

ENVIRONMENTAL INDICATOR REPORT 2014

ENVIRONMENTAL IMPACTS OF
PRODUCTION-CONSUMPTION SYSTEMS IN EUROPE

European Environment Agency



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Foreword

In the second half of 2013, the European Union agreed its 7th Environment Action Programme (7th EAP), which sets out a long-term vision promoting 'living well, within the limits of our planet'. Concretely, the 7th EAP foresees a Europe in 2050 in which

- 'our prosperity stems from an innovative, circular economy where nothing is wasted and natural resources are managed sustainably';
- 'biodiversity is protected, valued and restored in ways that enhance our society's resilience';
- 'our low-carbon growth has long been decoupled from resource use (...)'.

It is becoming increasingly clear that incremental improvements will not be enough to meet these goals. The systems which underpin Europe's economy and human well-being will have to change fundamentally, including food, energy and clothing systems, and will need to be developed to new ones that continue to fulfil societal needs but in an essentially sustainable way. Europe will not, however, be able to reach long-term sustainability alone: European systems of production and consumption are inexorably linked with the rest of the world — through the import and export of resources, goods and services, and through global value chains both for supply and handling waste.

Transforming such systems to long-term sustainability will require a good understanding of the systems' dynamics and how they interact with the environment. Through its *Multiannual Work Programme 2014–2018*, the EEA aims to contribute to this by developing new insights and building knowledge.

In this third edition of annual environmental indicator reports, the EEA sheds some light on Europe's production-consumption systems, what drives them and how they impact the environment, both in Europe and beyond. It also examines options for making them more

sustainable. While indicators and analyses supporting this perspective are not well established and sparse, the report shows that ways of moving away from current unsustainable systems, technologies and behaviour need to be found, and systems in which Europeans' needs are met without using yet more resources or putting ever more pressures on the environment, including the climate, developed.

When I was appointed as Executive Director in June 2013, I made a commitment for the EEA to strengthen long-term perspectives to help Europe find pathways to transitions that would enable European countries meet the long-term visions and goals that our leaders have agreed. With this report, we in the EEA are taking a first step in analysing systems with a long-term perspective, recognising that we will, of course, further develop and refine the long-term perspective in the coming years. The next step of this journey will be our '2015 State and outlook of the environment' report, which will be published early next year.

Professor Hans Bruyninckx,
Executive Director

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Executive summary

Across the world, there is growing recognition that the prevailing model of economic growth, grounded in ever-increasing resource use and pollutant emissions, cannot be sustained indefinitely. In the coming decades, with global population expected to increase to 9 billion people from 7.6 billion today, continued improvements in living standards and well-being will depend on a transition to a green economy globally that can meet society's needs while preserving the natural systems that sustain us.

Increasingly, this ambition is reflected in policies and initiatives at all levels of governance. In Europe, for example, the European Union's 7th Environment Action Programme (7th EAP) includes the vision that in 2050, we live well, within the planet's ecological limits and the priority objective of turning the EU into a 'resource-efficient, green and competitive low-carbon economy'.

To examine what the concept of green economy means in practice and evaluate Europe's progress in achieving this transition, in 2012 the European Environment Agency (EEA) initiated a new series of environmental indicator reports. The first two reports in the series focused on green economy and the European environment, addressing resource efficiency and resilience (EEA, 2012a), and the links between European resource demand, environmental degradation and changes in human health and well-being (EEA, 2013d).

This report provides another perspective on the green economy transition, addressing the global value chains that meet European demand for goods and services. In doing so, it goes beyond previous reports and analyses to address the global dimension of Europe's economic activities. This perspective is highly relevant because European production and consumption systems rely heavily on imported resources and goods. In doing so, the related environmental pressures from these systems largely affect other world regions, while European consumers are unlikely to have much knowledge of these impacts and European policymakers have relatively little authority to

influence them. The continuing globalisation of trade flows therefore creates a significant challenge for environmental governance.

The analysis in this report focuses on selected production-consumption systems, which link environmental, social and economic systems across the world — generating earnings, supporting ways of living, and meeting consumer demands — and also account for much of humanity's burden on the environment. Production and consumption are addressed together because they are highly interdependent. Only by adopting an integrated perspective is it possible to get a full understanding of these systems: the incentives that structure them, the functions they perform, the ways system elements interact, the impacts they generate, and the opportunities to reconfigure them. The overall objective is to highlight ways that production-consumption systems can be adjusted to augment societal benefits and minimise societal costs.

Assessing the environmental and socio-economic impacts of highly sophisticated, global production-consumption systems presents significant knowledge challenges. Whereas there are established indicators to track environmental pressures from production in Europe, indicators that capture the pressures embedded in imported raw materials and goods are far less mature. Nevertheless, the data available allow an interesting picture to emerge from the drivers that shape production-consumption systems, the (positive and negative) pressures and impacts caused by these systems, and the types of tools that can help to mitigate these pressures and impacts.

Part 1 of the report investigates the overall trends in production-consumption systems in Europe and related environmental pressures. It explains how these systems are influenced by an array of interlinked factors, including economic, technological, demographic and sociological factors, as well as global megatrends.

Part 2 presents three selected production-consumption systems: food, electrical and electronic goods and clothing. These are production-consumption systems with large shares of imports to the European economy and are especially characterised by the globalisation of their supply chains. Together the three systems account for a considerable share of the pressures and impacts of European production-consumption systems on the environment.

For each of the three production-consumption systems, available indicators are used to describe the characteristics and trends of the specific system, as well as the trends and hotspots of related environmental pressures and impacts. This quantitative analysis is accompanied by an assessment of opportunities to move these systems in a more sustainable direction.

Food

Europe's food system is part of a global market in which food and animal fodder are increasingly traded across the globe. Imports of food and fodder to the EU are increasing, indicating that a considerable share of life-cycle environmental pressures and impacts related to food consumption in Europe is felt outside its borders. Food is the household consumption category with the highest embedded environmental pressures. Large amounts of food losses and food waste across the whole food chain are responsible for a considerable share of environmental impacts and a waste of resources.

A more economically, socially and environmentally sustainable food system in Europe would imply healthier diets, less food waste and the production and consumption — including from imports — of higher-quality food with lower impacts on climate change and biodiversity in particular. Environmental impacts from food production in Europe can be mitigated through regulation and market-based instruments, including the removal of environmentally harmful subsidies. Business and civil society have an important role to play through greening of supply chains and changes in consumption behaviour.

Electrical and electronic goods

The production-consumption system of electrical and electronic goods is characterised by highly complex supply chains, with large and increasing imports to Europe, especially from Asia. European households buy and use ever more appliances, driven by technological development, falling prices and the trend towards smaller and therefore more households. Consumption trends have led to increased electricity consumption by European households, despite

many appliances becoming more energy-efficient. The environmental impacts of the production phase of the supply chain are felt largely outside Europe.

The production-consumption system of electrical and electronic goods would be more sustainable with higher-quality appliances, replaced less rapidly, and with more options for leasing appliances and for materials recycling by producers. Opportunities for reducing the life-cycle environmental impacts include making products more energy- and resource-efficient, modular design enabling upgrading and repair, take-back and re-manufacturing, and capturing more of the valuable materials from e-waste.

Clothing

Partly driven by the liberalisation of global tariffs, much clothing production for European consumption has been relocated to countries with low labour costs. In these countries, producing fabrics and clothing often provides many jobs and generates a significant portion of national income. In Europe, the sharp decline in the relative price of clothing has increased consumer spending power. The growing consumption of cheap clothes has also augmented resource demands and environmental and social pressures across the life cycle: water and pesticide use when cultivating natural fibres, water and energy use for washing and drying, and emissions from waste.

Better outcomes could be achieved if Europeans were to buy fewer, better-quality clothes from socially and environmentally sustainable sources. Businesses and civil society have a particularly important role to play in mitigating impacts outside Europe — for example through better supply-chain management, changing consumption patterns, new business models for sharing and leasing clothes, and improved handling of garments (washing and drying). Impacts from the use and end-of-life phases can be mitigated by regulation and market-based instruments.

Part 3 of the report concludes that the current EU policy framework that regulates and steers the life-cycle environmental impacts of production-consumption systems is rather limited: it is still mostly targeted on impacts that occur within Europe, and focuses mainly

on the production and end-of-life stages. Policies addressing the environmental impacts of products and their consumption are still in their very early stages, except those on the energy efficiency of electrical and electronic goods. Furthermore, information-based instruments such as labels, which have limited or no effects on many consumers, dominate this policy area. Market-based instruments, such as taxes and subsidy removal, and strong regulation have only been put in place to a very limited extent.

The above underlines that realising long-term sustainability visions will require fundamental transitions to make production-consumption systems — including the food, electrical and electronic goods and clothing systems analysed in this report — sustainable. Europe is locked in to certain technologies, processes and patterns of behaviour, etc. that hinder the transitions needed to realise the vision of the EU's 7th EAP, and transitions are therefore required at different levels.

The report argues that a number of societal trends and new business models are emerging, which provide some indication of how sustainable production and consumption patterns might look in the future. These include social innovation, collaborative and participative consumption, prosumerism and technical innovation. Possibilities for upscaling them and their potential contribution to reduce life-cycle environmental impacts of production-consumption systems still needs to be seen.



INTRODUCTION

Part 1 Introduction

Chapter 1 Perspectives on the transition to a green economy

- Background
- An integrated perspective on production and consumption
- Applying systems logic to global production and consumption
- Report aims and structure

Chapter 2 Production-consumption systems in Europe — European and global impacts

- Production-consumption systems in Europe
- Domestic and global impacts of European production-consumption systems
- Focus on food, electrical and electronic goods and clothing

Chapter 3 Factors and global megatrends shaping the environmental impacts of production-consumption systems

- Factors shaping the environmental impacts of production-consumption systems
- Global megatrends affecting production-consumption systems in Europe

1 Perspectives on the transition to a green economy

Background

In its report, *The European environment — state and outlook 2010*, the European Environment Agency (EEA) drew attention to the need for Europe to adopt a more integrated approach to addressing persistent, complex, systemic challenges (EEA, 2010b). Recognising the shortcomings of the conventional economic model for addressing such challenges, the report identified transformation to a green economy as one of four key environmental policy priorities for the years ahead. A green economy was defined as 'one in which environmental, economic and social policies and innovations enable society to use resources efficiently, thereby enhancing human well-being in an inclusive manner, while maintaining the natural systems that sustain us'.

The European Union's 7th Environment Action Programme (7th EAP; EU, 2013) confirms that a priority objective is to 'turn the EU into a resource-efficient, green and competitive low-carbon economy'. In addition, it formulates a vision for 2050:

'In 2050, we live well, within the planet's ecological limits. Our prosperity and healthy environment stem from an innovative, circular economy where nothing is wasted and where natural resources are managed sustainably, and biodiversity is protected, valued and restored in ways that enhance our society's resilience. Our low-carbon growth has long been decoupled from resource use, setting the pace for a safe and sustainable global society.'

In 2012 the EEA initiated a series of environmental indicator reports to examine what the green economy concept means in practice and to evaluate Europe's progress in effecting this transition. These reports share a common format and, as far as possible, use established environmental indicators hosted by the EEA.

The first report in the series, the *Environmental indicator report 2012* (EEA, 2012a), measured progress towards the green economy,

focusing on two key aspects of the transition: resource efficiency and ecosystem resilience. Based on analysis of six environmental themes, it concluded that European environmental policies appear to have had a clearer impact on improving resource efficiency than on maintaining ecosystem resilience. While improving resource efficiency remains necessary, it may not be sufficient to conserve the natural environment and the essential services it provides in support of economic prosperity and cohesion.

The *Environmental indicator report 2013* (EEA, 2013d) addressed a different aspect of the green economy concept, focusing on the environmental pressures associated with resource-use patterns, their impacts on human health and well-being, and possible levers for altering these impacts. It concluded that while the environmental pressures from resource use in Europe seem to be declining, the absolute environmental burden remains considerable. Moreover, some aspects appear unsustainable in the context of rapidly growing global demand.

The analysis also found that resource-use patterns are strongly interdependent, with bioenergy and food production, for example, competing for land, energy and water resources, and with different environmental feedback mechanisms operating simultaneously. The interdependence of resource-use systems introduces many trade-offs and co-benefits into governance options, necessitating an integrated response. The analysis identified spatial planning and land management as key approaches for framing governance strategies capable of increasing resource efficiency, maintaining environmental resilience and maximising human well-being.

An integrated perspective on production and consumption

The present report extends the analysis of the green economy further, developing an integrated perspective that embraces some global dimensions of the challenge. The focus of the analysis is on production-consumption systems that link environmental, social and economic systems across the world — supporting livelihoods across the value chain, but also accounting for much of humanity's burden on the environment.

The logic underpinning this analysis is that production and consumption need to be addressed together because they are highly interdependent. Focusing on production or consumption in isolation provides only a partial picture of the issues. Only by adopting an integrated perspective is it possible to get a full understanding of these systems: the incentives that structure them, the functions they perform, the ways system elements interact, the impacts they generate, and the opportunities to reconfigure them.

This report addresses the production-consumption systems that meet European demand for three product types: food, electrical and electronic goods and clothing. These categories were selected because imported goods and resources play an important role in meeting European demand in each area. The associated impacts, both positive and negative, are thus dispersed across global supply chains, creating complex governance challenges.

Applying systems logic to global production and consumption

Viewing production and consumption as aspects of a complex unified system exposes some of the challenges of 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. The production-consumption system for food can be used to illustrate this point. 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 tradition. Systems thinking can thus involve a shift from focusing on purely physical flows to embracing related soft-system interactions such as those structured by social norms or perspectives (Bosch et al., 2007).

The multifunctional character of production-consumption systems means that different groups are likely to have contrasting incentives for facilitating or resisting change. Alterations to such 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 segment. Individuals or groups may have particularly strong interests in maintaining the status quo if they have made investments, for example in training or machinery, that could become redundant as a result of changes.

Several related governance challenges emerge from the complexity and scale of the production-consumption systems that today meet European demand. Driven by a combination of economic incentives, consumer preferences, technological innovation, investment in transport infrastructure and policy measures aimed at facilitating trade, production networks for many goods today span the globe, engaging numerous actors. As a result, consumers normally have only a limited awareness of the full social, economic and environmental implications of their purchasing decisions. And since market prices for end products are extremely unlikely to reflect the full costs and benefits arising along the value chain, consumer choices often produce environmentally and socially undesirable outcomes.

Government efforts to manage the socio-economic and environmental impacts of production-consumption systems face similar obstacles. In addition to the great difficulty that states face in monitoring the impacts associated with highly complex and diverse supply chains, governments have limited legal authority to influence activities outside their borders. Intergovernmental mechanisms can offer a means of extending state authority, but they are often slow-moving in character and limited in scope. Moreover, international trade agreements can actually constrain the ability of governments to regulate production-phase impacts overseas.

Adopting an integrated perspective on production-consumption systems highlights both the range of socio-economic and environmental costs and benefits that arise along the value chain, and the related constraints to governance that can result. More positively, however, it also directs attention to potential leverage points where comparatively small interventions can have far-reaching impacts (Meadows, 2008; WEF, 2011).

The need to quantify, manage and mitigate such impacts has resulted in innovative approaches to governance in recent years. Examples include the growing involvement of businesses and civil society in managing environmental flows by greening supply chains and through certification and labelling. They also include social innovations such as product-service systems, collaborative consumption and community-based initiatives. It is increasingly acknowledged that fundamental improvements in sustainability will require governance and business models that fundamentally change existing production-consumption systems. Regulatory measures targeting the functioning of these systems and measures targeting the individual behaviour aspect of the same systems must go hand in hand.

Several key concepts, including green economy, resource efficiency, sustainable consumption and production and circular economy, are increasingly being discussed and used in Europe, and imply considerable changes in the way production and consumption are organised. Indicators have a crucial role in tracking progress towards the implementation of these policy concepts.

Whereas there are established indicators to track environmental pressures from production in Europe, or rather from the territorial perspective, indicators that grasp environmental pressures of whole production-consumption systems are less mature. The extensive and growing trade between Europe and other parts of the world increasingly requires indicators that also capture pressures embedded in traded raw materials and goods imported for consumption in Europe.

Several approaches are being developed and tested in Europe to give this broader picture; these include multi-regional input-output methods, life-cycle analysis and environmental footprint-type indicators.

Report aims and structure

Using the examples of food, electrical and electronic goods and clothing, this report aims to illustrate the sophistication of production-consumption systems, the costs and benefits that they generate, the

trade-offs involved in effecting change, and the associated challenges and opportunities.

Like the *Environmental indicator report 2013*, the focus is on European demand, European production and impacts on European citizens. What distinguishes the 2014 report is the comprehensive analysis of pressures all along the value chain, the role of trade and the influence of global drivers of change.

Part 1 of the report introduces the global dimension of European economic activities. Production and consumption activities in Europe rely heavily on flows of resources and goods from other regions. Many of the related environmental, social and economic impacts, both positive and negative, therefore occur outside Europe, beyond the direct control of European policy. An overview is provided of the drivers and global megatrends that affect production and consumption in Europe, as well as an integrated assessment of trends in the region's consumption expenditure, the trade flows involved, associated resource use and environmental impacts.

Part 2 presents the analysis of the three production-consumption systems. Each chapter begins by defining the scope of the system, setting out European consumption trends for each product type, the global production networks that supply that demand, and the drivers that shape the system structure. The analysis then presents the socio-economic and environmental impacts that arise along the value chain — from the extraction of raw materials to waste management. The final section of each chapter examines how the production-consumption system could be reconfigured to provide better outcomes for society, and the governance mechanisms available to effect such changes, both within Europe's borders and beyond.

Part 3 identifies and explores common themes emerging from the analysis in Part 2, including ways that Europeans could influence globalised production-consumption systems. It also looks at concepts that have the potential for a fundamental transformation to more sustainable production-consumption systems, including non-state market-driven governance approaches, the circular economy, ecodesign and eco-innovation, and social innovations such as collaborative consumption.

2 Production-consumption systems in Europe — European and global impacts

Key messages

Production-consumption systems in Europe ⁽¹⁾ have manifold economic, social and environmental impacts, both positive and negative, in Europe itself and in other regions of the world. A considerable and increasing share of environmental pressures associated with European consumption occurs elsewhere.

Household consumption increased by almost a quarter between 1996 and 2012. The largest shares of European consumption expenditure are on housing (including energy services), food and mobility. These same categories have the highest environmental impacts; the impacts of electrical and electronic goods and clothing are also considerable and increasing.

In the past two decades, the production structure in Europe has changed in large part due to a shift of industrial production to regions of the world with lower labour costs: the share of services in the EU economy has increased, with the largest growth in the information and communication services sector.

The European economy is highly dependent on trading with the rest of the world. Electrical and electronic goods and clothing, and to a lesser extent food, are production-consumption systems with globalised supply chains and large shares of imports to the European economy. Production of these goods in Europe still contributes considerably (but decreasingly) to gross domestic products (GDP) and jobs, while these sectors continue to grow in many less developed countries.

Production-consumption systems in Europe

Production-consumption systems generate a complex mixture of environmental, social and economic costs and benefits globally, supporting livelihoods across the value chain but also accounting for much of humanity's burden on the environment.

⁽¹⁾ In terms of country coverage in figures and text, this report aims to show aggregated data for the EU-28 or EU-27 Member States. Data shown on a country-by-country basis include EEA-33 (EU-28 plus Iceland, Liechtenstein, Norway, Switzerland and Turkey) and EEA cooperating countries (Albania, Bosnia and Herzegovina, the former Yugoslav Republic of Macedonia, Kosovo under the UN Security Council Resolution 1244/99, Montenegro and Serbia), as far as data are available. This approach has been chosen for consistency.

Efforts to monitor and manage Europe's environmental impacts have focused on production within Europe, seeking to identify policies to reduce associated resource use and environmental impacts. While this strategy has been successful to some extent in reducing certain environmental pressures, increasing the resource efficiency of production may not, by itself, lead to absolute reductions in resource use or impacts. This is because efficiency improvements tend to lead to lower production costs and prices, encouraging higher levels of consumption. Avoiding this type of rebound effect (Chapter 7) and shifting to more sustainable ways of living requires an integrated perspective on reconfiguring production-consumption systems.

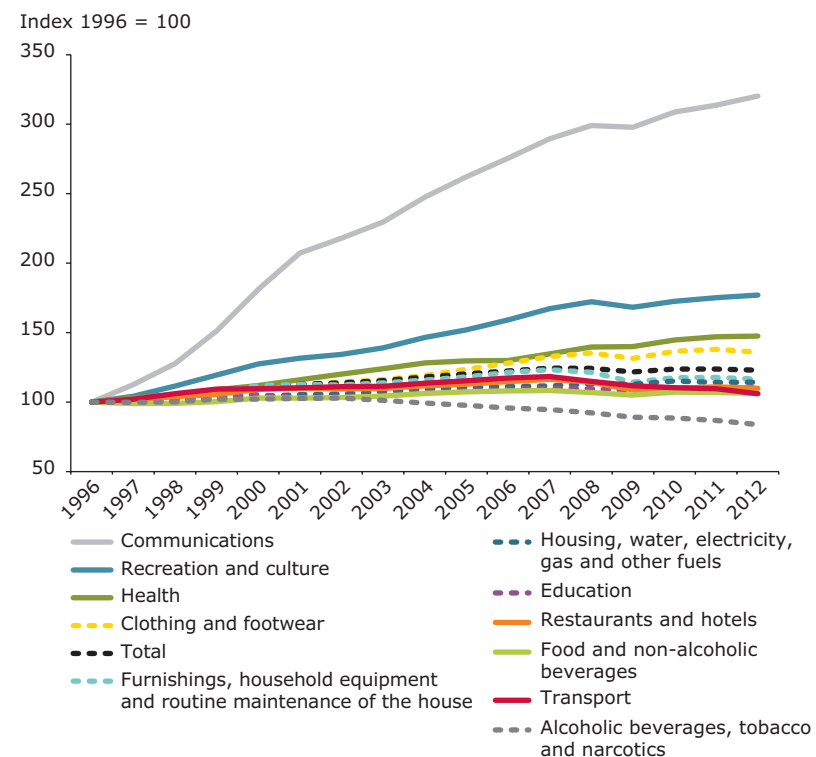
Monitoring the impacts of selected production-consumption systems on the environment more broadly, as is reflected by this report, provides a wider picture, also encompassing the impacts of globalised value chains embedded in trade. Thus, it provides a basis for a more systemic and integrated policy perspective.

Trends in consumption patterns in Europe

Consumption expenditure consists of household final consumption expenditure (i.e. all purchases by resident households to meet their everyday needs) and government final consumption expenditure (i.e. goods and services provided to citizens and financed by tax revenues). This report focuses on household consumption, which dominates total consumption expenditure and represents around 60 % of EU-28 GDP on average over the past one and a half decades.

Household consumption expenditure in the EU-28, Iceland and Norway increased by 23 % in real terms between 1996 and 2012. Total expenditure in real terms fell due to the economic crisis that began in 2007 and has since stayed nearly flat (Figure 2.1). Although expenditure on communications, recreation and culture, as well as health, increased considerably in real terms, their share of total expenditure is still small. Europeans spend on average the largest share of their income on housing (including energy services), transport and food (Figure 2.2). Overall, the relative shares of spending for different consumption categories (in nominal values) have remained rather stable, with the exception of housing. In 2012 European citizens on average spent 24 % of their total expenditure

Figure 2.1 Household expenditure per person by consumption category, EU-28, Iceland and Norway, 1996–2012



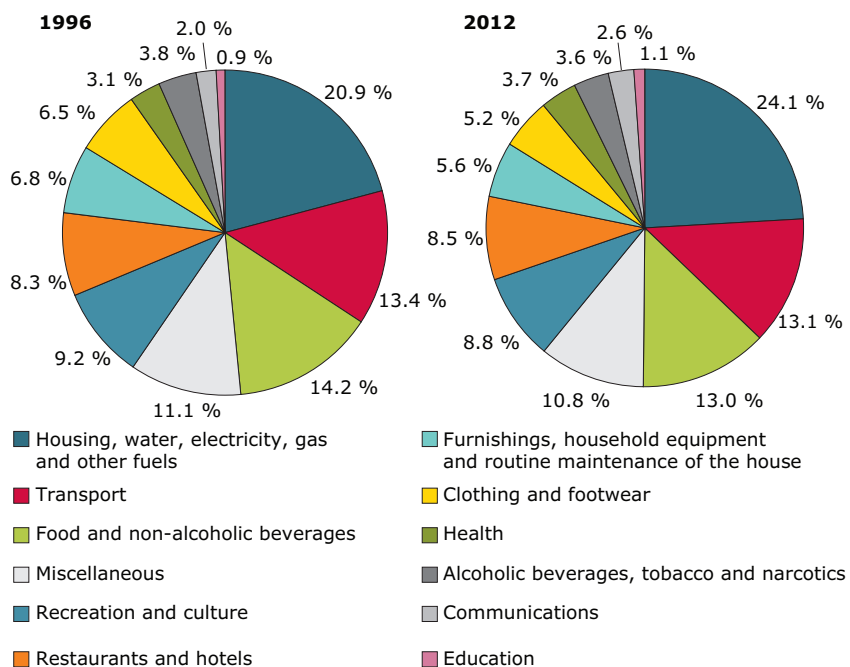
Note: The figure presents expenditure trends in real terms, i.e. adjusted to eliminate the effects of price inflation. The underlying volume trends may reflect changes in the quantity, quality or mixture of goods and services purchased.

Source: EEA indicator SCP 013, based on Eurostat data (Final consumption expenditure of households by consumption purpose — COICOP 3 digit — volumes (nama_co3_k)).

on housing, up from 21 % in 1996. It can be assumed that above-average price increases for housing, including energy, are the main drivers of this.

Interestingly, the share of expenditure on food and non-alcoholic beverages decreased slightly, from 14 % to 13 %, although prices

Figure 2.2 Share of household expenditure by consumption category, EU-28, Iceland and Norway, 1996 and 2012



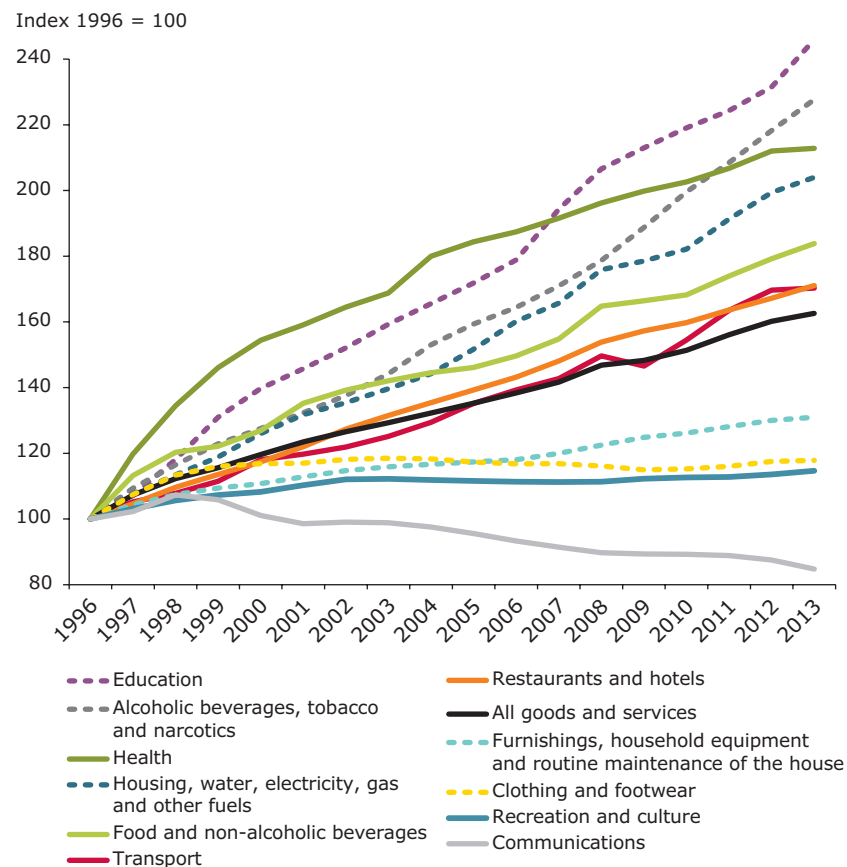
Note: Expenditure in nominal values.

Source: EEA indicator SCP 013, based on Eurostat data (Final consumption expenditure of households by consumption purpose — COICOP 3 digit — volumes (nama_co3_c)).

increased above the average for all consumption categories (Figure 2.3), and absolute expenditure on food and non-alcoholic beverages also increased in real terms. This is in line with a generally observed trend in economic development when, as incomes rise, the share of expenditure on food decreases, while the share of expenditure on less essential items such as tourism, recreation and communication increases. The share of expenditure on clothing also fell slightly, from 7% to 5%. One of the reasons is that clothing prices have remained flat since 2000, making clothes cheaper relative to other goods. A similar picture emerges for furnishings and household equipment, where the share of expenditure decreased slightly while prices increased well below the total consumer price index.

Expenditure on communications, mainly telecommunication services and devices, more than tripled over the period (Figure 2.1). This was driven by rapid development of communication networks and technical innovation in devices, and by a significant decrease in the consumer prices of telecommunications services and electronic devices such as mobile phones, computers and tablets (Figure 2.3). Technological developments and falling prices have resulted in a completely new communications culture.

Figure 2.3 Changes in consumer prices, EU-28, 1996–2013



Source: EEA based on Eurostat data (Harmonised indices of consumer prices (HICP), (prc_hicp_aind)).

Trends in production structure in Europe

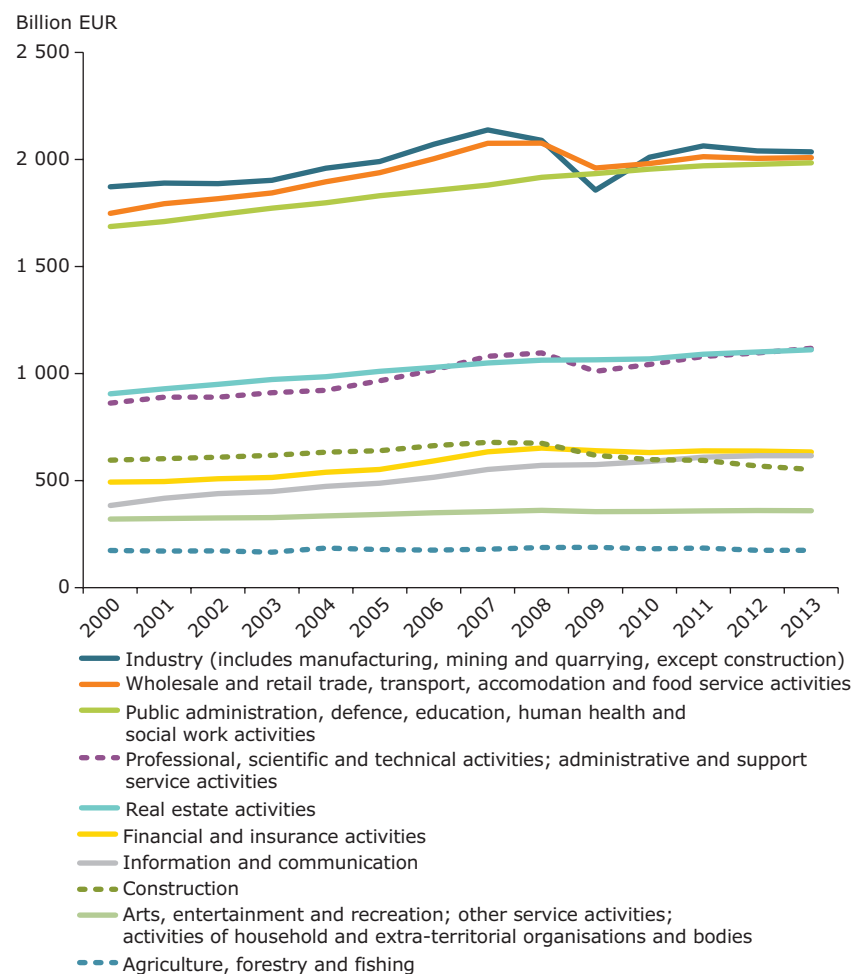
Since 2000 the overall economic structure of the EU (EU-28) has changed, with a decrease in the share of industrial sectors in total gross value added (GVA), and a move towards a more service-orientated economic structure. The largest increase in real terms, 63 % between 2000 and 2013, was in the information and communications sector; the GVA of other service sectors increased by more than 20 % during this period. In contrast, the growth in industrial sectors was about 10 % while the construction sector shrank by 4 % (Figure 2.4).

Figure 2.4 shows that the economic and financial crisis that started in 2007 affected the industrial sector — manufacturing, mining and quarrying — only temporarily, as by 2011 the sector had bounced back almost to the pre-crisis level. The same pattern is also seen for the trade, transport, accommodation and food services sectors. The crisis triggered a decline in the construction sector that was still ongoing in 2013, but did not affect the trend of some service sectors, such as information and communication, or public administration, defence and education.

This growth in the service sectors — comprising all sectors shown in Figure 2.4 except industry, construction and agriculture, forestry and fishing — is also reflected in the increasing share of their contribution to GDP. While the overall contribution of the manufacturing industry to GDP since 2000 has dropped, the European Commission aims to reverse this trend with its commitment to re-manufacture the European economy, aiming at a 20 % share of manufacturing in the EU's GDP by 2020 (EC, 2012a).

The rise in services as a share of GDP is attributed to the higher income elasticities of final demand for services. This shift in demand towards services is a consequence of the increased income of EU citizens over time (EC, 2013b).

Figure 2.4 Development of different economic sectors, EU-28, 2000–2013 (sectoral GVA in 2005 prices)

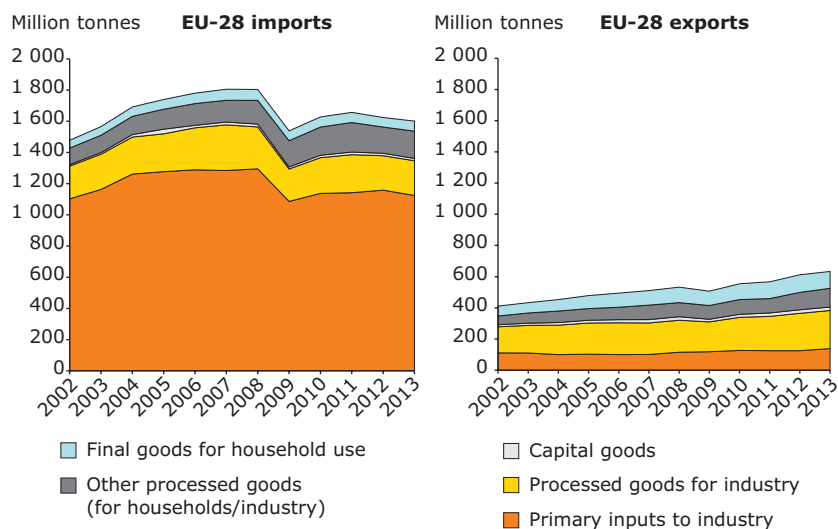


Source: EEA based on Eurostat data (National accounts by 10 branches — volumes (nama_nace10_k)).

Global trade

Europe trades extensively with the rest of the world. In terms of value, imports ⁽²⁾ into the EU-28 only slightly exceed exports from the EU-28 (Eurostat, 2013d). The picture differs significantly for trade in terms of weight, with imports nearly three times exports (Figure 2.5). The most striking difference between imports and exports is the large net import of primary materials, such as fuels, for input to EU production and to a lesser extent the net export of processed goods for final and industrial consumption. Fuels account for the largest share of import volumes (EEA, 2012b). This imbalance in trade volumes, in terms of weight, illustrates the EU's dependency on resources from the rest of the world and has implications for the EU's security of supply of key raw materials.

Figure 2.5 Foreign trade by weight, EU-28, 2002–2013



Source: ETC/SCP elaboration on Eurostat data (EU-28 trade since 2002 by BEC (DS_032655)).

⁽²⁾ Trade is described in this report from an EU perspective: imports thus mean goods/services imported into the EU. Net imports are imports minus exports.

The weight of imported processed goods is rather small compared to imported primary inputs. However, processed goods include, for example, parts for many types of household items such as electronics.

Figure 2.5 illustrates the continuing role of the EU as a manufacturer of goods, but one that relies to a considerable degree on imports of raw materials and exports of primarily finished and semi-finished products. Trade, both imports and exports, has increased over the past decade.

Domestic and global impacts of European production-consumption systems

Production-consumption systems are the direct and indirect cause of manifold environmental, economic and social benefits and impacts. Consumption activities in Europe generate direct pressures, for example by burning fuels, while production activities require resource inputs and generate direct pressures such as emissions.

Environmental pressures from production activities in Europe have, to a degree, decoupled from economic output. For example, in the period 2004–2010, emissions of nutrients and heavy metals to water from manufacturing decreased in most European countries for which data are available (EEA, 2014e), and nutrient emissions from agriculture decoupled from agriculture's economic output in the same period (EEA, 2014c). Emissions of tropospheric ozone precursors (nitrogen oxides, non-methane volatile organic compounds and carbon monoxide), and acidifying air pollutants (ammonia, nitrogen oxides, and sulphur oxides) from production in the EU-27 declined in the period 2000–2007, whereas greenhouse gas emissions and total material input increased, albeit less than economic output (EEA, 2014g).

However, since Europe imports a considerable share of raw materials and intermediate and final products from other regions, the environmental pressures associated with its economic activities spread well beyond its borders. These indirect pressures and their associated impacts are not felt by the consumers of imported goods, whether they are producers or final consumers. Nevertheless, the consumption of these goods can be perceived as the ultimate indirect cause of the impacts.

Figure 2.6 indicates that most of the global environmental pressures caused by EU-27 household consumption, also termed environmental footprints, grew less than household consumption expenditure or decreased in absolute terms in the period 1996–2009. The dominant cause of these trends was improved eco-efficiency in the production of goods and services (EEA, 2012b). However, water and materials use as well as greenhouse gas emissions associated with EU-27 household consumption still increased in absolute terms.

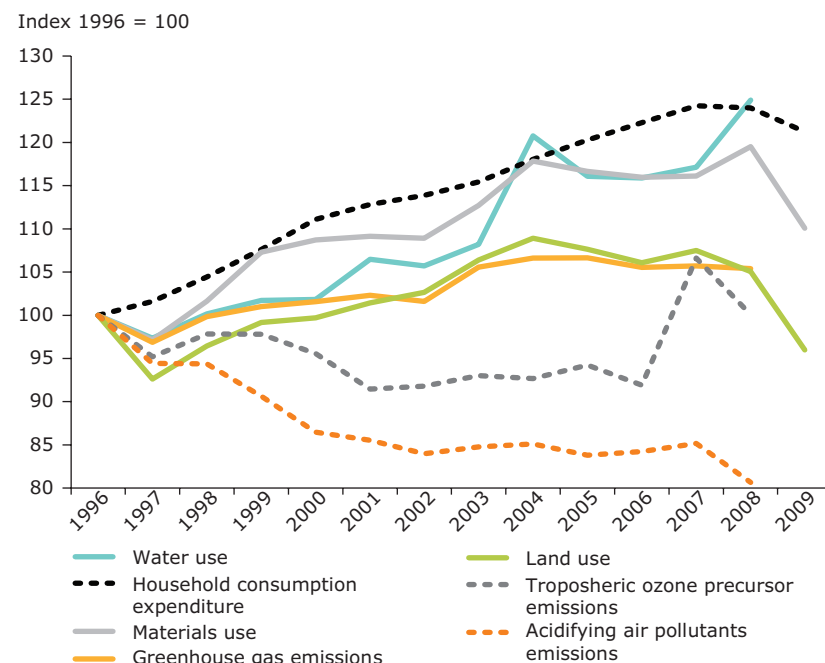
These results are based on analysis of multi-regional environmentally extended input-output models ⁽³⁾ (EC, 2012d). The growth in greenhouse gas emissions illustrated in Figure 2.6 contrasts with the decreasing trends in EU emissions calculated using production-based methods (EEA, 2013f). However, uncertainties related to emissions from a consumption perspective are higher than those related to production-based or territorial emissions (EEA, 2013f). The main reasons for this are that consumption emissions are calculated using data on production emissions and combining them with information on supply, use and international trade of goods and services and their associated emissions.

Another key uncertainty is the limited availability and quality of emission inventory data sets of non-Organisation for Economic Co-operation and Development (OECD) countries. Moreover, detailed data on supply, use and trade are only available with a considerable delay, which is why the environmental footprints in this report can only be shown until 2008/2009. Further development of tools and methodologies is therefore needed to improve understanding of emissions from a consumption perspective (EEA, 2013f).

The environmental footprints shown in Figures 2.6 and 2.7 do not take into account where exactly the pressures occur. For some pressures, such as land use, water use, acidifying air

⁽³⁾ Environmentally extended input-output tables (EE-IOT) combine national accounts, which show flows of money between economic sectors and between economic sectors and final users, with physical accounts of resource use and emissions from sectors. Multiregional EE-IOTs link national EE-IOTs together through their imports and exports. EE-IOTs can be analysed to estimate the resources and emissions caused along the production chains of products for final use.

Figure 2.6 Environmental footprint of household purchases of goods and services, EU-27, 1996–2009



Note: The environmental footprint includes pressures within and outside Europe associated with household purchases of goods and services, but excludes direct pressures emitted by households, for example by burning fuels for space heating or driving a car.

Source: ETC/SCP elaboration based on JRC/IPTS (EC, 2012d) analysis of World Input-Output Database (WIOD) and Eurostat household expenditure data (Final consumption expenditure of households by consumption purpose — COICOP 3 digit — volumes (nama_co3_k)).

pollutants and tropospheric ozone precursors, environmental impacts vary depending on the location of emissions or resource use. For example, water use is of more environmental concern in water-stressed areas. The figures therefore give only a rough picture of the actual environmental impacts related to European consumption. Moreover, the water footprint includes the consumption of surface water, groundwater and rainwater as well as the volume of freshwater that is required to assimilate the load of pollutants based on existing ambient water quality standards. It can be argued that

rainwater consumed is of less relevance than, for example, surface and groundwater. In addition, water and land use management have to be subject to regional sustainable management as an answer to global environmental pressures. The analysis would thus profit from a more detailed investigation of the links between water consumption and the water catchment areas of origin and from splitting the footprints up according to different types of water footprints, but this type of analysis is currently not available.

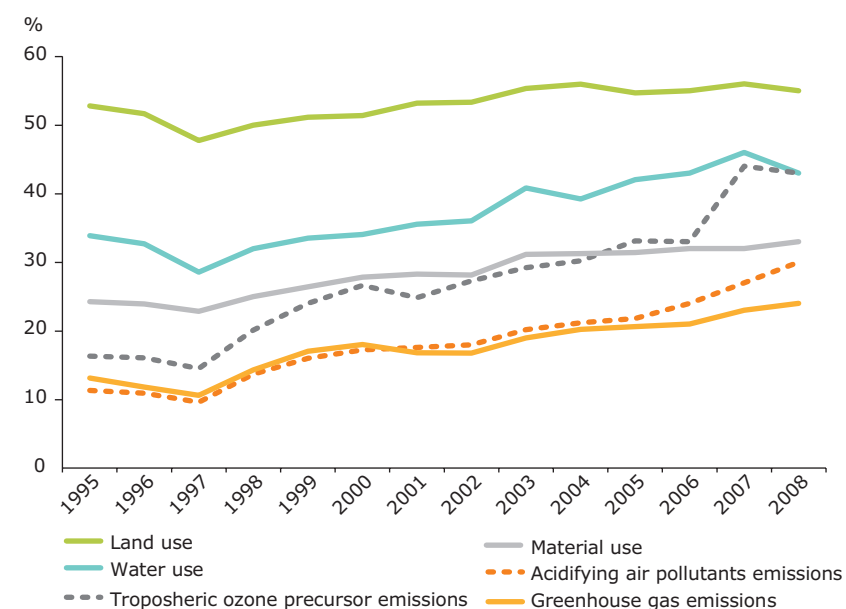
A considerable share of environmental pressures associated with consumption in the EU-27 is felt outside the EU's territory (Figure 2.7). Depending on the type of pressure, between 24 % and 56 % of pressure occurs outside the EU, with the highest share for land use and the lowest for greenhouse gas emissions. In addition, the shares of all environmental pressures associated with consumption in the EU that are felt outside EU borders increased during the period 1995–2008 ⁽⁴⁾ (Figure 2.7).

Environmental impacts from activities outside Europe can be local, regional or global, and thus can also have repercussions on Europe's environment and population. This is particularly the case for greenhouse gases released during the whole production chain of imported products.

Production-consumption systems support the material needs of European citizens for nutrition, shelter, mobility, clothing, recreation, etc., and they create jobs and income. The average European citizen has benefited from increasing incomes and falling consumer prices for some goods, especially imported products such as clothes and consumer electronics. However, there are huge differences in incomes, and thus also in consumption levels and patterns, both between countries and within many European countries. For example, 17 %

⁽⁴⁾ No explanation has been found for the significant increase in the share of the tropospheric ozone precursor (TOP) footprint occurring outside the EU-27. It may be the result of an error in the World Input-Output Database (WIOD) that was used to produce the results shown in Figure 2.7. TOP emissions in the countries not included as separate regions in the WIOD and collectively denoted 'Rest of the World' rose dramatically between 2006 and 2007. This increase was due to a large increase in emissions of carbon (CO) and non-methane volatile organic compounds (NMVOCs) in the production of refined petroleum products. However, no explanation could be found for this.

Figure 2.7 Share of the environmental footprint exerted outside EU borders associated with the EU-27's final demand, 1995–2008



Note: The footprint relates to total final demand, comprising household consumption, government consumption and capital investment.

Source: ETC/SCP elaboration based on JRC/IPTS analysis of World Input-Output Database (WIOD) (EC, 2012d).

of EU-27 citizens were assessed to be at risk of poverty in 2011, and 20 % or more in Bulgaria, Greece, Lithuania, Romania and Spain. Moreover, 9 % of the EU population suffers from severe material deprivation, i.e. they are not able to afford some items considered by most people to be desirable or even necessary to lead an adequate life (Eurostat, 2013b).

Trade in consumer goods, intermediates and raw materials also creates economic and social benefits in the countries exporting to Europe: for example, around a fifth of global employment is linked to trade (EEA, 2014h). However, working conditions, including health and safety, vary largely between the countries Europe is trading with, as well as between economic sectors and social groups.

The International Labour Organisation (ILO, 2013) states that many workers, especially in developing countries, are affected by work-related deaths and injuries, often women, children and migrants. Work in agriculture, fishing and mining, for example, often includes potentially hazardous activities (ILO, 2013).

On the other hand, the production of goods exported to Europe might have contributed to the considerable changes in global income distribution, with high growth, particularly in China and to a lesser extent India, lifting a large number of people out of extreme poverty (Lakner and Milanovic, 2013).

Focus on food, electrical and electronic goods and clothing

The key consumption areas of food, housing and mobility account for the highest overall shares of household consumption expenditure as well as for more than two thirds of key environmental pressures (EEA, 2012c), if analysed from a life-cycle perspective. This includes all the environmental pressures related to the use phase and to all the upstream processes during the production of goods and services related to food, housing and mobility. These areas have been analysed in some detail by the EEA and others at the European level (EEA, 2012c, 2013e; EC, 2006, 2012d).

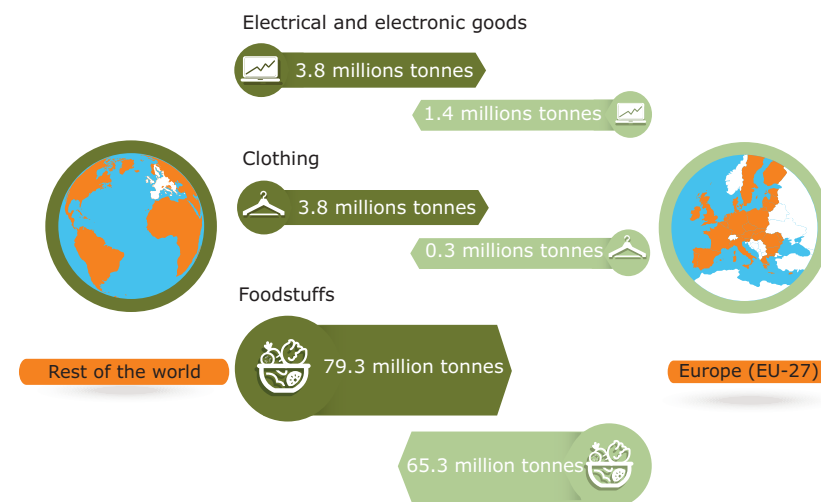
This report, however, is concerned with production-consumption systems that are characterised by a high degree of globalisation in their supply chains, and by substantial environmental pressures. While in general supply chains are becoming longer throughout the economy (in terms of number of production stages), more complex and more international, the longest supply chains were identified in the production of motor vehicles, basic metals, electrical machinery, textiles and food (De Backer and Miroudot, 2012).

Production-consumption systems with these characteristics pose specific challenges to policymakers since the environmental and social consequences associated with them lie largely outside the direct influence of European policy. A combination of various approaches will be needed to reduce the overall pressures from such systems. Food, electrical and electronic goods and clothing have

been chosen as examples to illustrate these challenges. All three systems are characterised by an imbalance between imports and exports to and from Europe, with imports exceeding exports by a factor of 1.2 (food) to 11.2 (clothing) by weight (Figure 2.8).

In addition, imports account for an important and increasing share of consumption in Europe in all three areas: clothing imports accounted for 87 % of European clothing consumption (by value) in 2012, up from just 33 % in 2004, and imports of electrical and electronic goods accounted for 74 % of consumption, up from 50 % in 2007 ⁽⁵⁾. However, the EU also exports such goods; taking this into account, net imports accounted for 59 % of clothing consumption, and for 38 % of consumption of electrical and electronic goods (Eurostat, 2013d).

Figure 2.8 Trade balance for food, electrical and electronic goods and clothing by weight, EU-27, 2012



Note: Food trade includes live animals. Data for food refer to 2010.

Source: ETC/SCP and EEA based on Eurostat data (EU trade since 1988 by CN8 (DS-016890)); Eurostat (2011).

⁽⁵⁾ Due to the complexity of food trade patterns, a similar calculation for food is not available.

Of the three systems, food contributes heavily to a large range of environmental pressures including greenhouse gas emissions, emissions of acidifying air pollutants and tropospheric ozone precursors, and material, water and land use. Pressures associated with food (together with drink and tobacco) range from 17 % of greenhouse gas and tropospheric ozone precursor emissions to 64 % of land use caused by household purchases in the EU (EC, 2012d).

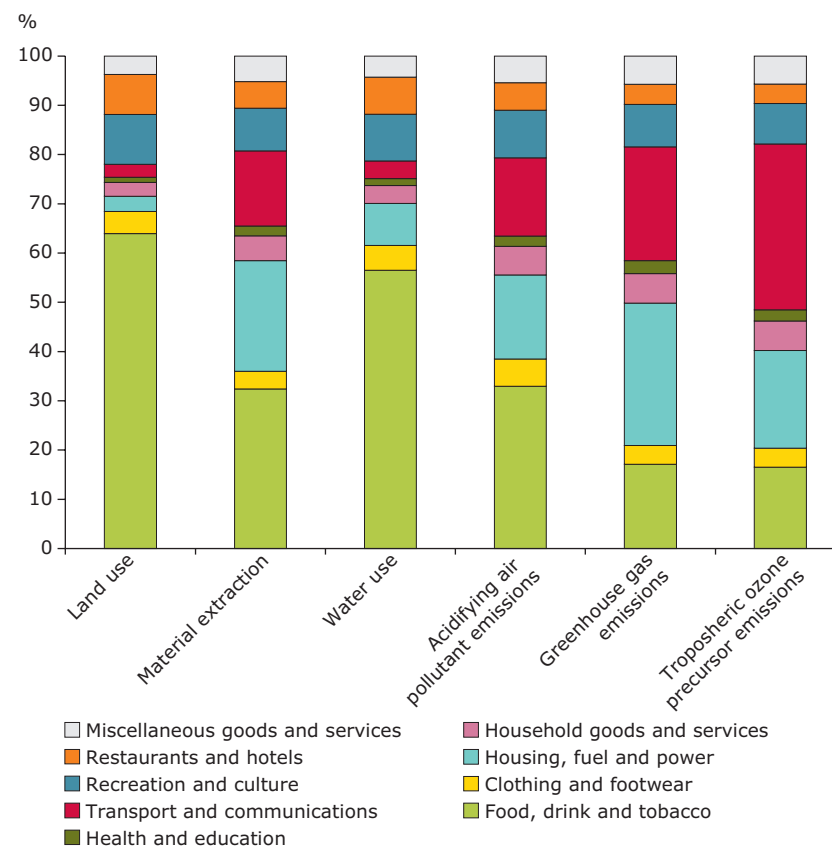
Clothing and footwear is responsible for 4–6 % of the aggregated pressures (Figure 2.9). Previous EEA analysis using a different methodology broadly confirmed these findings. It also identified food, including non-alcoholic beverages, as contributing between 16 % and 34 % to greenhouse gas emissions, acidifying air pollutant emissions, tropospheric ozone precursor emissions and materials use, whereas clothing and footwear were found to contribute around 1 % to pressures caused by private household consumption (EEA, 2012c). In these studies, pressures from electrical and electronic goods are dispersed across several consumption categories and are thus difficult to quantify because of the high degree of sectoral and product aggregation in the models.

Currently available multi-regional environmentally extended input-output models do not include information on chemicals released to the environment associated with the consumption of products and services in Europe.

However, using alternative methods, the Swedish Environmental Protection Agency and the Swedish Chemicals Agency have identified textiles and electrical and electronic goods as two important sectors with respect to potential impacts from chemical pollution (SEPA and KEMI, 2011). For example, more than 1 900 chemicals used in textile production were identified in a non-exhaustive mapping exercise by the Swedish Chemicals Agency of which 165 are classified as hazardous with respect to health or the environment under the EU's 2008 Classification, Labelling and Packaging Regulations (KEMI, 2013).

Although the three production-consumption systems that are the focus of this report represent a large share of EU consumption coming from imports, their associated manufacturing sectors in the EU are far from insignificant in size. Moreover, these EU

Figure 2.9 Share of the EU-27's global environmental footprints caused by different household consumption categories, 2008



Source: ETC/SCP elaboration based on JRC/IPTS analysis of World Input-Output Database (WIOD) (EC, 2012d).

sectors ⁽⁶⁾ showed widely varying economic performance between 2000 and 2012. The output of the textiles sector fell by 24 % during this period (in real terms). The economic performance of the food and beverages sector was positive (+ 7 % in real terms), but still lower

⁽⁶⁾ Food and beverages (C10–C12), textiles and apparel (C13–C15), and computer, electronics and electrical equipment (C26 and C27) — all NACE rev2 classification.

than the overall performance of the economy (+ 17 % GVA). The situation in the manufacture of electrical and electronic goods was mixed: manufacture of electrical goods increased by only 3 % (GVA) compared with a staggering 81 % for the manufacture of electronic equipment during the period (Eurostat, 2014h).

The steep increase in output of the manufacturing sector of electronic equipment, including computers, was, however, not reflected in employment figures — the sector reduced its workforce by 23 % between 2000 and 2011. The growth in output of the other sectors studied in more detail was also achieved with a reduced workforce. Employment in agriculture, forestry and fishing went down considerably more (– 20 %) than in the food manufacturing sector (– 3 %). Not surprisingly the textile sector faced the biggest loss (– 43 %) in terms of employment (Eurostat, 2014b), reflecting the substantial shift of textiles manufacturing to countries outside the EU .

The large degree of globalisation of the production-consumption systems of food, electrical and electronic goods and clothing, combined with their considerable environmental impacts and their social and economic importance, thus warrants closer investigation. They serve as examples for a better understanding of system dynamics and trends, and for investigating possible opportunities for change.

3 Factors and global megatrends shaping the environmental impacts of production-consumption systems

Key messages

Production-consumption systems are shaped by an array of factors that create lock-ins to largely unsustainable systems; ways out of lock-ins are essential if sustainability visions for 2050 are to be realised.

Factors influencing production-consumption systems include prices, income and taxation; trade and global production chains and their impacts on prices; technological advances, new business models and marketing; urbanisation and infrastructure developments; demographic patterns related to the size and structure of the population; and, critically, social and cultural factors such as habits, social norms and heritage.

Global megatrends also have a major influence on production-consumption systems. In particular, populations are expanding and increasingly being concentrated in very large cities. Global economic output is projected to increase almost fivefold in the period 2000–2050, and from 2010 to 2030 the number of middle-class consumers could increase from 1.8 billion to 4.9 billion worldwide. These and other megatrends are substantially altering global demand for goods and services and their impacts on the environment.

Factors shaping the environmental impacts of production-consumption systems

Existing production-consumption systems largely define what consumers perceive as normal, affordable, available and socially acceptable, and what producers and distributors perceive as profitable, low risk and well-established. Production-consumption systems are shaped by an array of interrelated factors, including:

- economic factors such as income, trade, prices, taxation, availability of resources and capital;
- demographic factors;
- technology and innovation;
- urbanisation and infrastructure;

- social and cultural factors;
- business models and marketing.

Economic factors driving production-consumption systems

Production-consumption systems reflect a complex interaction between the supply side (production of goods and services) and the demand side (private, intermediate and public consumption).

On the demand side, the most important factors influencing consumption patterns are the degree of disposable income at the individual household level and prices (OECD, 2008). The change in demand resulting from a change in price depends on the price elasticity of that particular product or service. For example, price elasticities for basic food items such as bread, milk and eggs are lower than for restaurant meals, as going to a restaurant is much easier to avoid than purchasing basic food. In other words, when the price for basic food items increases, then the consumption only decreases a bit because of low price elasticity. But increases in prices in restaurants would result in large decreases in consumption because of high price elasticity.

Consumption also includes intermediate consumption by private companies (business-to-business) and government consumption, so the level of funding available for spending by private companies and public authorities is also an important shaping factor. Business-to-business consumption depends very much on the economic situation of the private sector, while public-sector consumption depends very much on political priorities including fiscal policies, and on finance being made available from income and other taxes.

On the supply side, the goods and services put on the market depend to a large extent on economic production factors, including labour, energy and materials costs in particular, but also on available investment, production technologies, infrastructure, and trade and other regulations. Trade liberalisation combined with lower labour costs and less regulation in many developing countries can act as driving forces for a shift towards the production of goods consumed in Europe to other regions of the world. Some sectors, including the

metals, telecommunications, electrical, textiles, food and chemical sectors have been particularly affected by relocations since 2000 (EP-ITRE, 2006).

The effects of resource use on the environment and society, such as the full costs of preventing and cleaning up pollution or climate change mitigation, are in many cases not included in the prices of goods and services. Instead, the costs associated with negative effects are mostly paid for by the wider society. This lack of internalisation of external effects — the costs to society of environmental degradation — in the prices of products and services represents a market failure that drives production-consumption systems on the basis of high resource use and large environmental impacts.

Demographic factors shaping production-consumption systems

Production-consumption systems in Europe are by their nature also shaped by the size of the population, the distribution of the population across various age groups, the share of the population that is an active part of the workforce, the location of people and the workforce, the number of people per household, and the living space available per person. The total population of Europe has been increasing, albeit slowly, acting as a driver of total household consumption expenditure: the EU-28 population reached 506 million in January 2013 (Eurostat, 2013a).

Another demographic trend is towards smaller and therefore more households, with an increase in the number of households of 10 % in the period 2005–2013 (Eurostat, 2014a), whereas population only grew by 2 % in the same period (Eurostat, 2014c). Drivers behind this trend include increasing numbers of divorces, decreasing birth rates, ageing and changing lifestyles. With fewer people in each household and the increase in one-person households, each person on average takes up more square metres. This has led to higher demand for space and increases in stocks of household appliances and consumer goods (EEA, 2012c). One-person households consume on average 38 % more products, 42 % more packaging and 55 % more electricity per person than four-person households, as well as producing significantly more waste per person (Williams, 2007; Gram-Hansen et al., 2009).

Technology and innovation as drivers of production-consumption systems

Technology and innovation have changed production and lifestyles significantly. They have completely reshaped what can be produced, how fast and at what cost, transforming the goods and services available for private and public consumption. The emergence of convenience foods and a variety of household appliances, combined with modern information and communication technologies, have changed our systems and patterns of mobility, recreation and leisure activities, and food consumption beyond recognition compared to those of only one or two generations ago.

Markets and policies play an important role in deploying technological changes. Competition encourages innovative and improved products, and variety and novelty are cornerstones of modern life. When new goods and services first enter the market they are often considered luxuries and are typically expensive. As the market for early adopters saturates, companies may lower their profit margins or produce cheaper versions in order to maintain or increase sales (Mont, 2007). This process means that once-luxury goods become part of normal consumption patterns, as has happened with cars, personal computers and mobile phones.

Urbanisation and the role of infrastructure in production-consumption systems

Most European consumption takes place in cities and towns: just below 75 % of EU citizens live in urban areas and this is expected to grow to 80 % by 2050 (UN, 2012b). Urban density and the design of the built and natural environments of cities can therefore play a crucial role in shaping consumption and production patterns. Furthermore, many rural residents in Europe have to a large extent adopted urban lifestyles and luxuries, working in towns or cities and using other urban services. However, they often commute long distances and on average use more living space per person. Overall, urban densities allow more efficient energy, transport and housing systems (EEA, 2010c).

Industrial production now seldom takes place in city centres since less space is available there and real estate prices are higher than

in suburban or rural areas, and also because local environmental regulations are often more stringent in city centres to mitigate the health impacts of pollution. Instead, industrial production often now takes place in industrial centres around large cities that provide adequate access to both workforce and infrastructure resources.

Social and cultural influences on production-consumption systems

People's behaviour is greatly influenced by the lifestyles of friends, family and colleagues and increasingly by the lifestyles, both real and fictional, portrayed in the media. People want to belong to a social group, and they look towards others and behave in a manner consistent with prevailing norms in order to establish their status within it (Government Communication Network, 2009). Consumer culture encourages many to seek status or a place in society through the purchase of material possessions and other lifestyle choices. In this way, consumption is used to help construct personal and collective identity. Fitting in with social groups is a crucial driver of consumption, as people use goods to signify and maintain both membership of a group and status within it.

In addition to group identity, personal identity can also be a relevant psychological driver of consumption as people are not born with a fixed identity, and in the Western world roles are no longer defined by tradition. People have a strong need to define their own identity, and their material possessions may play an important part in this (Halkier, 1998). A further psychological factor is the symbolic role goods play in daily lives: possessions are not only functional and personal, they may also have meanings to others.

Research confirms the commonly held belief that people are led more by desires than by actual needs; this is often used in marketing campaigns, based on the idea that people respond more strongly to desires than to rational ideas (Belk et al., 2003; Kahneman, 2011). Desires are strongly influenced by the media, marketing and popular culture (Henderson, 2005). As the basic needs of most Europeans have been met, the advertising industry is increasingly creating new desires to ensure that consumers buy new products. This is known in marketing as problem recognition: the consumer is prompted to perceive a need or want, and is motivated to act upon it (Belch and Belch, 2007).

Many consumption decisions and behaviours are driven by habit as well as context (Gronow and Warde, 2001; Shove, 2003; Michie, 2013) rather than by rational and conscious decision-making processes, and they become stronger every time they are repeated, which is one reason why they can be difficult to change. History and cultural norms also play a role in shaping consumption choices.

Business models and marketing

Production culture and business models are largely based on a model that aims to maximise the number of products sold, and on a linear take-make-dispose pattern in which producers are not responsible for their products after they have been sold (EMF, 2013a). In addition, past investment in production systems and infrastructures has in many cases created lock-ins to systems that rely heavily on fossil fuels and cheap supply of materials, such as the current European transport system with its high dependence on fossil-fuel-based private car use and road transport of goods. A focus on labour productivity has resulted in considerably slower growth in the productivity of materials in the EU than the growth in labour productivity and to some degree also energy productivity (EEA, 2010b, 2012b).

There are high pressures on businesses towards short-term thinking, especially for those operating on the stock market and aiming for shareholder value maximisation, and companies are more inclined to use tried and tested business models and technologies than trial new ones (Holmén and Fallahi, 2013).

In recent years, a trend can be seen in the development and implementation of new business models that enable more sustainable lifestyles and a more circular economy. These include initiatives by some of the largest global companies to introduce product-service systems that enable consumers to buy access to a service rather than buying a product (examples include leasing of cars, car-sharing schemes, buying access to light rather than light bulbs, leasing of white goods just to mention a few), to design products more sustainably, or to enable reuse and recycling of waste (WEF, 2014, 2013, 2012; Henriksen et al., 2012). But it also includes initiatives by smaller companies or groups of citizens to lease for example clothing, or for consumers to become prosumers who produce their own energy or food. Although many of these new business models are

still relatively small-scale, they are intensively discussed at important business and policy events such as the World Economic Forum and the Global Green Growth Forum. And a successful up-scaling of such business models, for example for reasons of increased raw material costs, could significantly change production-consumption systems in the future.

Global megatrends affecting production-consumption systems in Europe

At different times in the past 200 years, countries across the world have begun to shift from largely agrarian, rural societies towards urbanised, industrialised and service-based economies. This global process of social and economic transition can be broken down into a number of social, technological, economic, environmental and political global megatrends (EEA, 2014a), with linked and far-reaching implications for individual nations and citizens.

Globally, populations are expanding and concentrating in cities. In combination with better health and education, and accelerating technological innovation, these trends have driven growth in economic output, boosting resource demand and environmental burdens. As these processes have extended beyond today's developed regions to encompass the hugely more populous developing regions, in particular Asia, the impacts of these megatrends are becoming much more pronounced.

The pace and scale of current social and economic change is remarkable. Global economic output, for example, is projected to almost triple in the period 2010–2050 (EEA, 2013b). The share of OECD countries in global output is expected to roughly halve in that period, from 77 % to 42 % (EEA, 2013c). Extraction of resources – biomass, minerals, fossil fuels, metals – may more than double (EEA, 2013a). And in just two decades, from 2010 to 2030, the number of middle-class consumers could increase from 1.8 billion to 4.9 billion (EEA, 2013c).

Most of these global megatrends affect consumption in Europe, directly or indirectly. In some respects, they offer potential benefits to European consumers: for example, the rebalancing of economic

output across the world and the increasing integration of global markets enable Europeans to access a wide range of goods and services from locations with comparatively low labour costs. Similarly, accelerating technological change offers Europeans access to new types of goods and services, including more efficient and environmentally friendly ways of meeting their everyday needs.

But many of the megatrends also have the potential to undermine living standards. For example, rapid growth of the middle class in developing regions — and associated changes in diets, motor vehicle ownership and material consumption more generally — are likely to increase competition for resources, potentially driving up product prices. The effect of such trends could be to depress the spending power of consumers in Europe and elsewhere.

Growing global competition for resources could also threaten security of access to some goods and services, particularly those relying on a selection of commodities designated as critical raw materials (EEA, 2013a). More broadly, pollution, greenhouse gas emissions and demands on ecosystems associated with escalating global consumption present significant threats to the environment and human well-being.

Managing these impacts requires new forms of coordination, but the sophistication of global economic systems is not currently matched by similarly integrated systems of governance. The constraints on national and intergovernmental policy making leave a significant gap in global governance that can partly be filled by business and civil society activities.



THEMATIC INDICATOR-BASED ASSESSMENTS

Part 2 Thematic indicator-based assessments

Chapter 4 Food

- Production-consumption system trends
- Impacts on the environment and society
- Opportunities for change

Chapter 5 Electrical and electronic goods

- Production-consumption system trends
- Impacts on the environment and society
- Opportunities for change

Chapter 6 Clothing

- Production-consumption system trends
- Impacts on the environment and society
- Opportunities for change

4 Food

Key messages

The food system in Europe is part of the global food market in which food and animal fodder are increasingly traded across the globe. The increasing trend in imports of food to the EU indicates that a considerable share of life-cycle environmental impacts related to food consumption in Europe is felt outside the region.

Food is the household consumption category with the highest embedded environmental pressures, with meat and dairy having the highest impacts per kilogram of product. One third of the animal fodder for meat and dairy production is imported to the EU, causing substantial consumption of water and energy, high demand for land, and even land conflicts, among other issues, in countries beyond Europe.

In addition, a gradual shift from low- to high-intensity farming has resulted in loss of semi-natural habitats rich in biodiversity, while high amounts of greenhouse gases are emitted across the food supply chain.

Food wastage is nowadays seen as the key challenge in terms of increasing resource efficiency and reducing environmental impacts; nevertheless, manifold opportunities for prevention and reduction are possible across all parts of the food system.

Looking towards 2050, opportunities for change across Europe's food system span from further greening agricultural and fisheries policies, through creating sustainable supply chains and changes in diets, to substantially reducing food wastage. Responsibility for change lies with all actors, from governments to producers, retailers and consumers.

Production-consumption system trends

The food system

Some 7 % of the world's population lives in the EU. What consumers buy and eat affects the entire value chain and life-cycle impacts of the food production-consumption system within and beyond Europe's borders. Europeans' habits create and stimulate food production processes and influence the global food market. However, food

demand is shaped by other key actors in the food system, thereby determining which and how many natural resources are used, and this influences the impacts on the environment. Food producers find their own ways to place and promote various types of products, influencing diets and decisions on how much to buy, and determining the price. But food production is also an expanding industry that provides jobs and social security, encourages rural development, and helps to ensure food security.

The main purpose of a food system is to ensure food security. Food system activities/elements can be described in terms of the food supply or value chain (Figure 4.1) as:

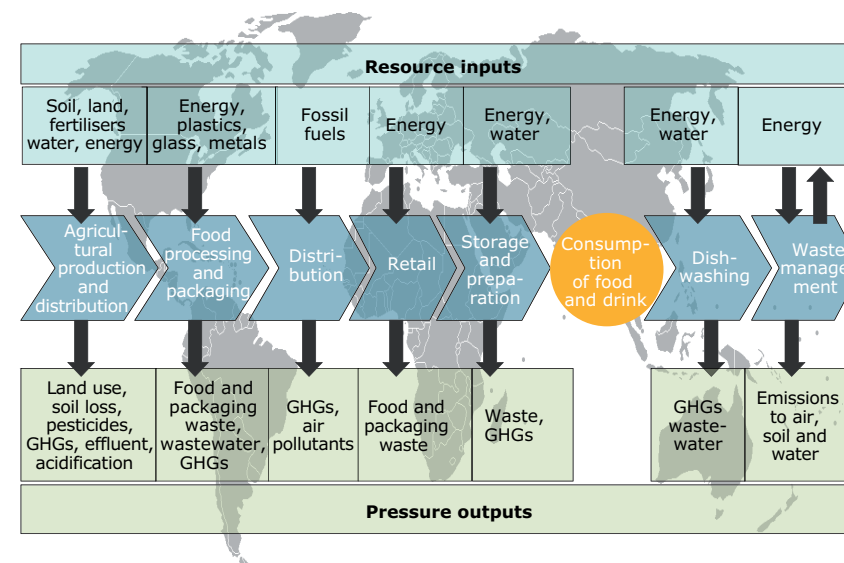
- production phase, covering food production, processing and packaging;
- distribution phase, including transport infrastructure, trade, retail and storage;
- consumption phase, including food preparation and storage at home;
- waste phase, including waste generation ⁽⁷⁾ and management.

Food consumption in Europe

The factors that influence patterns of food consumption include demographics, availability of food products, economic factors, cultural and personal preferences, social values, education and health. All play an important role in decisions about purchasing and preparing food (EC, 2008a; ESF, 2009). To analyse the drivers more closely, this chapter focuses on the most common food products consumed by average European households, such as meat, dairy, fish and seafood, cereals, fruits and vegetables. Non-alcoholic and alcoholic beverages

⁽⁷⁾ It is important to mention that food wastage is generated across the entire food system, creating additional environmental burdens. According to the UN Food and Agriculture Organization (FAO) definition, food wastage includes food losses (that occur in the production, post-harvest and processing stages) and food waste (that arises at the retail and consumption stages). The food wastage concept should be distinguished from waste defined by the EU's Waste Framework Directive (EU, 2008).

Figure 4.1 Simplified overview of the key elements of the food system



Source: EEA (2012d), revised.

and catering services ⁽⁸⁾ are generally excluded from the analysis, unless they form an integral part of the particular data set.

Economic drivers of food consumption

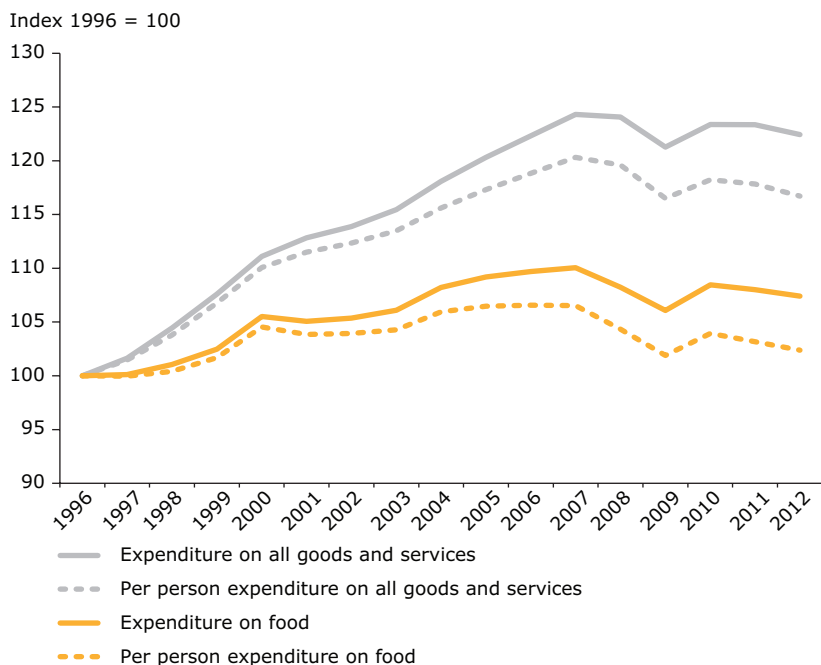
The main drivers of what and how much food ends up on a consumer's plate include economic factors such as disposable income and food prices, and availability of food products. Household expenditure per person on food in the EU-28 increased by less than 3 % in real terms between 1996 and 2012 (Figure 4.2), while aggregated household spending per person grew by 17 %, with two

⁽⁸⁾ In some countries such as Austria, household expenditure is as high for catering services — including eating in restaurants and canteens — as for direct food purchase; each covering approximately 10 % of expenditure (Eurostat 2014e). Considering also that data on catering services are not readily available for all the European countries covered in this report, caution is needed when interpreting particular indicators (Figure 4.4).

periods of decrease reflecting the economic downturn. The share of food in total household expenditure fell slightly, from more than 13 % in 1996 to 12 % in 2012 (Figure 4.4).

The drop in household expenditure on food and on all products and services from 2007 onwards can be explained by the economic crisis that started that year, with the largest effects on low-income households. Expenditure on food in these households represents a significant share of their budget, limiting their food choices (EC, 2008a).

Figure 4.2 Real final consumption expenditure on food compared to all goods and services, EU-28, 1996–2012

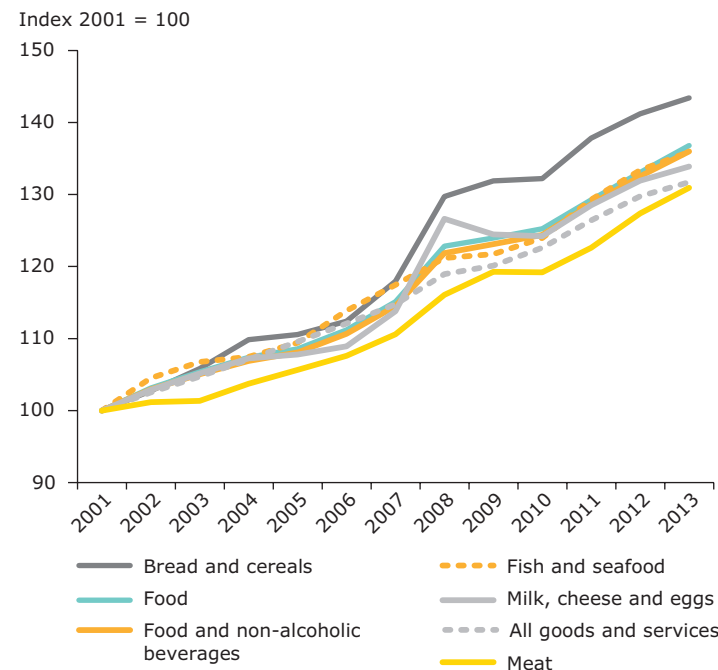


Note: The figure presents expenditure trends in real terms, i.e. adjusted to eliminate the effects of price inflation. The underlying volume trends may reflect changes in the quantity, quality or mixture of goods and services purchased.

Source: Adapted from the SCP013 indicator, based on Eurostat data (Final consumption expenditure of households by consumption purpose — COICOP 3 digit — volumes, nama_co3_k).

Figure 4.3 shows changes in consumer food price (°) indices for different products between 2001 and 2013 (Eurostat, 2014f). Food consumer price indices in the EU-27 increased by more than 3 percentage points per year on average over this period, slightly higher than the increase in overall consumer price indices. However, food prices increased — and more rapidly than consumer prices for average goods — between 2006 and 2008. Comparable trends are observed for different food products, but with differences between

Figure 4.3 Consumer price indices for food and all goods and services, EU-27, 2001–2013



Note: HICP = harmonised indices of consumer prices. Data on food subcategories are available for the EU-27 from 2001 only.

Source: EEA and ETC/SCP based on Eurostat data (HICP (2005 = 100) — annual data (average index and rate of change)).

(°) The price of food at each step of the supply chain can be split into three parts: agricultural commodity price, producer food price and consumer food price, for every individual food commodity/product (EC, 2009a). This report uses data pertaining only to the final consumer food price.

processed foods such as cereals and dairy products (up to 18 percentage points) and unprocessed food such as meat and fish (up less than 10 percentage points). Processed food is based on the raw commodities most affected by fluctuations in international food prices (EC, 2008a).

Starting in 2007, several increases in international agricultural commodity and oil prices strongly influenced inflation in Europe, resulting in a rapid increase in consumer food prices, which reduced European household purchasing power by around 1 % (EC, 2008a).

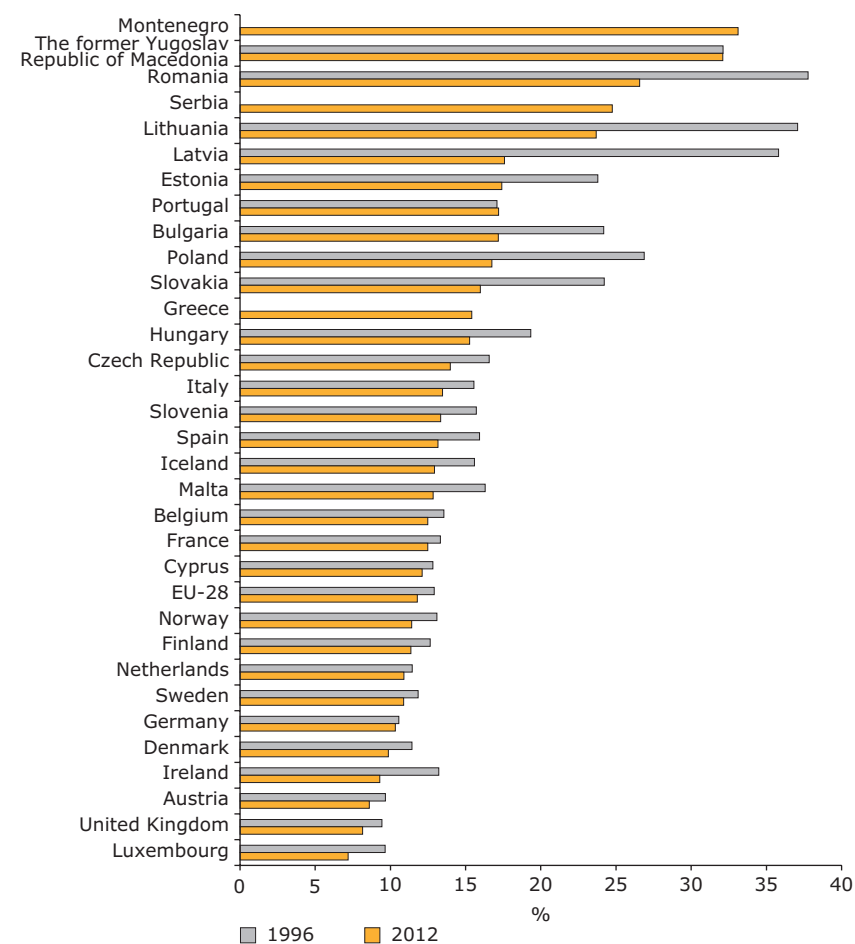
Country-by-country analysis of 32 European countries reveals significant differences in the share of household spend on food, ranging from more than 30 % in the former Yugoslav Republic of Macedonia and Montenegro in 2012, to less than 10 % in Luxembourg, the United Kingdom, Austria and Ireland. The extremes coincide with the lowest and highest food prices as well as available household incomes. Almost all the countries for which data are available show a declining trend in food expenditure as a share of household expenditure between 1996 and 2012, with the sharpest drop, of 50 %, recorded in Latvia, where food represented 36 % of total consumption expenditure in 1996 but only 18 % by 2012 (Figure 4.4).

In the EU-28, price level indices in 2012 show that food products were generally cheaper in Member States that joined the EU as of and after 2004, the only exception being Cyprus. In 32 European countries, the highest price levels were in Norway, Switzerland and Denmark, and the lowest in the former Yugoslav Republic of Macedonia.

The correlation between disposable income levels and spending on food in 27 European⁽¹⁰⁾ countries for 2012 is shown in Figure 4.5. The highest expenditure is in Norway and Luxembourg, where real disposable income per person exceeds EUR 30 000, and the lowest in Bulgaria. In countries with lower disposable incomes, consumers tend to spend a higher share of their income on food than in countries with higher disposable incomes. However, there is a marked divergence in spending on food between countries of similar wealth, suggesting that factors other than income play an important role in shaping consumption choices.

⁽¹⁰⁾ The 27 European countries represented here differ from the EU-27.

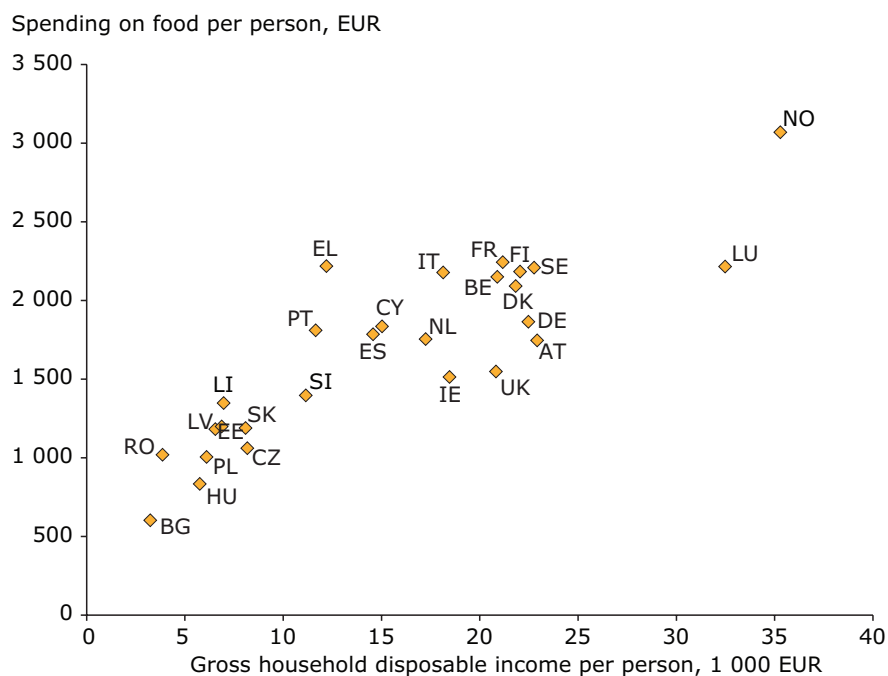
Figure 4.4 Household expenditure on food as a proportion of total household expenditure in selected European countries, 1996 and 2012



Note: 1996 data are not available for Greece, Montenegro and Serbia. Data for 2012 are missing for several countries and have been filled by data of the closest available year. Specifically, for Norway, Greece, Bulgaria and the former Yugoslav Republic of Macedonia instead of 2012, 2011 data have been presented. For Romania 2010 data have been used instead of 2012 data, and for Lithuania, 2009 data have been used instead of 2012 data.

Source: EEA and ETC/SCP based on Eurostat data (Final consumption expenditure of households by consumption purpose — COICOP 3 digit — aggregates at current prices, nama_co3_c).

Figure 4.5 Per person spending on food and per person household disposable income in selected European countries, 2012



Note: AT: Austria, BE: Belgium, BG: Bulgaria, CY: Cyprus, CZ: Czech Republic, DK: Denmark, EE: Estonia, FI: Finland, FR: France, DE: Germany, EL: Greece, HU: Hungary, IE: Ireland, IT: Italy, LV: Latvia, LI: Lithuania, LU: Luxembourg, NL: Netherlands, NO: Norway, PL: Poland, PT: Portugal, RO: Romania, SI: Slovenia, SK: Slovakia, ES: Spain, SE: Sweden, UK: United Kingdom.

Due to lack of data for 2012, 2011 data are used for Bulgaria, Greece and Norway, and 2010 data for Romania.

Source: EEA based on Eurostat data (Final consumption expenditure of households by consumption purpose — COICOP 3 digit — aggregates at current prices (nama_co3_c), Non-financial transactions (nasa_nf_tr), and Demographic balance and crude rates (demo_gind)).

Consumption patterns in Europe

When purchasing food, consumers are influenced by a wide range of factors including price, quality and dietary issues, as well as habits and marketing-related factors such as product brands and product placement campaigns. There are also health issues, such as obesity, related to the level and type of food consumed. More than half of the EU adult population was overweight or obese in 2008/2009 (Eurostat, 2011; EEA, 2013d).

Food consumption per person in the EU-28 increased by more than 3 % between 1995 and 2011 (EEA, 2014b), in line with increases in GDP and household purchasing power⁽¹¹⁾. This general upward trend, however, hides a change in the mix of food products consumed and dietary shifts driven by rising incomes, price incentives and changing lifestyles. Consumption levels for different food products vary noticeably between European countries (EEA, 2013d, 2014b).

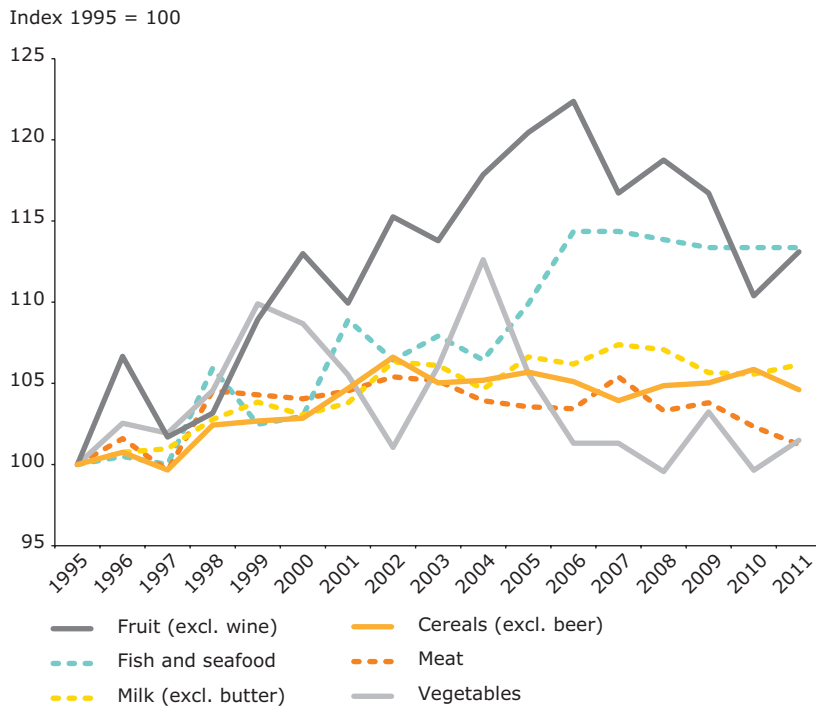
As can be observed in Figure 4.6, meat consumption per person in the EU-28 remained broadly stable over the period 1995–2011, influenced by increasing prices and changing preferences. In the same period, consumption of fish and seafood per person rose by more than 13 %, associated with a shift in dietary preferences, and growing demand for open-water and freshwater fish and seafood, in particular crustaceans such as prawns or mussels, and cephalopods such as squid. The increase in consumption of other food types, such as fruit, milk, vegetables and cereals, ranged from less than 2 % to 13 %.

Food production in Europe and trade flows with the rest of the world

The turnover of the European food and drink industry has increased steadily, to more than EUR 1 000 billion in 2012. It currently represents the largest manufacturing sector in the EU and employs more than 4 million people. Its GVA represents 2 % of EU GVA (FoodDrinkEurope, 2013; Eurostat, 2014g).

⁽¹¹⁾ Caution is needed when interpreting data on food production, consumption and trade balance as the data were extracted from two different sources — FAO and Eurostat. Data sometimes have different temporal coverage.

Figure 4.6 Trends in consumption of selected food products (quantities), EU-28, 1995–2011



Note: Data for milk exclude milk products such as butter and cheese.

Source: EEA SCP 020 indicator, based on FAO data (Food supply database; Livestock and fish primary equivalent and Crop primary equivalent data sets).

European food products are increasingly traded internationally. In terms of value in 2012, the EU was a net exporter of food and drink products with a trade balance of EUR 23 billion. Nevertheless, the EU's share of global exports has been gradually declining, from more than 20 % in 2002 to slightly above 16 % in 2012 (FoodDrinkEurope, 2013).

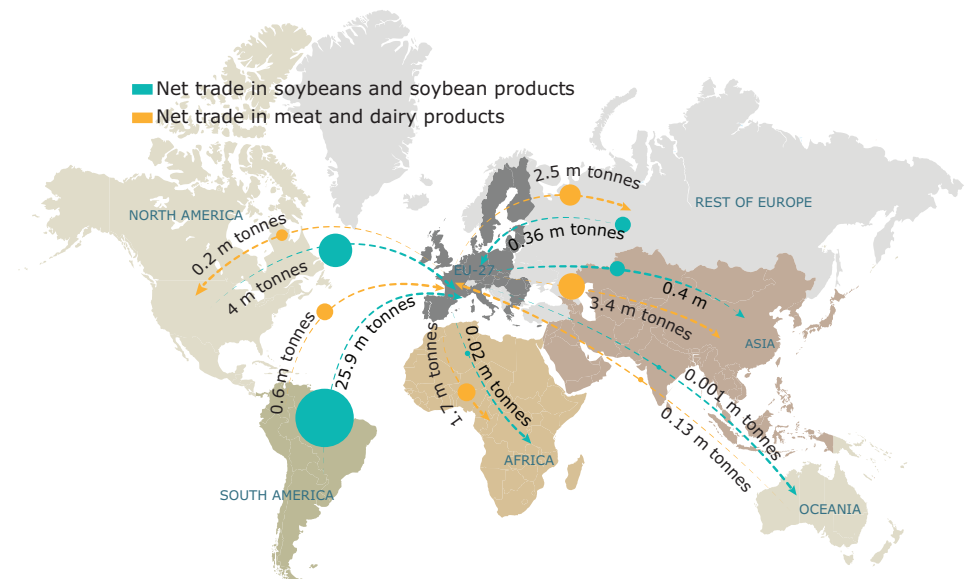
Statistics over the past decade indicate a steady rise in key food products imported to the EU, with the exception of dairy products. This could indicate increasing food dependency on imports, as well as a possible increase in the related environmental pressures experienced outside the EU.

Quantities of imported meat more than doubled between 1995 and 2011, with the largest exporters being Brazil, New Zealand and Thailand. Moreover, the EU imports more than 30 million tonnes of soybeans and soybean products (Figure 4.7), much of which is used as fodder for meat and dairy production (Eurostat, 2011, 2013c).

In terms of agricultural production, almost half the EU-28 livestock population, including poultry, was concentrated in three countries in 2010: France, Denmark and the United Kingdom. Total meat production was 42 million tonnes, of which more than half was pork. The largest EU producers of pork were Germany, Spain, France, Poland and Denmark (Eurostat, 2011).

Imports of the majority of fish and crustacean products, mostly processed fish, increased between 2000 and 2010 by 44 % to nearly

Figure 4.7 Net trade flows in soybean, meat and dairy products between the EU-27 and other world regions, 2012



Note: The flows are a mixture of products for final consumption and intermediate products.

Source: ETC/SCP and EEA based on Eurostat data (EU trade since 1988 by CN8 (DS-016890)).

5 million tonnes. Norway was the largest supplier to the EU-27, accounting for more than 21 % of all imports, followed by China with 10 %. Imports of prawns and shrimps come mostly from Asian countries. Aquaculture production is also increasing on a global scale, by 7 % per year (Eurostat, 2011; EC, 2014a).

The largest quantities of fish caught in EU Member States in 2010 were in the Netherlands, Spain, Denmark, France, Ireland, Italy and Germany, with a combined 2.6 million tonnes, equal to those of Norway and Iceland put together. Aquaculture in Europe accounts for about 20 % of fish production. As aquaculture production in the EU-28 has been steady since 1995, increasing consumption has been met by imports (Eurostat, 2011; EEA, 2011a; EC, 2014a).

Imports of cereals increased by 26 % between 2000 and 2010, to more than 10 million tonnes, mainly from Canada, the United States, Brazil and Argentina (Eurostat, 2011).

Imports of dairy products declined to only 0.24 million tonnes in 2010, a very small quantity compared with EU-27 milk production of around 149 million tonnes in 2009. Milk production quotas were introduced in the mid-1980s and are currently being phased out (Eurostat, 2011).

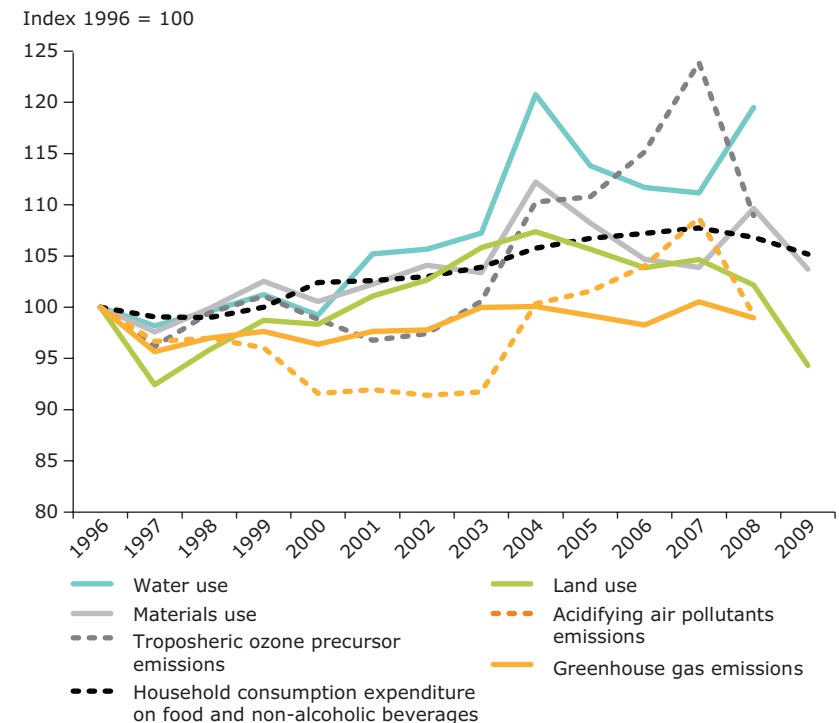
Impacts on the environment and society

Food is the household consumption category with the highest embedded environmental pressures, causing more than one third of acidifying air pollutant emissions and one sixth of greenhouse gas and tropospheric ozone precursor emissions (EEA, 2013d). The demand for food requires significant natural resources, in particular land, water and energy, and leads to environmental impacts (emissions, waste) and other impacts (social, economic, health), at each stage of the production-consumption system (Figure 4.1), far beyond European borders. Increasing imports imply that the cumulative effects of European food consumption are increasing beyond EU borders.

Figure 4.8 shows that global pressures from the consumption of food and non-alcoholic beverages were higher in 2009 than in 1996, with the exception of greenhouse gas and acidifying air pollutant

emissions, which remained stable or declined. This is despite household consumption expenditure on food only increasing slightly in the same period (Figure 4.2). Following the economic crisis, all environmental pressures except the water footprint dropped rapidly – and far more rapidly than expenditure.

Figure 4.8 Global environmental footprint caused by household purchases of food and non-alcoholic beverages, EU-27, 1996–2009



Note: Global pressures caused by household purchases of all products, which have been allocated to the classification of individual consumption by purpose category (COICOP) for food and non-alcoholic beverages. It does not cover household storage and preparation of food or management of household food waste. Caution is needed when comparing pressures with expenditure as they might include different groups of products.

Source: ETC/SCP elaboration based on JRC/IPTS analysis of World Input-Output Database (WIOD) (EC, 2012d) and Eurostat household expenditure data (Final consumption expenditure of households by consumption purpose – COICOP 3 digit – volumes, nama_co3_k).

Box 4.1 Environmental impacts of the global food system

The current global food system is responsible for:

- 2 billion hectares of arable land degraded over five decades by unsustainable agricultural practices, with a 2–5 million hectares degraded annually;
- 70 % of freshwater consumption;
- nearly 21 % of fossil-fuel use;
- 30 % of total global greenhouse gas emissions;
- 80 % of deforestation as a result of agricultural expansion;
- a 75 % decline in global fish stocks associated with uncontrolled overfishing and habitat degradation;
- genetic erosion, species loss and conversion of natural habitat caused by food production (considered to be the main global driver).

Source: UNEP, 2012a.

Impacts of the production phase

Embedded pressures vary greatly between food categories. Meat and dairy products have the highest global footprint of carbon, raw materials and water per kg of any food. This is due to low conversion efficiency caused by the high land and energy demands of fodder inputs (EEA, 2013d). For example, production of 1 kg of beef requires 617 litres of water, known as the blue water footprint (i.e. use of surface and groundwater for irrigation and processing). Production of 1 kg of cheese requires 254 litres of water, and 1 kg of tomatoes, 64 litres of water (Water Footprint Network, 2014). Irrigated agriculture is one of the largest consumers of water in the EU, especially in southern Europe, with low-efficiency equipment, methods and practices accounting for a very high proportion of this.

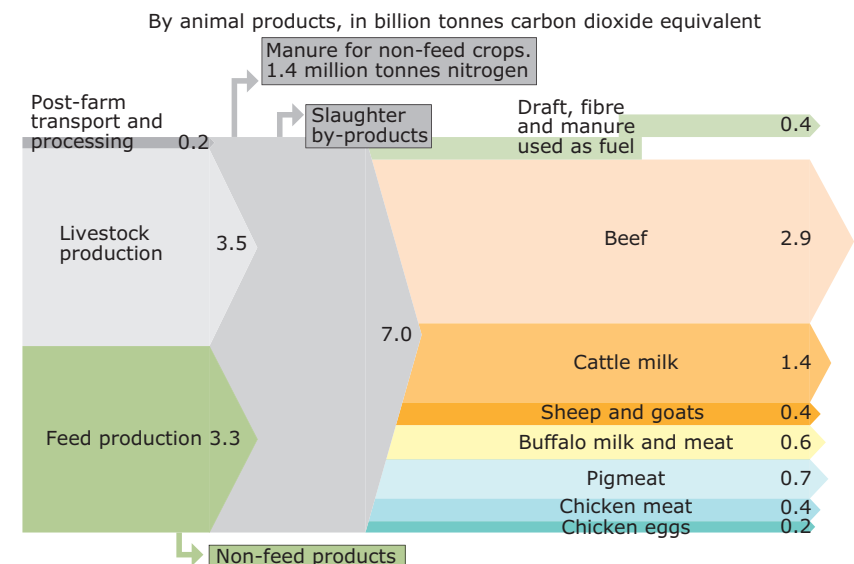
The consumption of meat and dairy products is responsible for a significant fraction of the global environmental impacts caused by EU consumption as a whole: it contributed, on average, close to 25 % of the environmental impacts from the total consumption (domestic final use) of all goods and services in the EU-27, while constituting only 6 % of the economic value. Total EU consumption of meat and

dairy products is also responsible for a particularly large share, around 20–50 %, of aquatic eco-toxicity, acidification, eutrophication and nature occupation⁽¹²⁾ (EC, 2008c).

In terms of greenhouse gas emissions (Figure 4.9), the production of livestock and fodder globally generates more than 3 billion tonnes each of carbon dioxide equivalent. Post-farm transport and processing account for a tiny fraction of these emissions.

More than one third of European meat consumption is met by imports⁽¹³⁾. Meat production in countries such as France, Denmark

Figure 4.9 Greenhouse gas emissions from the global livestock supply chain



Source: Heinrich Böll Foundation and Friends of the Earth Europe (2013), based on FAO data. Reproduced with permission.

⁽¹²⁾ The life-cycle assessment impact category 'nature occupation' refers to the impacts of land use (for agriculture in this case) on the ecological quality of the land compared to what was there previously.

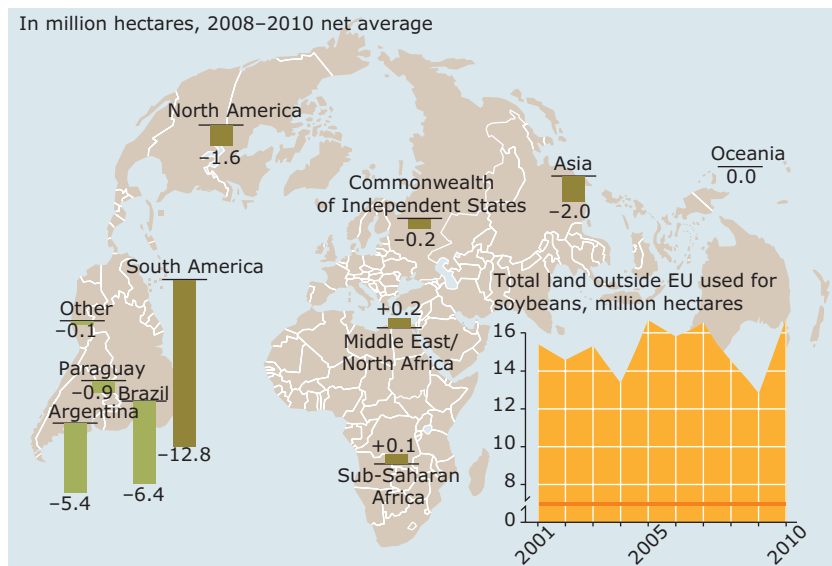
⁽¹³⁾ Figures on imports to the EU should be interpreted with caution as percentages are calculated from different databases (Eurostat and FAO), and sometimes for different years.

and Germany is responsible for significant local environmental problems, with high emissions of nitrogen, phosphorus, effluents and waste, as well as degrading land, water, air and soil (EEA, 2013a).

European meat production also depends on the import of large quantities of fodder, amounting to 30 % of total consumption in 2010, a rate that has been stable for more than a decade. Cattle are no longer fed only on grass, but also with concentrates based, for example, on maize, wheat and soybean. Crops intended for feed are transported over long distances with manure also often shipped elsewhere to be spread on fields, adding to transport-related environmental pressures (Heinrich Böll Foundation and Friends of the Earth Europe, 2013).

Nearly one third of the world's cultivated land is being used to grow animal feed. In the EU alone, 45 % of wheat production is used for this purpose, with 30 % of overall use met by imports. Figure 4.10 shows land used around the world to provide the EU with soybeans, another

Figure 4.10 Land used to grow soybeans for European consumption



Source: Heinrich Böll Foundation and Friends of the Earth Europe, 2013. Reproduced with permission.

important fodder crop. In Brazil and Argentina, expanding soybean cultivation has caused semi-natural habitats high in biodiversity to be lost (Underwood et al., 2013) while fodder production competes directly with Brazil's well-established bio-ethanol production sector, creating a source of land conflicts.

Within the EU, high-nature-value, low-intensity farming systems with fairly rich biodiversity are in decline (EEA, 2013d). For example, one of the indicators is a fall in the population of grassland butterflies, which almost halved in two decades due to the shift in rural land use (EEA, 2013g).

With respect to fish and seafood, close to two thirds of current European demand is met by imports. It is difficult to assess environmental implications, as they depend on which fish species are being consumed, the changing status of fish stocks and the fishing methods used. Currently about one third of commercial fish stocks in the North-East Atlantic and half of the assessed commercial fish stocks in the Mediterranean Sea are being fished beyond safe biological limits. Further increases in fish consumption may increase pressures on these stocks (EEA, 2011a, 2011c, 2014b).

Aquaculture, the farming of finfish, shellfish and aquatic plants which accounts for about 20 % of fish production in Europe, is one of the world's fastest-growing food sectors, supplying about half of fish demand worldwide. Different types of aquaculture generate very different pressures on the environment, the main ones being discharges of nutrients, antibiotics and fungicides (EC, 2014a; EEA, 2011a).

Impacts of the consumption and waste phases

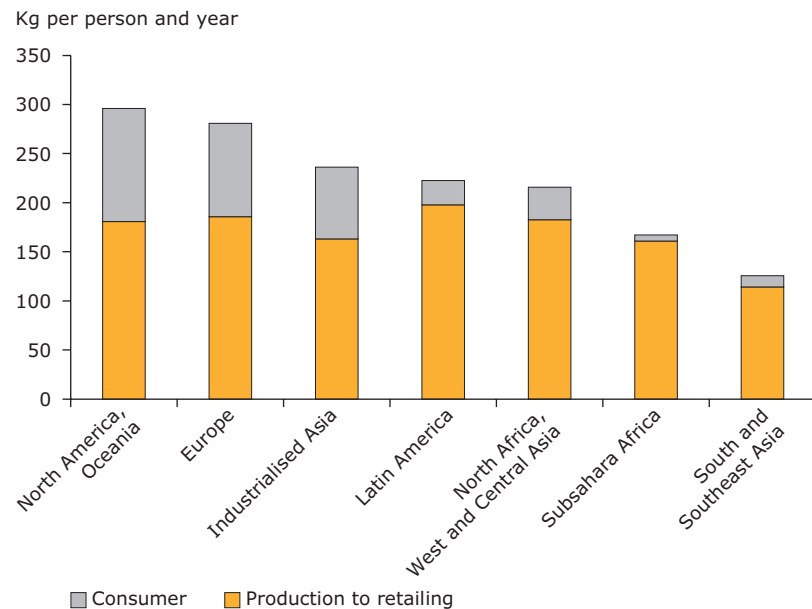
Food waste occurs along the entire food supply chain and has important environmental and economic implications. According to the FAO (2013), at the global level roughly one third of the food produced for human consumption, excluding fish and seafood, is wasted, amounting to about 1.3 billion tonnes per year, with direct economic costs of USD 750 billion. Annual food waste also causes the emission of 3.3 billion tonnes of greenhouse gases every year (FAO, 2013). In developed countries, food waste is mainly generated at the retail and consumption stages; in the developing world losses at the production,

harvesting, processing and transport stages predominate (UNEP, 2012a). Figure 4.11 shows the relative contributions to per person food wastage of the production and consumption phases across the globe.

Underwood et al. (2013) estimated that the overall proportion of food wasted along the entire food chain in the EU-27 represented roughly a sixth of the food produced — 138 million tonnes a year, or about 280 kg per person. Estimates for individual EU Member States range from 398 kg per person in the Netherlands to 171 kg in Slovakia (Underwood et al., 2013).

Another study suggested that annual food waste generated in the EU-27 to be 179 kg per person in 2008, but did not include food waste from agricultural production and post-harvest handling

Figure 4.11 Average food wastage per person



Note: In this graph Europe extends to 42 countries. Gustavsson et al. (2011) advise caution in using these particular data sets as they are based on rough estimates.

Source: Gustavsson et al. (2011), reproduced with permission.

(Bio Intelligence Service et al., 2010). Projections for food waste in the EU suggest an increase of 40 % by households by 2020 if no action is taken, mainly due to population growth and increasing affluence (Bio Intelligence Service et al., 2010).

According to FAO (2013), 'the further down the value chain a food product is wasted, the greater the environmental consequences, since the environmental costs incurred during processing, transport, storage and cooking must be added to the initial production costs'. Wastage of cereals in and from Asia is an important problem, having major impacts on carbon emissions, water and land use. Wastage of meat is comparatively low across the globe, with high-income countries and Latin America generating 80 % of all meat wastage (FAO, 2013).

Opportunities for change

Changes in agricultural policy and practice and liberalisation of the food market over the past 50 years have 'increased the world's capacity to provide food for its people through increases in productivity, greater food diversity, and less seasonal dependence' (Kearney, 2010). The food system has changed considerably as a result of production shifting from traditional to industrial, the growth in income levels and falling food prices, and globalisation and international trade, with the EU, United States, China, India and Brazil frontrunners in the global market (EEA, 2013d; FoodDrinkEurope, 2013).

Nevertheless, major challenges to and opportunities for change remain. Although Europe has indigenous production of many food products, obtaining secure supplies from other regions may become increasingly difficult because of the limitations and fragile nature of the global food market. Slower responses to ever-increasing demand and sudden shifts in food prices could seriously affect the average consumer at the end of the chain (EC, 2008a). Box 4.2 gives some of the reasons for change required over the next 40–50 years to reconfigure the current food system to work more efficiently, and to improve the security of food supplies in a way that does not jeopardise the environment and health, yet still keeps up with economic growth.

Current policies, practices and actors influence how the food system functions. The EU has established policies in several areas

Box 4.2 Outlook for the global food system

The global population is projected to increase from 7.6 billion to more than 9 billion by 2050. It is expected that more than two thirds of the population will live in urban areas and income levels are predicted to double. The FAO suggests that, in order to feed this large, more urban and richer population, food production will have to increase by 70 % (FAO, 2012).

Europe's population is expected to increase by 3 % by 2060 (Eurostat, 2014d) and consumption by 5 % (EEA, 2013d). In addition, the latest Intergovernmental Panel on Climate Change (IPCC) *Summary for Policymakers* (IPCC, 2014) suggests severe climate change implications for human health, global food security and economic development, affecting natural systems — water resources, biodiversity and sea levels — across the globe.

A number of projections indicate reductions of more than 25 % in the yields of maize, rice and wheat by 2050, with possible increases afterwards. Many fish species, a food source for a large proportion of the population, are expected to migrate because of changes in ocean temperatures. Catches could decline by more than 50 % in some parts of the world, including the tropics and Antarctica, and ocean acidification might worsen the situation. On land, animals, plants and other organisms are expected to begin to move towards higher ground or the poles (IPCC, 2014).

to bring together aspects of production and consumption such as agriculture, rural development, fisheries, aquaculture and food safety (in particular food labelling and food quality), and link them to existing environmental policies. In terms of practices, the focus is on options for increasing agricultural productivity while adapting to the impacts of climate change, including reducing emissions from agriculture, reversing the decline in farmland biodiversity, reducing food waste, and redirecting bio-waste to bioenergy production. Although governments and governmental interventions play an important role in shaping the food market, there are also several other key actors in the decision-making process along the food supply chain (EC, 2014a; Underwood et al., 2013).

Production-phase opportunities

Europe has the capacity and resilience to respond to the increasing challenges facing the food system. In particular it has a highly productive food system, relatively robust soils, a good balance of high- and low-intensity farming systems, developed infrastructure

and support services across the EU Member States, and a number of research institutions. The reform of the Common Agricultural Policy (CAP) has triggered contrasting views: one supporting an immediate increase in production volumes and another putting stronger emphasis on sustainability and greening (Underwood et al., 2013).

According to the EEA (2013d) 'the CAP (EU Common Agricultural Policy) still lacks an overarching strategy addressing agriculture's resource efficiency and its impact on carbon, water and nutrient cycles'. Production-based interventions, such as agricultural subsidies, could be better geared towards practices with lower environmental impacts, for example organic farming, with increases in overall resource efficiency in terms of external chemical inputs, water and energy use, land use and waste generation.

One priority for the EU is to conserve its own productive resources in order to respond better to unpredictable challenges and future food demands. This could be achieved by proper management and maintenance of key resources such as agricultural land, soil, water supplies, infrastructure, a highly skilled workforce, sophisticated supply industries, and research capacity (Underwood et al., 2013), thereby taking into account the multi-functional role of agriculture.

The European Parliament's Science and Technology Options Assessment (Underwood et al., 2013) sees innovation and the sharing/replicating of best practices as the core of the EU's agriculture sector, which should increase yields and European competitiveness worldwide and maintain a high level of production. However, this could prove difficult because European crop yields are already very high, and because of challenges such as the unpredictable nature of climate change and shortages of water. The issue is further linked to the debate about the precautionary principle in the area of genetically modified organisms (GMOs) in overall bioscience developments.

A shift towards consumption of more products from organic farming is also an option. Comparisons of organic and non-organic production on the basis of life-cycle assessment show mixed results for different products (Williams et al., 2014). Reduced impacts resulting from no inputs of artificial fertilisers and lower animal-feed inputs are often offset by greater direct energy use

and the application of manure. However, organic farming can be beneficial in terms of biodiversity and eco-toxicity due to the lower intensity of land use and a reduced use of pesticides, though these are not well recorded by life-cycle assessment methods. Moreover, organic farming tends to preserve soils in the long term and is being promoted through the European Action Plan for Organic Food and Farming.

Nonetheless, organic farming is often, at least in the short term, less productive per hectare than non-organic farming (Williams et al., 2014), and thus requires more land, though these differences might reduce considerably when viewed over a longer period (Maeder et al., 2002). All other things being equal, a major shift to organic production would mean either more biodiversity-rich land being taken into production or an increase in imports leading to greater environmental impacts overseas. However, a significant shift to organic farming without increasing imports or land under production could occur if the shift were accompanied by a complimentary move towards diets with a lower meat and dairy content and therefore lower demand for land (EEA, 2013d).

There is a need to align existing European policies on agriculture, food, environment and biodiversity with bioenergy policies. The biofuels sector competes with the food sector as a result of a policy target, currently under review, designed to promote the use of renewable energy in the transport sector (Underwood et al., 2013).

Finally, the food industry and retailers have an option to engage in improving their supply-chain management, and to work towards reducing environmental and social impacts upstream, for example by setting sustainability standards for the raw materials and intermediate products they purchase.

One way of increasing the transparency of supply chains is to shorten them. Local food production and direct sales from farm to consumer have become more widespread in Europe over the past few years. A number of EU Member States have developed supportive frameworks for local production. France, for example, produced an action plan in 2009 to develop a shortened food chain and Italy has established legislative decrees for the regulation of farmers' markets (EC, 2013d). At the EU level, the European

Commission proposed that short supply chains be subject to thematic sub-programmes within rural development programmes of the CAP (EC, 2010c).

As well as reducing environmental impacts from the transport of food and food waste, a move towards short supply chains would support small farms and put consumers more closely in touch with food production. This would increase awareness of environmental impacts, seasonal food, nutrition, etc.

Consumption-phase opportunities

More sustainable production of food should be complemented by dietary shifts and a reduction in food waste by European consumers. One challenge is to reduce European demand for animal-based food (EEA, 2013d; Underwood et al., 2013) — the average European's consumption of meat, dairy, eggs and fish is around twice the global average, which implies a higher environmental footprint.

Reducing red meat and dairy consumption can have both environmental and health benefits. A 2009 study by the European Commission Joint Research Centre's Institute for Prospective Technological Studies (JRC/IPTS; EC, 2009b) investigated the environmental implications of a switch to healthier diets in Europe.

Two of the three healthy-diet scenarios investigated included a reduction in the consumption of beef and pork by around 60 % in favour of chicken and fish (although it might increase the pressure on fish stocks), and one of these, the so-called Mediterranean-diet scenario, also included a 9 % reduction in the consumption of dairy products: according to the study, a 100 % shift to this diet across the EU-27 would reduce overall environmental impacts related to food consumption by around 8 %. The other two healthy-diet scenarios resulted in lower but still positive gains, though these gains diminished somewhat when rebound effects were taken into account (EC, 2009b).

Careful choices in policy packages and instruments are necessary if citizens are to be guided towards healthier diets with lower environmental impacts. Change may be achieved by combining different measures, including raising awareness, increasing

acceptance of green economic incentives, and nudging⁽¹⁴⁾ consumers towards more sustainable choices. Examples of nudging include making more sustainable options the standard and most easily accessible choice in canteens or supermarkets (Underwood et al., 2013).

If consumers are to make informed choices, proper information needs to be clearly displayed on food products. Misleading and unclear food labels, for example best-before and use-by dates often confuse customers, and lead to still-edible food being discarded. Opportunities to improve this situation include streamlining food labelling and a review of the regulations underpinning it (including product traceability and impact measurement), with a view to abolishing some types of labels for some foods, alongside information campaigns by governments and retailers (Underwood et al., 2013).

An initiative by the European Food Sustainable Consumption and Production Round Table to establish the Environmental Assessment of Food and Drink Protocol – the ENVIFOOD Protocol – aims to facilitate consumer choice for green products. The protocol represents the first sectoral framework methodology that integrates both global (ISO) and EU (Product Environmental Footprint – PEF) standards in order to provide specific guidance for conducting an environmental footprint assessment in the food, feed and drink sector (EC, 2013b).

Other opportunities include replacing standards based on the appearance of food with standards related to quality, such as nutritional value, growing conditions, purity and taste (Underwood et al., 2013).

Role of retailers

Retailers have multiple options to reduce consumers' environmental impacts from food, including influencing choice by, for example, only

⁽¹⁴⁾ Nudging is an umbrella term for attempts to influence the choices of people without limiting their free choice. Nudging recognises that people are not rational beings, but rather beings with inertia to change, bounded willpower and influenced by biases and habits (The Danish Nudging Network, 2014). Nudging as a means to stimulate behavioural change among individuals and communities in support of public policy implementation is gaining momentum in public institutions throughout Europe (Dolan et al., 2010).

offering certain certified food products, or marketing by discounting food close to expiry dates.

The retailers' role both in influencing consumers and increasing the resource efficiency of the EU economy are addressed by activities of the EU Retail Forum. Established by European retailers in cooperation with the European Commission in March 2009, this is a multi-stakeholder platform set up to exchange best practices on sustainability in the European retail sector. It is part of the Retailers' Environmental Action Programme. The Retail Forum produces issue papers each year, which include recommendations for retailers on such areas as labelling, life-cycle information for everyday products including food, and minimising waste (Retail Forum, 2014).

A further element of the Action Programme is the Matrix of Environmental Action Points (MAP) (Box 4.3), a publically available list of commitments and environmental targets made by individual retail companies/associations (EC, 2014f).

Public campaigns and education are needed to link food consumption with the production process, its environmental impacts and health implications. For example, environmental and other impacts are much larger for processed than for unprocessed food. National

Box 4.3 Implementation of the EU Retailers' Matrix of Environmental Action Points (MAP)

Examples include a target to increase organic sales of food from 6 % to 10 % of total food sales (Coop Sweden), reduce fresh food waste from farm to fork by 10 % by 2015 (ASDA, United Kingdom), implement gold/silver/bronze sustainability benchmarking for food suppliers by 2015 (Marks & Spencer, United Kingdom), and reduce imported soy from South America as chicken feed (REWE, Germany). However, very few of the commitments within the area of communication concern food, and these all concerned communication on sustainable fish products and healthier foods. The number of commitments appears to have diminished during the second three-year period of the Action Programme, beginning in 2012.

Twenty members of the Retailers' Environmental Action Programme committed to a retail waste agreement in 2012 to carry out at least two awareness-raising initiatives to reduce food waste within stores and supply chains on a global and/or national level by the end of June (Retail Forum, 2013).

governments could join retailers and the restaurant and hotel sector to run awareness campaigns tailored to different groups to encourage consumers to waste less food: school curricula, for example, could cover the issue more fully than at present.

Waste prevention

In the past, EU policies have addressed food waste as part of biodegradable waste. The EU Landfill Directive (European Council, 1999) requires all Member States to reduce the amount of biodegradable municipal waste sent to landfill and the EU is stepping up efforts to reinforce full implementation. The EU's waste hierarchy also promotes the diversion of food waste from landfill towards composting and bio-digestion.

Most recently, the European Commission's communication on a circular economy is 'considering presenting specific proposals to reduce food waste' (EC, 2014c). The communication proposes that Member States develop national food-waste prevention strategies, and endeavour to ensure that food waste in the manufacturing, retail/distribution, food service/hospitality sectors and households is reduced by at least 30 % by 2025. The EU's 7th EAP requires the Commission to develop 'a comprehensive strategy to combat unnecessary food waste and work with Member States in the fight against excessive food-waste generation'. In addition, the Waste Framework Directive required EU Member States to adopt waste prevention programmes by the end of 2013. A first screening of the programmes adopted by that date showed that 18 out of 20 reviewed programmes included measures to tackle the generation of food or organic waste (EEA, 2014i).

Reducing food waste involve relevant stakeholders in the process, providing information aimed at EU consumers, basic information on the causes of food waste, tips for preventing it, and information on the quantities and impacts of food waste in the EU and globally (FUSIONS, 2014). Public information campaigns are needed to increase awareness and understanding of waste policies and stimulate a change in behaviour (EU, 2013). In this regard, the Health and Consumers Directorate-General of the European Commission is looking into the potential of using behavioural science insights to improve policy design and implementation (Ciriolo, 2011).

5 Electrical and electronic goods

Key messages

The production-consumption system of electrical and electronic goods is characterised by fast-changing supply chains, with large and increasing imports, especially from Asia. The environmental impacts at the production end of supply chains are felt mainly outside Europe.

European consumption is shaped by rapid technological developments, falling prices, more households and fewer persons per household, driving the purchase of more appliances. Appliances are often exchanged for new ones before they fail, and consumer electronics have become subject to fashion. Electricity consumption by households has increased, despite many appliances becoming more energy-efficient.

Purchase/discard behaviour has made end-of-life electrical and electronic goods (e-waste) one of the fastest growing waste streams. E-waste contains valuable materials and hazardous substances yet considerable amounts still end up in landfills or are illegally exported to countries outside Europe.

Such exports often end up being handled by unskilled, ill-equipped workers with consequent pollution and health risks for local people and the local environment. European priorities include curbing illegal shipments and ensuring that e-waste is collected and properly treated in the existing European recycling infrastructure.

Opportunities for reducing the life-cycle environmental impacts of electrical and electronic goods include making products more energy-efficient; smart, modular design enabling upgrading and repair, take-back and re-manufacturing; and capturing more of the valuable materials from e-waste.

Production-consumption system trends

Consumption trends

The use of electrical and electronic goods is an integral part of modern Europe, at home and at work. Households use a large array of electrical and electronic goods, from household appliances such as washing machines, refrigerators and lamps to electronics such as computers, mobile phones, electronic toys and smoke detectors. The

EU Directive on waste electrical and electronic equipment (WEEE Directive; EU, 2012) covers a list of more than 80 different types of consumer-oriented appliances.

Electrical and electronic goods are a growing consumption area. Rapid technical development of electronic goods is clearly reflected in household expenditures: expenditure on telephones has seen an extraordinary and continuous growth since 1996, driven by the introduction of mobile phones and recently smartphones, and by falling prices (Figure 5.3).

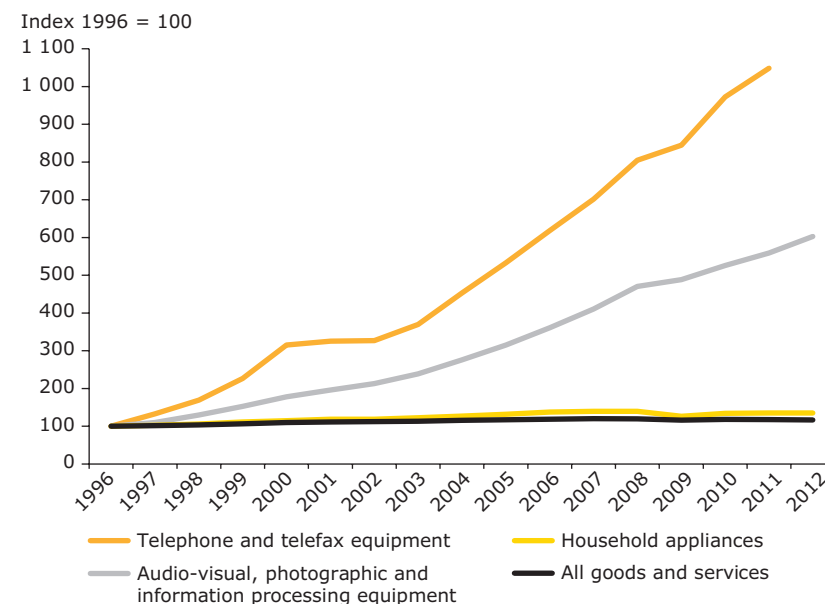
Expenditure on other electronics such as computers, tablets, TV sets and CD players has grown less but still increased five-fold, reflecting the introduction and rapid take-up of new technologies. In contrast, household spending on electrical goods such as freezers, ovens and hair dryers has been more stable. The differing trend between electrical appliances and electronics also shows that electrical appliances are replaced less often than electronics, reflecting the differing trends in technological development and other driving forces such as fashion in electronics.

Expenditure on electrical and electronic goods was only very slightly influenced by the economic crisis that started in 2007 (Figure 5.1). However, annual average expenditure on telephone and fax equipment (EUR 26 per person in 2012) still accounts for a small portion of total expenditure compared to audio-visual, photo and IT equipment (EUR 212 per person) and household appliances (EUR 116 per person) (Eurostat, 2014e, 2014c).

The data include expenditure on repairs and on recorded media such as DVDs; however, Danish data show that most of this growth has been in equipment and not in recorded media, and that repair expenditures are negligible (Statistics Denmark, 2013). The growth in expenditure on electrical and electronic goods combined with falling prices (Figure 5.3) means that the volumes of appliances purchased have increased significantly.

In spite of the rapid growth of expenditure on electronics, the share in total household expenditure of electrical and electronic goods in the EU-27 fell from 2.8 % in 1996 to 2.5 % in 2012 (Figure 5.2). This can be explained by the fact that absolute expenditure on electrical

Figure 5.1 Real final consumption expenditure on disaggregated electrical and electronic goods, EU-27, 1996–2012



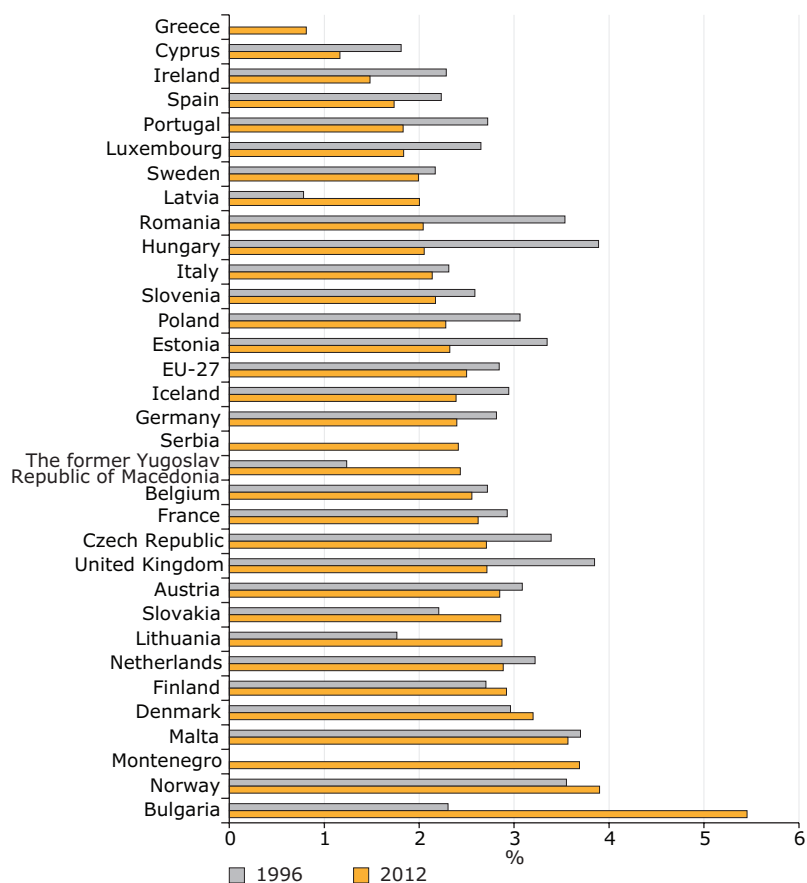
Notes: The figure presents expenditure trends in real terms, i.e. adjusted to eliminate the effects of price inflation. The underlying volume trends may reflect changes in the quantity, quality or mixture of goods and services purchased. Telephone and fax equipment includes mobile phones.

Source: Adapted from the SCP013 indicator, based on Eurostat data (Final consumption expenditure of households by consumption purpose – COICOP 3 digit – volumes, nama_co3_k).

and electronic goods is still small compared to expenditure on food, transport and housing, and by a considerable increase in absolute expenditure on housing.

The share of electrical and electronic goods in total household expenditure varies significantly across Europe. In the majority of countries households now spend less of their budget on electrical and electronic goods than they did in 1996. Exceptions include Bulgaria, where households now spend a larger proportion of their budget on these goods than any other European country for which data are available (Figure 5.2).

Figure 5.2 Household expenditure on consumer electrical and electronic goods as a proportion of total household expenditure in selected European countries, 1996 and 2012



Notes: Electrical and electronic goods include household appliances, telephone and fax equipment, and audiovisual, photo and IT equipment. Data for 1996 are missing for Greece, Montenegro and Serbia. Data for 2012 are missing for several countries and have been filled by data of the closest available year: for Bulgaria, the former Yugoslav Republic of Macedonia, Greece and Norway 2011, for Romania 2010, and for Lithuania 2009. The shares for Ireland and Latvia do not include telephone and fax equipment due to data gaps. Finally, data for telephone and fax equipment do not exist for 2012 and are replaced with 2011 data for all countries. No data are available for Croatia.

Source: EEA and ETC/SCP based on Eurostat data (Final consumption expenditure of households by consumption purpose — COICOP 3 digit — aggregates at current prices, nama_co3_c).

Production trends

The electrical and electronic goods production industry is growing and developing rapidly and is an increasingly important sector of both the European and global economies, contributing to economic growth and the creation of millions of jobs. In the EU-27, manufacturing of electrical and electronic goods employed more than 4.3 million people and generated value added of more than EUR 220 billion in 2008 (Ecorys, 2011). In 2009, the sector accounted for exports worth more than EUR 210 billion. The production of electrical goods is predominant, while the smaller electronic goods sector in the EU remains behind its major competitors — United States, Japan, China. Europe was responsible for 20 % of the global production of EUR 1 234 billion by the electronics industry in 2010 and represented nearly one third of the value of the global electronics market in 2008 (Ecorys, 2011).

Factors influencing the production-consumption system

One of the key drivers for the growth in consumption of electrical and electronic goods in households is rapid technological development. Consumer electronics in particular are experiencing rapid innovation and replacement cycles. For example, the lifetimes of notebook computers are falling to less than three years as a result of high innovation rates and diminishing prices (Prakash et al., 2012). The appearance of new products and fashion trends also play an important role (Luttrupp et al., 2013). Innovative and entirely new product groups have been developed, such as gaming consoles, smartphones and tablet computers, further increasing the numbers of electrical and electronic devices in households.

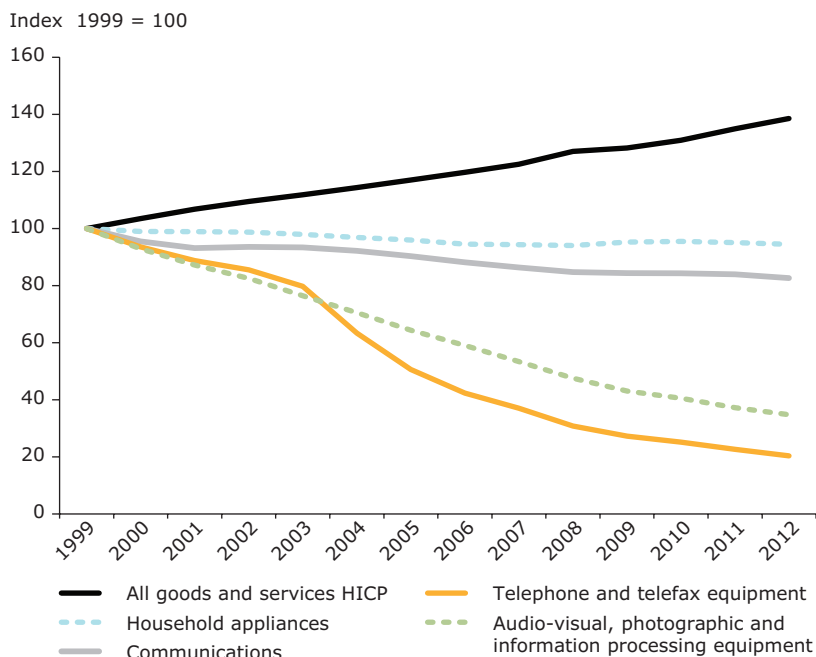
Falling consumer prices might also have contributed to the increase in purchases. Prices of audio-visual, photographic and information processing equipment such as cameras and computers have more than halved since 1999 and for telephone equipment have decreased even more dramatically, while the overall consumer price index rose by almost 40 % (Figure 5.3).

Another important driver is the growth in the number of households in the EU-28, + 10 % between 2005 and 2013 (Eurostat, 2014a), due mainly to a decrease in the average number of people per household

(Eurostat 2014a), while population grew by only 3 % in the same period (Eurostat, 2014c).

There is some evidence that consumers often replace existing, fully functional appliances with new ones (relative obsolescence). However, there are no reliable trend data on the lifespan of electrical and electronic goods (Cooper, 2010b), and no reliable data could be found on the second life of electrical and electronic goods that are replaced by new ones. Cooper classifies three forms of obsolescence:

Figure 5.3 Consumer price indices for different types of electrical and electronic goods, EU-27, 1999–2012



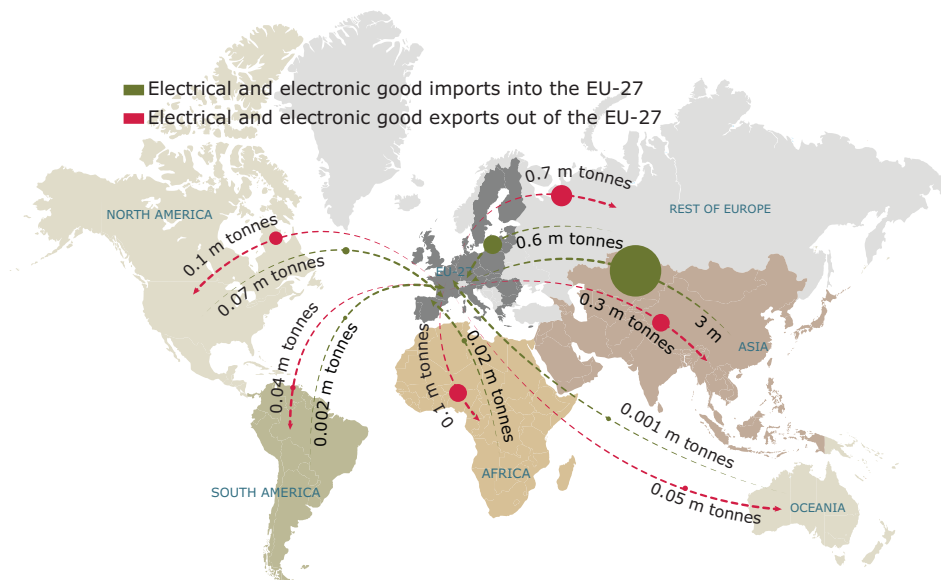
Note: Data for the category Telephone and fax equipment are only available for EU-27, not EU-28. 2012 data are missing for the same category. Communications includes postal services, telephone and fax services and telephone and fax equipment. The category All goods and services refers to the overall consumer price index, not only electrical and electronic goods and services.

Source: EEA based on Eurostat data (HICP (2005 = 100) – annual data (average index and rate of change)).

technological, where a product of better quality or functionality is available; economic, where the cost of repair or upgrading is high compared to replacement; and psychological, shaped by style, fashion or change in perceived need. The average duration of use of a smartphone is about one and a half years, while its design life is at least five years longer (Li et al., 2012).

Planned obsolescence, the deliberate design of products to fail prematurely in order to stimulate repetitive consumption, might also contribute to the rapidly growing market for electrical and electronic goods (Slade, 2007). Schridde et al. (2013) identified many examples of planned obsolescence, including batteries that cannot be changed, non-availability of exchange parts, placing of heat-sensitive parts next to heat sources, use of plastics instead of metal, use of warning systems that indicate the end of life well before its technical end,

Figure 5.4 Trade flows in electrical and electronic goods between the EU-27 and other world regions, 2012



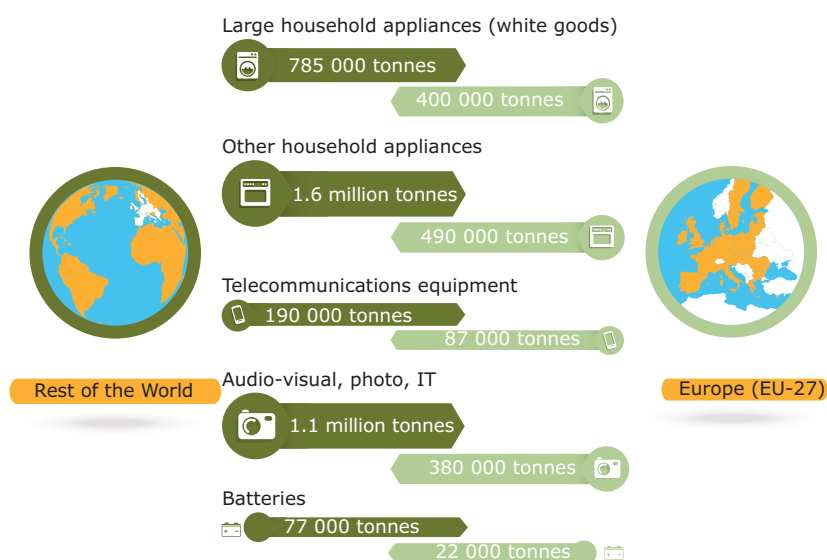
Source: ETC/SCP and EEA based on Eurostat data (EU trade since 1988 by CN8 (DS-016890)).

and strategies to discourage repair. Overall, reparability and options to upgrade electrical and electronic goods and thereby extend their useful life do not currently seem to be a core design concept.

A considerable and increasing share of electrical and electronic goods purchased is imported: from around 50 % in value terms in 2007 to 74 % in 2012. In terms of net imports (imports minus exports), the share was 22 % in 2007, and 38 % in 2012 (Eurostat, 2013d). The data do not include parts and components, only final products. In terms of weight, most imported electrical and electronic goods come from Asia (Figure 5.4).

The value chains for electrical and electronic goods are increasingly globalised (EC, 2012c), particularly for consumer electronics (D cision Etudes et Conseil, 2009). Overall, the EU-27 imports 270 % more electrical and electronic goods by weight than it exports (Figure 5.5).

Figure 5.5 Trade balance for different types of electrical and electronic goods, EU-27, 2012



Source: ETC/SCP and EEA based on Eurostat data (EU trade since 1988 by CN8 (DS-016890)).

Impacts on the environment and society

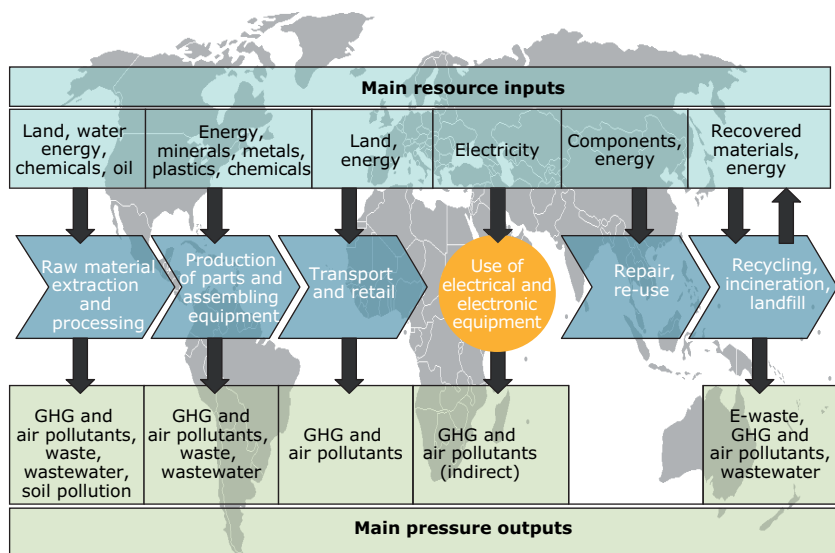
The production and consumption of electrical and electronic goods has many economic, social and environmental impacts within and outside Europe. The industry creates employment in, for example, mining, processing of materials, and assembling of appliances. In many of the countries producing electronics, however, harsh working conditions and low wages pertain, for example in China and Malaysia (China Labor Watch, 2012; SOMO, 2013). On the other hand, the internet — and related electronic devices — constitutes 'a vital medium of economic and societal activity: for doing business, working, playing, communicating and expressing ourselves freely' (EC, 2010b).

All forms of electrical and electronic goods are associated with environmental impacts during the extraction of raw materials, production and use, and at the end of their life. During the use phase, energy consumption represents the main pressure for most of the products, and dishwashers and washing machines contribute to household water consumption. Figure 5.6 illustrates the value chain for electrical and electronic goods and the main environmental pressures and resource inputs. Urban mining — recovering materials and components from waste electrical and electronic goods through recycling — can be expected to become more and more relevant.

Mining and materials processing often cause high pressures on the environment, with possibly negative health impacts on local populations. The OECD expects an increase in environmental impacts from mining and processing due to rising demand for metals and minerals, and a large share of these being mined in non-OECD countries with weak environmental laws (OECD, 2008).

In particular, small and medium-sized mining operations in developing countries, for example artisanal gold mining activities in Mali, Nigeria and Tanzania, often operate without proper health and safety standards (Kippenberg and Coehn, 2013). Mining projects have repeatedly been implicated in heavy environmental pollution in many countries, and in violations of human rights, including the denial of environmental information and the right to health, justice and peaceful protest, and encouraging corruption (Kippenberg and Coehn, 2013).

Figure 5.6 Overview of the value chain of electrical and electronic goods



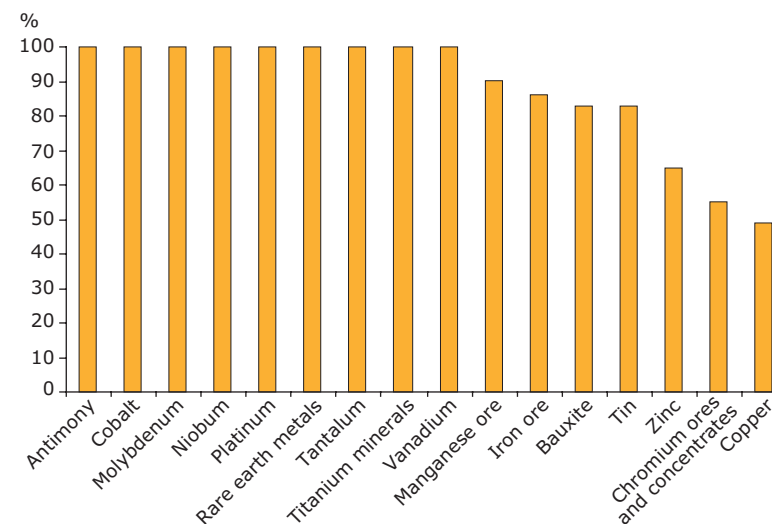
Source: EEA.

The production of electrical and electronic goods, for consumer-oriented equipment as well as equipment used in industry, services and the public sector, requires a large amount of specific materials, especially metals, plastics and chemicals. European production of electrical and electronic goods depends heavily on imports of metals: the share of imports in the EU-27's consumption of metals ranged from 50 % for copper to 100 % for a wide range of high-tech metals, including rare Earth metals (Figure 5.7), implying risks for the security of supply.

Impacts of the production phase

In terms of production impacts related to energy requirements, in general the larger the amount of electronic components required in a given product, the larger the impacts per unit weight. This is because electronics manufacturing is particularly energy-intensive, requiring

Figure 5.7 Share of net imports in the EU-27's consumption of selected materials



Note: Consumption is calculated as EU-27 mine production plus imports minus exports.

Source: EEA, 2012b.

up to 140 times more energy per kilogram than plastics (WRAP, 2010; Prakash et al., 2012).

The materials used in the production of electrical and electronic goods – including metals, plastics and rare metals – are associated with a wide range of human health and environmental pressures. These often arise at the point of production/extraction of raw materials and/or at end of life (UNU et al., 2008).

All materials included directly in electrical and electronic goods are associated with an additional materials footprint of unused and used materials that have been extracted to produce the product. The size of the materials footprint depends on the material used (Ritthoff et al., 2002). For example, gold in mobile phones accounts for less than 1 % of the actual weight, but more than half of the total materials footprint. In contrast, on average 60 % of a mobile phone is plastic, but this makes up only 1 % of its total materials footprint (Chancerel and

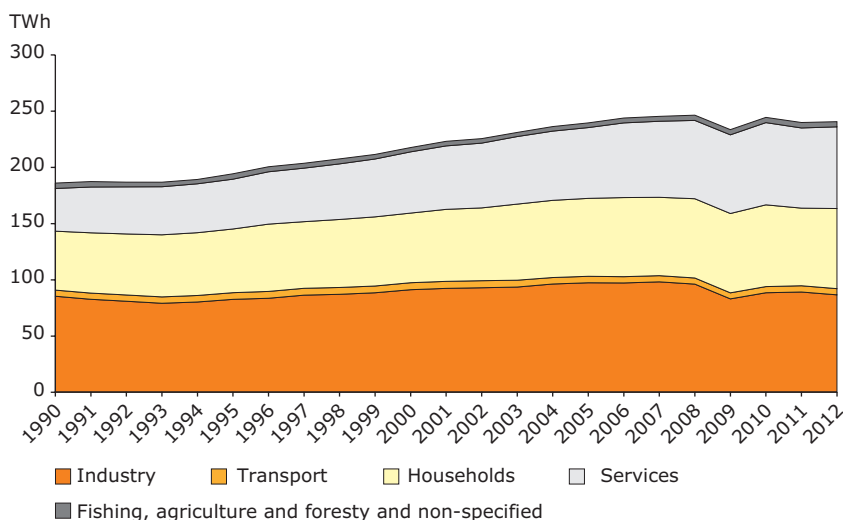
Rotter, 2009). Thus precious metals like gold can be responsible for a considerable share of the product's environmental impacts (Chancerel, 2010).

Impacts of the use phase

Electricity consumption and associated environmental pressures dominate the environmental impacts of the use of electrical and electronic goods. In 2012, households accounted for nearly one third of final electricity consumption in the EU-28 (Figure 5.8).

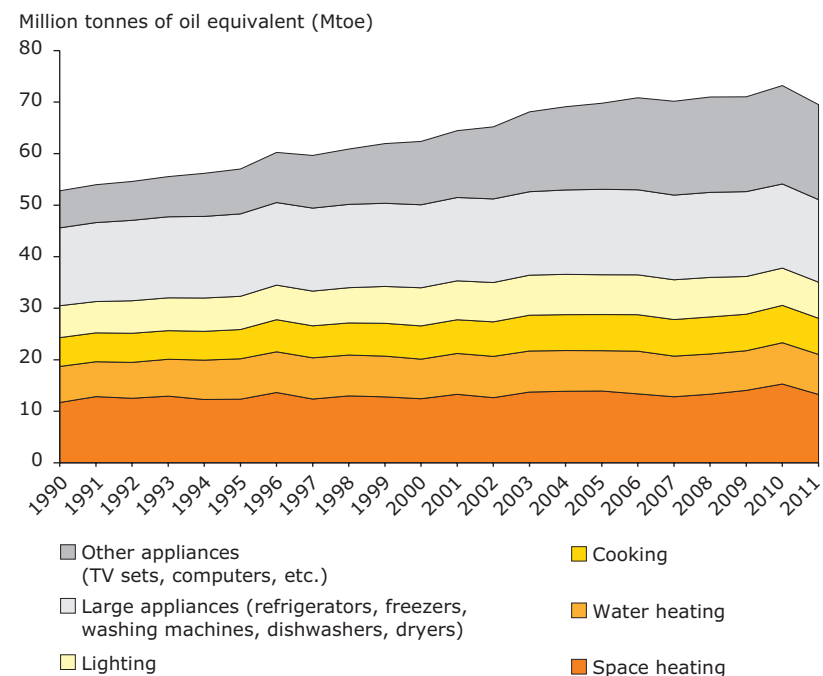
Household electricity consumption has grown by 37 % since 1990. Most of this has been driven by appliances such as TV sets, computers and other electronics, while electricity consumption by large household appliances such as refrigerators, freezers, washing machines, dishwashers and dryers has remained relatively stable (Figure 5.9), and began to fall in 2010, but it remains to be seen whether this will continue.

Figure 5.8 Final electricity consumption by sector, EU-28, 1990–2012



Source: ENER016 indicator, based on Eurostat energy statistics (Supply, transformation, consumption – electricity – annual data (nrg_105a)).

Figure 5.9 Final household electricity consumption by use, EU-28, 1990–2011

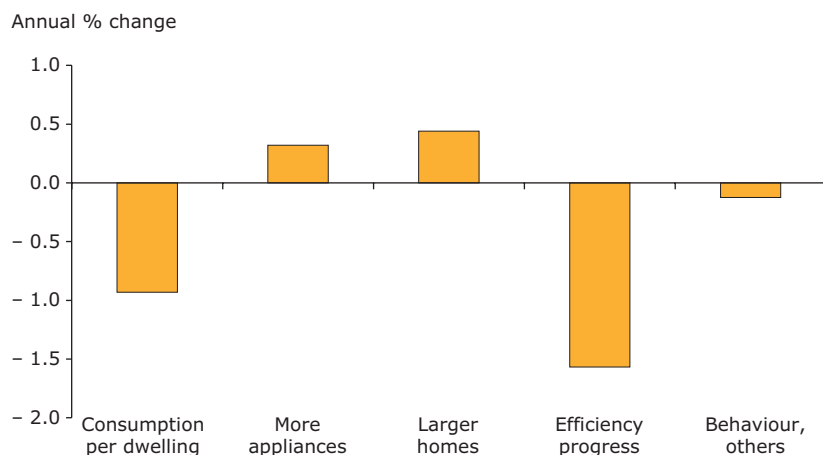


Source: SCP023 indicator, based on data from Enerdata (ODYSSEE: Energy Efficiency Database).

However, while the total electricity consumption of all households has increased by nearly 37 % since 1990, electricity consumption per household has only increased by around 15 %. The remaining increase resulted from a 21 % rise in the number of households between 1990 and 2010 (Enerdata, 2013).

When looking at total energy consumption per household – not only electricity used in the home, but also fuels and energy used in district schemes for space heating, cooling and cooking, without transport fuels – energy consumption per dwelling has decreased by 0.8 % annually since 1990. Figure 5.10 shows that the reduction in energy consumption per dwelling has been mainly due to improvements in energy efficiency, with the trend towards more appliances and more floor

Figure 5.10 Drivers of the change in average annual energy consumption per household, EU-27, 1990–2011



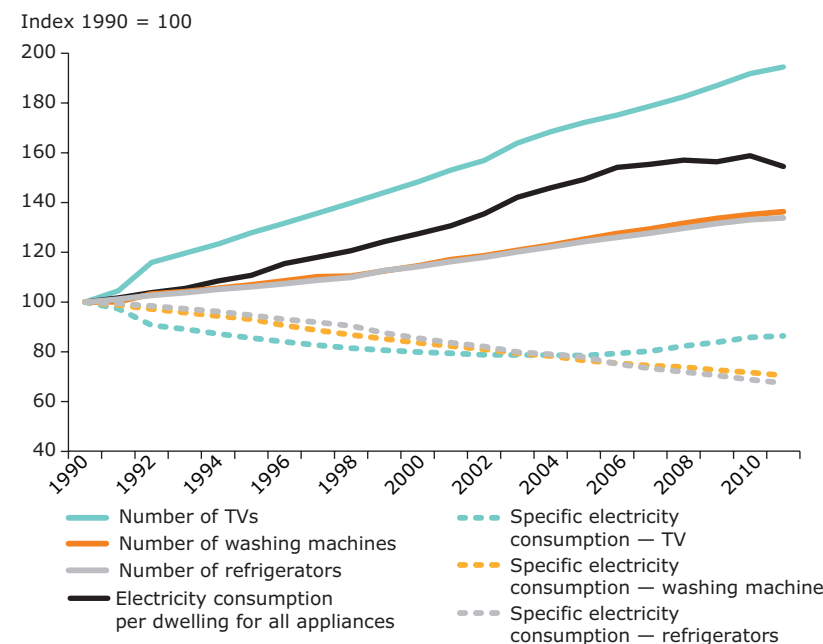
Note: The data do not include transport fuels used by households. Larger homes refers to increased floor space per person.

Source: ENER037 indicator, based on data from Enerdata (ODYSSEE: Energy Efficiency Database).

space per person partly offsetting this positive effect. In addition, the increasing numbers of TV sets, washing machines and fridges outpaced the energy efficiency improvements for these appliances (Figure 5.11).

As well as electricity consumption during use, devices using the internet also indirectly result in energy consumption in the data centres and servers that run and maintain the internet. This internet infrastructure is responsible for around a third of the carbon footprint of the information and communication technology sector.

Figure 5.11 Trend in energy efficiency and number of electrical appliances in households, EU-28, 1990–2011



Note: The specific electricity consumption of an appliance is the electricity used per unit function of the appliance i.e. per wash cycle, per hour of viewing/cooling etc.

Source: SCP023 indicator, based on data from Enerdata (ODYSSEE: Energy Efficiency Database).

Impacts of the end-of-life phase

Many of the hazardous substances contained in electrical and electronic goods may be released into the environment at their end of life. Depending on their age and type, products contain varying levels of hazardous substances that can damage the environment and human health. Even where effort is made to remove such materials through recycling, large concentrations can be found in landfills and at recycling facilities. Many products contain flame retardants such as polybrominated diphenyl ethers (PBDEs) in their plastic components. While PBDE is prohibited, it is still omnipresent in waste from electrical and electronic goods. If these substances leach into the environment

they can accumulate in organisms and the food chain with subsequent impacts on the organisms at the top of the food chain (Robinson, 2009).

Waste electrical appliances also contain significant quantities of plastics and metals, especially steel, aluminium and copper. Electronic equipment in addition contains a large range of other metals in small amounts, including precious metals like gold and silver and special metals such as rare Earths, antimony, cobalt, lithium, tantalum, tungsten and molybdenum.

Many of these are strategically important for the technological development of a modern society, including energy efficiency and renewable energy technologies (EC, 2010d). Some have been classified as critical metals because of a combination of supply risks and technological importance for society. The demand for these critical metals for the production of electrical and electronic equipment is driven mainly by innovation and overall trends such as miniaturisation (Faulstich, 2010; Chancerel, 2010). The number of metals and chemical elements used to produce computer chips has increased from around 12 in the 1980s to around 60 today (National Research Council of the national academies, 2008).

Table 5.1 shows a simplified cost breakdown for a personal computer that has become waste, differentiating between the different

Table 5.1 Weight and market values for materials in a typical desktop PC

Cost breakdown	Weight (g)	Revenue (EUR)
Steel, aluminium	5 241	1.41
High-grade PC-boards	448	4.03
Low-grade PC-boards	397	1.39
Chips and processors	68	2.55
Hard-disk drive	598	0.45
Cables	198	0.28
Other valuable items	444	0.27
Plastics without flame retardants	122	0.03
Plastics for energy recovery	226	- 0.02
Weight/net revenue for PC	7 742	8.61

Source: UNEP, 2013.

components and materials. The valuable parts containing the precious metals are mainly the printed wire boards with the chips and processors. Other parts such as plastics often have a negative value for the recyclers because they have to pay for their disposal.

Waste electrical and electronic equipment, or e-waste, can be seen as both a resource and a potential hazard. It is important to collect all the e-waste generated, recycle or reuse as much of it as possible, and take care of hazardous substances. The urban mining concept sees the recycling of materials from e-waste as an increasingly important source of secondary materials for the economy.

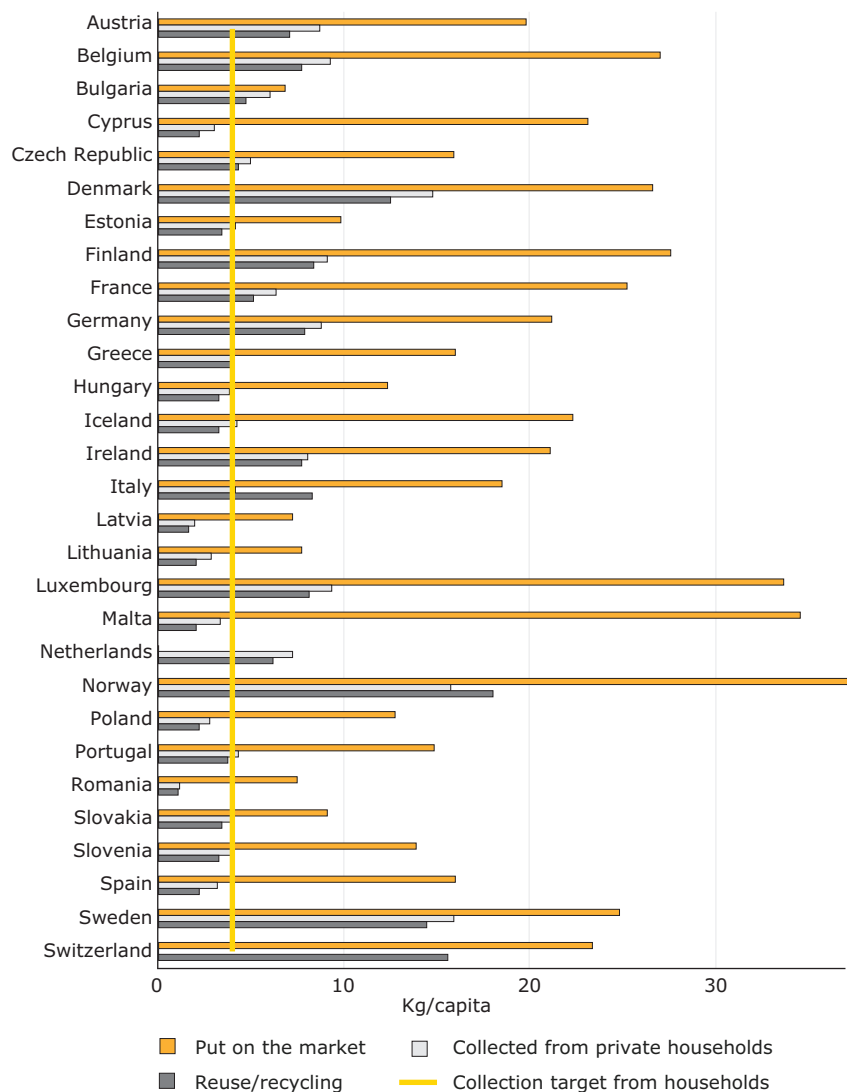
Figure 5.12 indicates that once e-waste is collected, it is recycled to a high degree in most of the EU Member States and countries of the European Free Trade Agreement for which data are available, although there is still room for improvement. The level of collection in many countries is still very low, especially compared to the amount put on the market. Several EU Member States do not meet the target of 4 kg of collected e-waste per inhabitant from households laid down in the 2008 EU WEEE Directive (Figure 5.13), and greater efforts will be needed to meet the more ambitious collection and recycling targets of the revised 2012 WEEE Directive (EU, 2012).

Low collection levels are a serious hindrance to the recovery of materials from e-waste. In many cases, the low collection rate is the defining factor for the overall recovery rate (UNEP, 2013). However, data on the collection of e-waste show generally improving trends.

Recovery technology is constantly improving, but it is difficult and sometimes impossible to recover all materials due to the complexity of the products and many other factors including thermodynamics, technology, human error, politics, theft and economics. In Europe, valuable metals are lost mainly because of insufficient collection and mechanical pre-processing, whereas final processing is rather efficient (UNEP, 2013).

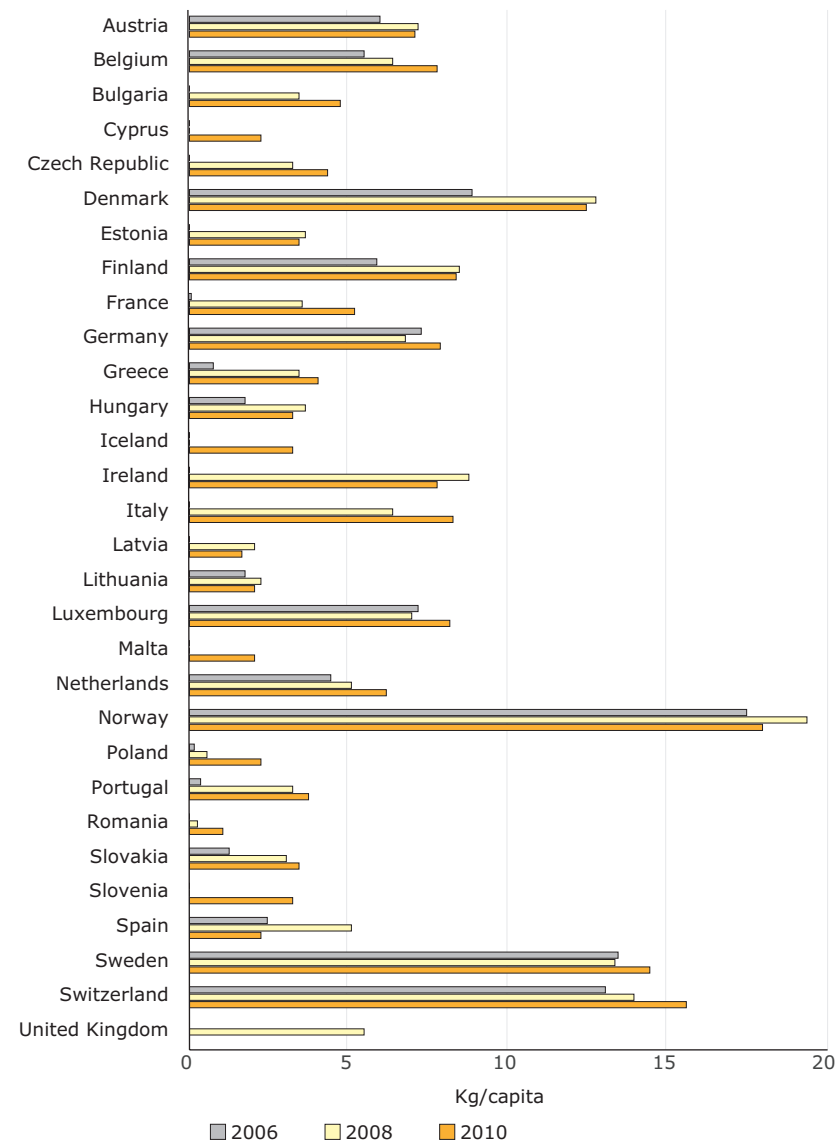
The share of plastics in electrical and electronic goods is increasing, and is estimated to account for around a fifth of e-waste. The waste contains a large variety of plastic types, some of which have been found to contain substantial amounts of hazardous substances

Figure 5.12 Electrical and electronic goods put on the market, and e-waste collected, reused and recycled in selected European countries, 2010



Source: Waste003 indicator, based on Eurostat data (Waste electrical and electronic equipment (WEEE) (env_waselee), population on 1 January (tps00001)) and data provided by the Swiss Federal Office for the Environment, to the EEA.

Figure 5.13 E-waste reused and recycled in selected European countries, 2006, 2008 and 2010



Source: Waste003 indicator, based on Eurostat data (Waste electrical and electronic equipment (WEEE) (env_waselee), population on 1 January (tps00001)) and data provided by the Swiss Federal Office for the Environment, to the EEA.

regulated by the EU Directive on the restriction of the use of certain hazardous substances (RoHS Directive; Wäger et al., 2012).

Export of e-waste to non-OECD countries is prohibited by the Waste Shipments Regulation (EU, 2006b). There is little information on cross-border movements of e-waste between EU Member States as it is not a reporting category in the Waste Shipments Regulation and the Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and Their Disposal (UNEP, 1989). Aligning the waste codes of the European List of Waste and the codes of the Basel Convention would enable a much better understanding of what type of e-waste is moved across borders (EEA, 2009).

Exports of used electrical and electronic goods are legal but nevertheless create environmental impacts beyond Europe. For example, in West Africa, a major destination for used electrical and electronic goods from the EU, the trade is driven by large income inequalities between Europe and Africa, high demand for appliances in the destination countries and low wages for repair.

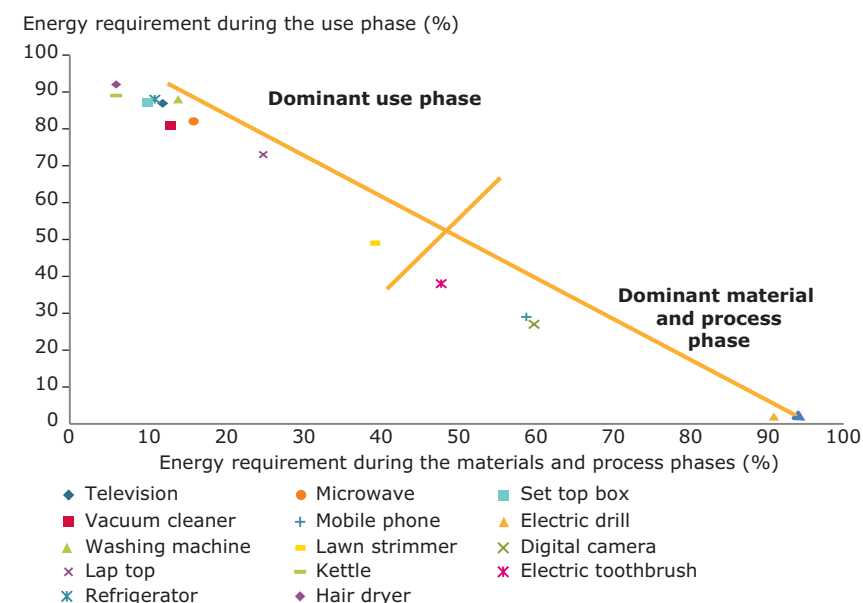
The majority of the appliances imported to West African countries are tested and repaired and thus re-used. However, they finally end up in Africa's informal recycling sector where e-waste is largely handled in conditions harmful to both human health and the environment. Burning of cables is probably a major source of dioxin emissions. Ozone-depleting substances and greenhouse gases from refrigerators and air conditioners are usually not treated properly in the informal sector but are directly released to the environment. In addition, informal recycling focuses mainly on aluminium, copper and steel, and is rather inefficient for other materials (UNEP, 2012b). China and India face a similar situation, with the majority of imported e-waste coming from the United States and a smaller share from Europe (UNEP, 2013).

Hotspots of environmental pressures through different stages of the life-cycle of electrical and electronic goods

The hotspots of environmental pressures along the life-cycle of electrical and electronic goods depend on the type of product. The United Kingdom's Waste and Resources Action Programme (WRAP) investigated the energy consumption and greenhouse gas emissions

along the life-cycle of 15 types of goods with high-volume sales in the United Kingdom, and found that life-cycle emissions and energy consumption were dominated by the production (materials and process) phase and the use phase; energy consumption in the use phase was dominant for refrigerators, TV sets and electric kettles, whereas energy consumption in the production phase was dominant for electric drills and blenders (WRAP, 2010) (Figure 5.14). Another and more recent study, looking at greenhouse gas emissions instead of energy, found a different result for laptops: here, the majority of greenhouse gas emissions in the life-cycle occurred during the production phase and the authors concluded that even if a new laptop was 70 % more energy-efficient than the one it replaces, it would take 6–13 years of use to compensate for the additional environmental impacts of its production, much longer than the typical lifespan. In addition, the authors found that the relevance of the use phase decreased when environmental pressures other than greenhouse gas emissions were taken into account (Prakash et al., 2012).

Figure 5.14 Share of in-use and production energy requirements for a number of electrical and electronic goods



Source: WRAP (2010), reproduced with permission.

Opportunities for change

Both EU and national policies in European countries mainly address the energy consumption of larger household appliances during the use phase, and to some extent that of other electrical and electronic goods, as well as sound management of e-waste. Little public and policy attention has been focused on reducing the environmental footprint of the production phase of electrical and electronic goods, especially when this is outside Europe. Purchasing decisions are generally driven by technical features and price, and for white goods also by energy efficiency during use. Wider environmental and social considerations such as the sourcing of materials used to produce the appliances, work and health conditions during production, hazardous substances, reparability, recyclability and longevity do not seem to play a relevant role in purchasing decisions in Europe.

Current business models overwhelmingly aim at maximising sales through the rapid replacement of devices (Cooper, 2010b). Information about product durability and after-sales support such as repair services is often not available for consumers (Cooper and Christer, 2010). One obstacle is the lack of obligations for manufacturers to provide spare parts, thereby discouraging repair.

There is a wide range of opportunities to improve the environmental performance of the production-consumption system. The particular challenge is to reduce negative environmental and social impacts without losing related benefits such as the continuing digitalisation of society and the jobs created in the assembly industry. Strategies like moving from ownership to leasing, renting and shared use, and designing products containing less hazardous substances need to be explored and encouraged.

Large potential lies in designing products that can more easily be recycled and have a longer life, for example through upgrading and reparability. There are multiple options for policies to increase the lifespans of electrical and electronic goods, ranging from extending product guarantees, consumer information on lifespans, differentiated value added tax (VAT) on repair services or longer-lasting products, to requirements to provide spare parts. However, little is known about their cost, efficiency and effectiveness (Cooper, 2010a).

The 7th EAP (EU, 2013) calls for measures to 'further improve the environmental performance of goods and services on the EU market over their whole life-cycle'. This should include 'optimising resource and material efficiency, by addressing, inter alia, recyclability, recycled content and durability'. Extending durability would help reduce the rapidly growing amount of e-waste and the environmental pressures from sourcing the materials and producing electrical and electronic goods. This would require new concepts to avoid a slowdown in innovation, which might include moving from ownership to product-service systems, with consumers buying access to a product rather than the product itself, and modular designs enabling upgrading and repair. The design of products is very important, but business models are needed that support such a change in design priorities. Little is known about the economic impacts of increasing durability either inside or outside Europe (Cooper, 2010b).

Production-phase opportunities

The globalised market for electrical and electronic goods offers both challenges and opportunities for reducing the environmental footprint of production. The high complexity of supply chains makes it difficult for consumers to make choices based on sustainability, or for producers to make the supply chain more sustainable.

Two EU environmental directives apply to the production of electrical and electronic goods, and the parts and materials used in them in the EU:

- the 2006 EU Mining Waste Directive (EU, 2006a), which regulates the management of waste from extractive industries;
- the 2010 EU Industrial Emissions Directive (EU, 2010b), which regulates emissions related to air, water and land, generation of waste, use of raw materials, energy efficiency, noise, prevention of accidents, and restoration of the site upon closure, including production and processing of metals, chemicals and plastics and surface treatment processes.

In addition, the RoHS Directive (EU, 2011), aimed at reducing or phasing out selected harmful substances from products, can also be expected to reduce the environmental impacts of production, as such

substances are not then handled during the production process. The mining and processing of many metals used in electronics do not take place in the EU, illustrated by an import dependency of 100 % for a range of metals (Figure 5.7), so that related environmental impacts are outside the EU.

There are opportunities for producers, importers and retailers to work towards greater sustainability, but this can be a considerable challenge because of the long and complex supply chains (Pathan et al., 2013). Initiatives within industry and with multi-stakeholder bodies include (Pathan et al., 2013):

- the Intergovernmental Forum on Mining, Minerals, Metals and Sustainable Development;
- the International Council on Mining and Metals (ICMM);
- the Framework for Sustainable Mining;
- the OECD Due Diligence Guidance for Responsible Supply Chains of Minerals from Conflict-affected and High-risk Areas;
- the Communities and Artisanal and Small-scale Mining (CASM) initiative;
- the Global Reporting Initiative Mining and Metals Sector Supplement, which addresses the sustainability of mining;
- the Electronic Industry Citizenship Coalition (EICC), an industry initiative that aims to improve ethical, environmental and social responsibility in the sector's supply chain;
- national initiatives including Finland's work on an action plan towards sustainable mining 2030, Finland being a producer of several metals used in the production of electrical and electronic goods (Pathan et al., 2013).

Key ideas currently being discussed or explored appear to focus on improving the resource efficiency of supply chains through the recycling of waste materials. Most of these opportunities span the life-cycle of the products and are therefore discussed in more detail below.

Use-phase opportunities

Ecodesign is a product policy approach addressing all phases of a product's life-cycle and implemented during the production phase. The Directive on ecodesign requirements for energy-related products (Ecodesign Directive; EU, 2009) provides a framework for setting minimum environmental performance and energy efficiency requirements for energy-related products. There is still considerable potential to improve the energy efficiency of electrical and electronic goods. The European Commission Joint Research Centre has estimated that the energy-saving potential of recently adopted ecodesign measures for a number of domestic and commercial appliances, including set-top boxes, air conditioners, refrigerators and televisions, will be 12 % of the EU's 2009 electricity consumption by 2020 (EC, 2013c).

Although environmental aspects other than energy efficiency are covered by the Ecodesign Directive, it has in practice been used mainly to set energy efficiency performance criteria. However, a methodology has been developed to address other environmental pressures, and pressures along the whole life-cycle of products. Thus there are opportunities to steer product design in a more sustainable direction, for example requirements on reparability or upgrading in order to prevent waste. The Ecodesign Directive could also be used more intensively to rule out design strategies that hinder repair or exchange of faulty parts.

The Ecodesign Directive is supplemented by the Energy Labelling Directive (EU, 2010a) and the EU Ecolabel Regulation (EU, 2010c), and the US-based Energy Star label is used in the EU for office equipment. However, the resultant energy efficiency improvements from these directives have so far been largely offset by increasing ownership and use of appliances (Figure 5.11). The European Commission's communication on a policy framework for climate and energy in the period from 2020 to 2030 (EC, 2014b) therefore stated that energy efficiency improvements for electrical equipment will need to be accelerated, also via ambitious EU-wide energy efficiency standards.

As well as influencing the EU market, ecodesign and product labels can also be expected to influence the highly globalised market, since

global producers have to comply with EU requirements and the same products are marketed all over the world. However, this effect will be limited by the continuing growth of non-European markets.

There is a whole range of options that have hardly been used but have significant potential to reduce the life-cycle environmental impacts of electrical and electronic goods, including:

- increasing product longevity and using it more or for longer. This is most relevant for products with the largest share of energy use and greenhouse gas emissions in the materials/process phase. It would help to ensure that the appliance is used to its design limits before being replaced (WRAP, 2010);
- upgrading of appliances (enabled by modular design);
- design enabling easy repair and exchange of parts;
- longer product guarantee periods and new kinds of warranties;
- shared use;
- moving from ownership to leasing or product-service systems;
- take-back and re-manufacturing;
- strategies to encourage reuse.

Current framework conditions — markets, business models, price structures, design strategies — and prevailing consumer habits do not necessarily favour such approaches, many of which are more systemic in character, such as product-service systems and shared use. Policies will be required to support such approaches, covering different products, purchasing patterns, use patterns and marketing strategies, and different relationships between producers, service companies and consumers. Many approaches will require the development, testing, implementation and scaling-up of new business models, and new types of governance and institutions. Such approaches cannot be brought about by individual consumers or producers, but require a multi-stakeholder approach as well as political resolve. Incentives are needed both for producers and for consumers if the

production-consumption system of electrical and electronic goods is to move in this direction.

Some countries use their national waste prevention programmes to promote some of these strategies. For example, Finland aims to broaden consumers' rights to information about the durability of products, and to revise minimum requirements for labelling and warranties in consumer protection legislation. Norway plans to promote the reuse and/or repair of discarded products at recycling centres (Miljøverndepartementet, 2013). Luxembourg wants to raise public awareness about longer use of products and to promote reuse through the establishment of repair and reuse centres (Le Gouvernement du Grand-Duché de Luxembourg, 2010). Austria plans to develop quality standards for second-hand products, to support reuse networks, and to develop networking platforms for the reuse and waste sectors (Federal Ministry of Agriculture, Forestry, Environment and Water Management, 2011).

As governments are large consumers of electrical and electronic goods, especially office equipment, green public procurement could have a significant influence on the market if used more widely. EU criteria have been issued, for example, for office IT and imaging equipment such as computers, printers and copy machines.

Box 5.1 Country example: reuse and repair centres and cafés

The idea of repair cafés started in the Netherlands in 2009. Small events, often in public cafés, bring together consumers with broken items and repair specialists such as electricians, seamstresses, carpenters and bicycle mechanics. People learn how to repair their own products by using the tools and materials provided in the café, free of charge. The organisation is based on volunteers.

The movement has gained significant momentum in the Netherlands and recently Germany, with more than 200 opening in the last two years (Wilts and Gries, 2013). More than 70 % of the products brought to the repair cafés can be used again, with significant resource savings. They also help to change people's mind-sets and act as laboratories for sustainable lifestyles and consumption patterns. The concept is spreading — to Austria, Belgium, France, Liechtenstein, Luxembourg, Switzerland and the United Kingdom.

In Austria, the Repair and Service Centre (R.U.S.Z.), a social enterprise in the city of Vienna, offers repair services for electrical and electronic goods and has developed a way to upgrade the energy efficiency of washing machines.

End-of-life phase opportunities

The EU's 7th EAP sets out a vision for the EU to become a 'circular economy, with a cascading use of resources and residual waste that is close to zero' (EU, 2013). The 2012 WEEE Directive (EU, 2012) sets targets for the collection, reuse, recycling and recovery of e-waste, tightening the targets set by the 2002 WEEE Directive, which introduced extended producer responsibility for e-waste in the EU, requiring producers and importers or their organisations to take back e-waste and ensure its environmentally sound management. In order to combat illegal exports of e-waste, the 2012 directive requires Member States to report annually on e-waste exports, and to carry out inspections of shipments that are suspected to be e-waste. It also requires exporters of used electrical and electronic goods to prove that the exported appliances are fully functional and not waste. Finally, it requires the development of European standards for the treatment of e-waste that should harmonise e-waste treatment across Europe over the coming years.

The EU RoHS Directive (EU, 2011) bans a number of heavy metals and other hazardous substances in electrical and electronic equipment, reducing health risks during use and emissions during production and end-of-life treatment. Under this Directive, activities have been launched to review the list of substances restricted in electrical and electronic goods (Öko-Institut, 2014), and further restrictions can be expected.

The aim to move towards a circular economy and improve resource efficiency will require increasing both e-waste collection efficiency and recycling efficiency for materials contained in electrical and electronic goods, for example by improving recycling technologies for capturing more of the critical metals. There is scope to improve pre-processing and dismantling, a prerequisite for high rates of capture of valuable materials (ECSIP consortium, 2013).

Currently, recycling focuses on a few main materials, while others, for example rare Earth metals, are lost in processing. The reasons include a lack of recycling technologies for many specific metals and the complexity of products, as well as economic barriers (UNEP, 2013). The WEEE Directive requires EU Member States to increase collection of e-waste, but its recycling targets are based on the weight of the e-waste collected. This does not encourage recycling of valuable materials that only occur in small amounts in the e-waste.

6 Clothing

Key messages

The textile and clothing industry has globalised in recent decades, driven in large part by the liberalisation of tariffs and the related relocation of production to countries with low labour costs. Today, the global production networks that supply Europe are highly diverse, comprising large multinational companies and an enormous number of small and medium-sized enterprises.

In many European countries clothing has become cheaper over the past decade relative to many other consumer goods; in exporting countries, production of fabrics and clothing often provides jobs and generates a significant portion of national income. Many of the production-phase impacts on people's health and the environment occur outside Europe, in countries with comparatively weak protection frameworks.

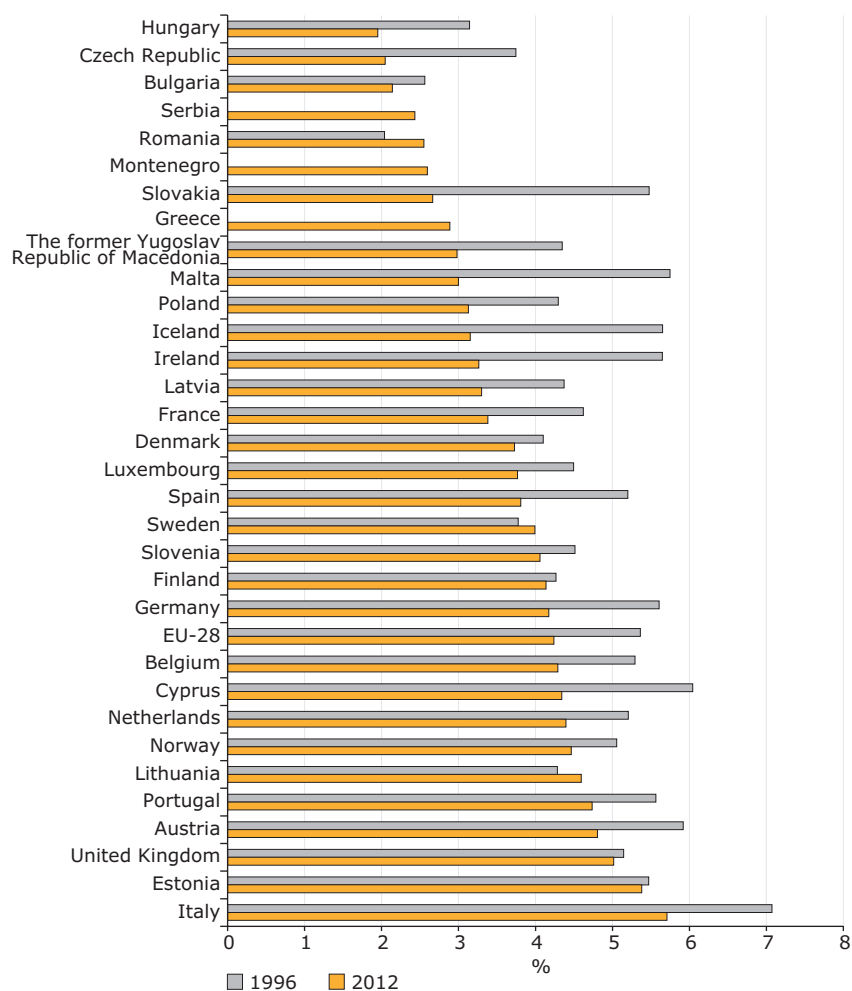
Growing European consumption has augmented resource demands and pressures across the life-cycle. Such pressures include water consumption and pesticide release when cultivating natural fibres, pollution from production and transportation, water and energy use for washing and drying, and emissions from waste. Growing implementation of new business models based on fewer and more sustainable materials and other resources, on sharing and leasing, reuse and recycling, likewise point the way towards greater sustainability.

Businesses and civil society have a particularly important role to play in mitigating impacts outside Europe — for example through improved supply-chain management, changing consumption patterns and better handling of garments (washing and drying). Within Europe's borders, governments generally have the greatest capacity to reduce impacts during the use and disposal phases, using regulations and market-based instruments.

Production-consumption system trends

Household spending on clothing in the EU-28 stood at EUR 314 billion in 2012, equivalent to 4.2 % of total household expenditure. In most European countries, spending on clothing has declined as a share of total household expenditure in the last two decades (Figure 6.1). This can partly be explained by the fact that clothing is in some respects a necessity, meaning that as incomes increase spending on clothing

Figure 6.1 Household expenditure on clothing as a proportion of total household expenditure in selected European countries, 1996 and 2012



Note: Data for 1996 are missing for Greece, Montenegro and Serbia. Data for 2012 are missing for several countries and the gap filled by data from the closest available year. Specifically, for Norway, Greece, Bulgaria and the former Yugoslav Republic of Macedonia 2011; for Romania 2010; for Lithuania 2009. No data are available for Croatia.

Source: EEA and ETC/SCP based on Eurostat data (Final consumption expenditure of households by consumption purpose – COICOP 3 digit – aggregates at current prices, nama_co3_c).

tends to grow less rapidly. However, a more important explanation is the significant decline in the cost of garments relative to other goods and services.

In the EU-28 as a whole, prices for clothing increased by just 3 % in the period 1996–2012, whereas the total Harmonised indices of consumer prices (HICP) rose by just over 60 % (Figure 2.3; Eurostat, 2014f). This corresponds to a 36 % drop in the cost of clothing relative to the aggregate consumption basket of EU consumers (Figure 6.2).

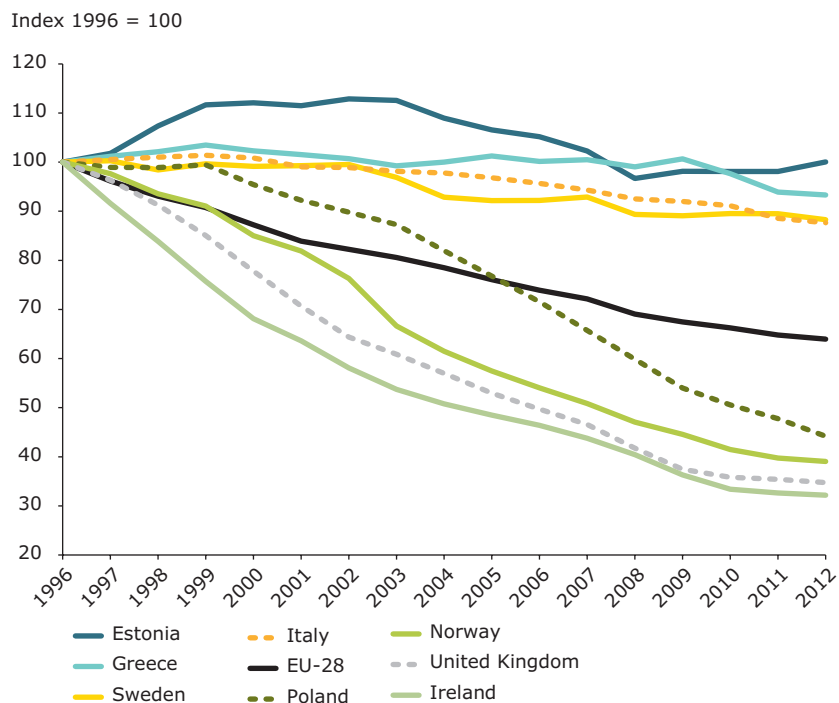
In some countries, the drop in prices has been even greater. Relative to total price inflation in each country, the cost of clothing in the United Kingdom and Ireland dropped by 75 % and 78 % respectively. Elsewhere the relative fall was much smaller. In Estonia, for example, clothing prices increased by the same amount as total HICP inflation over the period 1996–2012 (Figure 6.2).

Estimating changes in the quantity of clothing that Europeans consume poses some difficulties. Although the EU compiles quantitative data on trade and domestic production of goods from which consumption levels can be derived, the time series available for the EU-28 are relatively short. Moreover, aggregating the many different types of garment registered in the accounts is problematic because many items are listed by unit rather than by weight. Attempts to derive and interpret weight estimates are further complicated by changing weights of typical garments as the average fibre mix develops over time.

Nevertheless, there are strong indications that Europeans today consume substantially more clothing than two decades ago. When household expenditure data are adjusted to reflect changes in the price of clothing, they indicate that the volume of EU-28 clothing purchases actually increased by 40 % in the period 1996–2012. Population growth made a relatively small contribution to this overall increase; in per person terms, EU-28 real spending on clothes rose by 34 %. These increases were substantially larger than the growth in real expenditure on all goods and services (Figure 6.3).

The changes in clothing prices and consumption volumes can largely be explained by changes in production networks. As with other manufactured goods, clothing value chains have become increasingly

Figure 6.2 Consumer price indices for clothing relative to total HICP inflation in selected European countries, 1996–2012



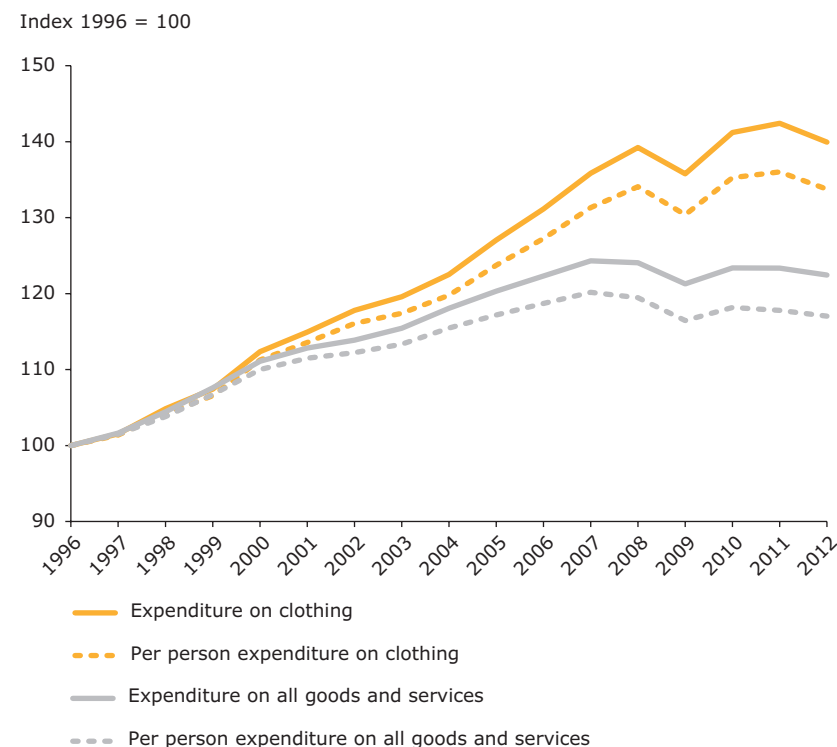
Note: The figure presents the trend in clothing prices relative to total HICP inflation. The countries included are the four EEA-33 countries with the highest relative price growth (Estonia, Greece, Sweden and Italy) and the four with the lowest (Poland, Norway, the United Kingdom and Ireland).

Source: EEA based on Eurostat data (HICP (2005 = 100) — annual data (average index and rate of change)).

globalised in the last half century, partly due to improved transport, in particular containerisation, and the removal of tariffs and other trade barriers (WTO, 2008). In 2012, global clothing exports totalled USD 423 billion, making clothing one of the world's most traded manufactured products (WTO, 2013).

Changes in production networks have been dramatic in the last two decades. In the years 1998–2009, the turnover of the EU textiles and

Figure 6.3 Real final consumption expenditure on clothing compared to all goods and services, EU-28, 1996–2012



Note: The figure presents expenditure trends in real terms, i.e. adjusted to eliminate the effects of price inflation. The underlying volume trends may reflect changes in the quantity, quality or mixture of goods and services purchased.

Source: Adapted from the SCP013 indicator, based on Eurostat data (Final consumption expenditure of households by consumption purpose — COICOP 3 digit — volumes, nama_co3_k).

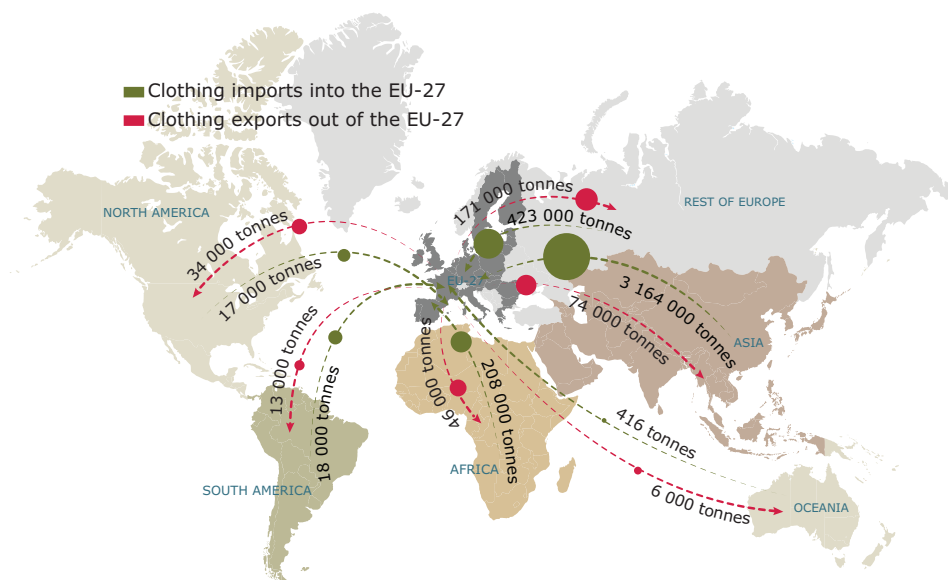
clothing sector declined by 28 % to EUR 167 billion. During this period, the number of people employed in the sector halved, falling to 2.3 million (Euratex, 2011).

The EU-28 imports large amounts of clothes, mainly from Asia (Figure 6.4). According to Eurostat ProdCom and Comext data, imports accounted for 87 % of European clothing consumption by

value in 2012, up from just 33 % in 2004 ⁽¹⁵⁾. The share of imported fibres in the final weight of consumed clothing is likely to be even higher. In part, this is because EU manufacturers also import raw materials and textiles from the rest of the world; in part it is because the production price per kilogram of clothing manufactured in Europe is likely to be higher than the price for imported clothing.

Earnings and prices are two key determinants of consumption, directly influencing an individual's purchasing options, but also shaping related decisions about product use. Choices about whether a piece of clothing has reached the end of its useful life — due to

Figure 6.4 Clothing trade flows between the EU-27 and other world regions, 2012



Source: ETC/SCP and EEA based on Eurostat data (EU trade since 1988 by CN8 (DS-016890)).

⁽¹⁵⁾ The figures presented here reflect the value of clothing imported for final use divided by total consumption (i.e. imports plus domestic production minus exports). Note that the share of net imports in final consumption is lower at 59 % in 2012.

wear and tear, shifting fashions or other causes — are likely to be influenced not just by its quality but also the cost of the garment and of a potential replacement, as well as factors such as repairing skills and cultural norms. Equally, decisions about whether to source clothes from second-hand retailers or to donate used clothes to friends or charity, rather than merely throwing them away, are likely to be influenced by price and income variables, alongside factors such as the accessibility of collecting bins.

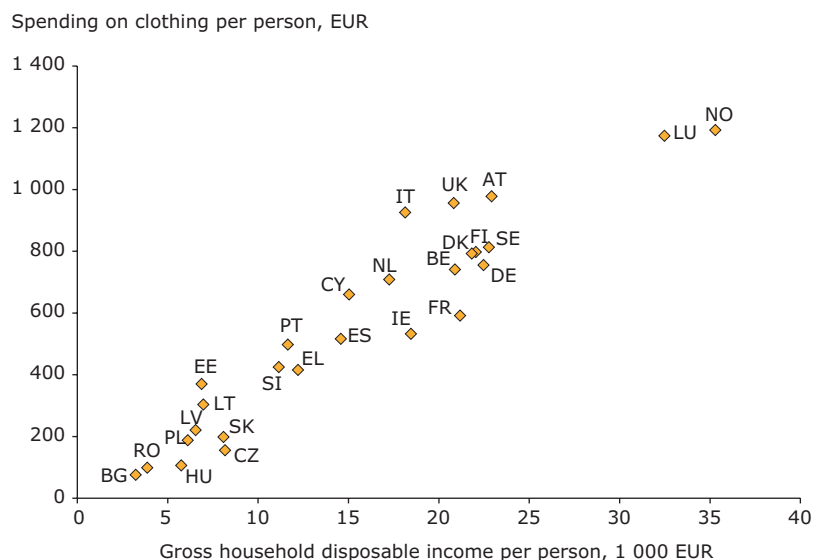
The economic recession in Europe in recent years provides some evidence of the influence of changing income on decisions about buying and using clothes. For example, research in the United Kingdom and Denmark has identified an increase in sales of clothing from charity shops following the economic crisis, alongside a drop in the supply of used clothes to these outlets (Palm et al., 2014).

At the same time, cultural factors, partly shaped by the clothing industry, also play an important role in shaping consumer choices about the amount, diversity and frequency of clothing purchases. Issues such as social status, business norms and historical traditions all contribute. As a result, consumers may differ quite strongly between and within countries in terms of their fashion orientation, quality preferences and price sensitivity (Texmedin, 2009).

As illustrated in Figure 6.5, there is a clear correlation between disposable income levels and per person spending on clothing. The highest expenditure is reported in Norway, where per person household disposable income exceeds EUR 35 000, and the lowest spending is in Bulgaria. Yet there is also marked divergence in clothing expenditure between countries of comparable wealth, indicating that factors other than income play an important role in shaping consumption choices.

For example, Italians spend more than 50 % more on clothes than the French, despite having lower disposable incomes. Estonians spend more than three times as much on clothing as Hungarians, despite having similar overall spending power. Differences in the relative cost of clothing between countries may influence spending levels but the national variation in per person clothing expenditure persists even when allowance is made for this.

Figure 6.5 Per person spending on clothing and per person household disposable income in selected European countries, 2012



Note: AT: Austria, BE: Belgium, BG: Bulgaria, CY: Cyprus, CZ: Czech Republic, DK: Denmark, EE: Estonia, FI: Finland, FR: France, DE: Germany, EL: Greece, HU: Hungary, IE: Ireland, IT: Italy, LV: Latvia, LI: Lithuania, LU: Luxembourg, NL: Netherlands, NO: Norway, PL: Poland, PT: Portugal, RO: Romania, SI: Slovenia, SK: Slovakia, ES: Spain, SE: Sweden, UK: United Kingdom.

The clothing expenditure data for Bulgaria, Romania, Greece and Norway are from 2011. The disposable income data for Romania are from 2011.

Source: EEA based on Eurostat data (Final consumption expenditure of households by consumption purpose — COICOP 3 digit — aggregates at current prices (nama_co3_c), Non-financial transactions (nasa_nf_tr), and Demographic balance and crude rates (demo_gind)).

Factors such as the age structure of a population and its distribution between cities, suburbs and the countryside have a large impact on purchasing decisions (Chapter 3). Younger people tend to replace their clothes more often as they attach greater importance to changing fashions than older consumers. In the United Kingdom, for example, 58 % of people aged 16–24 reported owning unworn items that are 'no longer my style/taste', compared to 36 % overall (WRAP, 2012b).

Another important aspect of consumer behaviour relates to choices about washing, drying and ironing clothes because energy, water and detergent use and related environmental pressures during the use phase of clothing account for a considerable share in environmental pressures across clothing's life-cycle (Figures 6.7 and 6.8). Habits and appliance ownership rates differ significantly from country to country. For example, rates of tumble dryer ownership vary widely between EU Member States, even among countries with similar climates. In Poland just 5 % of households own a dryer, compared to 68 % in the Netherlands (Presutto et al., 2010). Another study of selected EU Member States found that although ownership of washing machines was close to 100 % across Europe, average wash temperatures vary between 33 °C in Spain and 50 °C in the Czech Republic (Presutto et al., 2007).

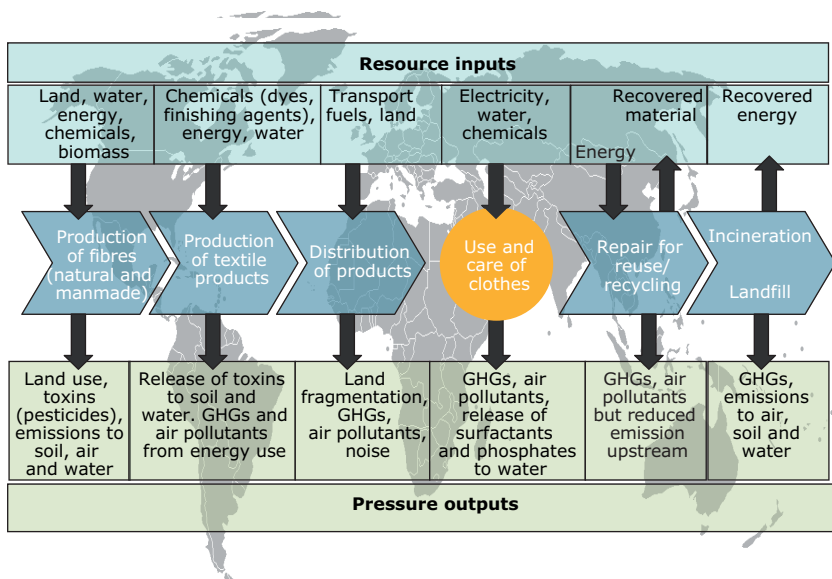
Research from Norway shows that clothing is often laundered when there is no real need to do so, and that the quantity of detergents used is far from optimal (Laitala and Boks, 2012; Laitala et al., 2012).

Impacts on the environment and society

Europe's consumption of clothing creates resource demands and environmental impacts at each life-cycle phase: production of natural or synthetic fibres, weaving and dyeing of fabrics, manufacture and distribution of garments, washing and repair and, ultimately, disposal (Figure 6.6).

The environmental impacts at each stage of a garment's life-cycle depend on the types and mix of fibres used and the associated production, use and disposal methods. For example, cultivating cotton, which accounted for approximately 33 % of world apparel fibre consumption in 2010, is often associated with significant use of water and land resources, and application of pesticides and fertilisers. Synthetic fibres such as polyester and nylon, which made up 60 % of global apparel fibre in 2010, are often produced using non-renewable resources and toxic chemicals (Defra, 2011; FAO and ICAC, 2013). The Swedish Chemicals Agency has identified more than 1 900 chemicals used during the production of clothing, of which 165 are classified in the EU as hazardous to health or the environment (KEMI, 2013).

Figure 6.6 Simplified overview of inputs and impacts across the life-cycle of clothing



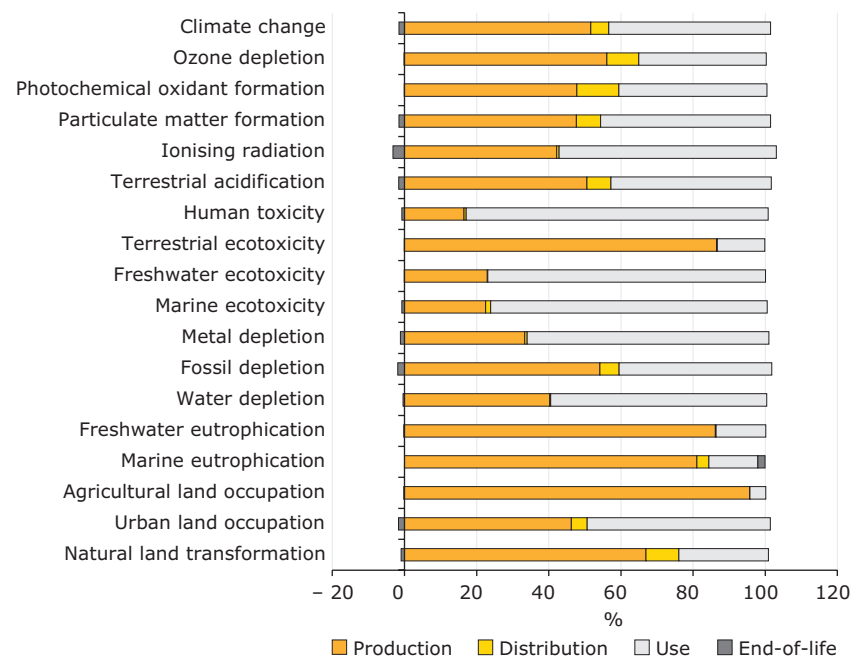
Source: EEA.

Further along the life-cycle, the choice of fibres also shapes environmental impacts by influencing the frequency of washing, the lifespan of garments and the possibilities for recycling.

As illustrated in Figures 6.7 and 6.8, the EU-27 consumption of textiles – of which 70 % by weight is clothing (EC, 2014g) – produces a diverse range of impacts across the life-cycle. The production and use phases dominate impacts, although their respective contributions to the different types of impacts vary greatly. For example, the production phase accounts for a very large proportion of the agricultural land use, terrestrial eco-toxicity, and marine and freshwater eutrophication associated with the life-cycle of textiles. In contrast, a substantial majority of human toxicity and freshwater and marine eco-toxicity results from the use phase.

Studies reviewed by the JRC/IPTS (EC, 2006) found that the environmental pressures of clothing ranged from 2 % to 10 %,

Figure 6.7 Environmental impacts of EU-27 consumption of textiles for each life-cycle stage (midpoint indicators)

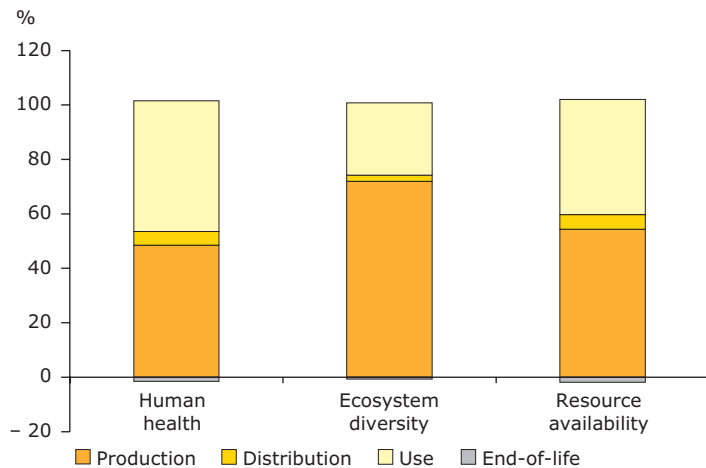


Source: EC, 2014g.

depending on type of pressure, of the life-cycle environmental impacts caused by EU-27 consumption, and that it is the fourth most significant consumption category in terms of environmental impacts, after housing, mobility and food.

According to calculations by the JRC/IPTS (EC, 2012d) using the World Input-Output Database (WIOD), consumption of clothing and footwear accounted for 3–6 % of environmental pressures resulting from total EU household consumption in 2008. As illustrated in Figure 6.9, the JRC/IPTS found that most of the production chain environmental pressures associated with EU clothing and footwear purchases grew significantly between 1996 and 2007, with water use increasing most rapidly (by 45 %). Pressures declined sharply after 2007, however, due to the economic crisis. Moreover, with

Figure 6.8 Environmental impacts of EU-27 consumption of textiles for each life-cycle stage (endpoint indicators)



Source: EC, 2014g.

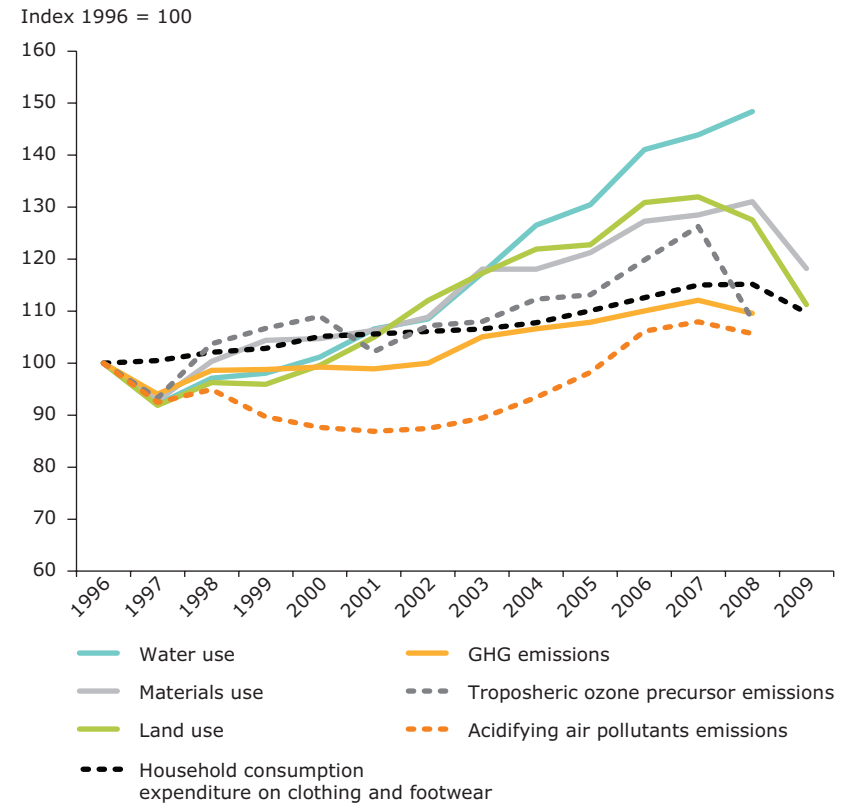
the exception of acidifying air pollutant emissions, pressures per euro of expenditure remain below the average for total household consumption.

Fibres and garments can today travel huge distances across their life-cycles. For example, cotton grown in Africa might be transformed in China into garments that are sold and worn in Europe and subsequently resold or donated in Africa. As a result, the environmental impacts associated with clothing bought and used in Europe are dispersed across the world. Quantifying and managing the impacts of European consumption of clothing has thus become far harder.

Globalisation of clothing-sector impacts

Globalisation of the clothing industry has created a mixture of social benefits and costs across the supply chain. Liberalisation of international trade has enabled production to shift to locations with comparatively cheap labour, offering European consumers access to cheaper clothing but bringing significant restructuring of the region's

Figure 6.9 Global environmental footprint caused by household purchases of clothing and footwear, EU-27, 1996–2009



Source: ETC/SCP elaboration based on JRC/IPTS analysis of World Input-Output Database (WIOD) (EC, 2012d) and Eurostat household expenditure data (Final consumption expenditure of households by consumption purpose – COICOP 3 digit – volumes, nama_co3_k).

clothing industry, with many job losses. Conversely, the expansion of production in low- and middle-income countries has created jobs and export revenues, benefiting both the individuals employed and society as a whole, for example by boosting tax revenues. The textile industry is estimated to employ at least 40 million people globally and plays an important role in poverty alleviation (Kirchain and Olivetti, 2013). Indirectly, the sector generates even more jobs. For example, the government of India estimates that every direct textile

industry job generates another 1.2 jobs in allied industries such as machinery, design and transport (Kirchain and Olivetti, 2013).

Evidence from several major Asian exporting countries indicates that although wages are low in the textile and garment sectors, they are often significantly higher than in relevant alternative employment, such as agricultural labour or domestic work. Moreover, employment is often heavily biased towards women, potentially offering greater financial independence and empowerment (Keane and te Velde, 2008).

The clothing sector is particularly important for the 36 countries that the World Bank (2014) defines as 'low income' (i.e. those with the lowest per person national income). As the World Bank (2011) notes, the clothing sector played a central role in the industrialisation process of most of today's developed and middle-income countries. Today, it is by far the main manufacturing export in most low-income countries. The share of these countries in the global clothing trade increased from 7 % in 1995 to 14 % in 2008. In comparison, their total share of the world's merchandise exports is less than 1 % (World Bank, 2011).

Alongside certain benefits, the outsourcing of clothing production carries significant human costs in producer countries. In part, these result from the pollution and environmental damage associated with producing fibres, fabrics and garments (Figure 6.7). In part, they are associated with the mistreatment of workers, including issues such as child labour and unacceptable working conditions (Defra, 2010).

The risks and human suffering sometimes associated with garment manufacture in developing countries were exemplified in April 2013 by the Rana Plaza tragedy in Bangladesh, when the collapse of factory buildings where clothing was being manufactured for a number of major European and North American brands caused the deaths of more than 1 120 workers.

Less directly, humans may suffer in regions where scarce water and land resources are allocated to producing goods for export rather than using them to meet domestic needs. In each case, many of the human costs of European consumption of clothing fall on populations in producer countries, where the rules and institutions for protecting the environment and workers are often comparatively weak.

Opportunities for change

The globalisation of clothing production networks makes it difficult to manage associated social and environmental impacts. European governments have limited capacity to influence environmental management and working conditions outside their territorial jurisdictions. Indeed, the span and complexity of global supply chains means that European consumers and even producers are unlikely to be aware of the full environmental and social impacts of their purchasing choices.

Since much of the harm that arises during production is externalised from the price of end products, social and environmental factors have little influence on purchasing decisions. Instead, in response to falling prices, Europeans today consume more clothes than they did 20 years ago, at greater cost to the environment (Figure 6.9). As such, they have become less resource-efficient in meeting their clothing needs.

The challenge today is to correct these trends while retaining, as far as possible, the benefits of globalisation for consumers and producers alike. There is no optimal global production network for clothing, since actions to improve one element of the system may have less desirable impacts in other areas. Measures that reduce the environmental impacts of production, for example, could mean that Europeans have to pay more for clothes, which might ultimately mean fewer jobs in manufacturing countries.

While acknowledging that any changes will create both winners and losers, it is possible to envisage adjustments to production and consumption practices that could together deliver a better system for meeting Europe's clothing needs. For example, environmental impacts could be reduced if Europeans allocated their spending on clothing to buying fewer, better-quality clothes derived from non-polluting sources; if they used clothing for longer; if they increased repair, reuse and recycling; and if they adjusted their cleaning methods. Social benefits in producing countries could be enhanced if global production-consumption systems promoted the manufacture of clothing in ways that generate less pollution while encouraging decent working conditions and fair pay.

To effect such changes, European governments, businesses and citizens have a range of tools available to influence different stages of the product life-cycle. These include:

- strengthening environmental and social labelling of clothes supported by value-chain traceability systems;
- introducing corporate social responsibility standards for clothing retailers;
- collaboration between clothing manufacturers, producers of appliances and detergent manufacturers to encourage and enable more resource-efficient washing and drying;
- up-scaling of promising sustainable business models such as leasing, resale of used own-brand garments and sharing;
- encouraging more repair, trading and swapping of used clothes;
- establishing efficient collection, sorting, reuse and recycling of clothing and other textiles.

Production-phase opportunities

Government measures

European production is covered by national and EU legislation concerned with production methods and working conditions. In contrast, European governments face important constraints in their ability to influence production methods in other parts of the world. Nevertheless, some opportunities do exist, notably in the area of green public procurement (GPP) policy.

The EU's GPP criteria for textiles, for example for hospitals, were issued in 2012, mainly targeting the avoidance of certain chemicals (EC, 2012b). Green public procurement is a voluntary instrument but, if more widely used across the EU, could boost demand for clothing and textiles produced sustainably within or outside Europe. However, it requires robust traceability systems for supply chains to ensure that criteria are being met.

In contrast to governments, whose authority is constrained by territorial boundaries and trade rules, businesses, non-governmental organisations and consumers may have greater capacity to exert influence through international supply chains and networks or coalitions.

Labelling

Since prices seldom provide much guidance to consumers on the social and environmental impacts of clothing purchases, labelling can play an important role in enabling citizens to differentiate between products on the basis of their environmental and social impacts.

A variety of labels exist for clothing and other textiles. The EU Ecolabel (EC, 2014e) and Nordic Swan (Nordic, 2014), for example, include criteria for textile products which constrain the use of certain hazardous substances and limit water use and atmospheric emissions during production. The Global Organic Textile Standards label can be awarded to 100 % organic cotton products (GOTS, 2014).

A study for the United Kingdom's Department for Environment, Food and Rural Affairs (Sinha and Hussey, 2009) found more than 40 different ecolabels worldwide that can be applied to clothing. The criteria for these labels vary greatly, covering issues such as minimal or zero use of hazardous chemicals, organic cotton sourcing and fair or ethical working practices. Only five include criteria to improve end-of-life management.

While the proliferation of labels suggests a certain amount of optimism about their potential, labelling faces some important limitations. As in other consumption areas, the diversity of labels creates uncertainty. Moreover, convenience is important. In addition, studies have shown that it is only for parts of the population that labels have any impact on purchasing decisions, and labels are generally most effective in combination with other policy instruments (Mont et al., 2013).

Traceability and measuring impacts

The globalisation of clothing production networks creates certain difficulties in quantifying and tracking impacts. Key issues are traceability and auditing, which require coordination across long and complex supply chains.

Information technology can offer some responses to this challenge. For example, the Better Cotton Initiative, which requires clothing companies to assume responsibility for the environmental and social impacts of production, uses a traceability system originally developed for certifying coffee production chains (UTZ, 2014).

Another challenge associated with globalised production networks is that they involve numerous firms along the value chain, generating diverse social and environmental impacts. Aggregating these impacts into a single metric that consumers can readily understand is difficult, but some attempts are under way. For example, the Sustainable Apparel Coalition is currently undertaking an initiative to develop and use the Higg Index to quantify the environmental and social performance of apparel and footwear products (SAC, 2014).

The European Commission — with the involvement of business — is currently testing a methodology for the environmental footprinting of products through a number of cases studies, including two in the clothing sector as well as household laundry detergents (EC, 2014h). These could possibly, over time, be used for more accurate labelling of product footprints.

Supply-chain management

Businesses increasingly face calls from consumers and interest groups to take responsibility for the social and environmental impacts linked to their supply chains. These demands appear well targeted since the transboundary character of global supply chains for clothing means that multinational corporations, rather than governments, may be better equipped to manage production phase impacts.

Public-sector bodies and non-governmental organisations can, however, play an important supporting role by creating frameworks to promote and facilitate corporate responsibility. The UN Global Compact, for example, is the largest voluntary corporate responsibility initiative in the world, engaging more than 10 000 firms and other stakeholders in more than 130 countries. Participating businesses commit to align their operations with a set of principles addressing human rights, labour, the environment and

corruption. If, for example, a buyer becomes aware of a health hazard in a factory in its supply chain then it is required to take action.

The Rana Plaza tragedy in Bangladesh illustrates some of the opportunities for enhancing supply-chain management. Following the disaster, companies in the United States and Europe signed accords committing to undertake inspections and improve conditions in supplier factories. At the same time, however, multinational businesses often rely on supply chains of very considerable breadth, depth and complexity, which potentially represents a significant obstacle to effective monitoring of impacts (The Guardian, 2013a, 2013b).

Education

Other opportunities to influence environmental impacts lie in educating clothes designers on the implications of their choices across a garment's life-cycle. This could include raising awareness about the pressures associated with different raw materials. It could also include training on how the choice of materials, colours and cut can influence washing requirements, and increase the potential for reuse and eventual recycling. Clearly, public-sector educational institutions and non-governmental organisations can contribute here.

Use-phase opportunities

Measures addressing the use and post-consumption phases of the life-cycle of clothing offer several important advantages. First, a substantial proportion of the environmental impacts associated with the life-cycle of clothing occur during the use phase. Second, measures that extend the use phase of garments can reduce demand for new clothes, thereby lessening production-phase impacts. Third, because the use and disposal phases occur within Europe's boundaries, the range of governance options available is broader.

The great majority of the clothing industry currently operates an entirely linear consumption model, with a large proportion of all items ending in landfill or incineration. And in high-income countries, disposal may occur after a limited useful life at the back of a wardrobe (EMF, 2013b). The active lifetime of clothing products can be extended by improving design and supporting additional measures, such as

donating or reselling used garments, establishing leasing and lending systems to replace garment ownership, and facilitating repairs.

Collection and resale

With a growing global demand for used clothing, a significant amount of clothing is collected in some countries for domestic resale and export. For example, of the 16 kg per person of textiles put on the Danish market each year, 6.3 kg (mostly clothing) is donated to organisations following consumer use. Of this, the majority, 4.7 kg per person, is exported for reuse and 0.5 kg is resold domestically. The remaining 1.2 kg is not fit for reuse and is sent for waste management, predominantly incineration (Tojo et al., 2012).

Nevertheless, even in countries with thriving collection practices, much of the reusable clothing and almost all non-reusable clothing still end up in mixed waste. This is in part due to the limited market for recycling, waste ownership rules and the fact that separate collection activities in European countries are largely carried out by charities rather than municipalities.

Charities and businesses that collect used textiles typically request citizens not to donate articles unfit for reuse since the market price for such articles is very low. Moreover, in many countries municipalities legally own all non-reusable discarded goods, but very rarely install systems for separate collection of textiles (Palm et al., 2014).

Businesses and governments have introduced measures to increase the collection of used garments. For example, the Swedish clothing company H&M operates a collection scheme for all textiles, not just its own brand, in all countries in which it operates. A number of other retailers such as Marks and Spencer engage in similar schemes, although the quantities collected by these schemes have so far been insignificant compared to charity collections. In France the return of clothing has been formalised through a mandatory extended producer responsibility system for clothing, home textiles and shoes (Box 6.1).

Leasing and lending systems

A number of companies have begun to lease clothing. For example, MUD Jeans in the Netherlands leases jeans and fleeces. Similarly,

Box 6.1 Extended producer responsibility (EPR) systems in France

France has more than 20 different extended producer responsibility systems covering products such as packaging, tyres, furniture and household chemicals. In 2006 it introduced an EPR system for clothing, household linen and footwear.

The 2006 legislation makes French producers and importers of clothing, linen and footwear responsible by law for ensuring reuse and recycling in the post-consumer phase. Companies can either organise their own reuse and recycling programme or contribute financially to an accredited collectively responsible organisation.

A single organisation, Eco TLC, has been accredited so far by the French public authorities to provide a collective system for the sector and 93 % of responsible companies are currently fee-paying members. In 2012, Eco TLC collected EUR 14 million from these companies. Annual contributions to the organisation are based on the preceding year's volume put on the market. Members who use a minimum of 15 % recycled fibres in their new textile products pay a reduced fee of 50 %.

Membership fees are used to support the sorting of collected textiles, communication to citizens by local authorities and a fund for research into improved recycling of non-reusable textiles. Future activities will include projects aimed at educating and assisting product designers to design with reuse and recycling in mind.

Eco TLC collected around 154 000 tonnes of textiles at 26 000 collection sites across France in 2012. This corresponds to around 25 % of the total volume of clothing, linen and footwear put on the French market. The quantity collected has increased by 8 % a year on average since the scheme was introduced and Eco TLC's current target is to collect 50 % of the market volume, of which 90 % is to be reused or recycled.

Source: Palm et al., 2014.

clothing libraries have appeared in a number of cities in Sweden and the concept is beginning to spread to neighbouring countries.

According to research in the United Kingdom by WRAP (2012a), half of survey respondents would consider hiring or leasing more clothes if it were easier (e.g. through major high street retailers), particularly designer dresses and clothes for going out and special occasions.

Enabling garment repair

Consumers are often reluctant to repair their clothing because of insufficient time or skills, the high cost of repairs and the low price of

replacements (Gibson and Stanes, 2011). Yet although many people lack the ability to alter clothing or undertake complex repairs, there is much interest in learning about how to do so (WRAP, 2012a).

Garments can be designed to make them easier to repair or alter, for example by including excess fabric, buttons or zippers (Rissanen, 2011; Goworek et al., 2013). However, in an analysis of the viability of various business models aimed at extending the active life of products, WRAP (2013) found that repair shops would need a change in framework conditions such as increases in textile prices before they would become viable.

Cleaning

While increasing the lifespan of garments offers many benefits, it does nothing to lessen the impacts associated with cleaning. In Europe, governments have introduced a variety of measures to reduce the environmental impacts of washing and drying — with product standards, labelling and consumer education playing a key role.

For example, the energy efficiency of washing machines and dryers is encouraged by the EU Energy Labelling Directive. Energy labelling has been very effective in reducing energy and water use in electrical appliances (Chapter 5). The Ecodesign Directive sets a framework for criteria for the EU market and is beginning to look beyond energy efficiency. The EU has also adopted a series of measures addressing chemicals in detergents (EC, 2014d); the EU Ecolabel and many others exist for washing detergents.

Education of consumers can play an important role in bringing about small behavioural changes such as reducing washing temperatures, washing at full load and avoiding tumble-drying whenever possible (Bio Intelligence Service et al., 2009). Design and fabric choice are also important — some materials such as wool are more dirt-resistant and should be washed at lower temperatures. Fabric treatments can also help repel dirt, although they may have environmental impacts (Laitala and Boks, 2012).

End-of-life opportunities

The recycling of textiles remains relatively marginal in the EU due to technical barriers for recycling fibres back into textile products and low market prices for other types of recycling. Most recycling appears to be down-cycling to industrial rags, insulation materials, etc. (Palm et al., 2014).

Although clothing waste is covered by the EU Waste Framework Directive, there are currently no specific targets for the reuse and recycling of clothing waste. Introducing targets could encourage governments to implement measures to improve management of clothing waste. However, the 70 % target for recycling municipal waste proposed by the European Commission (EC, 2014c) is likely to spur initiatives for textiles recycling.

One possible measure could be imposing mandatory extended producer responsibility (EPR) schemes. In addition to increasing collection, reuse and recycling of used clothing, such schemes could encourage upstream effects such as designing garments to facilitate reuse and recycling, or encouraging the use of recycled fabrics. As noted in Box 6.1, the French EPR system for clothing includes a 50 % reduced membership fee for articles that include a minimum of 15 % recycled fibres. Similar rebates could be given for producers who avoid the use of hazardous chemicals, avoid fibre mixes to allow easier recycling or produce more durable products (Watson et al., 2014).



3

REFLECTIONS

Part 3 Reflections

Chapter 7 Comparing the environmental and policy aspects of globalised production-consumption systems

- Reflections on the production-consumption systems perspective
- Similarities and differences between the food, electrical and electronic goods and clothing systems
- Policies

Chapter 8 Long-term visions and transitions to sustainable production-consumption systems

- Long-term policy visions
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7 Comparing the environmental and policy aspects of globalised production-consumption systems

Key messages

Analysing globalised production-consumption systems and their life-cycle impacts can reveal environmental hotspots and leverage points where action can have the strongest positive influence on system-wide change.

Globalisation of the world economy has been the most important driver shifting production to other parts of the world for the three systems examined in this report. Many countries around the world are highly dependent on these systems, so any changes to them could have considerable positive or negative effects on the livelihoods of millions of people.

The current EU policy framework that regulates and steers the life-cycle environmental impacts of these systems is mostly targeted on impacts that occur within the region. In that regard, policies mainly focus on the production stage and, increasingly, on the end-of-life phase.

Policies addressing the environmental impacts of products and consumption are still in the very early stages of development and implementation; policies on the energy efficiency of electrical and electronic goods are a notable exception.

EU policies have recently started to recognise the need to address production-consumption systems in a more integrated way, including in the 7th EAP.

Reflections on the production-consumption systems perspective

The supply side (production) and the demand side (consumption) of the economy are closely linked and should therefore be analysed together rather than separately. Analysis that captures one part of the system and its environmental impacts may overlook possible synergies that can be derived from an integrated analysis across the whole system.

One example of integrated analysis is the rebound effect: more efficient technologies lead to reduced costs for consumers, for

example in the purchase and use of appliances, which releases income for intensified use or for buying other goods and services that may damage the environment even more (Box 7.1). Such analysis is highly relevant in support of the design of effective environmental policies.

Box 7.1 The rebound effect

The rebound effect refers to behavioural change or systemic responses that can partly or fully offset the beneficial environmental effects of new pollution-abatement technologies such as more fuel-efficient car engines and energy-efficient household appliances. There is general agreement that the rebound effect exists and can be significant, but its size varies substantially from case to case (UKERC, 2007). It can be explained by a number of different economic reactions.

- **Direct rebound effect.** An increase in efficiency lowers the cost of consumption, which can then lead to an intensified use of the product. For example, fuel-efficient cars reduce the fuel cost per distance travelled, which can lead to more kilometres travelled and more fuel used.
- **Indirect rebound effect.** Sorrell (2012) identifies a number of broad types of single and composite indirect effects:
 - *embodied energy effects* — the equipment used to improve efficiency (e.g. thermal insulation) itself requires energy and resources to manufacture and install, which offsets some of the lifetime environmental savings achieved;
 - *output effects* — producers may use the cost savings from energy efficiency improvements to increase output, thereby increasing consumption of energy inputs as well as capital, labour and material inputs;
 - *energy market effects* — increased efficiency in the energy sector may translate into lower energy prices which encourages energy consumption to increase;
 - *composition effects* — both energy efficiency improvements and the associated reductions in energy prices reduce the cost of energy-intensive goods, encouraging consumer demand to shift towards these.
- **Economy-wide or general equilibrium effect.** This is more complex and refers to changes in aggregate consumption patterns which may lead to structural change, as well as to changes in relative prices (Brännlund et al., 2007). An example is time savings (Jalas, 2000) from efficiency improvements such as e-mail or e-banking, so that more time is available for other forms of consumption, such as leisure driving.

Many environmental pressures within Europe are decreasing (EEA, 2012a). This is partly because of more eco-efficient production in the region, but also because resource extraction and the manufacturing of many intermediate goods and final consumer products have relocated elsewhere. As the pressures exacted by activities abroad are not captured by traditional territorial environmental indicators, analyses that capture both sides of the coin are becoming more important for informing policy discussions.

Systems-wide analyses can reveal hotspots of environmental impacts; knowledge about where in the life-cycle the highest environmental impacts occur can direct environmental policies and increase their effectiveness.

Systems for which trade is a significant factor, which include food, electrical and electronic goods and clothing, pose challenges to more traditional process-based regulation since much of the production is beyond European jurisdiction. Other types of policy are needed such as product-focused regulation, as well as policies that manage and influence demand and consumption behaviour, for example market-based instruments.

System-wide analysis can also reveal possible leverage points, actors and stakeholders along the whole supply chain that might have the highest influence and opportunities to make changes to the system as a whole.

Currently available data and indicators to a large extent support analysis of the production side of the economy. Indicators on life-cycle pressures and impacts are much scarcer owing to extensive data demands and methodological challenges, and in most cases they relate to specific products.

Macro-level information on the life-cycle pressures of production-consumption systems has been made available in recent years through environmentally extended input-output (EE-IO) methodologies, in which national accounting is combined with environmental accounts; such approaches have been used for producing some of the analysis in this report. The data and methodologies for this type of analysis are maturing but are yet to be adopted for mainstream national environmental reporting by most EU Member States. They

still encompass higher uncertainties than territory-based data and methodologies, and also come with a considerable time lag and include only a limited number of pressures. However, they are indispensable for complementing the data and indicators that focus on the pressures from economic activities in Europe only (EEA, 2013f).

The need to take account of both the production and consumption perspectives has been recognised by the European Commission's Roadmap to a resource-efficient Europe (EC, 2011c). In order to monitor progress against the objectives of the Roadmap, the Commission has proposed a dashboard of indicators — alongside a lead indicator and more theme-specific indicators — that addresses both perspectives (Table 7.1).

Table 7.1 Dashboard of indicators in the European Commission's Roadmap to a resource-efficient Europe

	Production/territory perspective	Consumption/global supply-chain perspective
Land	Artificial land or built-up area (km ²) — available with restrictions in time series	Indirect land use/embodied land for agricultural and forestry products (km ²) — to be developed
Water	Water exploitation index (WEI, %) — available with restrictions on completeness of data and regional/temporal resolution (river basin/intra-annual variations)	Water footprint — to be updated and improved Embodied water — to be developed
Carbon	Greenhouse gas emissions (t) — available	Carbon footprint — estimates available from scientific sources

Source: EC, 2011b.

Similarities and differences between the food, electrical and electronic goods and clothing systems

Price developments in Europe for clothing, electrical and electronic goods and food have affected production-consumption systems. For clothing, prices having risen less than inflation and have decreased compared to other goods, resulting in the amounts consumed (by weight) increasing more than expenditure. For electrical and electronic goods, prices have fallen as well, particularly for phones, audio-visual equipment and computers, resulting in increased consumption and rapid replacement of appliances such as mobile phones, personal computers and televisions. Food prices,

meanwhile, have increased slightly above inflation, with some differences amongst food product categories.

The three production-consumption systems share several common features: a large part of demand for these goods in Europe is met by imports (to a smaller extent for food); they generate relatively large life-cycle environmental impacts; and there are substantial challenges with regard to limiting their environmental impacts while retaining their economic and social advantages. Environmental impacts in many cases are rising, driven by trends such as available incomes, prices and the number of households, as well as several cultural factors. These trends and drivers partly outweigh improvements in the eco-efficiency of production and products.

Assessment and comparison of the impacts of these systems have been based on the available indicators for prices and consumption expenditure and for life-cycle environmental pressures and impacts (Tables 7.2, 7.3 and 7.4).

The production processes and environmental impacts of food, electrical and electronic goods and clothing differ, but owing to the common importance of the trade there are some similarities in the kind of policy approaches required to address them.

Globalisation has been an important driver of shifting production to other parts of the world for all three, except for some food production for which the shift has been limited by the EU CAP providing subsidies and other support to keep agricultural production in Europe. Another similarity is that many countries around the world are highly dependent on these systems for income and employment, so any policy-driven changes could have considerable positive or negative effects on the livelihoods of millions of people, for example in Bangladesh (clothing), Malaysia (electrical and electronic goods) and Brazil (food).

The environmental pressures and impacts are considerable, for each system, across all phases of the life-cycle. For example, all three are highly dependent on resource inputs — such as land, water, energy, minerals, metals, plastics and chemicals — that lead to pressures on the environment within and outside Europe, including land and water pollution, waste, greenhouse gas emissions and the concomitant effects on climate, and other air pollutants.

Table 7.2 Selected indicators related to consumption expenditure and life-cycle impacts – food

Indicator	Level, share and/or trend	Implication/rationale
Real final consumption expenditure on food compared to all goods and services	Slight increase in food expenditure until the economic downturn in 2007, then slight decrease	Increases in overall consumption mainly due to growth in incomes and rising population
Consumer price indices for food and all goods and services	Increasing trend, slightly above overall inflation since 2001	Overall rather stable situation in Europe, influenced by global food markets
Household expenditure on food as a proportion of total household expenditure	Decrease in household expenditure on food as a share of total expenditure in all countries	With growing incomes, consumers tend to spend a higher share of their income on less basic items than food
Trends in consumption of selected food products (quantities)	Consumption of fruit and fish increasing most	Europeans seem to turn towards more healthy food
Net trade flows in soybean, meat and dairy products between the EU-27 and other world regions	EU is a net exporter (value) of food, but meat and fish imports are rising, and European meat production and consumption depends on feed imports	European food production-consumption systems depend increasingly on imports in spite of considerable domestic production
Global environmental footprint caused by household purchases of food and non-alcoholic beverages	Fluctuating, but overall increasing trend for most impact categories, but recently decrease of nearly all impacts	Footprint increasing, with overall growth in food consumption, but recently more positive trends
Average food wastage per person	High food wastage along the production-consumption chain	Food wastage is responsible for considerable environmental impacts

Table 7.3 Selected indicators related to consumption expenditure and life-cycle impacts – electrical and electronic goods

Indicator	Level, share and/or trend	Implication/rationale
Real final consumption expenditure on disaggregated electrical and electronic goods	Steep increase in household expenditure for electronics but stable for household appliances	Rapid technological development and falling prices lead to more consumption
Household expenditure on consumer electrical and electronic goods as a proportion of total household expenditure	Slight decrease in household expenditure on electrical and electronic goods as a share of total expenditure but increase in a few countries	The strong decrease in prices, especially for phones and electronics, enabled growth in volumes of appliances alongside reduced expenditure
Trend in consumer prices for different types of electrical and electronic goods	Growth below inflation for electrical appliances; decreasing prices for electronics such as phones, computers, etc.	Falling prices with technological development, economies of scale and shift of production to countries with low labour costs
Trade flows in electrical and electronic goods between the EU-27 and other world regions	EU is a net importer of electrical and electronic goods	The production-consumption system of electrical and electronic goods depends increasingly on imports
Share of imports in EU-27 consumption of selected materials	High level (between 30 % and 100 %)	Very high import dependency for many metals used in electrical and electronic goods
Final household electricity consumption by use	Increase in household electricity consumption	Household electricity consumption growth mainly driven by increased stock and use of electronics
Trends in energy efficiency and number of electrical appliances in households	Energy consumption per appliance decreasing; stock of appliances increasing; total energy consumption for appliances increasing	Consumption growth outweighs efficiency gains
Drivers of the change in average annual energy consumption per household	Efficiency improvements have caused lower energy consumption, partly offset by the effects of more appliances and more floor space per person	Increase in available income leads to more floor space per person; falling prices and technological development lead to more appliances being purchased
Electrical and electronic goods put on the market and e-waste collected, reused and recycled	Amounts collected increasing but overall still low; recycling rates increasing	Adequate systems still not in place to ensure high collection rates

Table 7.4 Selected indicators related to consumption expenditure and life-cycle impacts – clothing

Indicator	Level, share and/or trend	Implication/rationale
Household expenditure on clothing as a proportion of total household expenditure	In most European countries, spending on clothing has declined as a share of total household expenditure in the last two decades	Significant decline in the cost of garments leads to lower share of clothing in household expenditure
Consumer prices for clothing relative to total HICP inflation	Decreasing trends	Production moved to countries with lower labour costs and lower environmental protection; liberalisation of tariffs
Real final consumption expenditure on clothing compared to all goods and services	Increase until the economic downturn in 2007, then slight decrease in clothing expenditures	Cheaper clothing and growing expenditure implies larger amounts consumed and higher related total life-cycle impacts
Clothing trade flows between the EU-27 and other world regions	EU is a net importer of clothes	The European clothing production-consumption system depends increasingly on imports
Environmental impacts of EU-27 consumption of textiles for each life-cycle stage (midpoint indicator)	Production and use phases dominate all impact categories	Hotspots of environmental pressure from the production and use phase
Environmental impacts of EU-27 consumption of textiles for each life-cycle stage (end point indicator)	Increasing most for water use, and slightly for air emissions, greenhouse gases, land and materials; but reversal of previous trend for most impact categories started around 2008	Footprint increasing with rising production and consumption
Global environmental footprint purchases of clothing and footwear	Clothing and footwear is responsible for 4–6 % of aggregated pressures	Environmental impacts from clothing and footwear are small compared to other major consumption categories; chemicals not included

Source: EEA.

There are also differences in where the pressures on the environment occur within the life-cycles of the three systems. The hotspot of energy use for electrical and electronic goods is either in the use or in the production phase, depending on the type of product, its energy efficiency and use pattern. For clothing, the use phase is responsible for 40–80 % of the energy used throughout the life-cycle from washing, drying and ironing regularly. Nonetheless, the production phase — especially the choice of fibres — is also relevant (BSR, 2009). For food, the production phase, especially agriculture, causes the highest pressures along the life-cycle.

Policies

EU policy strategies now acknowledge the benefits of addressing production-consumption systems in a more integrated way. The 7th EAP calls for measures 'to further improve the environmental performance of goods and services on the Union market over their whole life-cycle including measures to increase the supply of environmentally sustainable products and stimulate a significant shift in consumer demand for such products.' The programme clearly recognises the need for more systemic changes compared to past developments, stating that by 2020, the programme should ensure that 'structural changes in production, technology and innovation, as well as consumption patterns and lifestyles have reduced the overall environmental impact of production and consumption, in particular in the food, housing and mobility sectors.'

The programme reinforces previous policies that included elements to make products more sustainable, including the 2008 Action Plan on Sustainable Consumption and Production (EC, 2008b), the 2011 Roadmap to a resource-efficient Europe (EC, 2011c), and the 2013 Single Market for Green Products Initiative (EC, 2013b). However, the 7th EAP goes beyond those policies with its call for more fundamental changes to production-consumption systems and its aim to set targets for the life-cycle environmental impacts of consumption.

Policies that aim to reduce environmental impacts during the life-cycles of the three production-consumption systems are already in place. However, existing policies targeted at the consumption phase are in many cases information-based instruments, with little

regulation and few effective market-based instruments in place. Table 7.5 provides an overview of existing policies for the three systems, distinguishing between three phases of the life-cycle.

The production side of all three systems, as far as it takes place in Europe, is comprehensively regulated through EU policies. The Common Agricultural and Fisheries Policies have a long history of regulation, and environmental pressures from the production of clothing, electrical and electronic goods, and food processing are regulated by the Industrial Emissions Directive and other Directives targeting specific aspects of production. However, if products are imported, these regulations do not apply, and emission intensities may be higher or lower than in Europe.

There is no policy concerning production efficiency, particularly where production takes place in other countries. Some limited policies exist: for electrical and electronic goods, for example, there are minimum standards through the Ecodesign and RoHS Directives, mandatory labelling through the Energy Labelling Directive, and voluntary energy and ecolabels. Ecolabels also exist for clothing and food but they are voluntary and their market shares are rather low. Regulation of negative effects on health and the environment from chemicals in textile products is largely absent in the EU (KEMI, 2013).

For products where much of the production is outside the EU there is a potential to shift from process-based regulation to product-based regulation. This is already happening: the Ecodesign Directive and the RoHS Directive, for example, create a more level playing field for producers wherever they are located. The directives are aimed mainly at increasing energy efficiency during the use phase and protecting EU consumers and the EU environment at the waste stage, but there is also potential for reducing impacts at the production phase by setting restrictions on chemical use and minimum standards for material and energy efficiency during production.

A key policy opportunity not currently addressed for all three areas is demand-side management consistent with the environmental principles of polluter-pays and prevention in the EU Treaty. This has potential to influence production-based impacts as well as end-of-life/waste impacts and is not being used to any great extent in Europe. The objective of the European Commission's Roadmap to a

resource-efficient Europe (EC, 2011c) to reduce food waste might be the first attempt at demand-side management in these three areas.

EU waste policies address all three systems, mainly aiming at diverting waste from landfill and moving it up in the waste hierarchy which prioritises waste prevention, followed by reuse, recycling, other recovery, and finally disposal or landfilling as the least desirable option. However, specific targets only exist for e-waste.

No binding EU targets exist for prevention or reuse of waste from these three systems; however, a target to reduce food waste has recently been proposed by the European Commission (EC, 2014c), and countries are expected to develop waste prevention programmes by the end of 2013 as prescribed by the Waste Framework Directive (EU, 2008). EEA analysis shows that most countries address food waste and e-waste, and many also address clothing waste, in national programmes (EEA, 2014i).

Table 7.5 Main EU policies aimed at different phases of the life-cycle of food, electrical and electronic goods and clothing

Production-consumption system – Food		
Policies aimed at the production/supply side	Policies aimed at consumption/products/demand	Policies aimed at the end-of-life/waste phase
Common Agricultural Policy	Organic food label	Landfill Directive (diversion of biodegradable waste from landfill)
Common Fisheries Policy	Blueprint to Safeguard Europe's Water	Waste Framework Directive (50 % recycling target for municipal waste)
Pesticides Directive		Circular economy communication (food waste)
Nitrates Directive		
Industrial Emissions Directive (best available technologies for food processing, live-stock rearing, slaughtering)		
Regulation on genetically modified food and feed		
Organic food label		
Green public procurement criteria		
Water Framework Directive		
Water scarcity and droughts communication		
Blueprint to Safeguard Europe's Water		

Table 7.5 Main EU policies aimed at different phases of the life-cycle of food, electrical and electronic goods and clothing (cont.)

Production-consumption system – Electrical and electronic goods		
Policies aimed at the production/supply side	Policies aimed at consumption/products/demand	Policies aimed at the end-of-life/waste phase
Industrial Emissions Directive (best available technologies for metals processing, plastics production) Mining Waste Directive REACH Regulation RoHS Directive Ecodesign Directive Green public procurement criteria	RoHS Directive Ecodesign Directive EU Green public procurement criteria Energy Label Directive	WEEE Directive Ecodesign Directive RoHS Directive Green public procurement criteria Circular economy communication
Production-consumption system – Clothing		
Policies aimed at the production/supply side	Policies aimed at consumption/products/demand	Policies aimed at the end-of-life/waste phase
Industrial Emissions Directive (best available technologies for textiles and leather industry) REACH Regulation Green public procurement criteria Ecolabel Water Framework Directive Urban Waste-water Treatment Directive Water scarcity and droughts communication	Ecolabel EU Green public procurement criteria Urban Waste-water Treatment Directive	Landfill Directive (diversion of biodegradable waste from landfill) Waste Framework Directive (50 % recycling target for municipal waste) Green public procurement criteria Ecolabel Circular economy communication

Source: EEA.

8 Long-term visions and transitions to sustainable production-consumption systems

Key messages

The EU is increasingly formulating its environment and climate policies and several key sectoral policies, such as energy and transport, along two timeframes: 2020/2030 with regard to measurable objectives and targets; 2050 with regard to long-term visions with a societal transition perspective.

The 7th EAP provides a vision for 2050 'to live well, within the planet's limits'. At the global level, the World Summit on Sustainable Development in 2012 agreed on a common vision towards sustainable development and set the path for the development of goals and targets. Long-term visions to 2050 have also been developed by business and civil society.

Realising long-term visions will require fundamental transitions in production-consumption systems – including those analysed in this report. Europe is locked in to technologies, processes and patterns of behaviour, etc., that greatly hinder pathways to such transitions.

Regular policies, prevailing market-based approaches and established institutional frameworks are not in themselves solutions to the transitions challenge; rather, profound changes are required in dominant structures and thinking, supported by a coherent framework that recalibrates socio-economic and environmental policies and promotes social, financial and technological innovations across society.

A number of niche approaches are emerging, which provide some indication of how transitions could be realised. These include new business models and social innovation, such as product-service systems, collaborative consumption and prosumerism.

Long-term policy visions

The Europe 2020 strategy provides an overarching EU perspective on smart, sustainable and inclusive growth (EC, 2010a). The aim of increasing resource efficiency, which encompasses changes to production-consumption systems, features prominently in the strategy as one of seven flagship initiatives. It aims at a shift towards a resource-efficient, low-carbon economy, recognising the environmental prerequisites for sustainable growth (EC, 2011a).

With the adoption of the 7th EAP, policymakers in the EU have set the EU environmental agenda for the period 2014–2020 (including targets and aspirations beyond 2020) (Figure 8.1). The programme is framed by three, interrelated challenges: to protect nature and strengthen ecological resilience; to boost sustainable resource-efficient low-carbon growth; and to effectively address environment-related threats to health.

As importantly, the programme also provides a vision for 2050 — to live well within the planet's ecological limits, in an innovative and circular economy:

'Our prosperity and healthy environment stem from an innovative, circular economy where nothing is wasted and where natural resources are managed sustainably, and biodiversity is protected, valued and restored in ways that enhance our society's resilience. Our low-carbon growth has long been decoupled from resource use, setting the pace for a safe and sustainable global society.'

More specifically, the 7th EAP, for the first time in an EU policy document, requires the setting of targets related to the life-cycle environmental impacts of consumption:

'To set a framework for action to improve resource efficiency aspects beyond GHG emissions and energy, targets for reducing the overall life-cycle environmental impact of consumption will be set, in particular in the food, housing and mobility sectors.'

The programme notes that this will require:

'structural changes in production, technology and innovation, as well as consumption patterns and lifestyles (...), and 'giving impetus to the public and private research and innovation efforts required for the development and uptake of innovative technologies, systems and business models which will speed up and lower the cost of transition to a low-carbon, resource-efficient, safe and sustainable economy.'

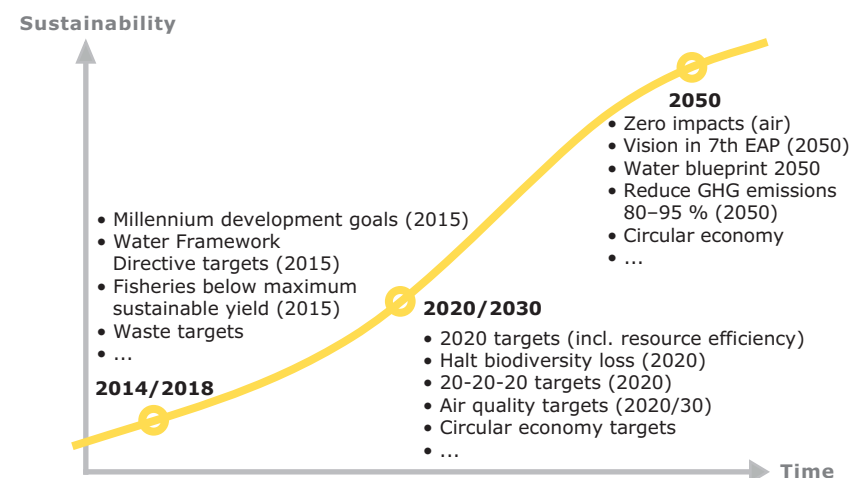
At the global level, world leaders at the World Summit on Sustainable Development in Rio de Janeiro in June 2012 (Rio+20) agreed on a common vision towards sustainable development that:

'renew[s] our commitment to sustainable development and to ensuring the promotion of an economically, socially and environmentally sustainable future for our planet and for present and future generations' (UN, 2012a);

'recognize[s] that poverty eradication, changing unsustainable and promoting sustainable patterns of consumption and production and protecting and managing the natural resource base of economic and social development are the overarching objectives of and essential requirements for sustainable development' (UN, 2012a).

The summit set the path for the development of concrete Sustainable Development Goals (SDGs) that could possibly replace the Millennium Development Goals (MDGs) that 'have been the most successful global anti-poverty push in history' (United Nations Secretary-General Ban Ki Moon, UN 2013). An open Working Group established by the United Nations has concluded its work by proposing a list of 17 goals, each accompanied by concrete targets, to be attained by 2030 (UN, 2014b).

Figure 8.1 Short-, medium- and long-term sustainability perspectives



Source: EEA Multiannual Work Programme 2014–2018, adapted.

Sustainability visions have also been developed at the level of business and civil society. In the Vision 2050 project, the World Business Council on Sustainable Development (WBCSD), with 29 global companies representing 14 industries, developed a vision of a world on track to sustainability by 2050. According to WBCSD (2010), this would be a world in which the global population is not just living on the planet, but living well and within the limits of the planet.

A very good example of sustainability visions developed by civil society is the EU-funded SPREAD Sustainable Lifestyles 2050 research project and social platform. It resulted in four different scenarios that describe what sustainable living might look like in four diverse future societies (Leppänen et al., 2013).

Sustainability transitions to realise visions

The challenge across the several visions is to find the transition pathways for society to achieve them. Such transitions are long-term and multi-dimensional in character and require fundamental processes of change in socio-technical systems — for example food, housing, energy and mobility — towards sustainable modes of production and consumption. The changes needed go well beyond the objectives and targets set out in EU environmental and climate policies to be reached by 2020 (and 2030).

Lock-ins to current production-consumption systems

Current production-consumption systems are locked in to certain technologies, for example infrastructure built up over many decades, such as roads and housing stock, retail developments, power stations, sewage networks and fossil-fuel engines, which hinder transitions to more sustainable patterns of production and consumption (Geels, 2011).

There are also lock-ins to current economic structures and thinking such as the perceived need to achieve GDP growth, which is increasingly dependent on trade with other regions of the world. Other economic lock-ins include the long lead times for large capital

investments, which realise profit many years after the investment is made.

Less evident are the lock-ins to certain patterns of behaviour deeply rooted in cultures and habits, for example preferences for not standing out in comparison with family, friends, neighbours and colleagues, preferences for copying the behaviour of celebrities, or preferences for owning goods rather than leasing or having access in some other way. Lock-ins to certain political and democratic structures are also relevant to current production-consumption systems.

Mechanisms of transition processes

Transitions are basically non-linear processes resulting from the interplay between three different levels: the macro, meso and micro.

At the macro level, transitions are influenced and formed by macroeconomic policies and trade patterns, as well as society-wide developments such as demographics, political ideologies, societal values and technical backdrops (Geels, 2011). These include the global megatrends discussed in Chapter 3 that to a large extent affect how Europeans produce and consume.

The production-consumption systems analysed in this report are at what some refer to as the meso or sector level. It is at this level that transitions take place. They are formed by the global megatrends and drivers at the macro level and by the up-scaling of good examples and niches at the micro level.

At the micro level, niches are practices reflecting innovation and new paradigms for businesses, whether start-ups, small or medium-sized enterprises or large companies; for public authorities at, for example, the EU, national, regional or local level; and for civil society, whether citizens or non-governmental organisations.

Niches can exemplify possible solutions and pathways towards change, and offer potential for up-scaling. They encompass both technical and social innovation, research and other experiments, and social and business entrepreneurship.

Factors that can contribute to transition processes include the creation of:

- long-term policy frameworks, for example the EU's 2050 agenda on energy and climate, biodiversity, resource efficiency and circular economy;
- high-level government and international organisations' support, e.g. by EU Member States, EU institutions across different policy areas, and various international organisations;
- long-term technology programmes with a variety of participants, e.g. public funding and private sector engagement as embedded in the EU's 2020 budget and Horizon 2020 (the EU Research and Innovation programme), and at the level of the Member States;
- strong public support, since changes in socio-technical systems have fundamental impacts on citizens (EEA, 2014f).

Up to now, efficiency-oriented approaches, aimed at making production processes and products and services more resource-efficient and eco-efficient, have dominated sustainability policies.

While augmenting resource efficiency remains essential, it is increasingly clear that it alone is not enough to deliver the longer-term objectives of the 7th EAP. Changes going beyond incremental efficiency improvements, such as demand-side management, are often seen as notoriously difficult, lacking acceptance, and as a threat to welfare and economic growth. Learning from niches and linking demand-side management to policies on human well-being and wider green economy policies can be effective approaches to overcome such barriers.

The concepts of green economy, resource efficiency, sustainable consumption and production, and circular economy introduced in the Annex imply, to a varying extent, major changes in the way production-consumption systems are organised. One example is the food system and the current discussion on how to prevent food waste through numerous measures and changes in the system. Also, a circular economy implies that goods are no longer simply discarded, but instead kept in use for a longer time, reused and their materials recycled as inputs into further production.

In this way, waste is increasingly seen as a resource, thereby encouraging technological innovation that further enables reuse and recycling and policies that ensure that goods are brought back into the economic system through take-back systems, separate collection, waste sorting, etc., as well as through re-manufacturing, repair and upgrading.

Viewing waste in this way also underpins moves towards product-service systems in which goods and services are leased or rented rather than sold, and gives producers incentives to design products differently, enabling reuse of components and easy recycling of materials. Social innovations are also encouraged, for example organising ways of sharing goods and services, either locally or through internet services. The 7th EAP and the European Commission's Communication 'Towards a circular economy – A zero waste programme for Europe' (EC, 2014c) are important strategic documents that can drive changes in European and national legislation.

Factors enabling transition in production-consumption systems

At the niche level, a number of trends and new business models are emerging which hint at how sustainable production and consumption patterns might look in the future. Four 'arcs' of transition, identified as part of an EEA stakeholder process to inform the 2015 State and outlook of the environment report, provide examples of such emerging niches:

- social innovation;
- collaborative and participative consumption;
- prosumerism and smart grids;
- eco-innovation and ecodesign (technological innovation).

The following section explains these approaches and gives some examples of niches within them that may have up-scaling potential.

Social innovation

Social innovation is a broad area of new strategies, concepts, ideas and organisations to meet societal needs. An EU research project on social innovation (TEPSIE) proposed the following definition:

'Social innovations are new solutions (products, services, models, markets, processes etc.) that simultaneously meet a social need (more effectively than existing solutions) and lead to new or improved capabilities and relationships and better use of assets and resources. In other words, social innovations are both good for society and enhance society's capacity to act' (Caulier-Grice et al., 2012).

In the area of the environment, social innovation often relates to configurations of production and consumption in time and space, or to services that both meet societal needs and create new social relationships. Social innovations often contribute to well-being through empowerment of citizens, positive social relations and building trust through collaborative approaches. Examples include urban design to reduce mobility requirements, video-conferencing, food education, meat-free days, food sharing, urban agriculture, eco-agro-tourism and transition towns (grassroots community initiatives).

Collaborative and participative consumption

Collaborative consumption is a collective term for different social innovation ideas that include 'traditional sharing, bartering, lending, trading, renting, gifting and swapping, redefined through technology and peer communities' (Botsman and Rogers, 2010). Collaborative consumption approaches generally move towards using services instead of owning products.

Also called a sharing economy, collaborative consumption can involve different sets of stakeholders: consumer-to-consumer (C2C), consumer-to-consumer but via business (C2B), business-to-consumer (B2C) and business-to-business (B2B) (EESC, 2014). The C2C and C2B models in particular can be understood as social innovation. Examples include sharing cars, bikes and offices, mobility service packages, urban community gardens, clothes swapping and tool

rentals. Collaborative and participative consumption is often assumed to be less harmful to the environment as more people share the same good or service. However, this may not always be the case, as sharing schemes sometimes give citizens access to goods and services they would otherwise not be able to afford, for example private transport by car or holidays far from home.

Prosumerism and smart grids

Prosumerism is a concept that aims to reduce the distinction between producers and consumers, re-connecting consumers in ways that allow them to contribute to production processes. The most prominent example is generation of energy by consumers and involvement in smart grids. Others include linking transport and energy systems in smart grids (e.g. through electric vehicles and decentralised energy storage), cooperative approaches to food production and distribution, and a shift to more local/regional economies.

Eco-innovation and ecodesign (technological innovation)

Eco-innovation relates to technological developments in the widest sense, including reducing the environmental impacts of individual products or production processes (eco-innovation), and taking into account all the environmental impacts of a product at the earliest stage of design (ecodesign). Examples include multi-trophic aquaculture, bioenergy from algae or household wastes, and decentralised energy storage systems. It also includes efforts to increase the lifetime of products by improving their quality, reverting the observed trends of reduced prices, lower quality and lower durability.

These four arcs are not exhaustive and could be combined to create symbiosis and thereby become more powerful. For example, collaborative consumption approaches could drive ecodesign towards longer-lasting, repairable products, and re-manufacturing products instead of discarding them. Collaborative consumption is a specific example of social innovation. Implementation of prosumerism might profit from collaborative approaches. Citizens could be nudged into smart grids by making this the standard option in new houses.

There is a wealth of further approaches that aim to change production-consumption systems, many of them led by business or government. Examples include:

- **Choice-influencing or choice-editing, including nudging.** Producers and retailers as well as public and private service providers can influence consumer behaviour towards more sustainable options through such mechanisms as marketing, advertising and the use of certification (WBCSD, 2008). Nudging consumers towards more sustainable choices can be done, for example, by making sustainable products or services the default option, using people's tendency to choose the option of lowest resistance and stay with the status quo rather than trying something new (Ölander and Thøgersen, 2014).
- **Supply-chain management, corporate social responsibility and feedback mechanisms along the supply chain.** Growing pressures from shareholders, citizens, consumer groups and non-governmental organisations, frontrunners within business, and government initiatives are increasingly pushing businesses towards more sustainable and transparent supply chains. This approach is particularly relevant for highly globalised supply chains such as food, electrical and electronic goods and clothing. It might also be combined with certification and labelling to enhance the visibility of the efforts.
- **Certification, labelling and other information-based approaches.** Information-based approaches have been widely used in European product policies, and are currently being further developed within the European Commission's initiative to develop methodologies to measure the environmental footprints of products. Research shows the limited effects of information-based approaches, but this may be enhanced, for example, when they are combined with approaches that aim to influence choice, such as market-based instruments that result in prices which better reflect the true costs to society of goods and services.

- **Circular economy concepts including take-back schemes, re-manufacturing, industrial symbiosis.** Such approaches have been and are currently mainly driven by European and national waste policies and are increasingly being embraced by businesses (e.g. the Circular Economy 100 initiative of the Ellen MacArthur Foundation). In July 2014, the European Commission adopted a communication on circular economy that contains new ambitious waste targets for a move to a recycling society (EC, 2014c).

Although many of these approaches and initiatives are currently evolving both across Europe and globally, they still lack favourable framework conditions in which to flourish and diffuse into the economy and everyday consumption patterns. Policy re-design to create enabling frameworks for niches to experiment, gain experience and scale up, alongside citizen initiatives, entrepreneurship and intrapreneurship (entrepreneurs inside an organisation), have important roles to play in achieving this. Enabling factors might have different dimensions, including governance, infrastructures, legal and financial factors, capacity building and knowledge transfer, participation, and motivation/communication (UBA, 2014).

An array of existing policy tools and instruments are relevant to transitions but would benefit from recalibration, often in combination so that their effects can supplement each other, including to enable the up-scaling of niches. They encompass directives and regulations, market-based instruments including green fiscal reforms, research support to innovation, private-public partnerships and information-based instruments. These top-down policy measures are in many cases needed to enable the successful up-scaling of many of the bottom-up types of initiatives and efforts described elsewhere.

Annex Policy concepts and indicators

Policy concepts addressing changes in the way production and consumption are organised

In the last few years several new policy concepts have been introduced on the European and global level in an attempt to make production-consumption systems more sustainable. They have different perspectives and focus on varying aspects, and thus partly overlap. Their often rather vague definitions, however, have left them open to being differently understood and interpreted by policymakers and stakeholders. This annex provides a brief overview of how some of these concepts have been defined and used, with the aim of fostering a better understanding of how they require changes in production-consumption systems.

A **green economy** has been defined by UNEP as 'one that results in improved human well-being and social equity, while significantly reducing environmental risks and ecological scarcities' (UNEP, 2011). Meanwhile, the EU considers a green economy one 'that generates growth, creates jobs and eradicates poverty by investing in and preserving the natural capital upon which the long-term survival of our planet depends' (EC, 2011b; EEA, 2012a).

The 2012 EEA Environmental Indicator report (EEA, 2012a) put forward an approach to a green economy which called for resource efficiency as well as eco-system resilience. Based on analysis of six environmental themes, it concluded that European environment policies appear to have had a clearer impact on improving resource efficiency than on maintaining ecosystem resilience. While improving resource efficiency remains necessary, that alone may not be sufficient to conserve the natural environment and the essential services it provides.

Resource efficiency is a concept basically aimed at reducing the resource inputs and environmental pressures per unit of economic output. In the European context it is seen as a relatively broad concept covering resources beyond material resources and is understood to require 'that all resources are sustainably managed, from raw materials

to energy, water, air, land and soil' (EC, 2011a). A 2011 EEA report (EEA, 2011b) found that most European countries do interpret resource efficiency in line with this definition. The EEA also provides indicators and assessments for specific resources — for example, the EEA has published three specific indicators on water, assessing intensities of emissions to water of manufacturing, agriculture and the domestic sector in Europe (EEA, 2014c, 2014d, 2014e). Resource efficiency is now a key priority for EU policymakers, as underlined by the designation of resource efficiency as one of seven flagship initiatives in its Europe 2020 strategy for smart, sustainable and inclusive growth.

Sustainable consumption and production (SCP) is a concept introduced at the global level in 1994. It is defined as 'the use of services and related products, which respond to basic consumption and needs and bring a better quality of life while minimising the use of production natural resources and toxic materials as well as the emissions of waste and pollutants over the life-cycle of the service or product so as not to jeopardise the needs of future generations' (UNEP, 2010). The commitment to SCP was renewed at the 2012 UN Conference on Sustainable Development (UN, 2012a) with the adoption of a global framework of programmes on SCP (UN, 2012a) as one of the major outcomes of Rio+20. And most recently, sustainable consumption and production has been proposed as one of the sustainable development goals (SDGs) for the post 2015 development agenda (UN, 2014a).

The EU adopted a Sustainable Consumption and Production Action Plan in 2008, after which actions on SCP became strong elements of the Roadmap to a Resource Efficient Europe and most recently of the 7th EAP. European Union policies on SCP include the Eco-Design Directive, EU environmental labelling schemes and green public procurement policies.

In its vision for 2050, the 7th EAP calls for a '**circular economy** where nothing is wasted'. In July 2014, the European Commission adopted a communication on the circular economy (EC, 2014c), defining its systems as those that keep the added value in products for as long as possible and eliminate waste, and made it a key element of the EU's resource efficiency agenda. The concept laid out in the communication clearly goes beyond mere recycling. It includes approaches such as lightweighting, durability of products, efficiency, substitution of hazardous or difficult to recycle materials, eco-design and maintenance/

repair services, as well as developing alternatives to owning products (renting, sharing). Moving towards such approaches requires innovation in technology, organisation, society and financing (EC, 2014c).

The Ellen MacArthur Foundation defines the circular economy as:

'an industrial system that is restorative or regenerative by intention and design. (...) It replaces the 'end-of-life' concept with restoration, shifts towards the use of renewable energy, eliminates the use of toxic chemicals, which impair reuse, and aims for the elimination of waste through the superior design of materials, products, systems, and, within this, business models' (EMF, 2013a).

However, the concept was not new, it had, for example, been used in Germany's 1994 circular economy and waste act. The circular economy is similar in concept to that of urban mining, in which the stocks of materials in an economy are seen as potential mines from which to extract materials.

The EEA's 2014–2018 EEA multiannual work programme states that:

'a circular economy is ultimately about producing and consuming products and services rather differently from current practices and creating a more resilient environment, society and economy in the process. By assessing how products and services are designed, made, sold, used, reused and recycled we can determine how to get the maximum value from them, both in their use and at the end of their life. In essence, it is about an economic model where environmental pressures or wastes are minimised to as close to zero as feasible. Concepts such as industrial ecology, industrial symbiosis, cradle-to-cradle and systemsthinking characterise the issue of circular economy and are the focus of activities in Europe through EU Framework Research Programmes' (EEA, 2014f).

The 7th EAP introduced the concept into EU policy without exactly defining its scope, while the 2005 EU Thematic strategy on waste prevention and recycling had introduced the idea that the EU should become a 'recycling society', a similar concept.

Achieving a green economy, resource efficiency, sustainable consumption and production and a circular economy all require

changes to production-consumption systems. A circular economy focuses on materials whereas resource efficiency in a broader sense also addresses non-material resources such as land and energy. Resource efficiency can be achieved, at least to a certain extent, through technological means, while a green economy and SCP also require social innovation and breakthroughs.

Indicators for measuring progress towards sustainable production-consumption systems in Europe

For tracking progress towards more sustainable production-consumption systems, it is very important to develop and use indicators. Environmental pressures from production activities in Europe and direct pressures from consumption such as waste and wastewater from households are captured by a wide range of EEA indicators which have been in focus in the EEA's regular State and outlook of the environment reports. Analysis of environmental pressures embedded in traded products and services is still, however, a relatively new area, and related indicators are less mature (EEA, 2013f).

Such approaches are, nonetheless, receiving increased attention, most prominently in the EU's 7th EAP, which states that 'targets for reducing the overall life-cycle environmental impact of consumption will be set, in particular in the food, housing and mobility sectors. (...) Indicators and targets for land, water, material and carbon footprints as well as their role within the European Semester should also be considered in this regard'. The European Commission is currently working to develop footprint-type indicators for carbon, materials use, land and water, all to be used within the framework of the EU's Roadmap on a Resource Efficient Europe (EC, 2011a). Within the Single Market for Green Products Initiative (EC, 2013b), the European Commission has developed a method for assessing the environmental footprints of products (EC, 2013a), which is currently being tested in cooperation with voluntary stakeholders.

Several methods have been developed to quantify and assess life-cycle environmental pressures caused by consumption in Europe, including:

- Top-down, environmentally-extended, input-output (EE-IO) analysis-based approaches, such as the EEA's analysis using

national accounting matrices including environmental accounts (NAMEAs; (EEA, 2013e), the EIPRO study which developed a single region EE-IO table for the EU as a whole (EC, 2006) and multi-regional EE-IO approaches such as that used for the World Input-Output Database (EC, 2012d; Timmer, 2012), the Exiobase project (TNO et al., 2014), the EUREAPA project (One Planet Economy Network, 2014), and the EORA MRIO database (Lenzen et al., 2012, 2013).

- Bottom-up life-cycle analysis (LCA) approaches that have been developed to assess the life-cycle impacts of single products. However, the JRC has used a combination of trade statistics, national emissions inventories and life-cycle inventory (LCI) data for generic products to estimate the environmental pressures and impacts caused by total national and European final-use consumption (EC, 2012e).
- Hybrid methodologies, combining LCA and EE-IO approaches to allow a much broader group of environmental pressures to be considered than by EE-IO approaches alone. Hybrid approaches also allow translation of environmental pressures into impacts on humans and eco-systems. A hybrid methodology was for example used to assess the total environmental impact of Swiss production and consumption (Jungbluth et al., 2011).
- Various footprint methodologies with a focus on a specific environmental pressure category, such as a carbon footprint, water footprint (Hoekstra et al., 2009) material footprint (Wiedmann et al., 2013) and the ecological footprint aggregating several pressures into global hectares (Global Footprint Network, 2014). For water footprinting, an ISO standard is under development, including both methodologies for water quantity and water pollution (ISO, 2014).

The Swedish Environmental Protection Agency (SEPA) gives an overview of methods for calculating environmental pressures from consumption, including an assessment of the advantages and weaknesses of each method (SEPA et al., 2011). It concludes that most of the methods analysed still produce rather crude results. For most of them, both methods and data are still under development. It is out of the scope of this report to compare the robustness of

methodologies and data sets used in the different projects and approaches, or even to generate and compare results based on different methodologies and databases in a quantitative way. Instead, it was decided that this report should mainly and consistently use results generated by the European Commission's Joint Research Centre based on the World Input-Output Database (EC, 2012d; Timmer, 2012).

For analysing and measuring progress towards more sustainable production-consumption systems, the EEA has developed a framework and a set of indicators (SCP indicators). The approach includes a vision to guide the initial selection of indicators and to provide impetus for the development of better indicators. Based on the vision, 35 policy questions were defined, and subsequently a set of indicators were selected to provide answers to some of these questions. The policy questions and indicator set follows the following structure:

- headline questions and indicators aimed at politicians and the public;
- overall trends in SCP (or in production-consumption systems) which are further divided into components of the economy split according to life-cycle thinking (production – consumption – end-of-life), and into some key consumption clusters;
- a framework for change: questions and indicators about whether framework conditions are in place that will allow Europe to achieve the goal of sustainable production-consumption systems.

The policy questions and trends in the associated indicators are presented and assessed in ETC/SCP (2011). This indicator set makes as much use as possible of existing indicators, including those based on input-output analysis. For some of the policy questions, especially in the framework-of-change category, indicators do not yet exist; for others, proxy indicators have been used.

This report makes use of some of the established and regularly-maintained EEA environmental indicators, including ones selected from the SCP indicator set, and complement these with additional indicators suitable for the analytical approach used, where established and regular European indicators do not yet exist.

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