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Greenhouse gas emissions in Europe: a retrospective trend analysis for the period 1990–2008

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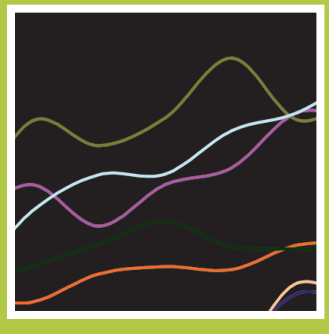

European Environment Agency

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Foreword: cross-sector linkages

The EEA's 'The European environment — State and outlook 2010 (SOER 2010)' report highlights that many of today's main environmental challenges are systemic in character and cannot be tackled effectively in isolation. This holds for linkages between environmental issues but also across environment and sector policy domains.

Furthermore, many links between environmental issues and socio-economic activities, go beyond linear cause-effect relationships. Often several activities combine to exacerbate environmental problems: this is well recognised, for example, in the context of greenhouse gas emissions, which stem from a wide range of sectoral activities. Where environmental pressures correspond to multiple, often interlinked sources and economic activities, the coherence between approaches to tackle related problems becomes increasingly important.

Frequently, multiple sources and economic activities interact to either enhance or counteract their respective environmental impacts — resulting in clusters of environmental pressures. Addressing such clusters (rather than merely addressing individual sources separately) can offer opportunities for more cost-effective responses. The potential co-benefits between climate mitigation and air quality improvements provide an example. Conversely, if not addressed coherently, the interaction within such clusters carries the risk that environmental action in one sector counteracts efforts made in another.

The need to integrate environmental concerns into sectoral activities and other policy domains has long been acknowledged — for example through the EU Cardiff integration process since 1998. As a result, many EU-level policies explicitly take into account environmental considerations to some degree; for example the Common Transport Policy and the Common Agricultural Policy (CAP). There are also specific reporting initiatives for several sectors, such as the Transport and Environment Reporting Mechanism (TERM). Such approaches, however, generally look at one sector only — and do not address cross-sectoral links.

If coherent policies across several sectoral and environmental domains are to be further developed the right analytical tools and approaches need to be available. This means more integrated analysis of environmental, economic and social impacts, trade-offs and costs as well as policy effectiveness. Integrated assessment tools, combining modelling and qualitative methods, new platforms for displaying analytical results to policy makers, and the use of environmental accounting techniques, for example, can help to bring this about. The EEA seeks to provide targeted analysis to support policy decisions at the interface between different policy areas and to further analytical approaches that look across several sectors and environmental issues.

Executive summary

This report presents a retrospective overview of the greenhouse gas (GHG) emission trends in Europe from 1990 to 2008, with a particular focus on the underpinning drivers and the influence of EU policies. The analysis is based on the combination of decomposition analyses to identify the respective influence of each identified driver and an overview of the main EU policies and their likely effects on these drivers. The period covered by the analysis stops in 2008. As a result, the analysis does not address the effects of the recent economic crisis on GHG emissions. This reinforces the conclusion on long-term emission drivers. The report covers the EU-27 and presents results for the other European Environment Agency (EEA) member countries (Iceland, Liechtenstein, Norway, Switzerland and Turkey) and Croatia (EU candidate country, together with Turkey) as far as data are available.

Overall GHG emission trends

EU GHG emissions were reduced between 1990 and 2008. Most of the reductions took place in the 1990s, but emissions have also been decreasing every year from 2003 until the last year considered in this report, 2008.

In 2008, GHG emissions in the EU-27 were 11.1 % below their 1990 level. Much of this reduction took place during the 1990s. After a steep increase between 1999 and 2003, the EU-27's emissions declined again from 2003, to reach 4 969 million tonnes (Mt) carbon dioxide (CO_2)-equivalent in 2008.

Between 1990 and 2008, the largest absolute emission reductions took place in Germany, the United Kingdom and most EU-12 Member States, while emissions increased most (in absolute terms) in southern EU-15 Member States (Greece, Spain, Italy and Portugal). Outside the EU, all the other EEA member countries except Switzerland experienced an increase in their total GHG emissions between 1990 and 2008, including a doubling of total emissions in Turkey.

Between 1990 and 2008, per gross domestic product (GDP) emissions decreased by 38 % in the EU-27 (GDP increased by 44 % while emissions decreased by 11 %), and by 34 % in the EU-15 (GDP increased by 43 % with a 6 % reduction in GHG emissions). GHG emissions per capita show significant differences across European countries, depending on national circumstances. Between 1990 and 2008, per capita emissions decreased by 16 % in the EU-27.

Predominant drivers

For the most part, the GHG emission trends observed in the EU between 1990 and 2008 resulted from economic factors. However, EU policies, some of which did not directly target GHG emissions, as well as national policies set up by some front-runner countries, also played a role in these trends.

GHG emissions in the EU during the period from 1990 to 2008 were significantly affected by economic or macroeconomic factors. Emission levels varied considerably in the 1990s under the influence of the political and economic process taking place in eastern Europe following the collapse of the Soviet Union. This led to the restructuring of the economies of these countries, including that of the reunified Germany. In the energy and industry sectors, a number of heavily polluting plants were closed and the structure of industry was subsequently modified. In the agriculture sector, decollectivisation resulted in a radical restructuring with very large decreases, for example, in the number of cattle. Across the energy, industry and agriculture sectors, the economic trends resulted in significant reductions in GHG emission levels. At the other end of the spectrum, the sustained economic development of southern European countries during the period from 1990 to 2008, accompanied by rising incomes, higher living standards and, consequently, higher energy demand, resulted in significant increases in emissions. For example, growing mobility of persons and increasing globalisation of trade led to an overall increase in transport emissions across the whole of Europe.

One should not assume that the predominant influence of economic factors shaping GHG emission trends between 1990 and 2008 detracts

from the important role played by policies. Although climate policies were not fully developed yet at EU level during the 1990s, they had started to be implemented in some EU Member States by means of national climate strategies or policies and measures such as energy or CO_2 taxation (e.g. in Denmark, Germany and Sweden). Other policies, including some not primarily designed to reduce GHG emissions, also played a role in reducing emissions during the period. Besides early energy efficiency policies, air pollution mitigation policies (such as Directive 88/609/EEC, the Large Combustion Plant (LCP) Directive) were particularly effective. Primarily aimed at limiting the pollution of large industrial installations, these policies targeted emissions of acidifying substances, ozone precursors and particles in the air. However, by placing emission limits on those pollutants, the policies resulted in efficiency improvements and provided further incentives to shift fuel sources, thereby indirectly reducing GHG emissions. Energy efficiency policies had a similar impact.

In the agriculture sector, the 1991 Nitrates Directive (Directive 91/676/EEC), which was initially aimed at limiting and reducing water pollution from agriculture practices, achieved significant reductions of nitrous oxide (N_2O) emissions from agricultural soils in the course of the 1990s by addressing the use of nitrogen-based fertilisers. The successive reforms of the CAP also had an influence on agricultural emissions.

Impacts of EU policies

Between 2000 and 2008, emission trends were more directly targeted by a range of energy and climate policies, e.g. the implementation of the European Climate Change programme. However, the steady increase in energy demand during this period — particularly electricity — outweighed the considerable EU-wide savings generated by energy efficiency improvements and the development of renewable energy.

Since 2000, the energy sector (both supply and use), which represents about 80 % of total GHG emissions, has seen a number of policy developments at EU level targeting reduction of emissions. The impact of these policies is difficult to distinguish from the overall impact of GHG emission trends. It can also be subject to varying interpretations due, for example, to the fact that EU policies cannot always be distinguished from the effects of policies implemented at national level.

Despite strong growth in the use of renewable energy sources (RES) for electricity generation between 2000 and 2008, particularly in the form of wind and biomass energy, promoted by Directive 2001/77/EC, the RES-E Directive, the share of renewable energy sources in total electricity generation in the EU has only slightly increased to between 16 % and 17 %. This relatively small market share is attributable to the parallel increase in thermal electricity generation that was necessary in order to absorb the steep rise in EU electricity demand. However in some EU Member States, the share of renewable energy increased strongly in absolute, as well as in relative, terms.

Likewise, the improvements in power generation efficiency were mostly offset by the negative consequences of increasing electricity demand. Despite a relative success in actually pushing a number of Member States to adopt energy taxation measures, the minimum taxation levels set at EU level were generally too low to induce a visible change in consumer behaviour with regard to energy demand over the years from 1990 to 2008.

In the freight transport sector, the constant growth in freight volume — at a rate faster than that of the GDP — has by and large outweighed the limited improvements in engine efficiency. Furthermore, the share of road transport in intra-EU and domestic transport increased compared with less carbon-intensive transport modes, from around 42 % in 1995 to 46 % in 2008. Policy initiatives were not sufficient to reverse this trend and only succeeded in keeping the share of railways in intra-EU freight transport roughly the same since 2001, at close to 11 %. In intra-EU passenger transport, railways also kept their market share of slightly more than 6 % that they had at the beginning of the decade.

Co-benefits

Taking example from the positive benefits on GHG emissions that resulted from the implementation of non-climate-related policies, systematically identifying, analysing and monitoring the impacts of measures in other policy areas would contribute towards better policy integration and coherence across different sectors.

The climate mitigation co-benefits obtained from the implementation of policies such as the LCP Directive, the Integrated Pollution Prevention and Control (IPPC) Directive (Directive 96/61/EC), the Nitrates Directive, the CAP reforms or even the Landfill Directive (Directive 1999/31/EC) constitute important examples of how co-benefits can be harvested across different sectors through the implementation of integrated policies. Whether

these co-benefits from non-climate-related policies were intended or not is not really relevant. More important for today's policymaker is the question of how such co-benefits — or any cross-cutting impact or side effect, positive or negative — might be identified, analysed and monitored in a systematic manner in order to maximise the benefits of new policies. In the end, further integration of policies across sectors will be crucial in achieving further emission reductions.

The following paragraphs provide more detailed results of the analyses carried out by sector in the report for the periods from 1990 to 2000 and from 2000 to 2008.

Transport

The **transport sector** (Chapter 4) experienced by far the largest increase in EU-27 GHG emissions between 1990 and 2008 (+ 24 % excluding international aviation and navigation, + 34 % when included). This is largely due to increasing mobility of persons and products in the context of globalised trade. A total of 94 % of the transport emissions are attributable to road transport. Road transport emissions fell by almost 2 % in 2008 as a result of very high international oil prices alongside the economic recession and increased fuel efficiency of vehicles. Passenger cars account for 60 % of road transport's final energy demand, while freight transport accounts for 36 %. Between 1990 and 2008, both **passenger** and **freight transport** demand increased due to economic growth and rising income levels. While the pace of the increase significantly slowed down for passenger transport during the period from 2000 to 2008, freight transport showed no sign of such slowing down — except in 2008, as a consequence of the economic recession. Recent trends show that international oil prices and the global economic situation exert the largest influence on the demand for transport.

CO_2 emissions from **passenger cars increased** steadily in the period from 1990 to 2000 owing to a sustained growth in transport demand and an increasing share of road transport compared with other modes. Between 2000 and 2008, the growth in transport demand — in particular road transport — was significantly reduced, and its effects on CO_2 emissions were further offset by fuel efficiency improvements due to the combined effects of technological improvements, dieselisation and, more recently, biofuel blending. Part of this trend can be attributed to the effects of voluntary commitments by car manufacturers, obligatory labelling of new passenger cars (Directive 1999/94/EC) and promotion of the use of biofuels. However, the voluntary commitments of car manufacturers and the Biofuels Directive (Directive 2003/30/EC) have fallen short of their initial objectives in terms of fuel efficiency and biofuel share in transport fuels, respectively.

Large increases in CO_2 emissions from **road freight transport** were observed in the period from 1990 to 2008, despite technical improvements in the fuel efficiency of truck engines. This was largely owing to the increasing prevalence of road over less carbon-intensive modes such as rail. Emissions continued growing faster than GDP during the period from 2000 to 2008. The various policy initiatives promoting alternative, generally less carbon-intensive transport modes, such as the first and second Marco Polo Programmes (Regulations (EC) No 1382/2003 and No 1692/2006) and the first and second Railway Packages (including Directives 2001/14/EC, 2001/16/EC, 2004/49/EC and Directive 2004/50/EC), were not sufficient to reduce the share of road in total freight transport and achieve the necessary decoupling of emissions from increased activity levels.

Agriculture

EU-27 GHG emissions from **agriculture** (Chapter 5) accounted for 10 % of total GHG emissions in 2008. Between 1990 and 2008, they decreased by 20 %. Cattle husbandry and the application of fertiliser to soils are the most important sources of GHG emissions from agriculture. Emissions from both sources decreased between 1990 and 2008. GHG emission drivers were primarily affected by macroeconomic factors such as intensification of the sector, which led to important GHG emission reductions. However, it is worth highlighting the role played by policies that were not specifically designed to reduce GHG emissions such as the CAP and the Nitrates Directive, in further reducing emissions in this sector.

Between 1990 and 2008, methane (CH_4) emissions from **cattle** decreased continually due to a declining number of cattle. In the early 1990s, this was largely a consequence of the restructuring and modernisation of the agriculture sector in eastern Europe, but the trend has since continued. Several aspects of the CAP, and its successive reforms, have indirectly affected GHG emissions from cattle: the combination of overproduction control through milk quotas (initiated in 1984), the successive reductions of intervention prices (in 1992 and 2000) and the introduction of the Single Farm Payment (SFP) (under the 2003 CAP reform). These limited

the economic attractiveness of cattle production in Europe, incentivised higher milk yield (to sustain production levels with less cattle) and therefore contributed to limiting or even decreasing cattle numbers, thereby limiting GHG emissions from this sector.

Between 1990 and 2008, N_2O emissions from **agricultural soils** were significantly reduced due to the lesser use of fertiliser per cropland, combined with a decreasing cropland area. Various national and EU policies aimed at reducing the amount of synthetic fertilisers applied to agricultural soils contributed to this decrease, in particular the Nitrates Directive. Its impact was the largest in the reduction of synthetic fertiliser application, but it also contributed to reducing input of organic fertilisers. The set-aside rules introduced in 1992 led to a significant but varying share of arable land being set aside, which is likely to have reduced GHG emissions associated with arable production. However, assessing the impact of the set-aside rule on GHG emissions is difficult, given the importance of other socio-economic factors for cropping decisions, in particular links between input and output costs. The SFP combined with rural development measures, in particular agri-environment schemes, also provided incentives to limit overproduction of arable crops and other agricultural commodities, leading, in turn, to reduced GHG emissions from agricultural soils. Cross-compliance requirements, progressively introduced since 2000, contributed to better management of organic and mineral fertilisers.

Waste

EU-27 GHG emissions from **waste** (Chapter 6) experienced the largest decrease in relative terms (– 30 %) among the main GHG-emitting sectors between 1990 and 2008. They accounted for 3 % of total GHG emissions in 2008 (this does not include emissions from waste incineration with energy recovery, which are reported under the energy sector). A total of 75 % of GHG emissions from waste (mainly CH_4) arise during solid waste disposal on land. These emissions decreased by 35 % between 1990 and 2008. Intensified separate collection, recycling and pretreatment of waste as well as landfill gas recovery were the major reasons for the strong decline. The Landfill Directive has exerted an important influence on these GHG drivers. The recovery of CH_4 from landfills played the most important role in reducing emissions from solid waste management between 1990 and 2008. The existence of national policies at Member State level contributed to important emission reductions prior to adoption of the Landfill Directive. The directive has furthered this trend since its entry into force in 1999.

Energy industry

EU-27 GHG emissions from the **energy supply sector** (Chapter 7) accounted for 33 % of the total GHG emissions in 2008 and decreased by 12 % from 1990 to 2008. Within this sector, the **production of public electricity and heat**, the single greatest source of CO_2 emissions in 2008, contributed 27 % of the total GHG emissions in the EU-27. CO_2 emissions from public electricity and heat production decreased by 9 % between 1990 and 2008. This overall reduction was achieved despite an increased demand for electricity in the EU during the whole period. The reduction was driven mostly by the closure of inefficient coal-fired power plants in the early 1990s (following the restructuring of eastern Europe economies), a fuel shift from coal and oil to gas and biomass, and an increased share of combined heat and power (CHP) for heat production. Despite this overall reduction, between 2000 and 2008, CO_2 emissions from the sector increased slightly, by 2 %. In the EU-15, the implementation of air pollution control measures for large combustion plants (the LCP Directive, later reinforced by the IPPC Directive) produced important co-benefits for GHG emissions, by encouraging efficiency improvements and fuel switching to cleaner fuels. These positive developments took place despite the fact that such policies were not specifically designed to reduce GHG emissions. Their effects added to those of energy policies specifically promoting energy efficiency.

More recently, setting a price signal for carbon emissions through the EU Emissions Trading System (EU ETS) within the EU-27 has now established a foundation for the implementation of further efficiency improvements and fuel switching, under the condition of meaningful carbon prices. The development of renewable energy sources to produce electricity led to important visible emission reductions, in particular during the 1990s (because the share of renewables in electricity production actually increased, as opposed to the overall trend in the period from 2000 to 2008 — despite a strong development in renewable production in absolute terms).

Between 2000 and 2008, the increase in electricity demand was mostly satisfied through increased production from gas-fired thermal power plants. This reduced the effects on total emissions of the relative growth of renewables, in particular

biomass and wind, reduced the share of nuclear power in total electricity generation, and led to the observed increase in emissions. However, in certain EU Member States, GHG emissions from this sector have decreased since 2000, mainly as a result of an increased use of RES. Despite the relative success of policies aiming to improve energy efficiency at consumer level, and thereby reduce the overall energy demand (e.g. the Energy Labelling Directive (Directive 92/75/EEC) and its subsidiary directives, the Energy Performance of Buildings Directive (Directive 2002/91/EC) and the Energy Services Directive (Directive 2006/32/EC)), their effects are masked by increased electricity demand.

Energy use from manufacturing and construction industry

Energy use — and thus also CO_2 emissions — from the EU **manufacturing and construction industry sector** fell between 1990 and 2008, while the gross value added (GVA) of products and services increased significantly. Most of the 25 % reduction in CO_2 emissions from this sector was achieved between 1990 and 2000, mainly due to energy efficiency improvements and further developments within industry. Part of these improvements actually reflected the closure of energy-intensive industries in eastern Europe in the early 1990s. Fuel shifting from coal to gas also delivered significant emission reductions. Since 2000, the rising share of biomass and the increased reliance on power generated from public electricity power plants (for which GHG emissions are reported under the sector 'Energy supply') have also contributed to reducing direct CO_2 emissions from the manufacturing industries sector. As was noted for the public electricity and heat plants, the LCP Directive and, to a lesser extent, the IPPC Directive resulted indirectly in GHG emission reductions by driving efficiency improvements and further incentivising fuel switching, in addition to energy policies specifically promoting energy efficiency. The EU ETS is also estimated to have driven some efficiency improvements in this sector.

Energy use from households

Between 1990 and 2008, CO_2 emissions from **households** in the EU-27 decreased by 11 %. The main reasons for this reduction were a fuel shift for domestic heating from coal and oil to gas in the 1990s, coupled with reduced energy demand in households due to efficiency improvements and improvements in household insulation between 2000 and 2008. Several EU directives contributed to reducing energy use in the households sector. As is the case with electricity production, the minimum levels of energy taxation set at EU level in the period considered did not represent a significant enough share of energy prices (in most Member States) to drive consumption levels down. Switching from fossil fuels to public electricity as an energy source, both for industrial users and for households, results in a transfer of the emissions linked to electricity or heat use from these sectors to the energy supply sector. Since 2005, this shift has also resulted in the transfer of emissions into a sector covered by the EU ETS. On the other hand, the reduction of electricity demand by households — or any other electricity end user not producing their own electricity — due, for example, to the implementation of energy efficiency measures, may have impacted the demand for allowances in the EU ETS. This provides an example of the importance of monitoring the impacts of measures across sectors.

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