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Summary of the results of the decomposition analysis performed using the PRIMES model

ECOFYS

Fraunhofer ISI

Author: Leonidas Mantzos ICCS/NTUA

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ΕΠΙΣΕΥ ICCS

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1 Modelling of ex-post impacts using PRIMES

1.1 Introduction

This report provides the results from the application of a modified version of the PRIMES model for the ex-post evaluation of selected EU climate change policies and measures. This work enables the identification of the key drivers of energy-related emissions of CO_2 with the EU between 2000 and 2005, as well as alternative estimates of the ex-post savings arising from selected policies.

The PRIMES model has been used on a stand-alone basis i.e. it has not be explicitly linked with the data or methods applied elsewhere in the project. However, the results from the PRIMES model have been compared with the results from the other ex-post evaluation methodologies in the main project report. This includes some discussion of the comparability of the results.

1.1.1 Scope and objectives

The objective of the PRIMES model analysis was twofold:

- to decompose the observed evolution of energy related CO_2 emissions over the period 2000-2005
- to analyse the impacts of selected EU policies and measures (PAMs) on this evolution.

A number of different case study PAMs have been analysed, as have a number of different energy sub-sectors. For each of the main energy sub-sectors the trend in CO_2 emissions between 2000 and 2005 has been decomposed so as to reflect:

- technological progress,
- structural changes in the EU economy,
- changes in international fuel prices and the implementation of EU PAMs.

The approach to the decomposition analysis is described further below.

1.2 Overview of the PRIMES model

The PRIMES model simulates a market equilibrium solution for energy supply and demand. The equilibrium is determined by finding the prices of each energy form such that the quantity producers find best to supply matches the quantity consumers wish to use. The model is behavioural but it also represents in an explicit and detailed manner the available energy demand and supply technologies and pollution abatement technologies. The system reflects considerations about market economics, industry structure, energy/environmental policies and regulation. These are conceived so as to influence market behaviour of energy system agents. The modular structure of PRIMES reflects a distribution of decision making among agents (sectors and sub-sectors) that decide individually about their supply, demand, combined supply and demand, and prices. The market integrating part of PRIMES simulates market clearing.

1.2.1 Model structure

The model is organised by energy production sub-systems (oil products, natural gas, coal, electricity and heat production, others) for supply and by end-use sectors for demand

(residential, commercial, transport, nine industrial sectors). Some demanders may be also suppliers, as for example industrial co-generators of electricity and steam.

Several end-uses and processes are distinguished:

(a) 11 industrial sectors, subdivided into 26 sub-sectors using energy in 12 generic processes (e.g. air compression, furnaces);
(b) 5 tertiary sectors, using energy in 6 processes (air conditioning, office equipment);
(c) 4 dwelling types using energy in 5 processes and 12 types of electrical durable goods (e.g. refrigerator, washing machine, television);
(d) 4 transport modes, 10 transport means and 10 vehicle technologies, 14 fossil fuel types, 4 new fuel carriers (e.g. hydrogen, methanol, bio-fuels) 10 renewable energy types,
(e) several supply sub-systems: power and steam generation, refineries, gas supply, biomass supply, hydrogen supply (not used in this project), primary energy production. The power generation sub-model represents 150 power and steam technologies, the electricity grid with import and export links in the EU internal energy market and details of load curves (typical days and hours) for electricity and steam;
(f) 7 types of pollutants emitted from energy processes and a series of associated policy instruments, including emission trading schemes.

1.2.2 Data sources

The model's database includes historical data, on which the model is calibrated. The present database covers 1990-2000 and 2000-2005. The main PRIMES data input sources are the following:

- NEW CRONOS – EUROSTAT: energy balance sheets (as available in June 2007); macroeconomic data; population data and projections; fuel prices data
- Various technology databases developed under EC programs:
  - MURE, ICARUS, ODYSSEE for demand sectors
  - SAPIENTIA, TECHPOL for supply technologies
- NEMS model database (US DOE)
- IEA database: fuel prices
- EPIC database: detailed data on existing power plants and their use
- UNIDO data and Industrial associations data (industrial statistics)
- Various surveys and qualitative information
- Specifically commissioned studies

1.2.3 Model coverage and output

The model simulates the European energy system and markets on a country-by-country basis and provides detailed results on energy balances, CO_2 emissions, investment, energy technology penetration, prices and costs by 5-years intervals over a time period from 2000 to 2030.

The model produces results for 2000 and 2005 as calibrated years. This means that all existing policy effects (e.g. RES-E directive, Biofuels directive, ACEA agreements, CHP directive, Buildings directive) have been appropriately quantified under PRIMES Baseline assumptions so as to reproduce the observed statistics. Results for year 2010 and beyond (up to 2030) are considered as projections (scenario years).

1.3 Methodological approach

In order to perform a quantitative analysis of the effects of selected EU PAMs to date, as well as to identify the role of other key socio-economic parameters (e.g. international fuel prices)

on the evolution of CO_2 emissions between 2000 and 2005, it was necessary to develop a modified version of the PRIMES model. To estimate the ex-post impacts to date the year 2005 can no longer be treated as a calibrated year, as is the case with the current model, since the results would not change for 2005 regardless of the policies analysed. Instead 2005 is made a projection year for which results are calculated by the model (allowing for deviation from observed statistics) on the basis of the assumptions introduced. In this context a number of alternative policy cases could be defined by altering different model assumptions.

However, when performing some test runs using 2005 as a projection year, and without altering any model assumptions compared to those introduced in the Baseline scenario (i.e. in the presence of existing policies and measures), it was found that the deviation of results for 2005 from observed statistics was in some cases significant. Therefore, a new version of the PRIMES model was developed, in which a number of model behavioural parameters were revised and adjusted (on a country by country basis) so that the projections for 2005 under the Baseline assumptions do not deviate from observed statistics. This provided a more sound basis for the analysis of the alternative policy cases.

1.3.1 Decomposition analysis

The PRIMES model was used to provide a detailed decomposition of the observed development of energy related CO_2 emissions over the period 2000-2005.

Decomposition analysis is a method that allows a better understanding of the role of different separate developments, that occur simultaneously, and have an impact on the evolution of the parameter in focus (in our case energy related CO_2 emissions). The *decomposition method* starts from the situation in which no effect besides the growth in activity level is included (''frozen efficiency'') in the analysis, and then calculates what the emissions are if only effect A had occurred, and then if effects A and B had occurred, etc. With this method, every effect is compared against a different baseline. The baseline of effect A is ''frozen efficiency'', the baseline of effect B is ''the frozen efficiency + effect A'', etc.

The following drivers were examined as part of the decomposition analysis:

- Activity changes: changes related to economic and demographic developments
- Structural changes: changes related to shifts in the structure of the EU economy (e.g. shifts away from primary and secondary sectors and towards services and high value added products) as well as behavioural changes arising from economic growth (e.g. increasing aviation and private cars activity occurring to the detriment of public transport means)
- Energy intensity changes: changes related to technology improvements taking place in the EU energy system
- Changes in the fuel mix: changes related to the development of fuel prices as well as technology developments (e.g. increasing competitiveness of natural gas fired power plants) and behavioural patterns (e.g. increasing use of electric appliances in the residential and tertiary sectors)

Starting from the "Frozen case" scenario, i.e. a scenario which reflects a situation in which no effects besides economic activity growth and demographic developments are taken into account, a number of alternative cases were examined. These included differentiated assumptions for one or more of the following drivers:

- Structural changes of the EU economy
- Technology characteristics
- Fuel prices and taxation policies
- Implementation of EU PAMs

The results obtained from the different cases (including the Baseline scenario which reflects the "real world") were then combined and analysed, through a meta-model specifically developed for the purpose of the project, in order to decompose the CO_2 emissions

developments over the period 2000-2005. The decomposition was performed both at the aggregate and the sectoral energy system level, and for each Member State separately. It should be noted that the decomposition results may differ for different levels of disaggregation. For example, decomposition results per industrial sector do not sum up to the corresponding decomposition results for total industry. This is explained by the fact that whereas for total industry the development of sectoral value added is used as the activity indicator, for specific industrial sectors the activity indicator relates to production levels of the different industrial processes involved (e.g. integrated steelworks versus electric arc processing production in the iron and steel industry).

The decomposition at the level of total final energy demand is obtained by summing up demand sector totals. The same is the case with regards to the decomposition at the level of the total energy system which is obtained by summing up total final energy demand, power generation, district heating and energy branch (for which only distinction between activity growth and changes in the fuel mix is possible).

1.3.2 Evaluation of policy impacts

In addition to decomposing the impact of the key socio-economic drivers upon CO_2 emissions, the PRIMES model was also used to quantify the impacts of three selected EU PAMs. As with the decomposition analysis, the modelling assumed that the parameters reflecting the corresponding effects remain as in 2000. These following three cases were examined:

- A case analysing the effects of the voluntary agreement with car manufacturers;
- A case analysing the effects of the Biofuels Directive; and,
- A case analysing the effects of the RES-E directive

The results obtained from the PRIMES model, for each of the policies considered, can be compared to the results from the alternative evaluation methodologies. This provides a cross-check of the results, and also provides some insights into the importance of certain effects that cannot be easily be captured with bottom up methods (e.g. impact of price signals).

The results of the PRIMES modelling can therefore be used to:

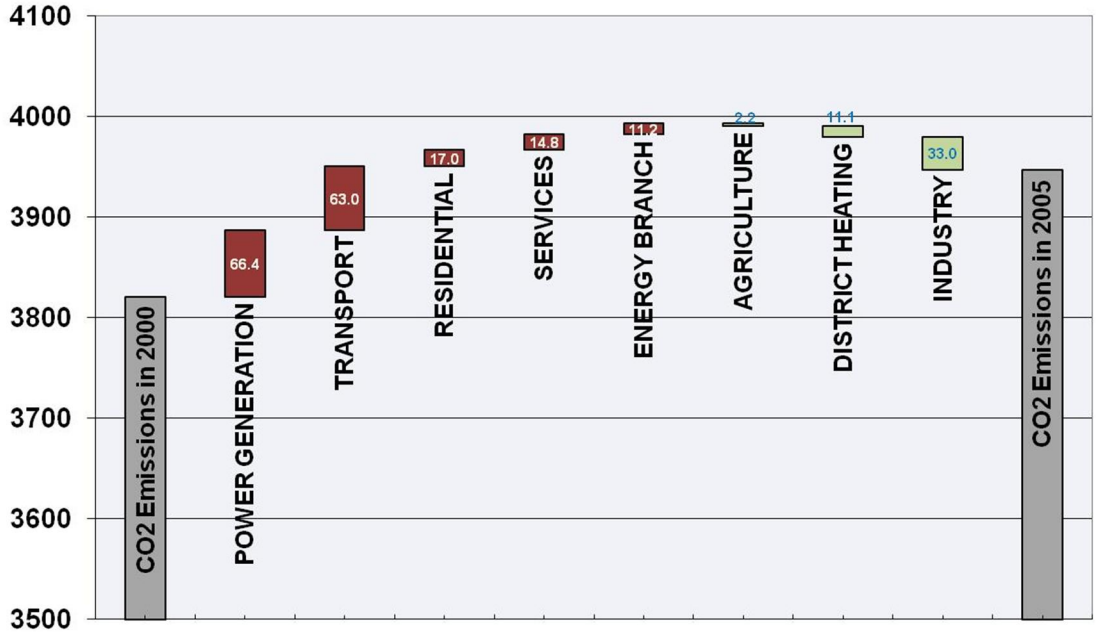
- refine the alternative methodologies (if needed);
- identify the areas where sensitivity analysis is required; and,
- validate the findings from the alternative methodologies.

In addition, the outputs from the PRIMES analysis provide an indicative estimate of the impacts within those Member States not covered by the other methodologies.

1.4 Drivers of emissions in EU-27: decomposition analysis for 2000 to 2005

Between 2000 and 2005 energy related CO_2 emissions in the EU27 energy system increased from 3,820 Mt CO_2 to 3,947 Mt CO_2 (+126.2 Mt CO_2 or +3.3%). As illustrated in Figure 1 power generation and the transport sector were the main drivers for this increase of CO_2 emissions whereas the most pronounced decline of CO_2 emissions was observed in industry.

Figure 1: CO_2 emissions (Mt CO_2) development in the EU27 energy system (2000-2005)



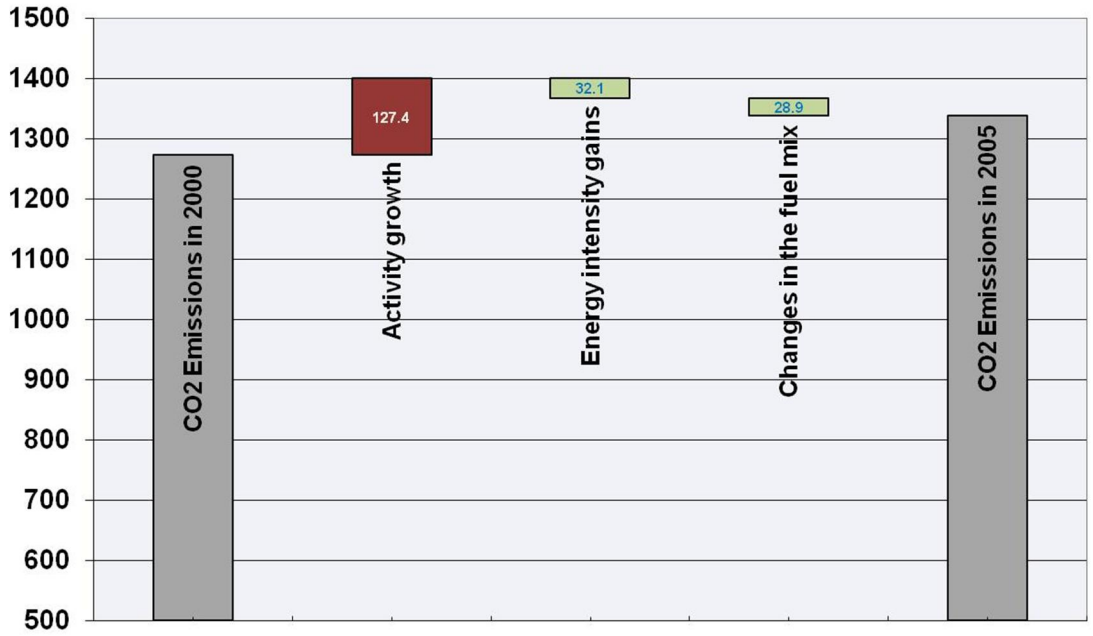
Source: PRIMES

In the power generation sector CO_2 emissions increased between 2000 and 2005 by 65.4 Mt CO_2 (+5.2%), an increase solely attributed to activity growth in the sector. This was partly counterbalanced by improvements in terms of energy intensity as well as changes in the fuel mix towards less carbon intensive energy forms (see Figure 2).

Activity growth in power generation corresponds to an increase of CO_2 emissions by 127.4 Mt CO_2. There are three different factors driving this increase: demographic changes (population growth as well as the change of households' size) which are estimated to account for 14% of the increase, economic development which accounts for 56% of the increase and changes in the demand side fuel mix (driven by various factors such as structural changes, behavioural patterns and fuel prices) which account for the remaining 30% of the increase.

On the other hand the EU27 power generation system undergoes significant improvements both in terms of energy intensity (-32.1 Mt CO_2) and changes in the fuel mix (-28.9 Mt CO_2). The increasing role of natural gas in power generation (the share of which reaches 21% in 2005 from 16.8% in 2000) involving investment and operation of new efficient natural gas power plants as well as the increasing deployment of renewable energy sources (and especially wind turbines with an attributed efficiency of 100%) are the main factors that explain this development.

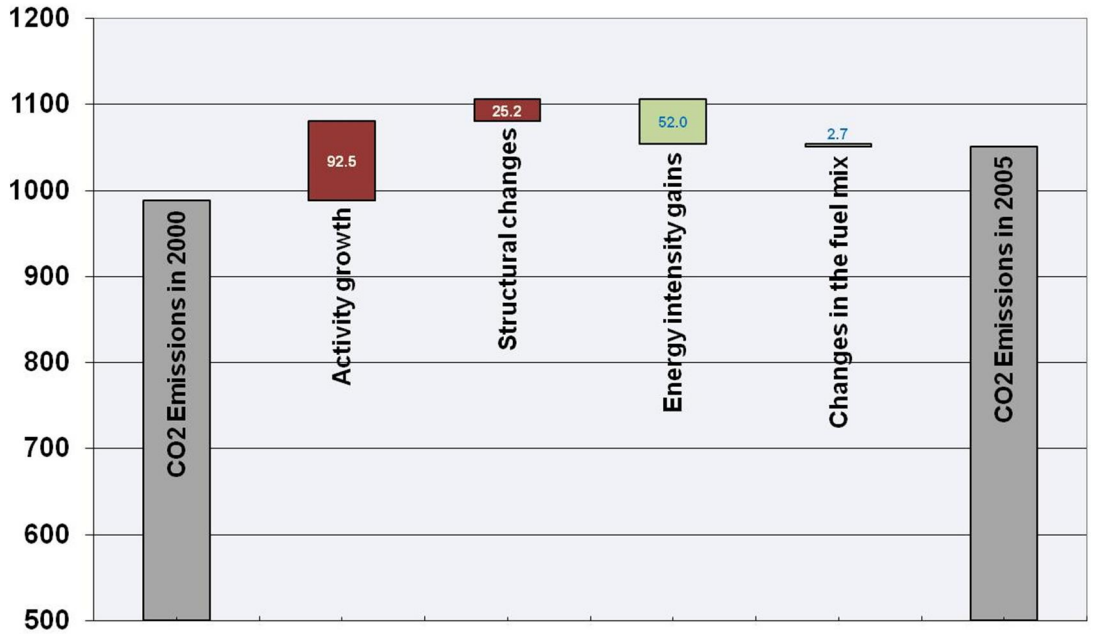
Figure 2: Decomposition of CO_2 emissions (Mt CO_2) development in power generation



Source: PRIMES

CO_2 emissions in the transport sector also exhibit a significant growth in 2000-2005 (+63 Mt CO_2 or +6.4%). This increase is mainly driven by activity growth the contribution of which is estimated at +92.5 Mt CO_2 from the quantitative analysis performed. Demographic developments account for around 26.5% of this increase the rest being the result of economic growth. Structural changes in the EU transport sector (increasing role for private cars, trucks and aviation transport activity) also lead to an increase of CO_2 emissions in the transport sector (+25.2 Mt CO_2).

Figure 3: Decomposition of CO_2 emissions (Mt CO_2) development in transport

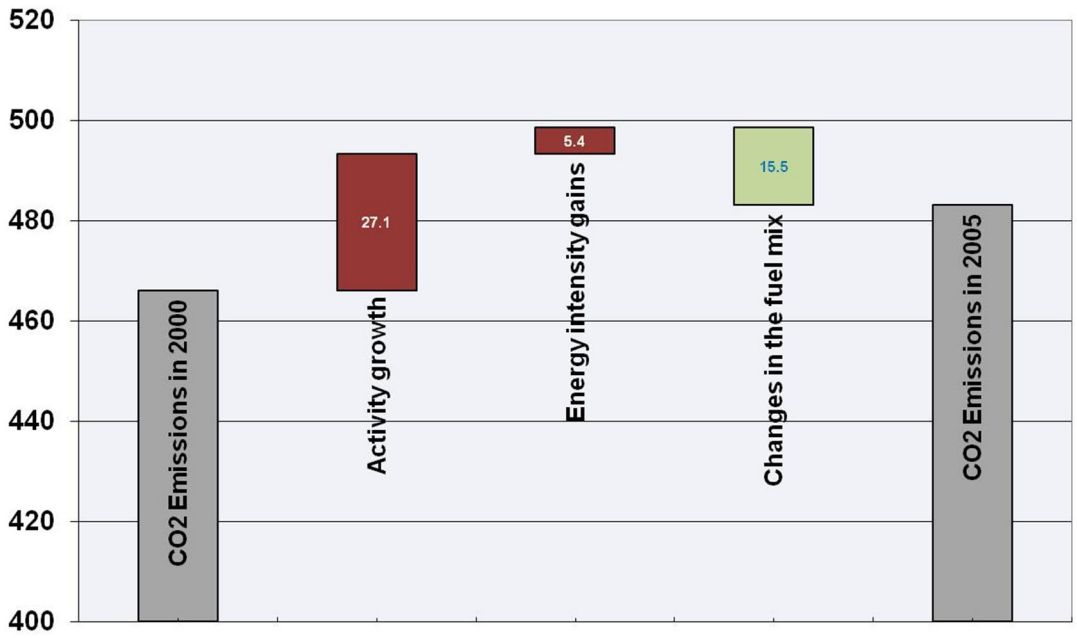


Source: PRIMES

The purchase of more efficient vehicles (with efficiency improvements accelerated due to the implementation of the ACEA agreement) in road transport as a result of normal replacement of old stock and additional transport activity demand, the further dieselisation of the private cars stock, the continuous electrification of the rail network and the need for new airplanes (with significantly improved efficiencies compared to old ones) arising from the high growth of aviation activity, result in a significant improvement of energy intensity in the transport sector which in turn leads to an estimated reduction of CO_2 emissions by -52 Mt CO_2. Changes in the fuel mix also lead to a limited reduction of CO_2 emissions in the sector (-2.7 Mt CO_2), a result mainly related to the penetration of biofuels.

The decomposition of CO_2 emissions development in the residential sector is illustrated in Figure 4. Both activity growth and energy intensity gains are calculated to lead to an increase of CO_2 emissions (+27.1 and +5.4 Mt CO_2 respectively). Demographic changes account for 31% of the activity growth related increase of emissions, the rest being the result of economic growth. Energy intensity in the residential sector also worsens (consumption per household increases from 1.47 toe in 2000 to 1.49 toe in 2005) as efficiency improvements in the sector occurring both in heating/cooling uses as well as in electric appliances are not enough to counterbalance the corresponding increase of energy requirements of consumers. Changes in the fuel mix account for a reduction of CO_2 emissions by -15.5 Mt CO_2 as carbon intensity in the residential sector improves. Thus, total CO_2 emissions in the residential sector increase by +17 Mt CO_2 (or +3.6%) in 2000-2005.

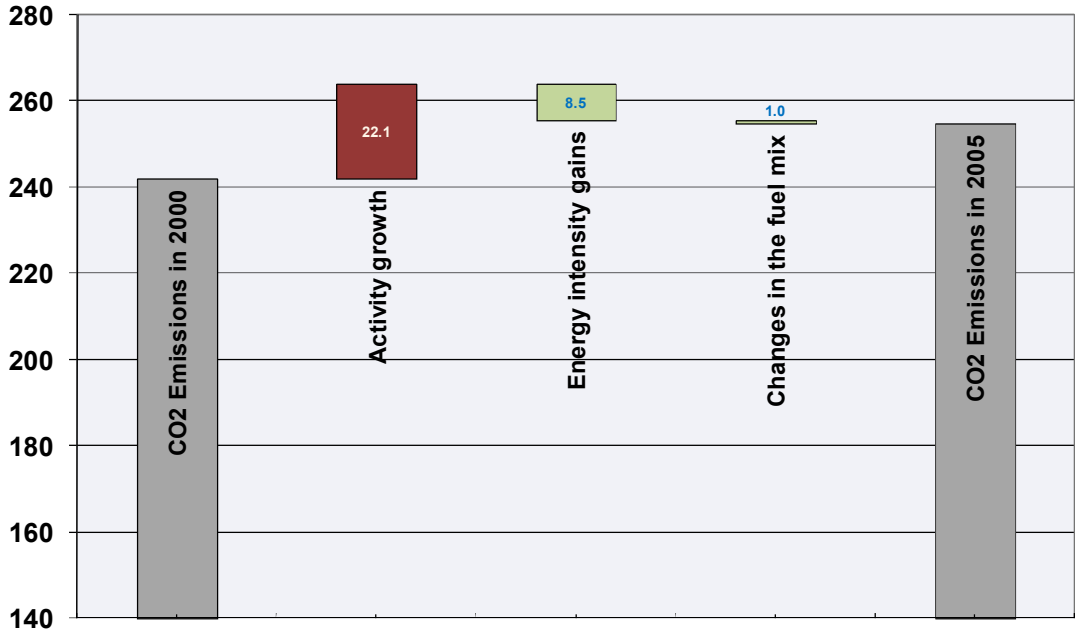
Figure 4: Decomposition of CO_2 emissions (Mt CO_2) development in residential



Source: PRIMES

In the tertiary sector CO_2 emissions exhibited an increase of +12.6 Mt CO_2 (+5.2%) in 2000-2005 (+14.8 Mt CO_2 in services and -2.2 Mt CO_2 in agriculture). As shown in Figure 5, energy intensity gains (-8.6 Mt CO_2) and to a less extend changes in the fuel mix (-1 Mt CO_2) partly counterbalanced the activity growth effect (+22.1 Mt CO_2, with demographic developments accounting for 20% of the increase and economic growth for 80%) in the sector.

Figure 5: Decomposition of CO_2 emissions (Mt CO_2) development in tertiary



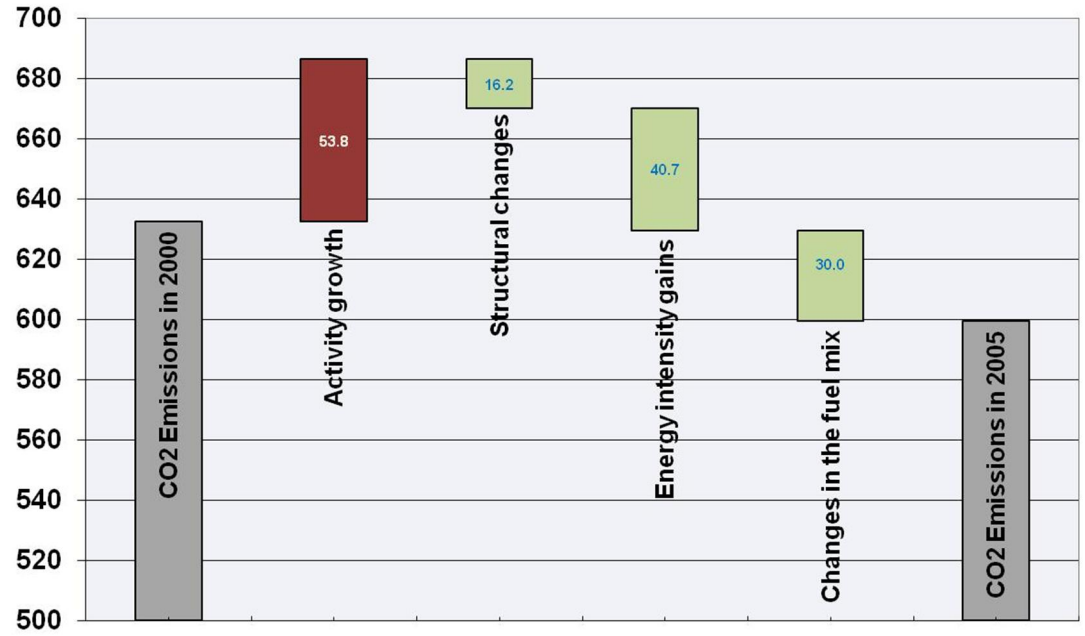
Source: PRIMES

CO_2 emissions in the energy branch are driven by activity growth (+12.7 Mt CO_2) whereas changes in the fuel mix leading a slight improvement of carbon intensity limit the increase to 11.2 Mt CO_2 (+6.4%) in 2000-2005.

As regards district heating, the observed strong decline of steam production (mainly due to the restructuring of new Member States energy systems) is the key driver for the projected decline of CO_2 emissions in 2000-2005 (-11 Mt CO_2 or -23.3%). Thus, activity development in the sector has the most pronounced negative effect (-9.6 Mt CO_2) followed by changes in the fuel mix (-2.2 Mt CO_2) whereas some slight worsening of energy efficiency leads to an increase of CO_2 emissions (+0.8 Mt CO_2).

CO_2 emissions in industry exhibit a strong decline in the period 2000-2005 (-33.0 Mt CO_2 or 5.3%). On the basis of activity growth effects CO_2 emissions from industrial sector would increase by some 53.8 Mt CO_2 in 2000-2005 (22% of this increase being attributed to population growth and the rest to economic developments). Structural changes (involving shifts away from energy intensive industrial sectors and towards value added intensive ones) have a negative effect on the evolution the evolution of CO_2 emissions (-16.2 Mt CO_2). The role of energy intensity gains is even more pronounced in reducing industrial CO_2 emissions (-40.7 Mt CO_2). Investment in more efficient technologies, the shift towards less energy intensive processes within industrial sectors (e.g. increased role for electric arc processing instead of integrated steelworks in iron and steel, significantly more pronounced growth for pharmaceuticals production compared to basic chemicals) as well as the restructuring of the industrial sector in new Member States (involving the closure or retrofitting of old inefficient industrial units but also the construction of new efficient units) are the main drivers that lead to the improvement of energy intensity in the EU energy. The changes in industrial production are also reflected on the fuel mix with demand for less carbon intensive energy forms gaining additional market shares (demand for electricity, distributed steam and biomass in industry exhibits a growth in 2000-2005 in industry compared to a decline for total industrial energy demand; demand for natural gas declines less than that for solid and liquid fuels). Thus, the carbon intensity of the EU industrial sector improves between 2000 and 2005 leading to a reduction of CO_2 emissions due to changes in the fuel mix by -30 Mt CO_2. The decomposition of CO_2 developments in industry is illustrated in Figure 6.

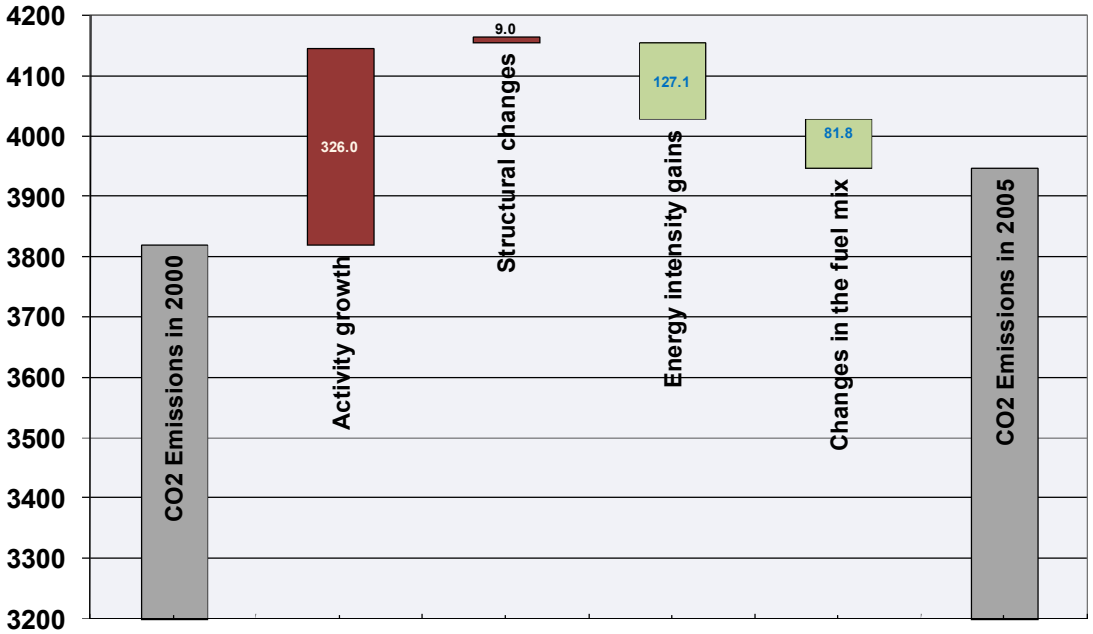
Figure 6: Decomposition of CO_2 emissions (Mt CO_2) development in industry



Source: PRIMES

The overall decomposition of energy related CO_2 emissions growth in the EU energy system in 2000-2005, as resulting from the quantitative analysis performed with the use of the PRIMES model is illustrated in Figure 7.

Figure 7: Decomposition of CO_2 emissions (Mt CO_2) development for the EU energy system



Source: PRIMES

The key driver for the observed increase of CO_2 emissions between 2000 and 2005 in the EU energy system is activity growth (+328 Mt CO_2, of which 21.5% arises from demographic developments and the rest from economic growth). Structural changes have also a limited contribution towards increasing CO_2 emissions (+8 Mt CO_2). On the other hand, the EU

energy system has undergone in the period 2000-2005 significant improvements both in terms of energy intensity and carbon intensity. Thus, energy intensity gains and changes in the fuel mix effects act towards reducing CO_2 emissions in the EU energy system (-127.1 and -81.8 Mt respectively) limiting the observed overall growth to 126.2 Mt CO_2.

Table 1: Decomposition of total energy related CO_2 emissions (Mt CO_2) development per Member State

	Activity growth effect	Structural changes effect	Efficiency improvement effect	Changes in fuel mix effect	Total
EU27	**326.0**	**9.0**	**-127.1**	**-81.8**	**126.2**
Austria	4.5	-0.1	7.9	0.5	12.7
Belgium	3.4	-0.4	-4.1	-6.5	-7.6
Bulgaria	6.9	1.4	-4.7	-0.6	2.9
Cyprus	1.3	0.1	-0.4	-0.2	0.7
Czech Republic	15.0	-3.0	0.4	-14.3	-1.9
Denmark	1.8	-0.3	-1.3	-3.7	-3.5
Estonia	2.4	0.1	-1.3	-0.1	1.1
Finland	5.3	-2.4	-0.3	-2.2	0.3
France	15.0	0.5	-10.7	0.0	4.9
Germany	58.4	-1.4	-48.7	-26.8	-18.5
Greece	11.7	0.2	-4.2	-0.8	7.0
Hungary	4.4	-1.2	1.3	-3.1	1.4
Ireland	7.5	0.8	-3.5	-1.1	3.6
Italy	21.0	7.1	7.6	-5.9	29.7
Latvia	1.5	0.3	-0.6	-0.7	0.4
Lithuania	3.8	0.3	-1.9	0.1	2.3
Luxembourg	1.3	0.1	1.8	0.3	3.5
Malta	0.3	0.0	0.2	0.0	0.6
Netherlands	15.3	2.9	-6.8	-5.5	5.7
Poland	28.4	-0.3	-19.3	-8.3	0.5
Portugal	4.7	0.0	0.7	-2.3	3.1
Romania	9.3	1.3	-8.6	4.1	6.1
Slovak Republic	10.3	-1.5	-5.2	-1.6	2.0
Slovenia	2.4	0.3	-1.1	-0.4	1.2
Spain	61.0	4.4	-9.6	0.4	56.1
Sweden	4.9	-2.2	-1.5	-3.2	-2.0
United Kingdom	24.3	2.0	-12.9	0.3	13.7

Source: PRIMES

Table 1 summarises the energy related CO_2 emissions decomposition results obtained from the quantitative analysis performed with PRIMES for all EU Member States. As can be seen in the table big differences among Member States exist as regards the role of the different factors in the development of CO_2 emissions. These differences relate to the different patterns of economic development, the different structures of the Member States energy systems but also the different levels of implementation of policies. Detailed decomposition results per Member State can be found in Appendix 1.

1.5 Impacts of key policies

In the context of the project three alternative cases were examined so as to exploit the effects of specific EU PAMs on the evolution of the energy related CO_2 emissions in the EU energy system between 2000 and 2005. The findings for these three cases are presented in the following.

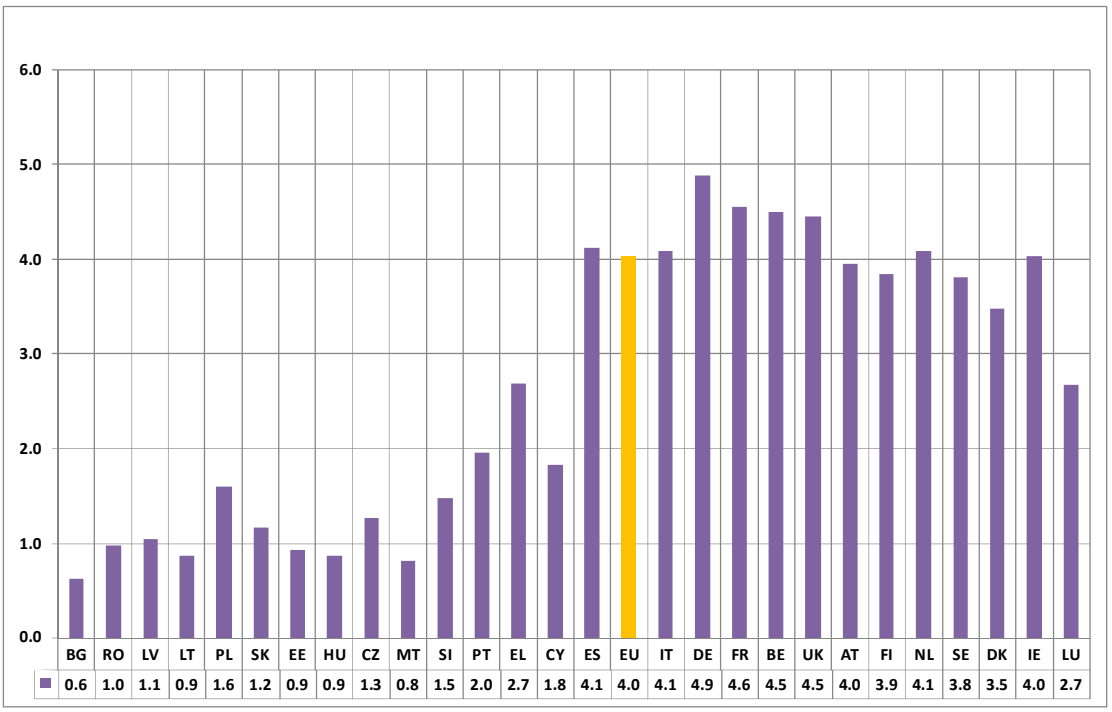
1.5.1 The role of the ACEA agreement

The first case examined the role that the agreement with car manufactures on lowering private cars emission factors played on the evolution of CO_2 emissions of the EU energy system.

This case was quantified with PRIMES by assuming that new car technologies available in the market in 2000-2005 improve at a pace similar to that historically observed and thus slower compared to observed trends. Technology and fuel choices as well as replacement rates for cars are an output of the model and thus deviate from observed statistics. In addition to the above, two important assumptions were incorporated in the analysis: first that overall transport activity and its structure remains constant at the observed 2005 levels and second that fuel prices remain unchanged to the observed 2005 levels. By introducing these two assumptions it was possible to fully capture the effects of the ACEA agreement on private cars CO_2 emissions without introducing side effects arising from changes in transport activity and/or fuel prices.

In the absence of the agreement with car manufactures as a driver, the improvement of cars efficiency in the EU for 2000-2005 is limited to 1% (compared to the observed improvement of 4.8%). Thus, CO_2 emissions from private cars in 2005 are projected to reach 501.7 Mt CO_2 (19.4 Mt CO_2 or 4.0% higher than observed statistics for 2005). The effect per Member State is illustrated in Figure 8 (in which countries are ordered by means of acceding GDP per capita).

Figure 8: Impact of the absence of the ACEA agreement on private cars CO_2 emissions per Member States (% change compared to observed statistics)



Source: PRIMES

The absence of the agreement with car manufactures results in a significantly more pronounced emissions from the EU Member States, ranging from 2.7% for Greece and Luxemburg up to 4.9% for Germany (with the exception of Portugal for which the impact is limited to only 2%). On the other hand the impact is significantly less pronounced for new Member States ranging between 0.6% in Bulgaria to 1.8% in Cyprus. This is despite the faster growth of private cars transport activity in the new Member States compared to the EU15. This is explained by the fact that the purchases of cars by consumers in new Member States concerned to a significant extent used vehicles from EU15 Member States.

Additional demand for liquid fuels leads to an increase of the operation of refineries which in turn results in higher energy requirements in the energy branch. Consequently, CO_2 emissions in the energy branch increase by 3.3 Mt CO_2 in 2005 compared to observed statistics and in power generation by 0.4 Mt CO_2 (due to the increased demand for electricity in refineries). In total, the effect of the implementation of the agreement with car manufactures in the EU energy system is estimated to save some 23.1 Mt CO_2 in 2005 (in other words CO_2 emissions in 2005 would be 0.6% higher than observed statistics in the absence of the agreement).

1.5.2 The role of the Biofuels Directive

In the second case, the Biofuels directive, it is assumed that EU Member States do not introduce any additional policies promoting the use of biofuels in the transport sector on top of those already introduced by 2000. Given that the biofuels share in gasoline and diesel oil does not affect their price at the pump (due to the existing subsidization policies) the structure of the transport sector remains unchanged in 2005 compared to observed statistics.

In the absence of additional support policies for biofuels CO_2 emissions in the transport sector are projected to increase by 7.3 Mt CO_2 (or +0.7%) compared to observed statistics, with the total quantity of biofuels consumed being reduced to about 750 Ktoe in 2005 (compared to an observed consumption of 3,200 Ktoe).

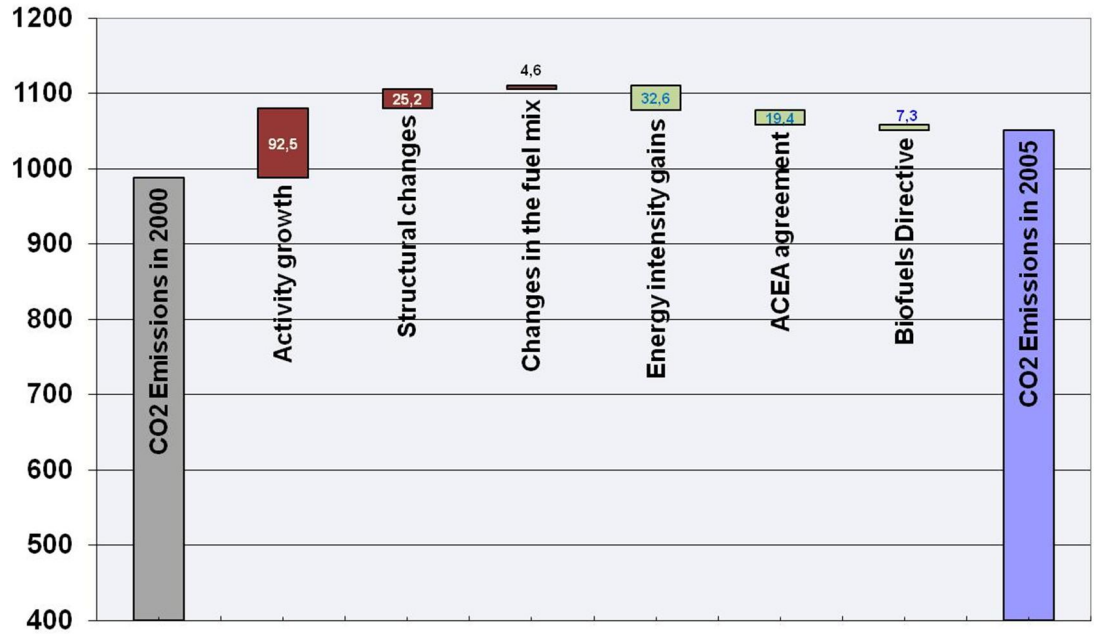
In addition, CO_2 emissions in the energy branch and in power generation would increase by about 0.5 Mt CO_2 (due to the higher operation of refineries). Thus, in the absence of additional support policies for biofuels in the EU energy system, CO_2 emissions in 2005 would increase by 7.8 Mt CO_2 (or 0.2%) from observed levels.

1.5.3 Revised decomposition of CO_2 emissions growth in transport

Combining the results of the two cases examined, on the role of the agreement with car manufactures and on biofuels support policies, with the results of the decomposition analysis performed provides a more detailed picture for the evolution of CO_2 emissions in the transport sector between 2000 and 2005 (see Figure 9).

While activity growth and structural changes effects remain the same as in the initial decomposition analysis performed, the new decomposition illustrates that close to 40% of the estimated efficiency gains effect is the result of the voluntary agreement with car manufactures (19.4 Mt CO_2 out of 52.0 Mt CO_2 which is the total energy gains effects). As regards changes in the fuel mix, the Biofuels directive has an important influence on the contribution of this factors to the overall trend in emissions. With the inclusion of the support policies for biofuels changes in the fuel mix is overall estimated to have a negative effect on the evolution of CO_2 emissions (-2.7 Mt CO_2) over the period. However, if the effect of biofuels support policies (-7.3 Mt CO_2) are separated out, the effect of changes in the fuel mix on the evolution of CO_2 emissions in the transport sector in 2000-2005 becomes positive (+4.6 Mt CO_2) This reflecting the increasing shares of diesel oil and kerosene in transport sector demand (occurring to the detriment of gasoline demand which is less carbon intensive).

Figure 9: Revised decomposition of CO_2 emissions (Mt CO_2) development in transport



Source: PRIMES

1.5.4 The role of the RES-E Directive

The last case examined in the context of the project with the use of the PRIMES model concerns the role of the RES-E Directive on the evolution of CO_2 emissions in the EU energy system in 2000-2005.

In constructing this scenario the following assumption were introduced:

- no additional support policies for renewable energy were implemented on top those existing in 2000
- electricity and steam demand is assumed not to change from observed 2005 levels (this means that changes in electricity and steam prices due to the non implementation of renewable support policies are not passed on to consumers)
- all known investment in RES that involve construction times of less than 3 years are not taken into account
- hydro power production is assumed to remain at observed levels

The introduction of these assumptions affects not only the power generation sector but also industry and district heating. This is both because of changes concerning cogeneration but also as a result of a lower deployment of biomass in industrial and district heating boilers.

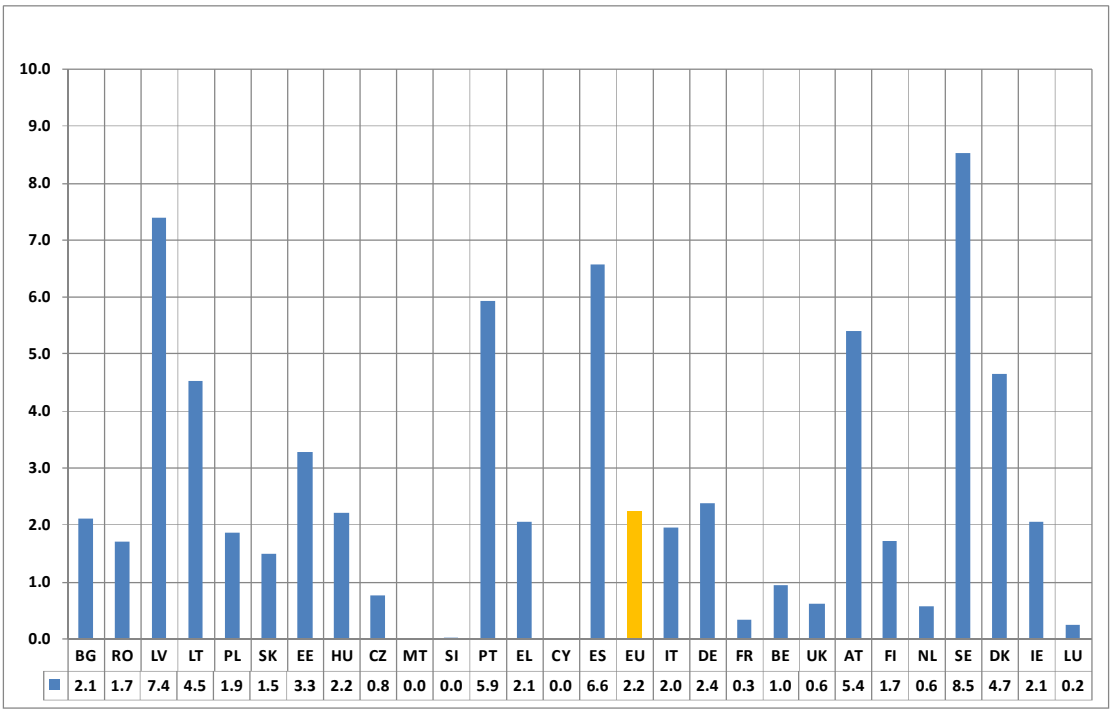
In the absence of additional support policies for renewable energy forms their share in gross electricity generation is limited to 12.1% in 2005 (from 14.5% in 2000) instead of the observed share of 14.9%. Electricity generation from wind turbines exhibits a limited growth of just 1% in 2000-2005 (compared to an observed threefold increase in the same period) while biomass based generation increases by 15% compared to an observed growth of 85%. The gap generated (around 91 TWh) is mainly satisfied by coal (42.6%) followed by natural gas (25.4%), oil (20.0%) and lignite (12%).

Electricity and steam generation from CHP power plants is also affected by the absence of renewable support policies. CHP electricity in 2005 is projected to be 9.0% below observed levels in 2005 with the corresponding decline for CHP steam reaching 7.8%. As a result of this reduced contribution of CHP units in satisfying steam requirements, generation in

industrial boilers and district heating increases. On the other hand, consumption of biomass in industrial boilers and district heating declines by 26%, limiting its share in total fuel input to 9.2% compared to an observed share of 13.4% in 2005.

Total electricity and steam generation costs are also affected by the non implementation of additional support policies for renewable energy forms; they are estimated to decline by 1.3% from observed levels in 2005.

Figure 10: Impact of the absence of RES-E Directive support policies on total energy system CO_2 emissions per Member States (% change compared to observed statistics)



Source: PRIMES

In the absence of support policies for renewable energy, total energy related CO_2 emissions in 2005 are projected to reach 4,036 Mt CO_2 (+88.7 Mt CO_2 or +2.2% compared to observed CO_2 emissions levels in 2005). CO_2 emissions in power generation are projected to increase by 58.0 Mt CO_2 (+4.3% from observed statistics), in industry by 19.6 Mt CO_2 (+3.3%) and in district heating by 11.1 Mt CO_2 (+30.5%). The effect for total energy related CO_2 emissions per Member State is illustrated in Figure 10 (in which countries are ordered by means of acceding GDP per capita).

1.6 Synthesis and conclusions

The PRIMES model has been used to quantify the key drivers of energy-related emissions of CO_2 within the EU between 2000 and 2005, as well an estimating the ex-post savings arising from selected climate change policies.

The analysis has been based upon a decomposition methodology whereby each of the individual drivers of energy use and CO_2 emissions have been isolated, thereby demonstrating the relative influence of each of the drivers on the overall trend.

The main findings from the analysis are as follows:

- Between 2000 and 2005 energy related CO_2 emissions in the EU27 energy system increased from 3,820 Mt CO_2 to 3,947 Mt CO_2 (+126.2 Mt CO_2 or +3.3%). Power generation and the transport sector were the main drivers for this increase of CO_2 emissions whereas the most pronounced decline of CO_2 emissions was observed in industry.
- EU policies and measures had an important role in slowing down the growth in emissions over this period. The combined effect of the EU Voluntary Agreement with car manufacturers and the implementation of the Biofuels and the RES-E Directives is an estimated reduction of CO_2 emissions of 120 Mt CO_2. In other words, and on the basis of PRIMES results in the absence of these policies, CO_2 emissions in 2005 would have reached 4,067 Mt CO_2 (+6.4% from 2000 levels, +3.0% from observed 2005 levels).

In relation to the broader objectives of the study, the following conclusions can be drawn:

- **Development of methodologies**

Existing models, such as PRIMES, which have been developed with the primary role of appraising the projected impacts of new policies, also have the potential to be modified for use in the ex-post evaluation of existing policies. A major strength of this approach is that, where the model in question was used for the original ex-ante analysis, it allows a consistent and comparable assessment of the differences between the ex-ante and ex-post estimates.

However, unless it was a specific requirement at the design stage, existing models may not have been constructed with ex-post evaluation in mind. It may therefore be appropriate, when commissioning the development of new models, for the EU Commission to give consideration to the use of the models in ex-post evaluation, as well as in the ex ante appraisal of new policies.

In doing so, it is important to understand the relative strengths and weaknesses of the different modelling tools. In particular, ex-post studies generally look at impacts arising over a relatively short period of time, so may not be best suited to econometric models that draw upon long term statistical trends.

- **Provision of quantitative ex-post estimates**

The PRIMES model provided an existing framework, including an existing database of activity and emissions data, and modelling relationships. This made the quantitative assessment of the policy impacts possible without the need for further data collection - although it did require certain modifications to the model to be made.

The modelling has delivered quantitative estimates of the ex-post impacts of three EU climate policies: the ACEA Voluntary Agreement, the Biofuels Directive and the RES-E Directive. Each of these policies has a number of common themes. They all act upon a single target sector (road transport, renewable energy). Data on the activities that are influenced by the Directives (vehicle emissions, biofuel consumption, and renewable electricity) is readily available from existing statistical sources. In addition, each of the policies can be considered

the primary mechanism targeting emissions in its respective sector. These factors combine to make it easier to evaluate the impacts of these policies than for certain other policies.

Analysis of the other energy policies would require additional data collection and more substantive modifications to the modelling framework. This was not possible within the scope of the study. In any case, the PRIMES model may not be the best framework within which to quantify the impacts of these policies. In particular, where data is required at a greater level of resolution, for example at a sub-sectoral level, more bespoke sectoral models might be more appropriate.

- **Recommendations for future ex-ante appraisal**

For each of the policies analysed the PRIMES modelling has identified the key issues and assumptions that have influenced the results of the evaluation. It is important that these factors are considered within future policies appraisals, where appropriate. For example, in the evaluation of the ACEA agreement for passenger cars, differences in purchase behaviour led to difference in the impacts of the policy within different Member States. It would be important to consider these behavioural factors in the ex-ante appraisal of future transport policies.

- **Capacity building**

The PRIMES model is a multi-country, multi-sector model. This provides advantages in that it allows the assessment of EU wide initiatives across all Member States in a consistent and coherent manner. It can also provide efficiencies; the assessment of interventions is a collective manner is more efficient than aggregating together a range of individual Member State or sector estimates. A downside of this approach is that the modelling capacity remains within a single institution with limited scope for capacity building elsewhere. This strand of the project has therefore had limited impact upon this objective.

Appendix 1: Drivers of emissions in EU-27 - decomposition analysis for 2000 to 2005 per Member State

EU27

Decomposition of energy related CO2 emissions growth in 2000-2005

	Activity growth effect	Structural changes effect	Efficiency improvement effect	Changes in fuel mix effect	Total
Iron and steel	-47.2	-7136.4	-7201.7	-3497.7	-17882.9
Non Ferrous metals	484.1	263.3	-923.8	-1660.0	-1836.4
Chemicals	4733.4	-2835.2	-269.9	838.7	2467.1
Non Metallic minerals	6687.3	-1839.6	-6846.0	-2895.9	-4894.2
Paper and Pulp	987.8	-215.8	-632.0	-1918.2	-1778.2
Food, Drink, Tobacco	491.0		-204.7	350.3	636.6
Engineering	3478.6		-2919.6	-3107.5	-2548.6
Textiles	-458.9		-10.5	763.5	294.1
Other industries	3457.0		694.3	-1672.0	2479.4
On-site CHP steam	-5656.8		-7322.4	-2165.4	-15144.6
Boilers steam	11272.7		-246.7	-5849.0	5176.9
INDUSTRY Total	53822.7	-16164.7	-40716.3	-29972.5	-33030.8
RESIDENTIAL Total	27105.4		5430.0	-15494.0	17041.3
Services	18825.6		-3905.1	-130.0	14790.5
Agriculture	3238.6		-4582.8	-833.8	-2178.0
TERTIARY Total	22064.2		-8488.0	-963.7	12612.5
Road transport	86206.7	12866.6	-44308.3	-3139.1	51625.8
Rail transport	447.0	-115.1	-381.7	-1076.4	-1126.1
Aviation	19955.4		-6986.2	0.0	12969.1
Inland navigation	1083.0		-1495.4	-9.2	-421.6
Passenger Transport	50477.9	11868.5	-47608.0	-2006.8	12731.5
Freight Transport	42070.5	13319.4	-4365.5	-708.7	50315.7
TRANSPORT Total	92548.4	25187.9	-51973.5	-2715.5	63047.2
TOTAL FINAL DEMAND	195540.6	9023.2	-95747.8	-49145.8	59670.3
POWER GENERATION	127407.1		-32086.4	-28945.5	66375.2
DISTRICT HEATING	-9595.2		779.8	-2243.2	-11058.6
ENERGY BRANCH	12677.6		0.0	-1491.5	11186.2
TOTAL	326030.1	9023.2	-127054.3	-81826.0	126173.0

Austria

Decomposition of energy related CO2 emissions growth in 2000-2005

	Activity growth effect	Structural changes effect	Efficiency improvement effect	Changes in fuel mix effect	Total
Iron and steel	1452.9	-553.2	-355.1	107.8	652.4
Non Ferrous metals	-11.8	-0.4	53.8	-17.0	24.6
Chemicals	82.8	-47.7	165.1	117.1	317.3
Non Metallic minerals	342.4	-90.1	-88.9	-125.2	38.2
Paper and Pulp	7.4	-16.0	7.2	-86.4	-87.9
Food, Drink, Tobacco	18.0		-32.1	-40.9	-55.0
Engineering	139.8		-64.2	-114.5	-38.9
Textiles	-5.6		5.3	-1.3	-1.6
Other industries	67.3		1151.6	-203.6	1015.4
On-site CHP steam	638.3		-183.5	-492.3	-37.4
Boilers steam	-11.1		-33.5	206.2	161.7
INDUSTRY Total	1288.8	-360.7	1744.1	-683.5	1988.8
RESIDENTIAL Total	447.4		290.0	-557.5	179.8
Services	209.4		388.1	342.2	939.7
Agriculture	-14.4		62.1	-138.3	-90.6
TERTIARY Total	195.0		450.3	203.9	849.1
Road transport	781.5	38.2	4821.1	11.7	5652.5
Rail transport	5.0	-0.7	-14.5	-1.8	-11.9
Aviation	190.6		71.2	0.0	261.8
Inland navigation	-5.2		14.5	0.0	9.3
Passenger Transport	545.9	100.1	2677.9	57.4	3381.4
Freight Transport	212.0	131.7	1896.4	290.2	2530.3
TRANSPORT Total	758.0	231.9	4574.3	347.6	5911.7
TOTAL FINAL DEMAND	2689.1	-128.8	7058.7	-689.6	8929.4
POWER GENERATION	846.2		782.5	1849.4	3478.2
DISTRICT HEATING	23.3		42.0	-133.3	-68.0
ENERGY BRANCH	920.2		0.0	-550.2	370.0
TOTAL	4478.8	-128.8	7883.2	476.4	12709.6

Belgium

Decomposition of energy related CO2 emissions growth in 2000-2005

	Activity growth effect	Structural changes effect	Efficiency improvement effect	Changes in fuel mix effect	Total
Iron and steel	-1669.4	-741.8	-2340.1	-1004.8	-5756.1
Non Ferrous metals	-85.9	2.3	-258.9	-224.2	-566.7
Chemicals	66.8	-102.2	265.3	436.7	666.7
Non Metallic minerals	-31.3	12.9	-283.7	9.2	-292.9
Paper and Pulp	13.6	1.3	10.5	102.8	128.2
Food, Drink, Tobacco	11.8		83.3	329.0	424.1
Engineering	1.2		-29.3	-6.8	-34.9
Textiles	-5.4		-1.6	85.9	78.8
Other industries	332.3		-1778.9	-880.8	-2327.4
On-site CHP steam	1707.9		-361.4	-101.9	1244.6
Boilers steam	-1036.5		25.6	-244.6	-1255.6
INDUSTRY Total	485.2	138.3	-5172.2	-3142.4	-7691.1
RESIDENTIAL Total	1011.3		-64.6	-656.2	290.5
Services	618.9		597.2	624.8	1840.9
Agriculture	108.7		366.1	-7.7	467.0
TERTIARY Total	727.6		963.3	617.1	2308.0
Road transport	511.8	-662.4	1274.8	131.0	1255.1
Rail transport	21.6	-6.5	-13.1	-57.8	-55.8
Aviation	714.5		-1454.3	0.0	-739.8
Inland navigation	75.7		179.8	-4.6	251.0
Passenger Transport	1928.9	-156.2	-540.2	163.4	1395.9
Freight Transport	-759.0	-353.7	489.5	-62.2	-685.4
TRANSPORT Total	1169.9	-510.0	-50.7	101.2	710.5
TOTAL FINAL DEMAND	3394.0	-371.7	-4324.1	-3080.3	-4382.1
POWER GENERATION	606.5		188.3	-2698.4	-1903.6
DISTRICT HEATING	-23.7		0.0	-38.6	-62.3
ENERGY BRANCH	-567.9		0.0	-653.8	-1221.7
TOTAL	3408.9	-371.7	-4135.8	-6471.0	-7569.7

Bulgaria

Decomposition of energy related CO2 emissions growth in 2000-2005

	Activity growth effect	Structural changes effect	Efficiency improvement effect	Changes in fuel mix effect	Total
Iron and steel	448.6	-108.2	-699.5	-143.4	-502.6
Non Ferrous metals	54.1	42.4	-112.2	-50.7	-66.5
Chemicals	-218.1	21.2	102.5	-111.4	-205.9
Non Metallic minerals	-53.5	45.2	317.1	176.7	485.5
Paper and Pulp	14.1	3.7	24.3	8.8	50.8
Food, Drink, Tobacco	15.9		-25.5	-29.3	-38.9
Engineering	51.7		-64.2	-52.4	-64.8
Textiles	23.2		-19.2	-13.7	-9.7
Other industries	184.5		-124.8	19.9	79.7
On-site CHP steam	426.8		-82.5	-69.7	274.6
Boilers steam	-407.7		20.2	-379.0	-766.5
INDUSTRY Total	2692.3	-568.3	-2040.8	-847.7	-764.4
RESIDENTIAL Total	8.4		-55.7	58.3	11.0
Services	100.1		-34.7	-156.6	-91.2
Agriculture	16.7		-42.7	14.5	-11.4
TERTIARY Total	116.8		-77.4	-142.0	-102.6
Road transport	1758.7	2108.5	-1935.7	48.7	1980.1
Rail transport	-19.1	8.4	-16.3	-16.9	-43.9
Aviation	237.7		57.6	0.0	295.3
Inland navigation	4.0		-1.6	-0.2	2.2
Passenger Transport	368.2	645.9	-91.0	-6.8	916.2
Freight Transport	1724.8	1283.0	-1797.9	107.5	1317.5
TRANSPORT Total	2093.0	1928.9	-1888.9	100.7	2233.7
TOTAL FINAL DEMAND	4910.5	1360.6	-4062.7	-830.7	1377.7
POWER GENERATION	1661.2		-592.5	99.5	1168.2
DISTRICT HEATING	137.4		-24.0	-32.5	80.9
ENERGY BRANCH	148.7		0.0	169.7	318.4
TOTAL	6857.7	1360.6	-4679.3	-594.0	2945.1

Cyprus

Decomposition of energy related CO2 emissions growth in 2000-2005

	Activity growth effect	Structural changes effect	Efficiency improvement effect	Changes in fuel mix effect	Total
Iron and steel	0.0	0.0	0.0	0.0	0.0
Non Ferrous metals	0.0	0.0	0.0	0.0	0.0
Chemicals	0.0	0.0	0.0	0.0	0.0
Non Metallic minerals	96.1	2.2	-215.7	-17.1	-134.5
Paper and Pulp	0.0	0.0	0.0	0.0	0.0
Food, Drink, Tobacco	0.0		0.0	0.0	0.0
Engineering	0.0		0.0	0.0	0.0
Textiles	0.0		0.0	0.0	0.0
Other industries	-4.8		22.4	3.9	21.5
On-site CHP steam	0.0		0.0	0.0	0.0
Boilers steam	0.6		0.0	-12.4	-11.8
INDUSTRY Total	26.8	69.9	-174.9	-46.7	-124.9
RESIDENTIAL Total	23.9		-4.0	-53.5	-33.5
Services	55.6		19.7	-49.6	25.7
Agriculture	0.0		0.0	0.0	0.0
TERTIARY Total	55.6		19.7	-49.6	25.7
Road transport	343.8	-107.3	86.7	-11.8	311.4
Rail transport	0.0	0.0	0.0	0.0	0.0
Aviation	167.2		-139.8	0.0	27.4
Inland navigation	0.0		0.0	0.0	0.0
Passenger Transport	305.9	24.6	26.0	-6.6	349.9
Freight Transport	70.6	0.0	-81.9	0.2	-11.1
TRANSPORT Total	376.5	24.6	-55.9	-6.4	338.8
TOTAL FINAL DEMAND	482.8	94.5	-215.0	-156.1	206.2
POWER GENERATION	847.1		-229.6	1.2	618.7
DISTRICT HEATING	0.0		0.0	0.0	0.0
ENERGY BRANCH	-66.7		0.0	-45.1	-111.8
TOTAL	1263.1	94.5	-444.6	-200.0	713.0

Czech Republic

Decomposition of energy related CO2 emissions growth in 2000-2005

	Activity growth effect	Structural changes effect	Efficiency improvement effect	Changes in fuel mix effect	Total
Iron and steel	-36.5	-788.2	218.3	-214.1	-820.6
Non Ferrous metals	-59.5	-13.2	83.0	-22.3	-11.9
Chemicals	645.8	-326.4	-151.4	-701.3	-533.3
Non Metallic minerals	43.4	256.0	-499.2	-307.5	-507.2
Paper and Pulp	23.5	-1.0	17.7	8.1	48.2
Food, Drink, Tobacco	-54.1		-4.9	-122.7	-181.7
Engineering	686.7		-538.0	-539.7	-391.0
Textiles	3.1		-16.7	-5.0	-18.6
Other industries	863.3		-2137.7	-465.6	-1740.0
On-site CHP steam	-913.2		805.3	-355.1	-463.0
Boilers steam	1346.6		-76.9	-954.8	314.9
INDUSTRY Total	7553.8	-3639.9	-5400.7	-2817.4	-4304.1
RESIDENTIAL Total	232.0		972.9	-2050.6	-845.8
Services	959.1		-1100.5	-978.8	-1120.2
Agriculture	72.2		-194.8	-123.3	-246.0
TERTIARY Total	1031.2		-1295.3	-1102.1	-1366.2
Road transport	903.3	376.3	3840.8	94.7	5215.0
Rail transport	-22.5	-16.0	13.7	-6.2	-31.0
Aviation	222.4		219.0	0.0	441.4
Inland navigation	4.5		-4.5	0.0	0.0
Passenger Transport	272.8	299.5	1598.6	68.0	2239.0
Freight Transport	397.4	362.5	2316.0	310.6	3386.5
TRANSPORT Total	670.2	662.0	3914.6	378.7	5625.5
TOTAL FINAL DEMAND	9487.2	-2977.9	-1808.5	-5591.5	-890.7
POWER GENERATION	5794.2		2239.8	-8593.1	-559.2
DISTRICT HEATING	-258.5		7.4	-252.0	-503.1
ENERGY BRANCH	-5.2		0.0	99.4	94.3
TOTAL	15017.6	-2977.9	438.7	-14337.1	-1858.7

Denmark

Decomposition of energy related CO2 emissions growth in 2000-2005

	Activity growth effect	Structural changes effect	Efficiency improvement effect	Changes in fuel mix effect	Total
Iron and steel	-52.5	0.0	-0.7	3.2	-50.0
Non Ferrous metals	4.4	0.0	-4.3	-4.2	-4.1
Chemicals	26.0	-2.1	-63.7	-121.2	-161.1
Non Metallic minerals	297.3	77.2	-479.6	-0.4	-105.4
Paper and Pulp	-1.6	1.7	-2.0	9.3	7.4
Food, Drink, Tobacco	-5.8		-62.0	-140.6	-208.3
Engineering	9.1		-2.1	-45.8	-38.8
Textiles	-5.9		4.4	-3.1	-4.6
Other industries	-108.5		129.6	-40.9	-19.8
On-site CHP steam	-87.8		323.0	381.9	617.2
Boilers steam	-123.8		26.6	-296.6	-393.8
INDUSTRY Total	-180.4	-287.9	279.3	-172.5	-361.5
RESIDENTIAL Total	150.1		77.8	-582.1	-354.1
Services	55.1		6.5	-22.7	38.9
Agriculture	295.8		-521.7	-61.2	-287.0
TERTIARY Total	350.9		-515.1	-83.9	-248.1
Road transport	229.3	-134.3	1047.3	62.5	1204.8
Rail transport	17.4	-16.2	6.1	-4.1	3.1
Aviation	220.2		148.2	0.0	368.4
Inland navigation	4.3		59.1	-1.3	62.1
Passenger Transport	393.1	66.2	678.1	64.5	1201.9
Freight Transport	-112.8	-54.3	592.6	11.1	436.5
TRANSPORT Total	280.2	11.9	1270.6	75.6	1638.4
TOTAL FINAL DEMAND	600.9	-276.0	1112.7	-762.9	674.7
POWER GENERATION	972.7		-2389.4	-2921.2	-4337.8
DISTRICT HEATING	-3.6		0.0	36.1	32.4
ENERGY BRANCH	199.6		0.0	-87.3	112.3
TOTAL	1769.6	-276.0	-1276.7	-3735.4	-3518.4

Estonia

Decomposition of energy related CO2 emissions growth in 2000-2005

	Activity growth effect	Structural changes effect	Efficiency improvement effect	Changes in fuel mix effect	Total
Iron and steel	-0.2	0.0	0.0	0.0	-0.2
Non Ferrous metals	1.0	0.0	0.0	0.0	1.0
Chemicals	3.1	1.2	-3.6	1.4	2.2
Non Metallic minerals	347.5	-15.8	-344.7	-20.9	-33.9
Paper and Pulp	-6.7	2.0	7.5	-2.9	-0.1
Food, Drink, Tobacco	7.3		-7.7	-9.5	-9.9
Engineering	19.2		-4.4	-1.1	13.7
Textiles	1.7		-2.2	17.5	17.0
Other industries	125.5		-39.0	-31.5	54.9
On-site CHP steam	0.0		0.0	59.3	59.3
Boilers steam	11.0		3.9	-87.5	-72.6
INDUSTRY Total	515.0	-9.0	-319.6	-154.9	31.5
RESIDENTIAL Total	17.3		-19.1	70.1	68.2
Services	86.9		-26.8	5.8	65.8
Agriculture	-1.0		73.4	54.8	127.2
TERTIARY Total	85.8		46.6	60.5	193.0
Road transport	440.8	74.4	-149.7	11.7	377.2
Rail transport	39.8	0.2	-47.8	-4.6	-12.4
Aviation	7.4		59.6	0.0	67.0
Inland navigation	-0.3		12.7	0.0	12.4
Passenger Transport	219.9	60.4	-123.3	6.4	163.3
Freight Transport	234.8	47.8	-7.4	5.7	280.9
TRANSPORT Total	454.7	108.2	-130.7	12.0	444.2
TOTAL FINAL DEMAND	1072.8	99.2	-422.8	-12.3	736.9
POWER GENERATION	1186.8		-818.9	-20.8	347.2
DISTRICT HEATING	139.8		-78.7	-152.0	-91.0
ENERGY BRANCH	24.9		0.0	46.5	71.4
TOTAL	2424.3	99.2	-1320.4	-138.6	1064.5

Finland

Decomposition of energy related CO2 emissions growth in 2000-2005

	Activity growth effect	Structural changes effect	Efficiency improvement effect	Changes in fuel mix effect	Total
Iron and steel	805.9	-399.6	-418.6	-287.4	-299.7
Non Ferrous metals	7.9	-4.4	8.6	63.3	75.3
Chemicals	8.2	0.7	-13.7	57.9	53.2
Non Metallic minerals	31.5	63.2	17.2	12.2	124.1
Paper and Pulp	-42.8	-0.4	-11.1	39.1	-15.2
Food, Drink, Tobacco	12.2		-13.6	30.0	28.6
Engineering	74.7		-100.6	-102.7	-128.6
Textiles	-2.6		-1.6	2.4	-1.8
Other industries	61.9		83.3	-429.6	-284.4
On-site CHP steam	-711.8		219.7	-777.9	-1269.9
Boilers steam	404.7		-18.3	662.2	1048.6
INDUSTRY Total	2448.8	-2543.1	27.2	-602.7	-669.7
RESIDENTIAL Total	115.8		44.2	-436.8	-276.8
Services	109.6		60.6	-134.2	36.0
Agriculture	-35.7		71.2	-83.9	-48.4
TERTIARY Total	73.9		131.8	-218.1	-12.4
Road transport	725.1	-55.5	175.0	16.3	860.9
Rail transport	-3.2	-1.7	10.2	-23.9	-18.6
Aviation	147.4		29.2	0.0	176.6
Inland navigation	-31.2		108.3	1.2	78.3
Passenger Transport	680.7	120.5	141.6	29.6	972.4
Freight Transport	-79.8	43.2	183.3	-21.9	124.8
TRANSPORT Total	600.9	163.7	324.9	7.6	1097.2
TOTAL FINAL DEMAND	3239.4	-2379.4	528.1	-1250.0	138.2
POWER GENERATION	1833.7		-845.7	-1083.9	-95.9
DISTRICT HEATING	309.2		24.3	139.9	473.4
ENERGY BRANCH	-120.5		0.0	-50.4	-170.9
TOTAL	5261.9	-2379.4	-293.3	-2244.4	344.8

France

Decomposition of energy related CO2 emissions growth in 2000-2005

	Activity growth effect	Structural changes effect	Efficiency improvement effect	Changes in fuel mix effect	Total
Iron and steel	-1453.7	869.7	-1915.5	-760.1	-3259.6
Non Ferrous metals	-412.0	167.2	-99.5	-485.8	-830.1
Chemicals	527.7	-628.0	266.9	-380.9	-214.4
Non Metallic minerals	663.2	-111.0	-1395.3	-804.4	-1647.4
Paper and Pulp	23.7	-6.7	-90.1	-372.9	-445.9
Food, Drink, Tobacco	146.5		-276.7	-311.4	-441.6
Engineering	305.1		-663.6	-96.8	-455.3
Textiles	-94.4		53.4	119.3	78.3
Other industries	366.2		792.2	849.5	2008.0
On-site CHP steam	-511.9		-94.9	-712.5	-1319.3
Boilers steam	1432.2		-55.8	966.1	2342.4
INDUSTRY Total	4375.6	-2540.7	-3750.5	-2269.2	-4184.8
RESIDENTIAL Total	4745.6		-442.8	-967.3	3335.5
Services	1953.5		3023.9	1619.3	6596.7
Agriculture	-563.0		1134.1	-25.4	545.7
TERTIARY Total	1390.4		4158.0	1593.9	7142.4
Road transport	5206.9	-1064.5	-6740.1	260.2	-2337.5
Rail transport	-45.8	-189.4	145.5	-384.6	-474.3
Aviation	3057.7		-4220.7	0.0	-1163.0
Inland navigation	-78.8		-1334.0	-30.2	-1442.9
Passenger Transport	5826.5	919.2	-14311.6	114.7	-7451.3
Freight Transport	-2754.6	2160.0	2756.0	-127.8	2033.5
TRANSPORT Total	3071.8	3079.2	-11555.7	-13.1	-5417.7
TOTAL FINAL DEMAND	13583.5	538.5	-11590.9	-1655.6	875.4
POWER GENERATION	2554.0		899.2	3609.0	7062.2
DISTRICT HEATING	0.0		0.0	0.0	0.0
ENERGY BRANCH	-1091.3		0.0	-1945.1	-3036.4
TOTAL	15046.2	538.5	-10691.7	8.2	4901.2

Germany

Decomposition of energy related CO2 emissions growth in 2000-2005

	Activity growth effect	Structural changes effect	Efficiency improvement effect	Changes in fuel mix effect	Total
Iron and steel	-1799.3	-1853.8	-8.2	-2677.1	-6338.4
Non Ferrous metals	76.8	-19.4	73.6	387.2	518.3
Chemicals	1500.1	-792.9	86.1	210.8	1004.1
Non Metallic minerals	-1859.8	515.3	-1629.0	-337.8	-3311.3
Paper and Pulp	468.9	-154.2	-574.0	-1487.2	-1746.5
Food, Drink, Tobacco	-150.2		-8.2	-980.1	-1138.5
Engineering	973.2		-619.8	-588.3	-234.9
Textiles	-57.3		-60.1	-67.1	-184.4
Other industries	-282.2		-444.5	-1376.2	-2102.9
On-site CHP steam	1631.8		-242.4	-455.8	933.7
Boilers steam	-1503.2		4.9	1329.3	-168.9
INDUSTRY Total	8586.3	-4298.0	-10251.6	-6806.5	-12769.9
RESIDENTIAL Total	5430.4		2224.1	-5400.4	2254.1
Services	2564.5		-941.1	-2838.6	-1215.1
Agriculture	414.6		-791.2	-319.1	-695.8
TERTIARY Total	2979.1		-1732.3	-3157.7	-1910.9
Road transport	11227.8	874.8	-26706.3	-4699.3	-19303.1
Rail transport	131.1	92.9	-304.9	-273.3	-354.2
Aviation	2980.3		-139.8	0.0	2840.4
Inland navigation	-31.2		152.1	0.0	120.9
Passenger Transport	7857.9	2147.1	-18066.6	-2967.8	-11029.4
Freight Transport	4664.6	764.1	-9046.1	-2049.2	-5666.6
TRANSPORT Total	12522.5	2911.2	-27112.7	-5017.0	-16696.0
TOTAL FINAL DEMAND	29518.3	-1386.8	-36872.5	-20381.6	-29122.6
POWER GENERATION	28602.6		-11841.0	-5990.0	10771.6
DISTRICT HEATING	-1388.4		0.0	-544.3	-1932.6
ENERGY BRANCH	1715.6		0.0	67.4	1783.0
TOTAL	58448.1	-1386.8	-48713.5	-26848.5	-18500.7

Greece

Decomposition of energy related CO2 emissions growth in 2000-2005

	Activity growth effect	Structural changes effect	Efficiency improvement effect	Changes in fuel mix effect	Total
Iron and steel	274.8	0.0	-237.9	-144.8	-107.9
Non Ferrous metals	-21.6	0.3	53.4	-125.5	-93.5
Chemicals	52.9	-28.8	-25.9	127.3	125.4
Non Metallic minerals	-110.7	0.9	-448.1	-221.5	-779.4
Paper and Pulp	6.1	-1.5	-34.5	-31.9	-61.7
Food, Drink, Tobacco	67.7		-70.5	-53.8	-56.6
Engineering	9.1		-19.4	2.8	-7.5
Textiles	9.2		-34.9	-10.3	-36.0
Other industries	193.5		-272.7	155.9	76.7
On-site CHP steam	0.0		0.0	126.9	126.9
Boilers steam	-164.1		10.0	-505.5	-659.6
INDUSTRY Total	1511.4	-306.9	-1899.2	-778.4	-1473.1
RESIDENTIAL Total	285.4		1367.7	572.9	2225.9
Services	202.7		162.7	384.7	750.1
Agriculture	-255.3		338.0	-14.5	68.2
TERTIARY Total	-52.6		500.7	370.2	818.4
Road transport	4085.4	433.3	-1971.9	-32.9	2513.9
Rail transport	16.5	27.2	-48.6	5.0	0.0
Aviation	583.0		-1009.2	0.0	-426.2
Inland navigation	128.4		346.7	2.3	477.3
Passenger Transport	2602.3	294.6	-1128.6	-10.7	1757.5
Freight Transport	2078.5	262.0	-1544.2	11.2	807.5
TRANSPORT Total	4680.8	556.6	-2672.8	0.4	2565.0
TOTAL FINAL DEMAND	6425.0	249.7	-2703.7	165.2	4136.2
POWER GENERATION	5073.0		-1523.9	-875.5	2673.6
DISTRICT HEATING	0.0		0.0	0.0	0.0
ENERGY BRANCH	251.9		0.0	-67.8	184.1
TOTAL	11749.9	249.7	-4227.6	-778.2	6993.9

Hungary

Decomposition of energy related CO2 emissions growth in 2000-2005

	Activity growth effect	Structural changes effect	Efficiency improvement effect	Changes in fuel mix effect	Total
Iron and steel	111.6	-339.3	40.4	-76.4	-263.7
Non Ferrous metals	-11.7	5.3	-0.6	-1.9	-8.8
Chemicals	37.9	-120.8	-62.0	-148.6	-293.5
Non Metallic minerals	69.1	-38.8	-62.3	149.6	117.5
Paper and Pulp	5.9	-1.4	10.1	45.9	60.4
Food, Drink, Tobacco	-72.5		64.1	-101.0	-109.4
Engineering	149.1		78.7	-135.6	92.1
Textiles	-5.3		2.1	14.5	11.3
Other industries	35.5		-6.8	85.5	114.1
On-site CHP steam	0.0		0.0	0.0	0.0
Boilers steam	222.1		8.0	-71.4	158.6
INDUSTRY Total	1407.2	-1249.5	-271.5	-7.4	-121.3
RESIDENTIAL Total	198.8		1356.0	-12.5	1542.3
Services	1022.7		-419.5	265.1	868.3
Agriculture	943.0		-1228.0	-88.3	-373.3
TERTIARY Total	1965.7		-1647.4	176.8	495.1
Road transport	612.3	275.0	1865.7	46.6	2799.7
Rail transport	-4.2	-1.8	-19.0	-46.1	-71.2
Aviation	86.6		-53.1	0.0	33.5
Inland navigation	0.0		0.0	3.1	3.1
Passenger Transport	24.1	115.9	1397.0	37.0	1574.0
Freight Transport	832.6	-33.8	336.5	55.8	1191.1
TRANSPORT Total	856.8	82.0	1733.5	92.8	2765.1
TOTAL FINAL DEMAND	4428.4	-1167.5	1170.4	249.8	4681.1
POWER GENERATION	-842.1		-8.6	-3412.3	-4263.0
DISTRICT HEATING	238.2		130.6	200.7	569.5
ENERGY BRANCH	539.3		0.0	-99.6	439.7
TOTAL	4363.8	-1167.5	1292.4	-3061.4	1427.3

Ireland

Decomposition of energy related CO2 emissions growth in 2000-2005

	Activity growth effect	Structural changes effect	Efficiency improvement effect	Changes in fuel mix effect	Total
Iron and steel	-51.7	0.0	0.0	0.0	-51.7
Non Ferrous metals	1043.4	4.3	-870.5	47.4	224.6
Chemicals	100.4	3.6	-141.1	14.3	-22.8
Non Metallic minerals	573.3	8.6	-295.7	106.2	392.5
Paper and Pulp	0.2	0.0	-0.8	-2.0	-2.7
Food, Drink, Tobacco	175.3		-157.7	18.1	35.7
Engineering	15.4		1.9	-64.7	-47.4
Textiles	-5.3		-3.0	7.9	-0.4
Other industries	153.8		-137.3	-9.7	6.9
On-site CHP steam	-21.7		23.8	8.4	10.5
Boilers steam	31.3		8.4	-230.5	-190.8
INDUSTRY Total	1461.8	525.9	-1699.4	66.0	354.4
RESIDENTIAL Total	758.6		243.2	-440.7	561.1
Services	849.8		-592.8	-451.3	-194.3
Agriculture	-92.7		98.9	0.0	6.2
TERTIARY Total	757.1		-494.0	-451.3	-188.1
Road transport	2799.6	497.2	-1045.5	22.0	2273.3
Rail transport	16.3	-41.1	33.0	-8.2	0.0
Aviation	389.5		271.1	0.0	660.6
Inland navigation	7.8		-29.2	0.0	-21.4
Passenger Transport	1477.4	106.8	-263.4	-0.1	1320.7
Freight Transport	1971.1	140.7	-512.1	-7.9	1591.8
TRANSPORT Total	3448.5	247.5	-775.5	-8.0	2912.4
TOTAL FINAL DEMAND	6426.1	773.4	-2725.7	-833.9	3639.9
POWER GENERATION	850.1		-816.0	-398.3	-364.2
DISTRICT HEATING	0.0		0.0	0.0	0.0
ENERGY BRANCH	180.7		0.0	114.6	295.3
TOTAL	7456.9	773.4	-3541.7	-1117.7	3571.0

Italy

Decomposition of energy related CO2 emissions growth in 2000-2005

	Activity growth effect	Structural changes effect	Efficiency improvement effect	Changes in fuel mix effect	Total
Iron and steel	1591.1	-185.0	-91.8	1276.6	2590.9
Non Ferrous metals	-116.0	17.7	43.7	-185.7	-240.4
Chemicals	-129.8	-319.8	549.1	1101.6	1200.9
Non Metallic minerals	2965.0	-1704.3	504.2	934.0	2698.9
Paper and Pulp	41.9	-9.4	51.0	568.7	652.2
Food, Drink, Tobacco	-95.9		266.0	176.7	346.9
Engineering	-144.3		618.5	-196.5	277.8
Textiles	-172.1		122.4	403.7	354.1
Other industries	-76.8		333.1	97.0	353.3
On-site CHP steam	-4267.3		-2648.9	-65.9	-6982.1
Boilers steam	3950.2		-13.7	-1052.9	2883.6
INDUSTRY Total	-4069.2	4777.7	1724.4	1703.3	4136.2
RESIDENTIAL Total	4207.0		2584.8	-179.2	6612.6
Services	754.6		3795.2	375.2	4925.0
Agriculture	-10.6		408.0	-69.9	327.5
TERTIARY Total	743.9		4203.2	305.3	5252.5
Road transport	3451.9	1957.6	44.9	545.9	6000.2
Rail transport	-17.5	-18.1	73.2	-161.6	-124.0
Aviation	1335.5		-233.4	0.0	1102.1
Inland navigation	-36.6		176.1	0.0	139.5
Passenger Transport	989.2	1125.7	-3444.8	78.5	-1251.4
Freight Transport	3090.8	1230.0	3874.7	173.7	8369.2
TRANSPORT Total	4080.1	2355.7	429.8	252.2	7117.8
TOTAL FINAL DEMAND	4961.8	7133.4	8942.3	2081.7	23119.1
POWER GENERATION	12962.4		-1380.5	-8503.9	3077.9
DISTRICT HEATING	0.0		0.0	0.0	0.0
ENERGY BRANCH	3038.4		0.0	484.4	3522.8
TOTAL	20962.6	7133.4	7561.7	-5937.9	29719.8

Latvia

Decomposition of energy related CO2 emissions growth in 2000-2005

	Activity growth effect	Structural changes effect	Efficiency improvement effect	Changes in fuel mix effect	Total
Iron and steel	26.9	0.0	-16.5	-3.7	6.7
Non Ferrous metals	0.0	0.0	0.0	0.0	0.0
Chemicals	3.4	-0.5	-2.0	-0.6	0.3
Non Metallic minerals	-2.9	5.0	72.6	82.8	157.6
Paper and Pulp	0.3	0.0	0.4	2.7	3.3
Food, Drink, Tobacco	5.2		2.3	28.0	35.5
Engineering	19.2		-13.5	1.7	7.5
Textiles	0.7		-6.3	5.5	-0.1
Other industries	58.7		32.8	-69.7	21.8
On-site CHP steam	0.0		0.0	0.0	0.0
Boilers steam	166.7		8.2	-273.4	-98.4
INDUSTRY Total	398.0	43.4	-125.9	-181.4	134.1
RESIDENTIAL Total	-3.0		25.4	184.3	206.8
Services	185.6		-95.4	-6.4	83.8
Agriculture	33.8		-17.3	-3.8	12.7
TERTIARY Total	219.4		-112.7	-10.2	96.5
Road transport	822.1	90.1	-294.2	14.3	632.3
Rail transport	67.1	1.0	-20.9	5.5	52.7
Aviation	25.4		69.0	0.0	94.4
Inland navigation	-13.7		0.0	0.0	-13.7
Passenger Transport	356.0	29.0	-69.9	9.5	324.5
Freight Transport	418.7	189.5	-177.6	10.5	441.1
TRANSPORT Total	774.7	218.5	-247.5	19.9	765.6
TOTAL FINAL DEMAND	1389.1	261.9	-460.7	12.6	1203.0
POWER GENERATION	351.5		-288.8	-467.2	-404.5
DISTRICT HEATING	-186.5		130.1	-195.8	-252.2
ENERGY BRANCH	-77.3		0.0	-85.6	-162.9
TOTAL	1476.9	261.9	-619.3	-736.0	383.4

Lithuania

Decomposition of energy related CO2 emissions growth in 2000-2005

	Activity growth effect	Structural changes effect	Efficiency improvement effect	Changes in fuel mix effect	Total
Iron and steel	0.0	0.0	0.0	0.0	0.0
Non Ferrous metals	0.0	0.0	0.0	0.0	0.0
Chemicals	5.6	2.5	-4.5	-3.5	0.2
Non Metallic minerals	178.8	-12.5	-93.0	68.0	141.4
Paper and Pulp	-2.5	0.0	-1.9	-6.9	-11.3
Food, Drink, Tobacco	14.0		-16.3	-7.4	-9.7
Engineering	93.5		-87.3	-7.8	-1.6
Textiles	2.6		-4.5	7.1	5.2
Other industries	108.0		-2.8	-51.6	53.6
On-site CHP steam	210.6		-85.9	0.0	124.8
Boilers steam	116.5		9.7	-163.2	-36.9
INDUSTRY Total	651.1	-80.4	-269.3	-35.8	265.6
RESIDENTIAL Total	19.5		-5.3	75.5	89.7
Services	127.9		-61.6	-14.8	51.5
Agriculture	19.9		-7.4	10.2	22.7
TERTIARY Total	147.8		-68.9	-4.7	74.2
Road transport	2332.4	97.5	-1478.8	-6.3	944.7
Rail transport	76.4	4.6	-70.8	-1.0	9.3
Aviation	22.2		35.7	0.0	57.8
Inland navigation	0.5		5.7	0.0	6.3
Passenger Transport	1418.9	115.8	-905.9	-6.7	622.1
Freight Transport	766.5	237.6	-607.0	-1.1	396.0
TRANSPORT Total	2185.4	353.3	-1512.9	-7.7	1018.1
TOTAL FINAL DEMAND	3003.8	272.9	-1856.4	27.3	1447.6
POWER GENERATION	684.7		-81.2	121.5	725.0
DISTRICT HEATING	-330.0		-3.1	-364.4	-697.5
ENERGY BRANCH	478.8		0.0	306.3	785.2
TOTAL	3837.3	272.9	-1940.7	90.7	2260.3

Luxembourg

Decomposition of energy related CO2 emissions growth in 2000-2005

	Activity growth effect	Structural changes effect	Efficiency improvement effect	Changes in fuel mix effect	Total
Iron and steel	-89.8	-25.9	126.4	3.3	14.1
Non Ferrous metals	0.0	0.0	0.0	0.0	0.0
Chemicals	5.2	-3.7	-0.8	-9.1	-8.4
Non Metallic minerals	33.8	-29.6	-164.9	-0.3	-161.0
Paper and Pulp	0.0	0.0	0.0	0.0	0.0
Food, Drink, Tobacco	0.1		0.1	-0.2	0.0
Engineering	0.0		0.0	0.0	0.0
Textiles	0.0		0.0	0.0	0.0
Other industries	60.8		-50.5	3.6	13.9
On-site CHP steam	-30.6		0.0	0.0	-30.6
Boilers steam	27.1		0.0	0.1	27.2
INDUSTRY Total	26.5	4.7	-67.2	-108.8	-144.8
RESIDENTIAL Total	112.3		14.1	-103.2	23.3
Services	10.0		-8.5	-40.8	-39.3
Agriculture	-4.0		18.8	10.0	24.8
TERTIARY Total	6.0		10.2	-30.8	-14.5
Road transport	667.5	-38.0	1543.1	73.6	2246.3
Rail transport	-6.8	-0.5	-1.5	-9.8	-18.6
Aviation	188.8		140.0	0.0	328.8
Inland navigation	0.0		0.0	0.0	0.0
Passenger Transport	398.2	54.9	341.4	47.7	842.2
Freight Transport	270.4	76.9	1353.0	14.0	1714.3
TRANSPORT Total	668.7	131.8	1694.4	61.7	2556.5
TOTAL FINAL DEMAND	813.6	136.5	1651.5	-181.1	2420.4
POWER GENERATION	477.9		142.6	496.3	1116.8
DISTRICT HEATING	0.0		0.0	0.0	0.0
ENERGY BRANCH	0.0		0.0	0.0	0.0
TOTAL	1291.5	136.5	1794.1	315.2	3537.3

Malta

Decomposition of energy related CO2 emissions growth in 2000-2005

	Activity growth effect	Structural changes effect	Efficiency improvement effect	Changes in fuel mix effect	Total
Iron and steel	0.0	0.0	0.0	0.0	0.0
Non Ferrous metals	0.0	0.0	0.0	0.0	0.0
Chemicals	0.0	0.0	0.0	0.0	0.0
Non Metallic minerals	0.0	0.0	0.0	0.0	0.0
Paper and Pulp	0.0	0.0	0.0	0.0	0.0
Food, Drink, Tobacco	0.0		0.0	0.0	0.0
Engineering	0.0		0.0	0.0	0.0
Textiles	0.0		0.0	0.0	0.0
Other industries	0.0		0.0	0.0	0.0
On-site CHP steam	0.0		0.0	0.0	0.0
Boilers steam	0.0		0.0	0.0	0.0
INDUSTRY Total	0.0	0.0	0.0	0.0	0.0
RESIDENTIAL Total	8.9		4.0	8.1	21.0
Services	-0.9		8.1	-0.7	6.5
Agriculture	0.0		0.0	0.0	0.0
TERTIARY Total	-0.9		8.1	-0.7	6.5
Road transport	43.8	-5.7	219.2	5.8	263.0
Rail transport	0.0	0.0	0.0	0.0	0.0
Aviation	28.4		-16.2	0.0	12.2
Inland navigation	0.0		0.0	0.0	0.0
Passenger Transport	63.8	2.2	107.1	5.0	178.0
Freight Transport	0.0	0.0	97.2	0.0	97.2
TRANSPORT Total	63.8	2.2	204.2	5.0	275.2
TOTAL FINAL DEMAND	71.7	2.2	216.4	12.4	302.7
POWER GENERATION	265.3		7.7	12.3	285.3
DISTRICT HEATING	0.0		0.0	0.0	0.0
ENERGY BRANCH	0.0		0.0	0.0	0.0
TOTAL	337.0	2.2	224.0	24.7	587.9

Netherlands

Decomposition of energy related CO2 emissions growth in 2000-2005

	Activity growth effect	Structural changes effect	Efficiency improvement effect	Changes in fuel mix effect	Total
Iron and steel	1461.7	-445.2	234.1	81.7	1332.4
Non Ferrous metals	-7.5	16.0	11.4	18.3	38.2
Chemicals	256.6	105.3	-167.6	1126.0	1320.4
Non Metallic minerals	-336.9	200.1	-103.5	-23.4	-263.7
Paper and Pulp	1.5	0.4	16.0	691.2	709.1
Food, Drink, Tobacco	8.1		69.2	1152.6	1230.0
Engineering	-67.0		15.8	64.7	13.6
Textiles	-5.1		-2.4	36.4	28.9
Other industries	-34.2		451.1	121.0	537.9
On-site CHP steam	-5454.7		-1308.8	106.8	-6656.8
Boilers steam	3253.3		-188.7	-809.9	2254.7
INDUSTRY Total	101.3	2235.9	-924.9	-867.5	544.8
RESIDENTIAL Total	1298.8		-1208.5	-1170.1	-1079.7
Services	976.0		-1938.5	-692.9	-1655.5
Agriculture	405.8		-228.7	51.7	228.9
TERTIARY Total	1381.8		-2167.2	-641.2	-1426.6
Road transport	1356.2	60.7	2682.9	252.8	4352.7
Rail transport	4.8	5.6	-12.8	-3.8	-6.2
Aviation	1048.5		-80.3	0.0	968.1
Inland navigation	47.5		-1467.6	0.0	-1420.1
Passenger Transport	1171.4	532.4	1146.4	219.2	3069.4
Freight Transport	746.3	84.5	-45.7	40.0	825.1
TRANSPORT Total	1917.7	617.0	1100.7	259.2	3894.5
TOTAL FINAL DEMAND	4699.7	2852.8	-3199.9	-2419.6	1932.9
POWER GENERATION	7314.4		-3637.9	-2161.3	1515.2
DISTRICT HEATING	616.1		0.0	0.0	616.1
ENERGY BRANCH	2624.3		0.0	-959.8	1664.5
TOTAL	15254.5	2852.8	-6837.8	-5540.7	5728.8

Poland

Decomposition of energy related CO2 emissions growth in 2000-2005

	Activity growth effect	Structural changes effect	Efficiency improvement effect	Changes in fuel mix effect	Total
Iron and steel	-2947.8	-1481.1	-853.9	-1074.6	-6357.5
Non Ferrous metals	58.1	-45.6	-108.9	-211.1	-307.5
Chemicals	722.7	-546.3	-523.1	-533.3	-879.9
Non Metallic minerals	-850.0	401.0	234.7	-813.4	-1027.6
Paper and Pulp	124.0	-36.6	-35.9	18.7	70.3
Food, Drink, Tobacco	127.7		-136.4	-144.9	-153.6
Engineering	644.5		-795.6	-599.3	-750.4
Textiles	-21.0		-16.0	-13.6	-50.7
Other industries	435.2		-512.1	-730.2	-807.1
On-site CHP steam	700.4		-36.2	133.1	797.3
Boilers steam	-2101.2		-84.8	-1510.0	-3696.0
INDUSTRY Total	9042.5	-3635.5	-11563.8	-7006.0	-13162.8
RESIDENTIAL Total	1107.3		260.5	916.9	2284.7
Services	823.4		407.6	1022.6	2253.6
Agriculture	2257.0		-4604.9	388.5	-1959.4
TERTIARY Total	3080.4		-4197.3	1411.1	294.1
Road transport	6518.9	1214.1	1001.7	-49.3	8685.4
Rail transport	-102.8	2.1	66.1	12.9	-21.7
Aviation	174.1		-320.2	0.0	-146.1
Inland navigation	-11.2		-1.2	0.0	-12.4
Passenger Transport	1986.4	1173.0	-2182.6	-217.8	759.0
Freight Transport	1981.7	2130.6	3000.5	633.4	7746.2
TRANSPORT Total	3968.1	3303.6	817.9	415.6	8505.2
TOTAL FINAL DEMAND	17198.3	-331.9	-14682.7	-4262.4	-2078.7
POWER GENERATION	13401.4		-4704.3	-2521.5	6175.6
DISTRICT HEATING	-2653.8		57.4	-266.4	-2862.8
ENERGY BRANCH	428.0		0.0	-1207.1	-779.0
TOTAL	28374.0	-331.9	-19329.6	-8257.4	455.1

Portugal

Decomposition of energy related CO2 emissions growth in 2000-2005

	Activity growth effect	Structural changes effect	Efficiency improvement effect	Changes in fuel mix effect	Total
Iron and steel	-42.5	-411.2	107.6	-379.0	-725.1
Non Ferrous metals	-16.5	0.3	-20.5	-18.8	-55.4
Chemicals	0.1	0.6	63.6	162.5	226.7
Non Metallic minerals	-491.6	92.0	-512.9	-250.9	-1163.5
Paper and Pulp	20.5	-8.2	121.8	-224.8	-90.6
Food, Drink, Tobacco	7.7		13.8	-51.8	-30.2
Engineering	11.7		24.2	16.3	52.2
Textiles	-20.4		2.3	168.0	149.9
Other industries	101.9		-147.4	-151.7	-197.1
On-site CHP steam	176.5		-39.0	-1101.1	-963.6
Boilers steam	684.4		101.6	-1440.6	-654.7
INDUSTRY Total	-9.1	-358.9	639.3	-3722.6	-3451.4
RESIDENTIAL Total	126.8		159.0	-29.9	256.0
Services	88.6		597.8	897.2	1583.6
Agriculture	-213.0		-185.7	-110.9	-509.6
TERTIARY Total	-124.4		412.1	786.3	1074.0
Road transport	2167.4	200.3	-1049.3	92.7	1411.0
Rail transport	7.5	6.2	-56.6	-53.1	-96.1
Aviation	297.8		-26.8	0.0	271.0
Inland navigation	18.3		-25.5	0.0	-7.2
Passenger Transport	1575.4	340.3	-1296.5	64.3	683.5
Freight Transport	772.2	-7.3	136.2	-6.0	895.2
TRANSPORT Total	2347.6	333.0	-1160.2	58.3	1578.7
TOTAL FINAL DEMAND	2340.9	-25.9	50.2	-2907.9	-542.7
POWER GENERATION	2355.0		634.4	621.1	3610.5
DISTRICT HEATING	0.0		0.0	0.0	0.0
ENERGY BRANCH	48.8		0.0	-26.7	22.1
TOTAL	4744.7	-25.9	684.6	-2313.5	3089.9

Romania

Decomposition of energy related CO2 emissions growth in 2000-2005

	Activity growth effect	Structural changes effect	Efficiency improvement effect	Changes in fuel mix effect	Total
Iron and steel	1715.0	-220.8	278.4	1371.1	3143.7
Non Ferrous metals	227.1	27.2	122.0	27.9	404.2
Chemicals	281.5	55.0	31.1	-58.8	308.8
Non Metallic minerals	325.9	-344.1	-591.8	-346.0	-956.0
Paper and Pulp	37.0	6.1	-71.5	-13.7	-42.1
Food, Drink, Tobacco	180.8		12.3	-181.2	11.8
Engineering	57.7		-446.5	-86.6	-475.4
Textiles	22.6		-64.6	-13.3	-55.2
Other industries	551.1		-511.5	16.7	56.2
On-site CHP steam	0.0		0.0	0.1	0.1
Boilers steam	705.4		-8.4	203.4	900.3
INDUSTRY Total	5042.1	-1663.1	-1448.9	1366.3	3296.4
RESIDENTIAL Total	195.3		-547.2	1054.9	703.0
Services	371.2		534.9	2010.4	2916.5
Agriculture	242.9		-658.3	9.0	-406.4
TERTIARY Total	614.1		-123.4	2019.4	2510.0
Road transport	7452.9	1260.7	-5319.7	22.2	3416.1
Rail transport	-110.3	75.0	-446.0	-188.4	-669.7
Aviation	159.7		-205.3	0.0	-45.7
Inland navigation	786.2		-986.5	-2.3	-202.7
Passenger Transport	1053.0	801.0	-2297.4	-55.2	-498.6
Freight Transport	4882.9	2123.5	-4356.9	347.2	2996.7
TRANSPORT Total	5935.9	2924.5	-6654.3	292.0	2498.1
TOTAL FINAL DEMAND	11787.4	1261.4	-8773.9	4732.6	9007.5
POWER GENERATION	-150.1		34.4	-969.5	-1085.3
DISTRICT HEATING	-2390.2		139.6	-70.0	-2320.6
ENERGY BRANCH	83.7		0.0	432.5	516.1
TOTAL	9330.8	1261.4	-8599.8	4125.4	6117.8

Slovak Republic

Decomposition of energy related CO2 emissions growth in 2000-2005

	Activity growth effect	Structural changes effect	Efficiency improvement effect	Changes in fuel mix effect	Total
Iron and steel	916.8	-292.9	274.2	196.6	1094.8
Non Ferrous metals	-3.8	0.0	60.8	107.8	164.8
Chemicals	24.0	-65.5	-51.4	-117.1	-210.0
Non Metallic minerals	257.3	-59.2	-670.2	-184.9	-657.1
Paper and Pulp	19.2	-2.3	61.8	19.5	98.2
Food, Drink, Tobacco	-3.5		9.3	137.5	143.4
Engineering	351.0		-383.6	-6.7	-39.2
Textiles	2.5		-9.2	6.4	-0.3
Other industries	699.1		-638.9	-171.2	-111.0
On-site CHP steam	782.3		-255.3	88.0	614.9
Boilers steam	171.7		-13.8	-1117.7	-959.7
INDUSTRY Total	6749.4	-1942.7	-3606.3	-1061.7	138.7
RESIDENTIAL Total	209.7		-631.9	-176.2	-598.5
Services	16.9		-1266.0	-688.6	-1937.7
Agriculture	109.4		-57.0	140.4	192.8
TERTIARY Total	126.3		-1323.0	-548.2	-1744.9
Road transport	878.0	152.2	-282.3	-30.2	717.7
Rail transport	0.0	0.0	0.0	0.0	0.0
Aviation	115.7		0.0	0.0	115.7
Inland navigation	0.0		0.0	0.0	0.0
Passenger Transport	47.3	81.4	127.7	28.5	285.0
Freight Transport	392.9	397.9	-330.0	87.5	548.4
TRANSPORT Total	440.2	479.3	-202.2	116.1	833.4
TOTAL FINAL DEMAND	7525.5	-1463.4	-5763.5	-1670.0	-1371.4
POWER GENERATION	-192.8		537.7	-455.8	-110.9
DISTRICT HEATING	293.9		42.3	-273.5	62.7
ENERGY BRANCH	2690.0		0.0	760.5	3450.5
TOTAL	10316.6	-1463.4	-5183.4	-1638.8	2031.0

Slovenia

Decomposition of energy related CO2 emissions growth in 2000-2005

	Activity growth effect	Structural changes effect	Efficiency improvement effect	Changes in fuel mix effect	Total
Iron and steel	21.7	0.0	-43.2	-38.0	-59.6
Non Ferrous metals	15.2	1.1	-0.5	-9.5	6.5
Chemicals	29.0	-17.3	19.2	-57.2	-26.4
Non Metallic minerals	-31.2	18.3	19.9	1.6	8.6
Paper and Pulp	-42.2	10.2	51.4	37.5	56.8
Food, Drink, Tobacco	-5.2		5.0	-4.0	-4.2
Engineering	67.2		4.0	-18.2	53.0
Textiles	-3.6		-1.4	-1.9	-7.0
Other industries	61.0		-56.0	-109.3	-104.4
On-site CHP steam	141.8		-0.4	60.3	201.8
Boilers steam	-63.9		-1.4	-113.9	-179.2
INDUSTRY Total	526.0	-93.3	-49.8	-437.0	-54.0
RESIDENTIAL Total	43.9		27.7	49.9	121.4
Services	195.6		-200.6	60.2	55.2
Agriculture	0.2		-3.1	-0.2	-3.0
TERTIARY Total	195.8		-203.6	60.1	52.2
Road transport	1220.5	299.7	-1028.0	53.5	545.7
Rail transport	4.4	0.1	-9.3	7.9	3.1
Aviation	6.8		-12.9	0.0	-6.1
Inland navigation	0.0		0.0	0.0	0.0
Passenger Transport	234.4	120.1	-496.8	22.7	-119.6
Freight Transport	849.2	292.3	-546.9	67.7	662.3
TRANSPORT Total	1083.6	412.4	-1043.7	90.4	542.7
TOTAL FINAL DEMAND	1849.3	319.2	-1269.5	-236.7	662.3
POWER GENERATION	582.8		197.8	-153.7	626.9
DISTRICT HEATING	2.8		9.6	4.1	16.6
ENERGY BRANCH	-5.4		0.0	-56.4	-61.7
TOTAL	2429.6	319.2	-1062.1	-442.7	1244.0

Spain

Decomposition of energy related CO2 emissions growth in 2000-2005

	Activity growth effect	Structural changes effect	Efficiency improvement effect	Changes in fuel mix effect	Total
Iron and steel	1133.0	-361.0	612.2	-999.3	384.9
Non Ferrous metals	85.5	-18.5	-54.8	-218.7	-206.5
Chemicals	297.1	-62.0	248.4	778.4	1261.9
Non Metallic minerals	4836.5	-1044.0	-280.9	-907.8	2603.8
Paper and Pulp	177.1	-3.5	62.3	-556.6	-320.7
Food, Drink, Tobacco	50.9		46.5	-16.5	80.9
Engineering	109.4		227.6	-312.2	24.9
Textiles	-27.1		-27.9	-20.3	-75.2
Other industries	65.2		1337.3	1720.7	3123.2
On-site CHP steam	3130.2		-1325.7	661.8	2466.3
Boilers steam	461.7		21.7	-608.7	-125.3
INDUSTRY Total	2999.4	1799.9	5885.3	-1466.5	9218.1
RESIDENTIAL Total	1739.8		2804.1	-626.6	3917.3
Services	1292.0		475.5	114.3	1881.8
Agriculture	-611.8		1995.2	23.5	1406.8
TERTIARY Total	680.1		2470.7	137.8	3288.7
Road transport	22611.6	5181.4	-12063.4	92.4	15822.0
Rail transport	52.5	-82.3	595.8	97.6	663.5
Aviation	1565.1		916.1	0.0	2481.2
Inland navigation	162.8		319.4	-21.4	460.8
Passenger Transport	9158.2	492.8	-988.1	138.6	8801.5
Freight Transport	17657.1	2075.4	-8888.7	-217.7	10626.0
TRANSPORT Total	26815.3	2568.2	-9876.8	-79.1	19427.5
TOTAL FINAL DEMAND	32234.6	4368.1	1283.2	-2034.3	35851.6
POWER GENERATION	28153.4		-10925.0	1881.4	19109.8
DISTRICT HEATING	0.0		0.0	0.0	0.0
ENERGY BRANCH	618.4		0.0	559.9	1178.3
TOTAL	61006.4	4368.1	-9641.8	407.0	56139.7

Sweden

Decomposition of energy related CO2 emissions growth in 2000-2005

	Activity growth effect	Structural changes effect	Efficiency improvement effect	Changes in fuel mix effect	Total
Iron and steel	419.8	107.5	153.0	389.4	1069.7
Non Ferrous metals	74.3	-29.6	-39.0	-114.5	-108.8
Chemicals	12.3	-15.9	18.4	146.7	161.5
Non Metallic minerals	9.6	16.0	-171.0	23.7	-121.7
Paper and Pulp	128.2	0.2	-316.4	-813.1	-1001.0
Food, Drink, Tobacco	-3.8		-23.5	16.3	-10.9
Engineering	141.7		-125.5	34.8	51.1
Textiles	-3.9		1.5	7.9	5.5
Other industries	29.1		-38.2	-142.2	-151.3
On-site CHP steam	65.4		352.3	60.8	478.4
Boilers steam	-213.7		-5.5	1018.1	798.9
INDUSTRY Total	2344.9	-2321.5	-27.7	1175.7	1171.4
RESIDENTIAL Total	171.4		-6.5	-2438.2	-2273.2
Services	387.6		-1252.3	-1304.1	-2168.9
Agriculture	89.3		-170.0	-201.1	-281.8
TERTIARY Total	476.9		-1422.3	-1505.3	-2450.6
Road transport	1233.0	140.9	327.2	-553.7	1147.3
Rail transport	7.4	0.3	0.6	-70.3	-62.0
Aviation	367.8		-611.3	0.0	-243.5
Inland navigation	3.1		-43.6	5.1	-35.4
Passenger Transport	943.1	176.1	-384.0	-338.0	397.2
Freight Transport	658.9	-6.8	78.1	-321.1	409.1
TRANSPORT Total	1602.0	169.3	-305.8	-659.2	806.3
TOTAL FINAL DEMAND	4595.3	-2152.2	-1762.3	-3426.9	-2746.1
POWER GENERATION	535.8		232.3	-161.2	606.8
DISTRICT HEATING	-132.9		0.0	-135.9	-268.7
ENERGY BRANCH	-136.8		0.0	547.2	410.4
TOTAL	4861.4	-2152.2	-1530.0	-3176.8	-1997.6

United Kingdom

Decomposition of energy related CO2 emissions growth in 2000-2005

	Activity growth effect	Structural changes effect	Efficiency improvement effect	Changes in fuel mix effect	Total
Iron and steel	-2283.6	93.6	-2265.3	875.4	-3579.8
Non Ferrous metals	-417.2	110.3	135.4	-622.1	-793.7
Chemicals	392.3	54.7	-874.8	-1199.0	-1626.8
Non Metallic minerals	-615.6	-104.3	318.8	-98.6	-499.7
Paper and Pulp	-29.5	-0.3	64.1	128.2	162.5
Food, Drink, Tobacco	32.8		58.6	657.0	748.4
Engineering	-240.4		67.1	-252.3	-425.6
Textiles	-89.5		69.5	30.6	10.5
Other industries	-590.5		3259.9	118.0	2787.5
On-site CHP steam	-3269.8		-2381.7	279.2	-5372.3
Boilers steam	3912.2		5.2	-361.7	3555.7
INDUSTRY Total	-2152.8	138.8	-1951.9	-1067.3	-5033.1
RESIDENTIAL Total	4442.6		-4039.9	-2603.9	-2201.1
Services	4809.6		-6044.9	-471.8	-1707.1
Agriculture	30.7		-437.8	-288.6	-695.7
TERTIARY Total	4840.3		-6482.7	-760.4	-2402.8
Road transport	5824.5	-398.6	-3173.8	386.0	2638.1
Rail transport	311.4	35.8	-243.4	110.2	213.9
Aviation	5615.3		-479.4	0.0	5135.9
Inland navigation	47.7		1024.0	39.2	1111.0
Passenger Transport	8578.9	2079.4	-9259.1	448.0	1847.2
Freight Transport	1102.6	-257.9	6467.1	-60.2	7251.7
TRANSPORT Total	9681.5	1821.6	-2792.0	387.9	9098.9
TOTAL FINAL DEMAND	16811.6	1960.4	-15266.5	-4043.7	-538.2
POWER GENERATION	10679.5		2100.1	3750.6	16530.2
DISTRICT HEATING	-3988.4		302.3	-165.4	-3851.5
ENERGY BRANCH	757.5		0.0	754.8	1512.3
TOTAL	24260.2	1960.4	-12864.2	296.3	13652.7