THE EUROPEAN ENVIRONMENT
STATE AND OUTLOOK 2015

4. RESOURCE EFFICIENCY AND THE LOW-CARBON ECONOMY

European Environment Agency

Cover design: EEA
Cover photo: © EEA
Layout: EEA

Electronic publication notice

This report has been generated automagically by the EEA Web content management system on 12 Mar 2015, 01:59 PM.

This report is available as a website at http://www.eea.europa.eu/soer-2015/synthesis/report/4-resourceefficiency.

Go online to get more interactive facts and figures.

On the report web page you may download the electronic publication (EPUB) for easy reading on your preferred eBook reader.

Please consider the environment before printing.

The EEA's report SOER 2015 gives a comprehensive assessment of the European environment's state, trends and prospects, in a global context. The EEA's task is to provide timely, targeted, relevant and reliable information on Europe's environment.

For **more information**, see **www.eea.europa.eu/soer** or scan the QR code.

PDF generated on 12 Mar 2015, 01:59 PM

European Environment Agency
Kongens Nytorv 6
1050 Copenhagen K
Denmark
Tel.: + 45 33 36 71 00
Fax: + 45 33 36 71 99
Web: eea.europa.eu
Enquiries: eea.europa.eu/enquiries

Contents

4. Resource efficiency and the low-carbon economy

4.1 Increased resource efficiency is essential for continued socio-economic progress

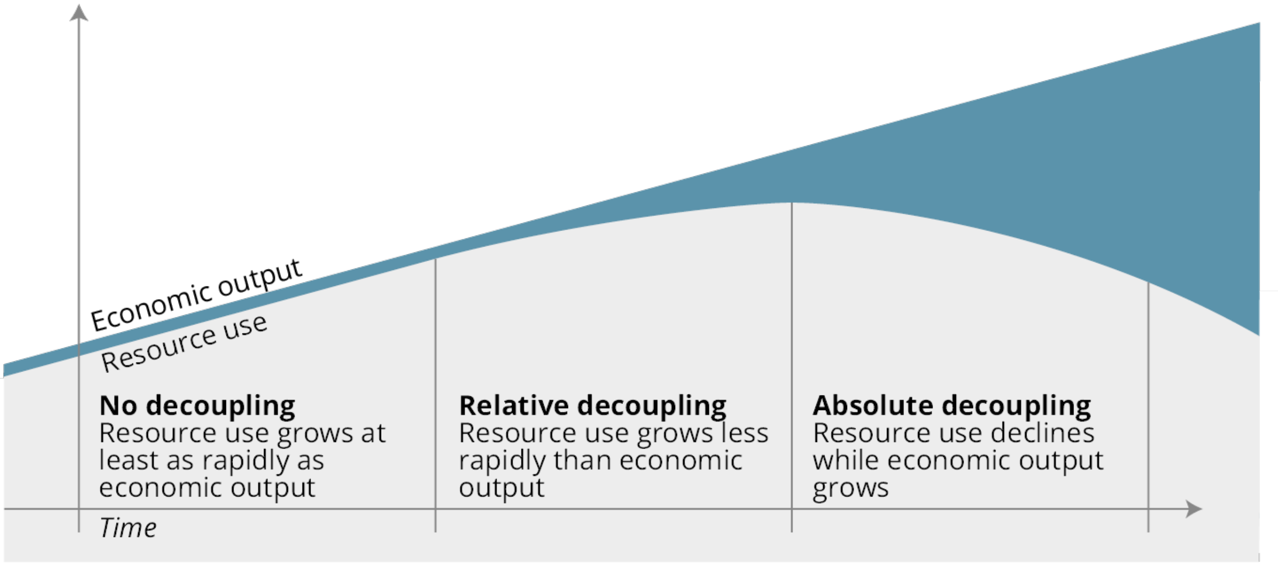
The emergence of resource efficiency and the low-carbon economy as European policy priorities is grounded in a recognition that the prevailing model of economic development — based on steadily growing resource use and harmful emissions — cannot be sustained in the long term. Already today, Europe's systems of production and consumption look vulnerable. The continent's ecological footprint (i.e. the area needed to meet Europe's resource demand) is twice the size of its land area (WWF, 2014), and the EU is heavily and increasingly reliant on imports to meet its resource needs (Eurostat, 2014d).

At the most basic level, resource efficiency captures the notion of 'doing more with less'. It expresses the relationship of society's demands on nature (in terms of resource extraction, pollutant emissions and ecosystem pressures more broadly) to the returns generated (such as economic output or improved living standards). The transition to a low-carbon economy is one particularly important aspect of the broader goal of reducing the environmental burden of society's resource use.

Increasing resource efficiency is essential to sustain socio-economic progress in a world of finite resources and ecosystem capacity, but it is not sufficient. After all, increasing efficiency is only an indication that output is growing more than resource use and emissions. It does not guarantee a reduction in environmental pressures in absolute terms.

In assessing the sustainability of European systems of production and consumption, it is therefore necessary to move beyond measuring whether production is increasing faster than resource use and related pressures ('relative decoupling'). Rather, there is a need to assess whether there is evidence of 'absolute decoupling', with production increasing while resource use declines (Figure 4.1). In addition to assessing the relationship of resource use to economic output, it is also important to evaluate whether the environmental impacts resulting from society's resource use are decreasing ('impact decoupling').

Figure 4.1 Relative and absolute decoupling



Source: EEA.

Box 4.1 Structure of Chapter 4

While the notion of 'doing more with less' is conceptually very simple, quantifying resource efficiency is often more complex in practice. First, resources differ greatly. Some are non-renewable, some renewable; some are depletable, some are not; some are hugely abundant, some extremely scarce. As a result, aggregating different resource types is often misleading and sometimes impossible.

Equally, the benefits that society derives from resources also vary greatly. In some instances it makes sense to evaluate resource efficiency by comparing resource inputs to economic outputs (for example GDP). In other cases, assessing whether society is using resources in ways that deliver the most benefits requires a broader approach, encompassing non-market factors such as the cultural values associated with landscapes.

Assessing resource efficiency trends therefore requires a range of different perspectives. Sections 4.3–4.10 of this chapter attempt to do this by addressing three different questions:

- Are we decoupling resource use, and outputs of waste and emissions from aggregate economic growth? This is addressed in Sections 4.3–4.5, which focus on material resources, carbon emissions, and waste prevention and management.
- Are we reducing the environmental pressures associated with particular sectors and consumption categories? This is addressed in Sections 4.6–4.8, which focus on energy, transport and industry. Agricultural trends and related environmental impacts are described in some detail in Chapter 3.
- Are we maximising the benefits that we derive from non-depletable but finite resources such as water and land? This is addressed in Sections 4.9 and 4.10.

4.2 Resource efficiency and greenhouse gas emission reductions are strategic policy priorities

In recent years, resource efficiency and the low-carbon society have emerged as central themes in global discussions on the transition to a green economy (OECD, 2014; UNEP, 2014b). The fundamental importance of these issues to future prosperity is likewise reflected in Europe's medium- and long-term planning. For example, priority objective 2 of the 7th Environment Action Programme (EU, 2013) identifies the need to 'turn the Union into a resource-efficient, green, and competitive low-carbon economy'.

At the strategic level, EU policy sets out a broad framework for resource efficiency and climate change policy, including a variety of long-term (non-binding) objectives. For example, the Roadmap to a Resource Efficient Europe (EC, 2011c) includes a vision for 2050, wherein 'the EU's economy has grown in a way that respects resource constraints and planetary boundaries, thus contributing to global economic transformation … all resources are sustainably managed, from raw materials to energy, water, air, land and soil'[(5)]. Similarly, the Roadmap to a low-carbon economy (EC, 2011a) stipulates that, by 2050, the EU should cut its emissions to 80% below 1990 levels through domestic reductions.

These are complemented by policies addressing specific pressures and sectors. The EU's 2020 targets on greenhouse gas emissions and energy consumption (EC, 2010) are prominent examples. Others include the Regulation on Registration, Evaluation, Authorisation and restriction of Chemicals (REACH) (EU, 2006), the Industrial Emissions Directive (EU, 2010a) and the European Commission's White Paper on Transport (EC, 2011e).

Another important cluster of policies aims to facilitate a shift away from the linear 'take-make-consume-dispose' pattern of growth, towards a circular model that extracts maximum value from resources by keeping them within the economy when a product has reached the end of its life. As noted in the European Commission's communication, Towards a circular economy: a zero-waste programme for Europe (EC, 2014d), the transition to a circular economy requires changes across supply chains, including in product design, business models, consumption choices, and prevention and management of waste.

Table 4.1 Examples of EU policies relating to Objective 2 of the 7th Environment Action Programme

Topic	Overarching strategies	Related directives
General	Resource-efficient Europe flagship initiative under the Europe 2020 Strategy Roadmap to a Resource Efficient Europe Roadmap for moving to a competitive low-carbon Europe	
Waste	Thematic Strategy on the prevention and recycling of waste	Waste Framework Directive Landfill Directive Waste Incineration Directive
Energy	Green Paper on a 2030 framework for climate and energy	Energy Efficiency Directive Renewables Directive
Transport	Roadmap to a single European transport area	Fuel Quality Directive Emissions Standards Directives
Water	Blueprint to Safeguard Europe's Water Resources	Water Framework Directive

Design and innovation	Eco-innovation Action Plan	Ecodesign and Energy Label Directives and the Ecolabel Regulation

Note: For more detailed information on specific policies, see the respective SOER 2015 thematic briefings.

4.3 Despite more efficient material use, European consumption remains very resource intensive

Trends and outlook: Material resource efficiency and use	
	5–10 year trends: There has been some absolute decoupling of resource use from economic output since 2000, although the economic recession contributed to this trend.
	20+ year outlook: European economic systems remain resource intensive, and a return to economic growth could reverse recent improvements.
No target	*Progress to policy targets:* The targets in this area are currently qualitative in character.
!	*See also:* SOER 2015 thematic briefings on resource efficiency; and consumption.

Faced with growing global competition for resources, European policies have put increasing focus on 'dematerialising' economic output, i.e. reducing the quantity of resources used by the economy. For example, the Roadmap to a Resource Efficient Europe (EC, 2011c) emphasises the risks associated with rising resource prices and the burdens on ecosystems that result from escalating demand for resources.

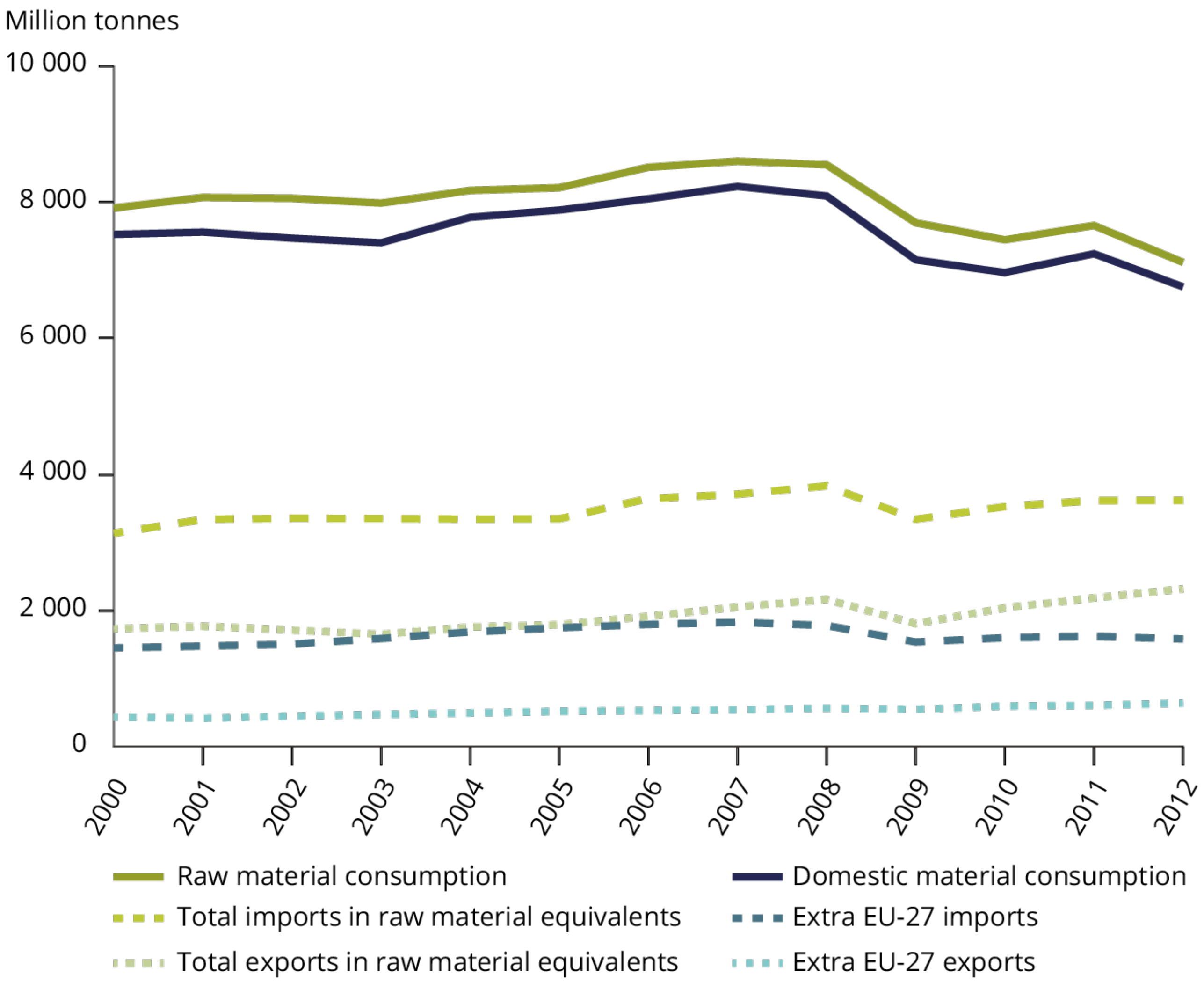
The EU's Resource Efficiency Scoreboard (Eurostat, 2014h), which is being developed pursuant to the Roadmap to a Resource Efficient Europe, presents a mixture of perspectives on resource efficiency trends. It establishes 'resource productivity' — the ratio of economic output (GDP) to domestic material consumption (DMC) — as its lead indicator. Domestic material consumption estimates the amount of raw materials (measured by mass) directly used by an economy, including both materials extracted from domestic territory and net inflows of goods and resources from abroad.

As the European Commission has noted (EC, 2014j), the indicator 'GDP/DMC' has some shortcomings. It clusters diverse resources by weight, obscuring huge differences in scarcity, value and associated environmental impacts. It also provides a distorted picture of resource demands from overseas, because it includes only net imports of resources, rather than encompassing the raw materials consumed in producing imports.

Recognising these limitations, Eurostat has developed EU-27 estimates of raw material consumption (RMC), which is sometimes described as the 'material footprint'. RMC provides a more complete picture of the resource use associated with European consumption by converting imports and exports into 'raw material equivalents', which estimate the raw materials used in producing traded goods. As illustrated in Figure 4.2, this conversion leads to a substantial increase in the resource use associated with EU external trade, although the overall impact on total EU resource consumption is fairly small.

Despite their limitations, DMC and RMC can provide a useful indication of the physical scale of the economy. As illustrated in Figure 4.2, EU resource consumption declined in the period 2000–2012, although the financial crisis of 2008 and subsequent economic recessions in Europe clearly contributed to this trend.

Figure 4.2 EU-27 domestic material consumption and raw material consumption, 2000–2012



Note: Raw material consumption data are only available for the EU-27. For comparability, the domestic material consumption data cover the same countries.

Source: Eurostat,2014d, 2014e.

In contrast to the decline in material consumption, EU-28 GDP grew by 16% between 2000 and 2012. As a result, EU-28 resource productivity (GDP/DMC) increased by 29%, from 1.34 EUR/kg of resources used in 2000 to 1.73 EUR/kg in 2012. Despite recent improvements in resource productivity, European consumption patterns remain resource intensive by global standards.

In addition, other estimates of European resource use present a less optimistic picture of efficiency improvements. For example, Wiedmann et al. (2013) calculate that the EU-27 material footprint increased in line with GDP in the period 2000–2008. This raises questions about the resource intensity of European lifestyles. Apparent efficiency improvements may partially be explained by the relocation of material extraction and manufacturing to other areas of the world.

4.4 Waste management is improving but Europe remains far from a circular economy

Trends and outlook: Waste management	
	5–10 year trends: Less waste is being landfilled due to reduced generation of some wastes, increased recycling and greater use of waste for energy recovery.
	20+ year outlook: Total waste generation is still high, although implementation of waste prevention programmes could alleviate this.
□	*Progress to policy targets:* Past successes with some waste streams, but only mixed progress across countries towards meeting recycling and landfill targets.
!	*See also:* SOER 2015 thematic briefings on resource efficiency; and consumption.

The notion of the 'circular economy where nothing is wasted' (EU, 2013) is central to efforts to boost resource efficiency. Waste prevention, reuse and recycling enable society to extract maximum value from resources, and adapt consumption to actual needs. In doing so, they reduce demand for virgin resources, thereby mitigating related energy use and environmental impacts.

Improving waste prevention and management requires action across the full product lifecycle, not merely the end-of-life phase. Factors such as design and choice of material inputs play a major role in determining a product's useful lifespan and the possibilities for repair, reusing parts, or recycling.

The EU has introduced multiple waste policies and targets since the 1990s, ranging from measures targeting specific waste streams and treatment options, towards broader instruments such as the Waste Framework Directive (EU, 2008b). These measures are complemented by product legislation such as the Ecodesign Directive (EU, 2009c) and the Ecolabel Regulation (EU, 2010b), which aim to influence both production and consumption choices.

As set out in the Waste Framework Directive, the overarching logic guiding EU policy on waste is the waste hierarchy, which prioritises waste prevention, followed by preparation for reuse; recycling; recovery; and finally disposal as the least desirable option. Viewed against this framework, European trends in waste generation and management are largely positive. Although data gaps and differences in national methodologies for calculating waste introduce uncertainties into data, there is some evidence that waste generation has declined. EU-28 per capita waste generation (excluding mineral wastes) declined by 7% in the period 2004–2012, from 1 943 kg/person to 1 817 kg/person (Eurostat, 2014c).

Available data indicate some decoupling of waste generation from economic production in the manufacturing and service sectors, and from household spending in the consumption phase. Per capita generation of municipal waste declined by 4% between 2004 and 2012, falling to 481 kg per capita.

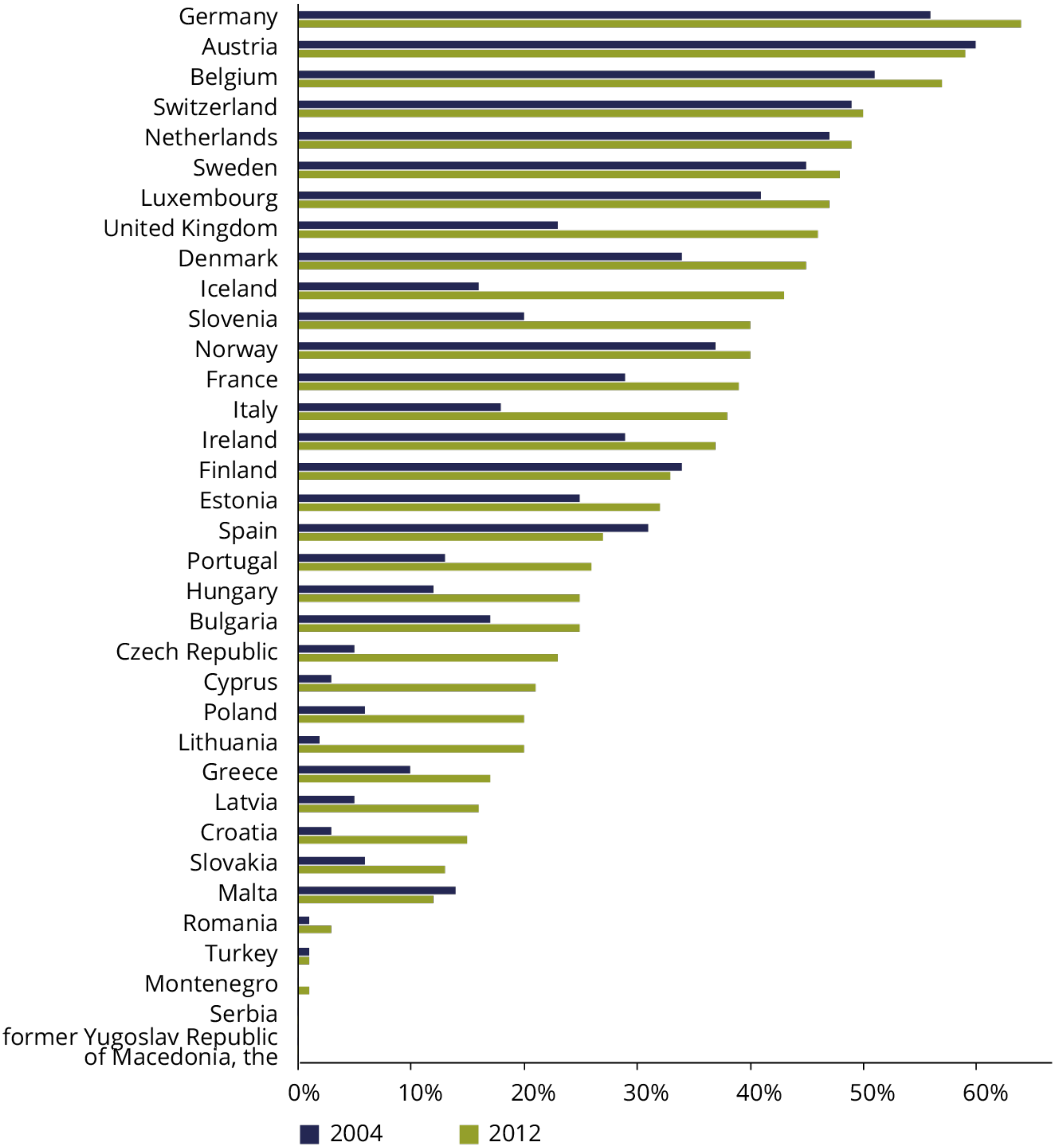
Looking beyond waste generation, there are also signs of improved waste management in Europe. Between 2004 and 2010, the EU-28, Iceland and Norway reduced the amount of waste deposited in landfills substantially, from 31% of total waste generated (excluding mineral, combustion, animal and vegetable wastes) to 22%. This was partly due to an improvement in recycling rates of municipal waste, from 28% in 2004 to 36% in 2012.

Better waste management has reduced pressures associated with waste disposal, such as pollution from incineration or landfilling. But it has also mitigated pressures associated with extracting and processing new resources. The EEA estimates that improved municipal waste management in the EU-27, Switzerland and Norway cut annual net greenhouse gas emissions by 57 million tonnes of CO_2-equivalent in the period 1990–2012, with most of that reduction achieved since 2000. The two main factors responsible for this were reduced methane emissions from landfill and avoided emissions through recycling.

Recycled materials meet a substantial proportion of EU demand for some materials. For example, they accounted for about 56% of EU-27 steel production in recent years (BIR, 2013). However, the large differences in recycling rates across Europe (illustrated for municipal waste in Figure 4.3) indicate that there are significant opportunities for increased recycling in many countries. Better recycling technologies, infrastructure, and collection rates could further reduce environmental pressures and European reliance on resource imports, including some critical materials (EEA, 2011a). On the other hand, overcapacity in incineration plants in some countries presents a competitive challenge for recycling, making it harder to shift waste management up the waste hierarchy (ETC/SCP, 2014).

Despite recent progress in waste prevention and management, EU waste generation remains substantial, and performance relative to policy targets is mixed. The EU appears to be progressing towards its 2020 objective of achieving a decline in waste generated per capita. But waste management will need to change radically in order to phase out completely the landfilling of recyclable or recoverable waste. Similarly, many EU Member States will need to make an extraordinary effort in order to achieve the target of 50% recycling of some municipal waste streams by 2020 (EEA, 2013l, 2013m).

Figure 4.3 Municipal waste recycling rates in European countries, 2004 and 2012



Note: The recycling rate is calculated as the percentage of municipal waste generated that is recycled and composted. Changes in reporting methodology means that 2012 data are not fully comparable with 2004 data for Austria, Cyprus, Malta, Slovakia and Spain. 2005 data used instead of 2004 for Poland due to changes in methodology. Due to data availability instead of 2004 data, 2003 data were used for Iceland; 2007 data used for Croatia; 2006 data used for Serbia. For the former Yugoslav Republic of Macedonia, 2008 data were used for 2004, and 2011 used for 2012.

Source: Eurostat Data Centre on Waste.

4.5 The transition to a low-carbon society requires greater greenhouse gas emission cuts

Trends and outlook: Greenhouse gas emissions and climate change mitigation	
	5–10 year trends: The EU has cut greenhouse gas emissions to 19.2% below 1990 levels while increasing GDP by 45%, halving 'emission intensity'.
	20+ year outlook: The projected reductions of EU greenhouse gas emissions as result of implemented policies are insufficient to bring the EU on a pathway towards the 2050 decarbonisation target.
☑/☒	*Progress to policy targets:* The EU is on track to 'over-deliver' on its international and domestic 2020 targets, but is not on track towards its 2030 and 2050 targets.
!	*See also:* SOER 2015 thematic briefing on mitigating climate change.

In order to avoid 'dangerous interference with the climate system', the international community has agreed to limit the global mean temperature increase since pre-industrial times to less than 2 °C (UNFCCC, 2011). In line with the Intergovernmental Panel on Climate Change assessment of the actions needed by developed countries to achieve the 2 °C target, the EU aims to cut its greenhouse gas emissions by 80–95% below 1990 levels by 2050 (EC, 2011a).

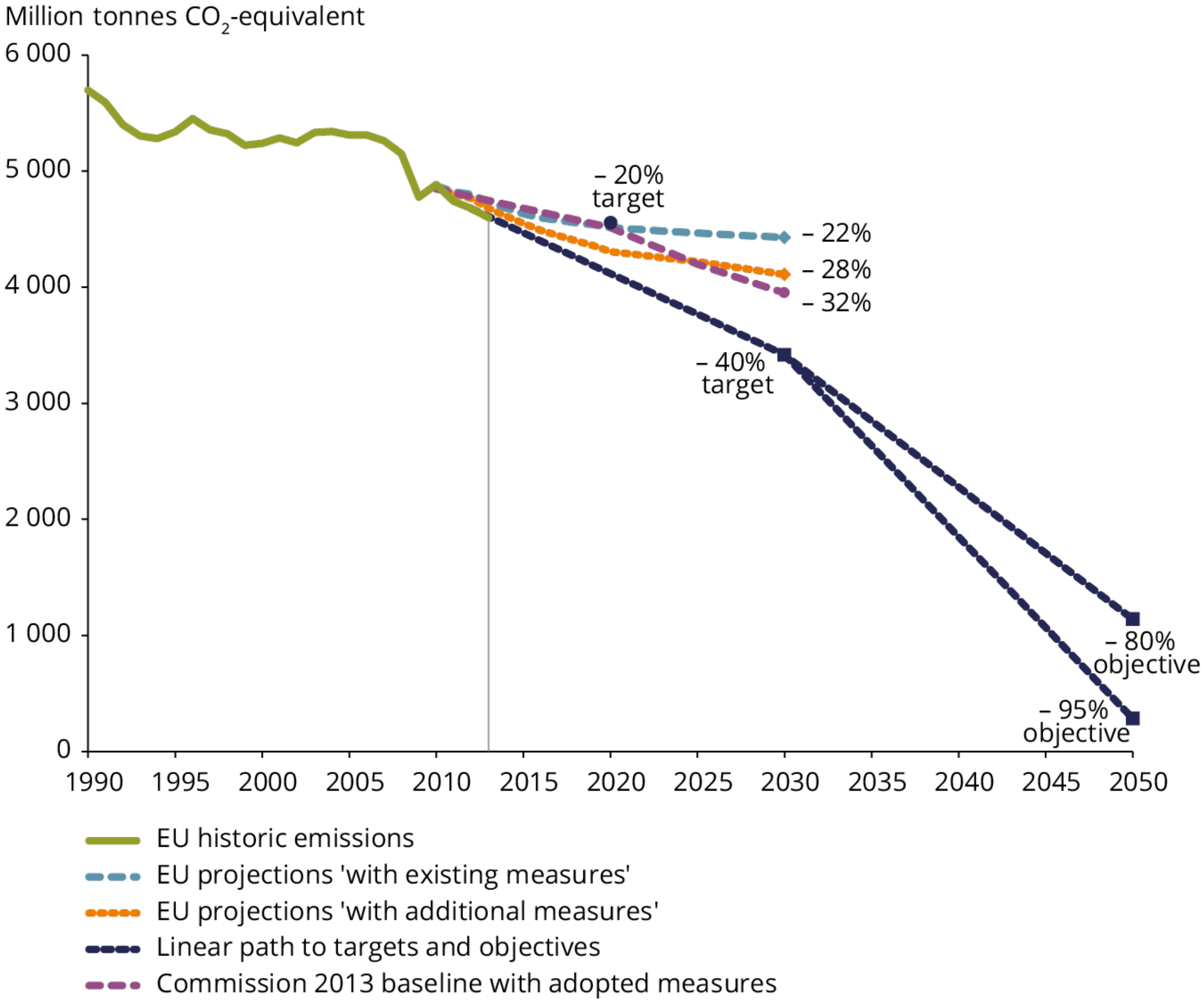
Pursuant to this overarching goal, European countries have adopted a number of policy measures, including international commitments under the Kyoto Protocol. For 2020, the EU has unilaterally committed to cut its emissions by at least 20% compared to 1990 levels (EC, 2010).

In the last two decades, the EU has made significant advances in decoupling carbon emissions from economic growth. EU-28 greenhouse gas emissions declined by 19% in the period 1990–2012, despite a 6% increase in population and a 45% expansion of economic output. As a result, greenhouse gas emissions per euro of GDP fell by 44% over this period. EU per capita emissions declined from 11.8 tonnes of CO_2-equivalent in 1990 to 9.0 tonnes in 2012 (EEA, 2014h; EC, 2014a; Eurostat, 2014g).

Both macroeconomic trends and policy initiatives have contributed to these emission reductions. Economic restructuring in eastern Europe during the 1990s played a role, particularly via changing agricultural practices and the closure of heavily polluting plants in the energy and industrial sectors.

More recently, the financial crisis and subsequent economic problems in Europe certainly contributed to a sharp decline in emissions (Figure 4.4), although EEA analysis indicates that economic contraction accounted for less than half of the decline in emissions between 2008 and 2012 (EEA, 2014x). In the period 1990–2012, climate and energy policies had a significant impact on greenhouse gas emissions, boosting energy efficiency and the share of renewables in the energy mix of European countries.

Figure 4.4 Greenhouse gas emission trends (1990–2012), projections to 2030 and targets to 2050



Source: EEA, 2014w.

The EU's success in mitigating carbon emissions is reflected in robust progress towards its policy targets in this area. EU-15 total average emissions in the period 2008–2012 were 12% below base-year levels[(6)], implying that the EU-15 comfortably achieved its 8% reduction target under the Kyoto Protocol's first commitment period. The EU-28 is already very close to meeting its unilateral 20% reduction target for 2020, and looks well set to achieve its commitment to reduce average emissions to 20% below base-year levels in the Kyoto Protocol's second commitment period (2013–2020).

These achievements notwithstanding, the EU remains far from the 80–95% reduction needed by 2050. According to Member State projections, existing policy measures would only reduce EU-28 emissions by one percentage point between 2020 and 2030, to 22% below 1990 levels, and implementing the additional measures currently planned would increase this reduction to 28%. The European Commission estimates that full implementation of the Climate and Energy Package for 2020 would reduce emissions in 2030 to 32% below 1990 levels (Figure 4.4).

These projections imply existing measures will be insufficient to achieve the 40% reduction by 2030, which has been proposed by the European Commission as the minimum needed to remain on course for the 2050 target (EC, 2014c).

Estimates of the emissions associated with European consumption (including greenhouse gas emissions 'embedded' in net trade flows) indicate that European demand also drives emissions in other parts of the world. Estimates based on the World Input-Output Database indicate that in 2009 the CO_2 emissions associated with EU-27 consumption equalled 4 407 million tonnes, which was 2% higher than in 1995 (EEA, 2013g). In comparison, the UNFCCC production-based estimate of 4 139 million tonnes in 2009, was 9% lower than in 1995. For more information on Europe's contribution to global emissions see Section 2.3.

These data indicate that, in order to meet its 2050 objectives and contribute fully to meeting the global 2 °C target, the EU will need to accelerate its implementation of new policies, while restructuring the ways that Europe meets its demand for energy, food, transport and housing.

4.6 Reducing fossil fuel dependence would cut harmful emissions and boost energy security

Trends and outlook: Energy consumption and fossil fuel use	
	5–10 year trends: Renewable energy has increased substantially in the EU and energy efficiency has also improved.
	20+ year outlook: Fossil fuels continue to dominate EU energy production. Transforming the energy system into an environmentally compatible one requires substantial investments.
☑	*Progress to policy:* The EU is on track to meet its 20% renewable energy target in 2020 and its 20% energy efficiency target in 2020.
!	*See also:* SOER 2015 thematic briefings on energy; and mitigating climate change.

Although fundamental to modern lifestyles and living standards, energy production is also responsible for considerable harm to the environment and human well-being. As in other world regions, fossil fuels dominate the European energy system, accounting for more than three-quarters of EEA-33 energy consumption in 2011 and almost 80% of greenhouse gas emissions (EEA, 2013i).

Cutting Europe's reliance on fossil fuels — by reducing energy consumption and switching to alternative energy sources — is essential to achieve the EU's 2050 climate policy goals. It would also deliver substantial additional economic, environmental and social benefits. Fossil fuels are responsible for most emissions of pollutants such as sulphur oxides (SO_X), nitrogen oxides (NO_X) and particulate matter. In addition, Europe's growing reliance on fossil fuel imports makes it vulnerable to supply constraints and price volatility, particularly in view of the escalating energy demand of fast-growing economies in south and east Asia. In 2011, 56% of all fossil fuels consumed in the EU were imported, compared to 45% in 1990.

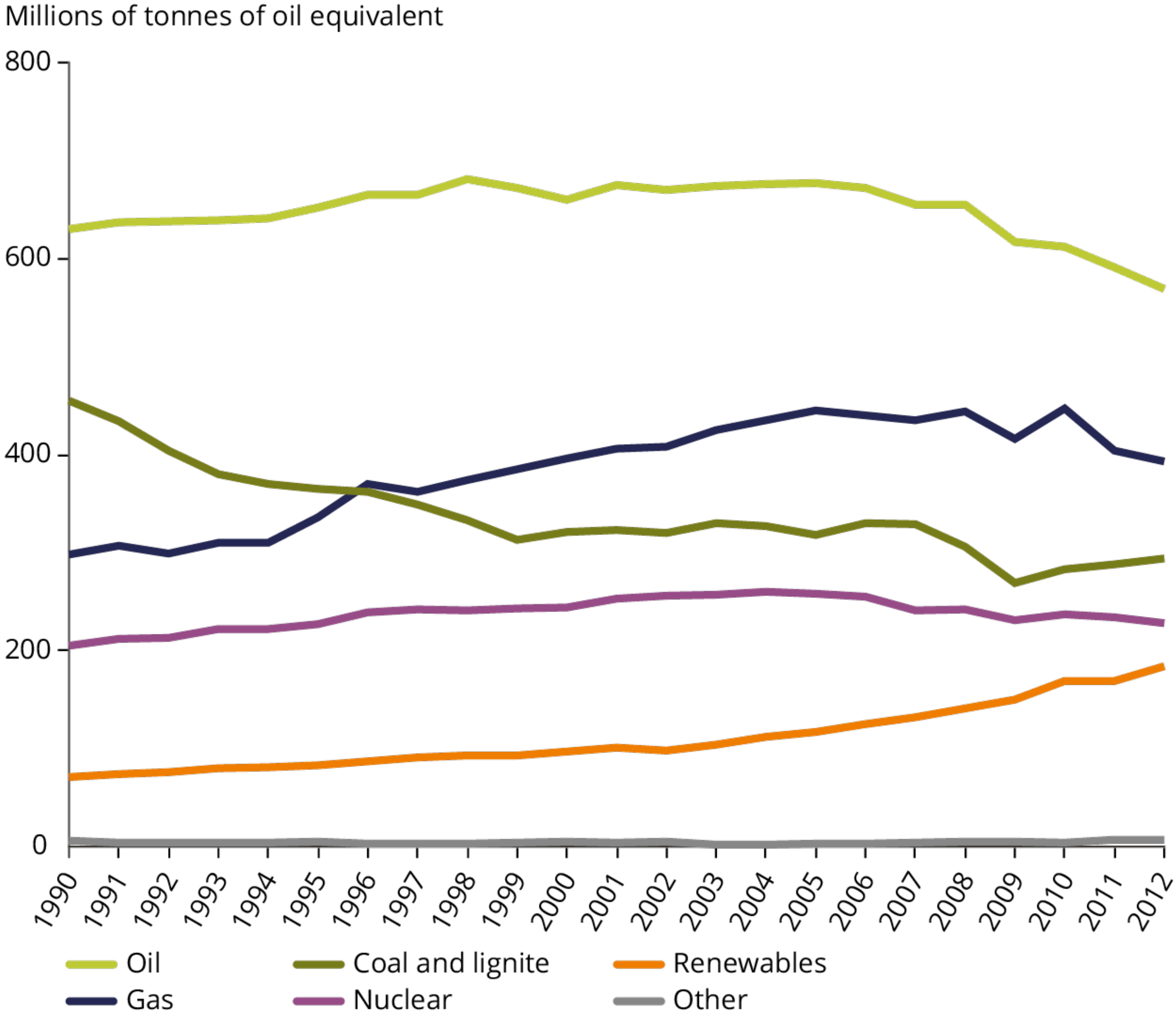
Responding to these concerns, the EU has committed that by 2020 it will reduce energy consumption by 20% relative to business-as-usual projections. In absolute terms, that translates into a 12% reduction relative to energy consumption in 2010 (EU, 2012). The EU also intends that renewable energies will contribute 20% of final energy consumption by 2020, with a minimum 10% share in transport (EU, 2009a).

European heads of state and government have agreed new headline targets for 2030, reducing greenhouse gases emissions by at least 40% from 1990 levels, increasing renewable energy to make up at least 27% of final energy consumption, and cutting energy consumption by at least 27% compared to business-as-usual (European Council, 2014).

The EU has already achieved some success in decoupling energy use from economic output. In 2012, gross inland energy consumption in the EU was 1% higher than in 1990, despite a 45% increase in economic output during that period. Although the economic turmoil of recent years has constrained energy demand, policies and measures have also played a key role. Looking ahead, analysis of national energy efficiency action plans indicates that full implementation and enforcement of national energy efficiency policies would enable the EU to achieve its 2020 target (EEA, 2014w).

Turning to the energy mix, the EU remains heavily dependent on fossil fuels, although their contribution to gross inland energy consumption declined from 83% in 1990 to 75% in 2012. This decline was largely offset by increased use of renewable energy, which accounted for 11% of EU primary energy consumption in 2012, up from 4% in 1990 (Figure 4.5). As a result, the EU is on track to achieve its 2020 target for renewables, which requires that they should account for 20% of the EU's gross final energy consumption (EEA, 2013n).

Figure 4.5 Gross inland energy consumption by fuel (EU-28, Iceland, Norway and Turkey), 1990–2012)



Note: The following percentage figures quantify the proportion of total gross inland energy consumption that each fuel contributed in 2012: oil 34%, gas 23%, coal and lignite 18%, nuclear 14%, renewables 11%, other 0%.

Source: EEA, 2014v.

Ensuring a cost-efficient transformation of the European energy system necessitates a diverse mixture of actions addressing both supply and demand at the continental scale. On the supply side, breaking the continuing dominance of fossil fuels will require a strong commitment to improving energy efficiency, deploying renewable energy, and continuous climate and environment proofing of energy projects. Substantial investments and regulatory change will be needed to integrate networks and facilitate the growth of renewables. On the demand side, there is a need for fundamental changes in society's energy use. Smart meters, appropriate market incentives, access to finance for households, energy saving appliances, and high performance standards for buildings can all contribute.

4.7 Increasing transport demand affects the environment and human health

Trends and outlook: Transport demand and related environmental impacts	
	5–10 year trends: The economic crisis lowered transport demand and reduced pollutant and greenhouse gas emissions, but transport continued to cause harmful impacts.
	20+ year outlook: Certain transport-related impacts are decreasing, but creating a sustainable mobility system will require faster introduction of measures to control impacts.
□	*Progress to policy targets:* Good progress to efficiency and short-term greenhouse gas targets but a significant distance remains toward longer-term policy objectives.
!	*See also:* SOER 2015 thematic briefing on transport.

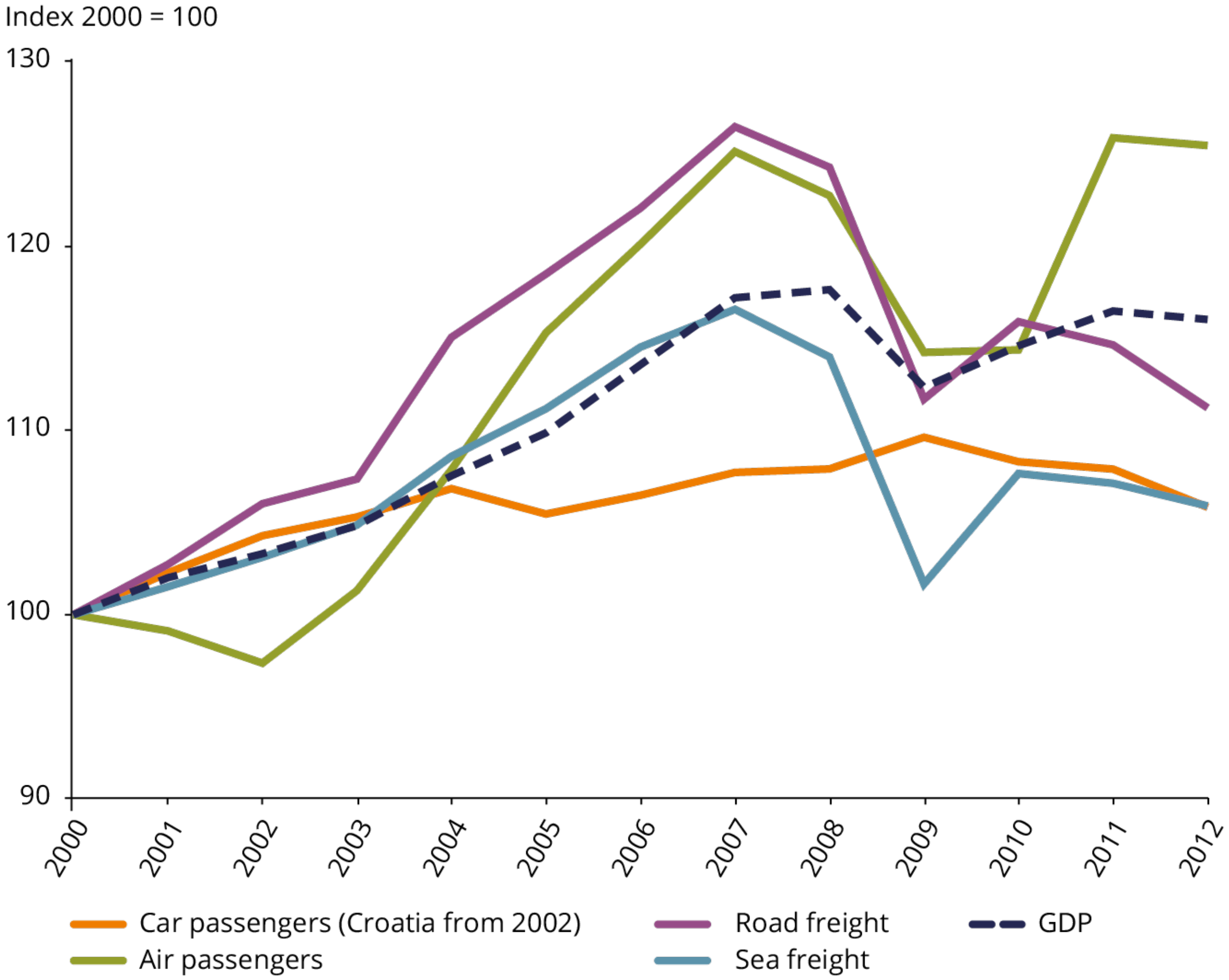
European demand for transport has increased in line with GDP in recent years, reflecting the close interdependence of transport and economic development. Although use of several transport modes has declined slightly since 2007 relative to their pre-recession peaks, air travel reached an all-time high in 2011 (Figure 4.6).

Transport systems can also impose numerous costs on society, particularly in terms of air and noise pollution (see also Sections 5.4 and 5.5), greenhouse gas emissions (Section 4.5) and landscape fragmentation (Sections 3.4 and 4.10). Harmful health and environmental impacts from transport can be reduced in three ways: avoiding unnecessary transport; shifting necessary transport from environmentally harmful to more environmentally friendly modes; and improving the environmental performance of all modes of transport, including the efficient use of infrastructure.

European measures to reduce transport emissions have tended to focus on the last of these approaches: improving efficiency. These measures have included fuel-quality standards; exhaust-emission limits for air pollutants and carbon dioxide (CO_2); and inclusion of the transport sector within national emission limits for air pollutants (EU, 2001b), and under the EU Effort Sharing Decision for greenhouse gases (EU, 2009b).

These measures have achieved some success. The introduction of technologies such as catalytic converters, for example, has greatly reduced road transport pollution. Member States are also making progress towards the goal of providing 10% of transport energy in each country from renewable sources by 2020. And carbon dioxide (CO_2) emissions per km are declining in accordance with the targets set out in EU legislation for new vehicles (EU, 2009d).

Figure 4.6 Growth in modal transport demand (km) and GDP in EU-28



Source: Based on EC (2014a) and Eurostat (2014b).

Nevertheless, efficiency improvements alone will not address all environmental concerns, partly because efficiency gains are often offset by growing demand (Box 4.2). Transport, including emissions from international transport, is the only EU sector to have increased its greenhouse gas emissions since 1990, accounting for 24% of total emissions in 2012. Road traffic is also the dominant source of noise in terms of the numbers of people exposed to harmful levels, with rail and aircraft also contributing to population exposure.

Alongside increasing traffic volumes, the promotion of diesel vehicles is contributing to air quality problems. This is because diesel cars generally emit more particulate matter and nitrogen oxides than petrol cars but less carbon dioxide, although recent data indicate that the carbon dioxide difference is decreasing (EEA, 2014l). In addition, NO_X emissions from diesel vehicles under real-world driving conditions often exceed the test-cycle limits specified in the Euro emission standards, a problem that also affects official fuel consumption and CO_2-emission values.

Developing alternative fuel vehicles could certainly reduce the burden placed on the environment by the transport system. However, it will require very large investments in infrastructure (in both the transport and energy sectors) and the displacement of entrenched fossil fuel-based systems. Moreover, it will not solve other problems such as congestion, road safety, noise levels, and land use.

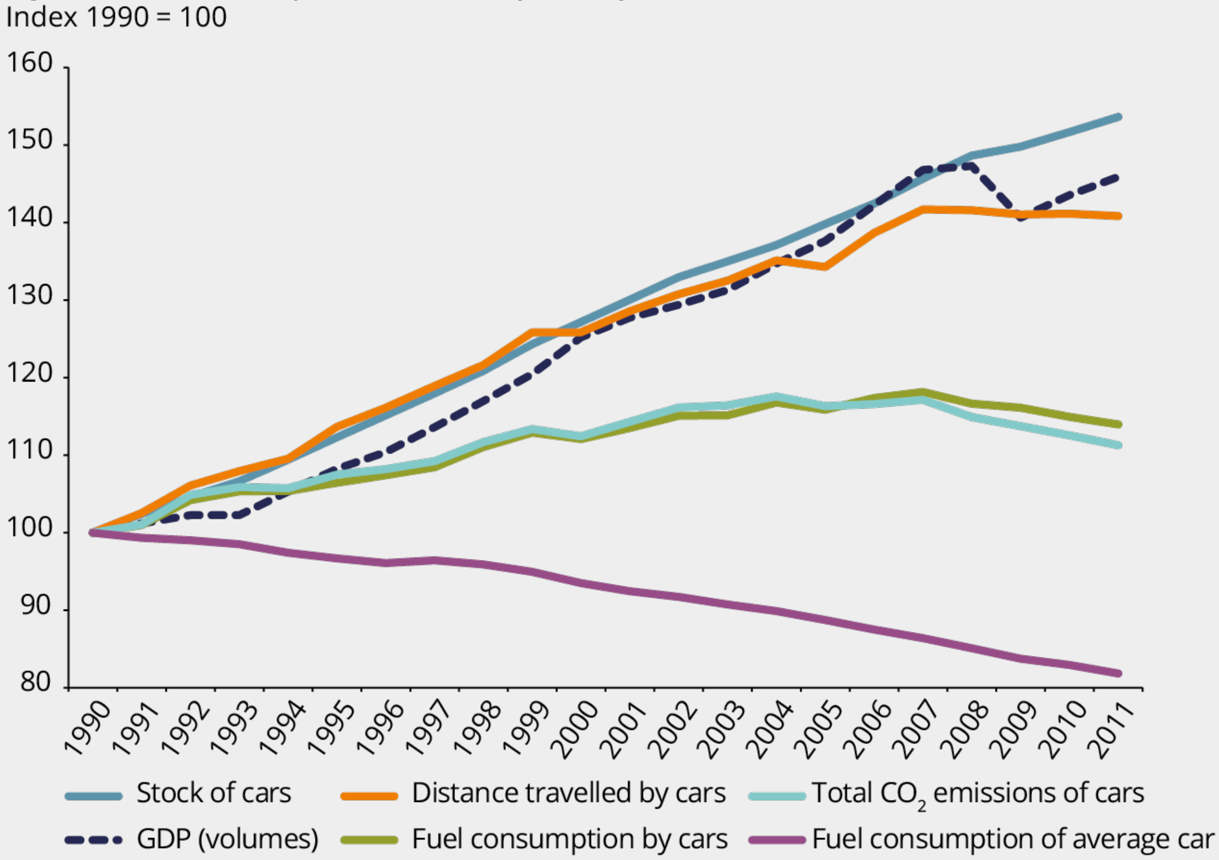
For these reasons, more fundamental changes in the way Europe transports passengers and goods will be needed. Encouragingly, there is some evidence of a cultural shift away from car use in developed regions, particularly among younger generations (Goodwin, 2012). At the same time, cycling, using a car pool, or opting for public transport are becoming more popular.

Box 4.2 Limited gains from efficiency improvements in the car transport sector

Efficiency improvements are often insufficient to guarantee a decline in environmental pressures. Technology-driven gains may be undermined by lifestyle changes or increased consumption, partly because efficiency improvements tend to make a product or service cheaper. This phenomenon is known as the 'rebound effect'. This trend is apparent in the transport sector. Although fuel efficiency and emission characteristics of cars improved steadily in the period 1990 to 2009, rapid growth in car ownership and in kilometres driven offset the potential improvements. The subsequent decline in distance travelled and fuel consumption was clearly linked to the economic problems since 2008.

The European Commission's White Paper on Transport (EC, 2011e) calls for carbon dioxide (CO_2) emissions from transport to be reduced by at least 60% by 2050, compared to 1990 levels. The use of new technologies has been identified as the most important means to achieve this reduction. However, as the trends in Figure 4.7 illustrate, technical solutions may not always deliver expected reductions in environmental pressures. Creating a transport system that maximises social and economic benefits, while minimising environmental and human harm, requires an integrated approach, addressing both production and consumption.

Figure 4.7 Fuel efficiency and fuel consumption in private cars, 1990–2011



Source: Odyssee database (Enerdata, 2014) and EC, 2014a.

4.8 Industrial pollutant emissions have declined but still cause considerable damage each year

Trends and outlook: Industrial pollution to air, soil and water	
	5–10 year trends: Industrial emissions are decoupling from industrial output in absolute terms.
	20+ year outlook: Industrial emissions are expected to decrease further, but harm to the environment and human health remains considerable.
□	*Progress to policy targets:* Good progress in implementation of Best Available Techniques. Policy has been strengthened through the Industrial Emissions Directive, which remains to be fully implemented.
!	*See also:* SOER 2015 thematic briefings on industry; air pollution; soil; and freshwater quality.

Like the energy and transport sectors, European industry delivers a complex mixture of benefits and costs to society. In addition to producing goods and services, the sector generates substantial employment, earnings and tax revenues. Yet industry also contributes significantly to the emissions of many important air pollutants and greenhouse gases, causing widespread harm to the environment and human health.

EU policies such as the Integrated Pollution Prevention and Control (IPPC) Directive (EU, 2008a) and related directives have played an important role in limiting the adverse environmental effects of industrial production in recent decades. More recently, the obligations on industry have been brought together in the Industrial Emissions Directive (EU, 2010a), which sets out requirements for some 50 000 large industrial installations to avoid or minimise emissions and waste.

In terms of climate change policy, the most important measure addressing industry is the EU Emissions Trading System (EU, 2003, 2009b) (Box 4.3). The EU Emissions Trading System addresses the greenhouse gas emissions from more than 12 000 installations in power generation, manufacturing, and industry in 31 countries. It also addresses the greenhouse gas emissions from about 1 300 aircraft operators, covering around 45% of EU greenhouse gas emissions in total. Greenhouse gas emissions covered by the EU Emissions Trading System decreased by 19% between 2005 and 2013.

Box 4.3 The EU Emissions Trading System

The EU Emissions Trading System is a tool for improving efficiency, offering a means to enhance economic returns within ecosystem boundaries. It operates by establishing a limit for the greenhouse gas emissions in various sectors and enabling participants to trade their individual emissions entitlements, thereby creating incentives for emission reductions to occur where they are cheapest.

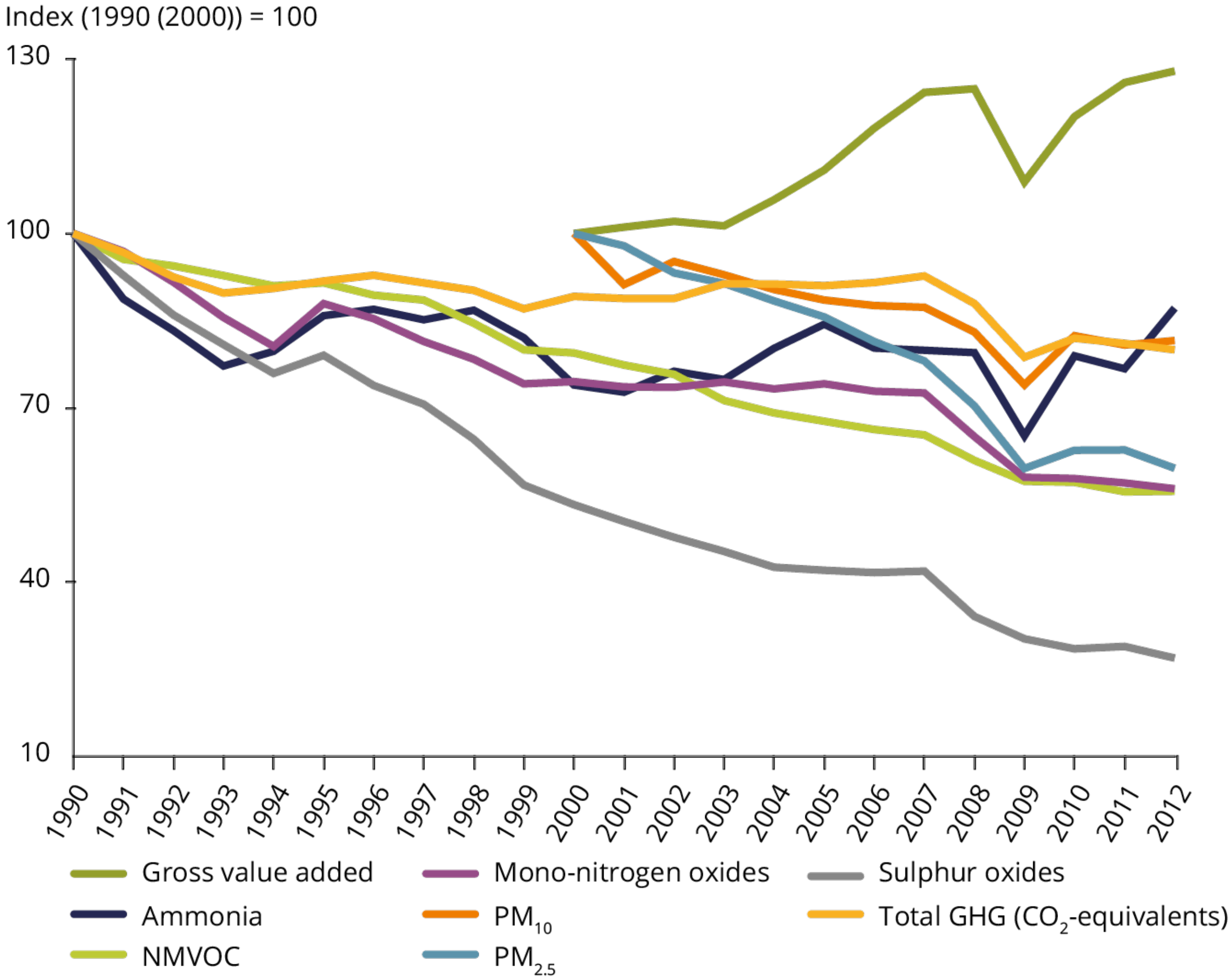
Although the EU Emissions Trading System has been successful in delivering emission reductions, it has been criticised in recent years for failing to incentivise sufficient low-carbon investment. This has primarily occurred because Europe's unanticipated economic difficulties since 2008 contributed to low demand for allowances. A large surplus of emission allowances accumulated, affecting carbon prices.

As an initial response, the ETS Directive was amended in December 2013 and the auctioning of 900 million allowances was later postponed from 2014–2016 to 2019–2020. In January 2014, the Commission proposed establishing a Market Stability Reserve to make the EU Emissions Trading System more robust and ensure that it continues to deliver cost-effective emission reductions (EC, 2014h).

Europe's industrial emissions of pollutants and greenhouse gases have decreased since 1990, while sectoral economic output has increased (Figure 4.8). Environmental regulations such as the EU's Large Combustion Plant (LCP) Directive (EU, 2001a), have contributed to these reductions. Other factors contributing to emissions reductions include energy efficiency, changes in the energy mix, end-of-pipe pollutant abatement technologies, a shift in Europe away from certain heavy and more polluting types of manufacture, and company participation in voluntary schemes to reduce environmental impacts.

Despite the improvements presented in Figure 4.8, industry continues to contribute significantly to European air pollutant and greenhouse gas emissions. In 2012, industry accounted for 85% of emissions of sulphur dioxide (SO_2), 40% of emissions of nitrogen oxides (NO_X), 20% of emissions of fine particulate matter ($PM_{2.5}$) and non-methane volatile organic compounds, and 50% of greenhouse gas emissions in EEA-33 countries (EEA, 2014b, 2014h).

Figure 4.8 Industry emissions (air pollutants and greenhouse gases) and gross value added (EEA-33), 1990–2012



Source: EEA, 2014o; and Eurostat, 2014f.

The costs associated with Europe's industrial air pollution are considerable. According to recent EEA analysis, the damage costs (relating to harm to human health, crop yield losses and material damage) associated with air pollution released by the 14 000 most polluting facilities in Europe are estimated to be at least EUR 329–1 053 billion in the five year period 2008–2012. It is estimated that half of the costs occurred as a result of the emissions from just 147, or 1%, of the facilities (EEA, 2014t).

Looking ahead, further implementation of the Industrial Emissions Directive will help reduce these impacts. In addition, the European Commission's proposed Clean Air Policy Package (EC) puts forward a new directive on medium-sized combustion plants (EC, 2013f), which would reduce the annual emissions from these plants by an estimated 45% for sulphur dioxide (SO_2), 19% for nitrogen oxides (NO_X), and 85% for particulate matter (EC, 2013d).

Future actions to strengthen pollution controls at source would also benefit from being complemented with measures to steer consumers towards less harmful products and services. As noted in Sections 4.3 and 4.4, consumption-based estimates of resource use and greenhouse gas emissions suggest that the benefits of less harmful production in Europe may be partially offset by increasing environmental pressures in other world regions linked to the production of goods for the European market.

4.9 Reducing water stress requires enhanced efficiency and water demand management

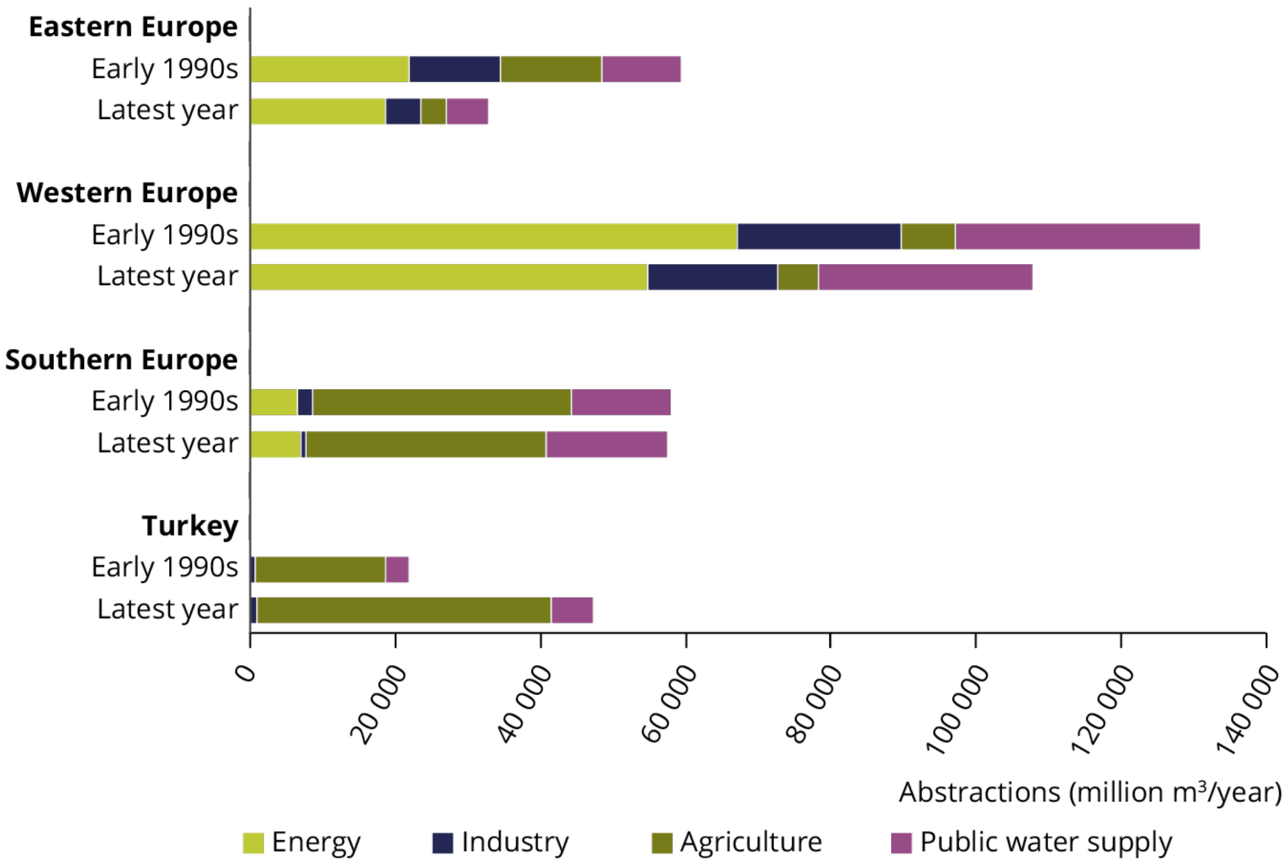
Trends and outlook: Water use and water stress	
	5–10 year trends: Water use is decreasing for most sectors and in most regions but agricultural water use, in particular in southern Europe, remains a problem.
	20+ years outlook: Water stress remains a concern in some regions, and efficiency improvements may not offset all impacts of climate change.
☒	*Progress to policy targets:* Water scarcity and droughts continue to affect some European regions, impacting both economic sectors and freshwater ecosystems.
!	*See also:* SOER 2015 thematic briefings on freshwater quality; hydrological systems and sustainable water management; climate change impacts and adaptation; and agriculture.

Freshwater ecosystems deliver essential services to our societies and economies. Yet in many instances, human demand for water is in direct competition with the water needed to maintain ecological functions. Managing water sustainably means first ensuring that humans and ecosystems alike have the quantity and quality of water to meet their needs, and then allocating and using the remaining resources in ways that most benefit society. The EU's Water Framework Directive and Groundwater Directive define the boundaries for sustainable water use via the 'good status' objective for surface water (rivers and lakes) and groundwater bodies (see Section 3.5).

In Europe, humans abstract on average around 13% of all renewable and accessible freshwater from natural water bodies, including surface waters and groundwater. Although this extraction rate is relatively low by global standards, over-exploitation still poses a threat to Europe's freshwater resources (EEA, 2009b).

European water abstraction has declined overall since the 1990s (Figure 4.9). However, agriculture, industry, public-water supply and tourism put considerable stress on Europe's water resources. Demand often exceeds local availability, particularly during the summer (EEA, 2009b, 2012j). Eurostat data for the period 1985–2009 indicate that five European countries (Belgium, Cyprus, Italy, Malta and Spain) abstracted more than 20% of their available resources, suggesting that their water resources are under stress. However, aggregated annual national data do not necessarily reflect the extent and severity of over-exploitation of water resources at sub-national levels, or seasonal variation in water availability and use.

Figure 4.9 Changes in the use of freshwater for irrigation, industry, energy cooling and public water supply since the early 1990s



Note: The data show the aggregate water abstraction per country or region. The 'early 1990s' data are based on the earliest available data for each country since 1990 and most relate to 1990–1992. The 'latest year' relates to the most recent available data for each country and most relate to 2009–2011. For an explanation of the countries included in each region see CSI 018.

Source: Eurostat, 2014a.

The costs associated with mismanagement of water resources can be very substantial. Over-abstraction is causing low river flows, lowered groundwater levels, and the drying-up of wetlands. All of these trends have detrimental impacts on freshwater ecosystems. In 2007, the European Commission (EC, 2007a) estimated that at least 17% of EU territory had been affected by water scarcity and put the cost of droughts in Europe over the previous 30 years at EUR 100 billion — with significant consequences for the associated aquatic ecosystems and dependent users (EEA, 2009b). Climate change is projected to increase water shortages, particularly in the Mediterranean region (EEA, 2012a).

There are many opportunities to enhance water-use efficiency, alleviating environmental pressures but potentially also delivering cost savings and co-benefits such as reduced energy use (for example in treatment of drinking water and wastewater).

Industrial and public water management can be improved through measures such as more efficient production processes, water-saving measures in buildings, and better urban planning. The variance in leakage rates from water pipes across Europe — from less than 10% in some locations to more than 40% in others — also points to opportunities to achieve substantial water savings (EEA, 2012c). In the agricultural sector, water-efficient irrigation techniques such as drip irrigation, altered crop patterns, and wastewater reuse are particularly promising (EEA, 2012h).

Across economic sectors, effective water metering and pricing have an essential role in improving demand management and incentivising the most beneficial allocation of water within society (after sufficient water has been allocated to satisfy the needs of humans and ecosystems). However, a review of European water pricing (EEA, 2013d) found that many Member States fall well short of the Water Framework Directive's requirement that they recover the full costs of providing water services, including resource and environmental costs. Irrigation water tariffs in particular are often highly subsidised, arguably incentivising inefficient water use.

4.10 Spatial planning strongly influences the benefits that Europeans derive from land resources

As with water resources, Europe's land resources are finite and can be used in diverse ways, such as for forestry, pasture, biodiversity conservation or urban development. These choices provide contrasting mixtures of benefits and costs to land owners, local people, and society as a whole. Land-use changes that offer increased economic returns from land (such as agricultural intensification or urban sprawl) can imply the loss of non-market benefits such as carbon sequestration or the cultural value of traditional landscapes. Better land management therefore consists of finding ways to balance such trade-offs.

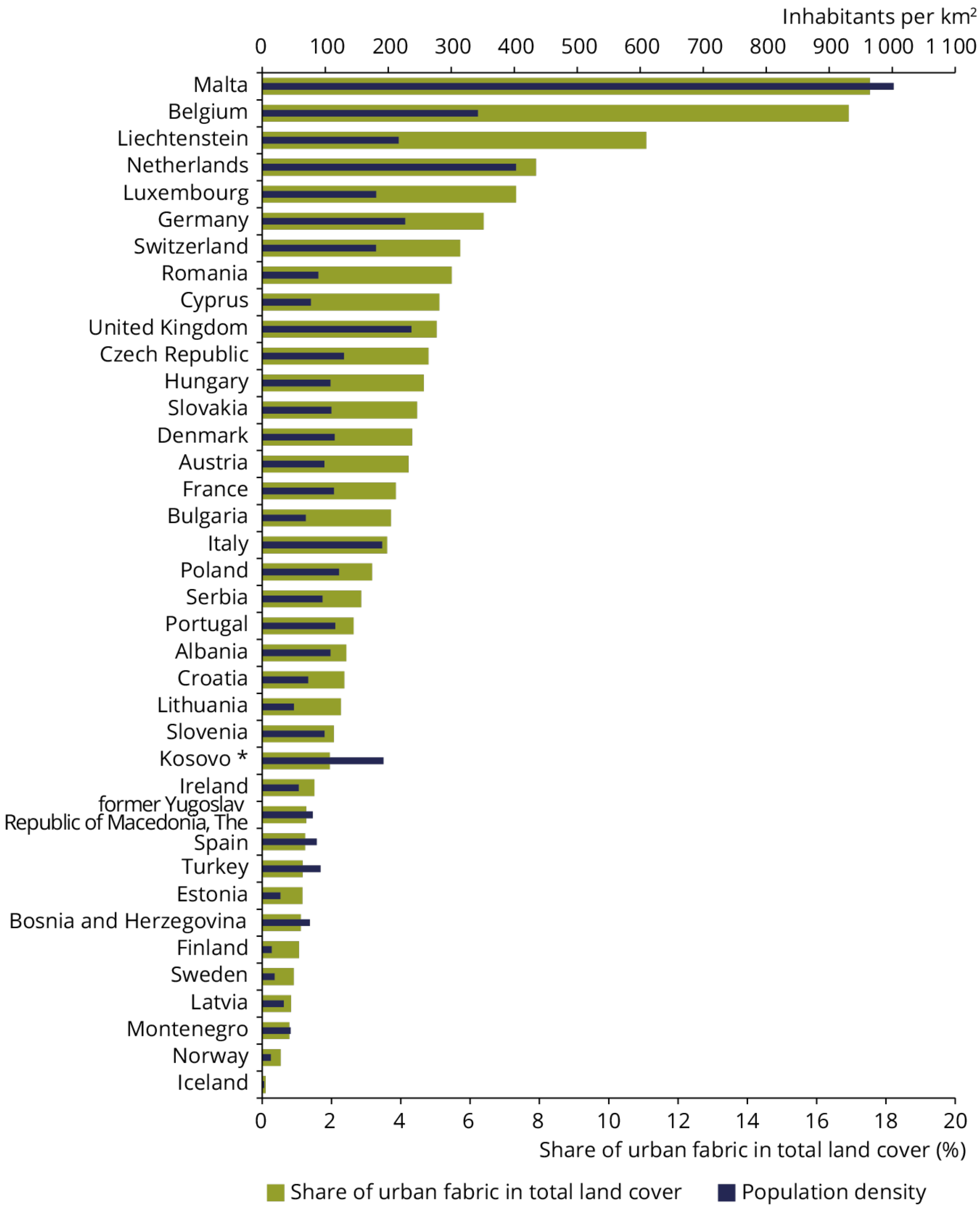
In practice, this tends to mean constraining the growth of urban areas and limiting intrusions of infrastructure (such as transport networks) into nature, since these processes can lead to biodiversity loss and degradation of related ecosystem services (see Sections 3.3 and 3.4). Diffuse settlement patterns often result in more resource-intensive lifestyles because of increased transport and domestic energy needs. This can further increase the burden on ecosystems.

The importance of urban infrastructure in determining land-use efficiency is reflected in the EU's goal of 'no net land take' by 2050. Europe faces a significant challenge in achieving this goal. The available data since 1990 indicate that residential urban areas expanded at four times the rate of population growth, while industrial areas grew more than seven times as rapidly (EEA, 2013f). Urban areas are therefore becoming less compact.

Although European population growth is likely to be minimal in coming decades, other drivers of increased housing demand may persist. Household formation is one such driver, and it can continue to grow — even in the absence of population growth — as households become smaller. The number of households in the EU-28 grew 23% between 1990 and 2010, from 170 million to 209 million. Increasing wealth, ageing of the population, and changing lifestyles are likely to sustain the reduction in average household size.

The striking differences in urbanisation patterns across Europe suggest that there are opportunities to improve land-use efficiency. For example, the share of urban land in Belgium is almost twice as high as in the Netherlands, despite a population density that is one third lower (Figure 4.10). These figures reflect differences in spatial planning. The Netherlands has more planning restrictions, more compact urban settlements, and a lower share of detached houses than Belgium.

Figure 4.10 Urbanisation patterns across Europe



Note: The land cover data derive from the most recent available update of the Corine Land Cover series (2006). The population data are for the same year.

* as defined under United Nations Security Council Resolution 1244/99.

Source: EEA, 2014c; and Eurostat, 2014g.

Better spatial planning has the potential to incentivise more resource-efficient approaches to the built environment. It can help to reduce energy use for commuting and for space heating, and avoid the intrusion of urban infrastructure into natural areas (EEA, 2013f). An integrated approach to spatial planning should optimise economic development opportunities and ecosystem services, reducing human exposure to environmental pressures, and reducing social inequities. The challenge is to design a future urban environment with broad public appeal, meeting the evolving needs of the population (EEA, 2013f). Part of the solution is likely to involve developing 'green infrastructure' within urban areas, i.e. planned networks of natural or semi-natural areas managed to deliver a range of ecosystem services (EC, 2013b).

Improved spatial planning would involve both increased restrictions on urban sprawl, and the alleviation of restrictions on development within urban areas. This is undoubtedly an area characterised by complex trade-offs. Some people prefer living close to nature, rather than in a compact urban setting. Equally, governments often impose restrictions on the height of new buildings to preserve a city's cultural identity and urban environment. These are undoubtedly characteristics that are valued by inhabitants and contribute to well-being. At the same time, it is important to recognise that such restrictions can also greatly increase the cost of housing in city centres (particularly impacting poorer households) and drive urban sprawl.

4.11 An integrated perspective on production-consumption systems is needed

Several consistent themes emerge from the above analysis of resource efficiency trends in Europe. In many areas, efficiency is improving: society is finding ways to increase economic output relative to the associated environmental pressures. Yet in most areas, the changes look unlikely to deliver on the EU's 2050 vision of an economy in which 'all resources are sustainably managed, from raw materials, to energy, water, air, land and soil.'

Part of the challenge appears to lie in the fact that innovations that alleviate pressures in one area can cause feedbacks that increase pressures elsewhere. Efficiency gains can reduce production costs, effectively increasing consumer spending power and thereby enabling increased consumption (the rebound effect). In the transport sector, for example, increasing fuel efficiency has had limited impact on overall fuel use because it has resulted in increased driving (Box 4.1). Similar trends have been seen in many other areas, including household appliances and space heating (EEA, 2012e).

Often these efficiency gains result from technological advances, but they can also arise from behavioural changes, such as throwing away less food. Reducing food waste in this way may reduce a consumer's demand for fresh produce, but it also leaves them with more money to spend on other things (WRAP, 2012). The aggregate environmental impact of this decision will depend on whether the consumer chooses to use those funds to purchase better quality, sustainably produced food, or rather to increase consumption of other goods and services.

These types of feedback effects suggest that there is a need to look beyond isolated efficiency improvements and instead address in an integrated way the production-consumption systems that fulfil societal functions (e.g. food, housing, mobility). Such a perspective implies focusing not just on material flows but also on the social, economic and environmental systems that structure society's resource use.

Viewing consumption and production as aspects of complex systems exposes some of the challenges in shifting to resource use patterns that produce better socio-economic and environmental outcomes. For example, drawing on Meadows (2008), it is apparent that production-consumption systems can serve multiple, potentially contradictory functions. From the perspective of the consumer, the primary function of the food system may be to supply food of the desired type, quantity, quality and price. From the perspective of the farmer or food processor, the food system's main function may be as a source of employment and earnings. For rural communities, the system may play a key role in social cohesion, land use and traditions.

The multifunctional character of production-consumption systems means that different groups are likely to have contrasting incentives for facilitating or resisting change. Alterations to complex systems are likely to generate trade-offs. Even if a measure produces a beneficial outcome for society as a whole, it may face strong opposition if it threatens the livelihoods of a specific group of people. Individuals or groups may have particularly strong interests in maintaining the status quo if they have made investments (for example in skills, knowledge or machinery) that could become redundant as a result of changes.

Globalisation further complicates the governance challenge. As highlighted in Sections 4.3 and 4.4, there is some evidence that Europe's reductions in the material and greenhouse gas emission intensity of production in recent years are partly due to the shift of some industrial output overseas. Although Europe appears to have made considerable progress from a production perspective, the trend looks less positive from a consumption perspective.

Such contrasting trends point to difficulties in reconfiguring the globalised systems that meet European demand for goods and services. European consumers and regulators alike have little information about the resource use and related impacts associated with highly complex and diverse supply chains, and they have limited ability to influence them using traditional, state-bound policy instruments. This reality points to the need for new governance approaches that transcend national boundaries and engage businesses and society more fully.

Notes

(5) The EU's Thematic Strategy on the use of natural resources (EC, 2005) defines resources broadly, including 'raw materials such as minerals, biomass and biological resources; environmental media such as air, water and soil; flow resources such as wind, geothermal, tidal and solar energy; and space (land area)'.

(6) Under the Kyoto Protocol, the greenhouse gas emission level in the 'base year' is the relevant starting point for tracking progress towards national Kyoto targets. Base-year levels are calculated primarily based on greenhouse gas emissions in 1990.

The EEA's report SOER 2015 gives a comprehensive assessment of the European environment's state, trends and prospects, in a global context. The EEA's task is to provide timely, targeted, relevant and reliable information on Europe's environment.

For **more information**, see **www.eea.europa.eu/soer** or scan the QR code.

PDF generated on 12 Mar 2015, 01:59 PM

European Environment Agency
Kongens Nytorv 6
1050 Copenhagen K
Denmark

+45 33 36 71 00
www.eea.europa.eu

European Environment Agency