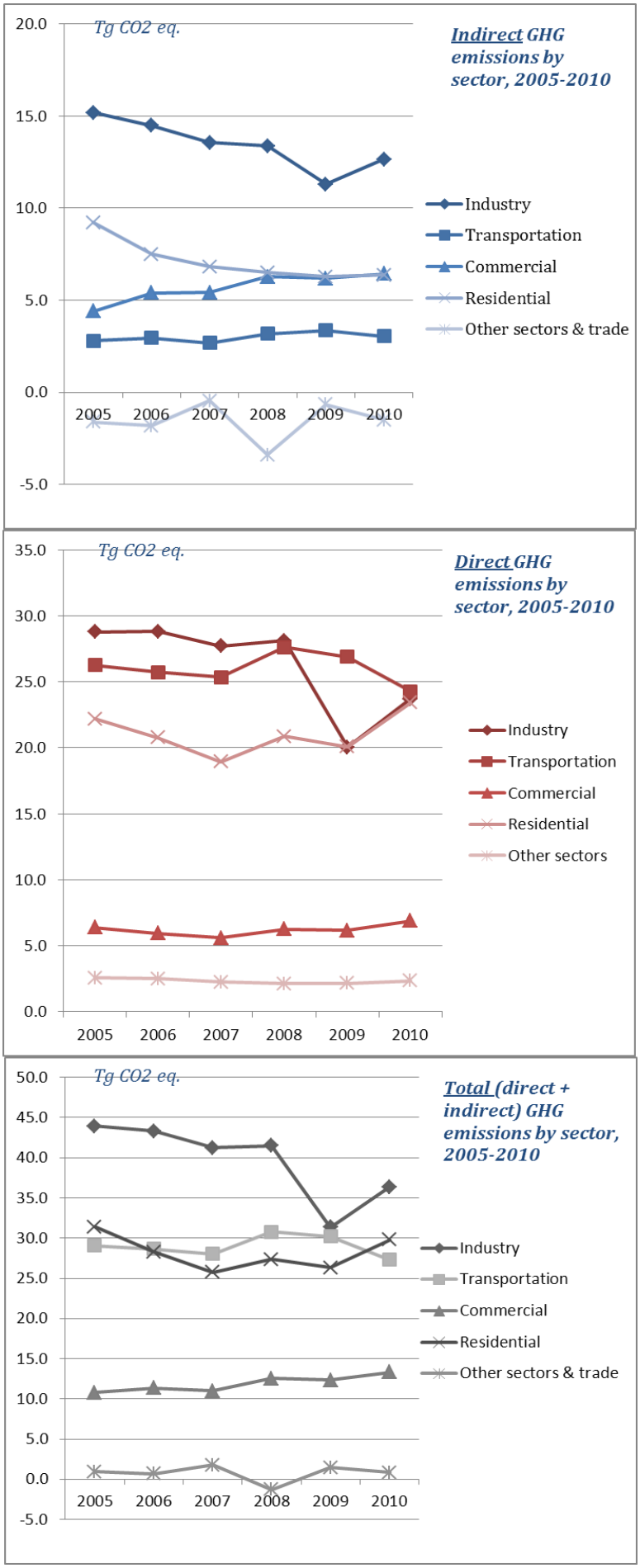
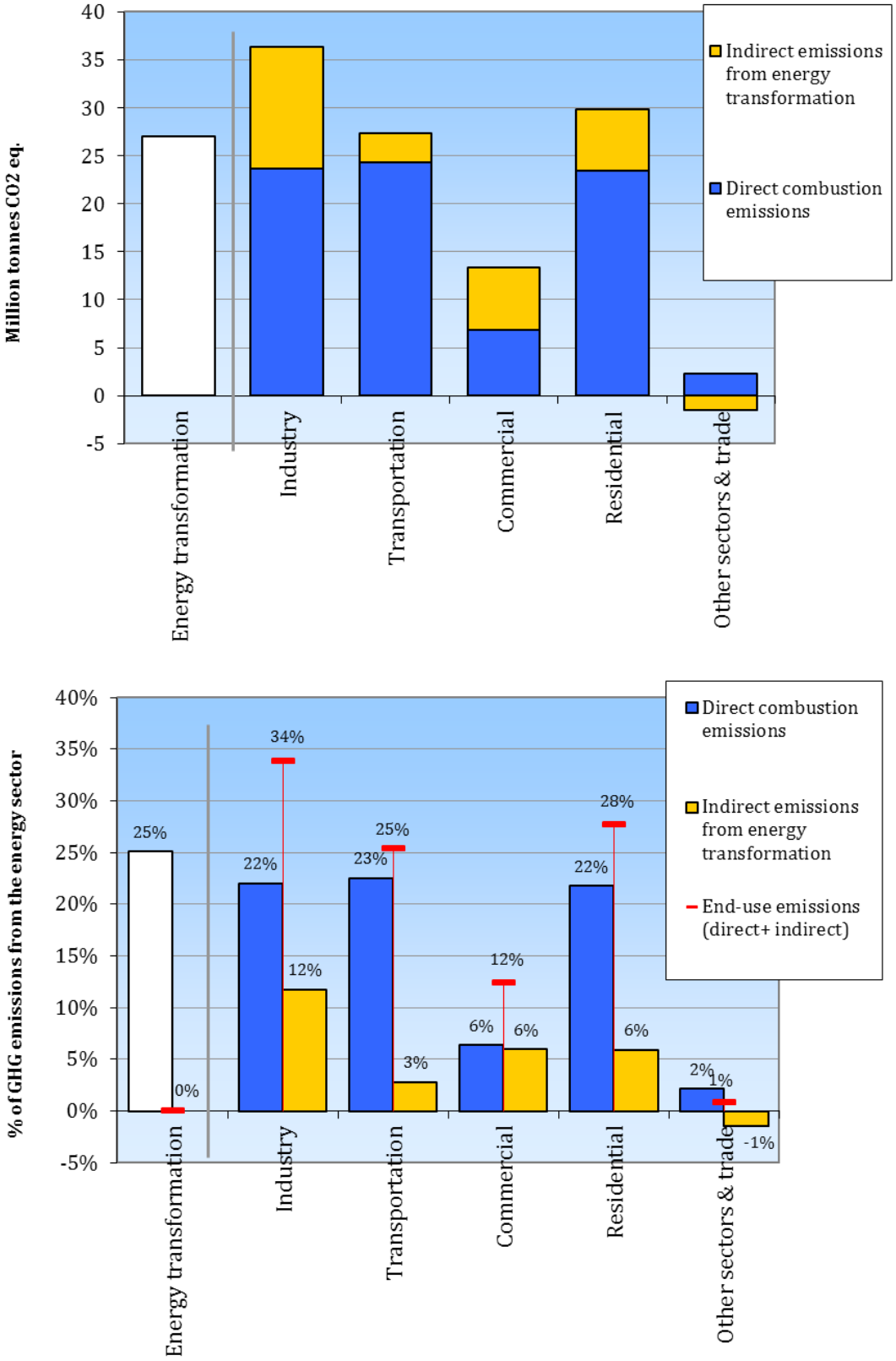


Figure A2.2 Direct and indirect GHG emissions by end use sector in Belgium in 2010



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, 2012

Figure A2.3 Trends in direct and indirect GHG emissions by end use sector in Bulgaria, 2005-2010

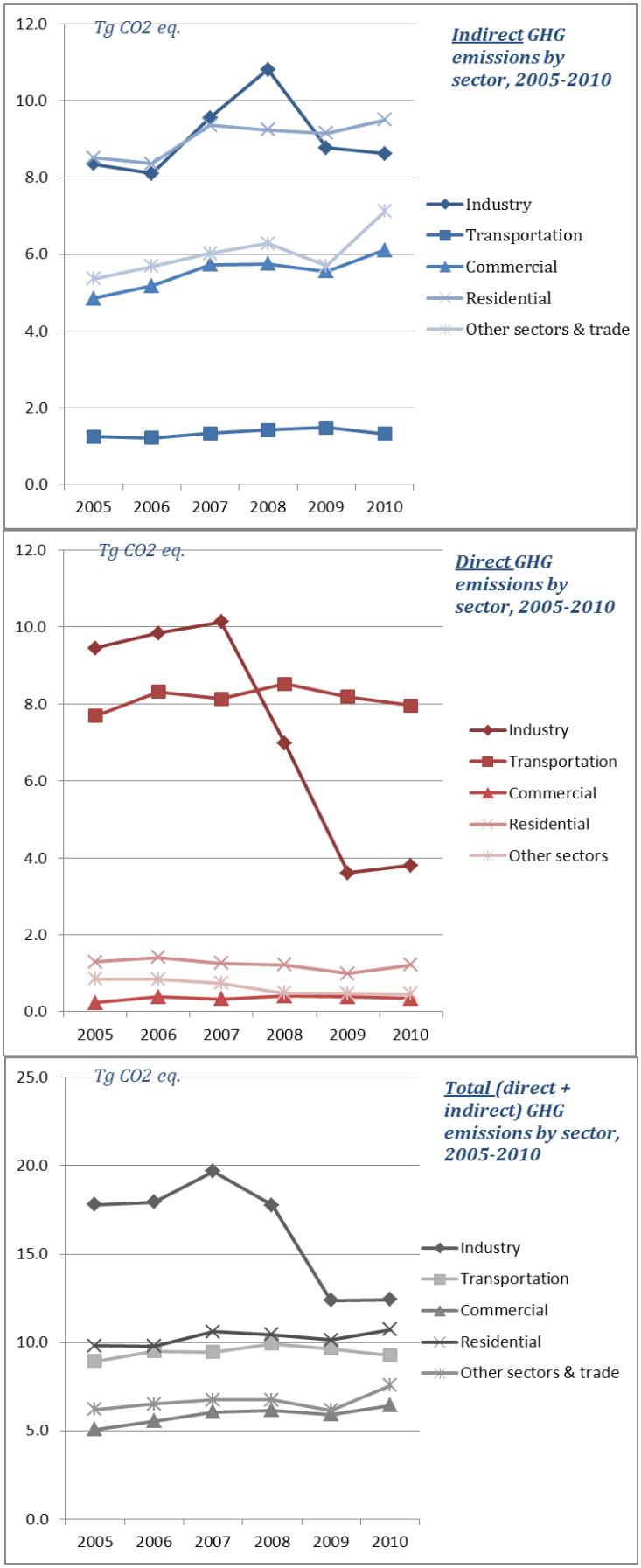
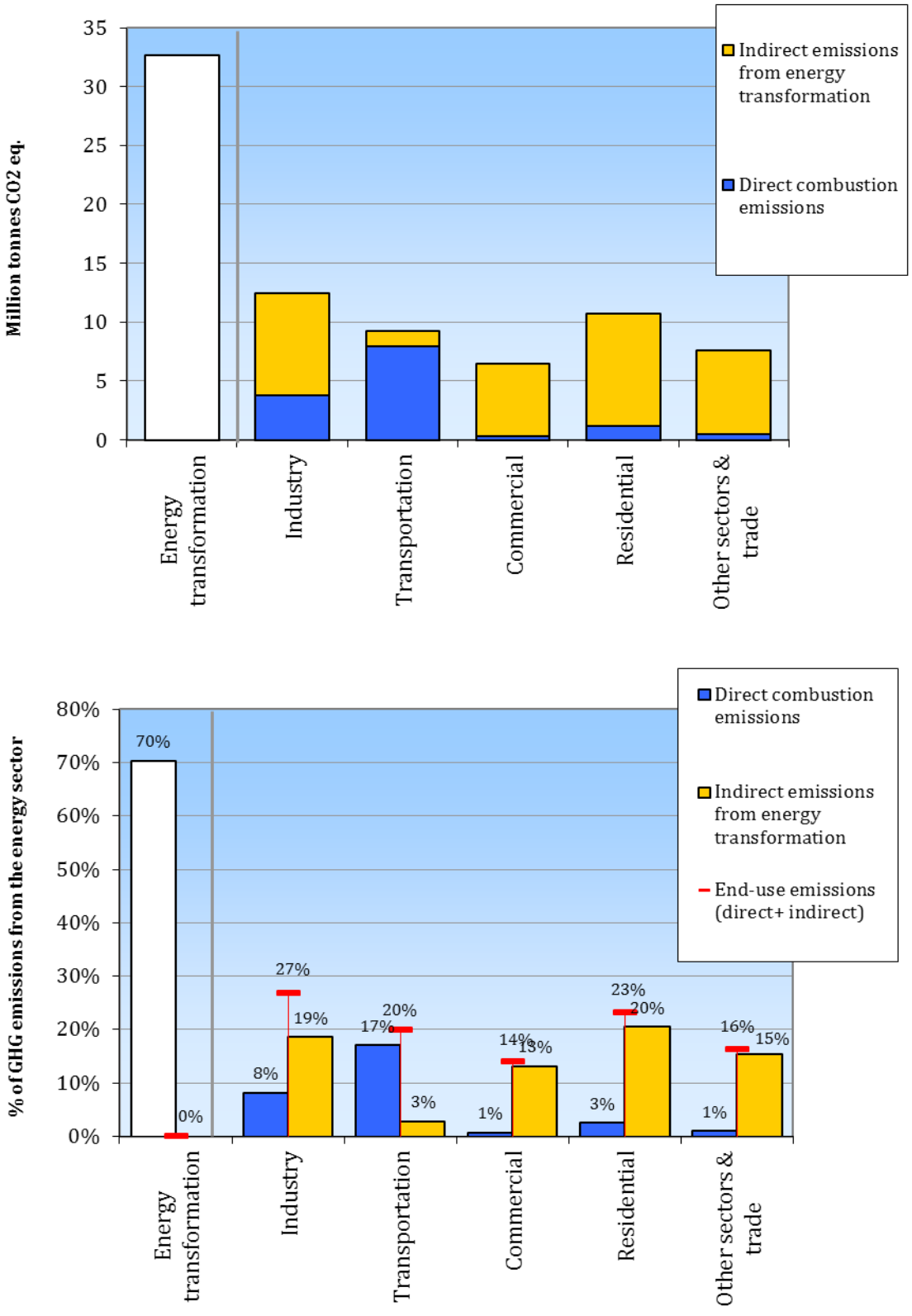


Figure A2.4 Direct and indirect GHG emissions by end use sector in Bulgaria in 2010



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, 2012

Figure A2.5 Trends in direct and indirect GHG emissions by end use sector in Czech Republic, 2005-2010

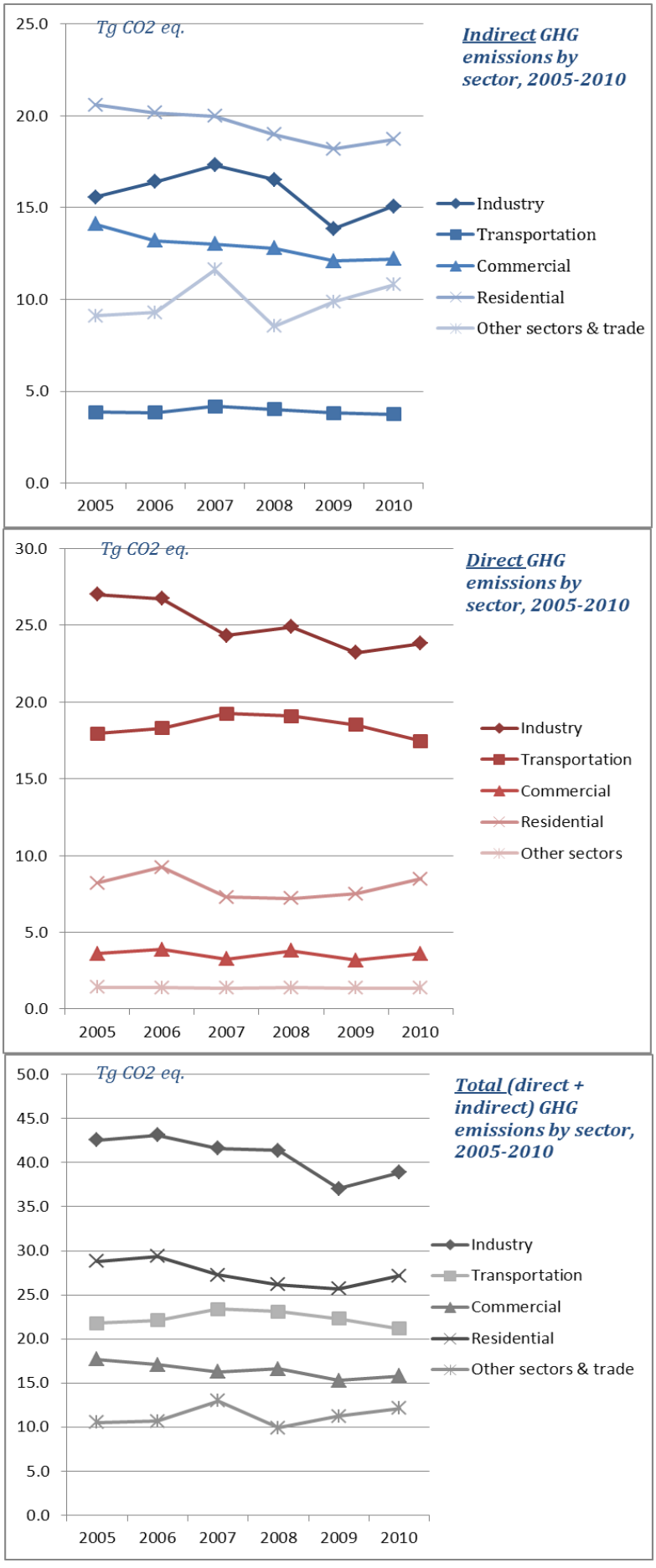
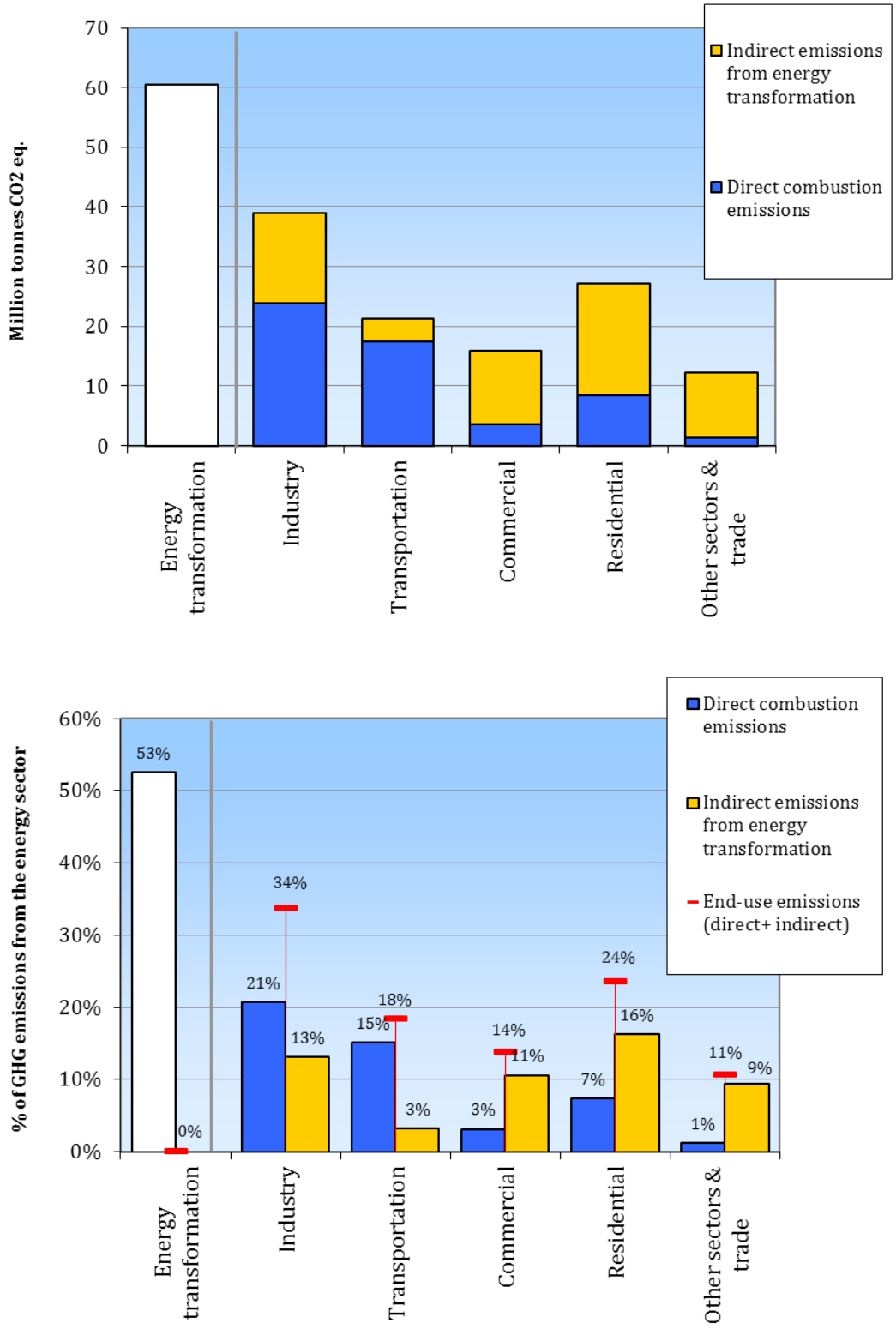


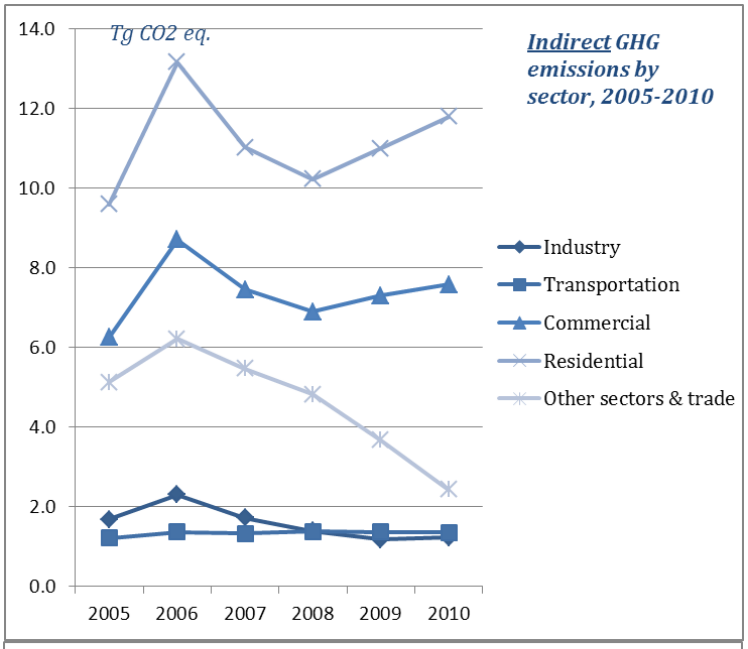
Figure A2.6 Direct and indirect GHG emissions by end use sector in Czech Republic in 2010

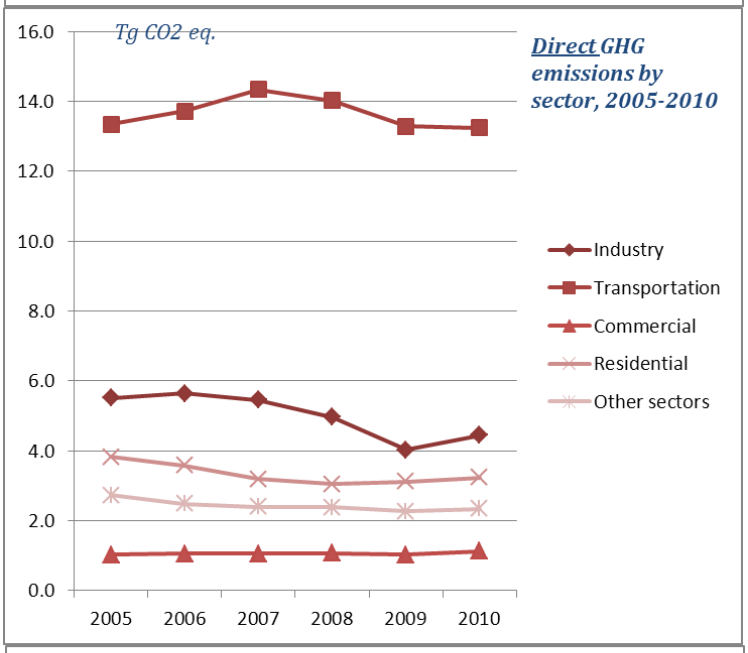


Note: The sum of direct and indirect emissions equals end-use emissions. The total indirect emissions allocated to end-users in a country can be smaller than the direct emissions from fuel transformation in that country if some of the indirect emissions are allocated to exports and international bunkers. 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, 2012

Figure A2.7 Trends in direct and indirect GHG emissions by end use sector in Denmark, 2005-2010





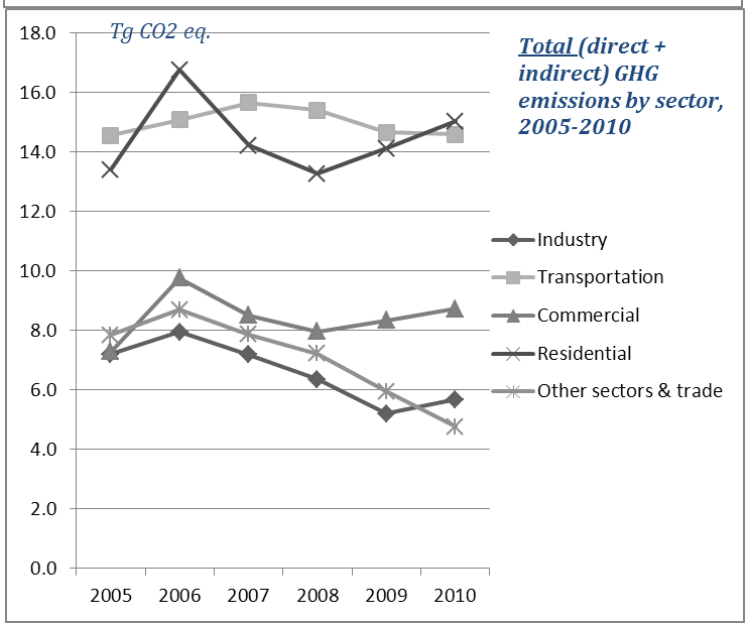
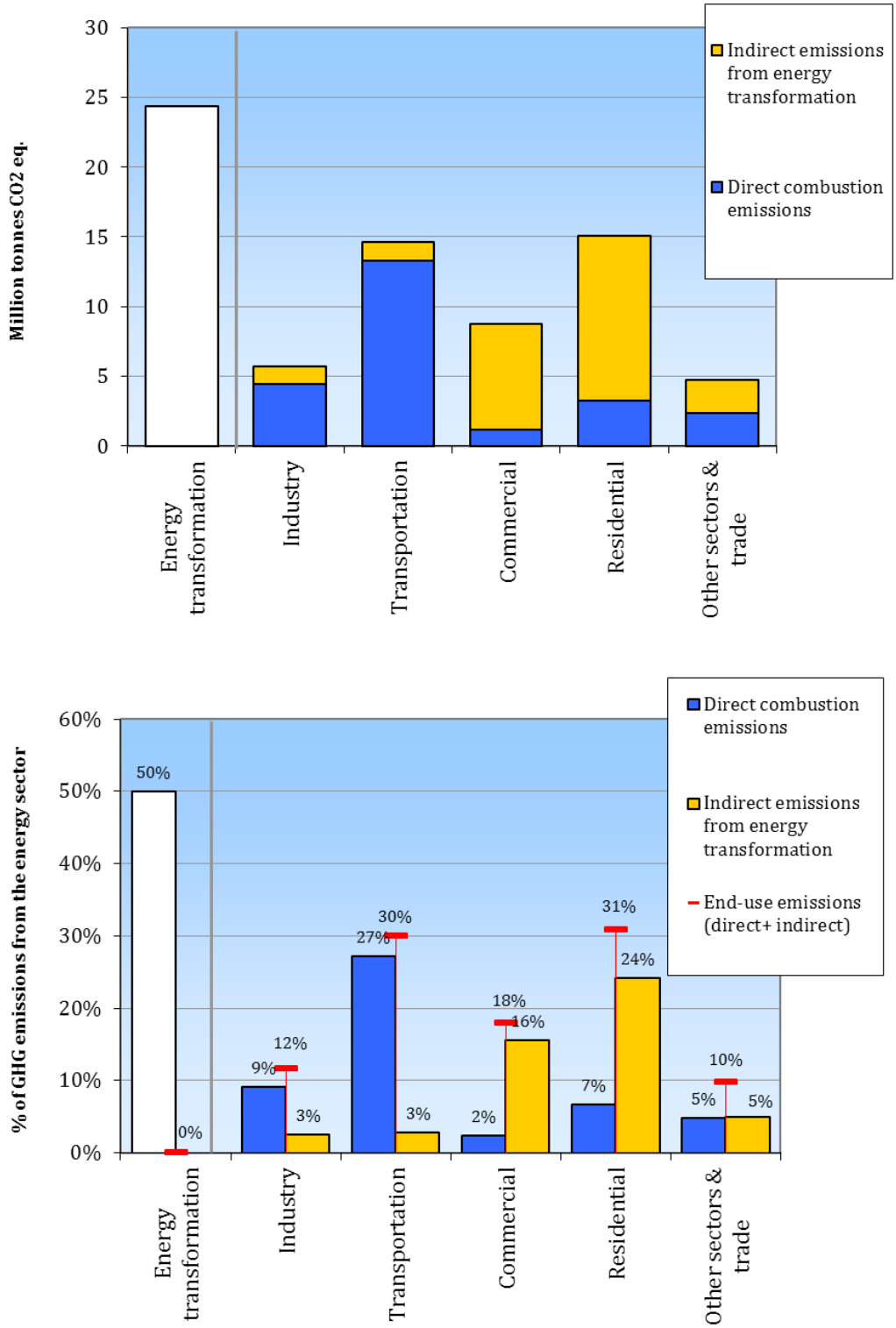


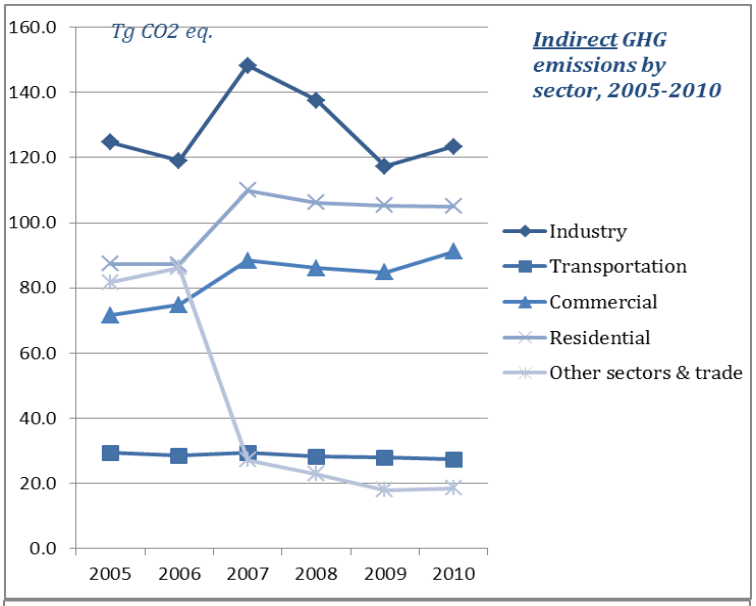
Figure A2.8 Direct and indirect GHG emissions by end use sector in Denmark in 2010

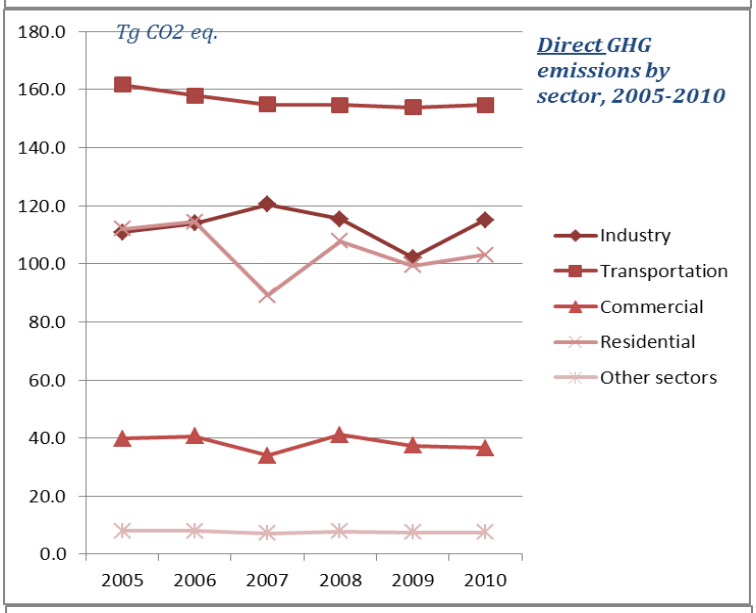


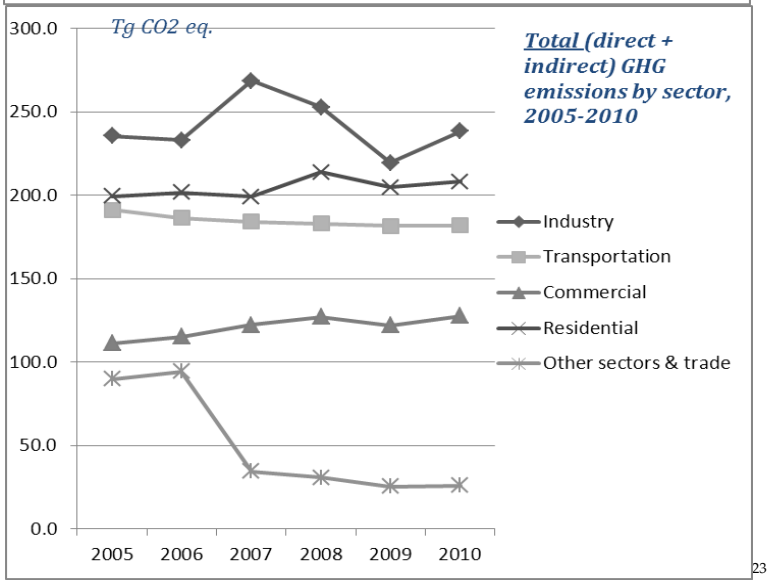
Note: The sum of direct and indirect emissions equals end-use emissions. The total indirect emissions allocated to end users in a country can be smaller than the direct emissions from fuel transformation in that country if some of the indirect emissions are allocated to exports and international bunkers. The indirect emissions allocated to end users including exports and bunkers equal 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' includes emissions from agriculture, forestry and fishing as well as the net (indirect) emissions from energy trade.

Source: EEA, 2012

Figure A2.9 Trends in direct and indirect GHG emissions by end use sector in Germany, 2005-2010



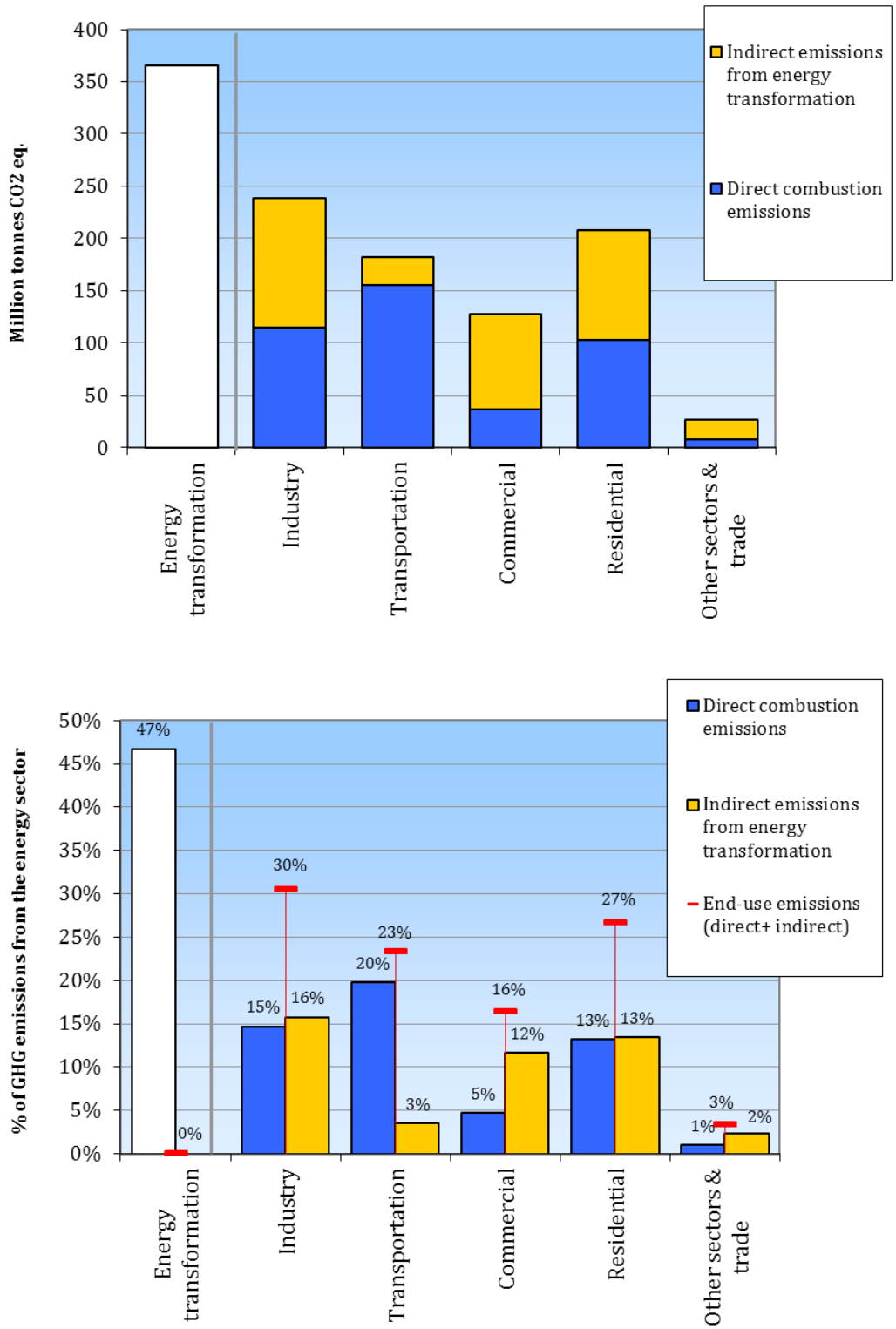




[23]

[23] 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.

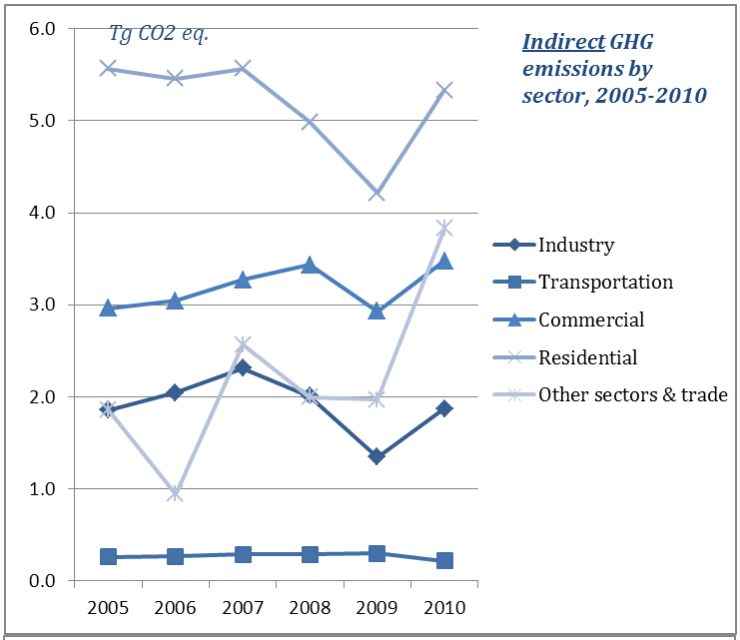
Figure A2.10 Direct and indirect GHG emissions by end use sector in Germany in 2010

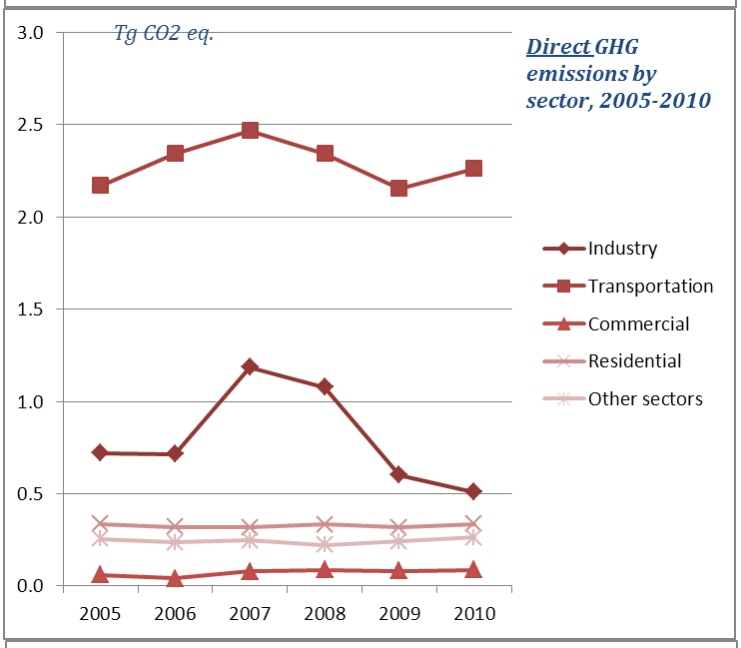


Note: The sum of direct and indirect emissions equals end-use emissions. The total indirect emissions allocated to end users in a country can be smaller than the direct emissions from fuel transformation in that country if some of the indirect emissions are allocated to exports and international bunkers. The indirect emissions allocated to end users including exports and bunkers equal 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' includes emissions from agriculture, forestry and fishing as well as the net (indirect) emissions from energy trade.

Source: EEA, 2012

Figure A2.11 Trends in direct and indirect GHG emissions by end use sector in Estonia, 2005-2010





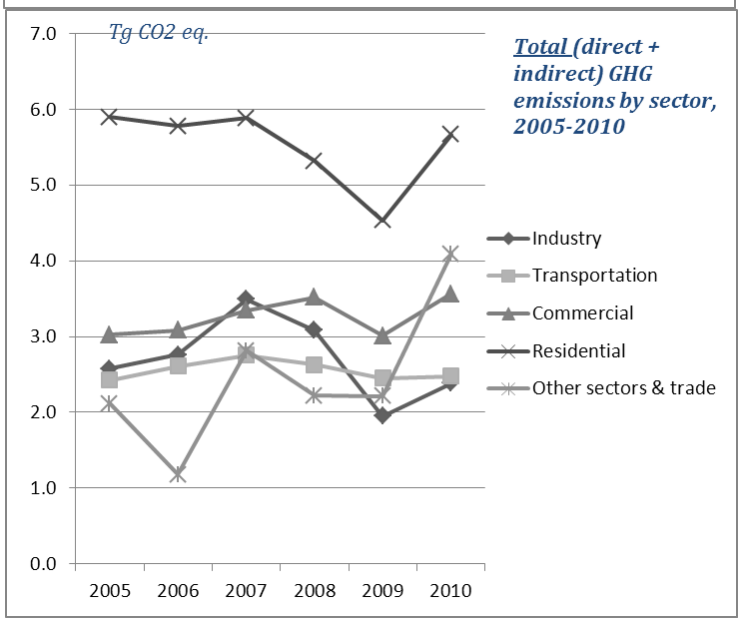
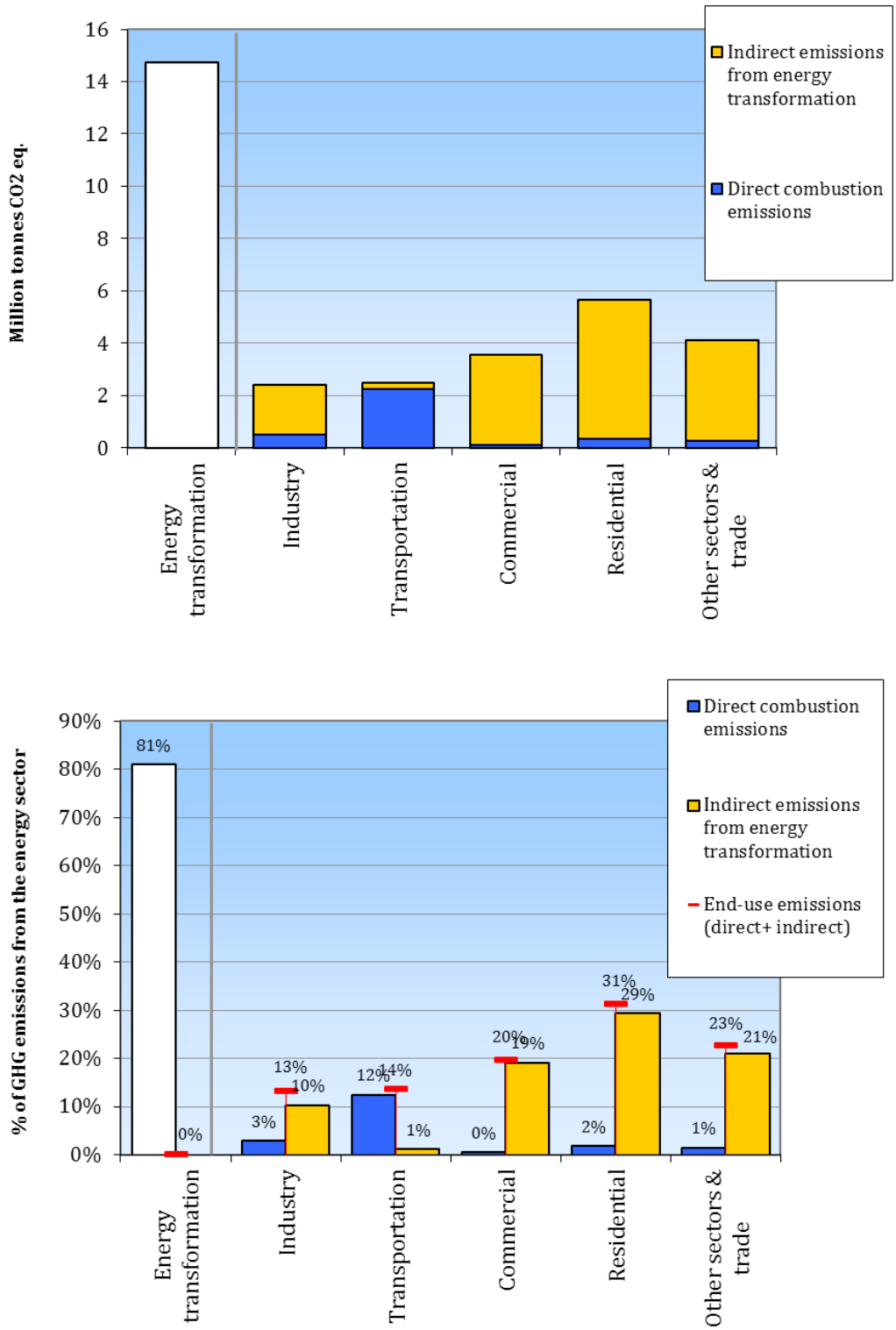


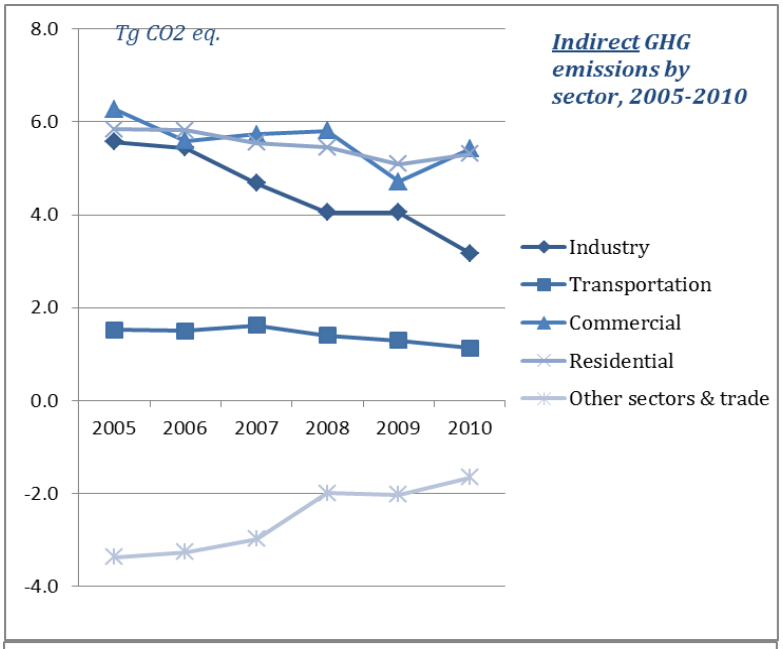
Figure A2.12 Direct and indirect GHG emissions by end use sector in Estonia in 2010

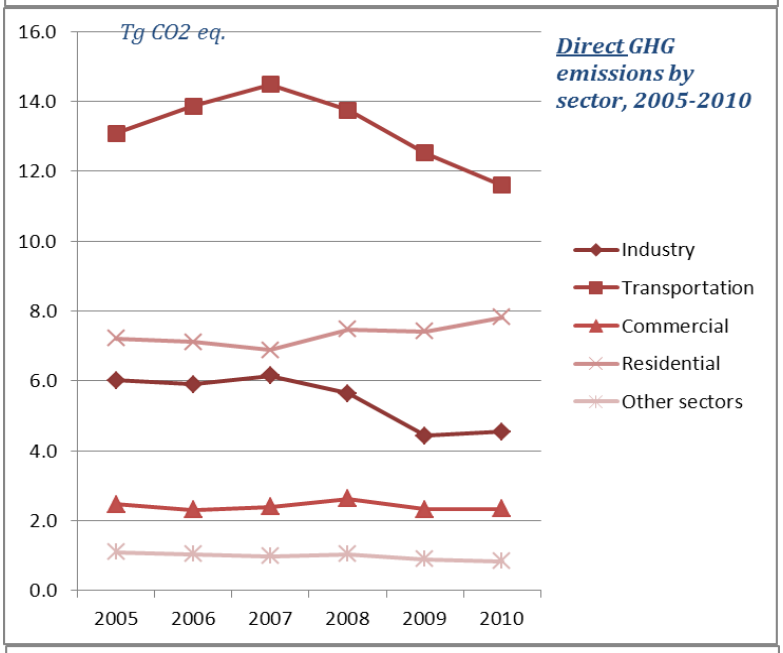


Note: The sum of direct and indirect emissions equals end-use emissions. The total indirect emissions allocated to end users in a country can be smaller than the direct emissions from fuel transformation in that country if some of the indirect emissions are allocated to exports and international bunkers. The indirect emissions allocated to end users including exports and bunkers equal 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' includes emissions from agriculture, forestry and fishing as well as the net (indirect) emissions from energy trade.

Source: EEA, 2012

Figure A2.13 Trends in direct and indirect GHG emissions by end use sector in Ireland, 2005-2010





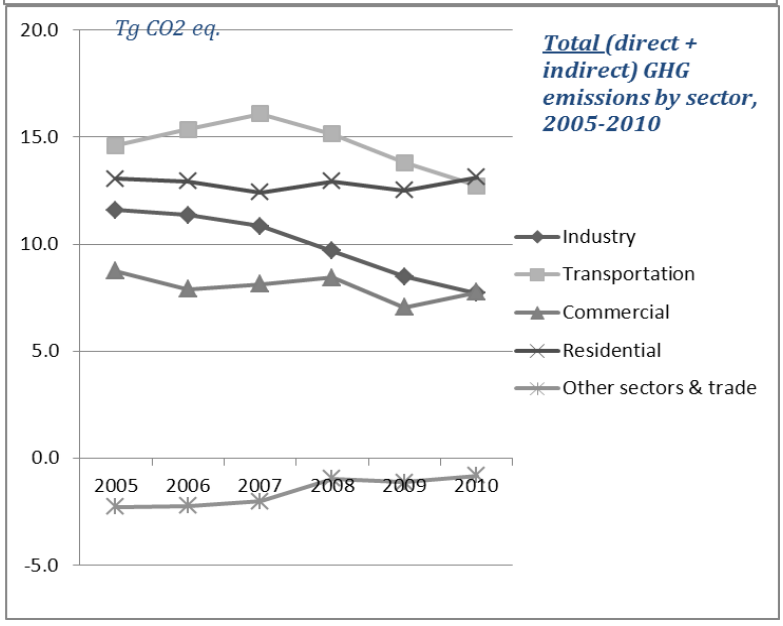
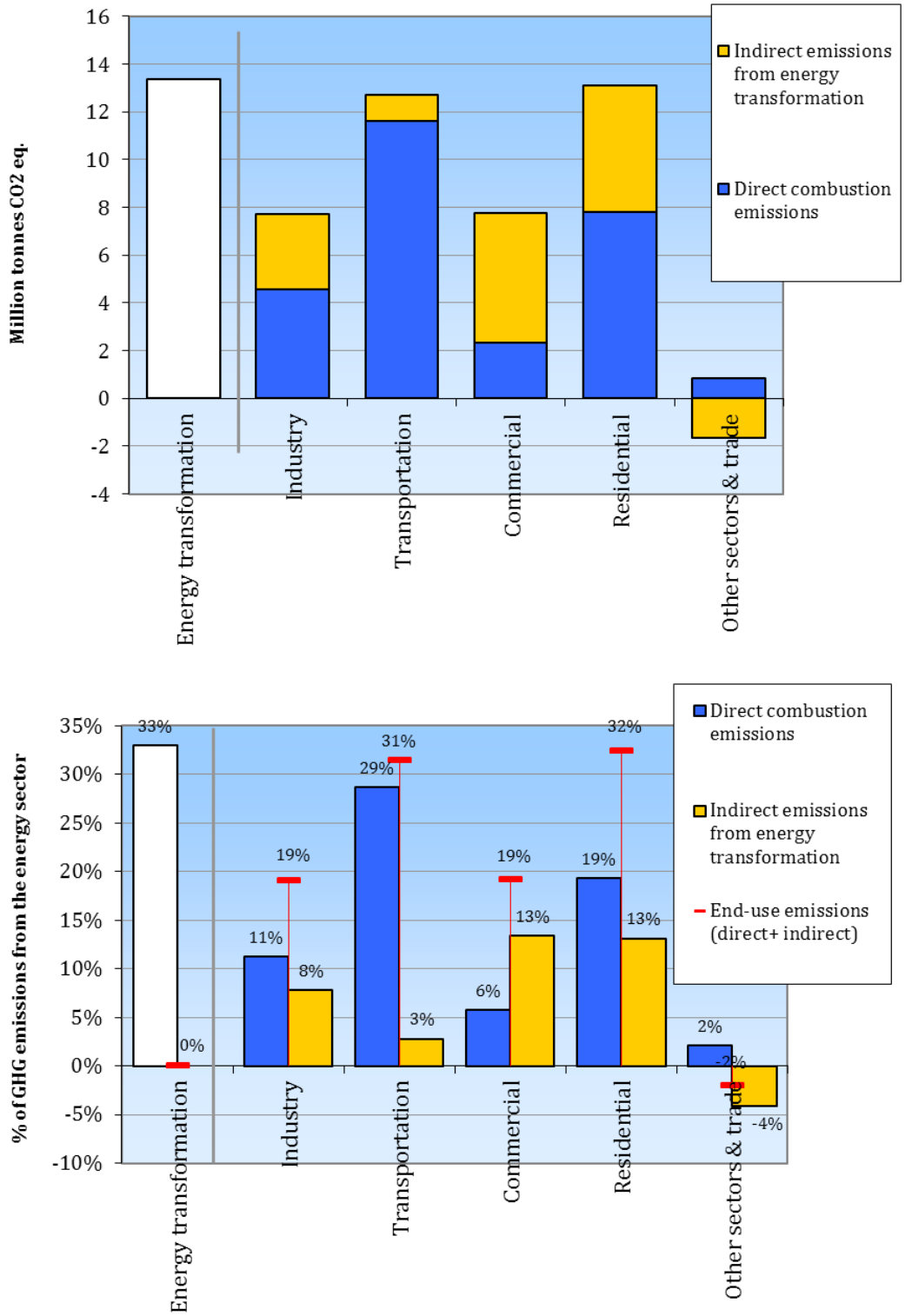


Figure A2.14 Direct and indirect GHG emissions by end use sector in Ireland in 2010



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 equal 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' includes emissions from agriculture, forestry and fishing as well as the net (indirect) emissions from energy trade.

Source: EEA, 2012

Figure A2.15 Trends in direct and indirect GHG emissions by end use sector in Greece, 2005-2010

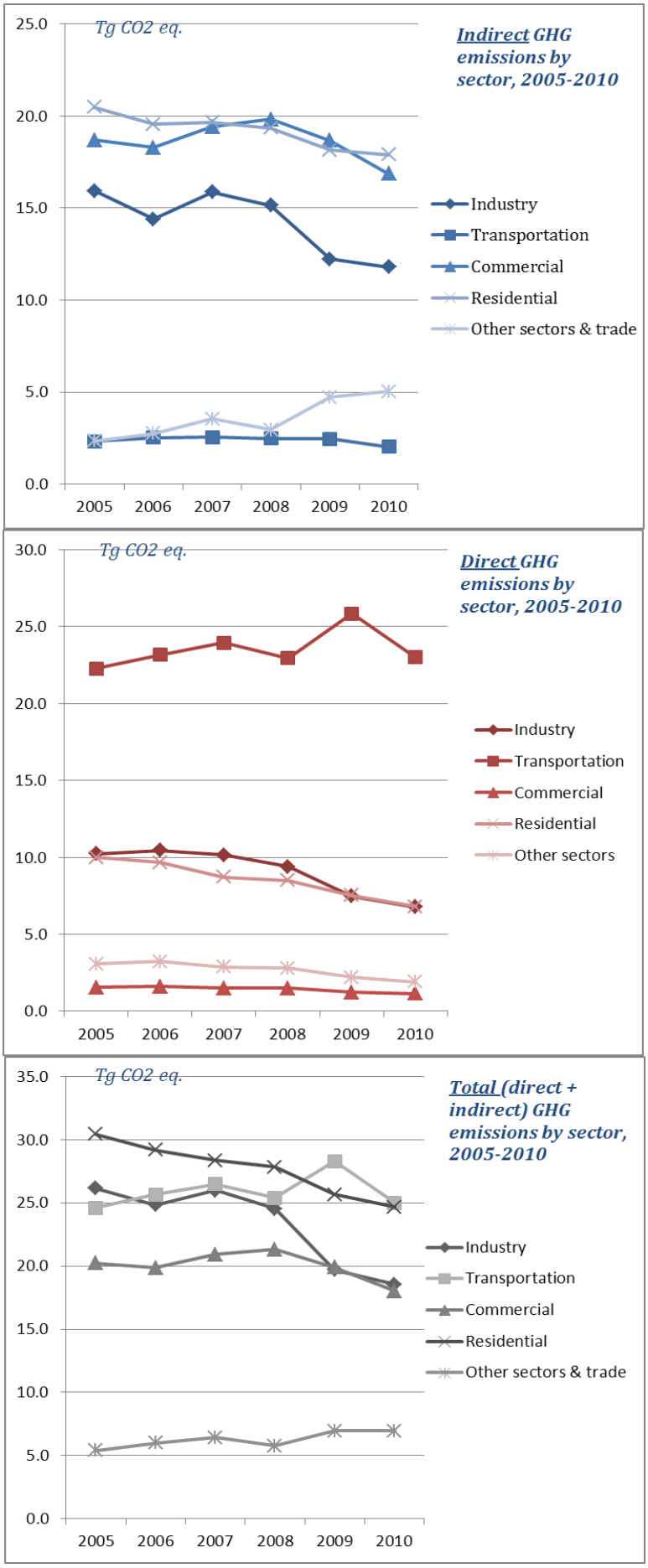
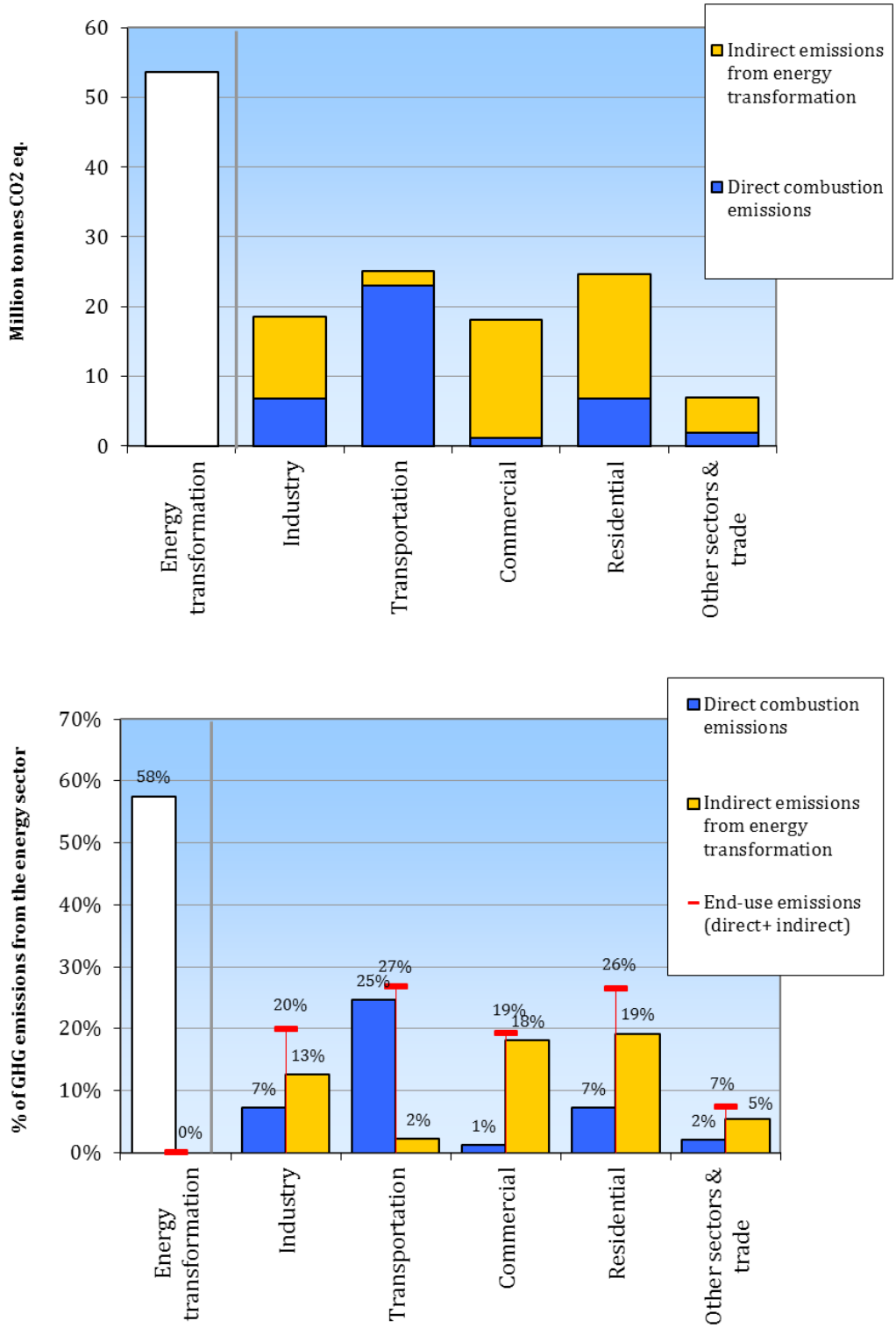


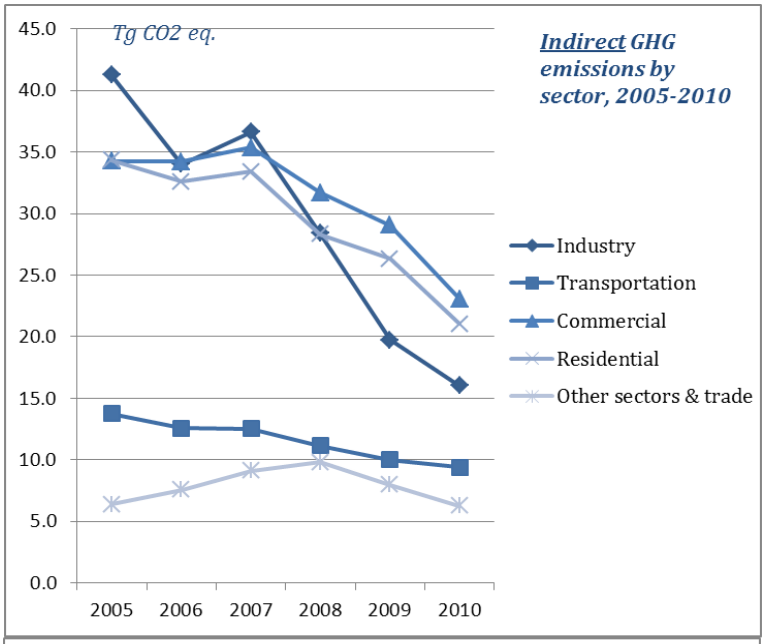
Figure A2.16 Direct and indirect GHG emissions by end use sector in Greece in 2010

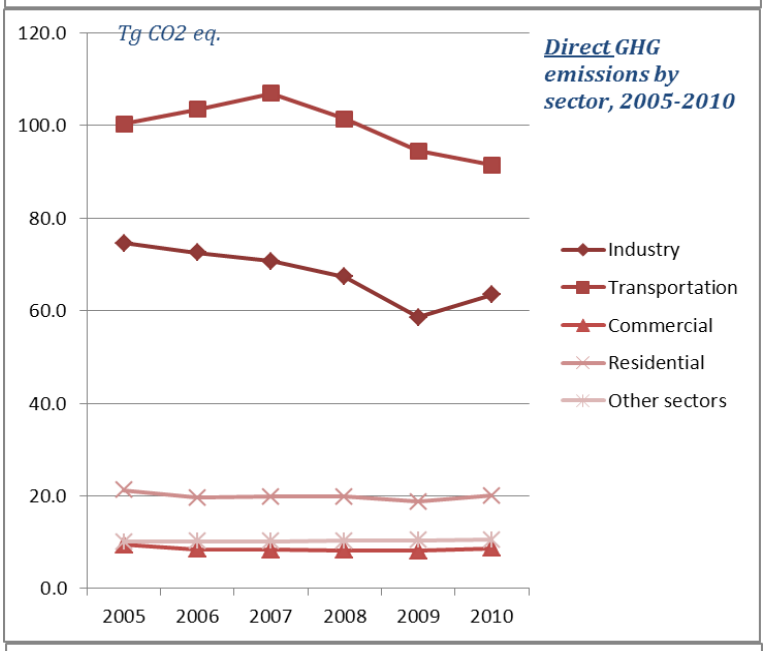


Note: The sum of direct and indirect emissions equals end-use emissions. The total indirect emissions allocated to end users in a country can be smaller than the direct emissions from fuel transformation in that country if some of the indirect emissions are allocated to exports and international bunkers. The indirect emissions allocated to end users including exports and bunkers equal 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' includes emissions from agriculture, forestry and fishing as well as the net (indirect) emissions from energy trade.

Source: EEA, 2012

Figure A2.17 Trends in direct and indirect GHG emissions by end use sector in Spain, 2005-2010





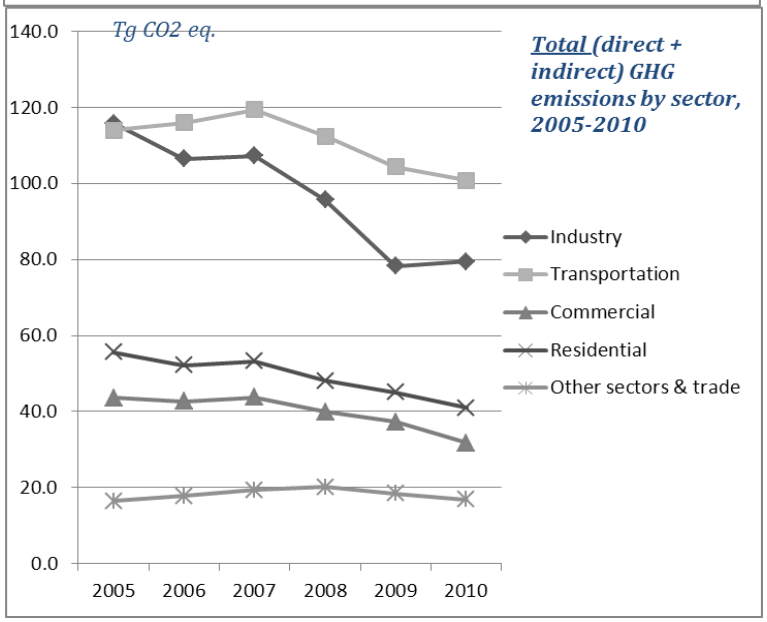
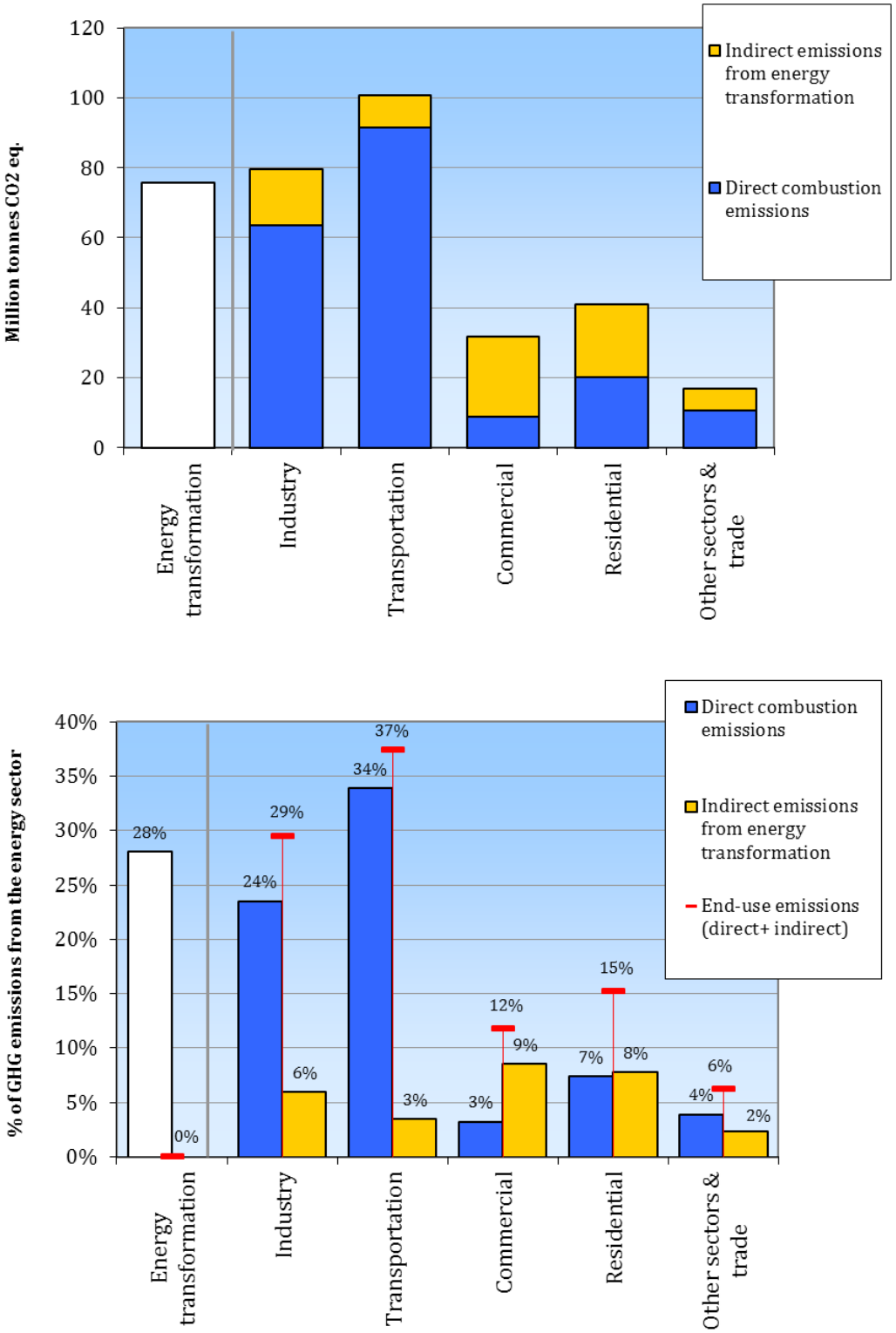


Figure A2.18 Direct and indirect GHG emissions by end use sector in Spain in 2010



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 equal 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' includes emissions from agriculture, forestry and fishing as well as the net (indirect) emissions from energy trade.

Source: EEA, 2012

Figure A2.19 Trends in direct and indirect GHG emissions by end use sector in France, 2005-2010

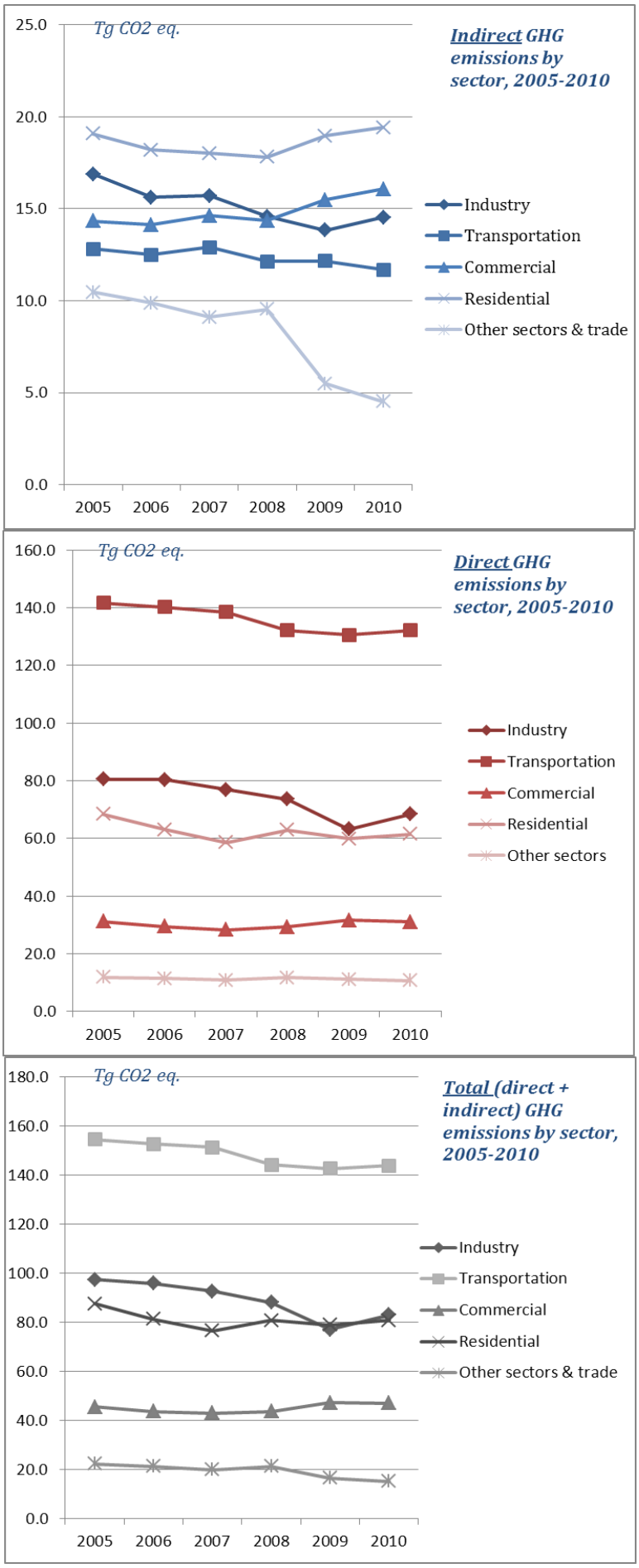
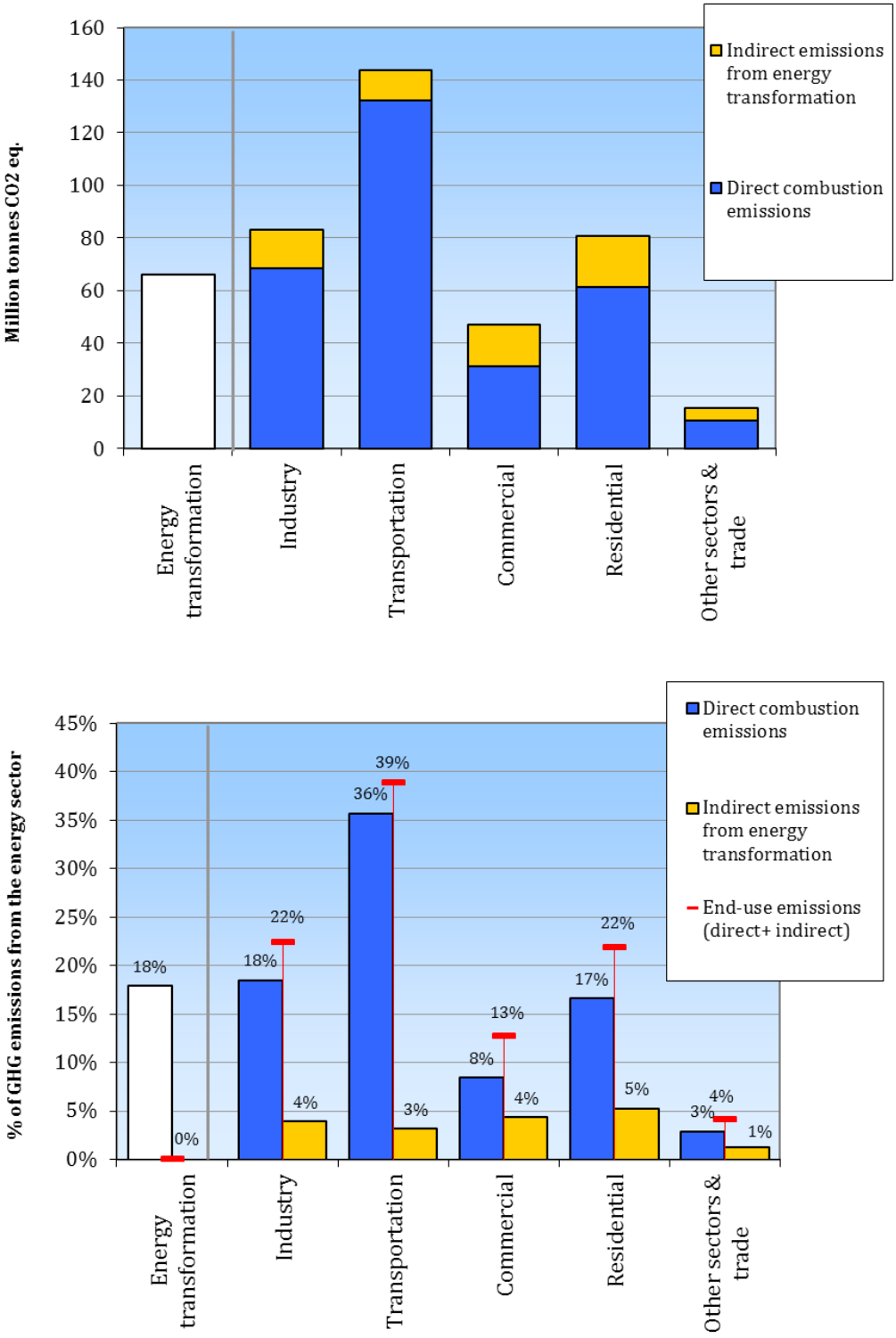


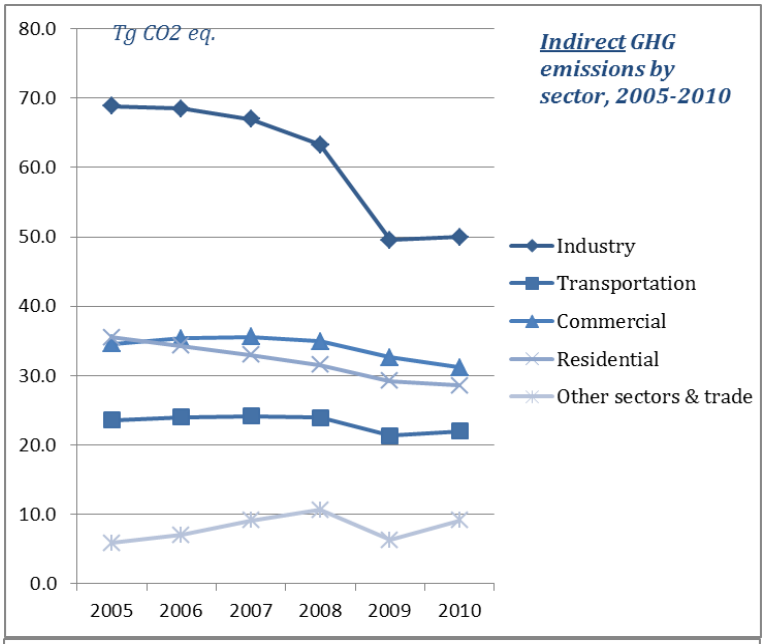
Figure A2.20 Direct and indirect GHG emissions by end use sector in France in 2010

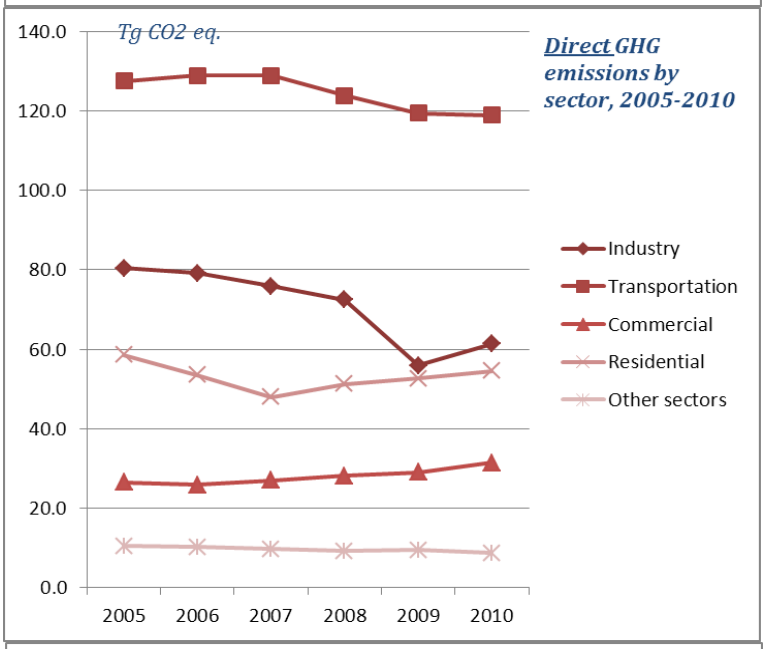


Note: The sum of direct and indirect emissions equals end-use emissions. The total indirect emissions allocated to end users in a country can be smaller than the direct emissions from fuel transformation in that country if some of the indirect emissions are allocated to exports and international bunkers. The indirect emissions allocated to end users including exports and bunkers equal 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' includes emissions from agriculture, forestry and fishing as well as the net (indirect) emissions from energy trade.

Source: EEA, 2012

Figure A2.21 Trends in direct and indirect GHG emissions by end use sector in Italy, 2005-2010





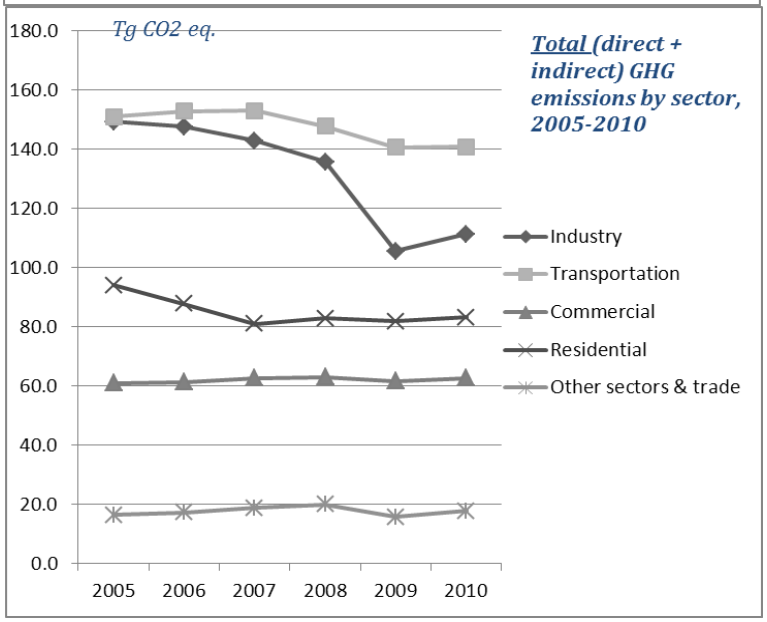
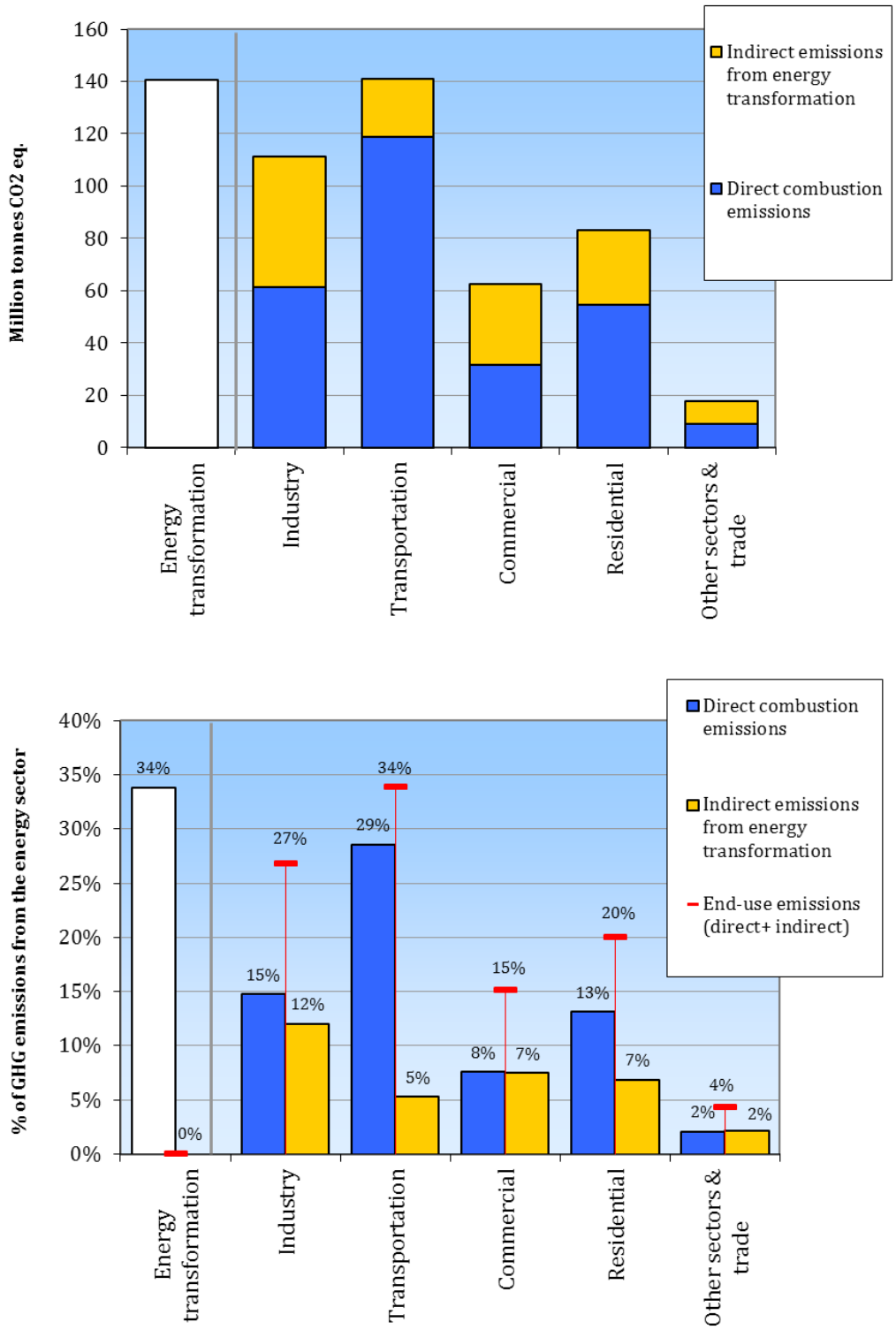


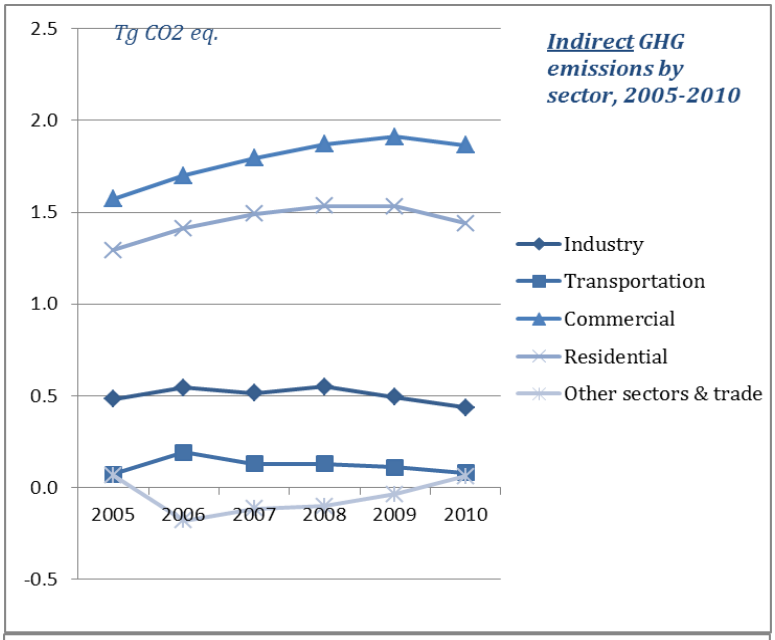
Figure A2.22 Direct and indirect GHG emissions by end use sector in Italy in 2010

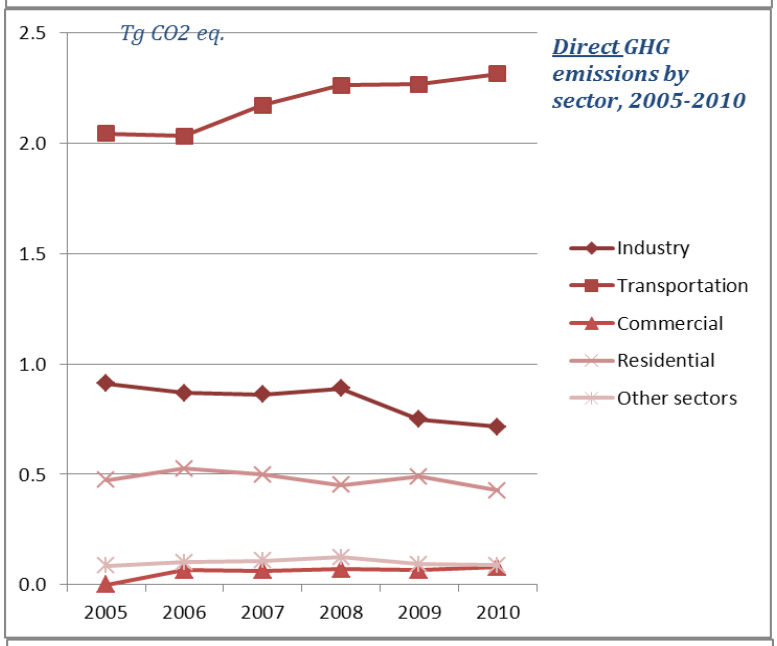


Note: The sum of direct and indirect emissions equals end-use emissions. The total indirect emissions allocated to end users in a country can be smaller than the direct emissions from fuel transformation in that country if some of the indirect emissions are allocated to exports and international bunkers. The indirect emissions allocated to end users including exports and bunkers equal 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' includes emissions from agriculture, forestry and fishing as well as the net (indirect) emissions from energy trade.

Source: EEA, 2012

Figure A2.23 Trends in direct and indirect GHG emissions by end use sector in Cyprus, 2005-2010





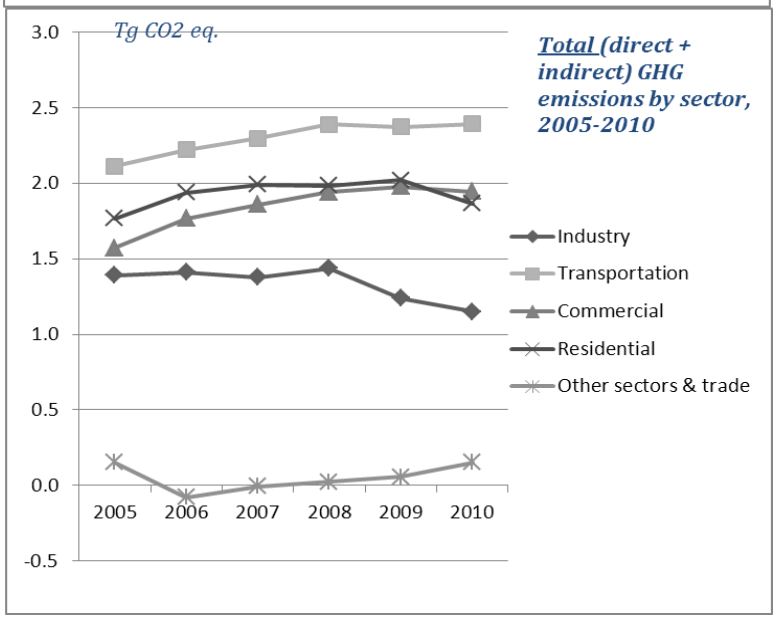
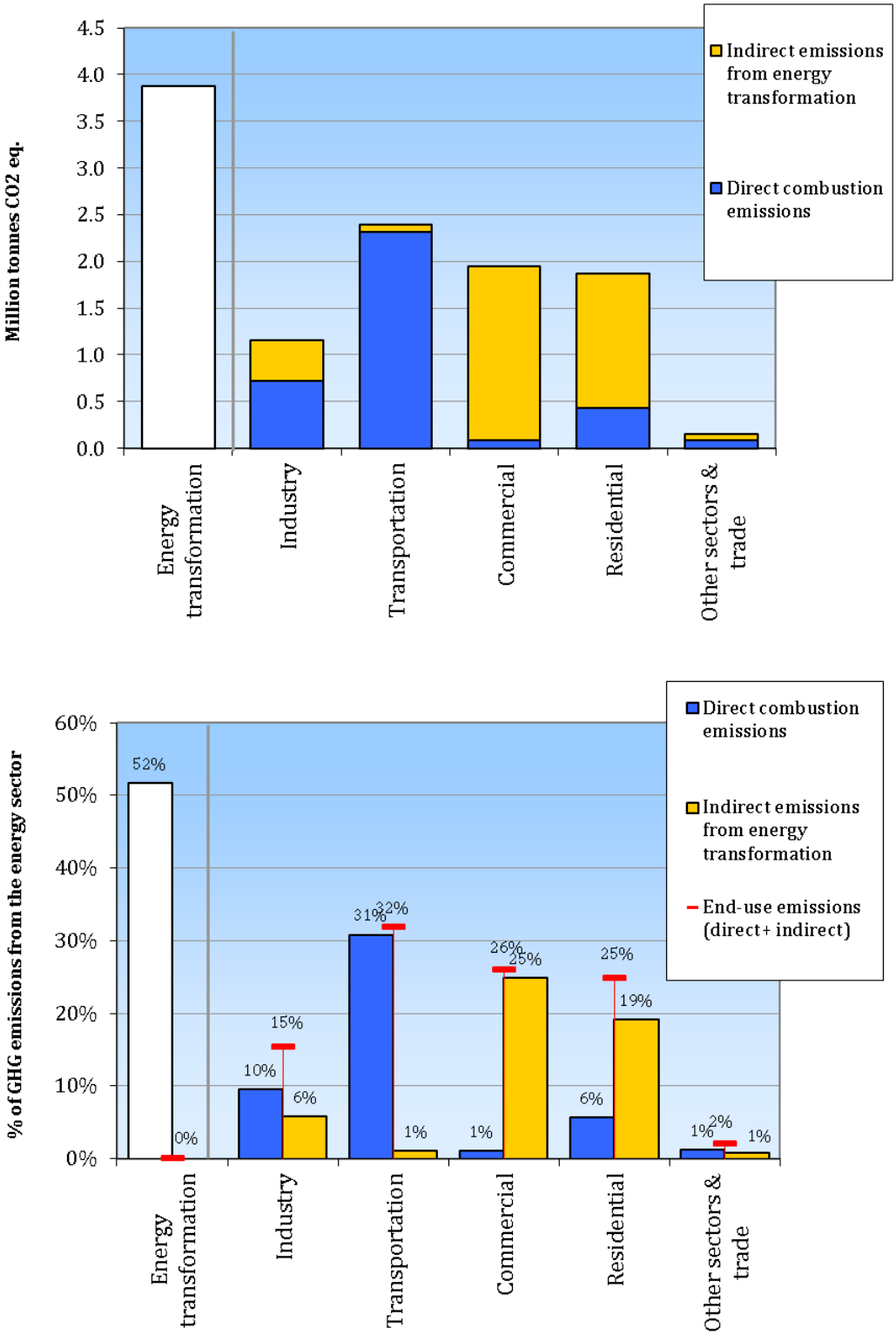


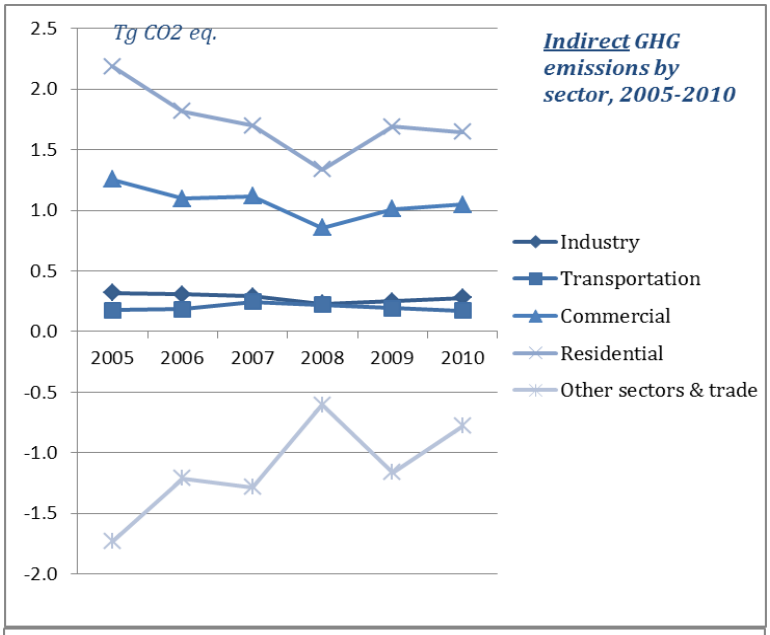
Figure A2.24 Direct and indirect GHG emissions by end use sector in Cyprus in 2010

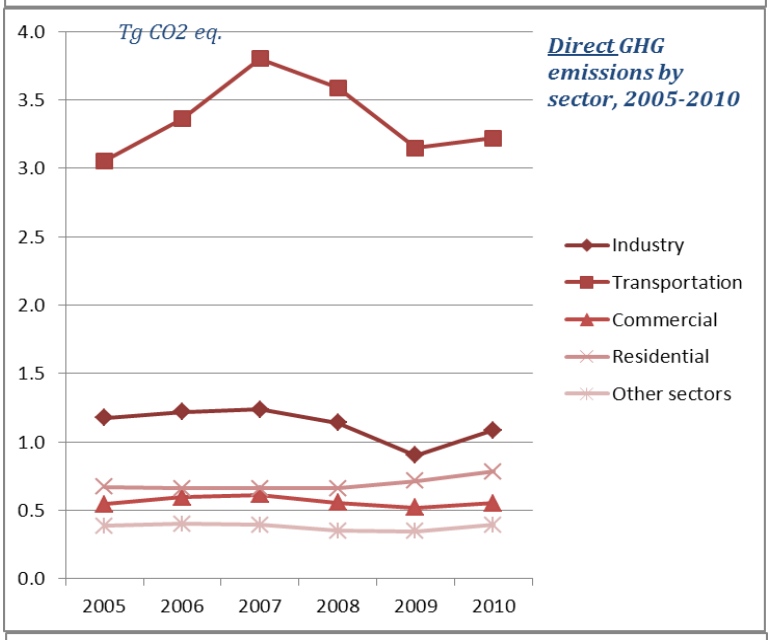


Note: The sum of direct and indirect emissions equals end-use emissions. The total indirect emissions allocated to end users in a country can be smaller than the direct emissions from fuel transformation in that country if some of the indirect emissions are allocated to exports and international bunkers. The indirect emissions allocated to end users including exports and bunkers equal 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' includes emissions from agriculture, forestry and fishing as well as the net (indirect) emissions from energy trade.

Source: EEA, 2012

Figure A2.25 Trends in direct and indirect GHG emissions by end use sector in Latvia, 2005-2010





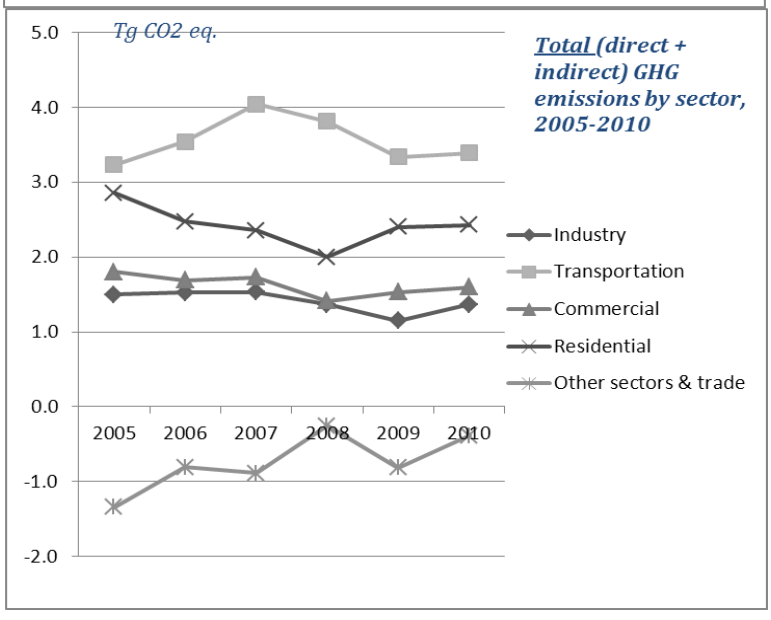
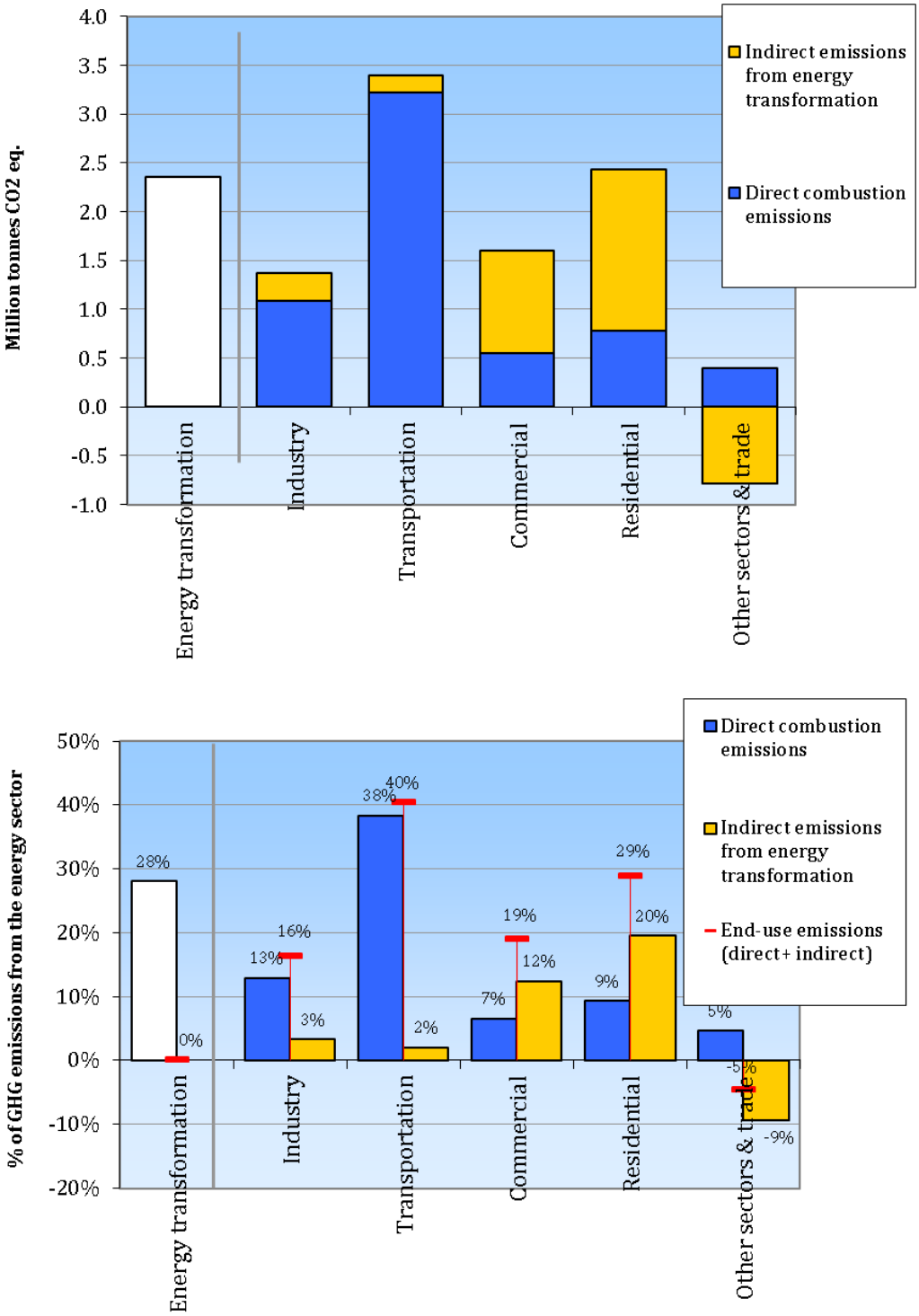


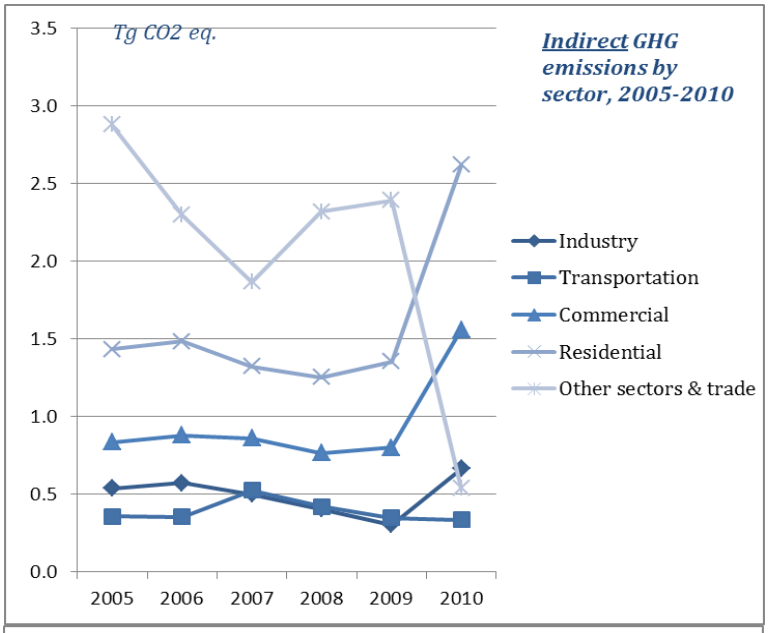
Figure A2.26 Direct and indirect GHG emissions by end use sector in Latvia in 2010

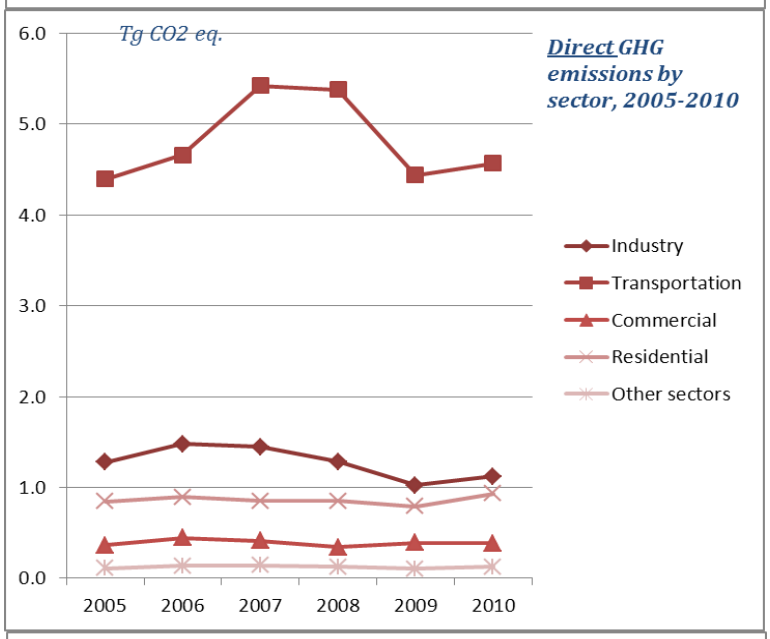


Note: The sum of direct and indirect emissions equals end-use emissions. The total indirect emissions allocated to end users in a country can be smaller than the direct emissions from fuel transformation in that country if some of the indirect emissions are allocated to exports and international bunkers. The indirect emissions allocated to end users including exports and bunkers equal 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' includes emissions from agriculture, forestry and fishing as well as the net (indirect) emissions from energy trade.

Source: EEA, 2012

Figure A2.27 Trends in direct and indirect GHG emissions by end use sector in Lithuania, 2005-2010





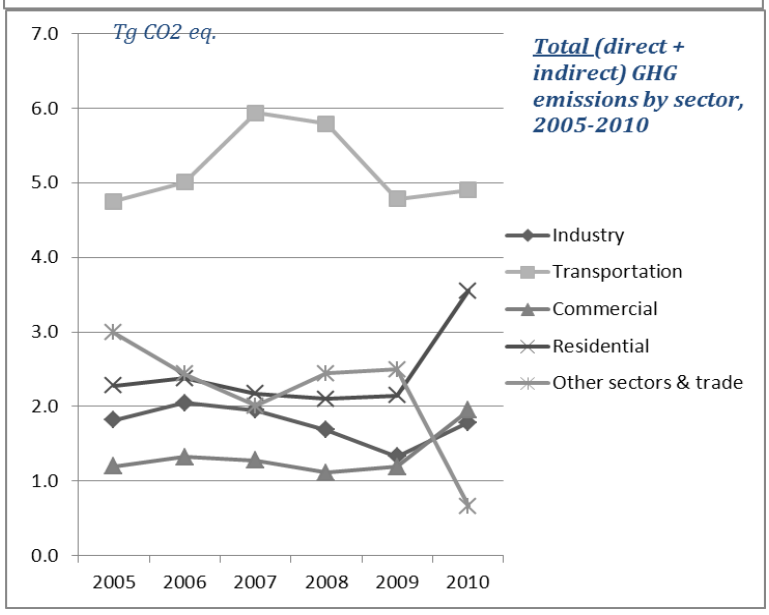
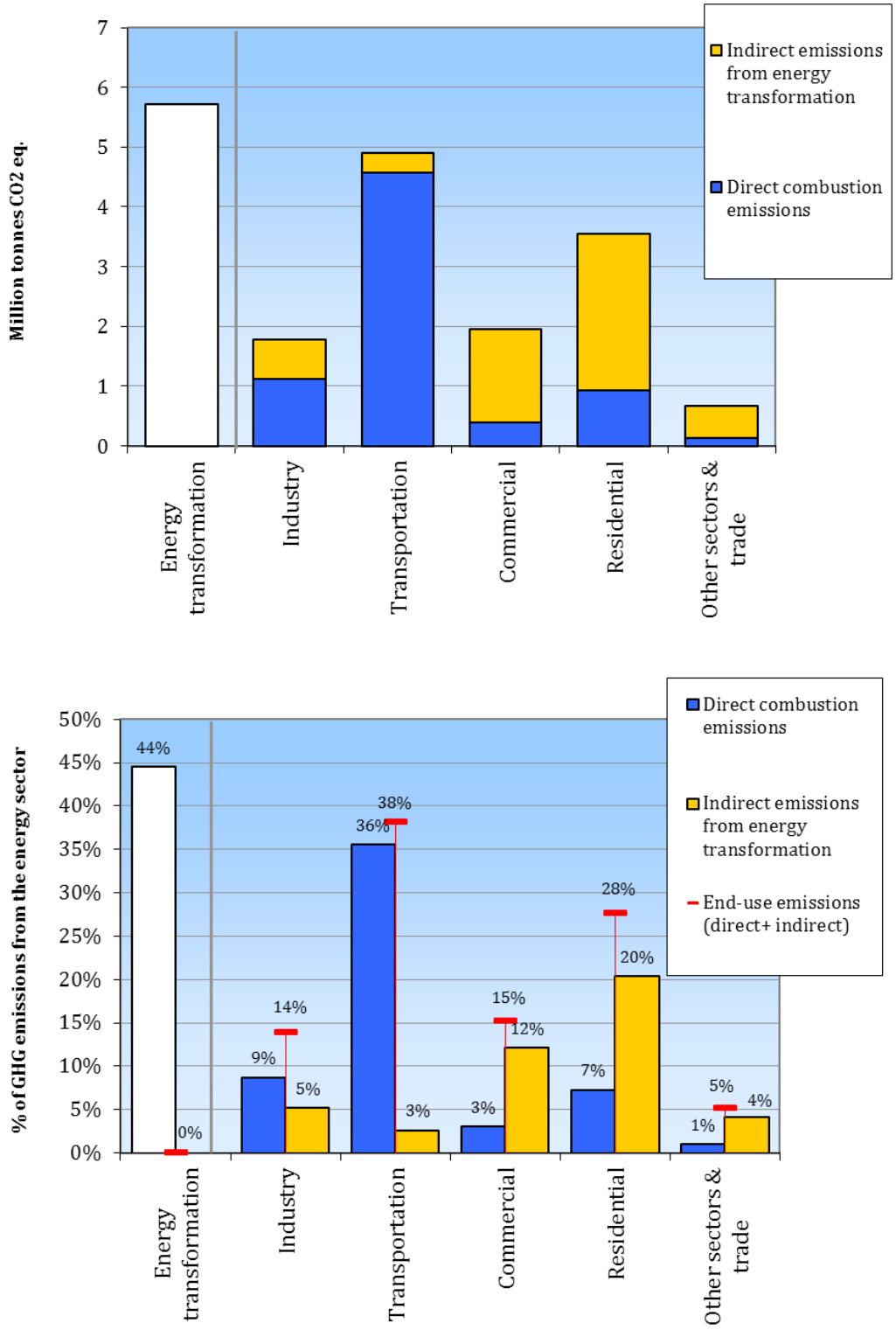


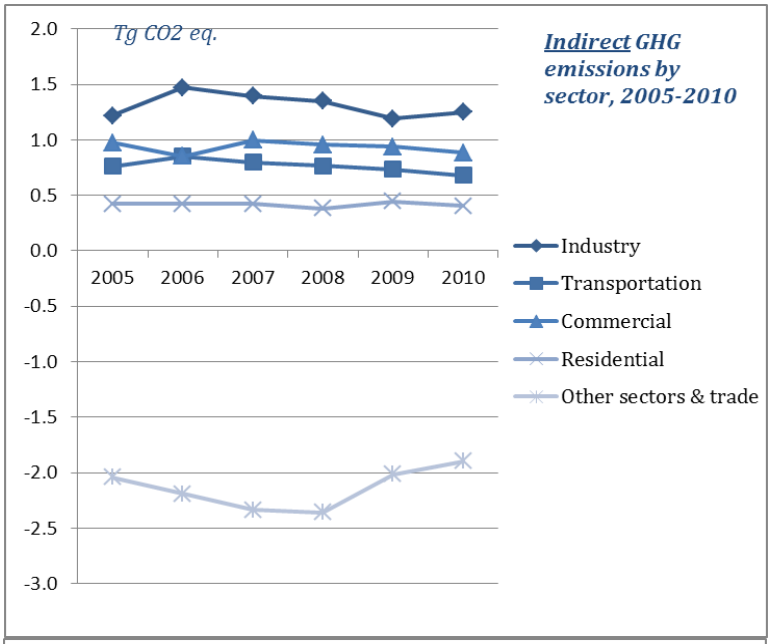
Figure A2.28 Direct and indirect GHG emissions by end use sector in Lithuania in 2010

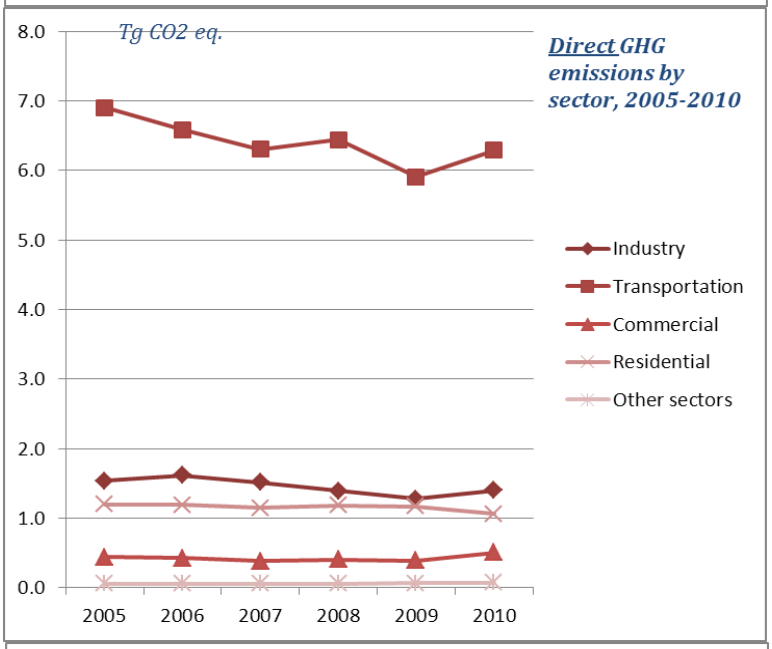


Note: The sum of direct and indirect emissions equals end-use emissions. The total indirect emissions allocated to end users in a country can be smaller than the direct emissions from fuel transformation in that country if some of the indirect emissions are allocated to exports and international bunkers. The indirect emissions allocated to end users including exports and bunkers equal 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' includes emissions from agriculture, forestry and fishing as well as the net (indirect) emissions from energy trade.

Source: EEA, 2012

Figure A2.29 Trends in direct and indirect GHG emissions by end use sector in Luxembourg, 2005-2010





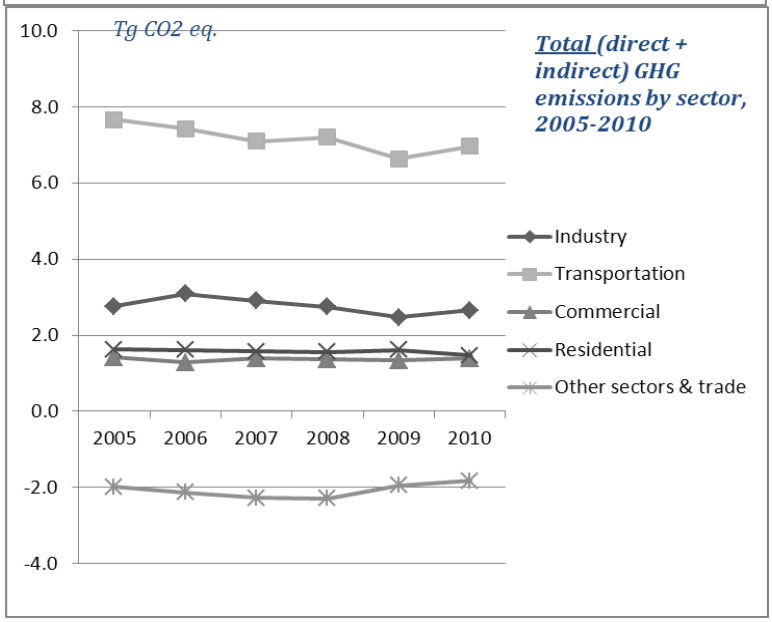
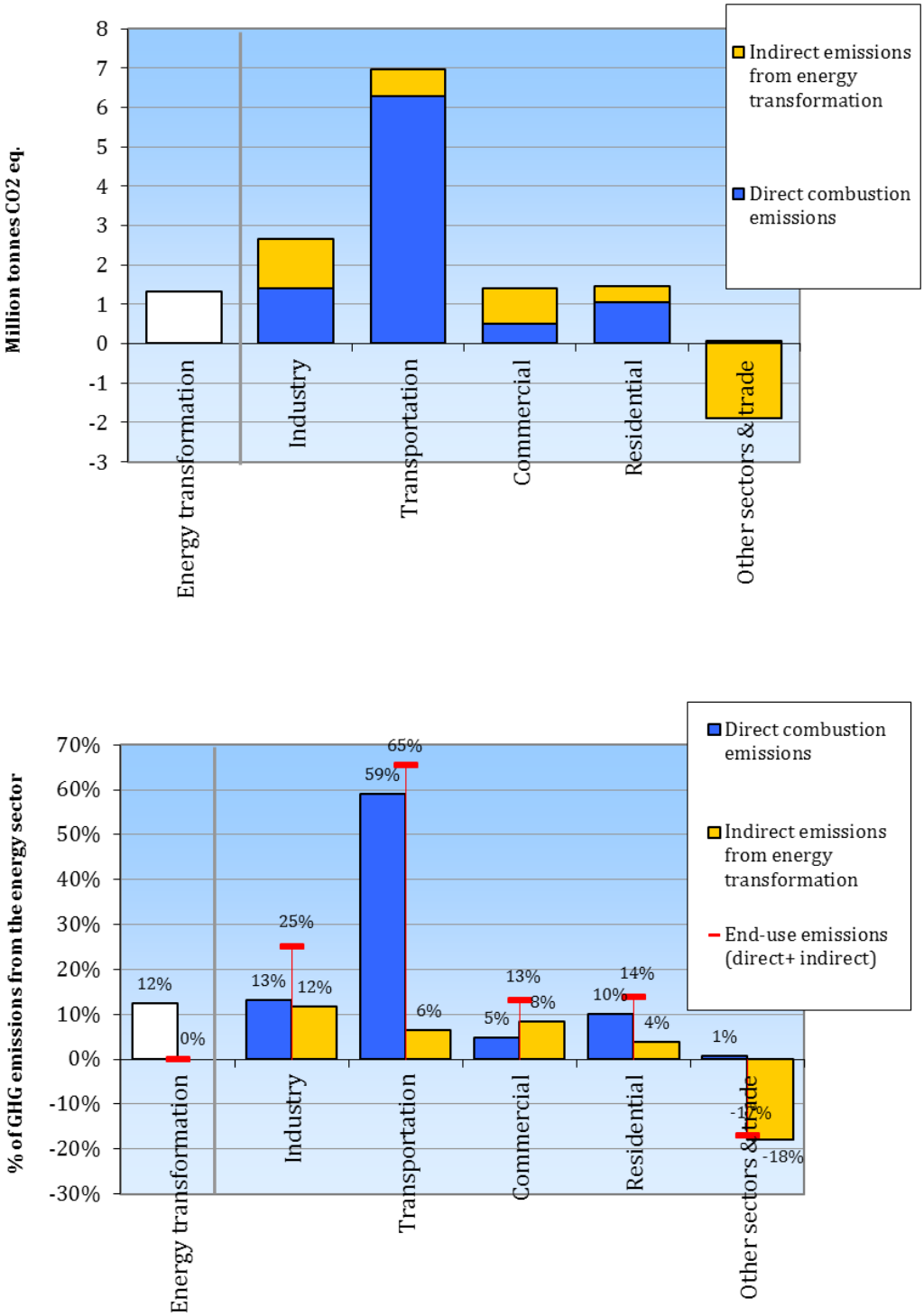


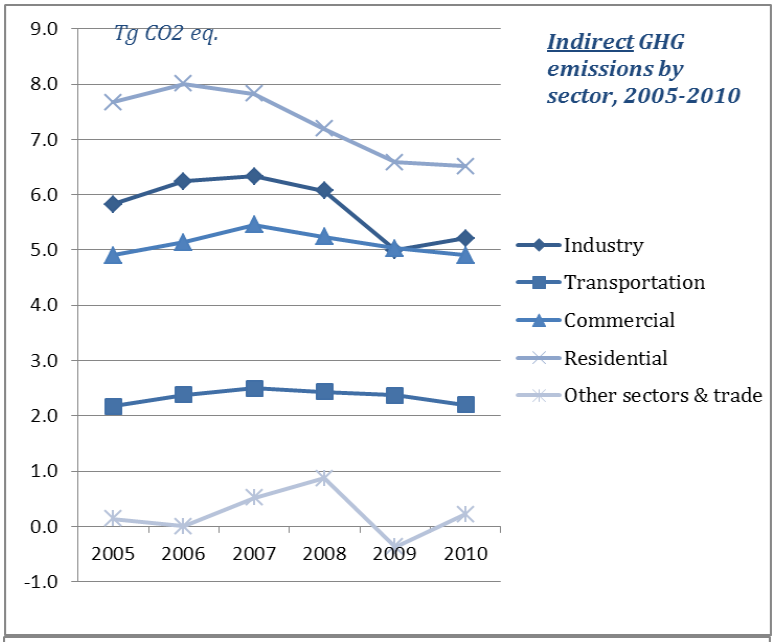
Figure A2.30 Direct and indirect GHG emissions by end use sector in Luxembourg in 2010

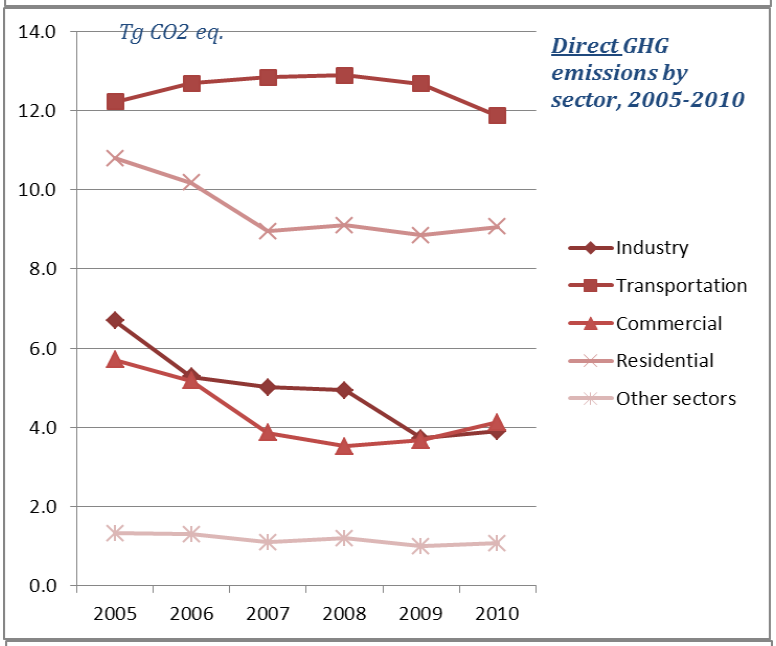


Note: The sum of direct and indirect emissions equals end-use emissions. The total indirect emissions allocated to end users in a country can be smaller than the direct emissions from fuel transformation in that country if some of the indirect emissions are allocated to exports and international bunkers. The indirect emissions allocated to end users including exports and bunkers equal 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' includes emissions from agriculture, forestry and fishing as well as the net (indirect) emissions from energy trade.

Source: EEA, 2012

Figure A2.31 Trends in direct and indirect GHG emissions by end use sector in Hungary, 2005-2010





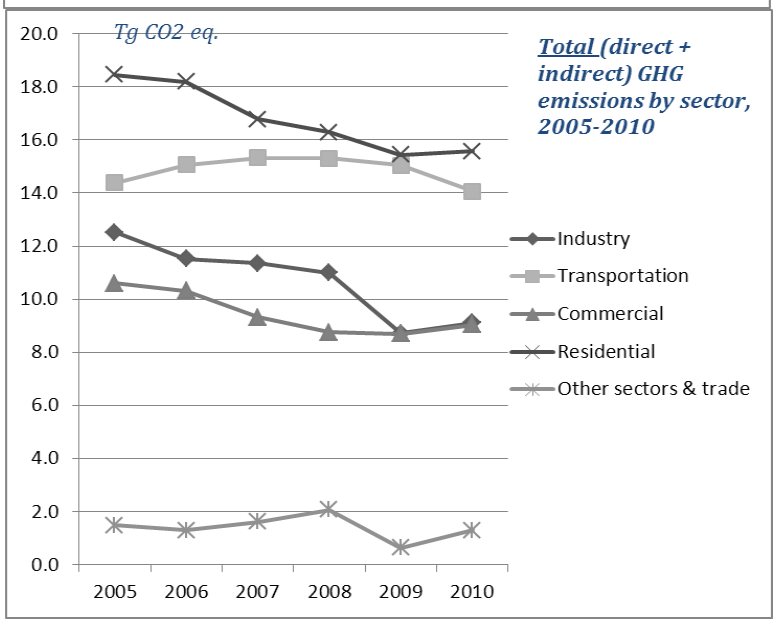
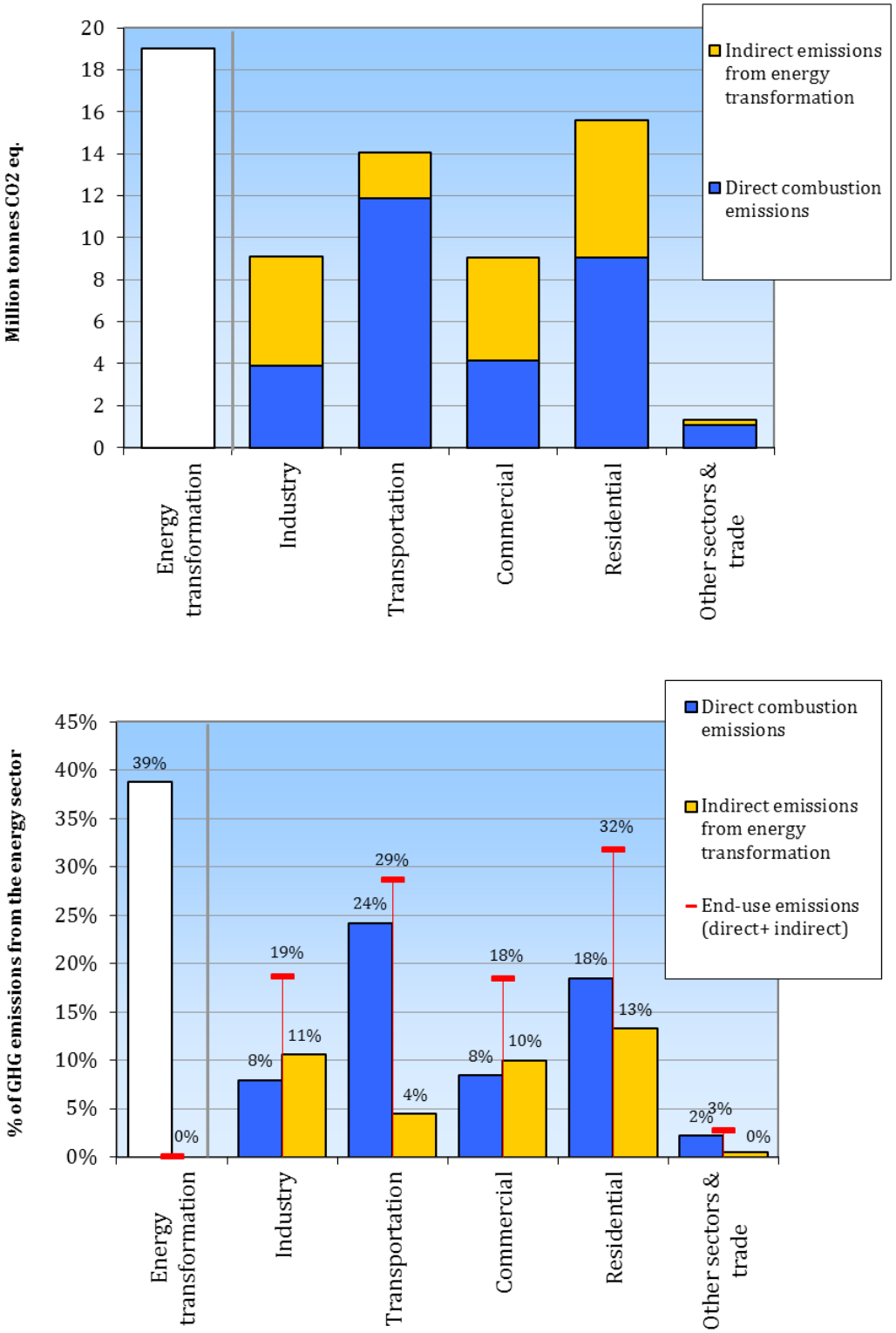


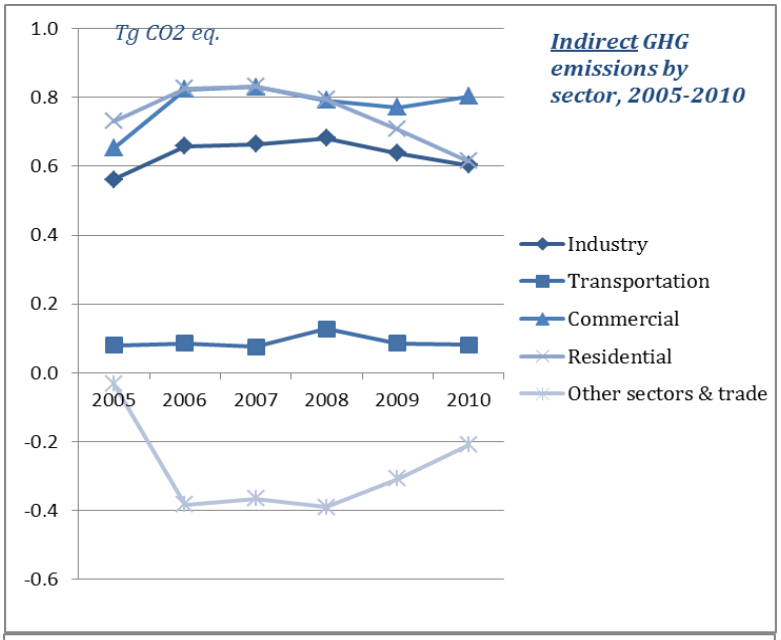
Figure A2.32 Direct and indirect GHG emissions by end use sector in Hungary in 2010

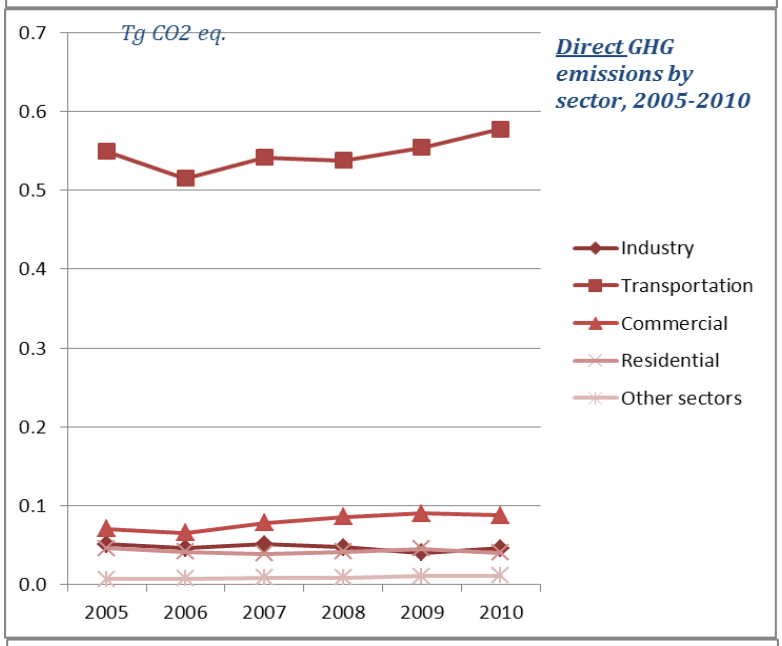


Note: The sum of direct and indirect emissions equals end-use emissions. The total indirect emissions allocated to end users in a country can be smaller than the direct emissions from fuel transformation in that country if some of the indirect emissions are allocated to exports and international bunkers. The indirect emissions allocated to end users including exports and bunkers equal 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' includes emissions from agriculture, forestry and fishing as well as the net (indirect) emissions from energy trade.

Source: EEA, 2012

Figure A2.33 Trends in direct and indirect GHG emissions by end use sector in Malta, 2005-2010





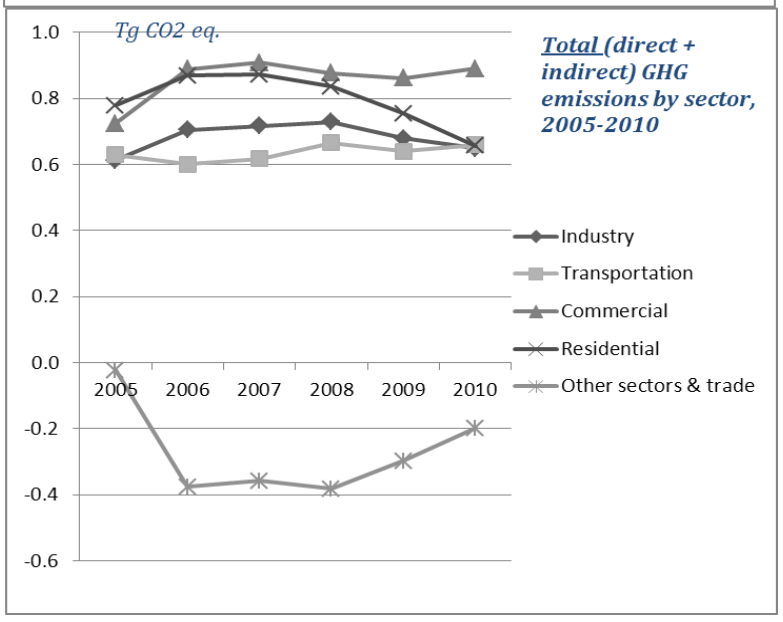
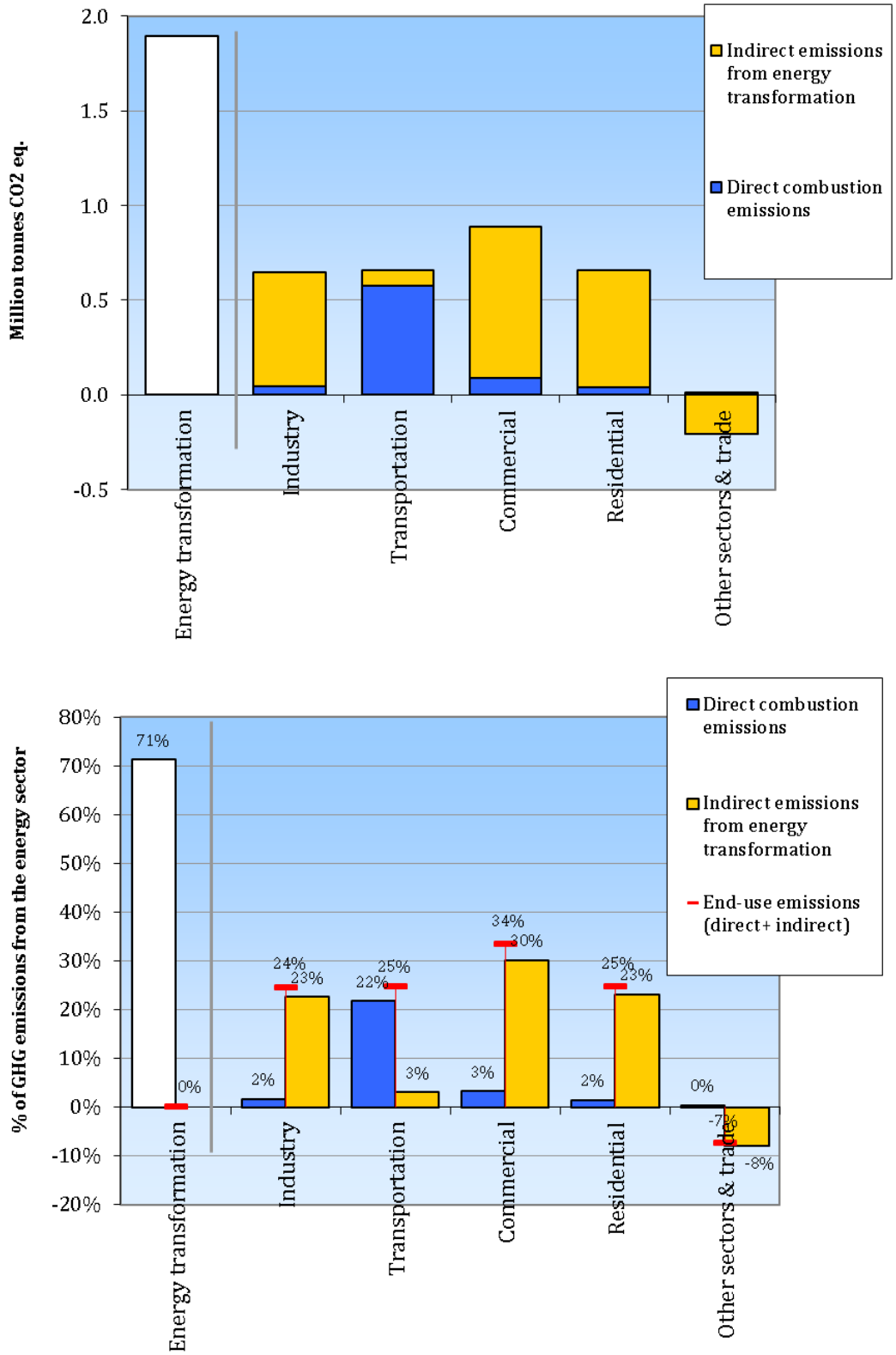


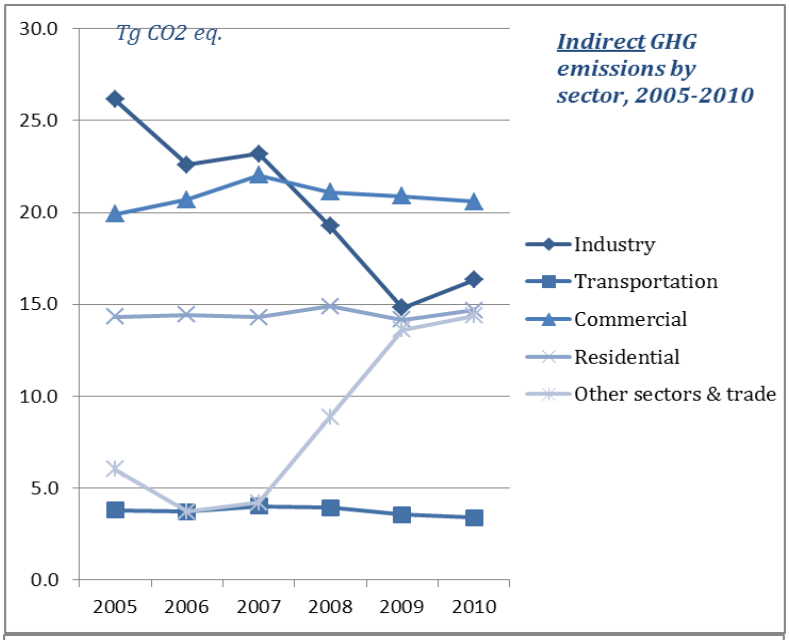
Figure A2.34 Direct and indirect GHG emissions by end use sector in Malta in 2010

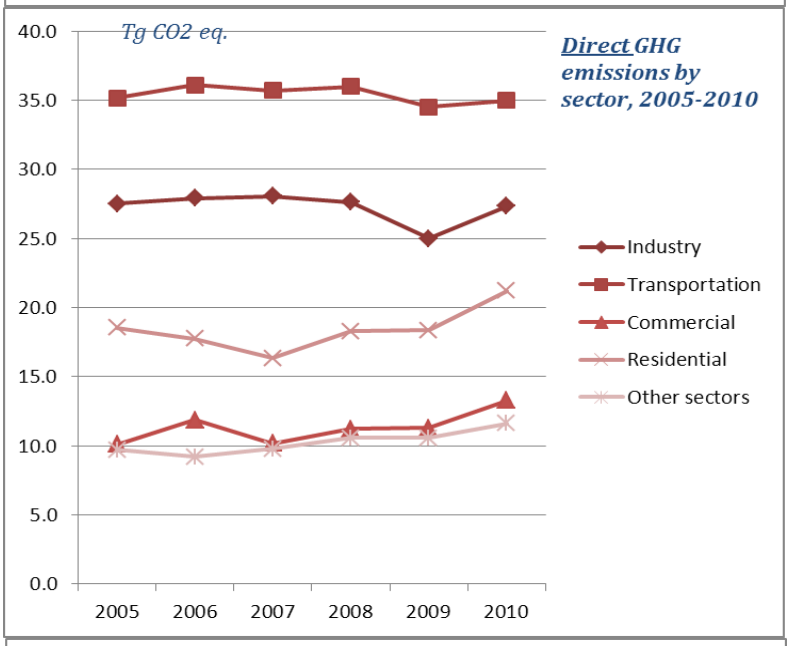


Note: The sum of direct and indirect emissions equals end-use emissions. The total indirect emissions allocated to end users in a country can be smaller than the direct emissions from fuel transformation in that country if some of the indirect emissions are allocated to exports and international bunkers. The indirect emissions allocated to end users including exports and bunkers equal 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' includes emissions from agriculture, forestry and fishing as well as the net (indirect) emissions from energy trade.

Source: EEA, 2012

Figure A2.35 Trends in direct and indirect GHG emissions by end use sector in Netherlands, 2005-2010





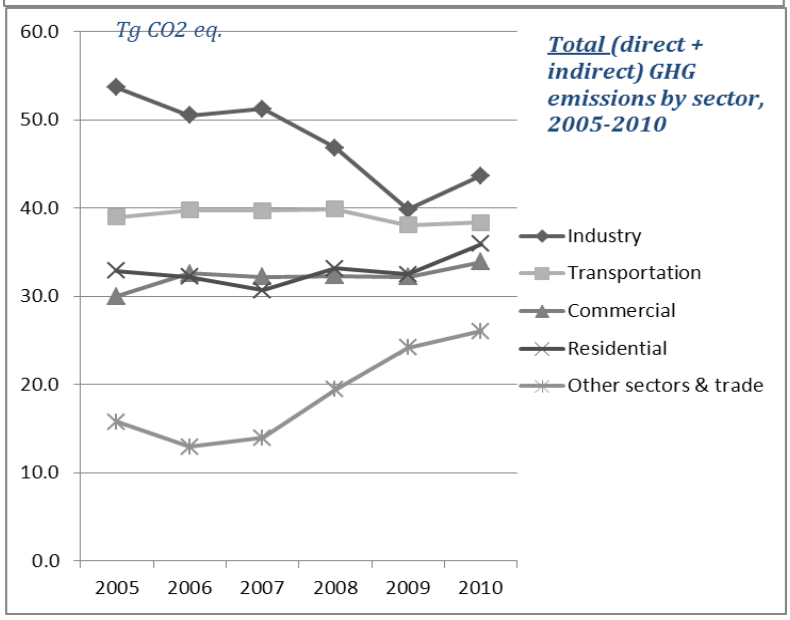
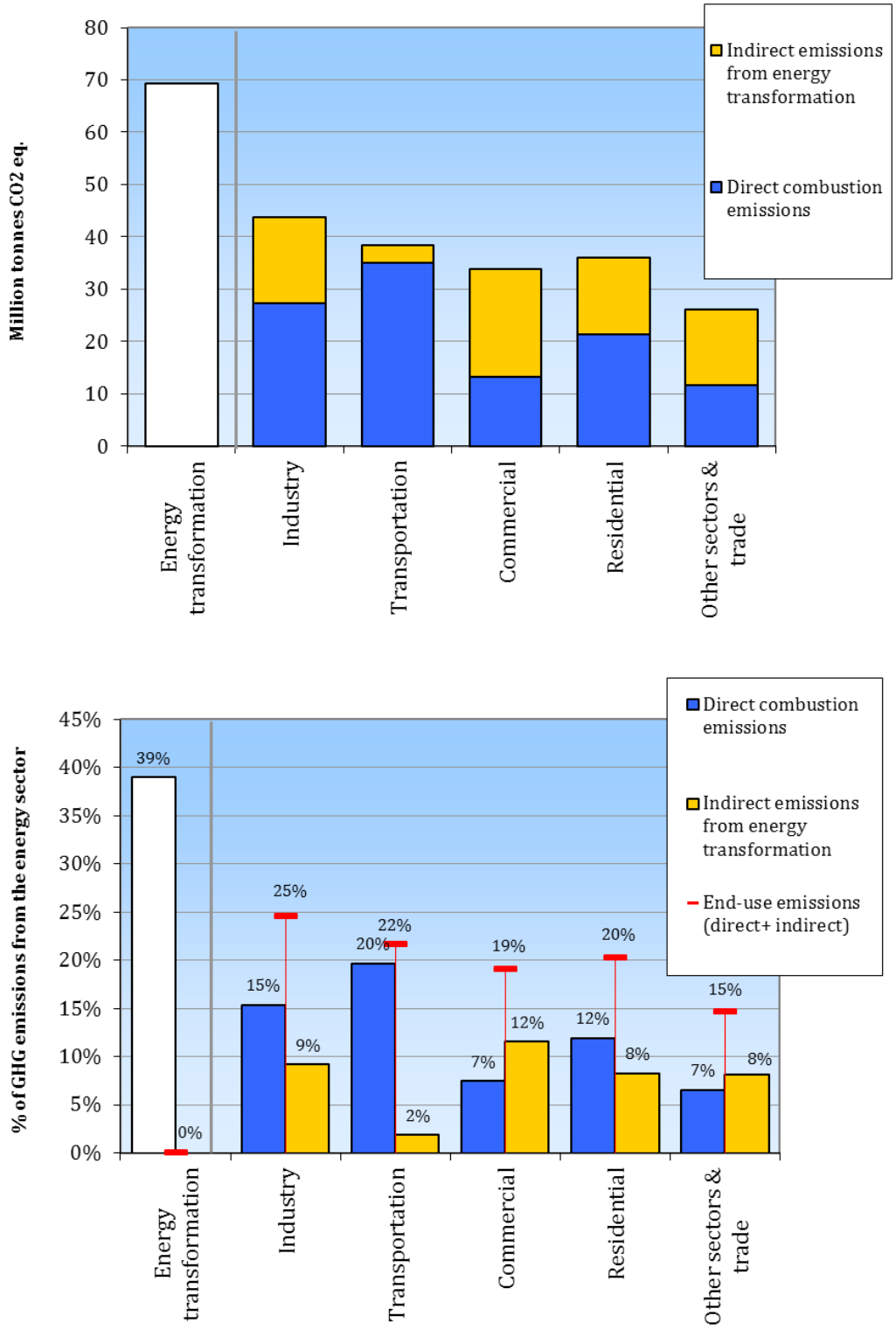


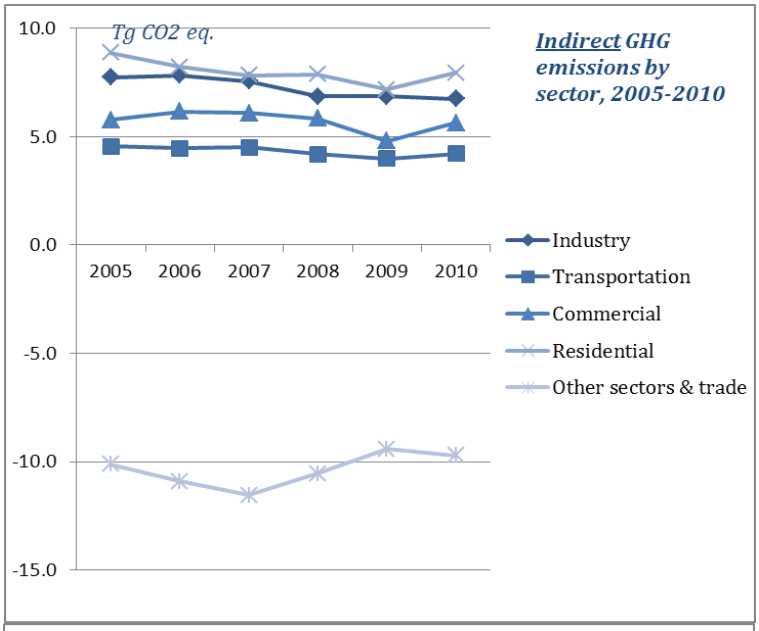
Figure A2.36 Direct and indirect GHG emissions by end use sector in Netherlands in 2010

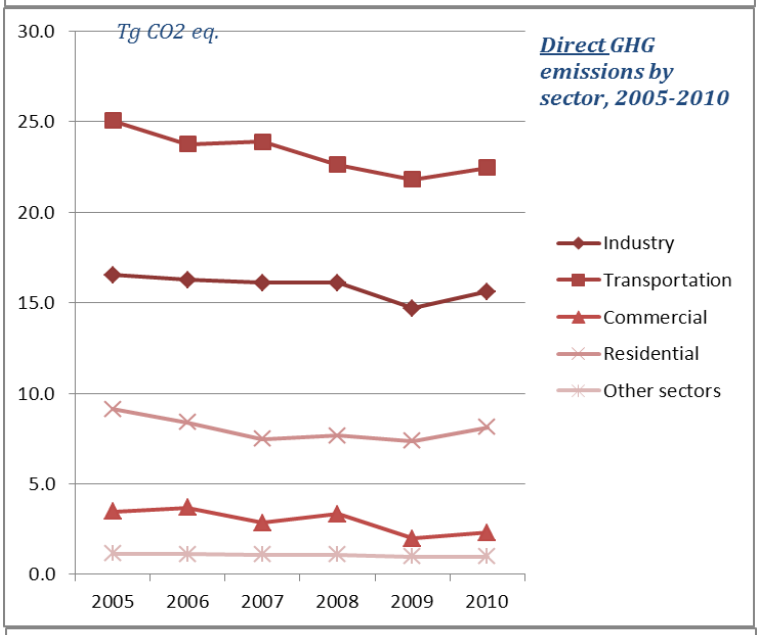


Note: The sum of direct and indirect emissions equals end-use emissions. The total indirect emissions allocated to end users in a country can be smaller than the direct emissions from fuel transformation in that country if some of the indirect emissions are allocated to exports and international bunkers. The indirect emissions allocated to end users including exports and bunkers equal 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' includes emissions from agriculture, forestry and fishing as well as the net (indirect) emissions from energy trade.

Source: EEA, 2012

Figure A2.37 Trends in direct and indirect GHG emissions by end use sector in Austria, 2005-2010





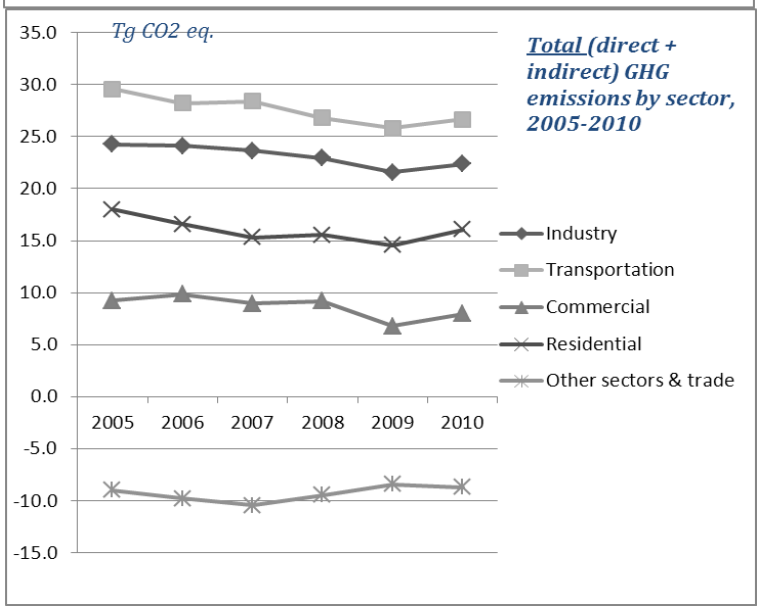
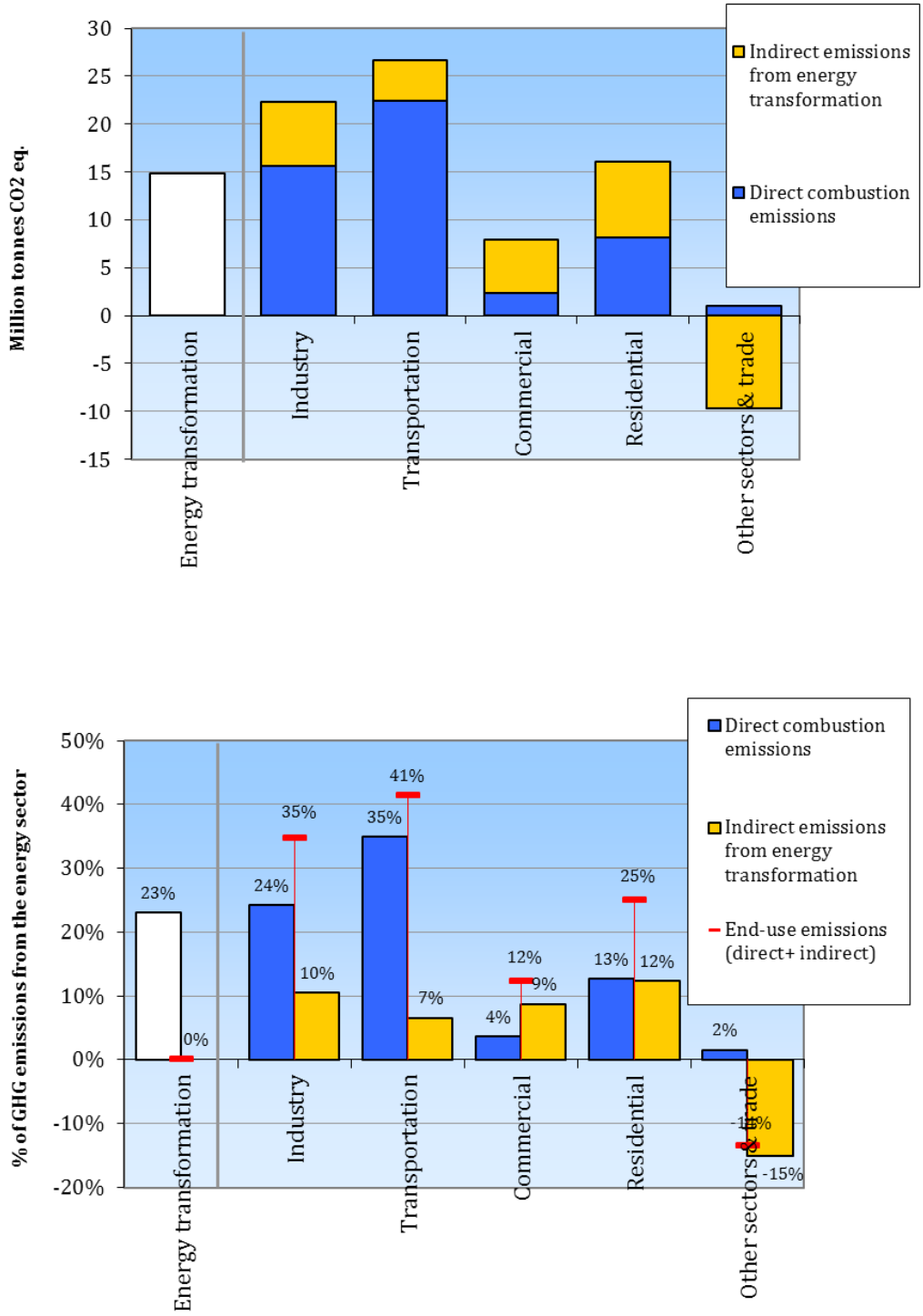


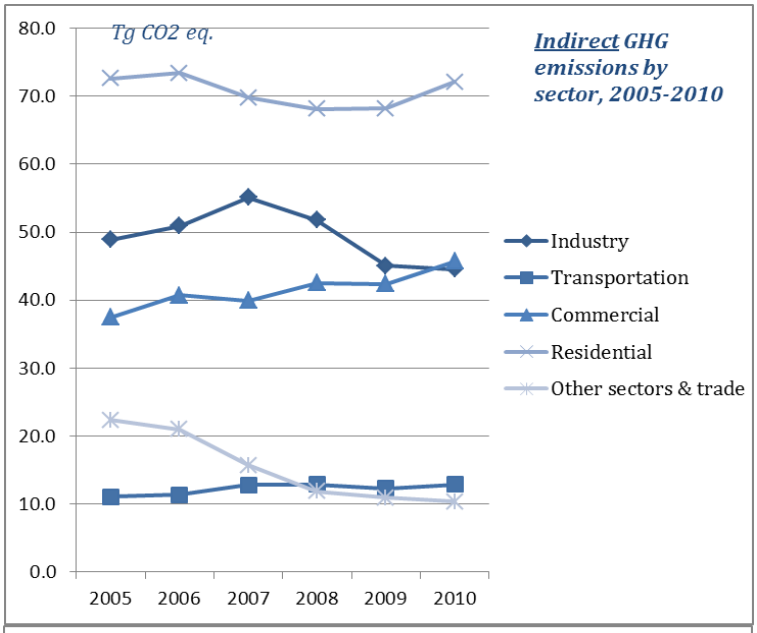
Figure A2.38 Direct and indirect GHG emissions by end use sector in Austria in 2010

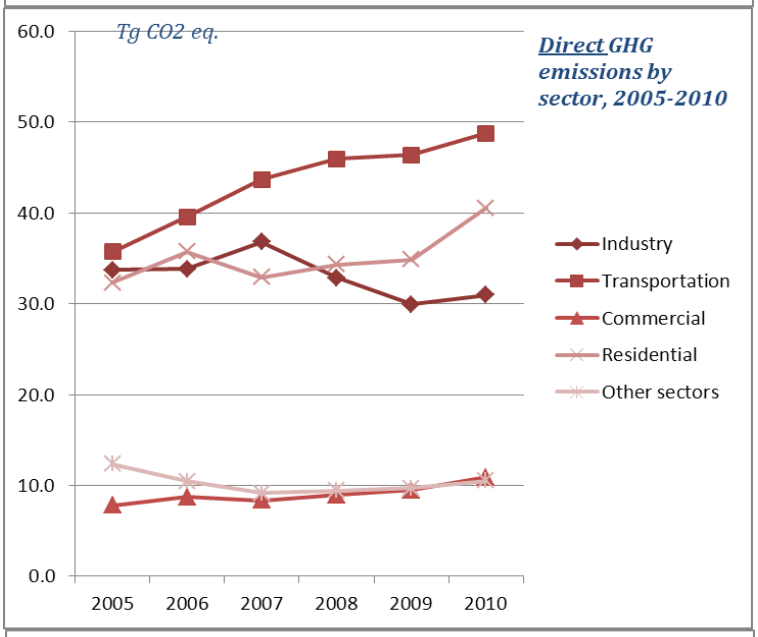


Note: The sum of direct and indirect emissions equals end-use emissions. The total indirect emissions allocated to end users in a country can be smaller than the direct emissions from fuel transformation in that country if some of the indirect emissions are allocated to exports and international bunkers. The indirect emissions allocated to end users including exports and bunkers equal 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' includes emissions from agriculture, forestry and fishing as well as the net (indirect) emissions from energy trade.

Source: EEA, 2012

Figure A2.39 Trends in direct and indirect GHG emissions by end use sector in Poland, 2005-2010





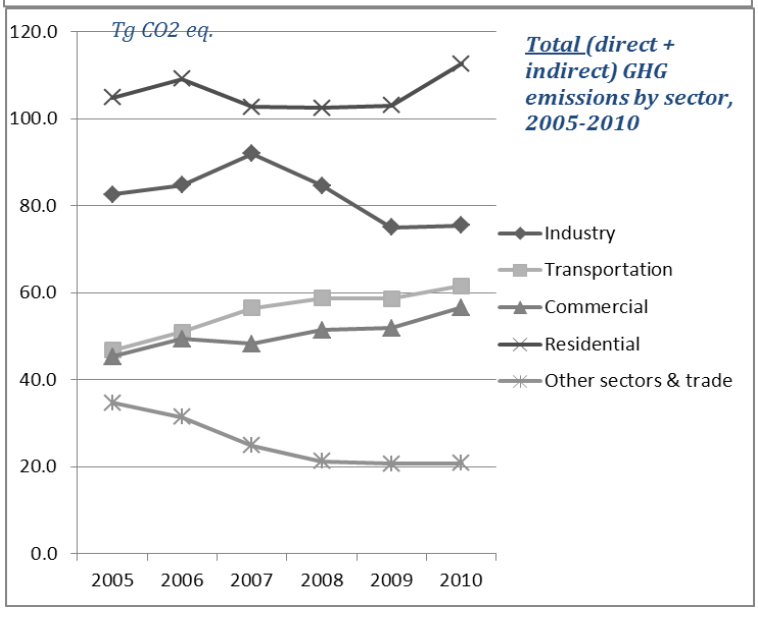
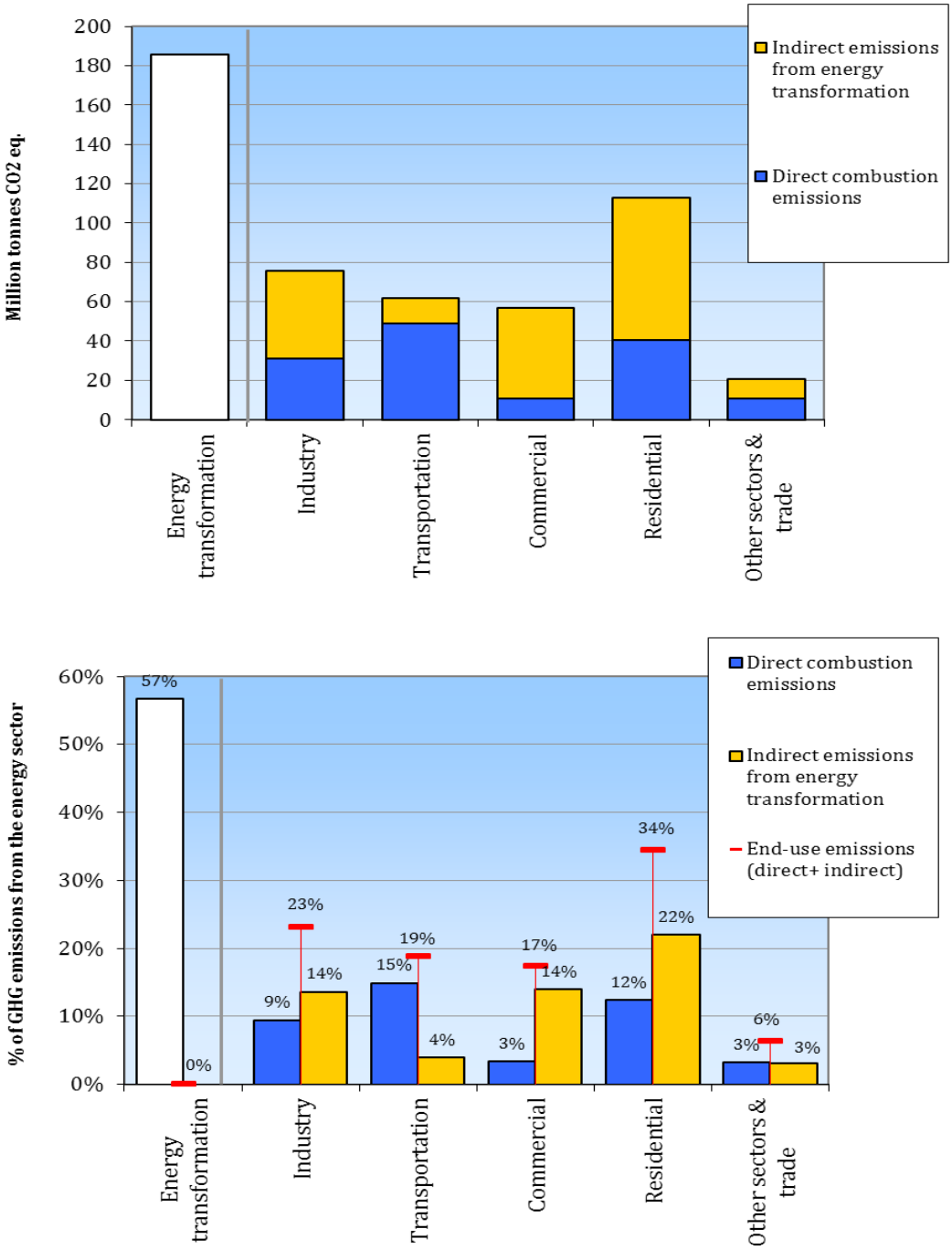


Figure A2.40 Direct and indirect GHG emissions by end use sector in Poland[24] in 2010

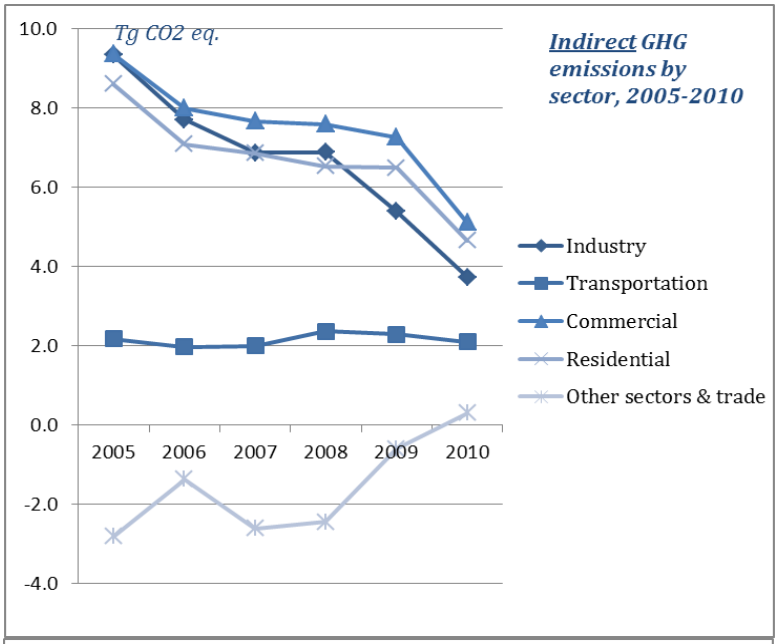


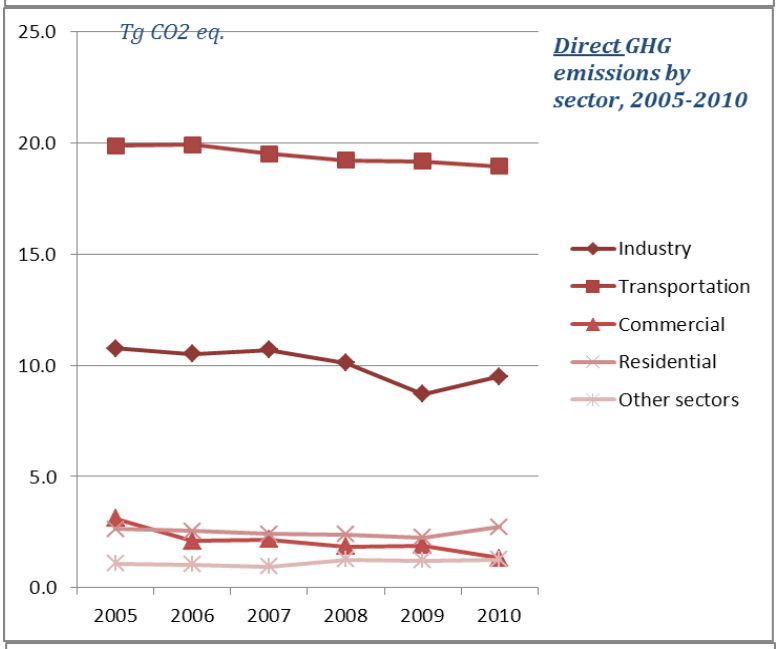
Note: The sum of direct and indirect emissions equals end-use emissions. The total indirect emissions allocated to end users in a country can be smaller than the direct emissions from fuel transformation in that country if some of the indirect emissions are allocated to exports and international bunkers. The indirect emissions allocated to end users including exports and bunkers equal 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' includes emissions from agriculture, forestry and fishing as well as the net (indirect) emissions from energy trade.

Source: EEA, 2012

[24] 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, 2005-2010





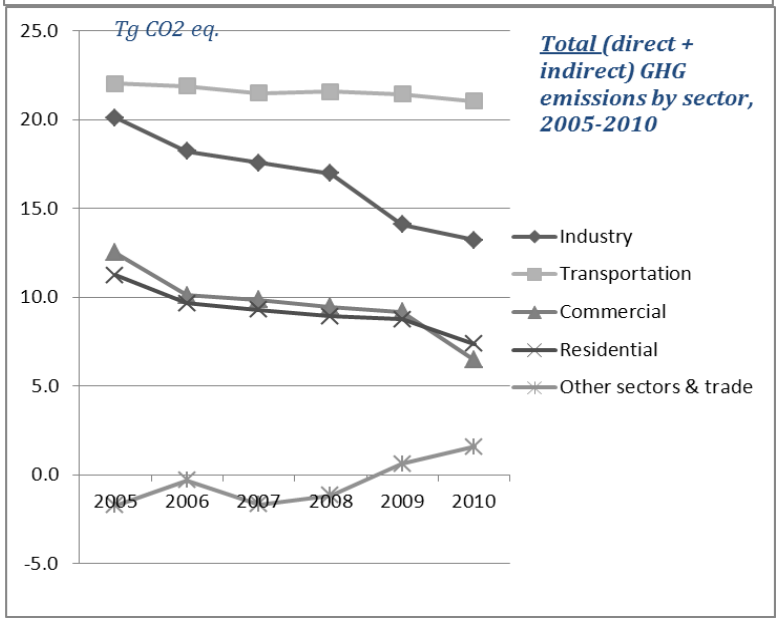
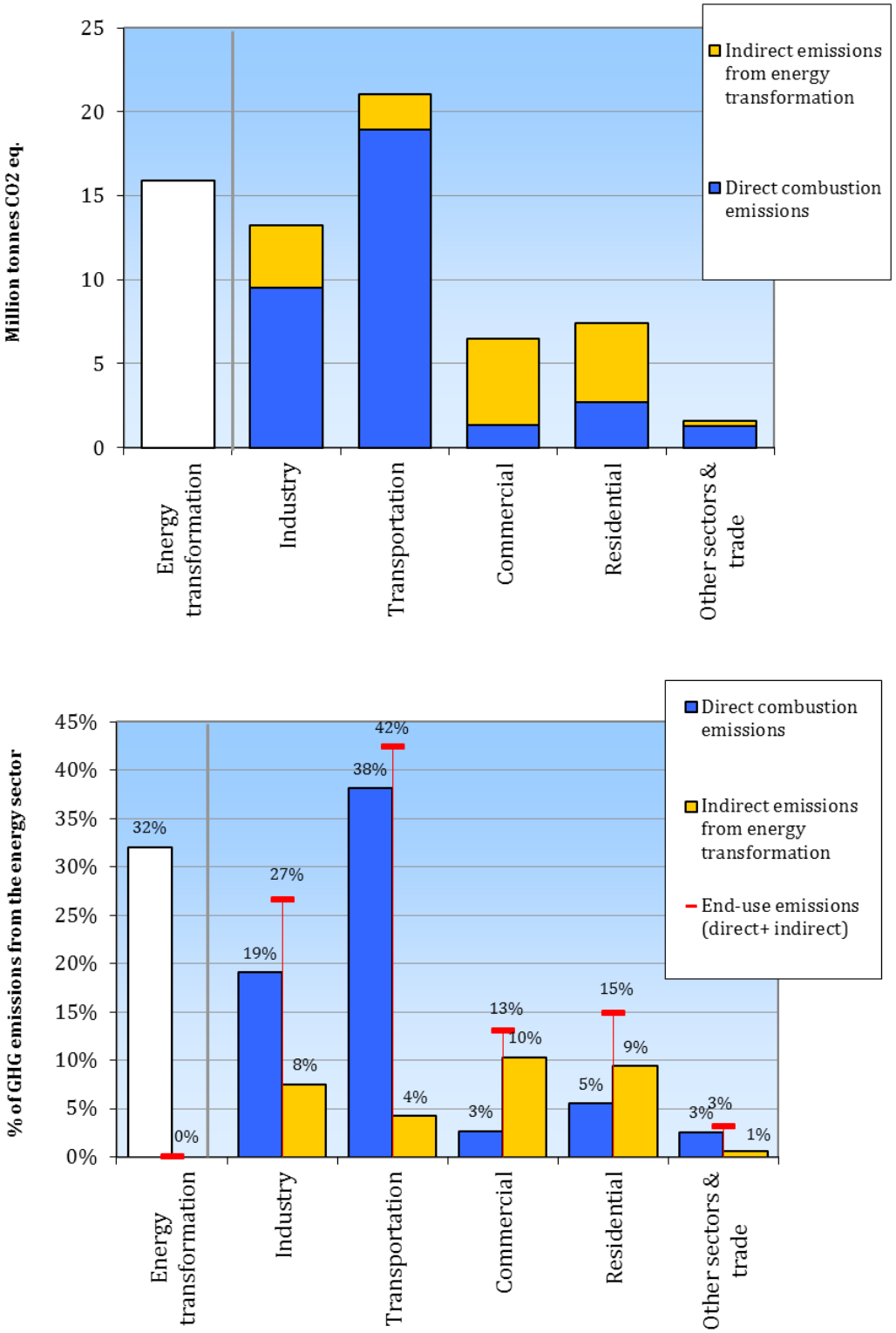


Figure A2.42 Direct and indirect GHG emissions by end use sector in Portugal in 2010



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 equal 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' includes emissions from agriculture, forestry and fishing as well as the net (indirect) emissions from energy trade.

Source: EEA, 2012

Figure A2.43 Trends in direct and indirect GHG emissions by end use sector in Romania, 2005-2010

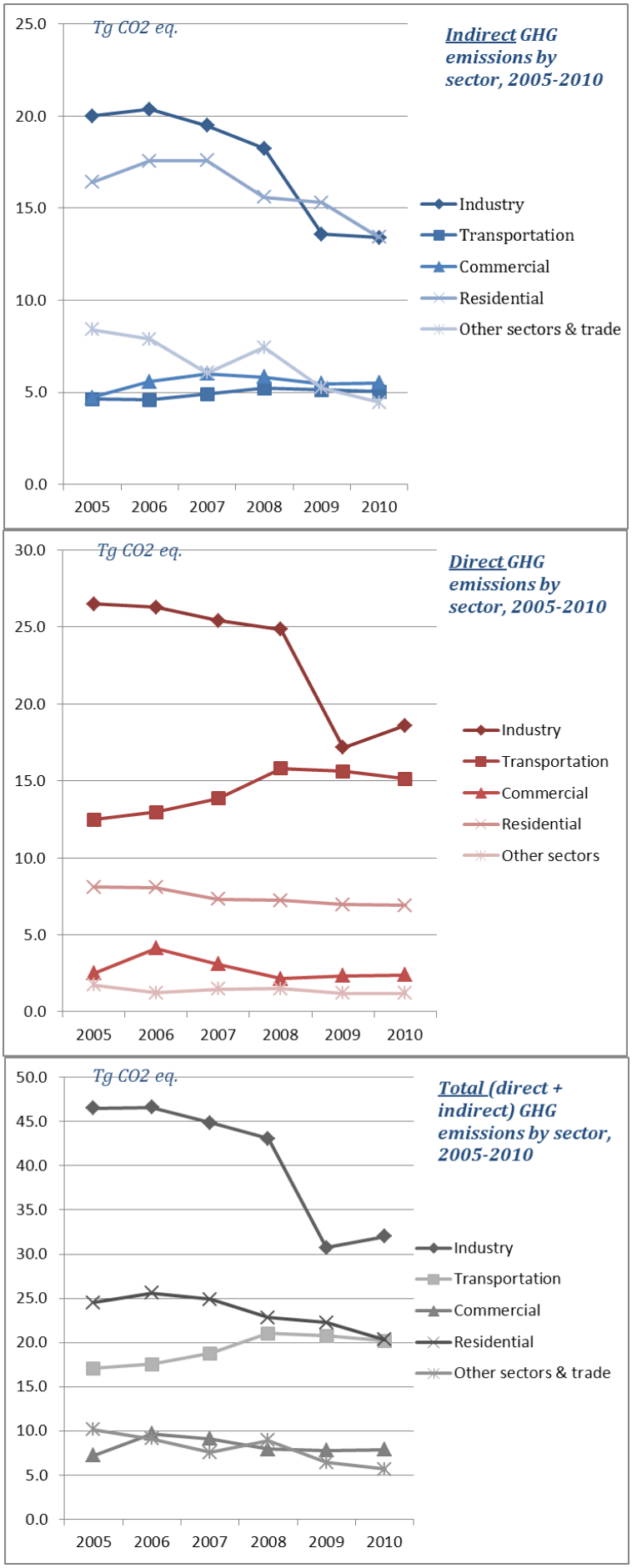
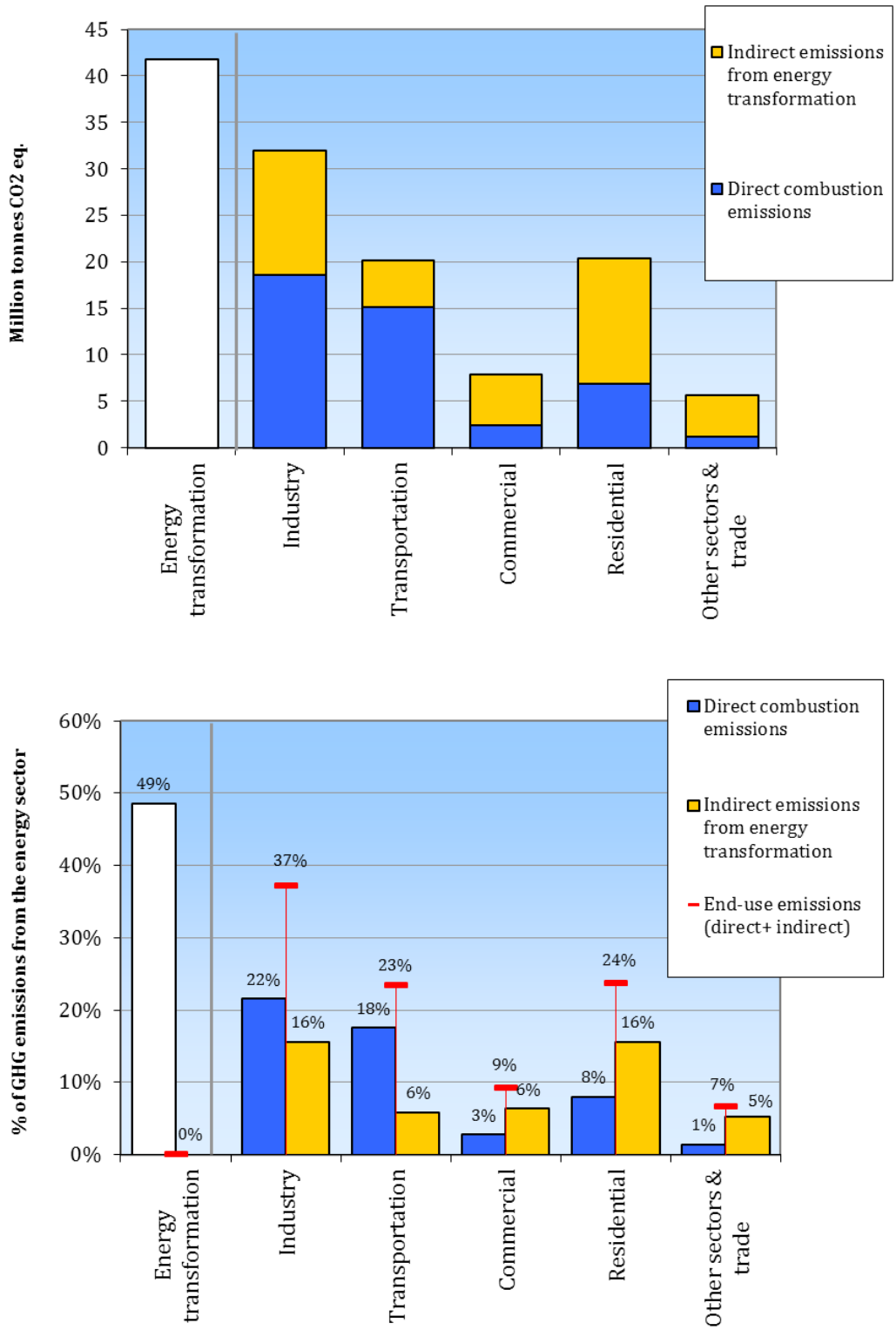


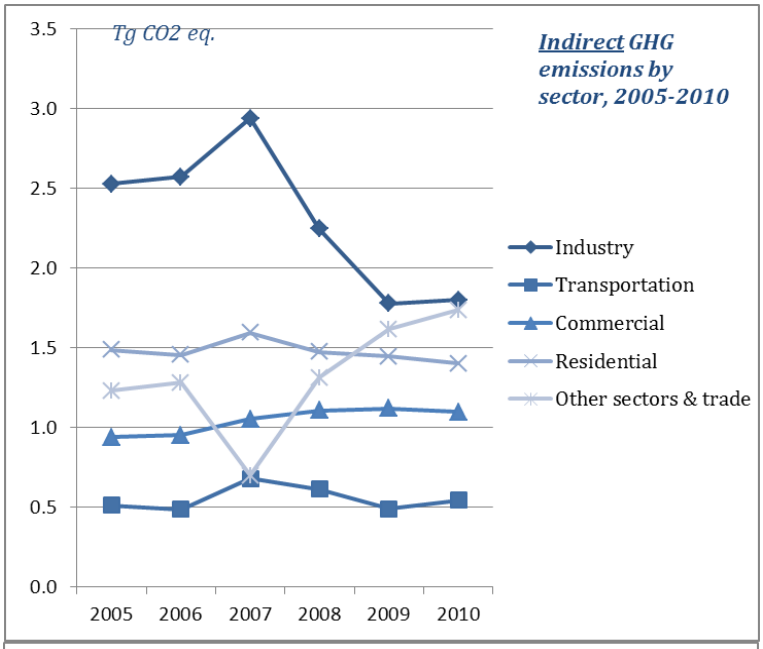
Figure A2.44 Direct and indirect GHG emissions by end use sector in Romania in 2010

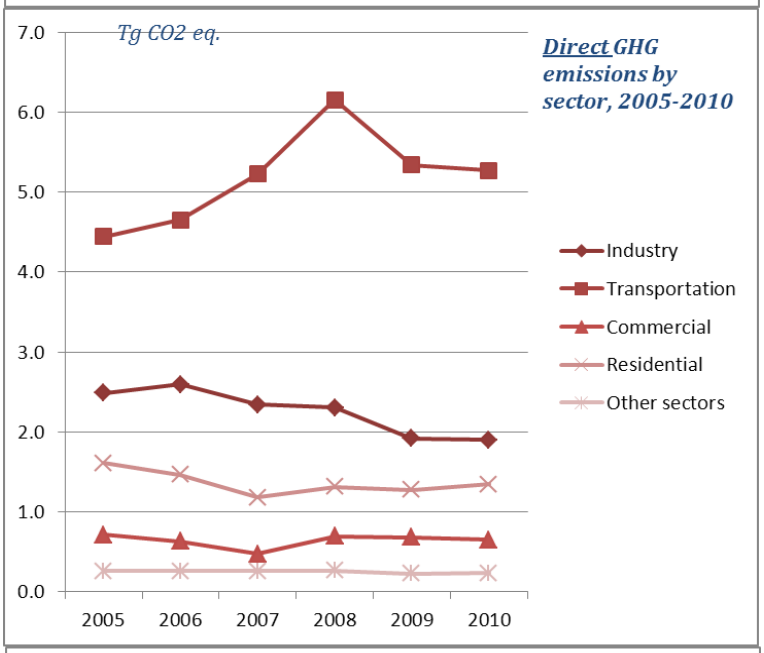


Note: The sum of direct and indirect emissions equals end-use emissions. The total indirect emissions allocated to end users in a country can be smaller than the direct emissions from fuel transformation in that country if some of the indirect emissions are allocated to exports and international bunkers. The indirect emissions allocated to end users including exports and bunkers equal 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' includes emissions from agriculture, forestry and fishing as well as the net (indirect) emissions from energy trade.

Source: EEA, 2012

Figure A2.45 Trends in direct and indirect GHG emissions by end use sector in Slovenia, 2005-2010





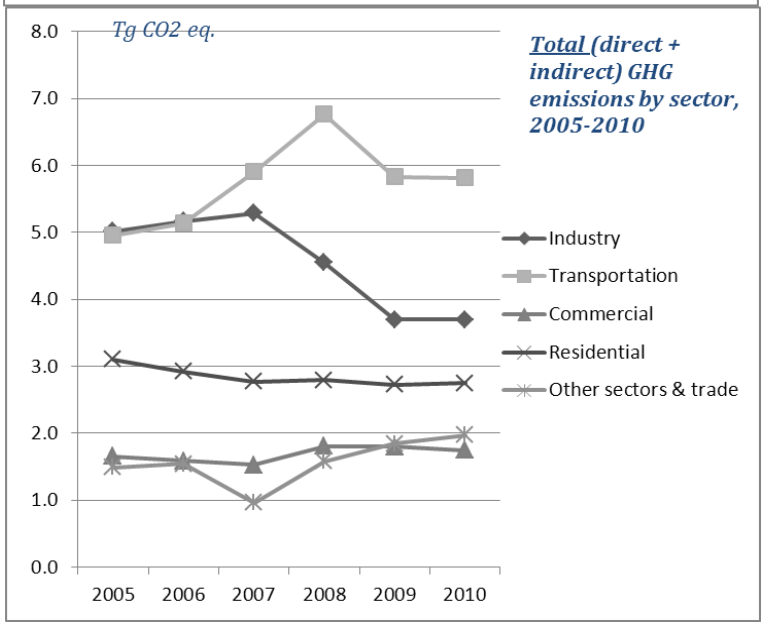
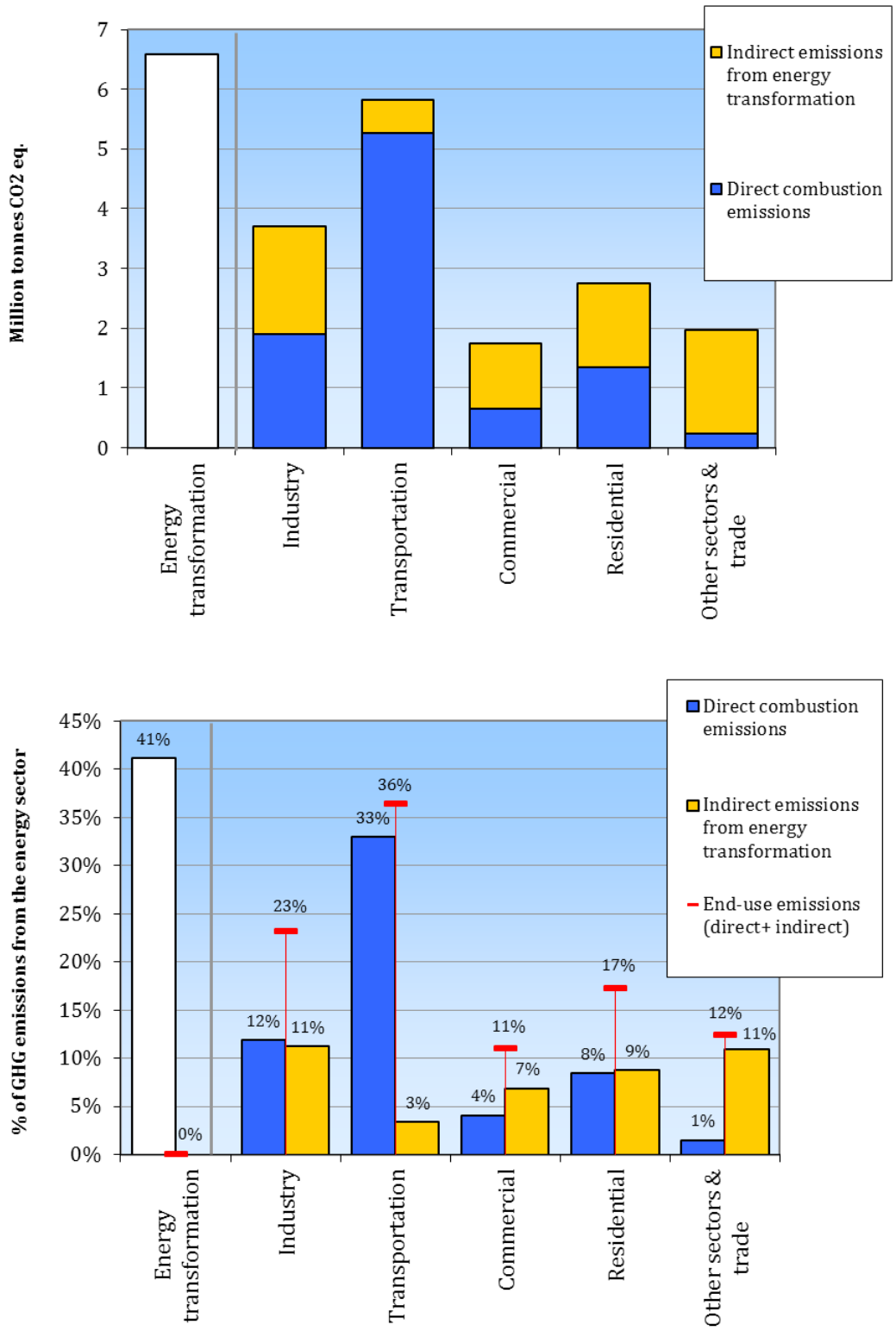


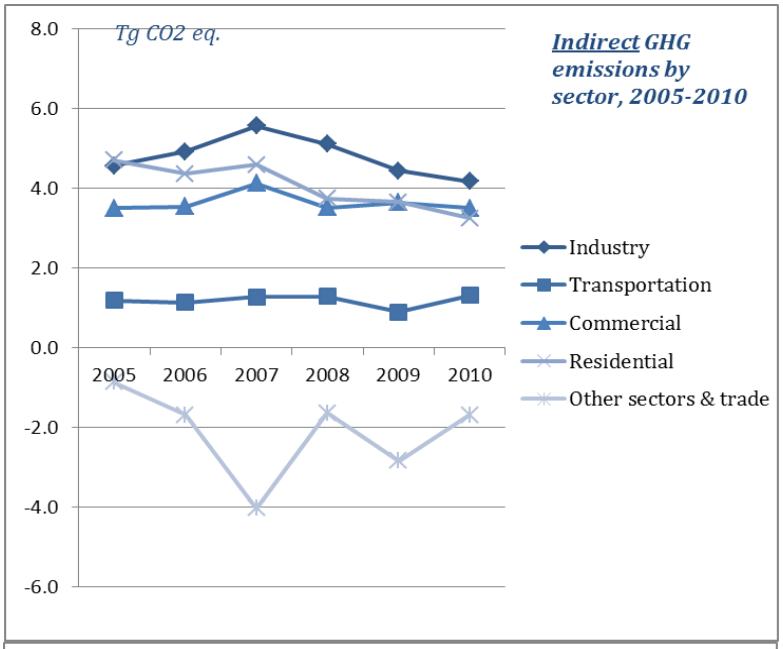
Figure A2.46 Direct and indirect GHG emissions by end use sector in Slovenia in 2010

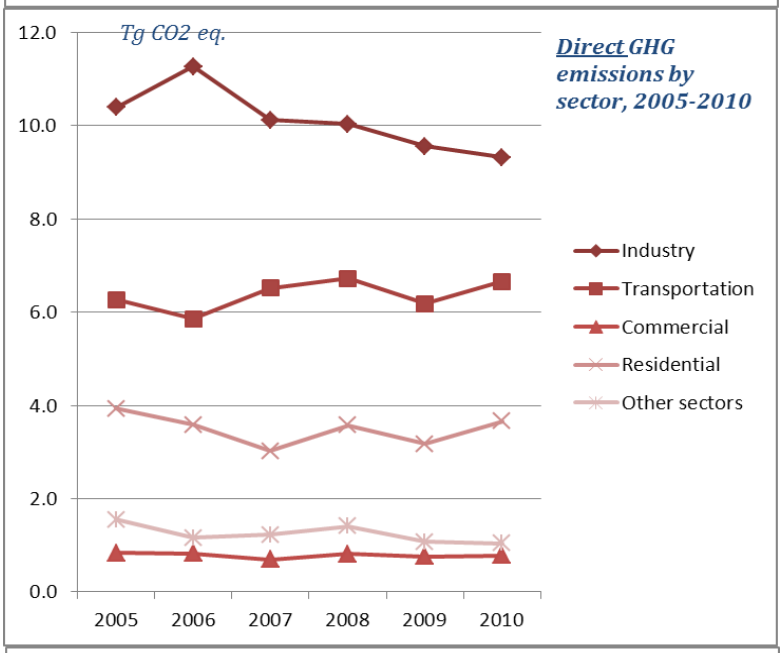


Note: The sum of direct and indirect emissions equals end-use emissions. The total indirect emissions allocated to end users in a country can be smaller than the direct emissions from fuel transformation in that country if some of the indirect emissions are allocated to exports and international bunkers. The indirect emissions allocated to end users including exports and bunkers equal 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' includes emissions from agriculture, forestry and fishing as well as the net (indirect) emissions from energy trade.

Source: EEA, 2012

Figure A2.47 Trends in direct and indirect GHG emissions by end use sector in Slovakia, 2005-2010





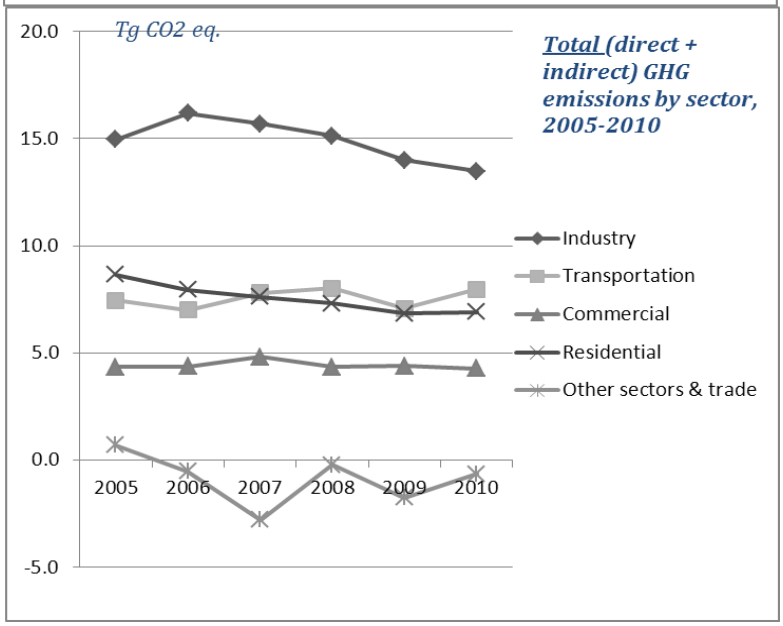
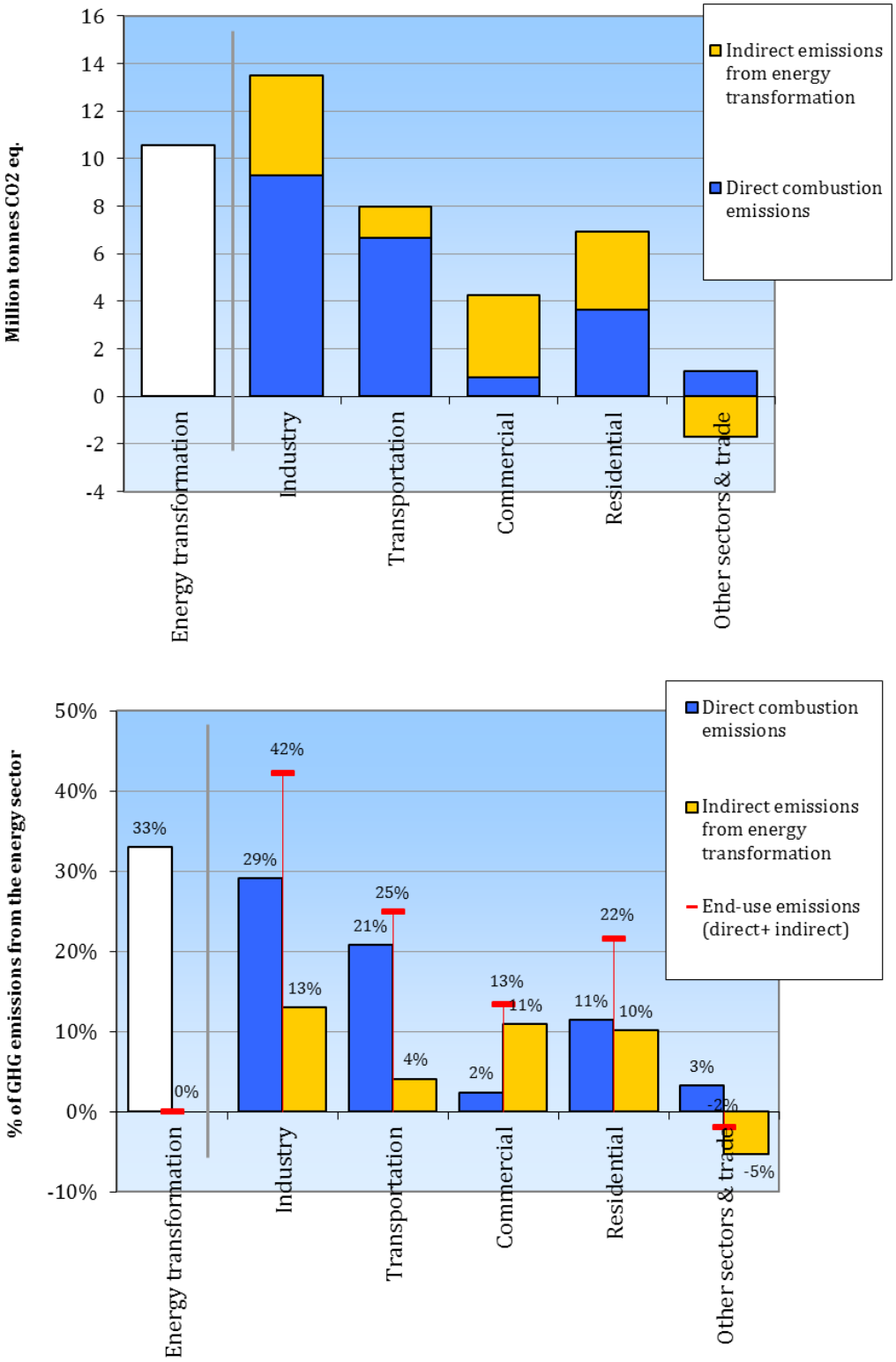


Figure A2.48 Direct and indirect GHG emissions by end use sector in Slovakia in 2010



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 equal 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' includes emissions from agriculture, forestry and fishing as well as the net (indirect) emissions from energy trade.

Source: EEA, 2012

Figure A2.49 Trends in direct and indirect GHG emissions by end use sector in Finland, 2005-2010

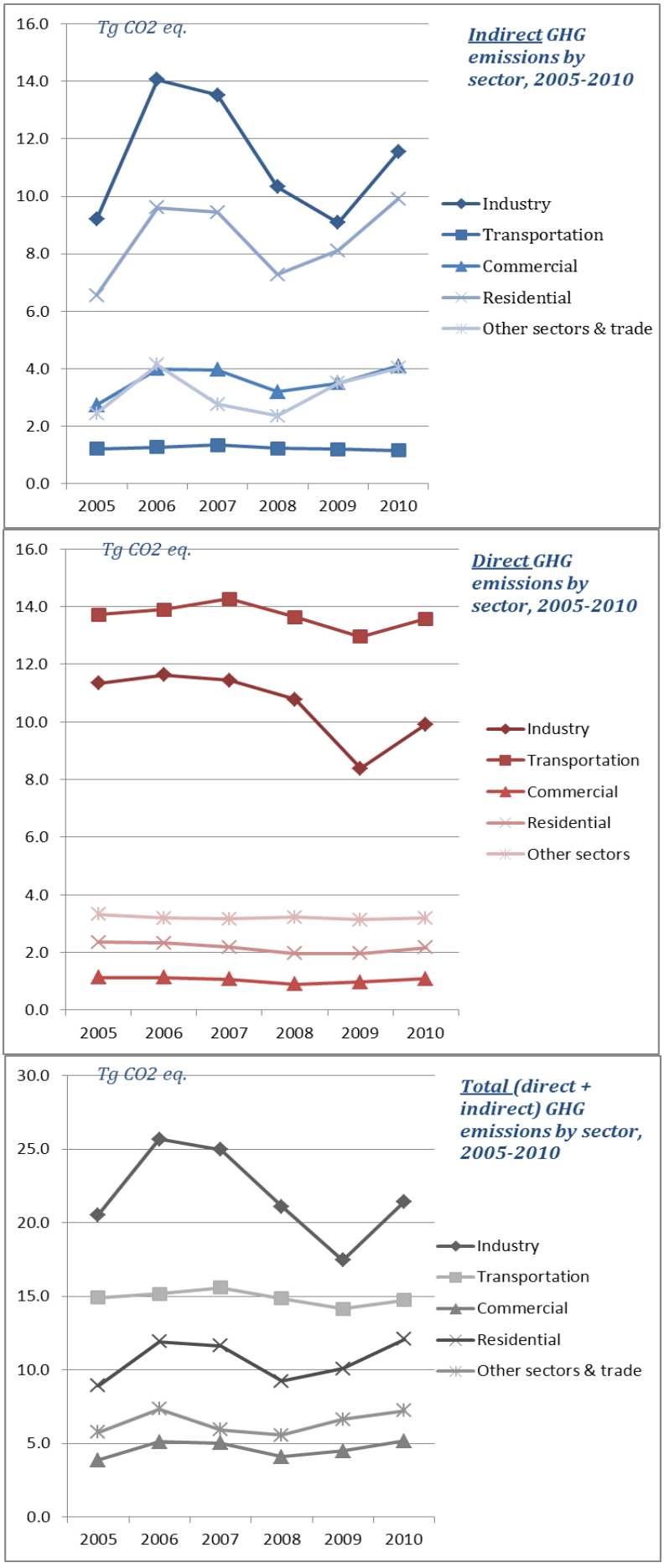
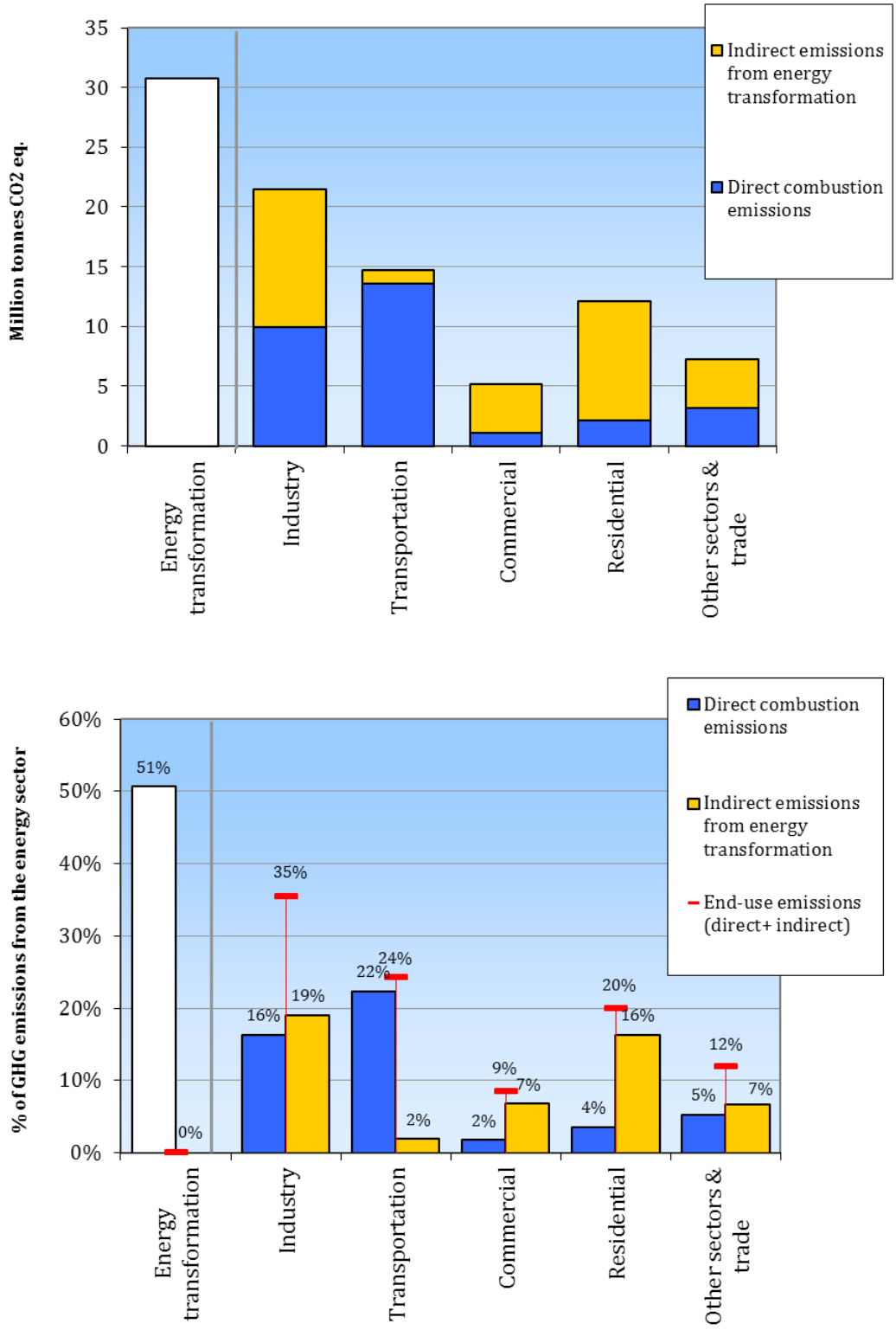


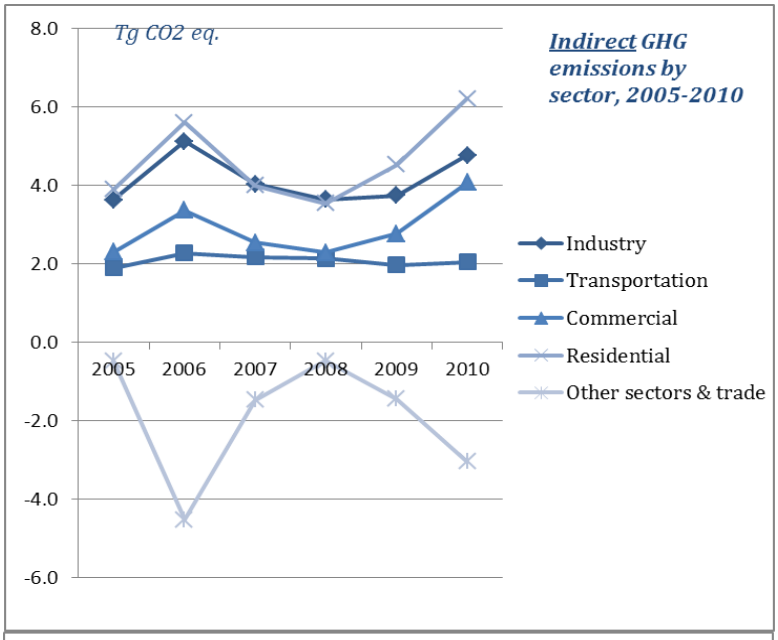
Figure A2.50 Direct and indirect GHG emissions by end use sector in Finland in 2010

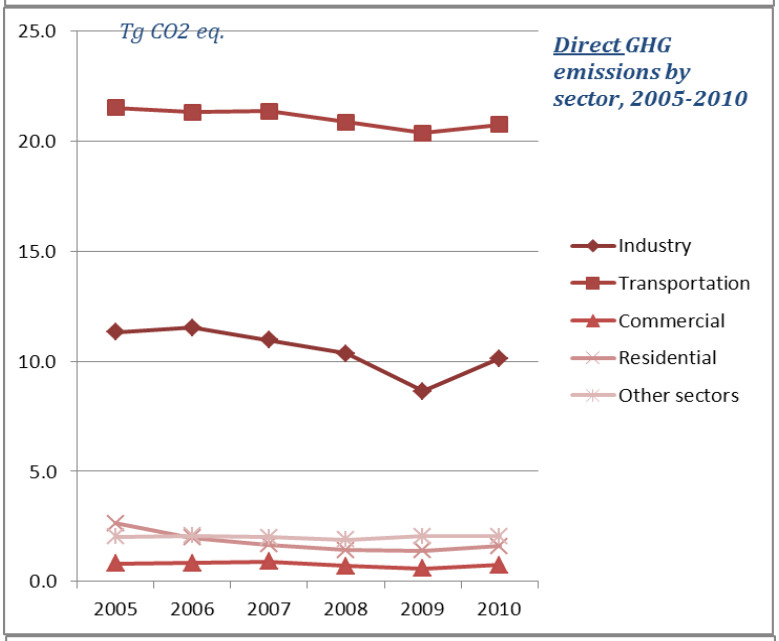


Note: The sum of direct and indirect emissions equals end-use emissions. The total indirect emissions allocated to end users in a country can be smaller than the direct emissions from fuel transformation in that country if some of the indirect emissions are allocated to exports and international bunkers. The indirect emissions allocated to end users including exports and bunkers equal 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' includes emissions from agriculture, forestry and fishing as well as the net (indirect) emissions from energy trade.

Source: EEA, 2012

Figure A2.51 Trends in direct and indirect GHG emissions by end use sector in Sweden, 2005-2010





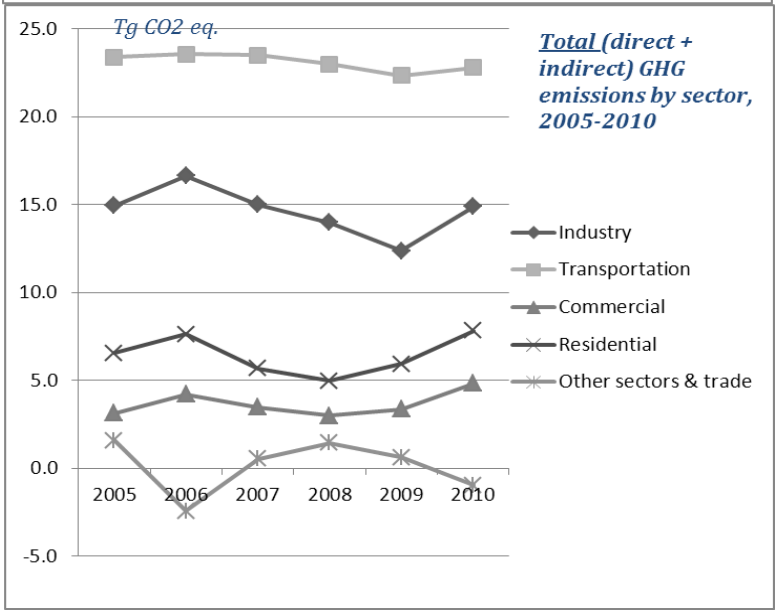
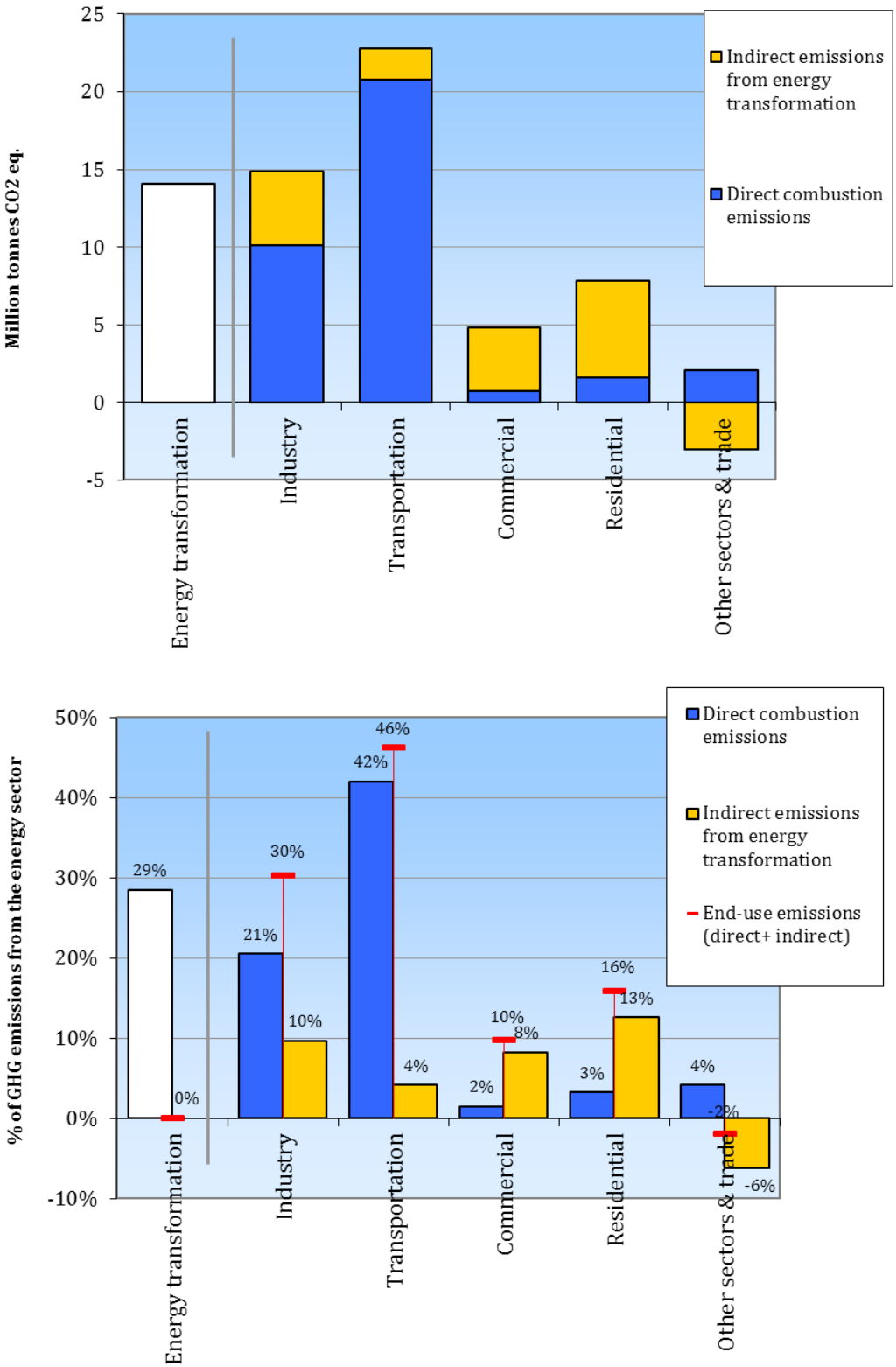


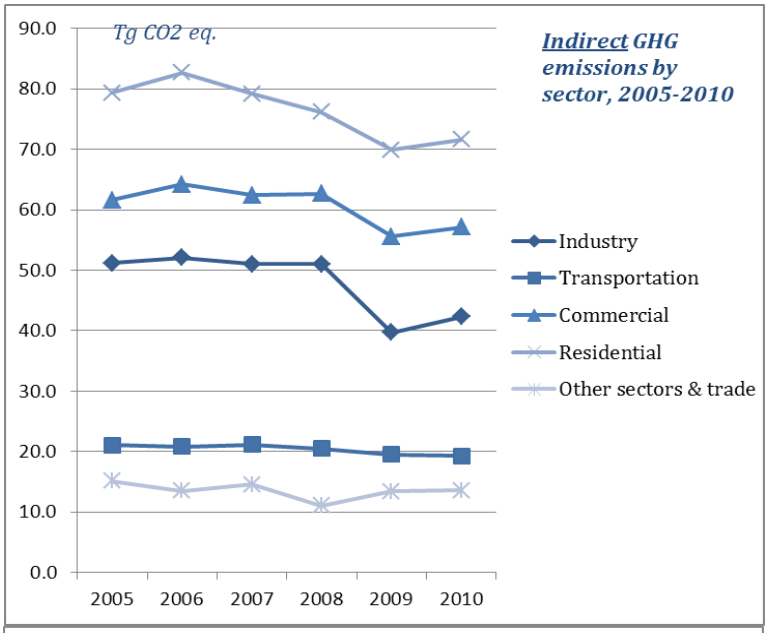
Figure A2.52 Direct and indirect GHG emissions by end use sector in Sweden in 2010

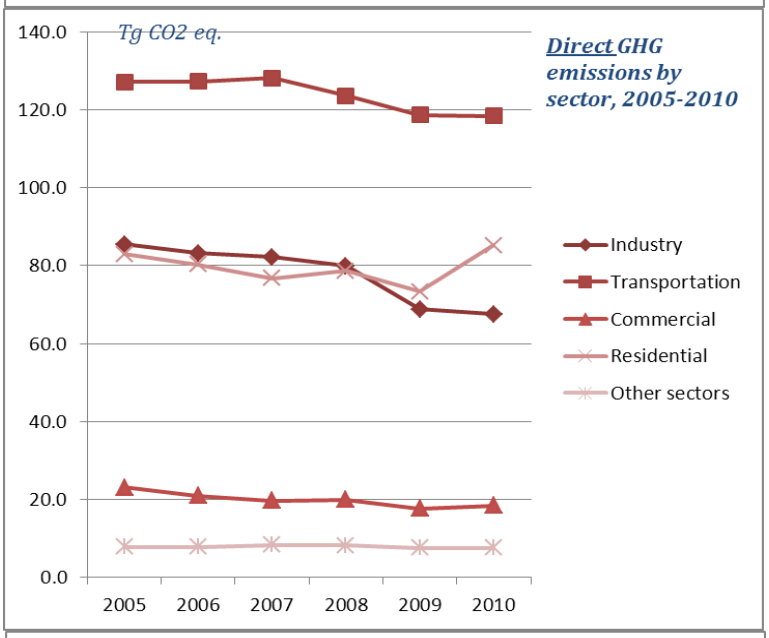


Note: The sum of direct and indirect emissions equals end-use emissions. The total indirect emissions allocated to end users in a country can be smaller than the direct emissions from fuel transformation in that country if some of the indirect emissions are allocated to exports and international bunkers. The indirect emissions allocated to end users including exports and bunkers equal 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' includes emissions from agriculture, forestry and fishing as well as the net (indirect) emissions from energy trade.

Source: EEA, 2012

Figure A2.53 Trends in direct and indirect GHG emissions by end use sector in United Kingdom, 2005-2010





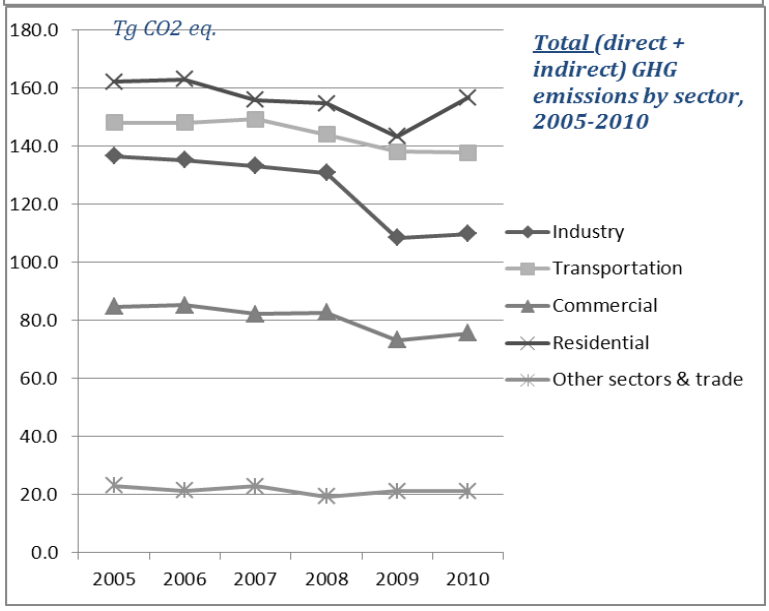
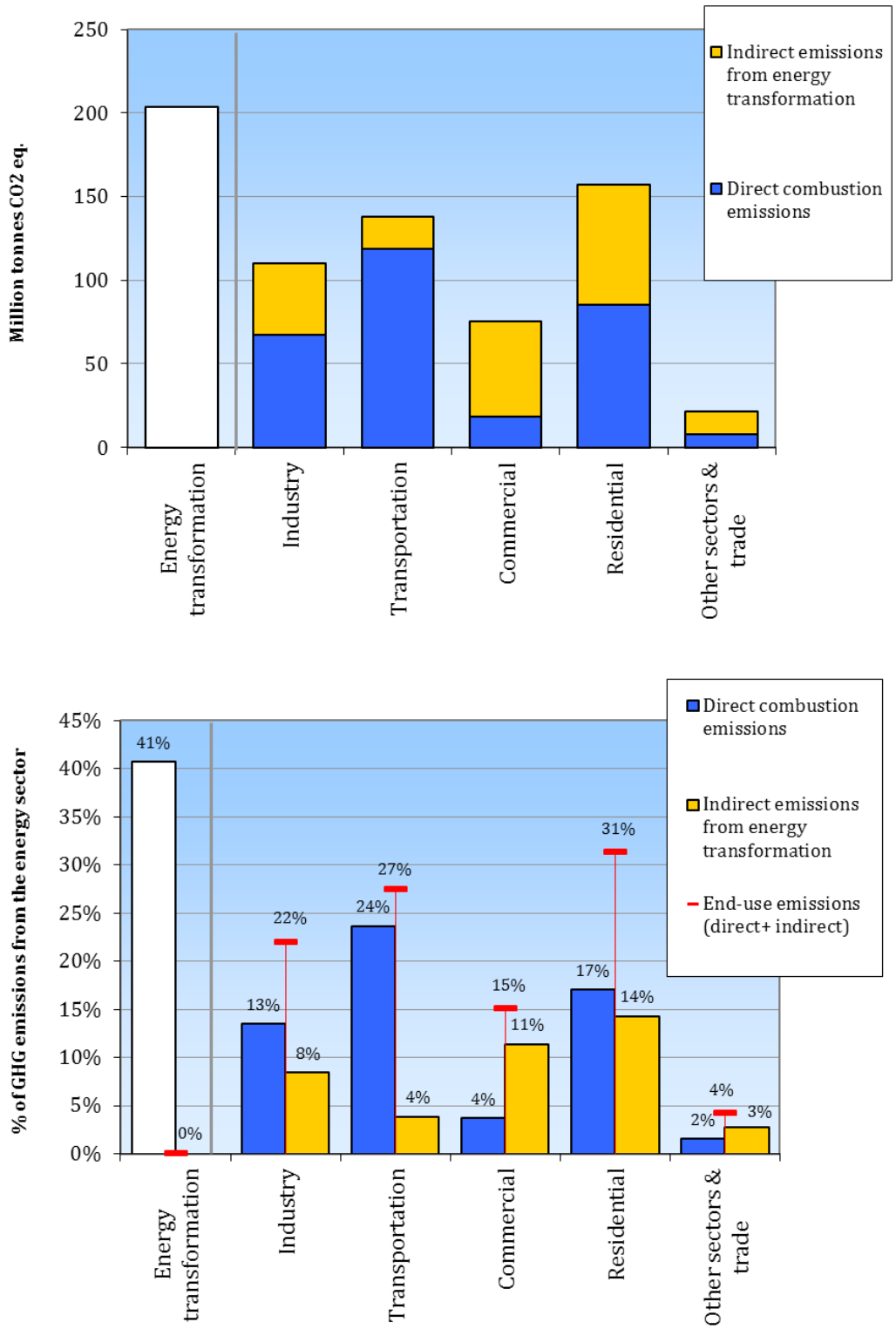


Figure A2.54 Direct and indirect GHG emissions by end use sector in United Kingdom in 2010



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 equal 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' includes emissions from agriculture, forestry and fishing as well as the net (indirect) emissions from energy trade.

Source: EEA, 2012

Figure A2.55 Trends in direct and indirect GHG emissions by end use sector in Norway, 2005-2010

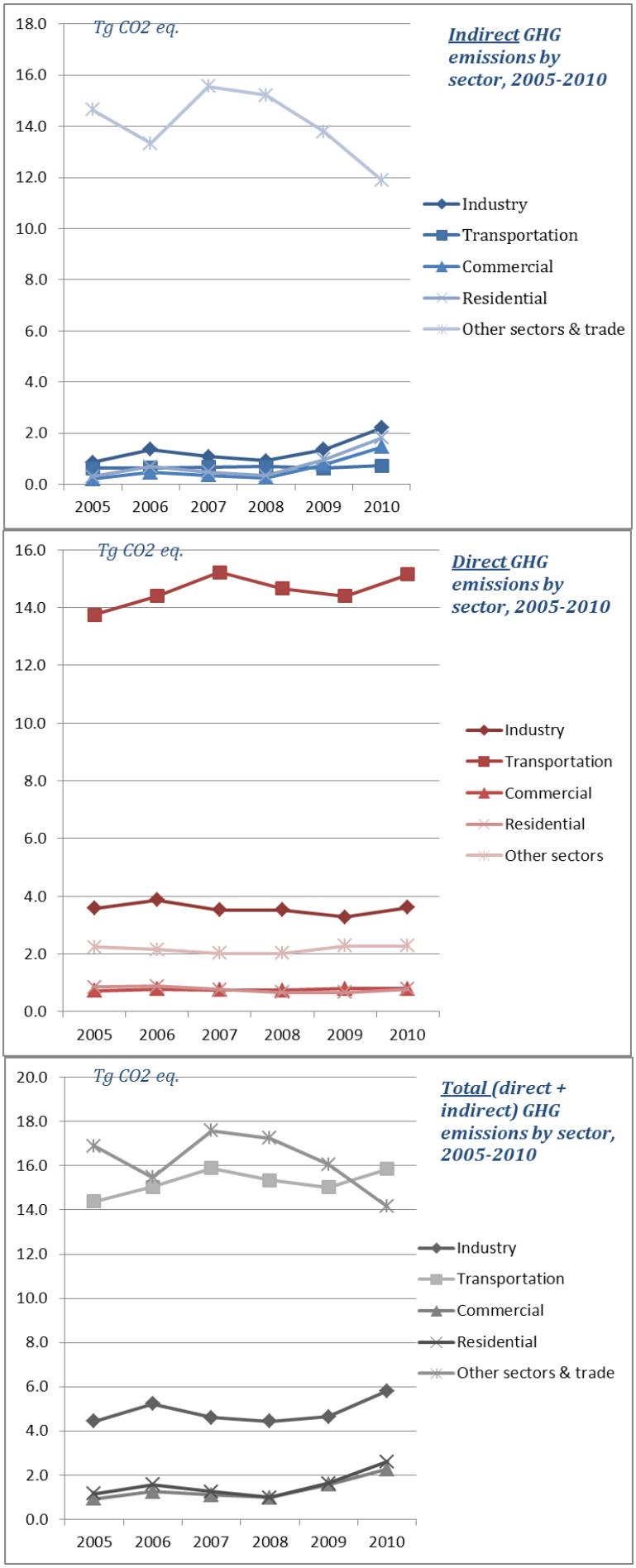
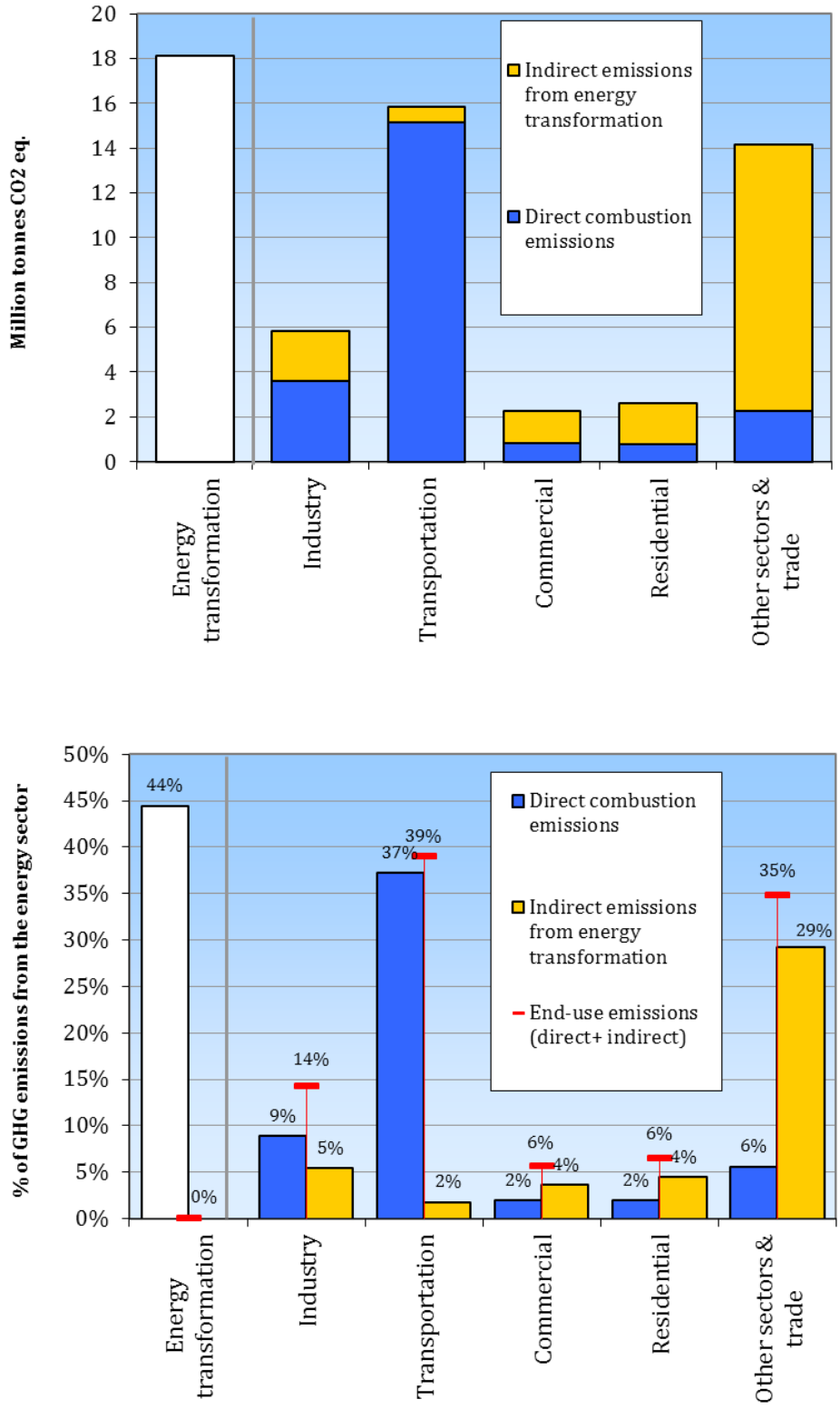


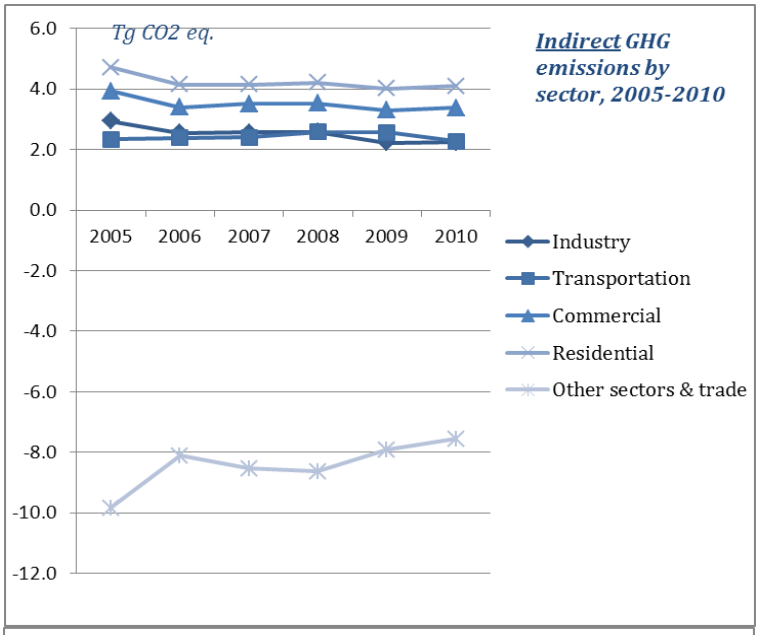
Figure A2.56 Direct and indirect GHG emissions by end use sector in Norway in 2010

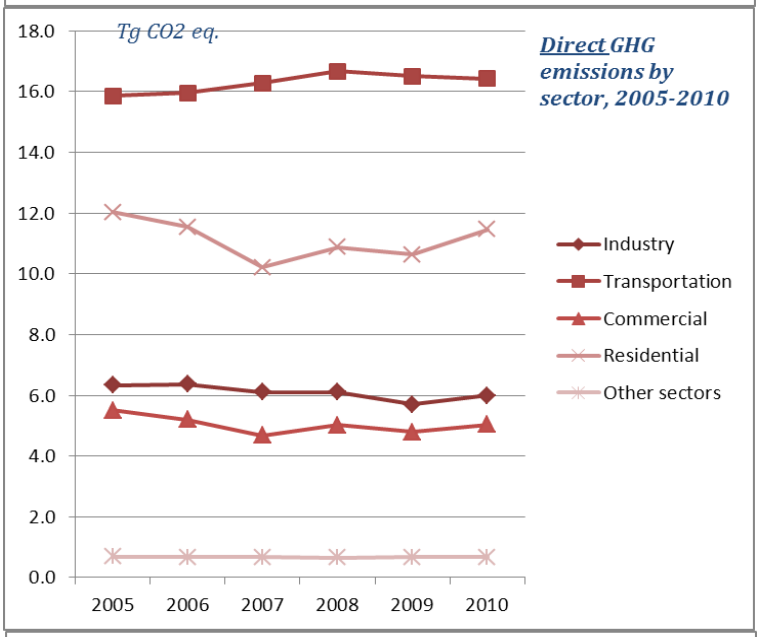


Note: The sum of direct and indirect emissions equals end-use emissions. The total indirect emissions allocated to end users in a country can be smaller than the direct emissions from fuel transformation in that country if some of the indirect emissions are allocated to exports and international bunkers. The indirect emissions allocated to end users including exports and bunkers equal 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' includes emissions from agriculture, forestry and fishing as well as the net (indirect) emissions from energy trade.

Source: EEA, 2012

Figure A2.55 Trends in direct and indirect GHG emissions by end use sector in Switzerland, 2005-2010





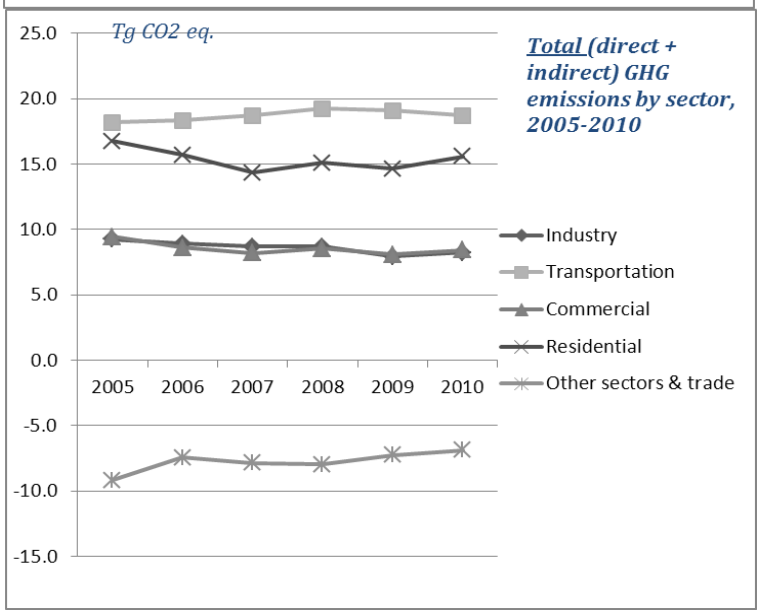
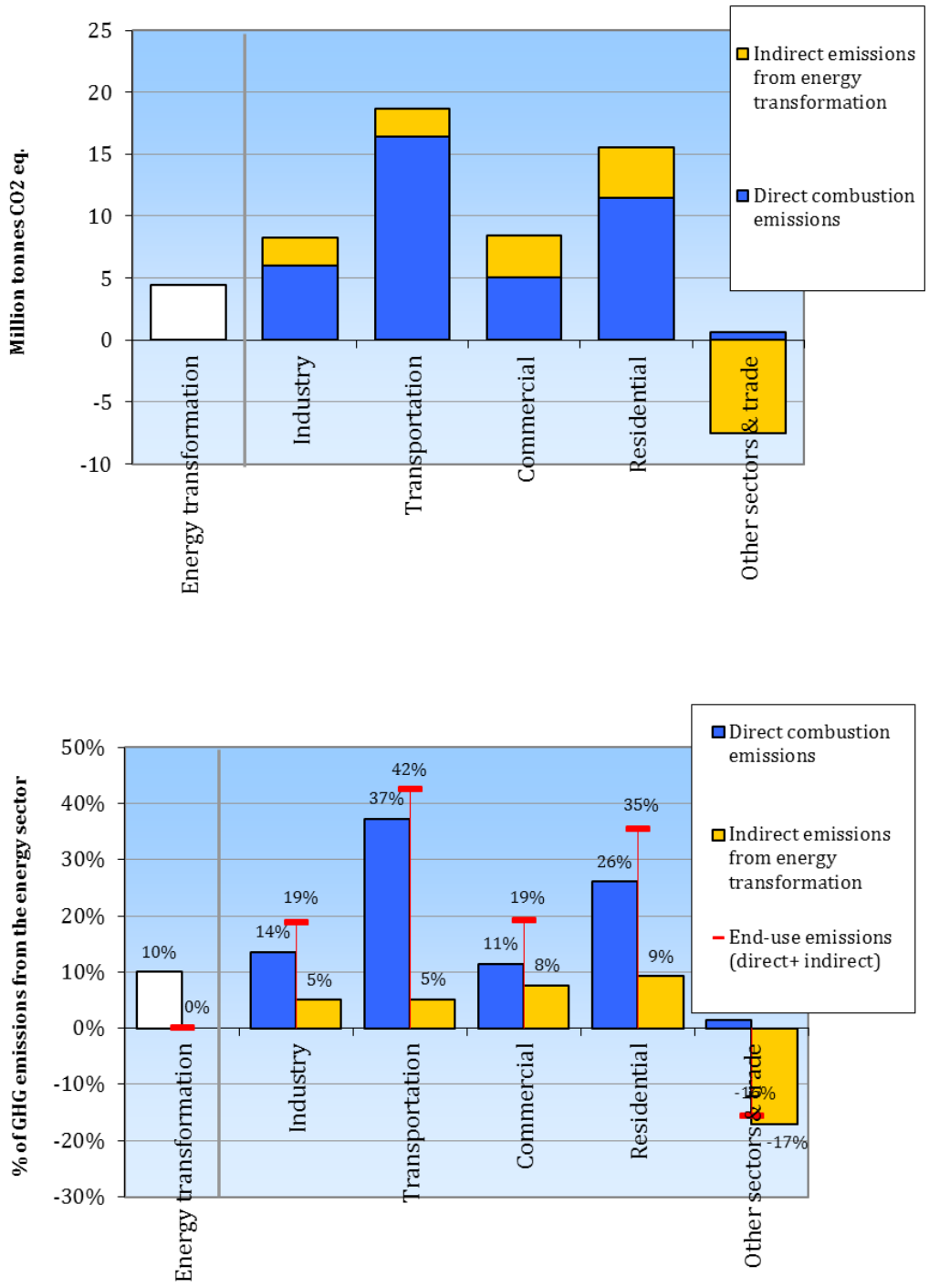


Figure A2.56 Direct and indirect GHG emissions by end use sector in Switzerland in 2010

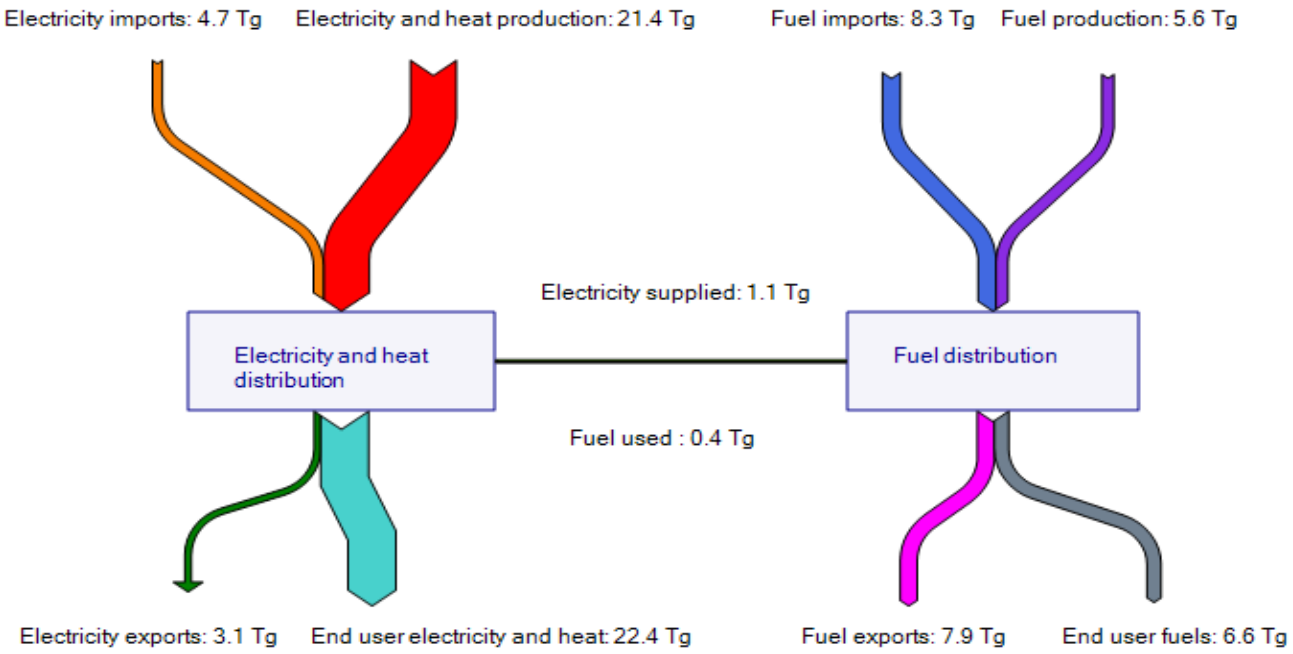


Note: The sum of direct and indirect emissions equals end-use emissions. The total indirect emissions allocated to end users in a country can be smaller than the direct emissions from fuel transformation in that country if some of the indirect emissions are allocated to exports and international bunkers. The indirect emissions allocated to end users including exports and bunkers equal 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' includes emissions from agriculture, forestry and fishing as well as the net (indirect) emissions from energy trade.

Source: EEA, 2012

Appendix 3 – Greenhouse gas emissions associated with energy flows in EU Member States and other EEA member countries: Transformation and distribution

Figure A3.1 Direct GHG emissions from energy transformation (upper chart) and indirect GHG emissions from energy distribution by end user (lower chart) in Belgium, 2010



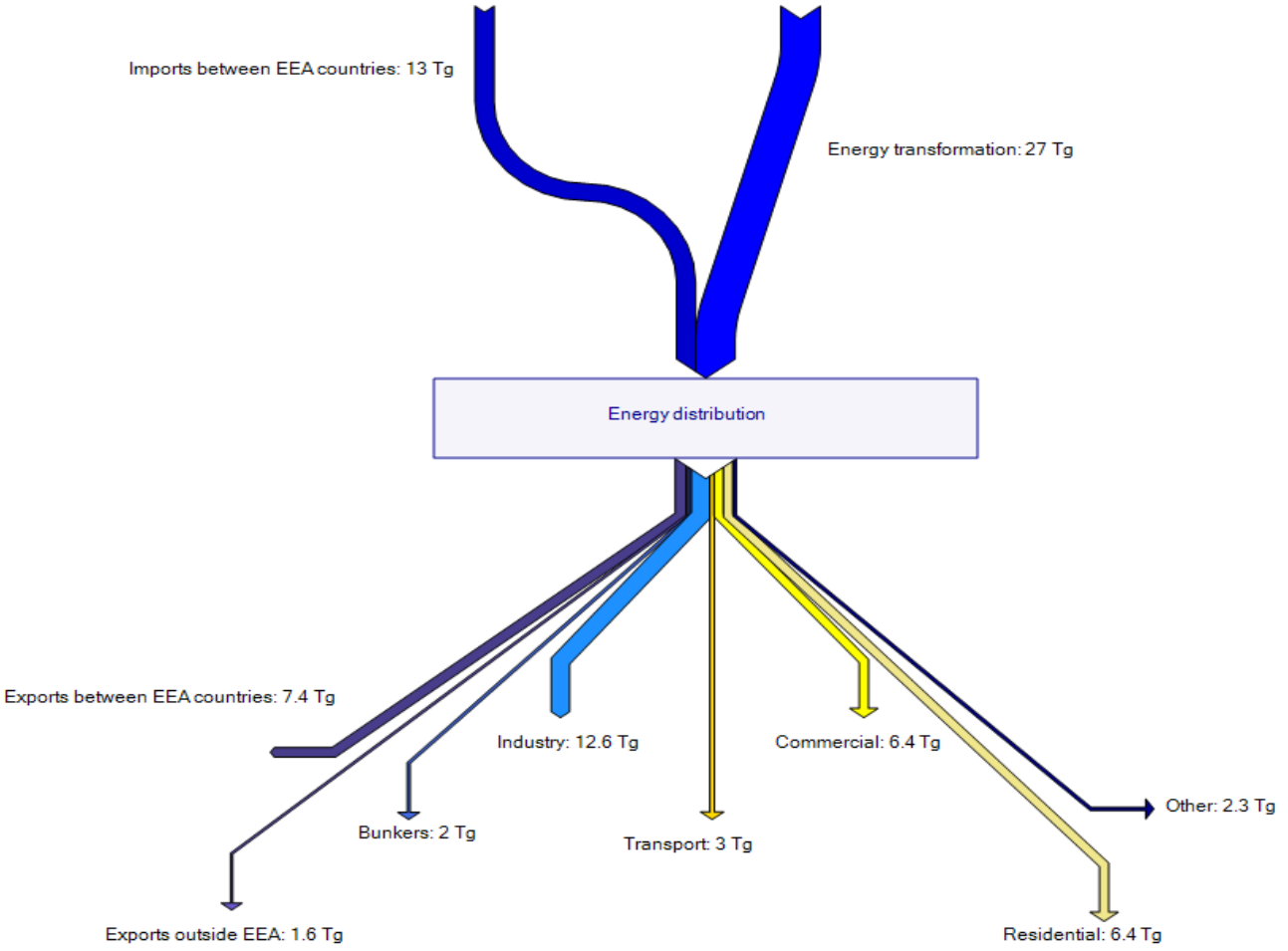
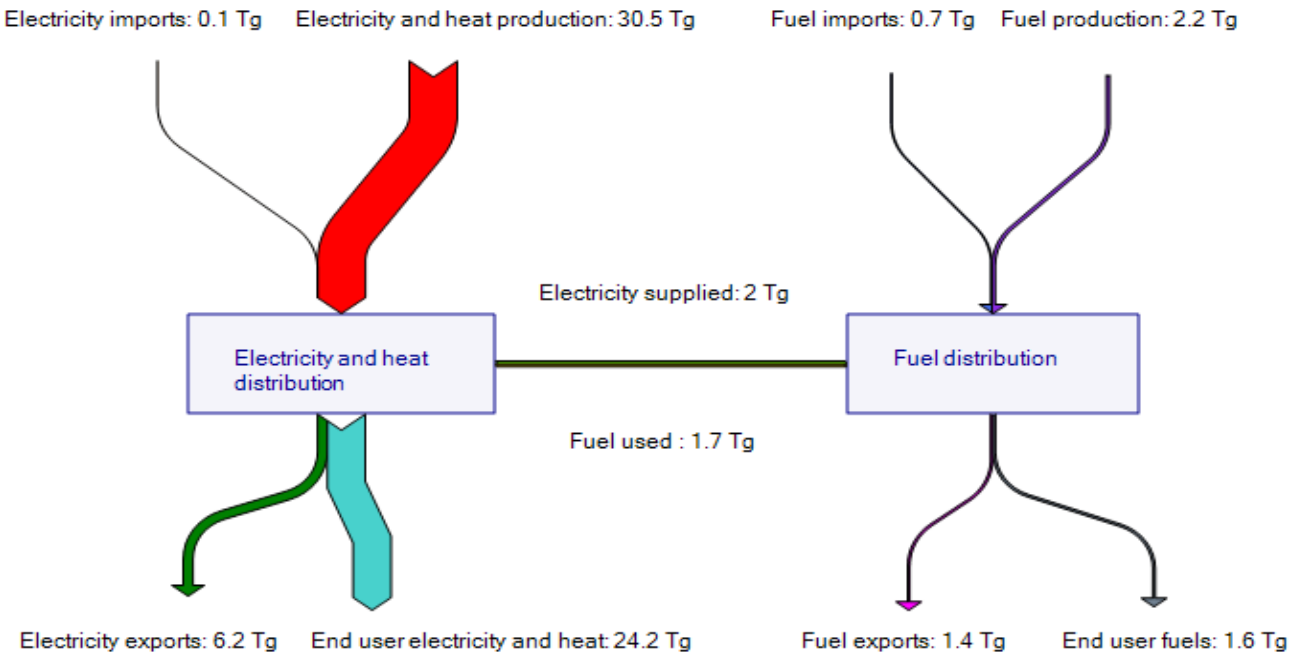


Figure A3.2 Direct GHG emissions from energy transformation (upper chart) and indirect GHG emissions from energy distribution by end user (lower chart) in Bulgaria, 2010



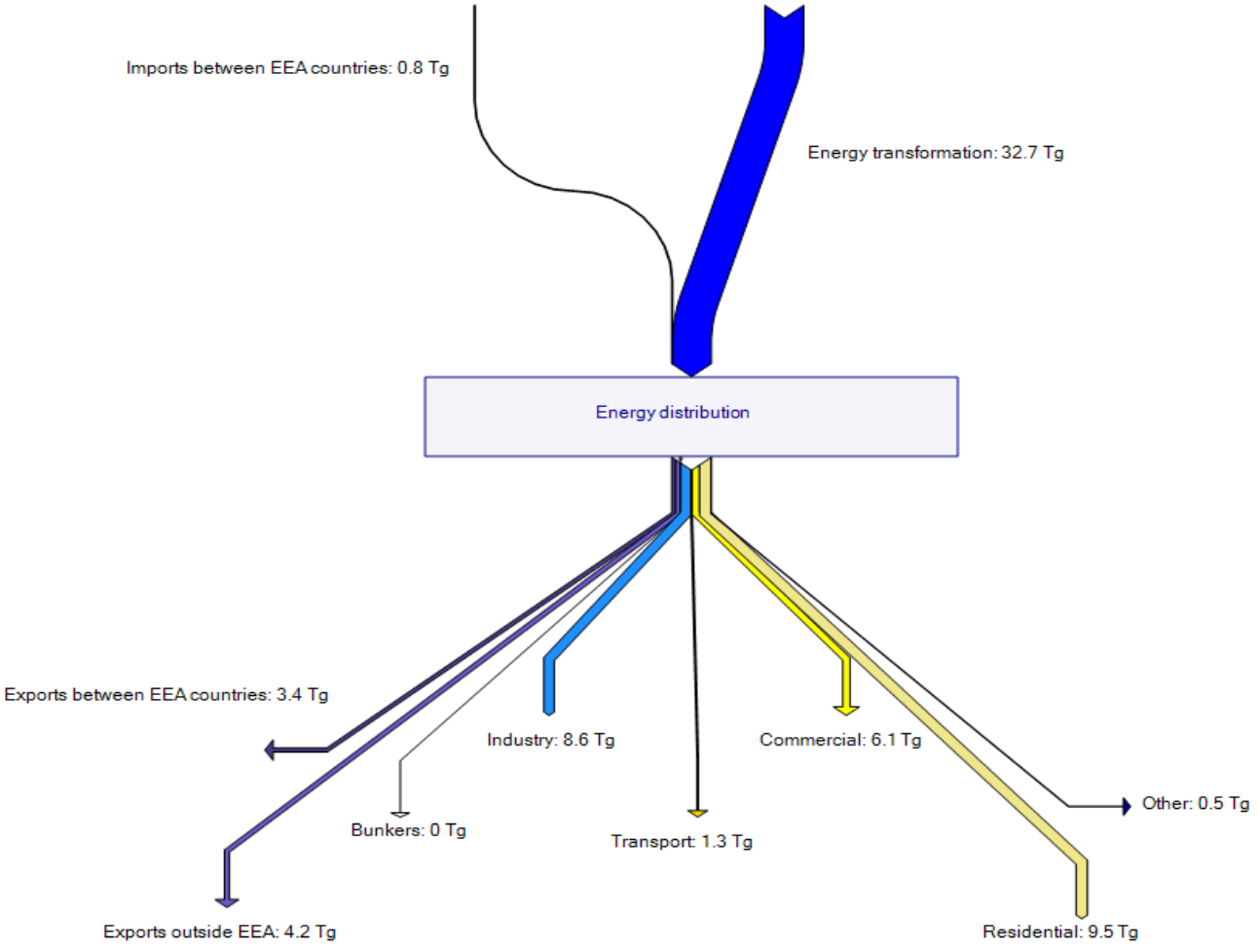
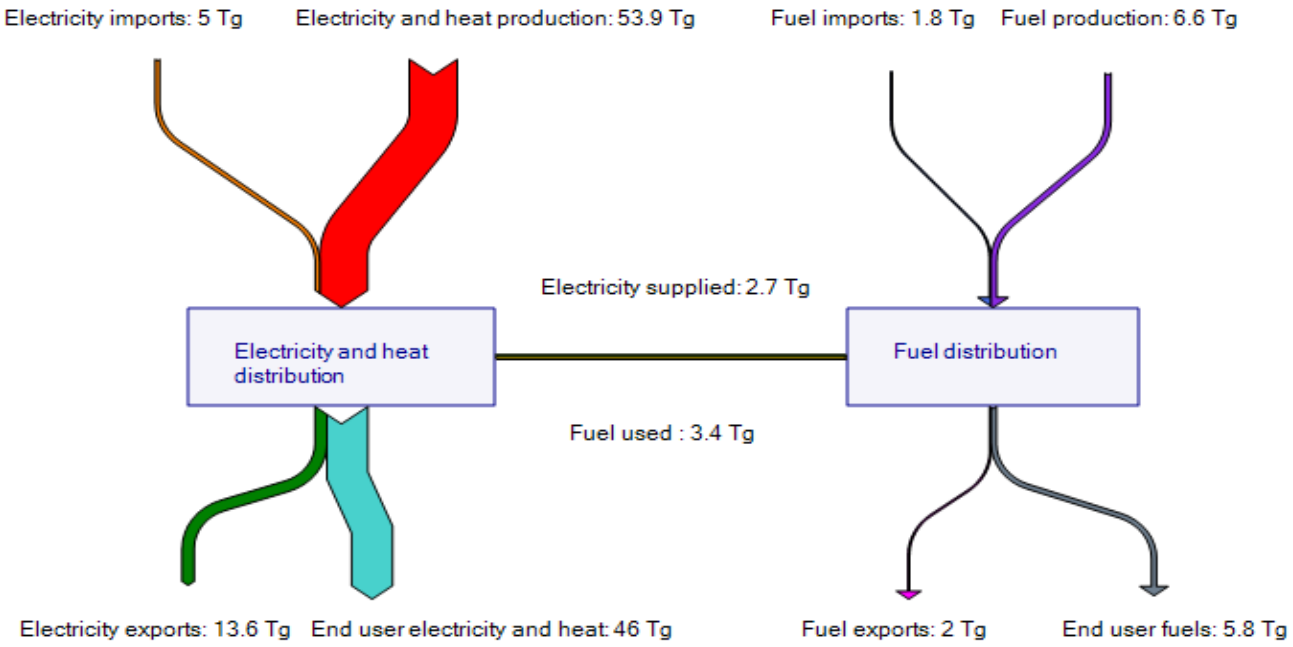


Figure A3.3 Direct GHG emissions from energy transformation (upper chart) and indirect GHG emissions from energy distribution by end user (lower chart) in Czech Republic, 2010



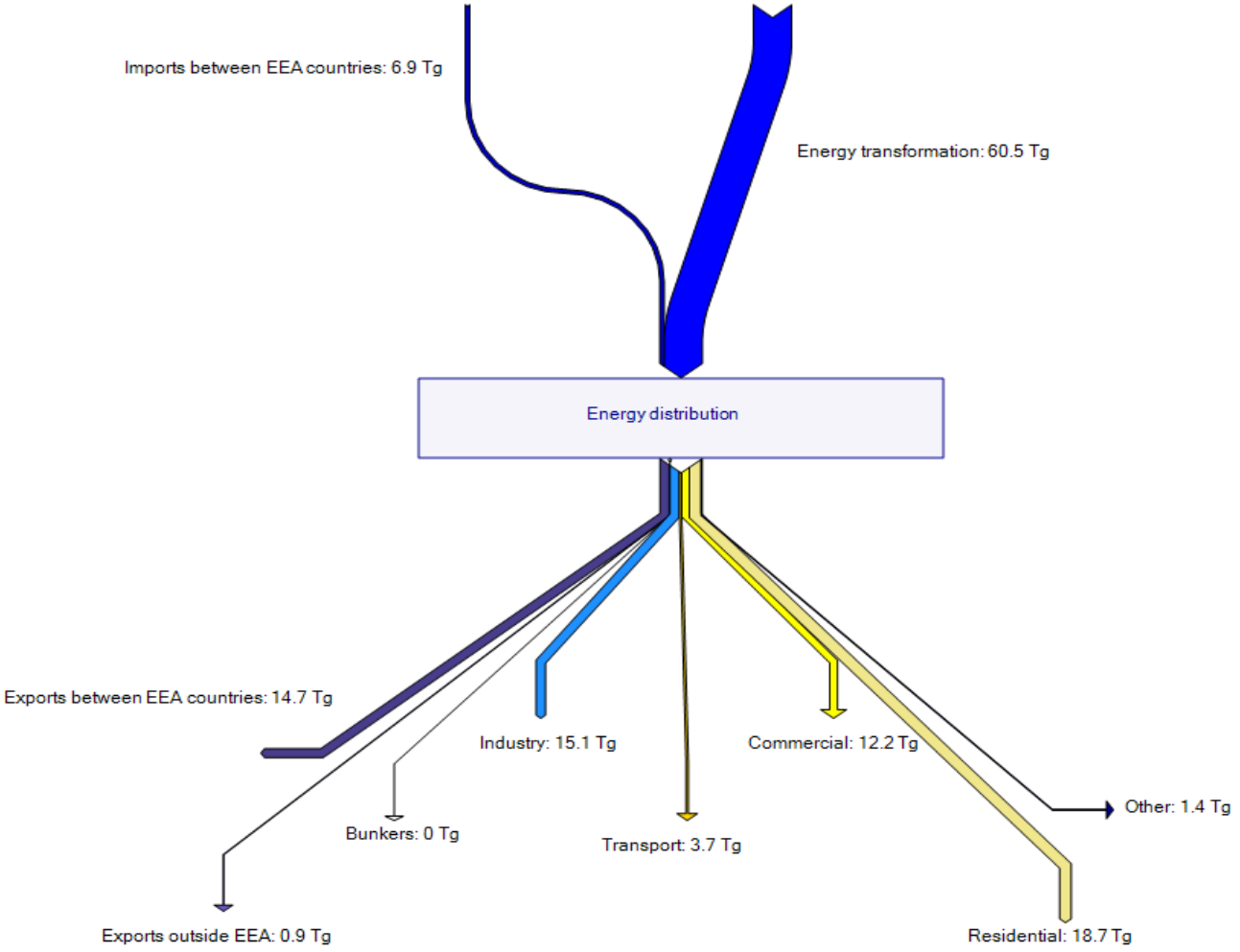
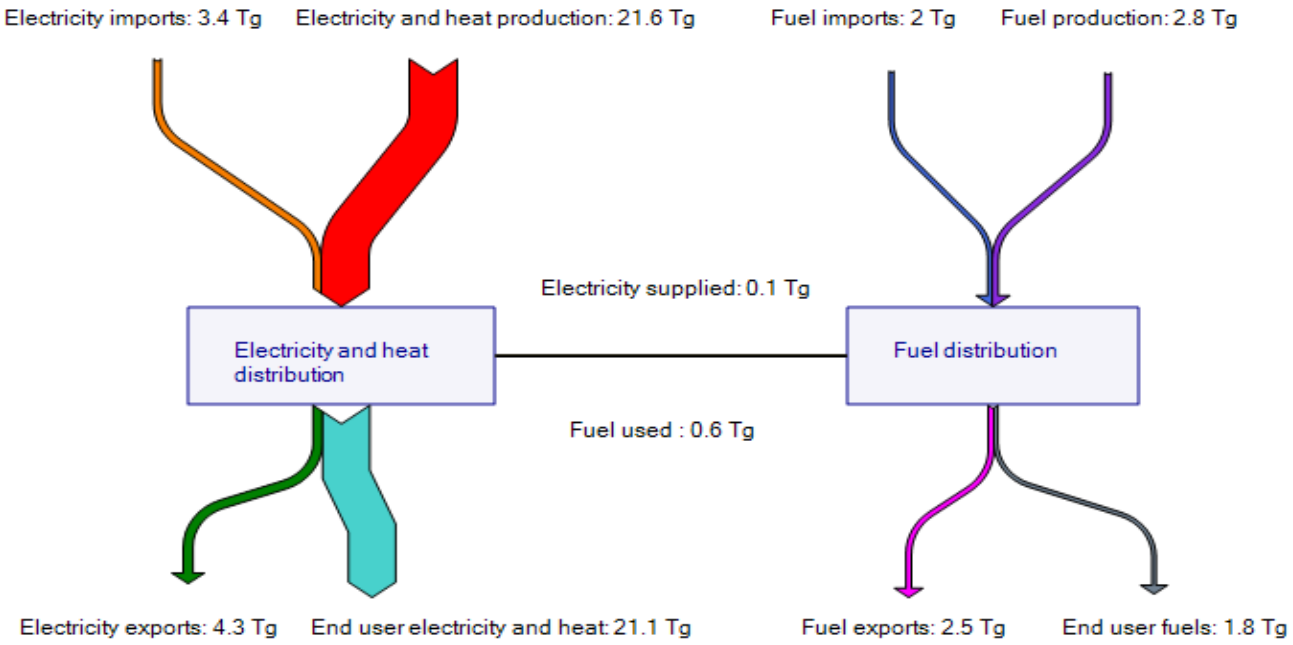


Figure A3.4 Direct GHG emissions from energy transformation (upper chart) and indirect GHG emissions from energy distribution by end user (lower chart) in Denmark, 2010



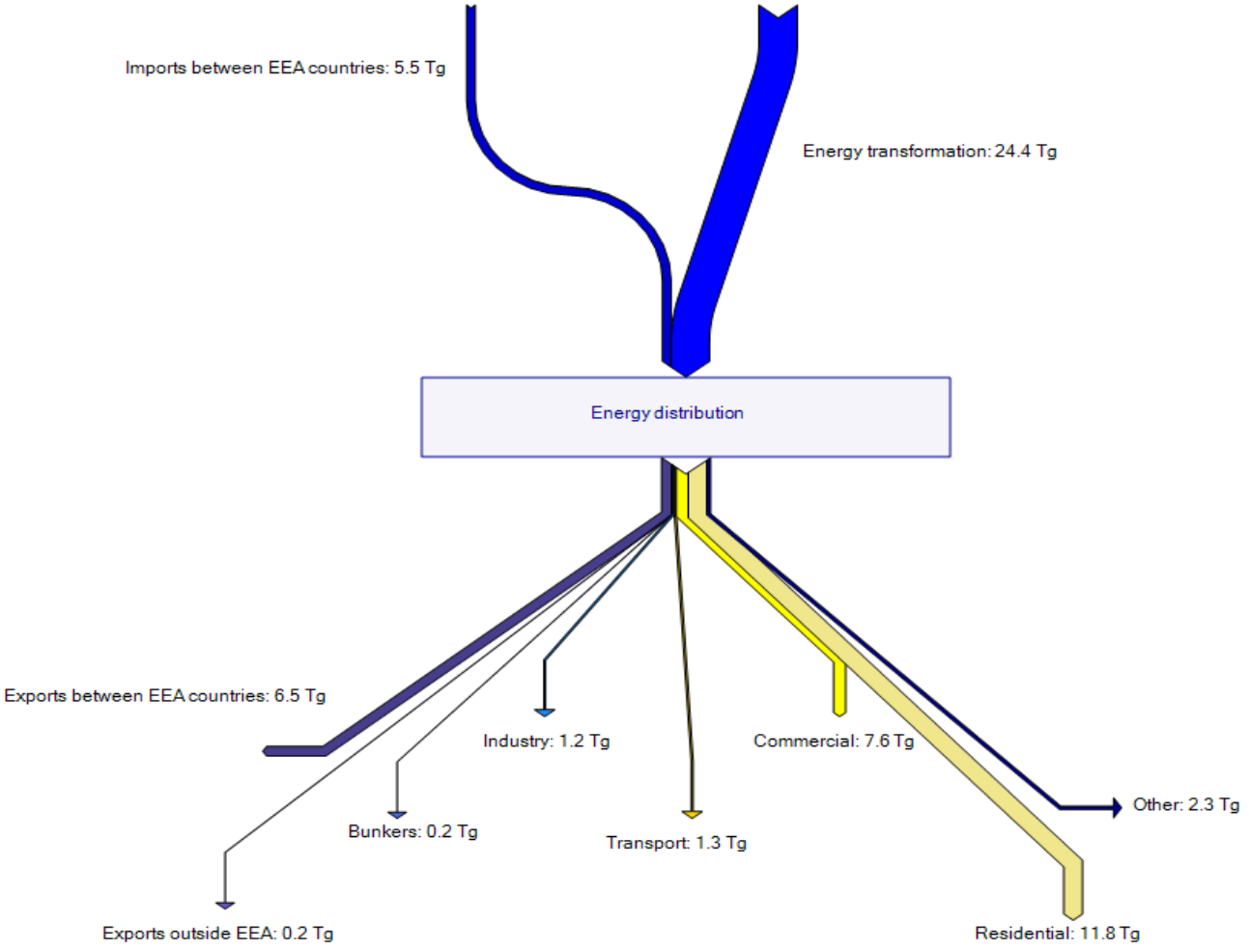
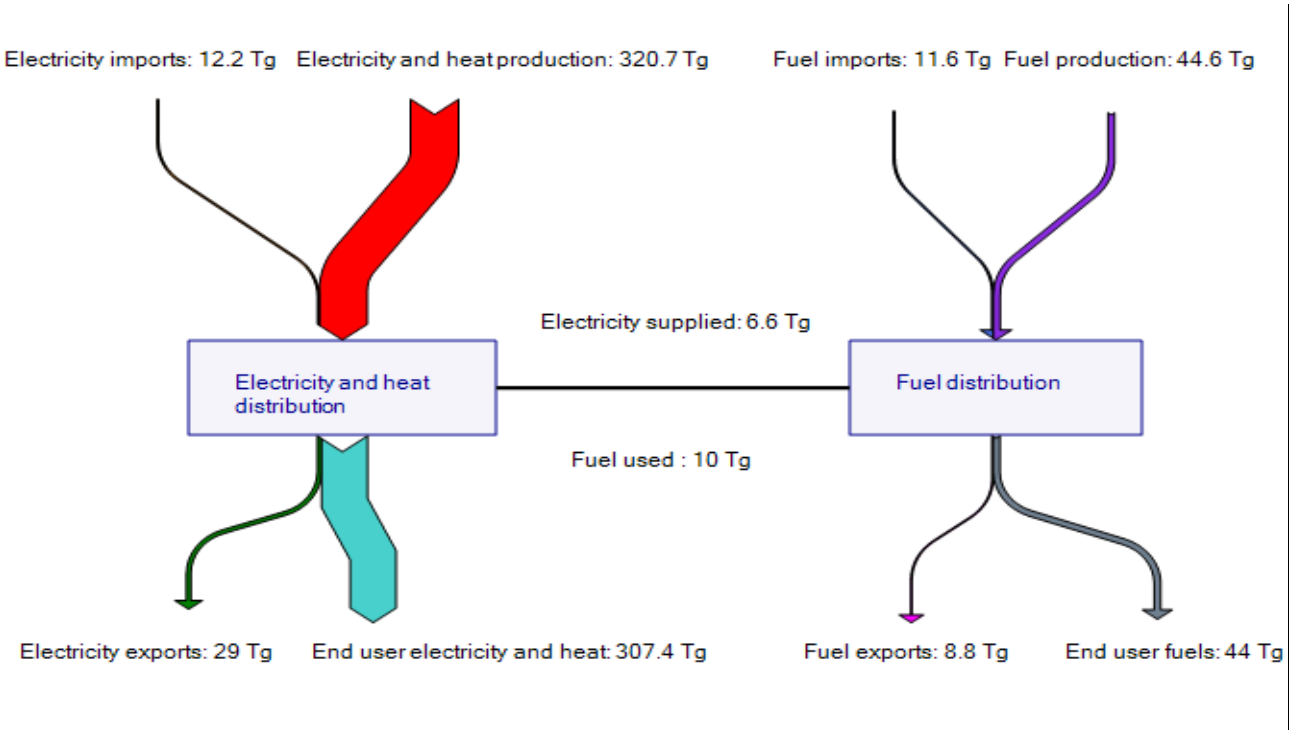


Figure A3.5 Direct GHG emissions from energy transformation (upper chart) and indirect GHG emissions from energy distribution by end user (lower chart) in Germany, 2010



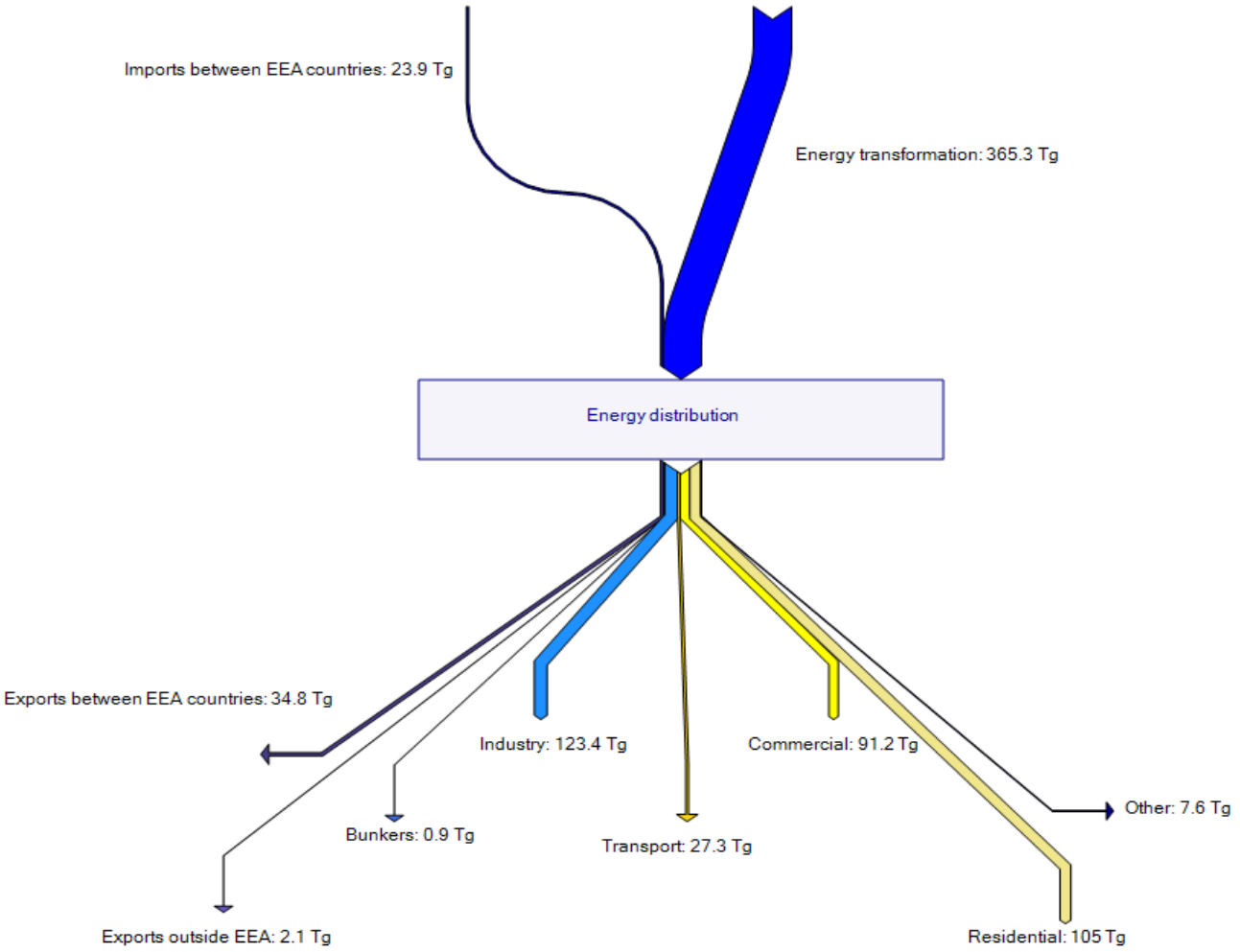
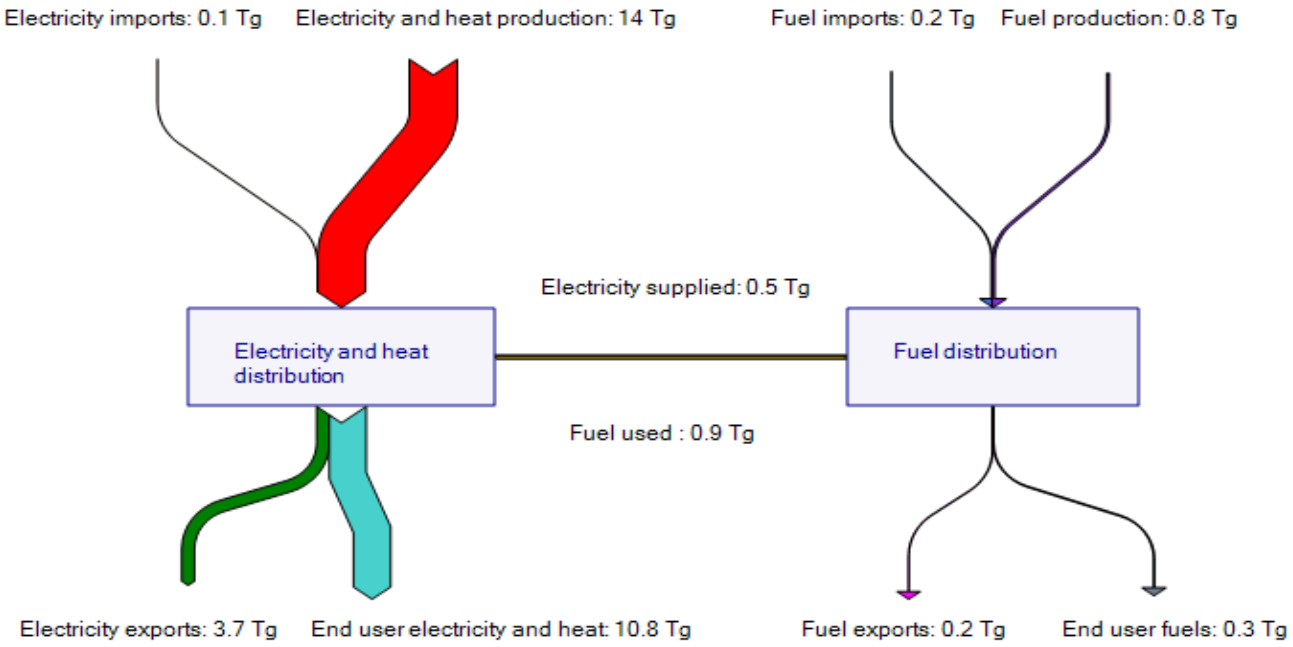


Figure A3.6 Direct GHG emissions from energy transformation (upper chart) and indirect GHG emissions from energy distribution by end user (lower chart) in Estonia, 2010



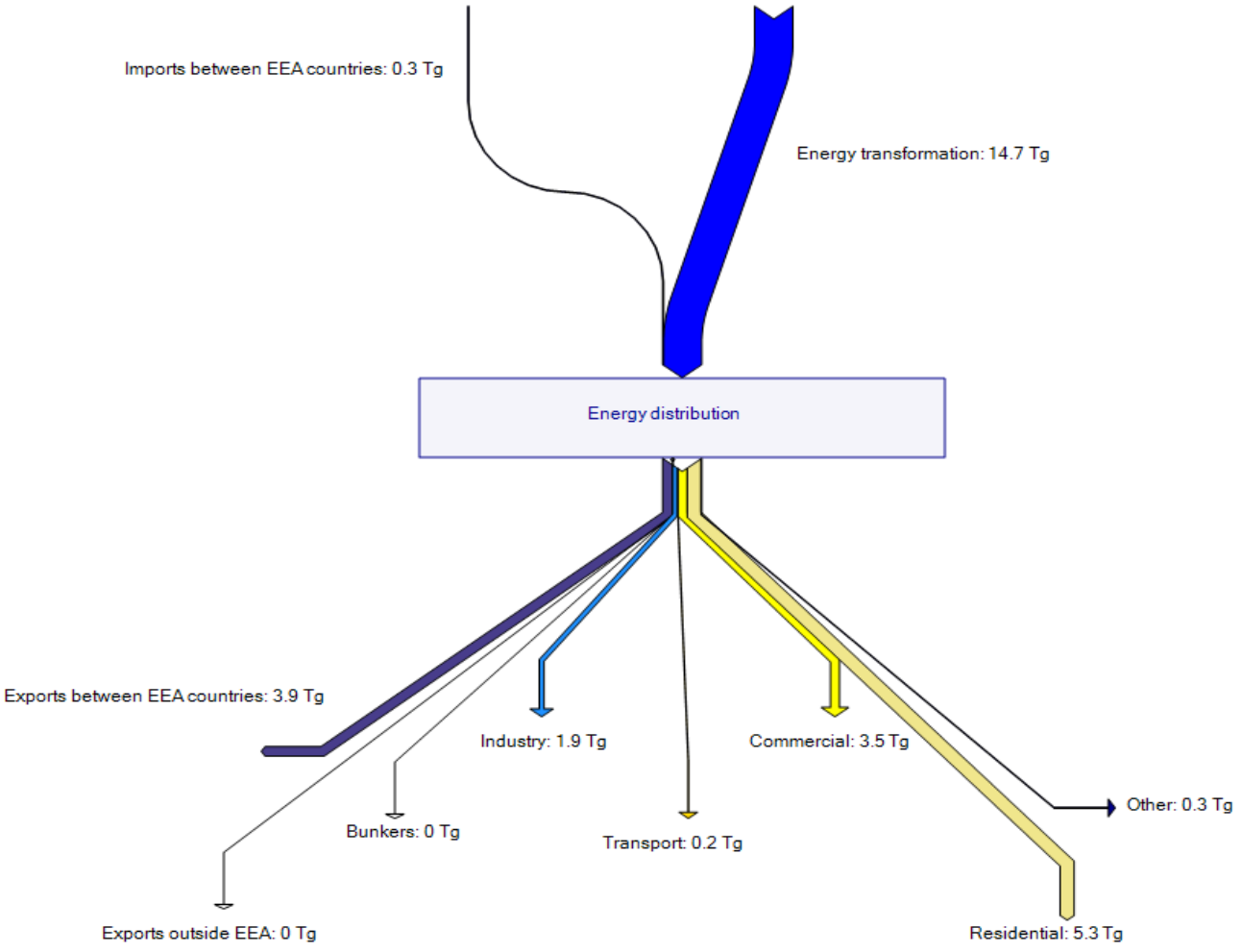
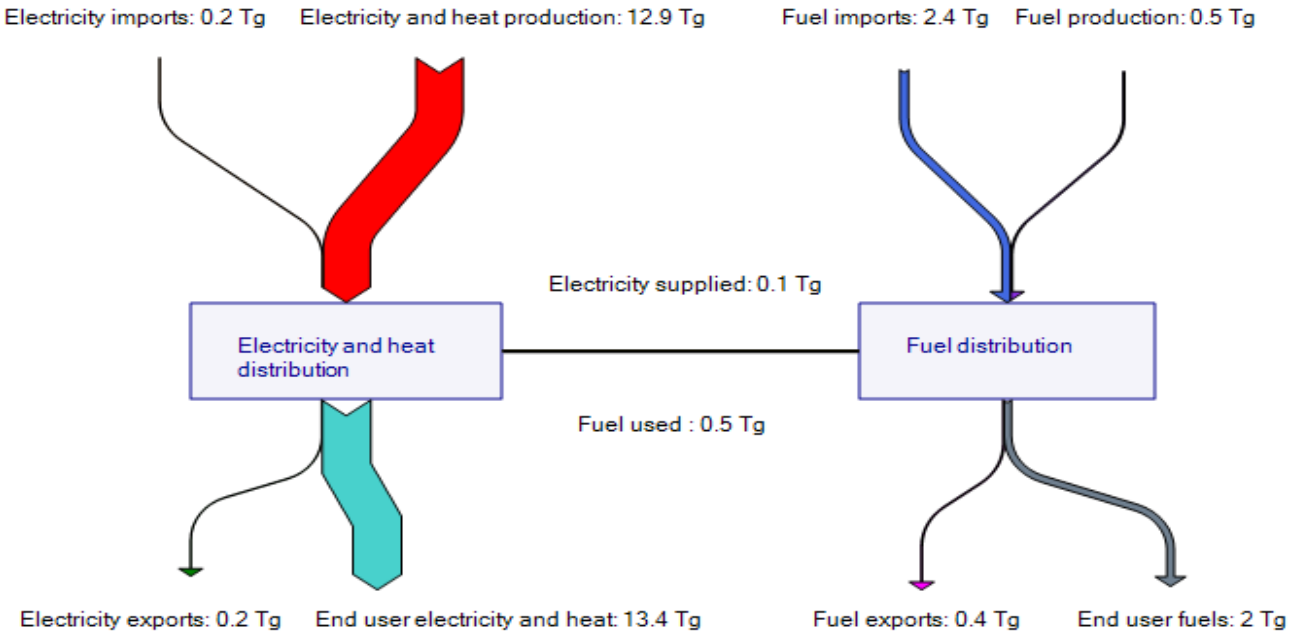


Figure A3.7 Direct GHG emissions from energy transformation (upper chart) and indirect GHG emissions from energy distribution by end user (lower chart) in Ireland, 2010



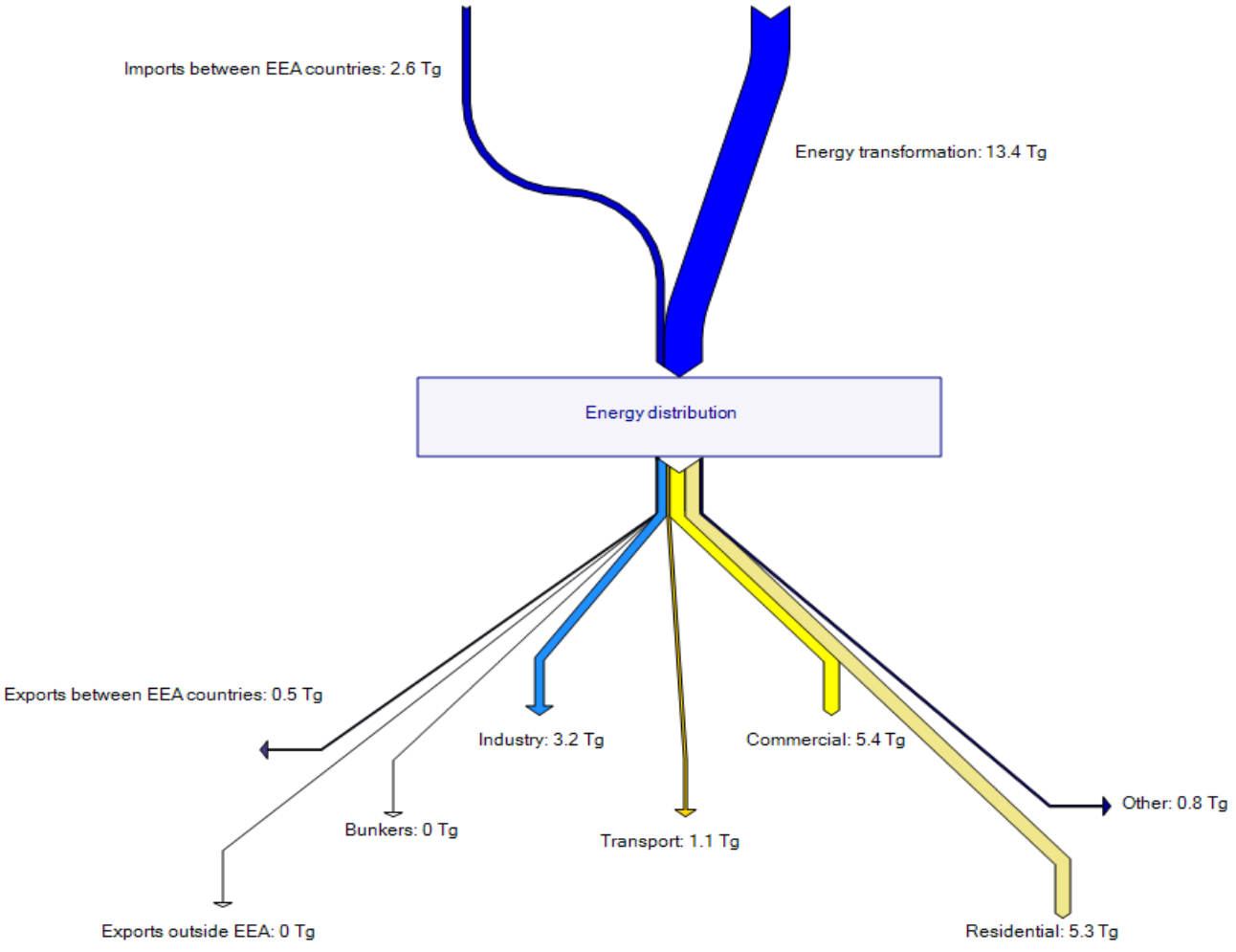
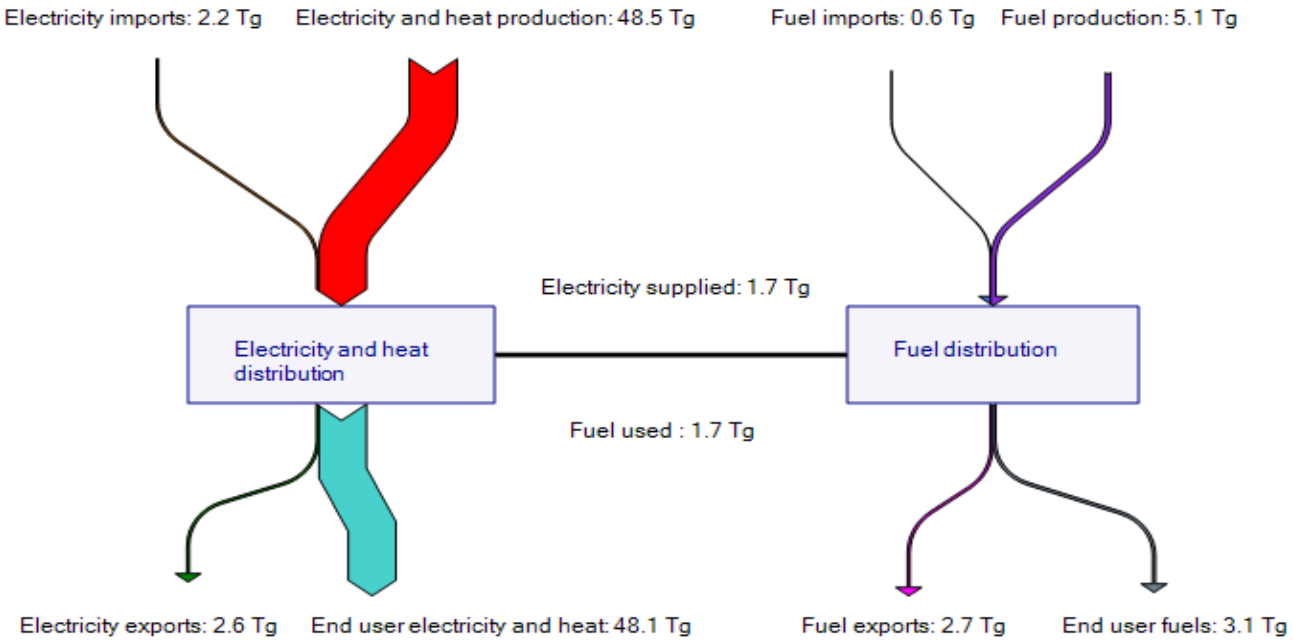


Figure A3.8 Direct GHG emissions from energy transformation (upper chart) and indirect GHG emissions from energy distribution by end user (lower chart) in Greece, 2010



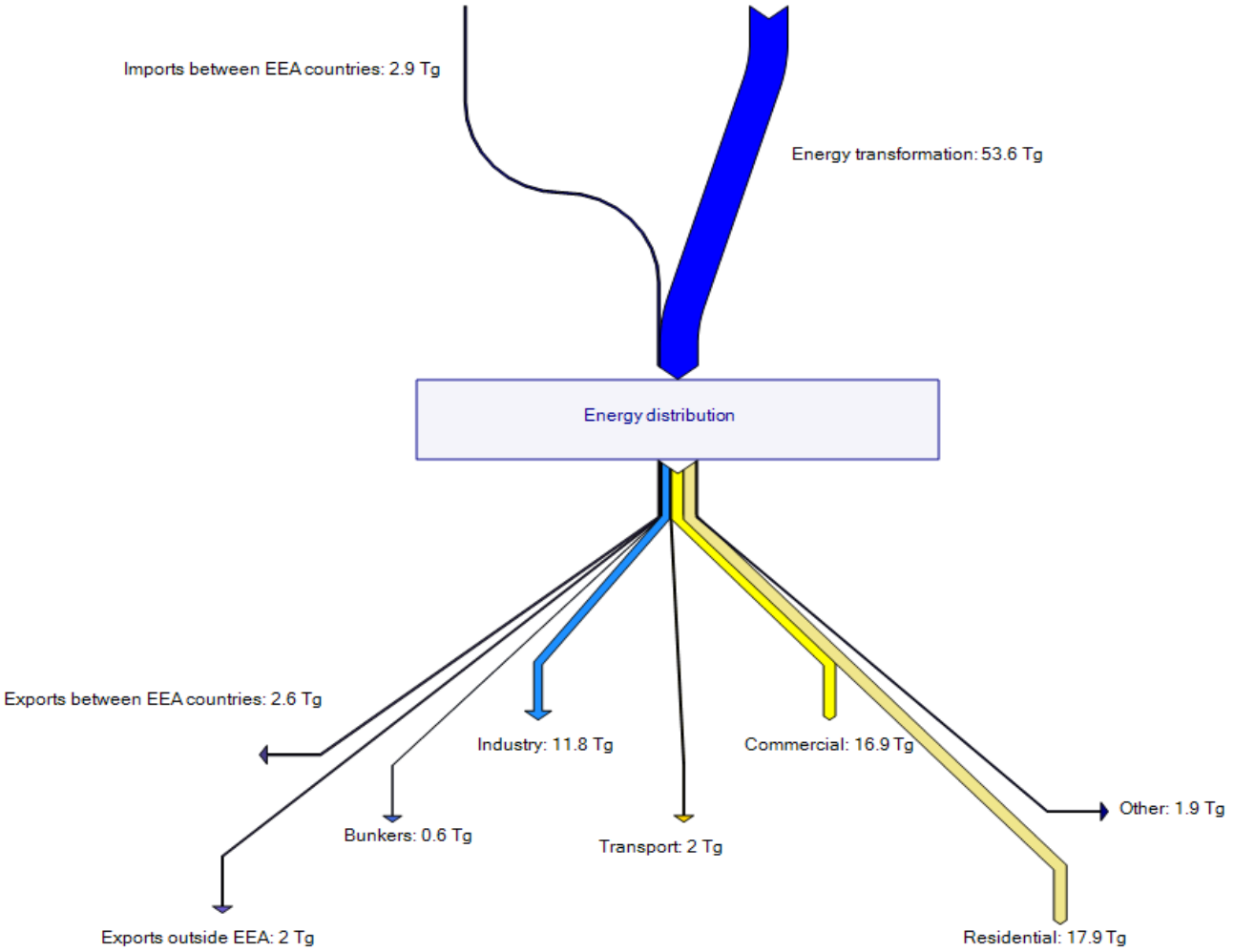
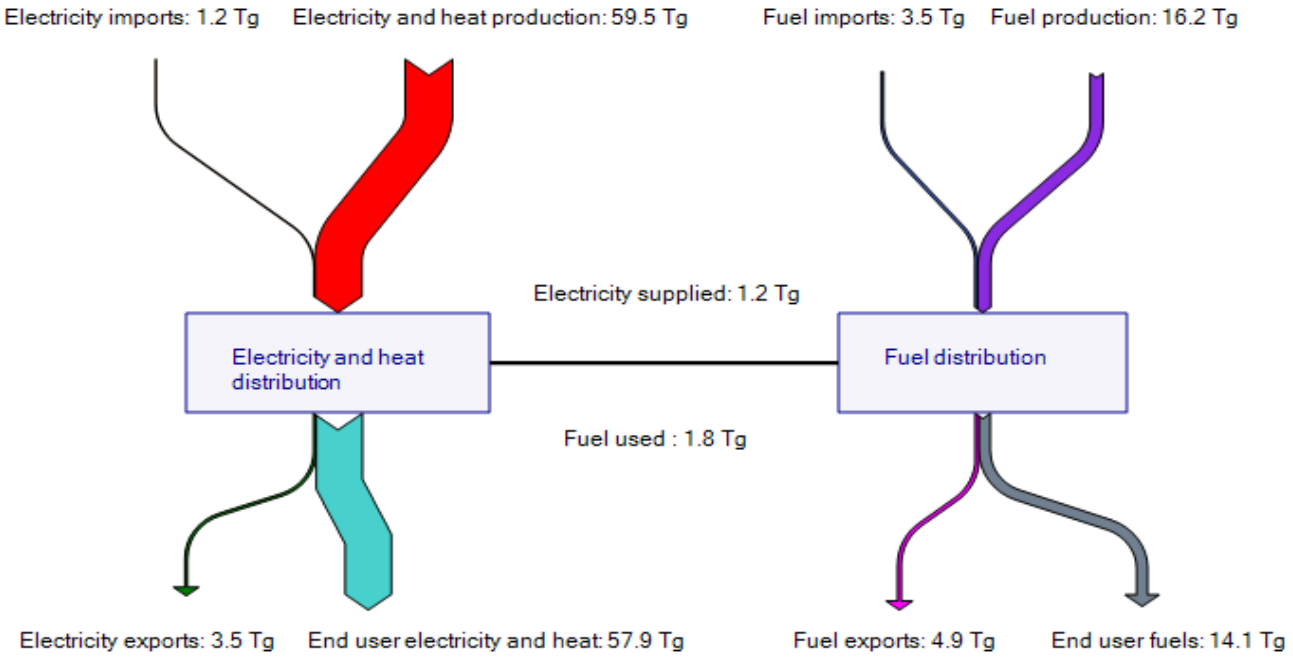


Figure A3.9 Direct GHG emissions from energy transformation (upper chart) and indirect GHG emissions from energy distribution by end user (lower chart) in Spain, 2010



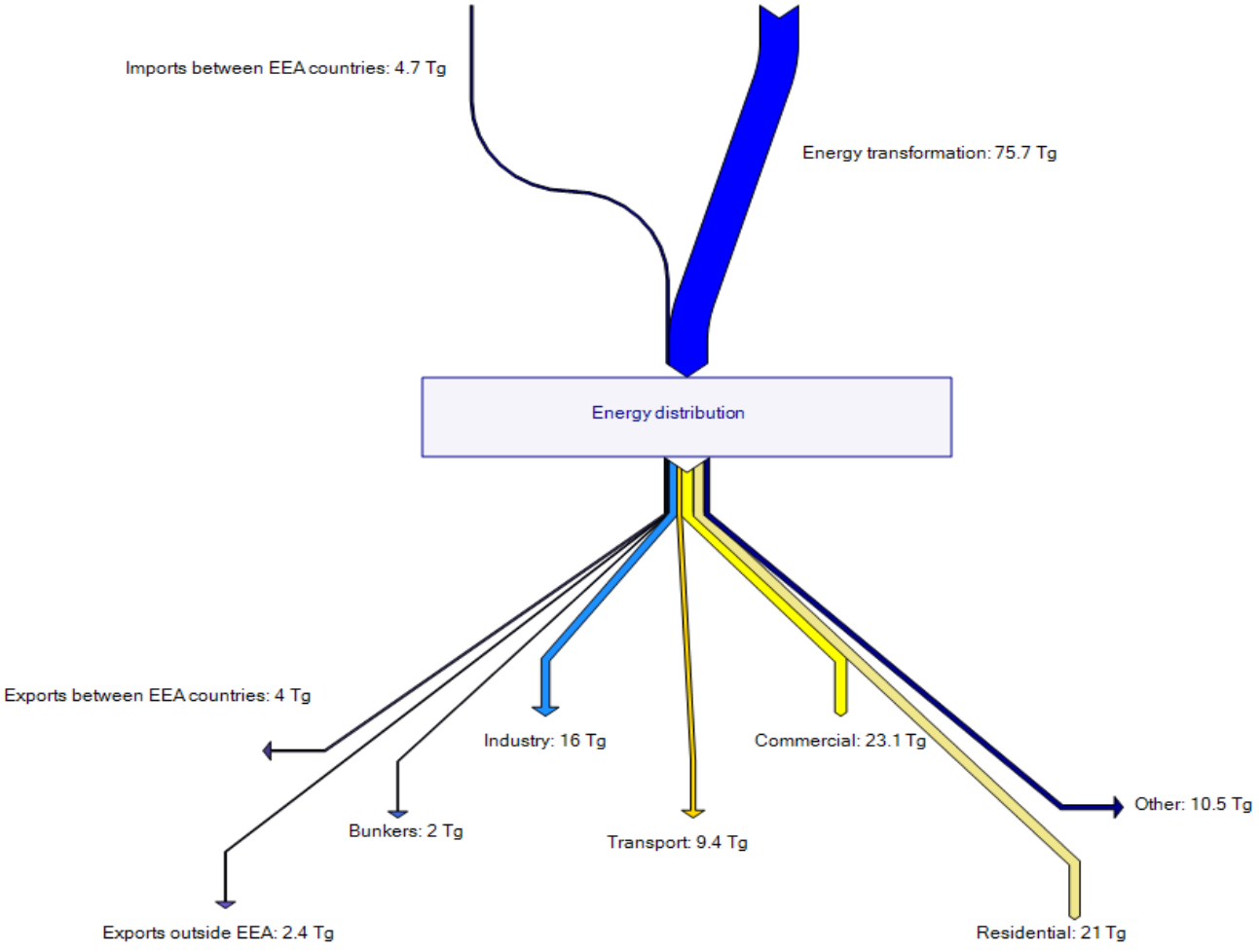


Figure A3.10 Direct GHG emissions from energy transformation (upper chart) and indirect GHG emissions from energy distribution by end user (lower chart) in France, 2010

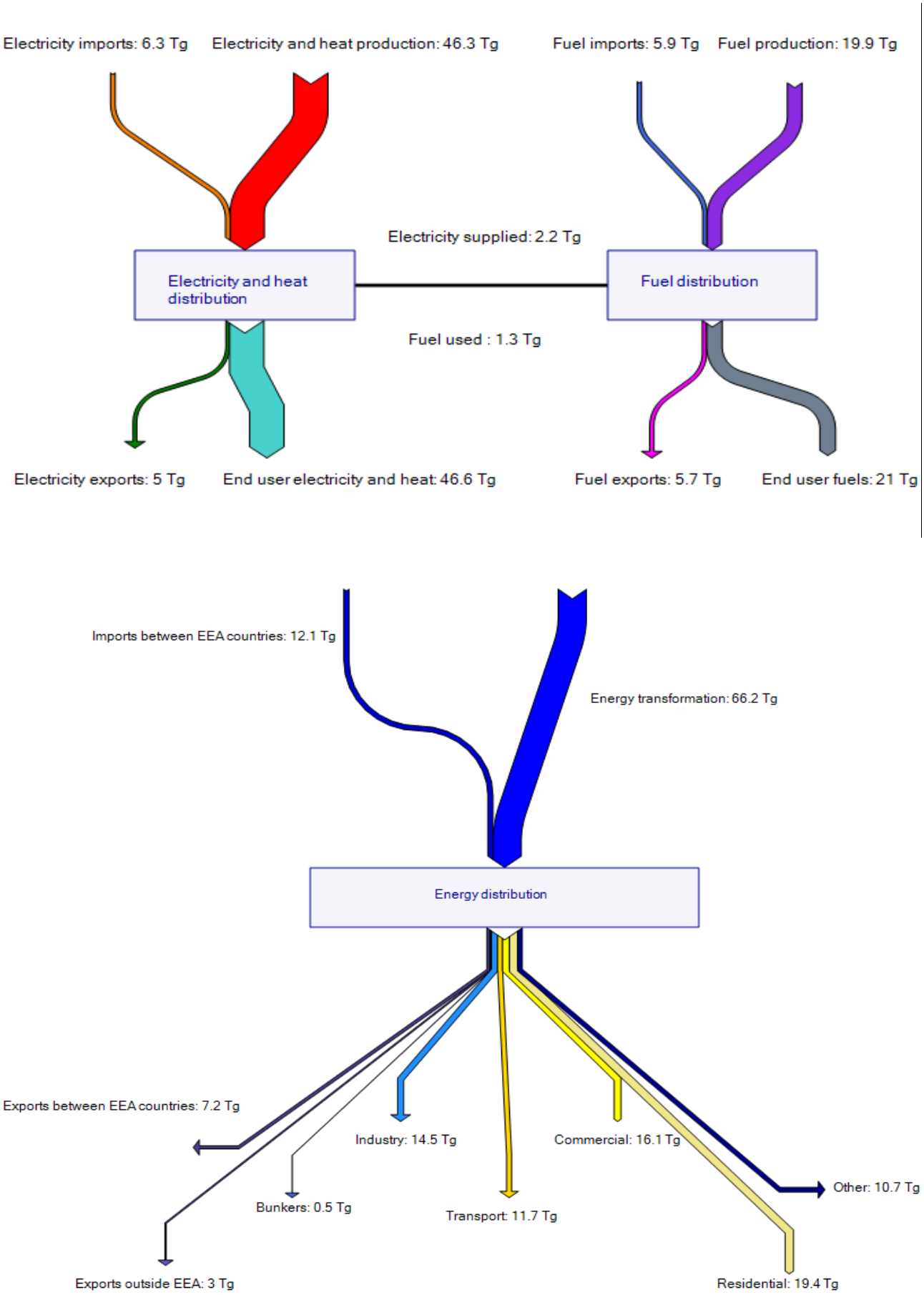
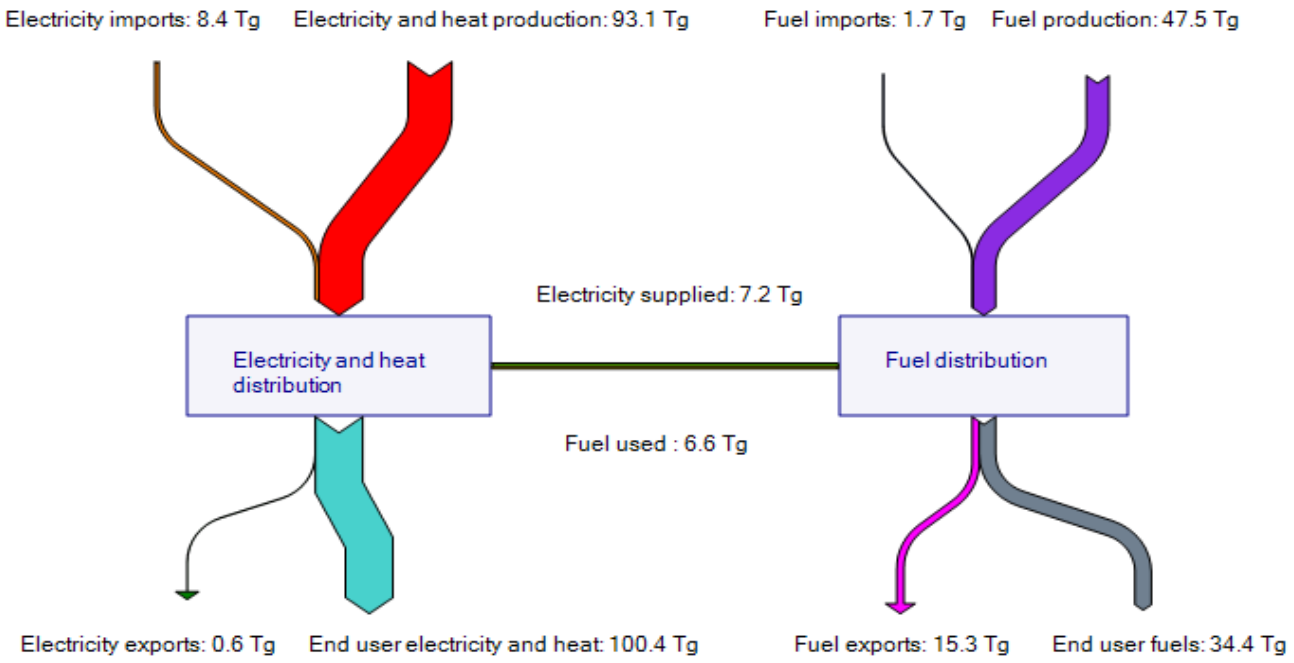


Figure A3.11 Direct GHG emissions from energy transformation (upper chart) and indirect GHG emissions from energy distribution by end user (lower chart) in Italy, 2010



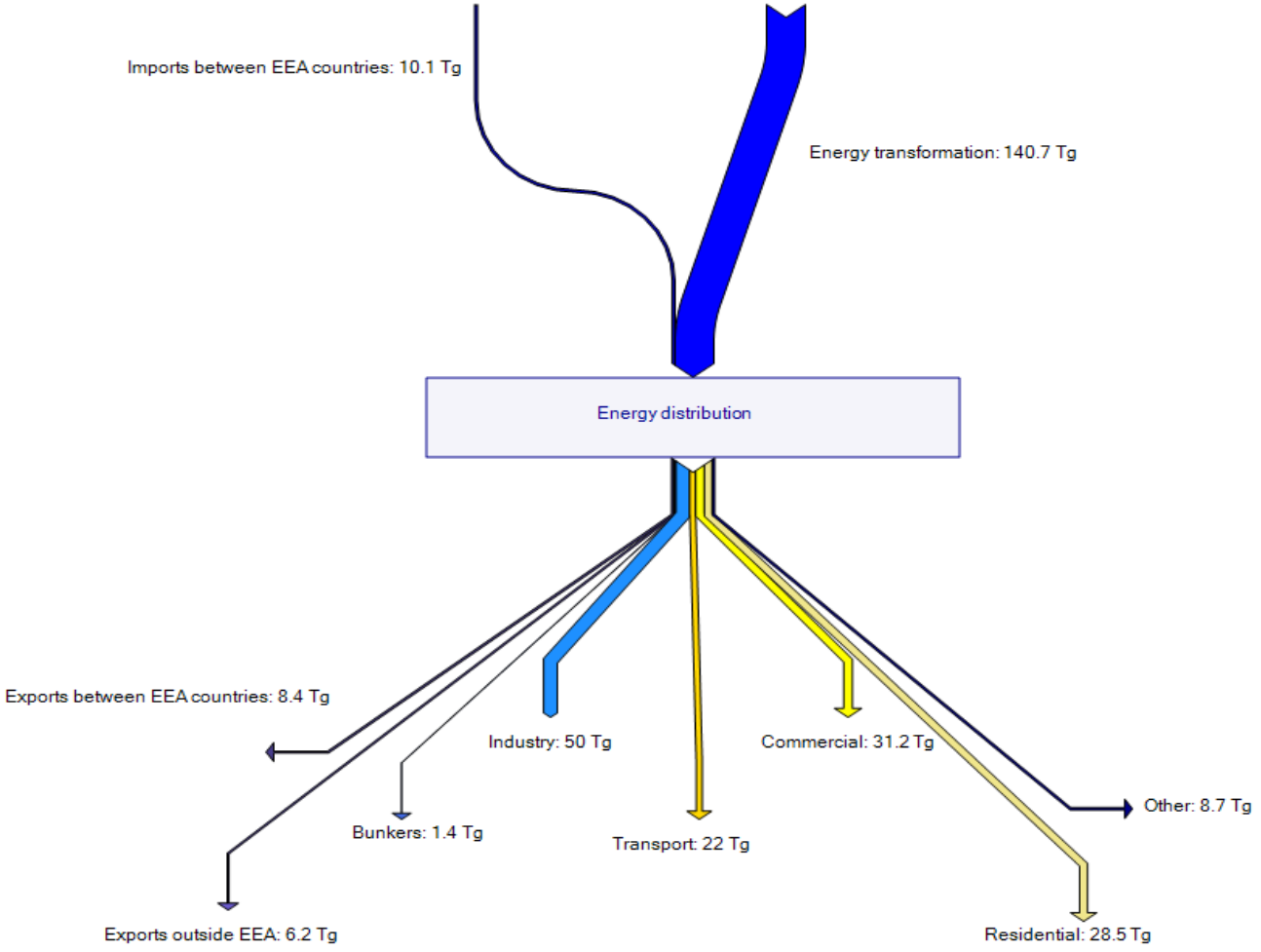
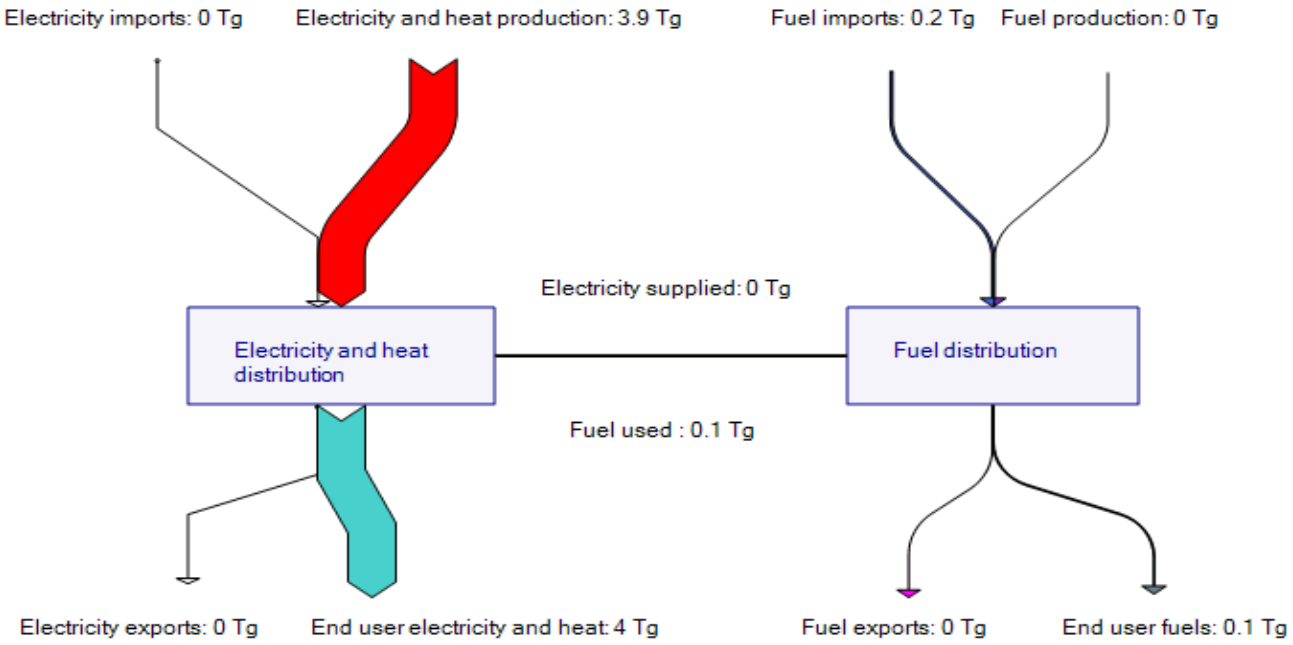


Figure A3.12 Direct GHG emissions from energy transformation (upper chart) and indirect GHG emissions from energy distribution by end user (lower chart) in Cyprus, 2010



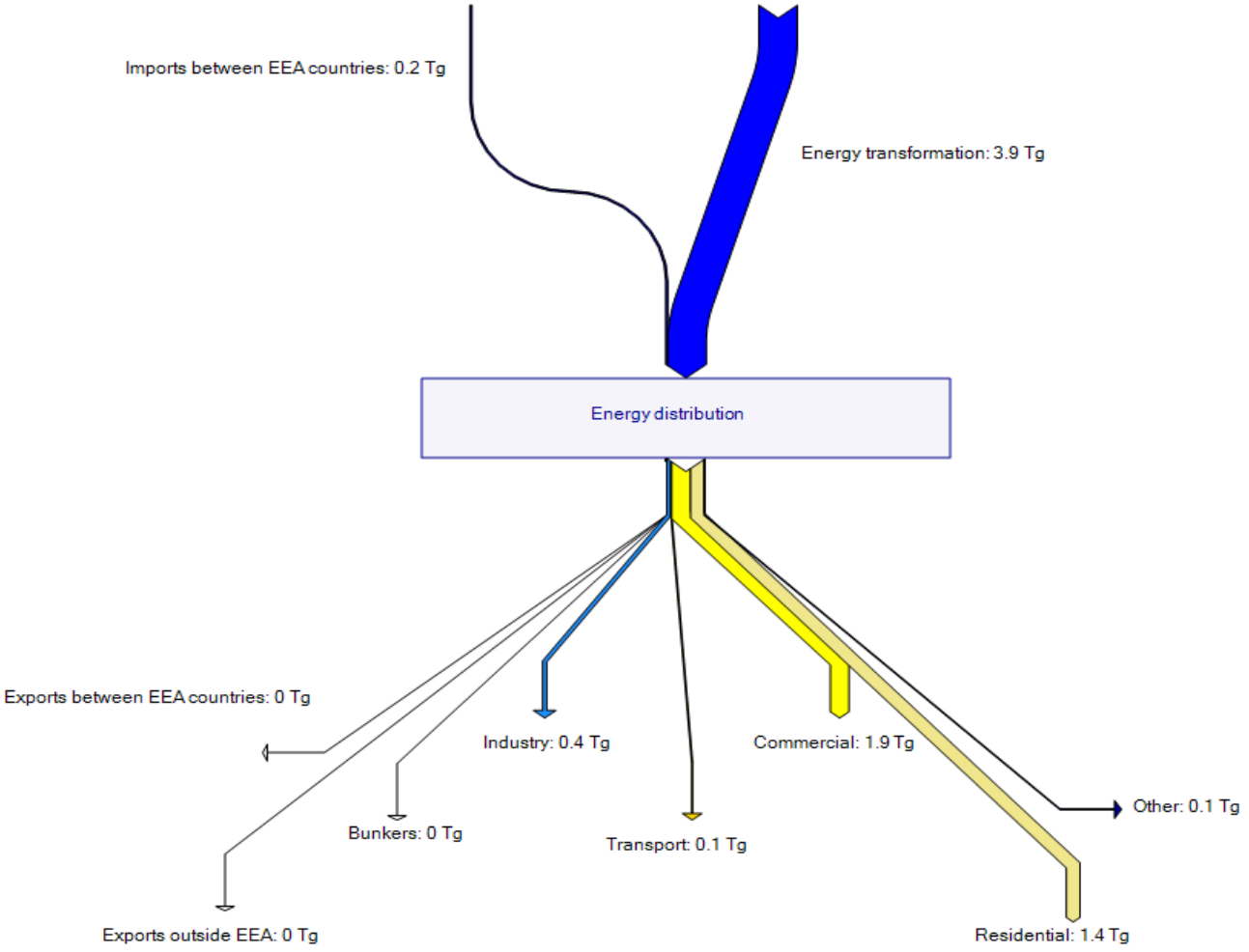
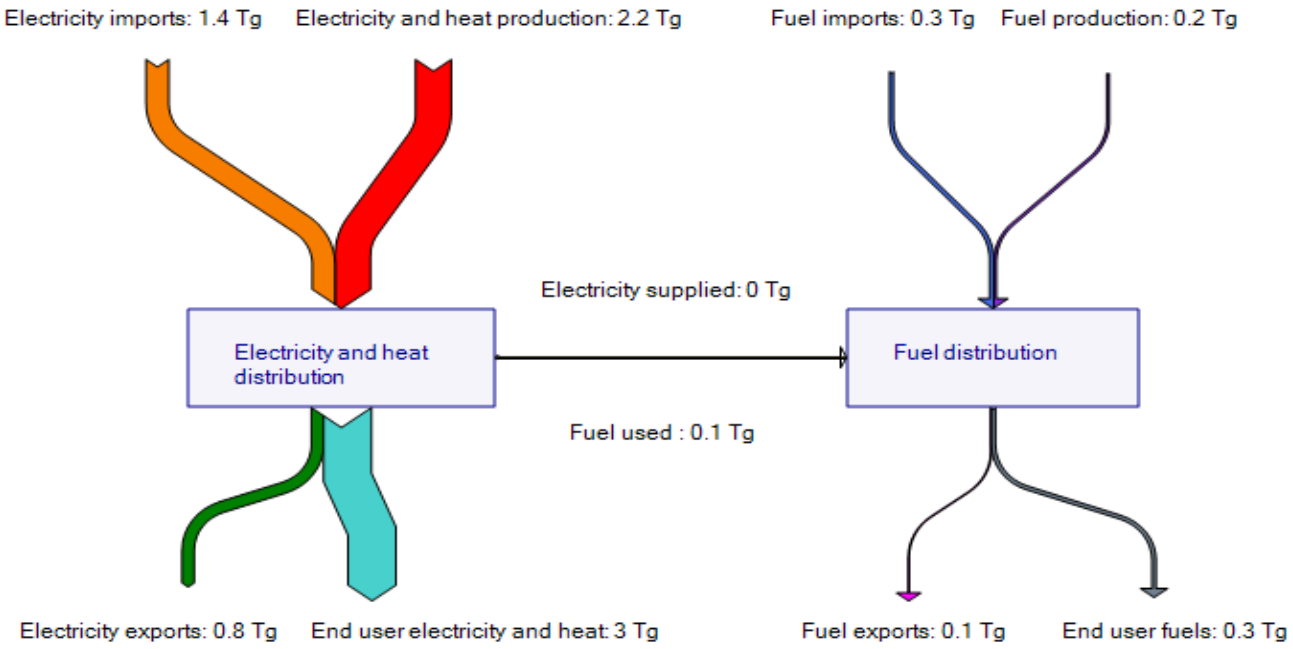


Figure A3.13 Direct GHG emissions from energy transformation (upper chart) and indirect GHG emissions from energy distribution by end user (lower chart) in Latvia, 2010



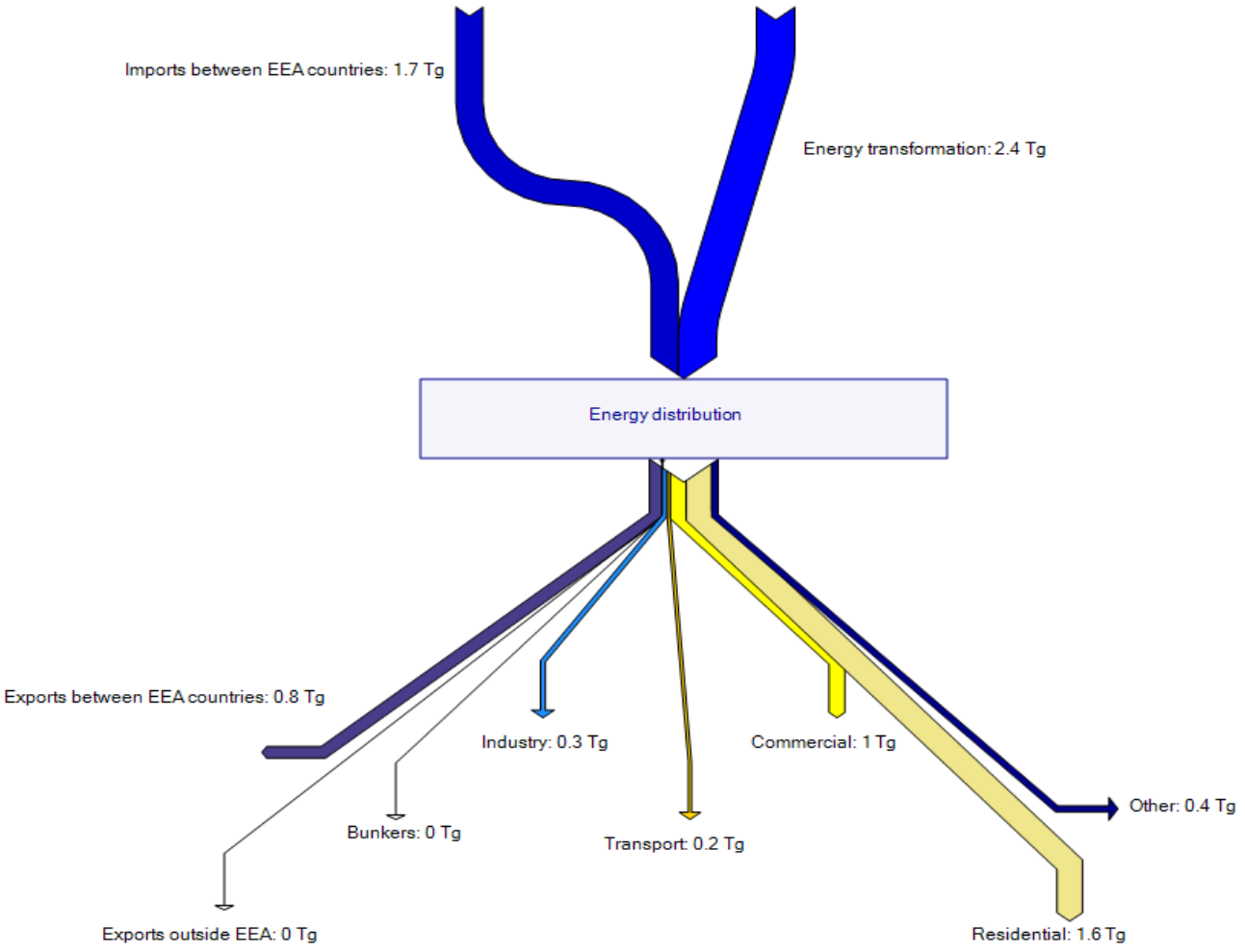
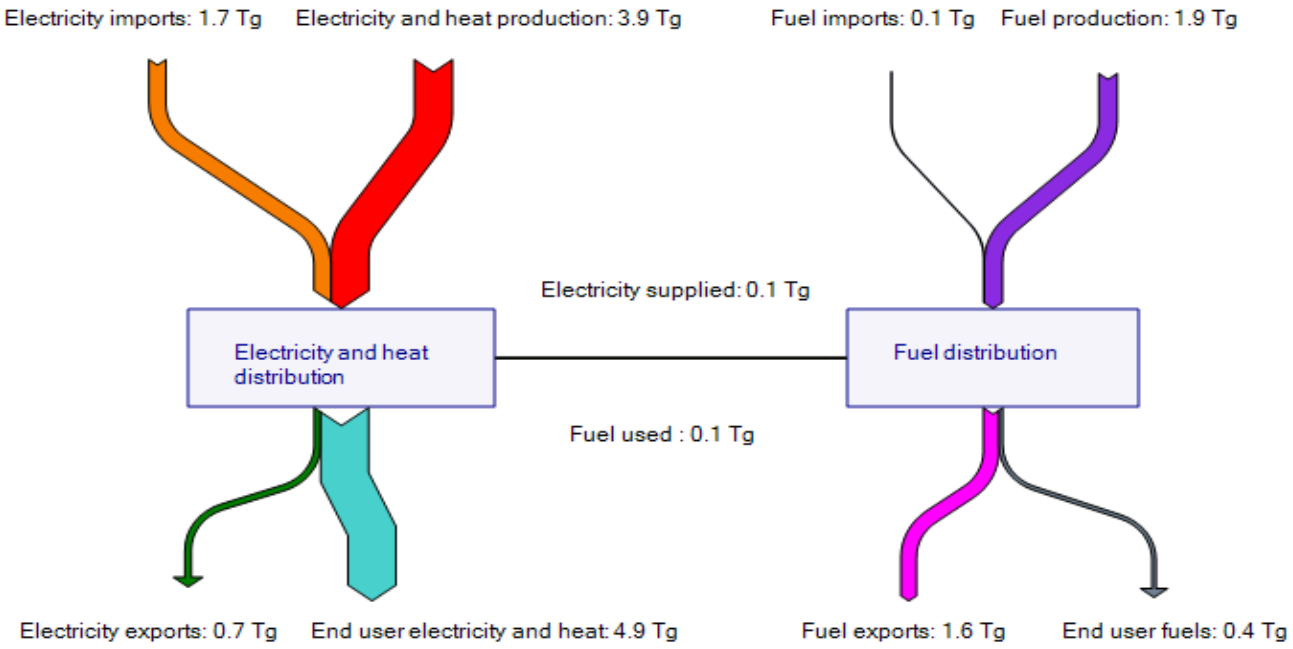


Figure A3.14 Direct GHG emissions from energy transformation (upper chart) and indirect GHG emissions from energy distribution by end user (lower chart) in Lithuania, 2010



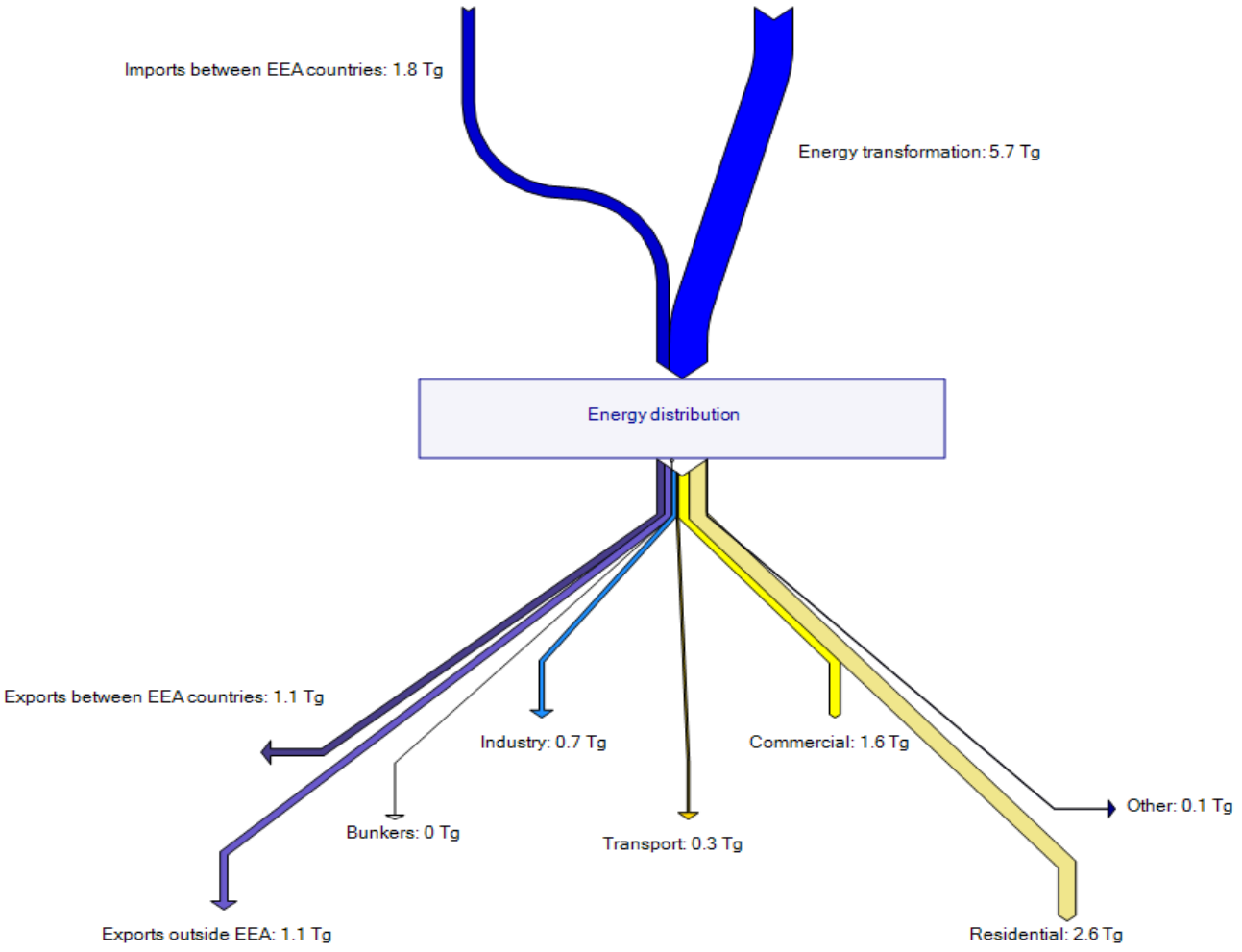
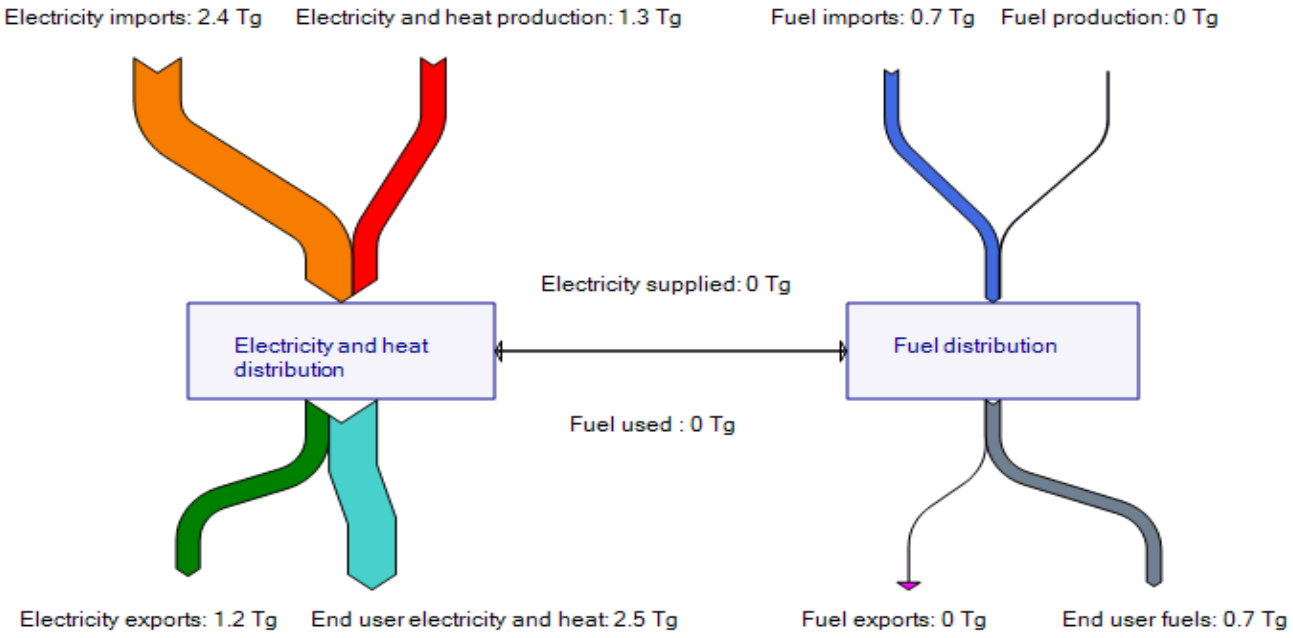


Figure A3.15 Direct GHG emissions from energy transformation (upper chart) and indirect GHG emissions from energy distribution by end user (lower chart) in Luxembourg, 2010



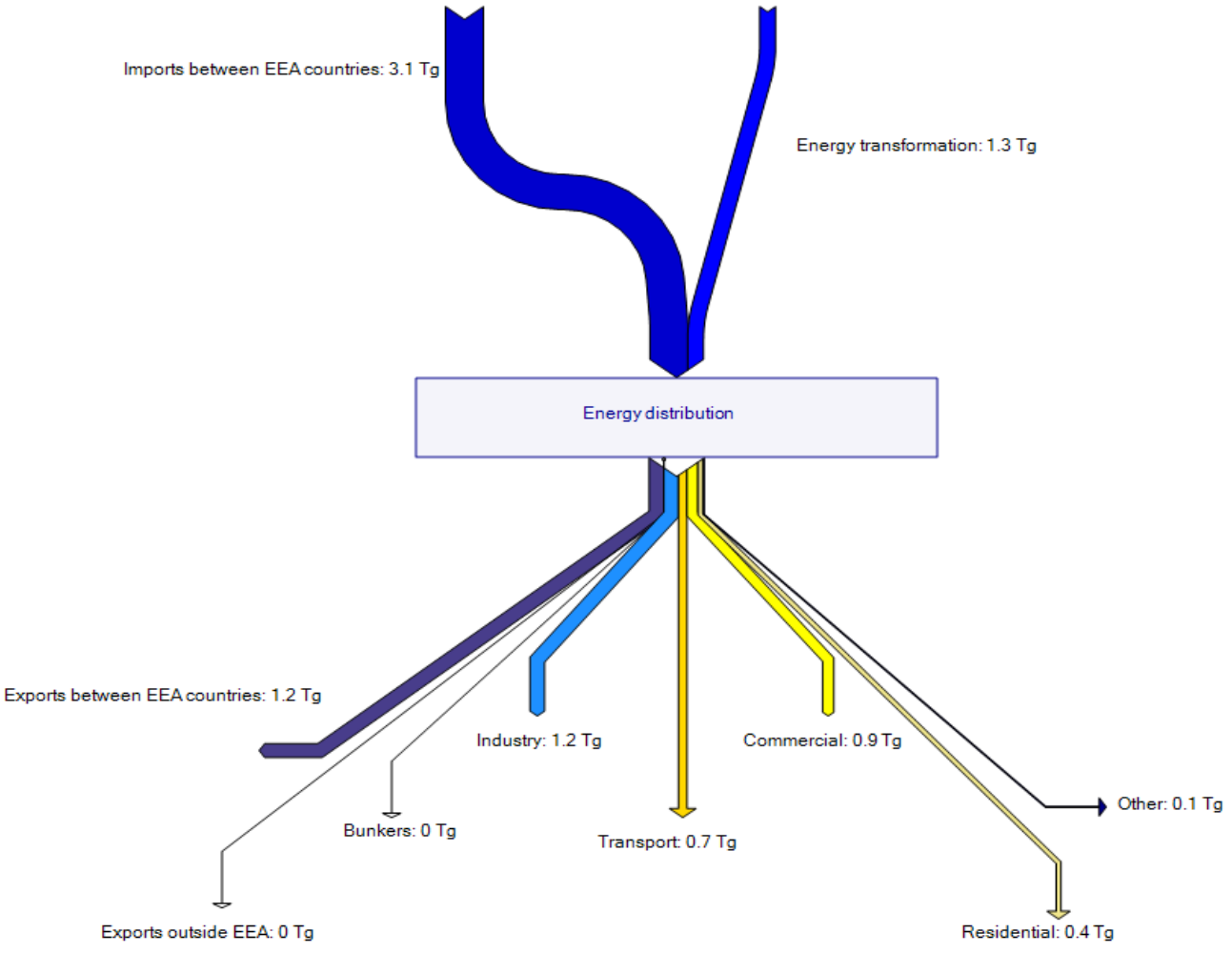
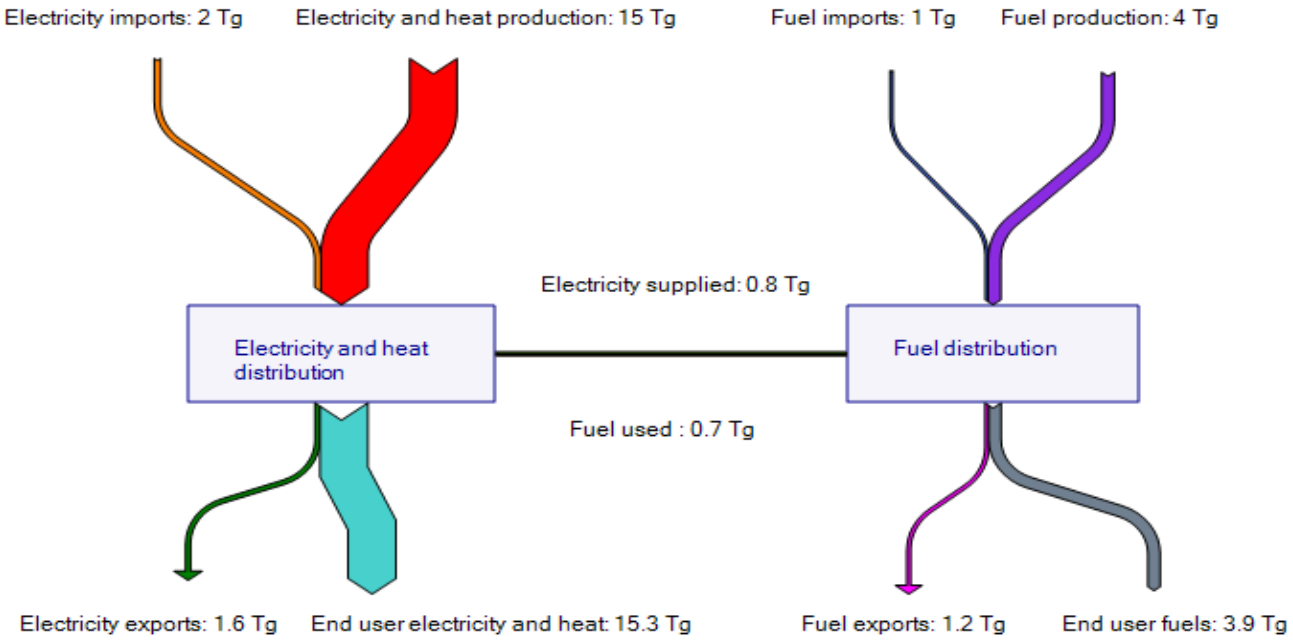


Figure A3.16 Direct GHG emissions from energy transformation (upper chart) and indirect GHG emissions from energy distribution by end user (lower chart) in Hungary, 2010



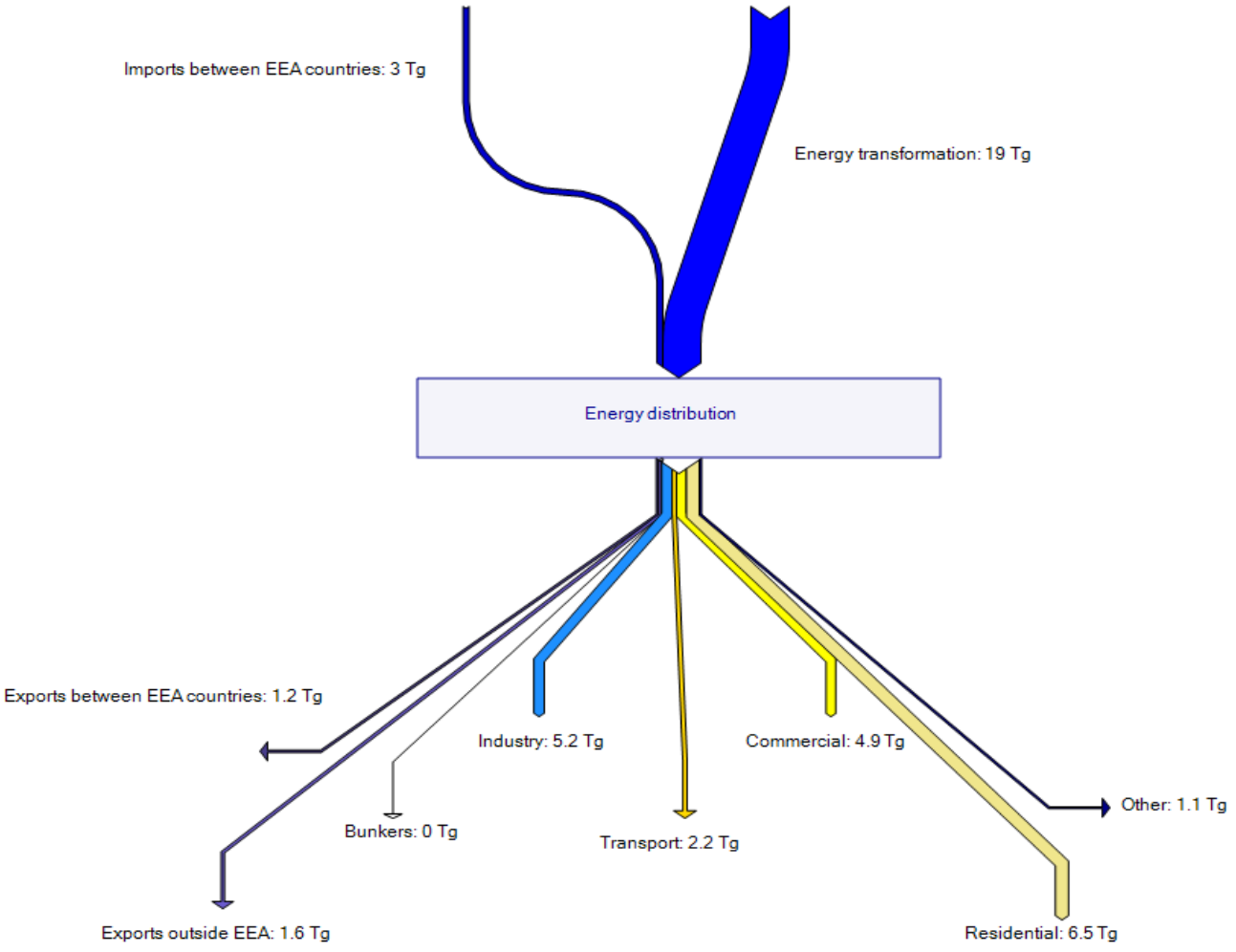
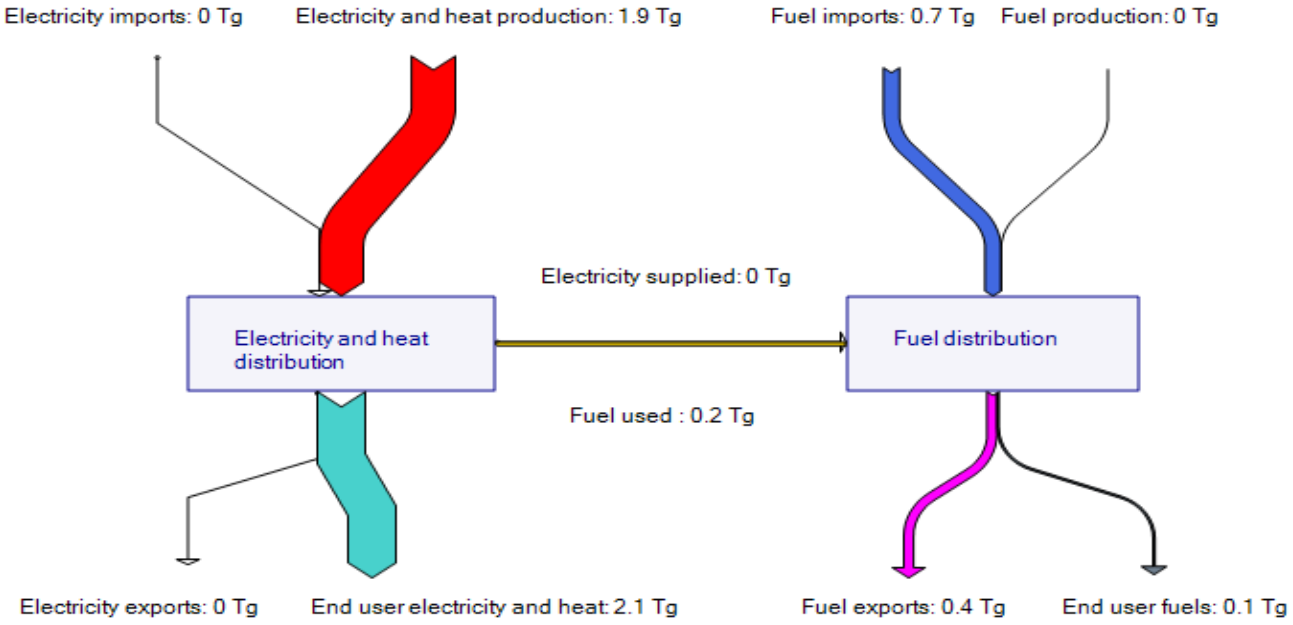


Figure A3.17 Direct GHG emissions from energy transformation (upper chart) and indirect GHG emissions from energy distribution by end user (lower chart) in Malta, 2010



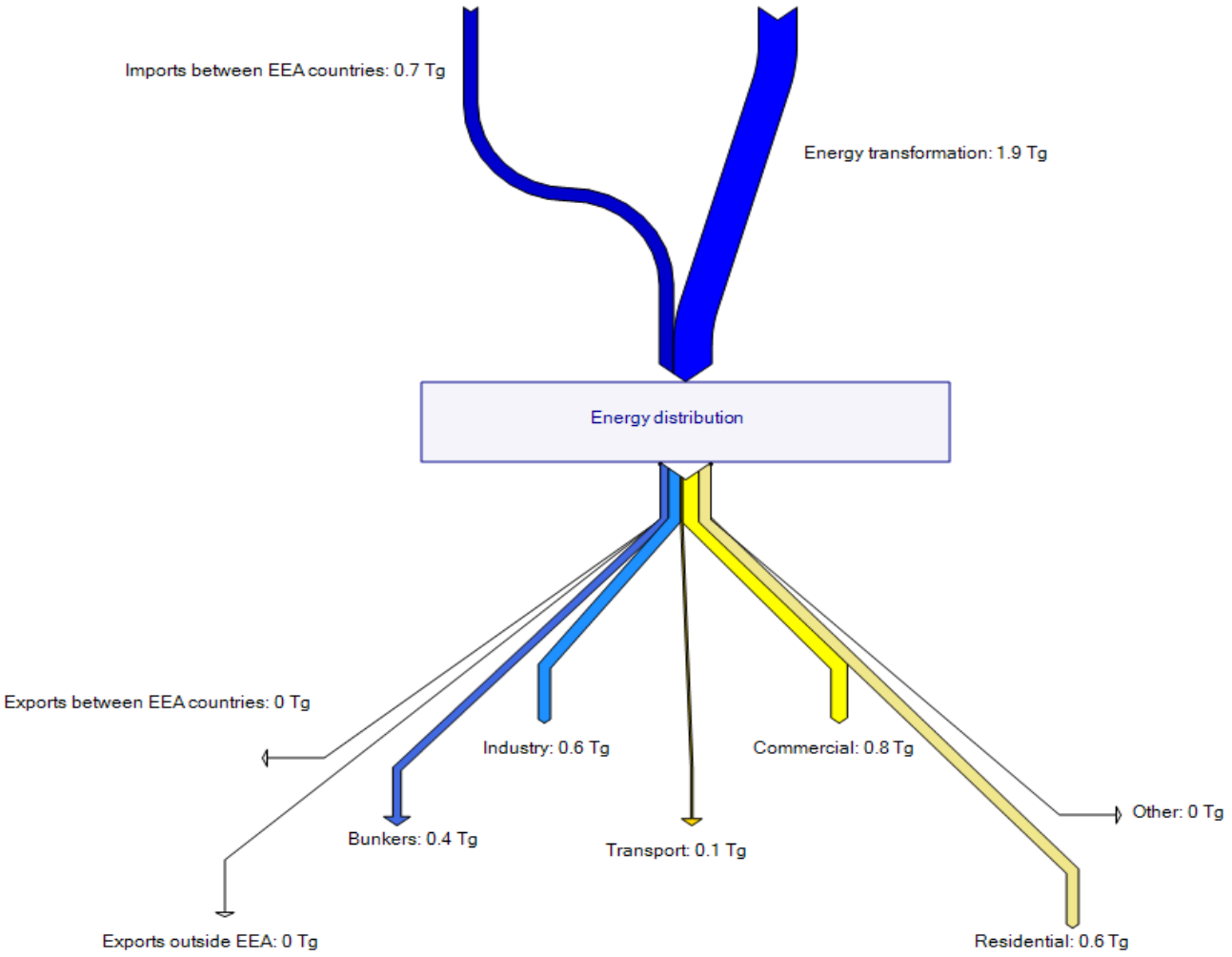
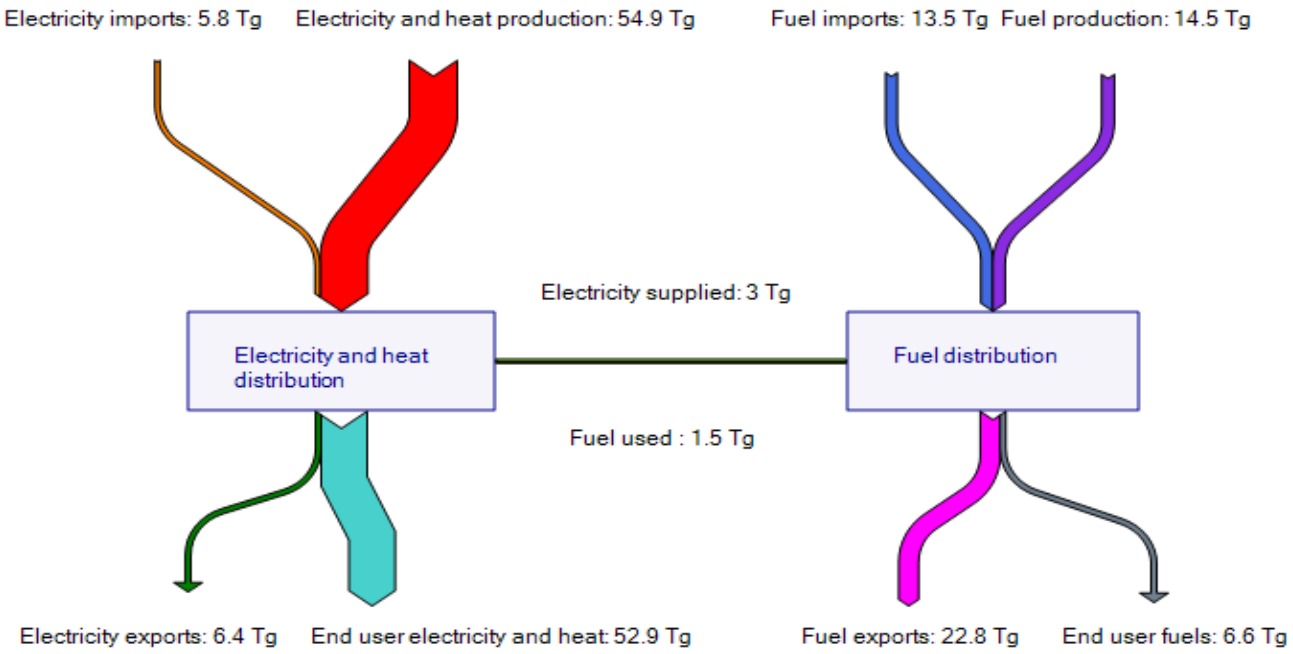


Figure A3.18 Direct GHG emissions from energy transformation (upper chart) and indirect GHG emissions from energy distribution by end user (lower chart) in the Netherlands, 2010



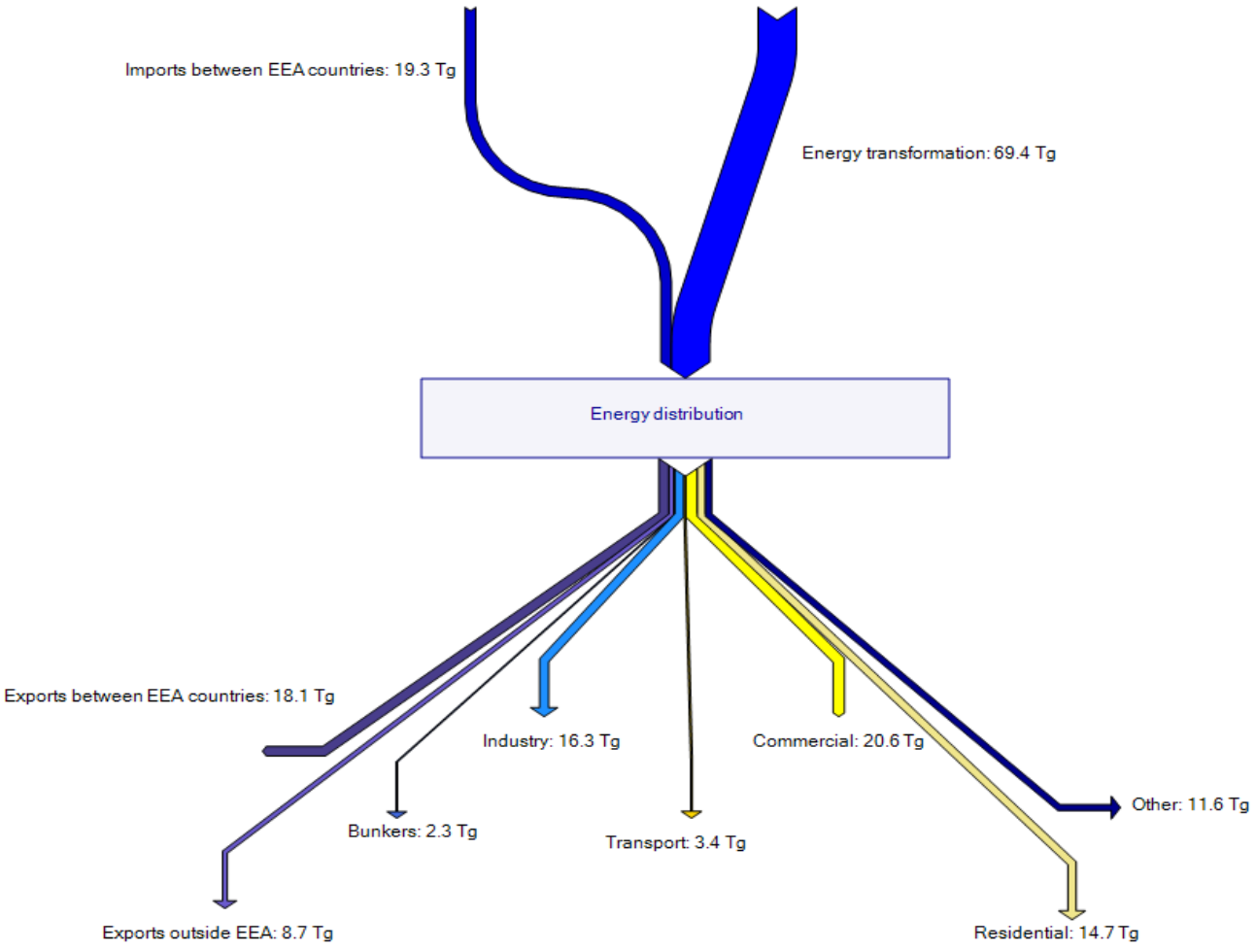
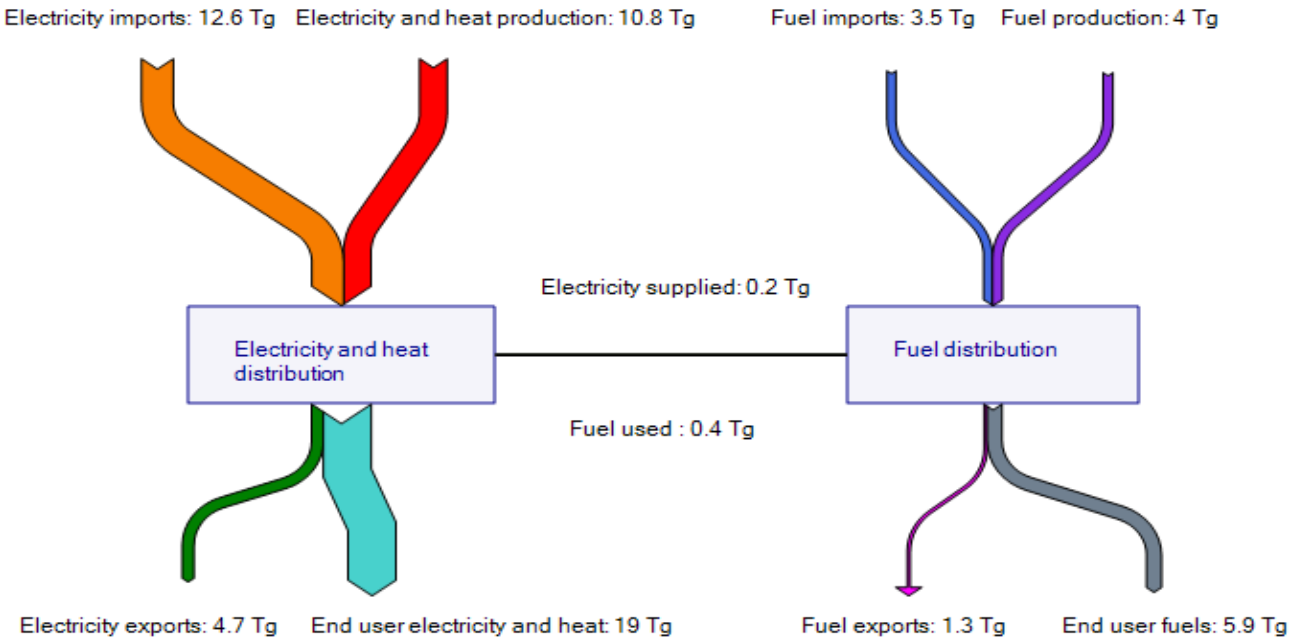


Figure A3.19 Direct GHG emissions from energy transformation (upper chart) and indirect GHG emissions from energy distribution by end user (lower chart) in Austria, 2010



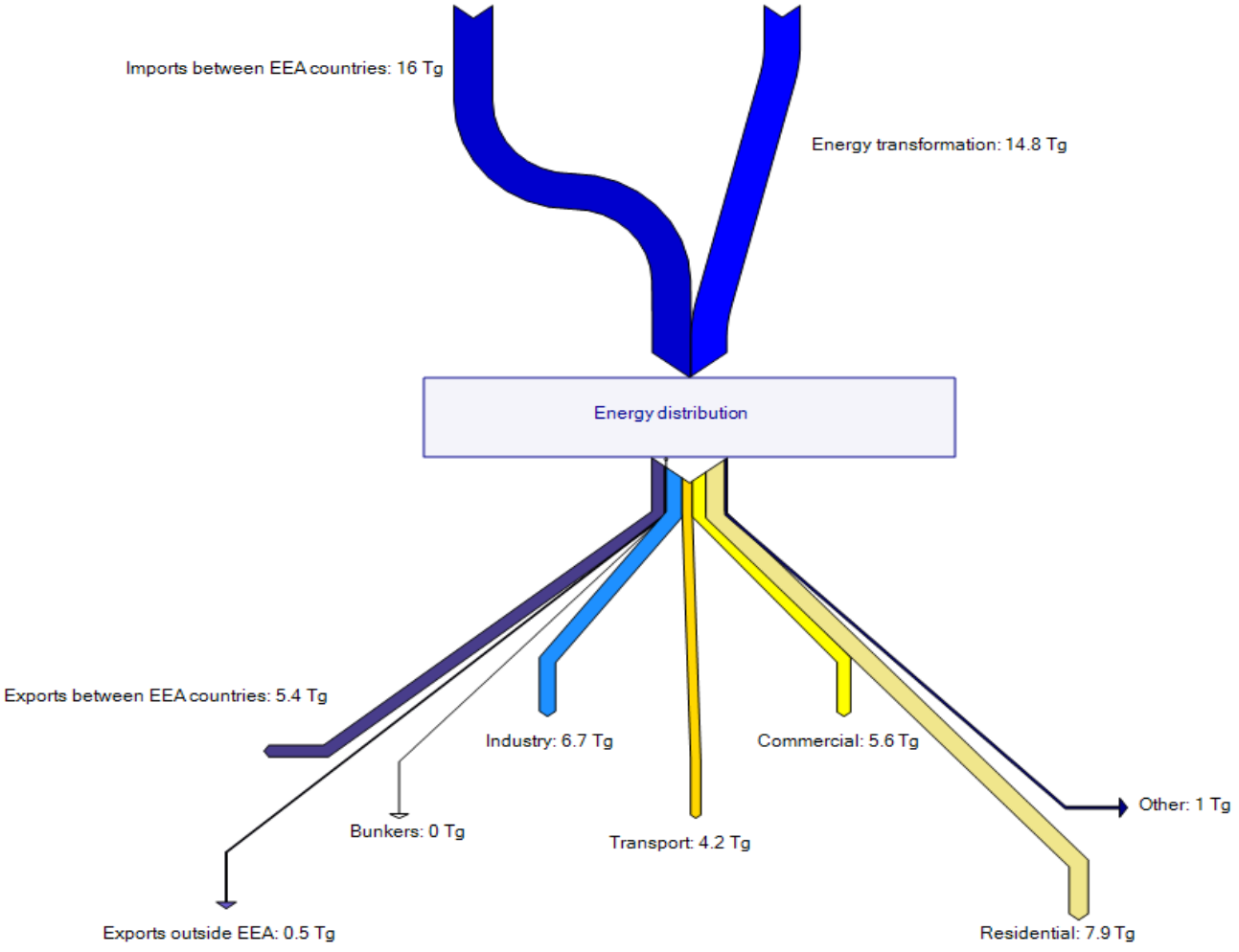
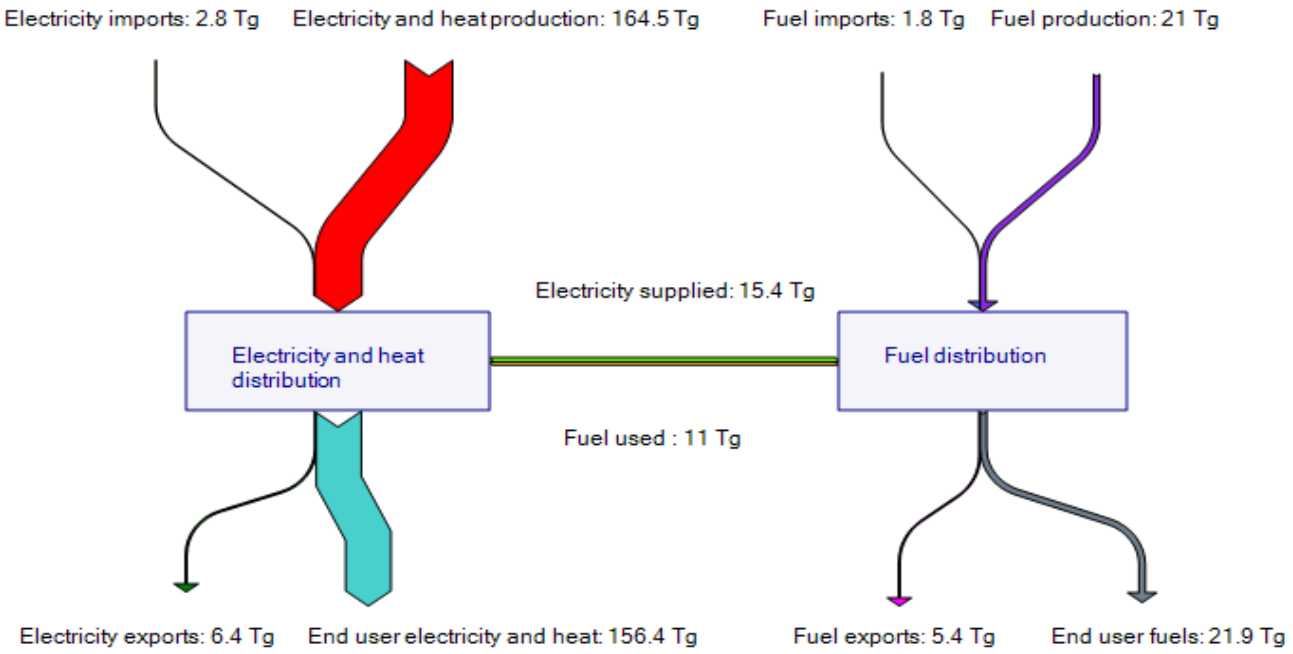


Figure A3.20 Direct GHG emissions from energy transformation (upper chart) and indirect GHG emissions from energy distribution by end user (lower chart) in Poland, 2010



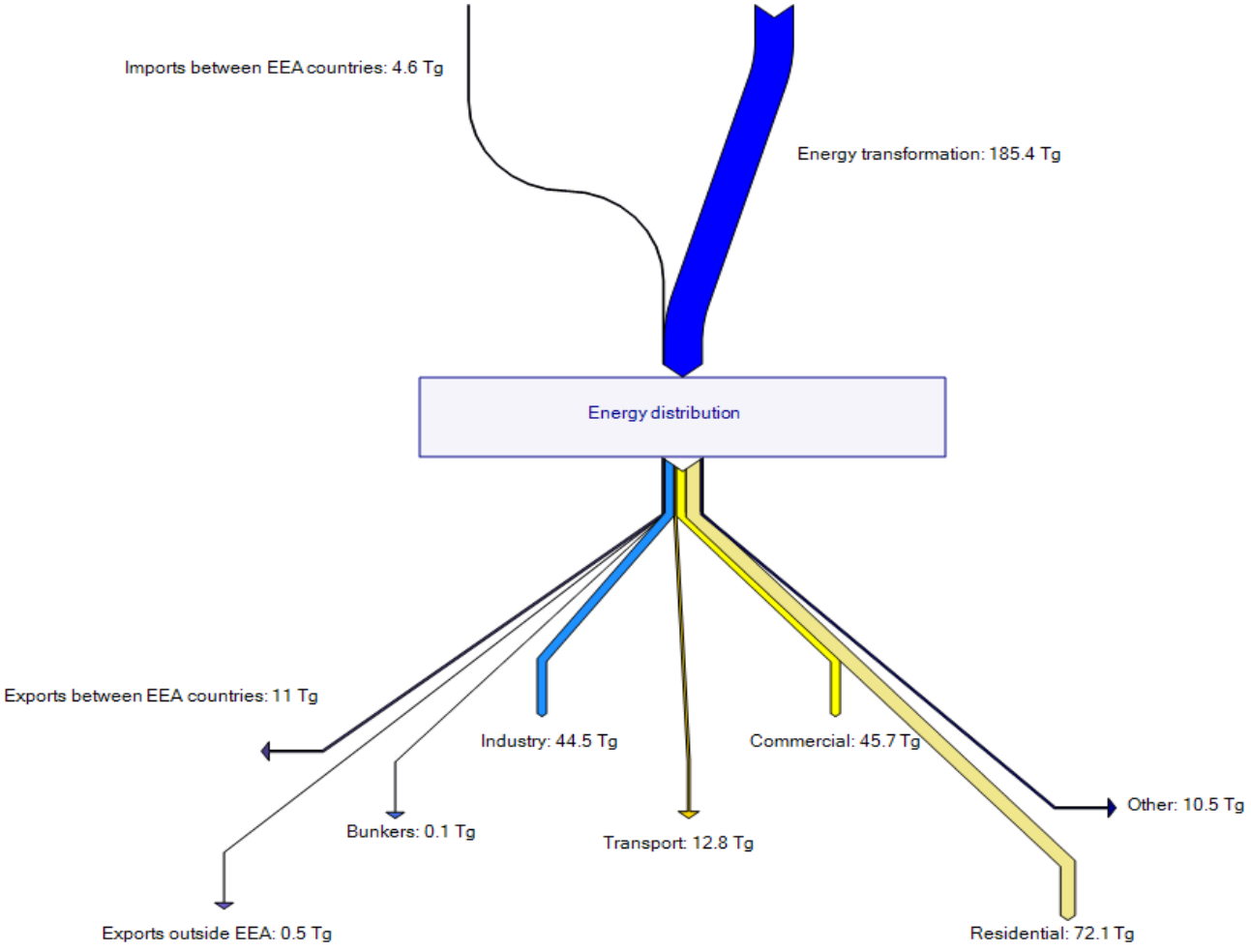
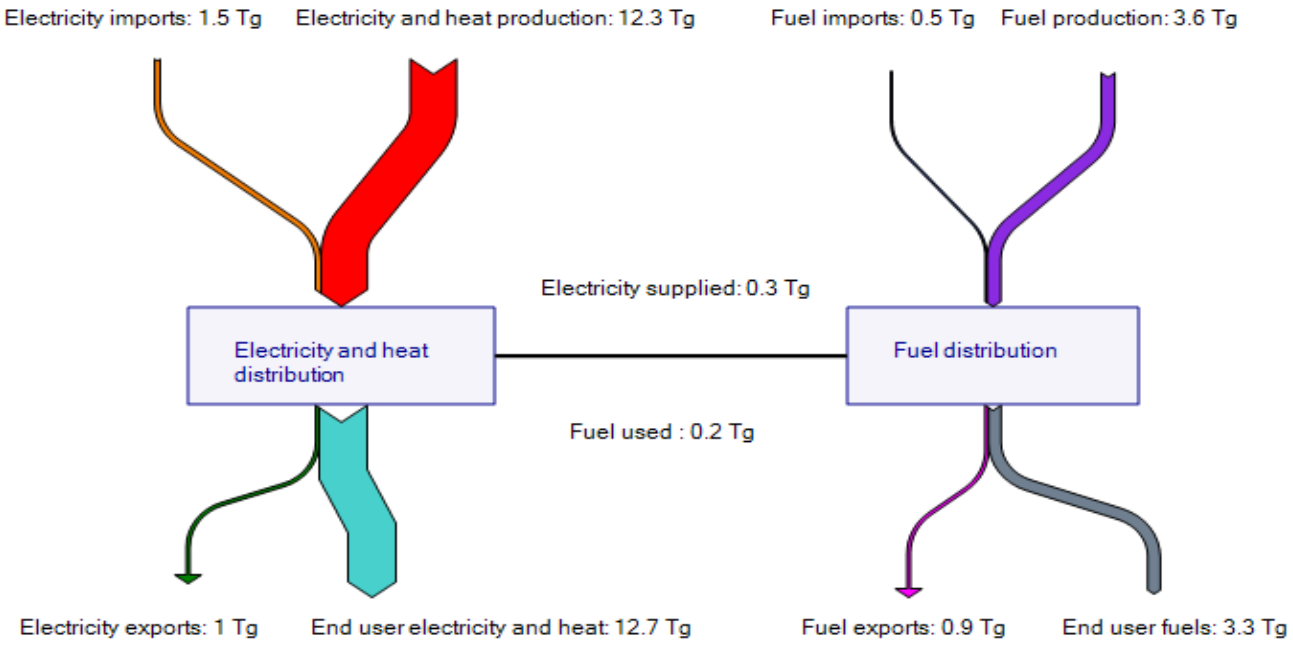


Figure A3.21 Direct GHG emissions from energy transformation (upper chart) and indirect GHG emissions from energy distribution by end user (lower chart) in Portugal, 2010



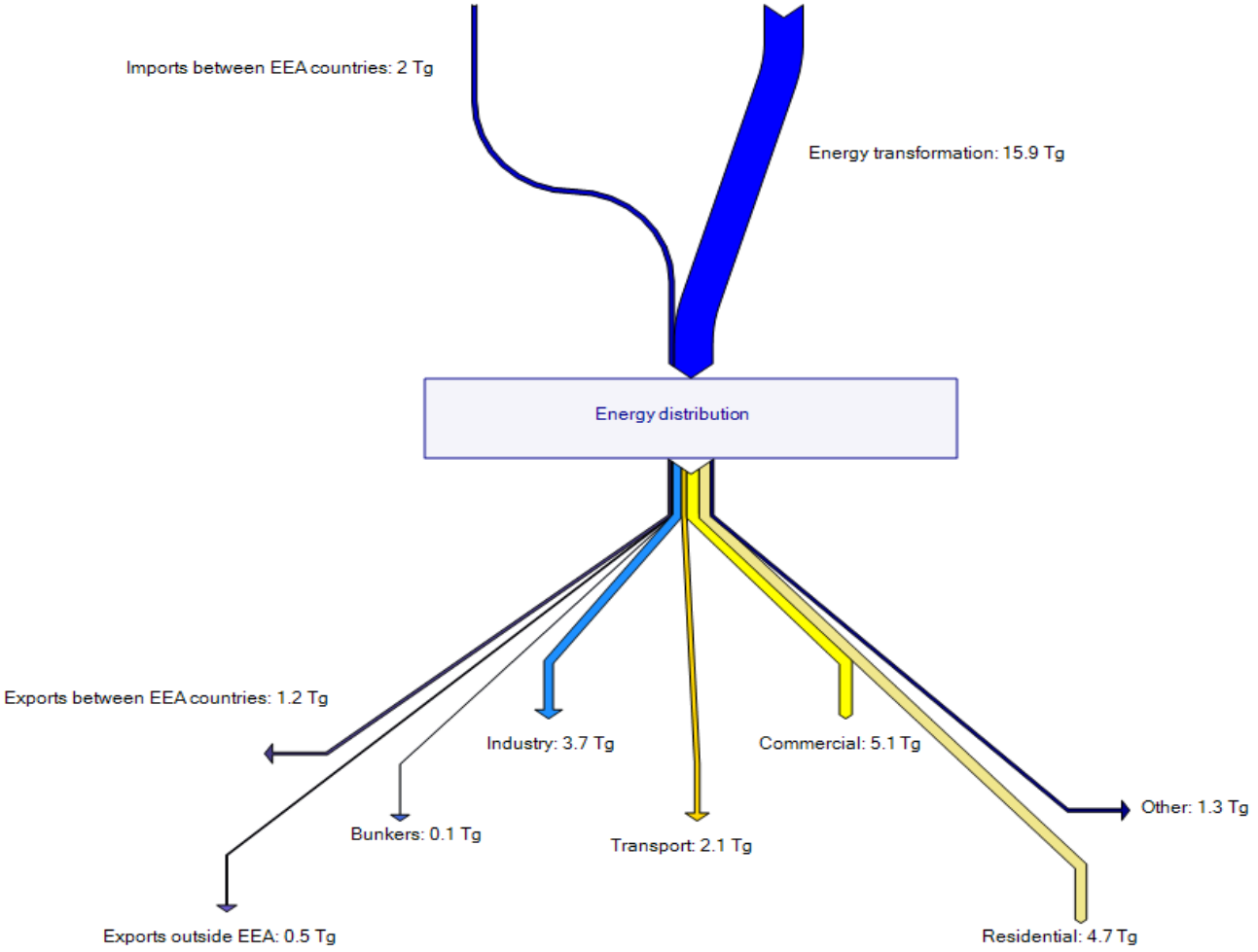
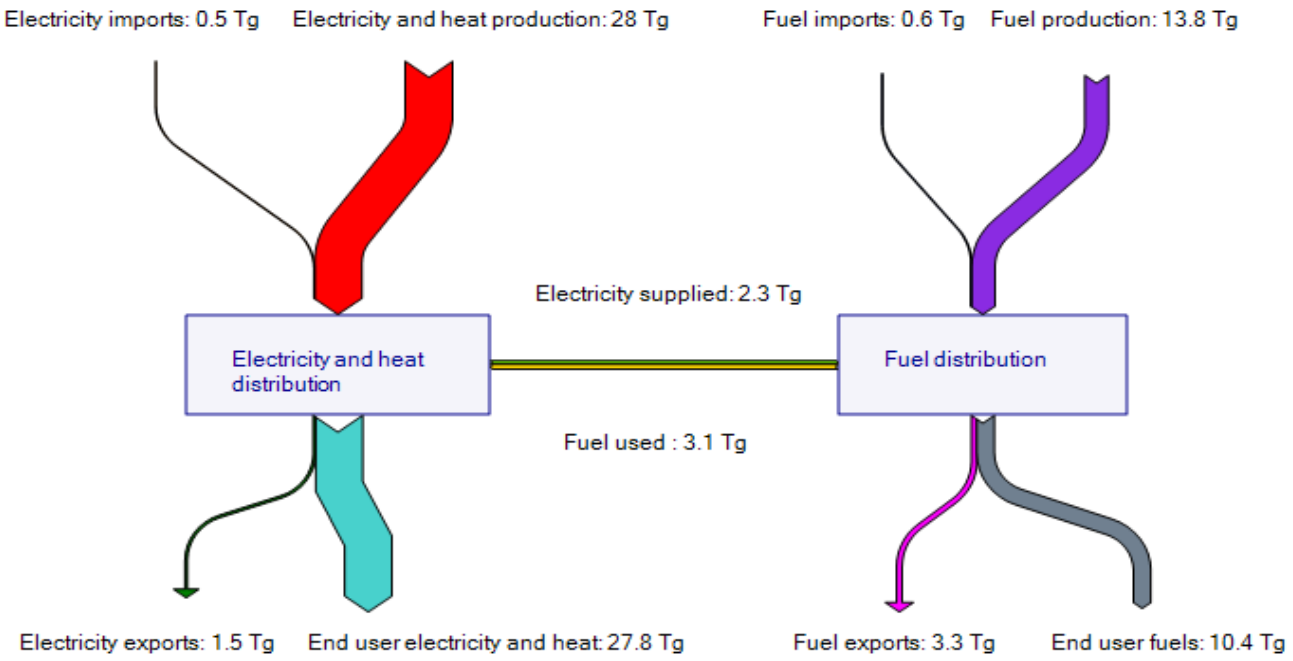


Figure A3.22 Direct GHG emissions from energy transformation (upper chart) and indirect GHG emissions from energy distribution by end user (lower chart) in Romania, 2010



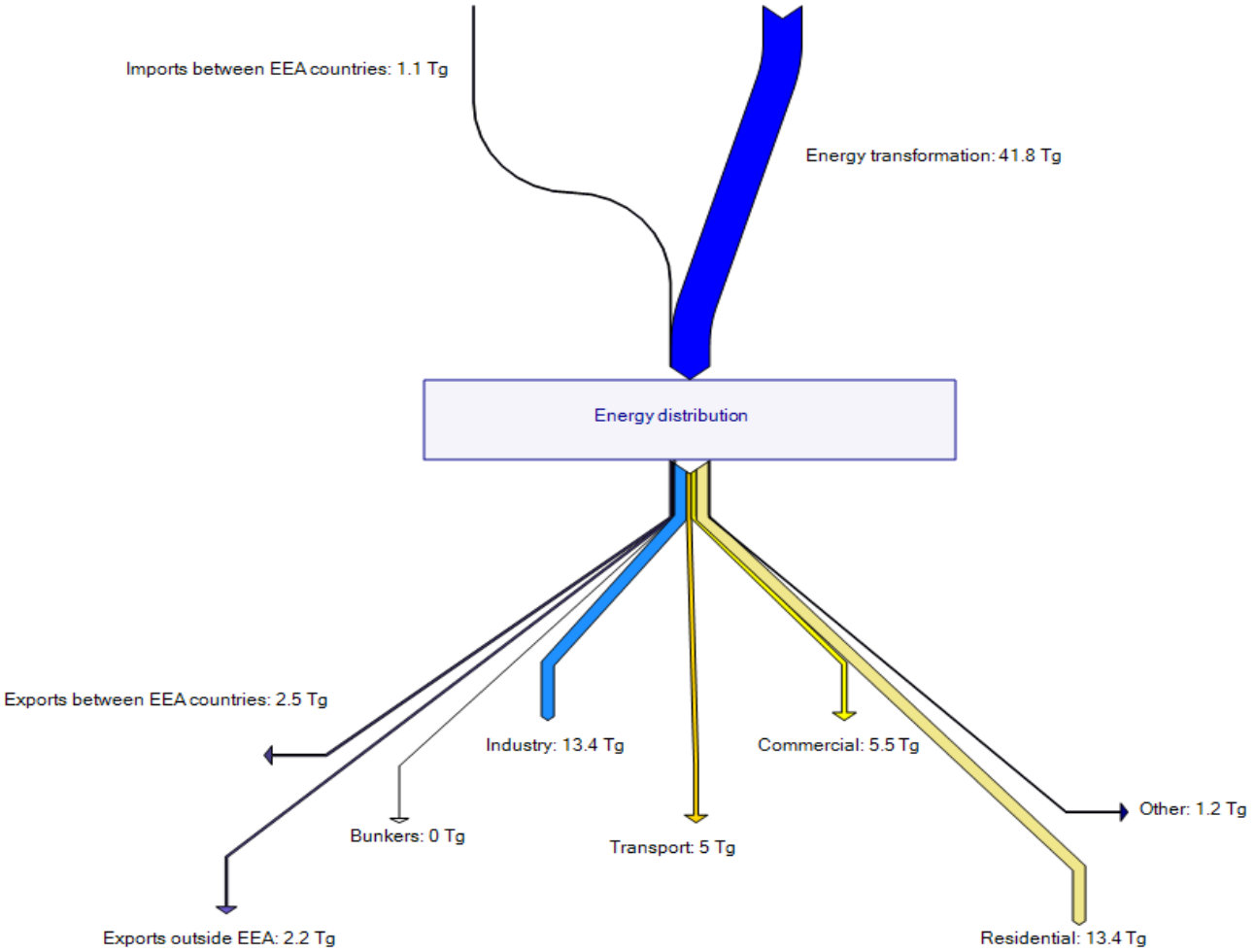
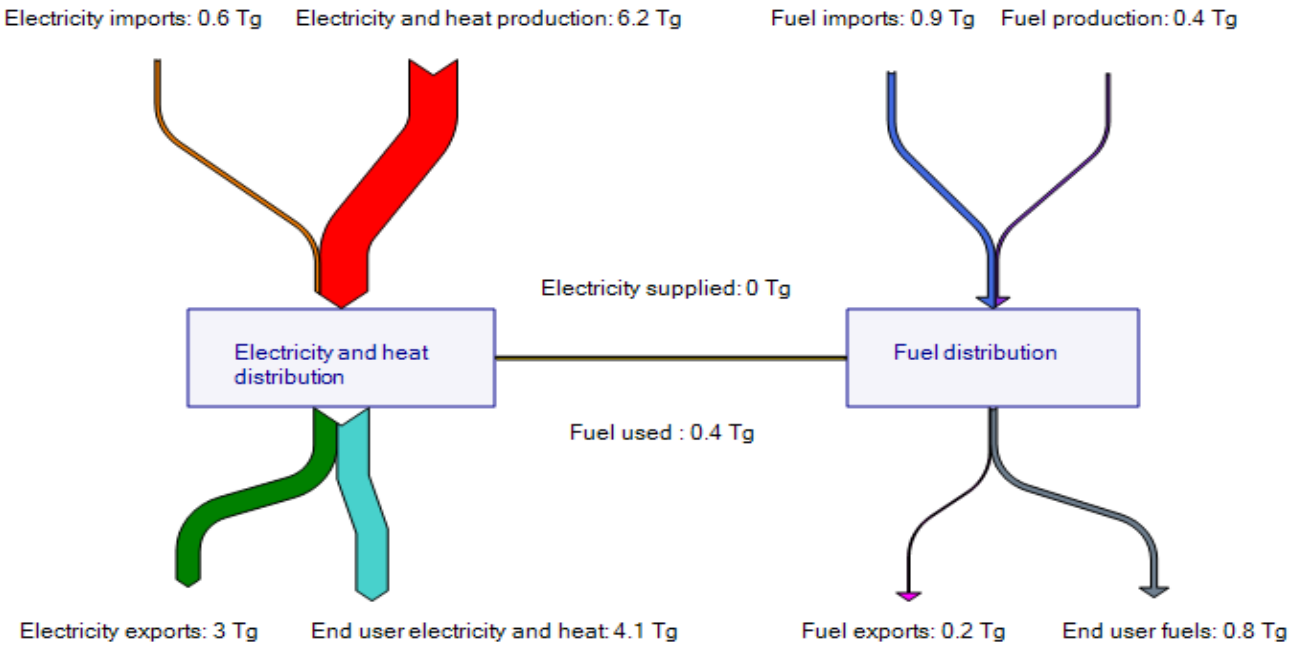


Figure A3.23 Direct GHG emissions from energy transformation (upper chart) and indirect GHG emissions from energy distribution by end user (lower chart) in Slovenia, 2010



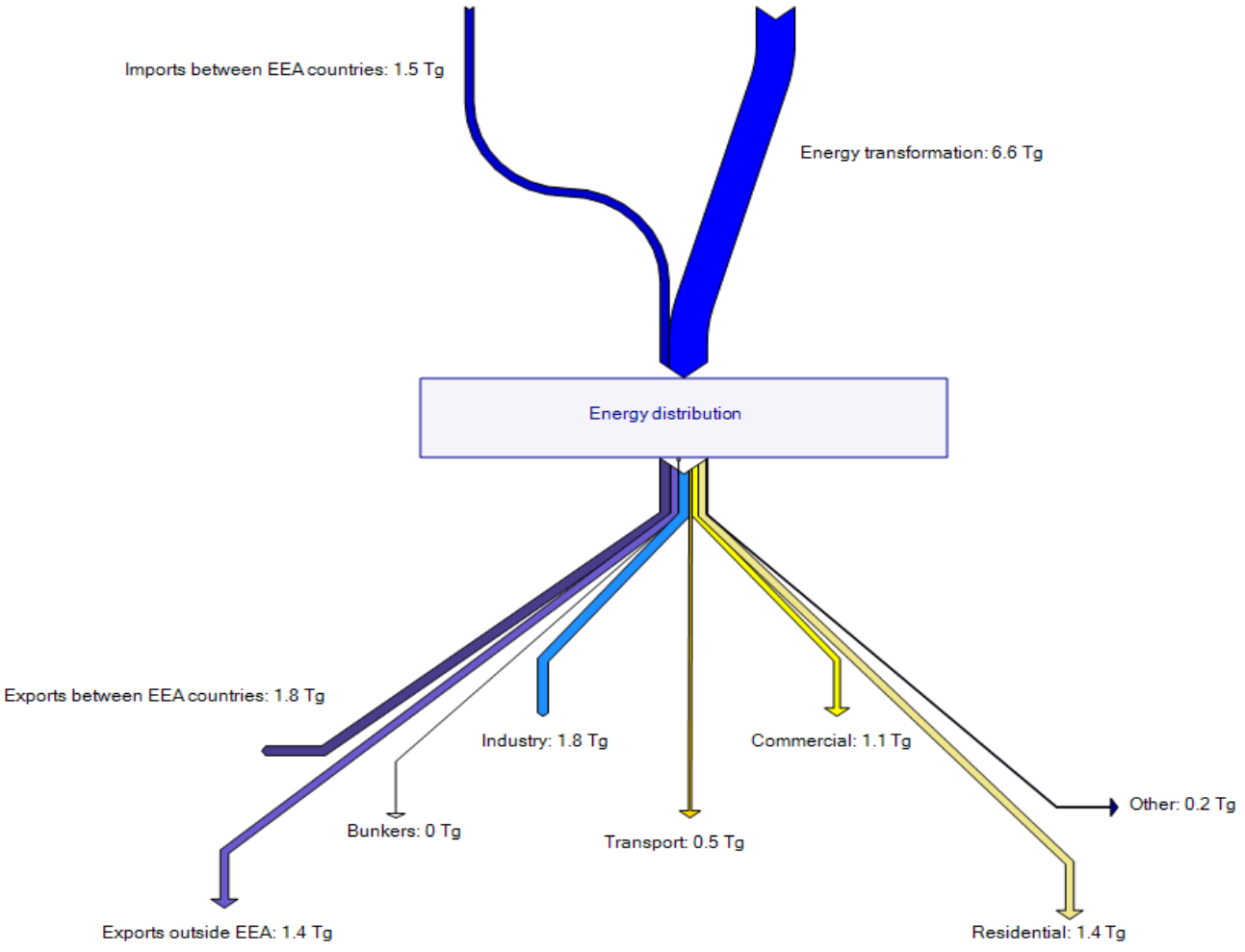
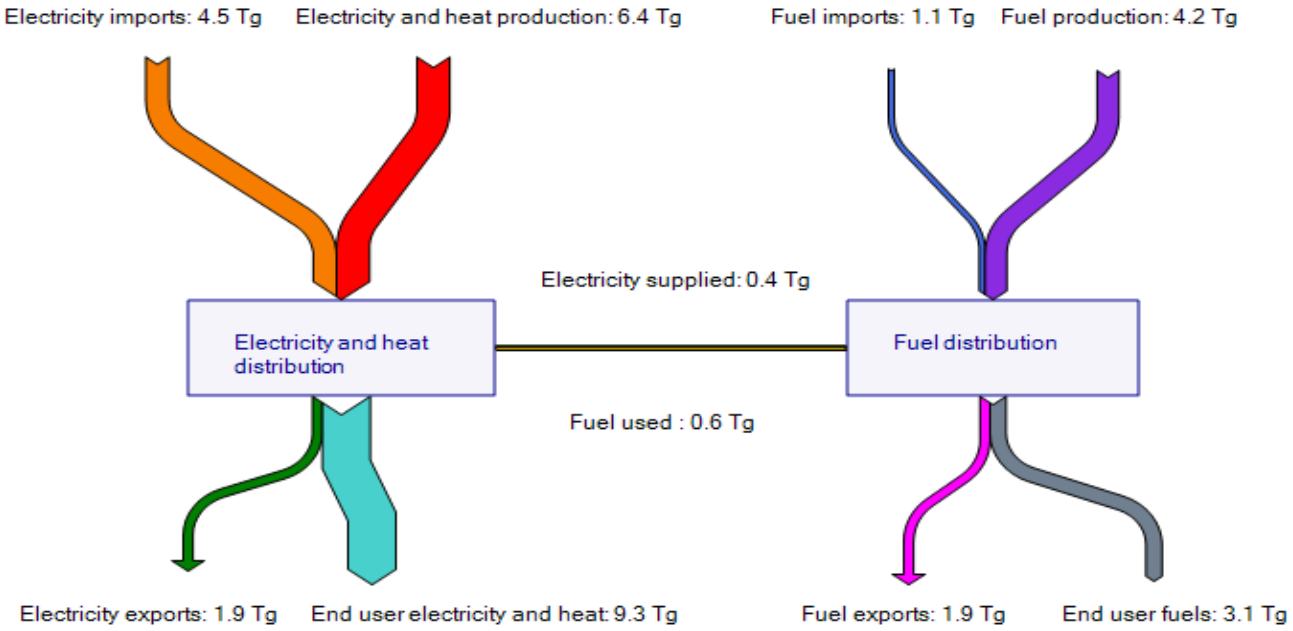


Figure A3.24 Direct GHG emissions from energy transformation (upper chart) and indirect GHG emissions from energy distribution by end user (lower chart) in Slovakia, 2010



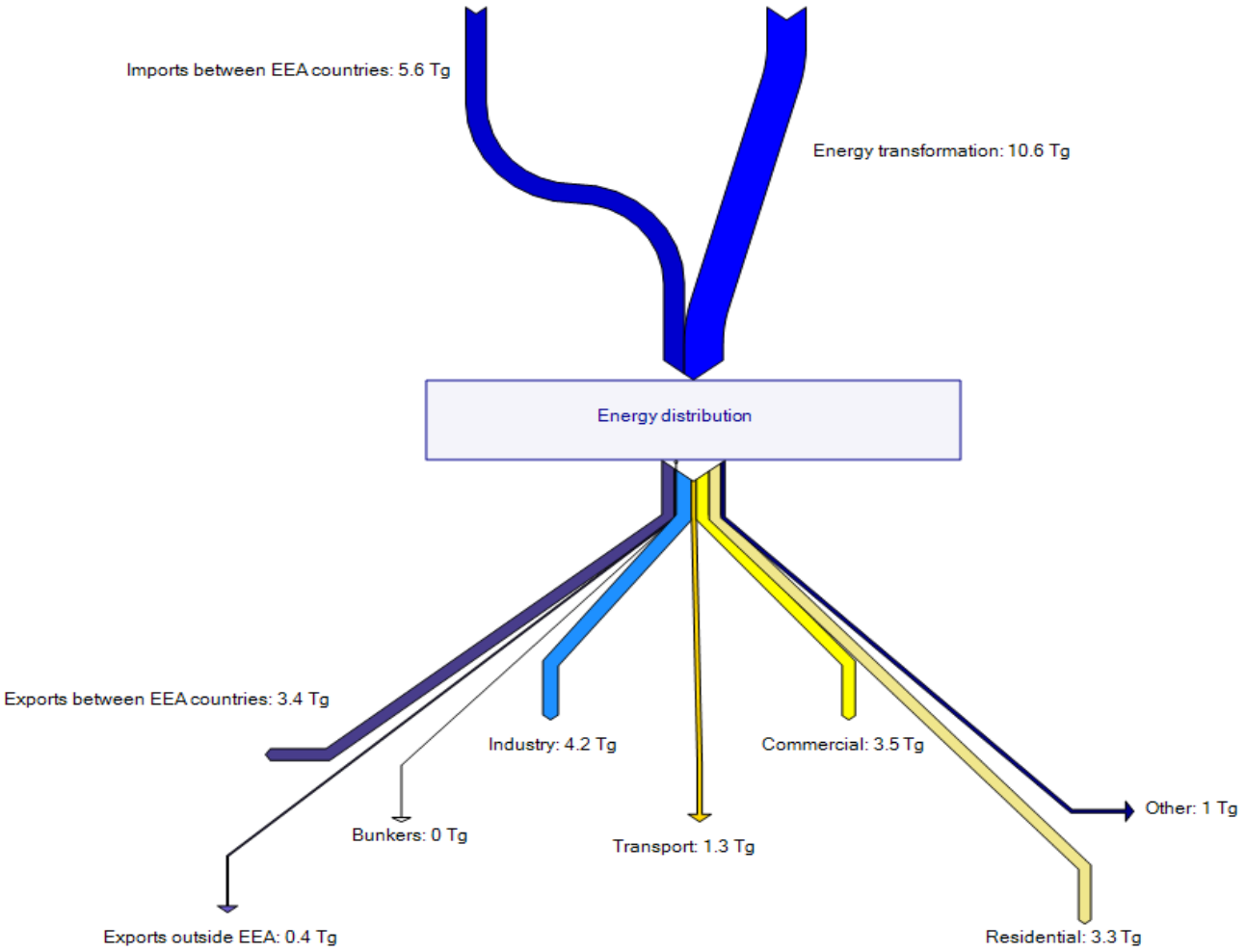
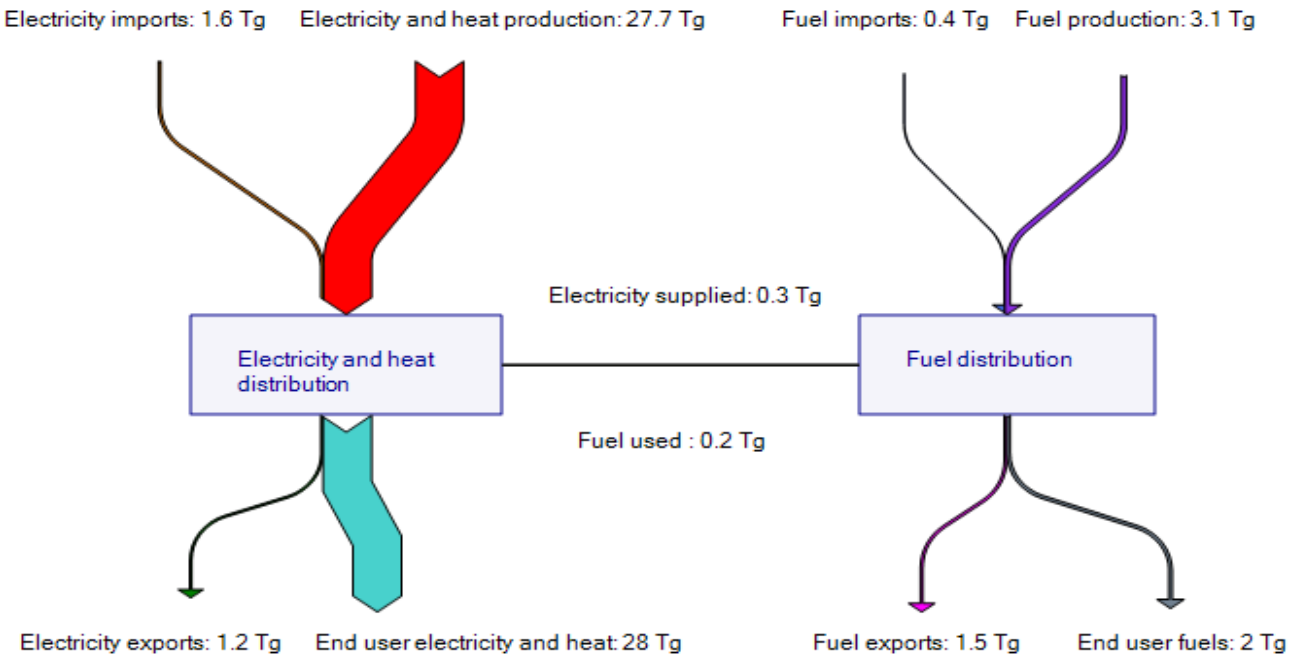


Figure A3.25 Direct GHG emissions from energy transformation (upper chart) and indirect GHG emissions from energy distribution by end user (lower chart) in Finland, 2010



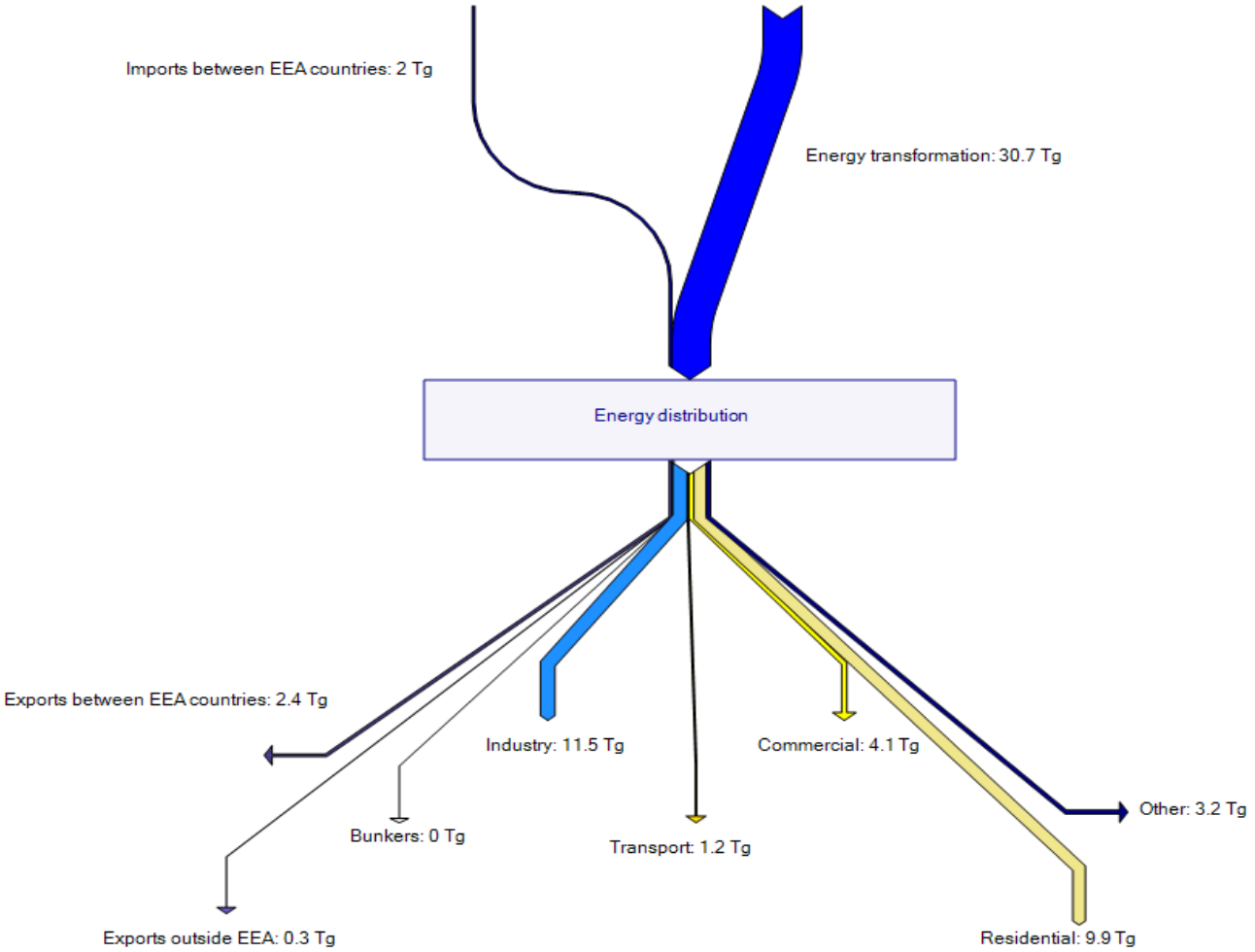
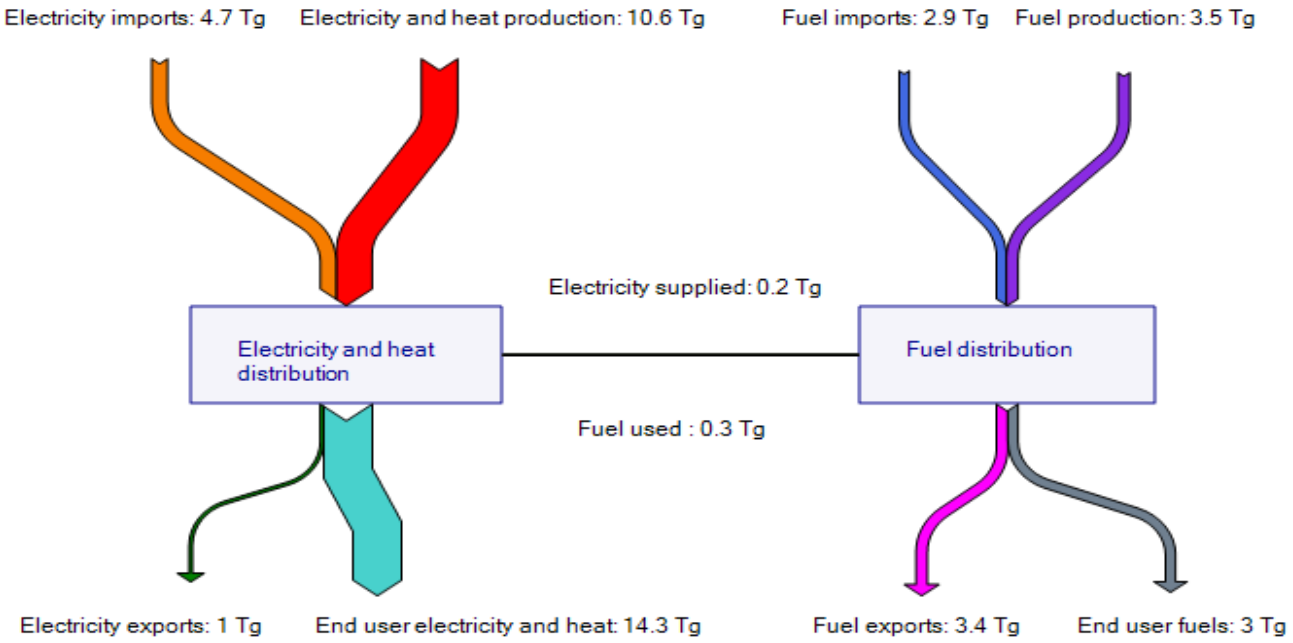


Figure A3.26 Direct GHG emissions from energy transformation (upper chart) and indirect GHG emissions from energy distribution by end user (lower chart) in Sweden, 2010



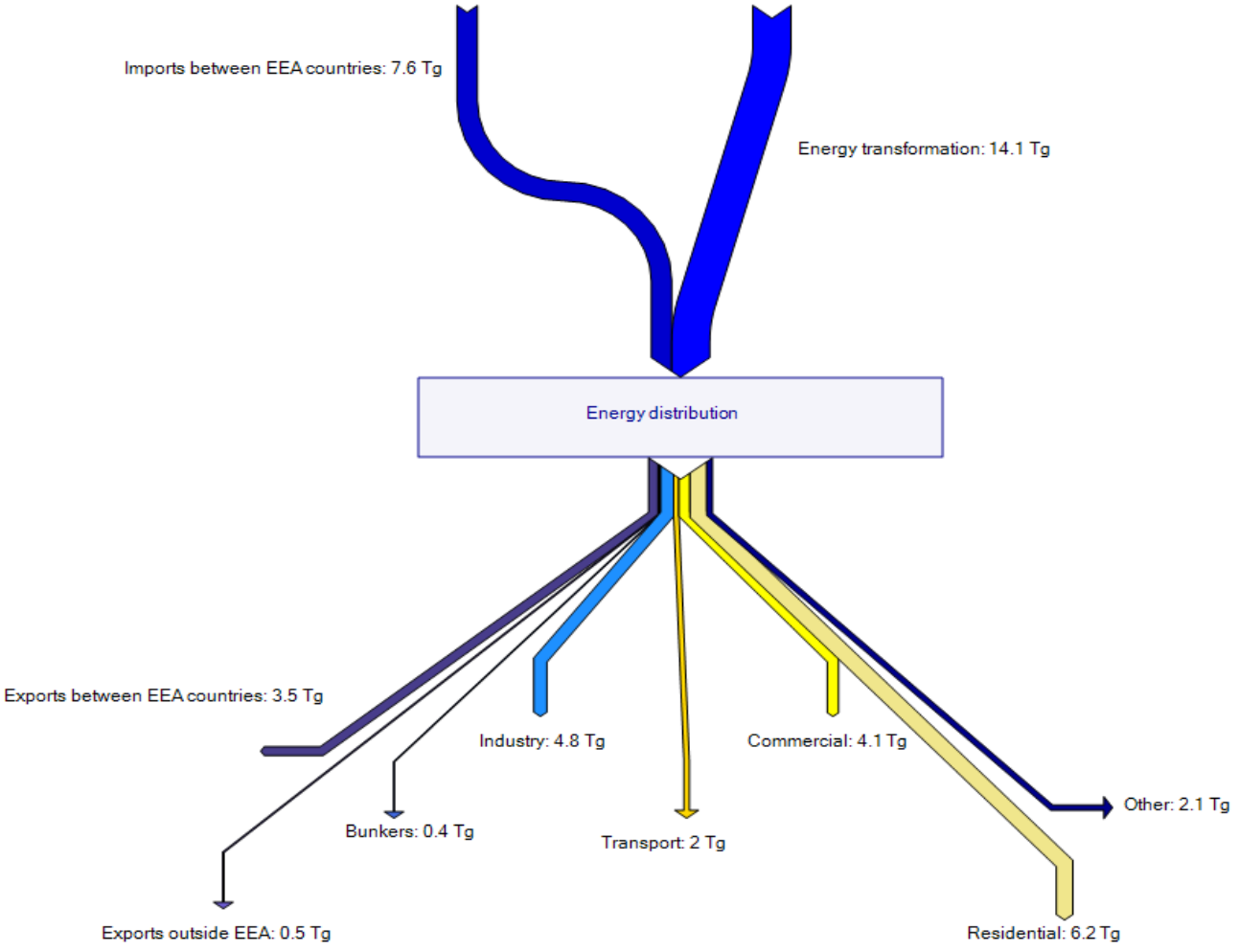
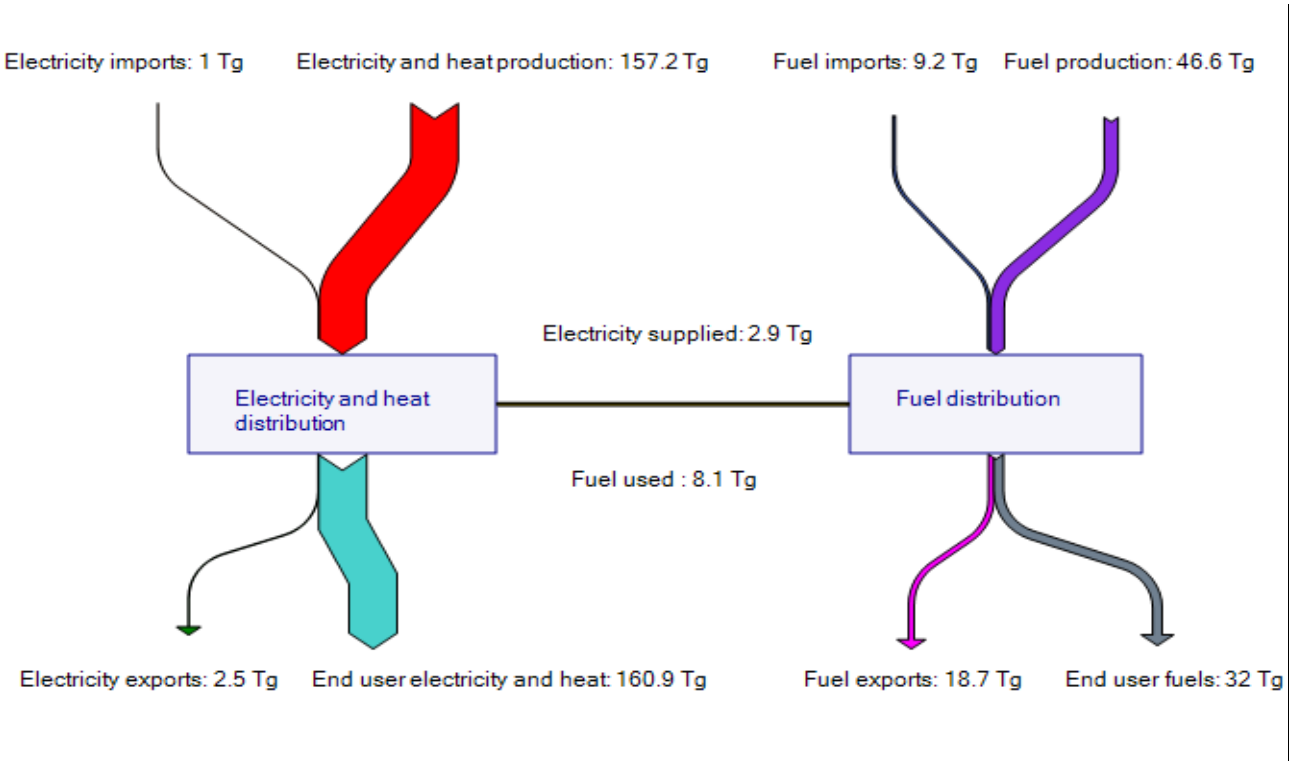


Figure A3.27 Direct GHG emissions from energy transformation (upper chart) and indirect GHG emissions from energy distribution by end user (lower chart) in the United Kingdom, 2010



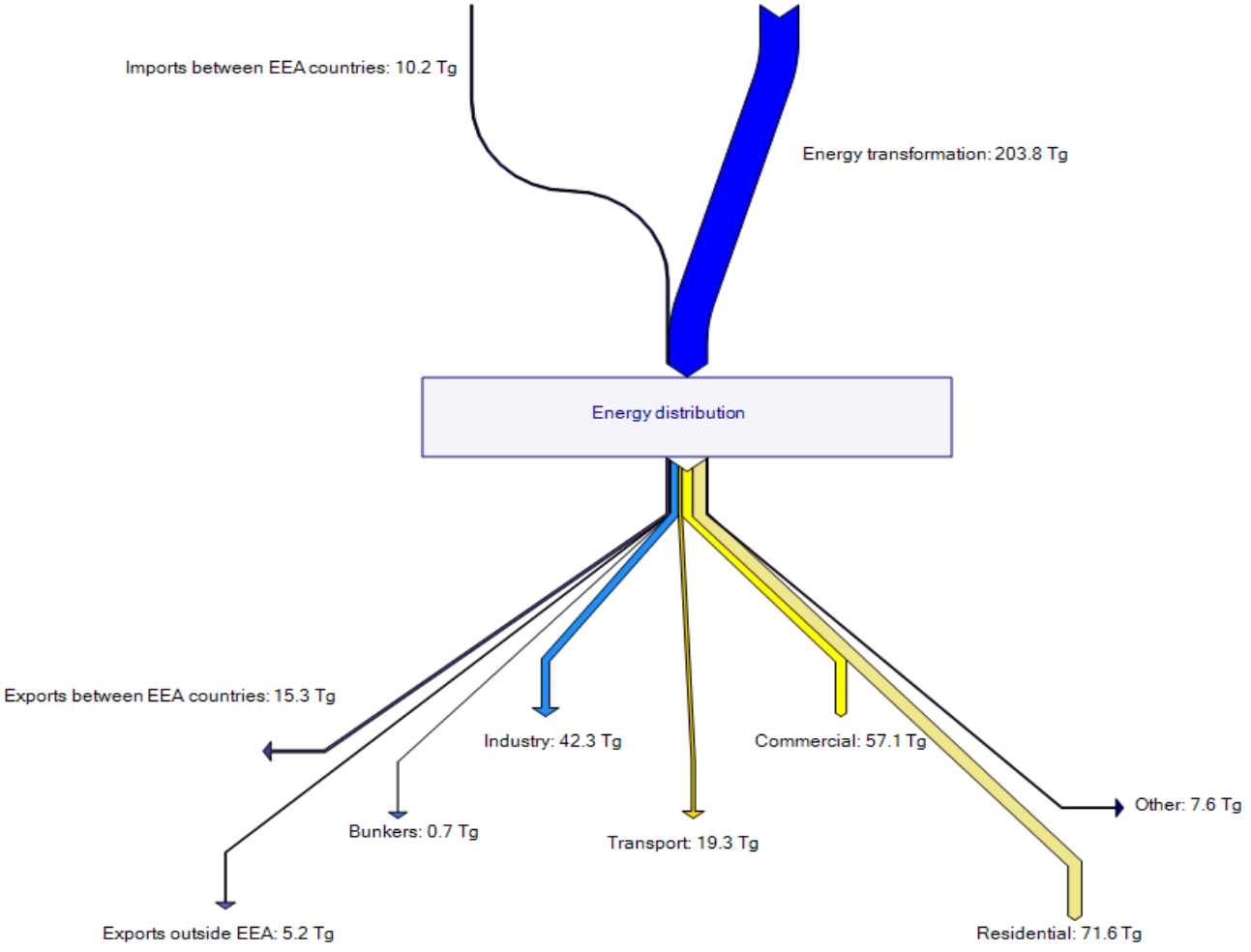
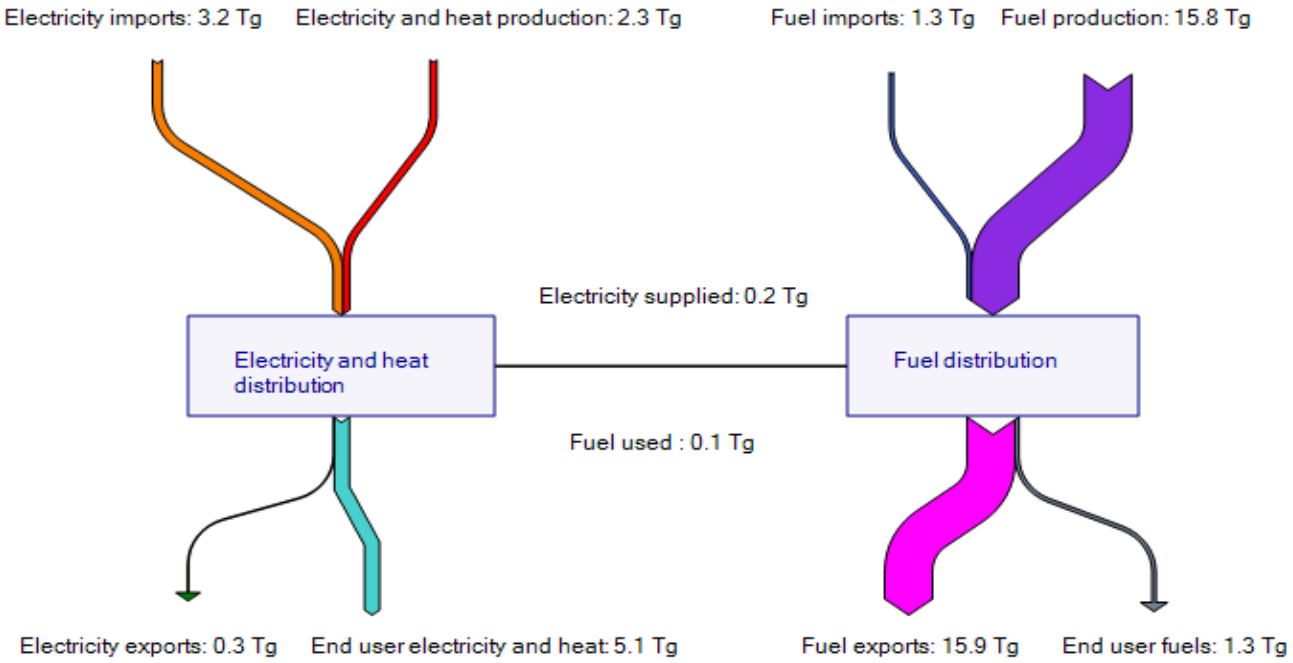


Figure A3.28 Direct GHG emissions from energy transformation (upper chart) and indirect GHG emissions from energy distribution by end user (lower chart) in Norway, 2010



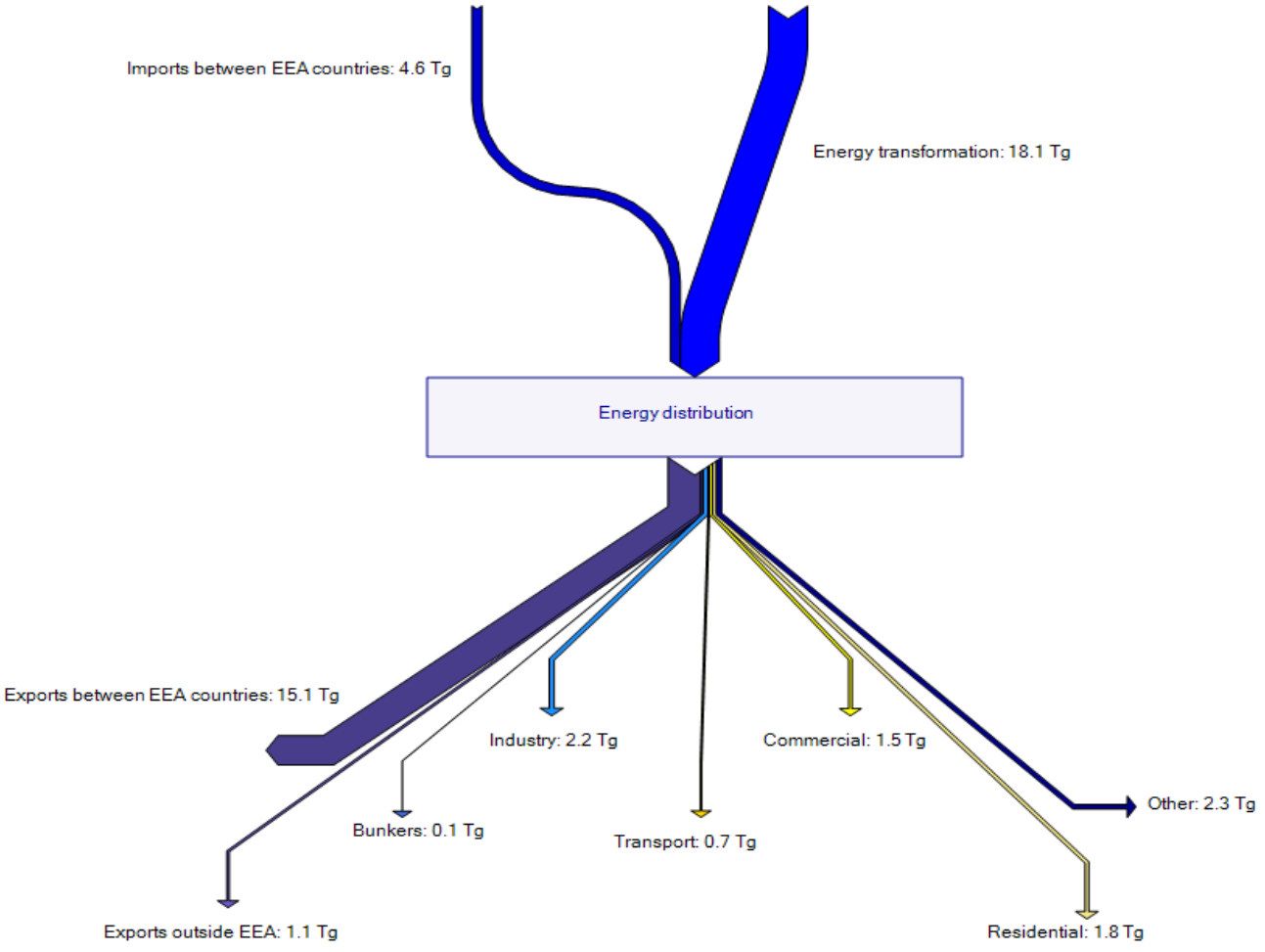
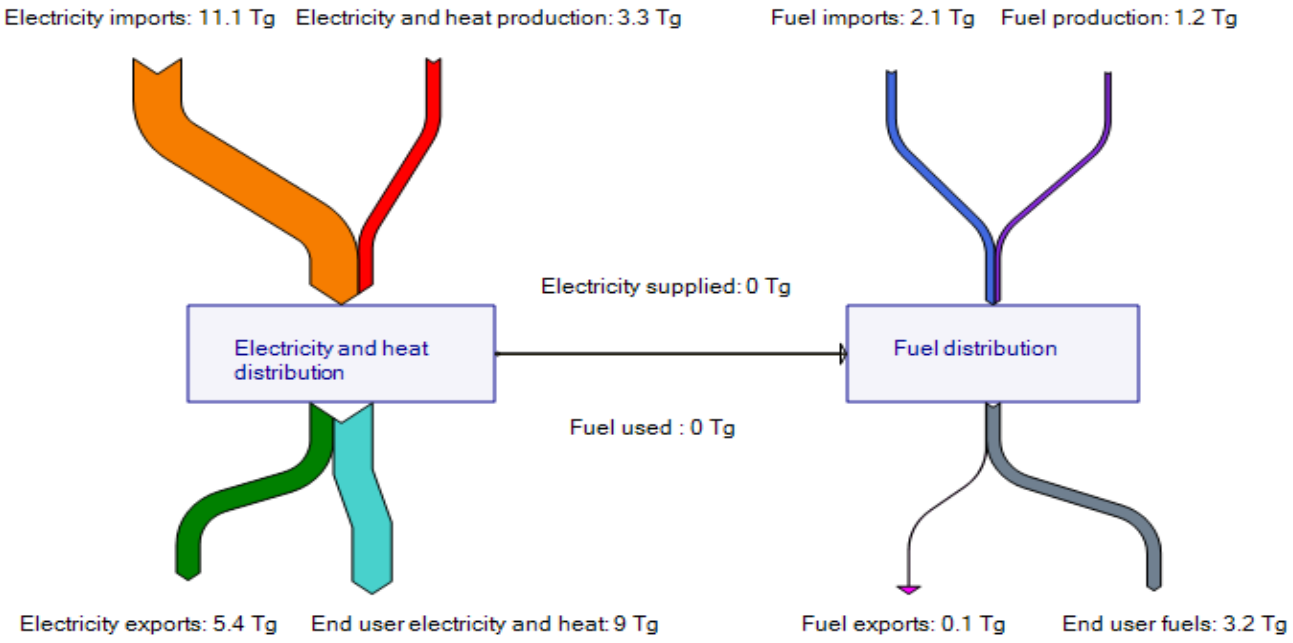
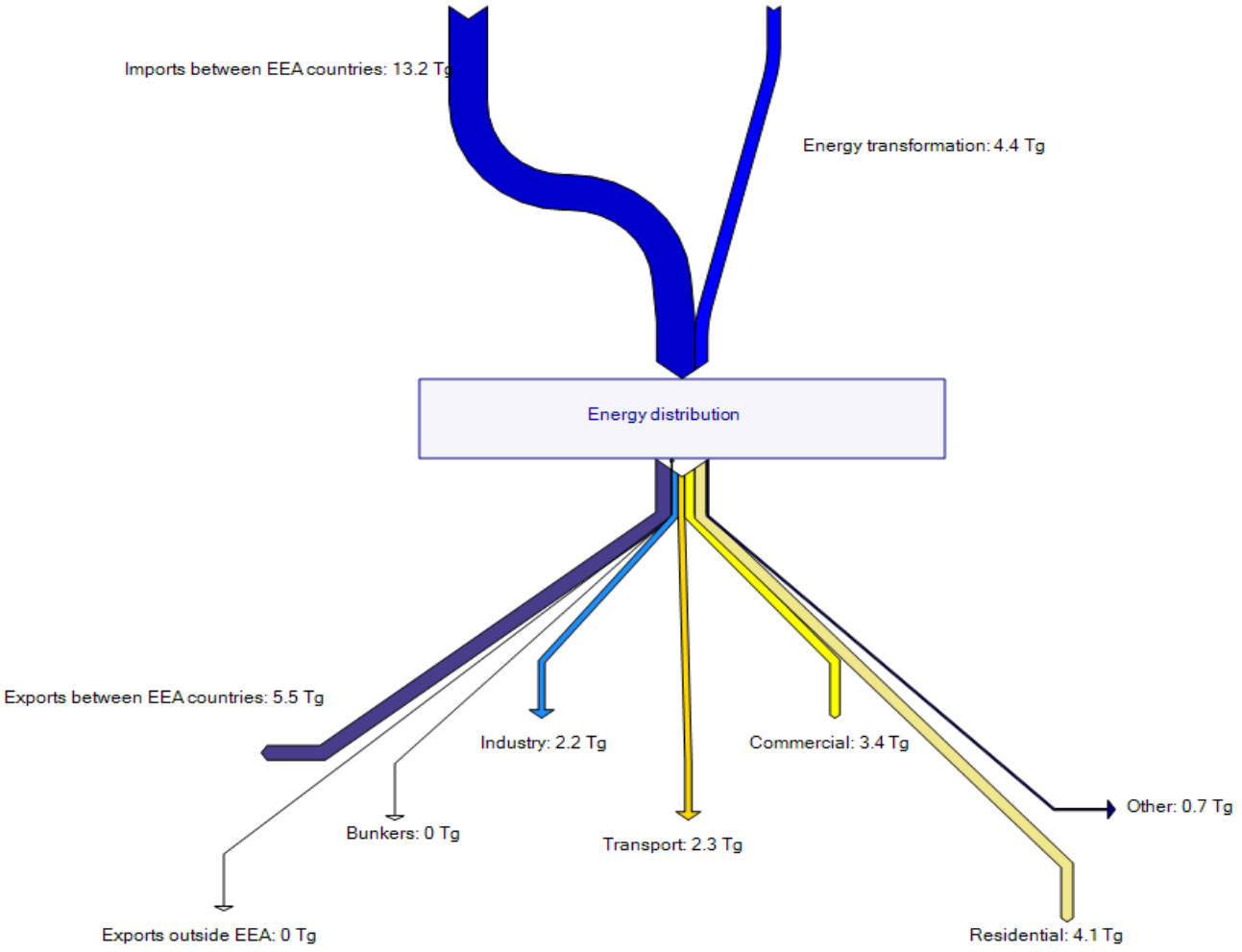


Figure A3.29 Direct GHG emissions from energy transformation (upper chart) and indirect GHG emissions from energy distribution by end user (lower chart) in Switzerland, 2010





Appendix 4 – Trends in nitrogen oxide and sulphur dioxide allocated to the end-user sectors between 2005 and 2010 in EU-27

Figure A4.1 Trends in direct and indirect nitrogen oxide (NO_x) emissions by end use sector in EU-27, 2005-2010

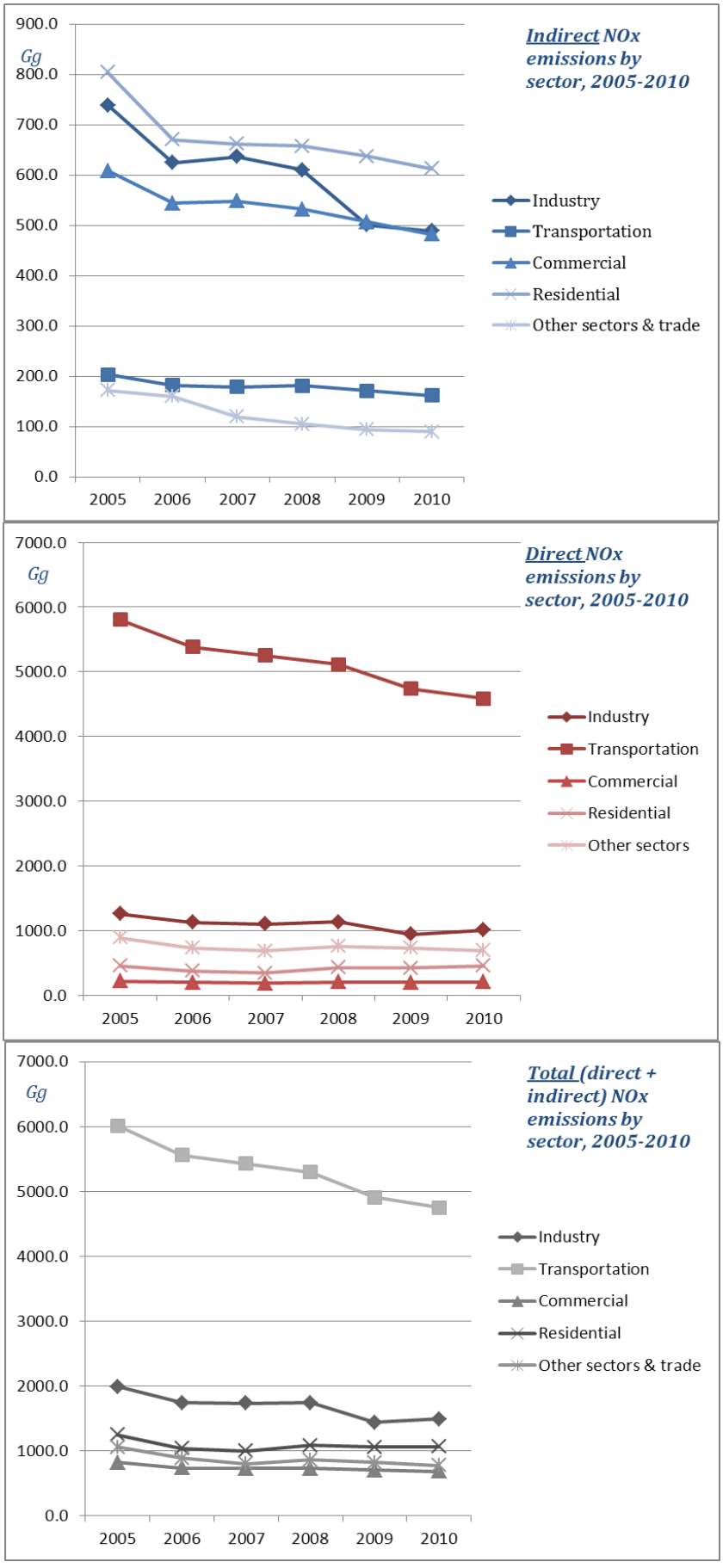
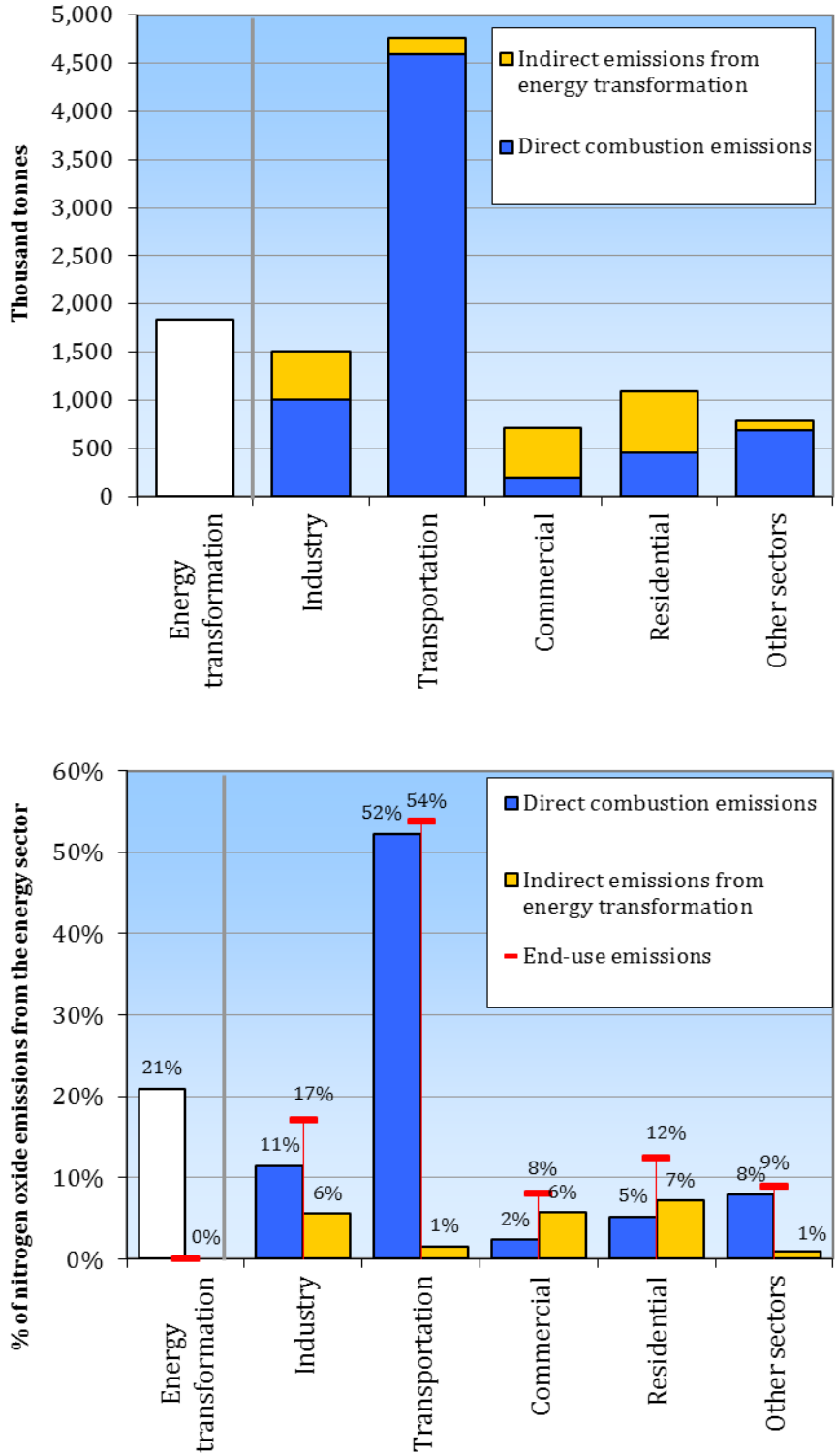


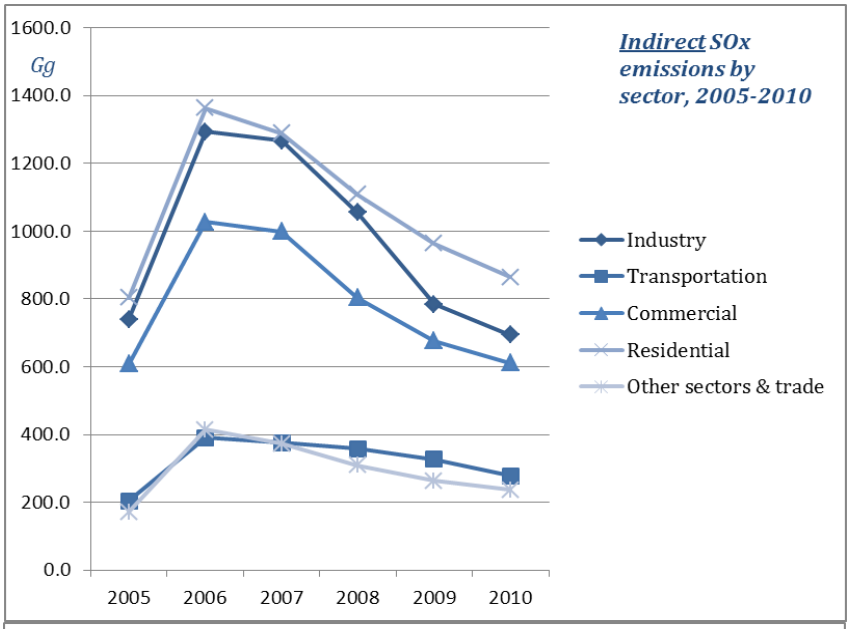
Figure A4.2 Direct and indirect nitrogen oxide (NO_x) emissions by end use sector in EU-27 in 2010

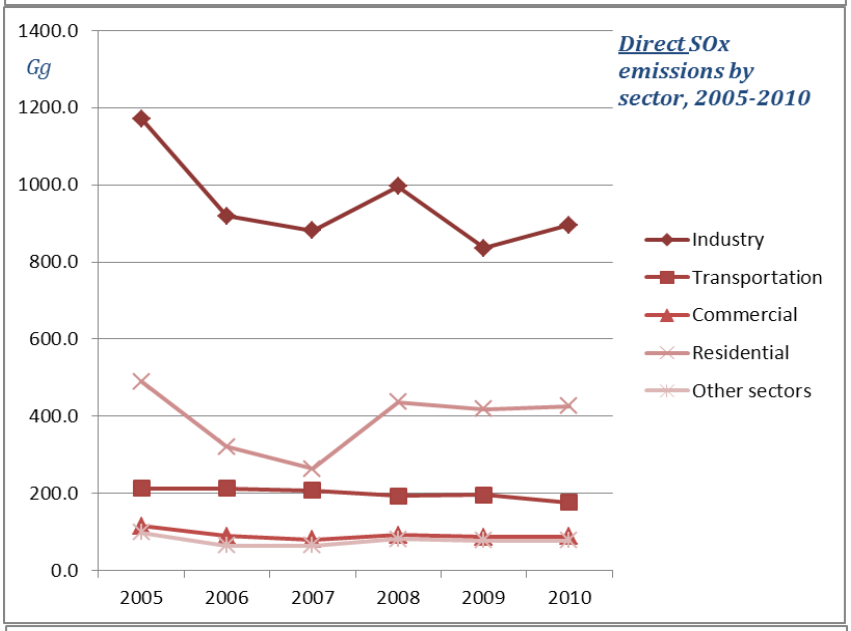


Note: The sum of direct and indirect emissions equals end-use emissions. The total indirect emissions allocated to end-users in a country can be smaller than the direct emissions from fuel transformation in that country if some of the indirect emissions are allocated to exports and international bunkers. 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, 2012

Figure A4.3 Trends in direct and indirect sulphur dioxide (SO_x) emissions by end use sector in EU-27, 2005-2010





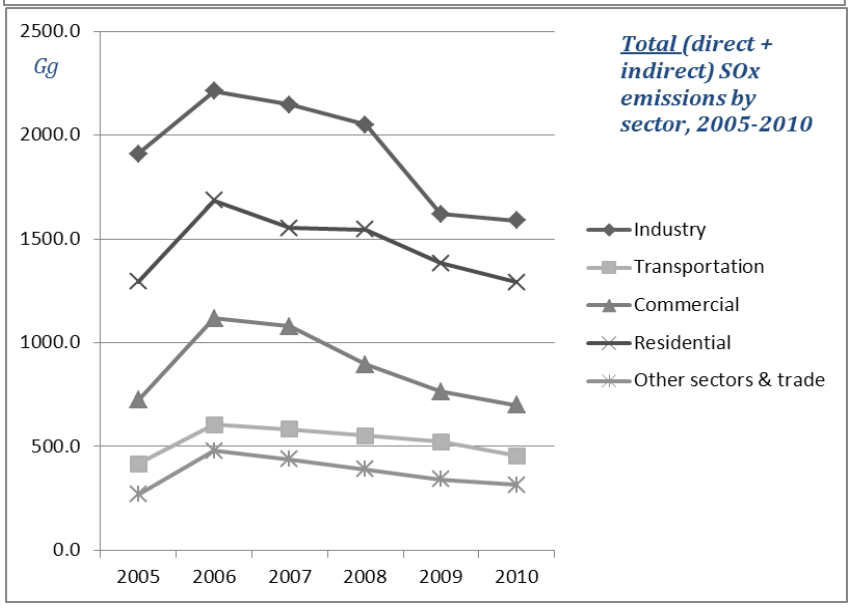
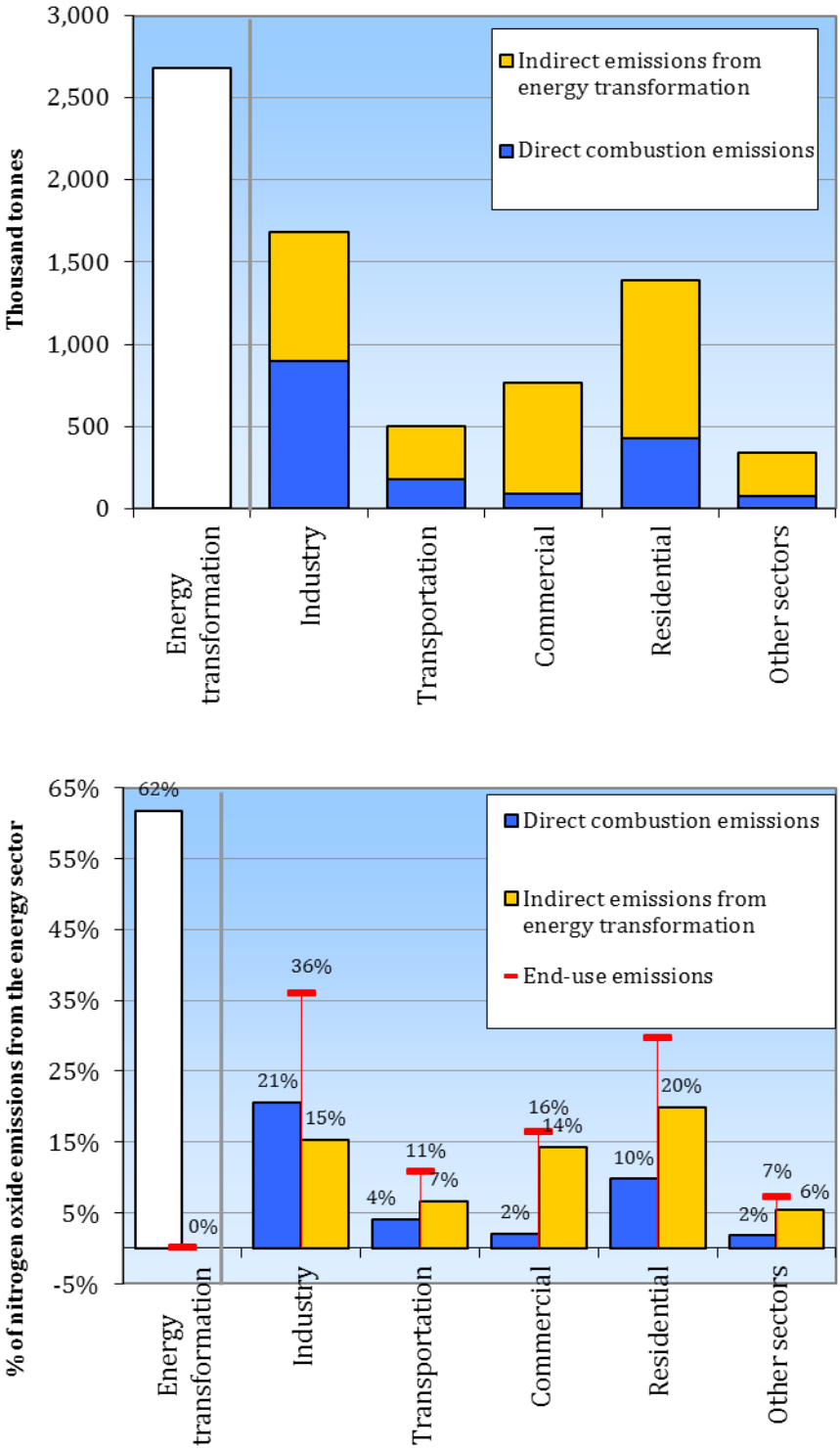


Figure A4.4 Direct and indirect sulphur dioxide (SO_x) emissions by end use sector in EU-27 in 2010



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, 2012