EEA Technical report | No 7/2014

# Progress on resource efficiency and decoupling in the EU-27

## Messages emerging from environmentally extended input-output analysis with relevance to the Resource Efficiency Roadmap and the 7EAP

ISSN 1725-2237

European Environment Agency

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Cover design: EEA
Cover photo © Pawel Kazmierczyk
Layout: EEA/Pia Schmidt



Luxembourg: Publications Office of the European Union, 2014

ISBN 978-92-9213-458-7
ISSN 1725-2237
doi:10.2800/17781


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# Contents

# Acknowledgements

This short report, consisting of a series of key messages, was prepared to illustrate ways in which input-output-based analysis can support policy makers in their decisions and choices. It follows up on the 2013 EEA report on environmental pressures from European consumption and production which describes the methodology of environmentally extended input-output analysis, illustrated with some country examples.

The analysis covers the period 2000–2007 only, as data from 2008 onwards is not backwards compatible, due to the change of NACE classification. This, however, can be considered a secondary problem here, given that this report is intended to serve as demonstration of capability to raise awareness of the applicability of input-output-based analysis to inform environmental policymaking.

Building on ongoing Eurostat's efforts to reduce the time lag of data, in 2016 the EEA will publish further analyses based on more-up-to date information covering the time series 2008 and beyond.

The EEA gratefully acknowledges the role of Eurostat as the producer of data used in this report, including supply and use tables and symmetrical input-output tables with environmental extensions for the EU-27 as a single region. Detailed breakdown of data sources used in this work is presented in Table 3.1.

This report was written by David Watson, Copenhagen Resource Institute, and José Acosta Fernández and Arkaitz Usubiaga from the Wuppertal Institute. Data development was provided by José Acosta Fernández, Helmut Schütz and Arkaitz Usubiaga from the Wuppertal Institute.

EEA project managers were Paweł Kaźmierczyk and Ybele Hoogeveen.

The EEA would also like to express thanks to Anton Steurer and Stephan Moll (Eurostat), Jan Weinzettel (Charles University, Prague) Stephan Lutter (Vienna University of Economics and Business) as well as John van Aardenne and Ricardo Fernandez from the EEA who provided valuable suggestions and comments during the work on this report.

# 1 Background

The central 2050 vision of the European Commission's Roadmap to a Resource Efficient Europe (hereafter referred to as the RE Roadmap) is of an EU economy that respects resource constraints and planetary boundaries (EC, 2011). A central element of the RE Roadmap is a thrust towards transforming the economy: boosting more efficient production, improving the resource efficiency of goods and services over their lifecycle, and encouraging more resource efficient consumption patterns of European citizens and governments.

These goals are also taken up by the 7th European Environment Action Programme (7EAP) which includes a transition to 'a resource-efficient, green and competitive low-carbon economy' as one of priority objectives (Priority Objective 2) for the EU between now and 2020 (European Parliament and Council, 2013). This general objective is supported by more detailed goals. These include reducing the environmental impact of the EU's production and consumption by 2020, in particular in the food, housing and mobility consumption clusters. A related goal is that environmental impacts from all major industrial sectors will be significantly reduced while resource efficiency of the same sectors will be increased.

The 7EAP also takes a global perspective with a further goal that by 2020 'the impact of consumption in the Union on the environment beyond its borders is reduced', i.e. that the global environmental impacts of EU consumption and key industrial sectors will be reduced.

**Box 1.1 Availability of data, reporting years and the 'missing' economic crisis**

As described in Chapter 2 there is an inherent delay in reporting of economic accounts from EU Member States to Eurostat which are necessary for the analysis presented in this report. Symmetric input-output tables had at the time of analysis only been made available up to the year 2008. An added complication is that from the year 2008 onwards, sectors and products in these accounts were classified according to a new NACE code system. This means that results obtained for 2008 cannot directly be compared to results from previous years. Bridging factors for converting the 2008 and beyond results to allow comparisons are yet to be developed.

As a result it has only been possible to carry out and present this analysis for the years 2000–2007. Thus the economic crisis that began in 2008 is not visible in the results presented here. The economic crisis will have significantly affected many of the trends observed and reported on in Chapters 3 to 6. The messages presented in those chapters should be read with this in mind. A follow-up EEA report is expected in 2016 which will cover a more recent time period to allow assessment of the effects of the crisis on pressures from consumption and production. That report will also make the best use of complementary activities in the field. Additional indicators of material flows such as raw material input (RMI) might be included and potentially additional environmental pressures such as energy or land use should these be made available by the time of the next report.

The time coverage of the data presented in this current report can be considered a secondary problem given that its main purpose is to raise awareness of the applicability of input-output-based analysis to inform environmental policymaking.

Environmentally Extended Input-Output Analysis (EE-IOA) is an accounting tool which can provide broad insights into the resource efficiency of European production and consumption patterns and thereby monitor whether trends are moving in the right or wrong direction.

EE-IOA makes use of physical data on environmental pressures (e.g. air emissions, resource extraction, material or energy use, land use) in combination with economic data at industry and country-wide level. This report considers air emissions and material resource requirements. The results of the EE-IOA can aid in identifying hotspots in the economy where policy should be focused to achieve the broad objectives of both the 7EAP and RE Roadmap. It also allows the overall progress against some of these objectives to be monitored over time.

In early 2013, the EEA published a technical report titled 'Environmental pressures from European consumption and production' (EEA, 2013) developed by the ETC/SCP, which describes the EE-IOA methodology in detail and outlines its potential for providing analyses useful to the resource efficiency policy area. The report also presented EE-IOA results for nine EU Member States. In 2011, Eurostat made available supply and use input-output tables (SUIOTs) for the EU-27 as a single region which allowed EE-IOA to be applied at the EU level. These SUIOTs are for the period 2000–2007 and follow the NACE Rev. 1.1 economic activity classification.

Eurostat has more recently published tables for 2008–2009 following the NACE Rev. 2 classification. The change in classification hinders comparability between specific economic activities or product groups. Environmental extensions for the aggregated EU economy ([1]) are normally available earlier than the SUIOTs. Air emissions accounts are published with a two-year time lag and economy-wide material flow accounts with a slightly longer 2½ year lag.

In this short report the EEA presents some key results for the EU-27 using the 2000–2007 SUIOT data along with the corresponding air emission and material flow accounts. The methodology of this assessment largely follows that described in the technical report. The objective is to support development of policies for resource efficiency by presenting trends and associated key messages in environmental pressures caused by economic activities, individual product groups and consumption areas in the EU-27 as a whole.

The EEA Technical report No 2/2013 and this current report present only a selection of the wide spectrum of results that can be drawn from the EE-IOA calculations performed during this multiannual project. The ETC/SCP is in the process of developing an internet-based tool for hosting all the EE-IOA calculations performed during the project. The tool includes an interface which allows users to develop their own queries of the data and produce results and graphs for use in policy assessments.

**Box 1.2 EEA package of EE-IOA products**

The EEA and the ETC/SCP have developed the following package of products for use by policymakers and researchers with an interest in SCP and resource efficiency at the macro level:

- EEA Technical report (EEA, 2013) describing the EE-IOA and outlining its potential within the resource efficiency policy area. Presents results for nine EU Member States, 1995, 2000, 2005. http://www.eea.europa.eu/publications/environmental-pressures-from-european-consumption.
- The current report presenting some key messages and EE-IOA results for the EU-27 as a block, 2000–2007.
- An internet tool for accessing all the results. Access can be gained by request, please contact Pawel Kazmierczyk: Pawel.Kazmierczyk@eea.europa.eu.

([1]) Compiled from data submitted by Member States to Eurostat under Regulation 691/2011 on European environmental economic accounts.

# 2 Approach

The production cycle of a product or group of products can be followed via exchanges of money from the extraction of materials and fuels to create its component parts to its eventual sale to the consumer. The various producers and consumers are interlinked via a myriad of different product chains creating a complex web of money and value exchanges. This is one way of viewing an economy.

Each producer in the web transforms inputs into outputs to add value to one or more goods and services. Each producer also causes extraction and use of materials and exerts environmental pressures either directly (e.g. a power company burning fuel to produce electricity) or indirectly somewhere else in the web of interactions via its demand for inputs from other actors (e.g. a power company demanding coal from a coal-mining company).

Since all economic actors have an influence on the extraction of materials and release of environmental pressures, they can all be included in a drive towards overall reductions in material extraction by, and environmental pressures from, the economy as a whole. The RE Roadmap was one of the first policy communications to recognise the need to include all actors in a general objective towards the development of an economy that respects ecological limits. The RE Roadmap's vision aims at boosting more efficient European industries, more resource-efficient products (i.e. goods and services) over their lifecycle, and more resource-efficient consumption patterns. These objectives are echoed under the second overall objective of the 7EAP.

Identifying which industries, which intermediate and final goods and services and which consumption patterns exert most environmental pressures is a first step in tackling resource efficiency. Monitoring trends in pressures exerted directly and indirectly via producers, products and consumers is also key in identifying progress against resource efficiency objectives. Environmentally-extended input-output analysis (EE-IOA) provides one method for examining these issues (see Box 2.1).

EE-IOA can be used to take a slice across the production chains between (EU and/or global) producers and (EU and/or global) final consumers and provide a snapshot of the economic flows at that point. This provides insights into where in the economy environmental pressures are directly occurring and the demand patterns further along value chains that are driving them.

The various kinds of analyses that can be carried out are described in Box 2.3. Each type of analysis can be used to answer its own set of policy relevant questions. First, Box 2.2 explains some of the terms used in Box 2.3 and elsewhere in this report.

**Box 2.1 Environmentally-extended input-output tables (EE-IOTs) and analyses (EE-IOA)**

EE-IOTs combine national or regional economic accounts with environmental accounts. The **economic accounts** are represented in monetary input-output tables. An input-output table shows the flows of money between economic activities or sectors within a country (for example between the agriculture sector, food processing industry, transportation equipment industry, banking and insurance services, etc.) and between these and final consumers (government, households and exports). They also include monetary flows related to imports from the rest of the world for intermediate use and final consumption and for re-export.

The **environmental accounts** comprise direct inputs and outputs to and from the environment for each economic sector or for each produced product group, usually described in physical terms e.g. tonnes, although environmental accounts can sometimes be expressed in monetary terms, e.g. environmental protection expenditure or environmental tax revenue. Primary environmental data, such as emission inventories, energy statistics and material flow accounts are adjusted to the classifications and accounting principles of national accounts before integrating them into the EE-IOT.

The resulting environmentally-extended input-output table (EE-IOT) can then be processed using well-defined algorithms to produce tables which follow the full production chains of goods and services for intermediate and final use. The production chains extend from the extraction of raw materials through the industries to the purchase of products by households, by government, and for export. The direct environmental pressures caused by industries and their demand for material resources are reallocated to the value chains of intermediate and final products according to the flow of money along the production chain of that product. In this way the direct and indirect environmental pressures caused by the purchase of different final product groups can be estimated and compared.

**Box 2.2 Explanation of terms**

To aid in understanding the descriptions of the analysis types presented in this report some terms need to be explained:

**Producers** and **final users**: these can be considered as points or nodes in the web of money flows and value flows through the economy. Final consumers include private households but also the public sector e.g. hospitals and schools. In addition final use includes capital investments made by industry. When looking at a domestic economy in isolation, **export** is also seen as a form of total final use since a product 'disappears' from the economy when it is exported. So-called 'domestic final use', however, refers only to consumption within the domestic economy i.e. excludes export. It should be noted that 'domestic' means national or regional. 'Domestic economic output' for example is the economic output of the country/region.

Producers are all businesses/organisations which create or add value to goods and services that are sold on to actors further down the chain. Producers also play a role as consumers since they purchase **intermediate products** from other producers. In EE-IOA individual producers are aggregated into groups of companies producing similar products. Here these are referred to as **economic sectors**: The higher the level of aggregation the greater the variation within each sector. Analysis in this report is done at 59-sector or 28-sector aggregation levels.

**Final products** and **intermediate products:** final products comprise goods and services which are purchased by private households and government for final consumption, i.e. they are not resold following any further processing. In contrast intermediate products are goods and services which producers purchase from one another as inputs to their own production processes, i.e. financial services and electricity which car manufacturers purchase from other producers to produce their cars. In EE-IOA products are aggregated into **product groups**: The higher the level of aggregation, the greater the variation within each product group. Analysis has been carried out in this report at 59-product or 28-product aggregation levels.

**Box 2.2 Explanation of terms (cont.)**

**Final** and **intermediate demand:** this is the demand for final and intermediate products as described above. These can also be termed final and intermediate use. As noted earlier total final use includes exported goods and services, but *domestic* final use only includes goods and services purchased for final use by national (or in the case of the EU economy, European) entities.

**Domestic** and **global pressures:** domestic environmental pressures are those which are exerted **directly** by domestic producers and/or consumers. In national accounts 'domestic' refers to a producer or consumer who is resident in the country even if some of their activities are carried out in other regions including international waters or airspace. Total domestic pressures calculated this way, therefore, vary somewhat from totals calculated using a territorial boundary as is used in national emissions inventories produced by countries under environmental treaties (e.g. the Kyoto Protocol). In this report domestic pressures refer to those caused by all EU-27 registered actors. When looking at **indirect** pressures caused by European consumers one can consider global pressures caused along the domestic and foreign production chains of all products consumed in the EU. This means that the pressures caused during the production of imports to the EU-27 are accounted for. The pressures included in the analysis presented in this report are summarised in Table 2.1.

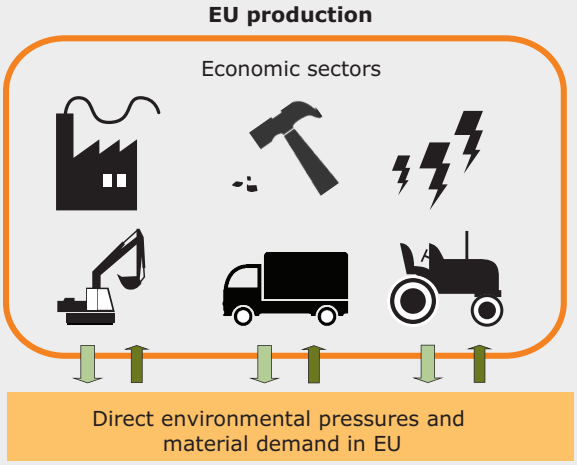
**Upstream** and **downstream flows**: these refer to flows along the value chain of products. The direction of flow is from extraction of materials at one end to final consumption at the other. If one looks upstream from an Actor X, one looks at the production chains of the intermediate or final products that Actor X is demanding, all the way back to extraction of materials. If one looks downstream from Actor X one considers all the actors that are demanding Actor X's intermediate and final products.

**Pressure intensity** and **resource efficiency:** environmental pressure intensity is the environmental pressure caused directly or indirectly by an industry or product per euro of output of the industry or per euro consumption expenditure on the product. For the purposes of this report and its relation to the RE Roadmap and 7EAP, resource efficiency of an industry is interpreted to mean the inverse of the pressure intensity i.e. the output of an industry per unit environmental pressure it releases.

**Decoupling:** the challenge to increase resource efficiency is often framed in terms of 'decoupling' economic output from environmental inputs. Decoupling can take several forms: Relative decoupling is achieved when the growth rate of an environmental pressure (e.g. resource use or emissions) is lower than the growth rate of the related economic activity. Absolute decoupling is achieved when the related environmental pressure either remains stable or decreases while economic activity increases. In the case of an industry the economic parameter can be output or gross value added (GVA). Both parameters have been used in various reports. Here we use economic output.

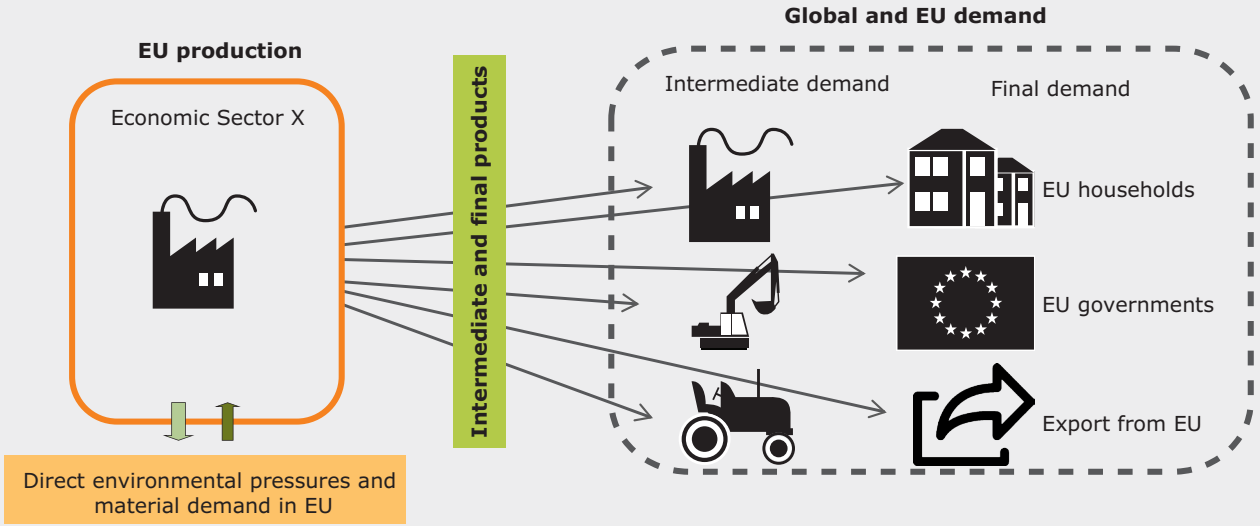
### Box 2.3 Types of EE-IOA analyses presented in this report

A number of different types of analyses can be performed using EE-IOA. These types of analyses can be used to view flows of value and money across the economy and to identify where environmental pressures occur and also what consumption patterns are driving these pressures. See Box 2.2 for an explanation of some terms.




1. **Direct pressures from economic sectors:** this analysis considers the domestic pressures caused directly by economic sectors ([2]) registered in the EU-27, e.g. direct emissions to air from all the producers within an aggregated economic sector such as manufacturers of food and beverages. These pressures are those released during production of output for both domestic consumption and for the export market. The pressures from a sector can be compared to the value added or output of that sector.

2. **Downstream drivers of direct pressures from a sector:** this analysis looks at the demand for the products of a single Sector X in the EU. The demand can be intermediate use by other sectors (demanding intermediate products from Sector X for their production), final domestic use (households and government) or demand from the export market. The direct pressures from Sector X are then allocated to the actors that are demanding its products. This allocation takes place according to the economic value of the products they are demanding i.e. if 10 % of the value of Sector X's output is demanded by Sector Y then it is also assumed that 10 % of Sector X's GHGs are indirectly caused by Sector Y's demand. It is important to note that at higher levels of sector aggregation, Sector X's demand for its own products can also become significant under this type of analysis. An example of this would be an electricity distribution company that buys electricity from a power generation company. Both these companies would be included in the same aggregated economic sector: Electricity, gas, steam and hot water.

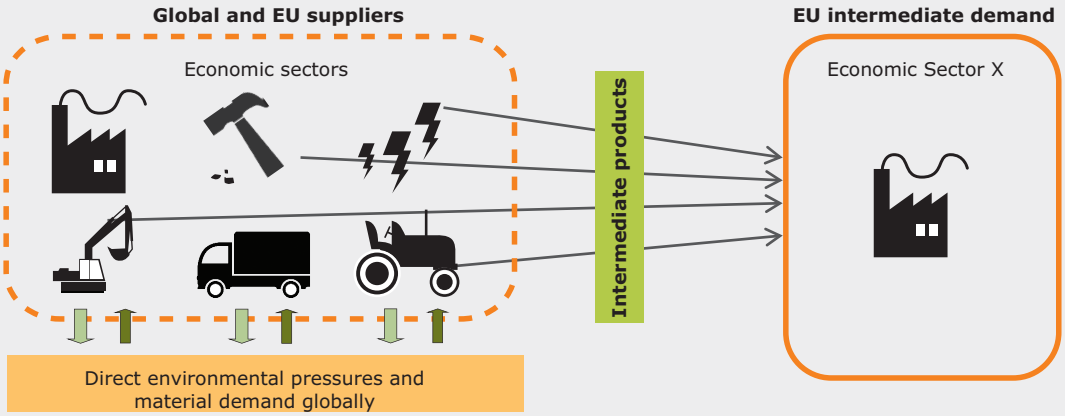



([2]) It should be noted here that the economic input-output tables used for the analysis show economic flows between economic sectors which have been grouped according to the types of products they are producing. These product-by-product IO tables are similar but not identical to industry-by-industry input-output tables, since the activities of a given company might be split between two or more different product types. This is described in more detail in the EEA Technical report (EEA, 2013). To avoid confusion in this report the groups in the IO tables are referred to as economic sectors.

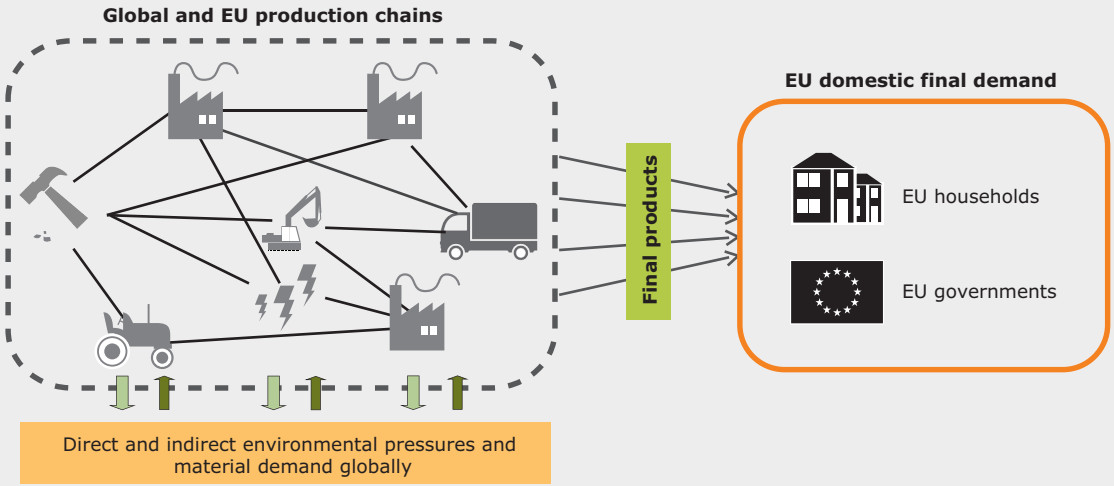
**Box 2.3 Types of EE-IOA analyses presented in this report (cont.)**

This analysis can either look at the actors immediately downstream from the industry which are demanding that industry's products (i.e. a single step downstream), or can look at the full chain of demand downstream from the industry, ending in domestic final use and export. Both approaches are used in this report.

3. **Upstream pressures caused by a sector's demand for inputs:** this type of analysis looks upstream from a given sector. It considers the intermediate products demanded by a Sector X in the EU of all other sectors both in the EU and abroad and calculates the pressures caused during the production of those intermediate products. This can either consider the pressures released during the production chain of the intermediate products demanded by Sector X or just the direct pressures caused by the sectors immediately upstream in providing inputs to Sector X. The latter approach has been used in this report.




4. **Pressures caused by final demand for products:** this is similar to Analysis Type 3. However, this time it is the domestic demand for final products that are considered, not the demand for intermediate products. This analysis estimates the total global materials extracted and other pressures exerted along the full global production chain of aggregated final product groups consumed in the EU by households, government and capital investment. This type of analysis provides what has elsewhere been described as a 'consumption perspective'.




There are many other types of analyses that can be carried out using EE-IOA. Only the ones used in this report are described above.

## 2.1 Policy relevance

The different types of analyses described in Box 2.3 can be used to answer different groups of questions which are relevant to some of the objectives of the RE Roadmap and the 7EAP:

**1. Direct pressures from economic sectors**

- Which key sectors in the EU cause most domestic environmental pressures including resource extraction and use?
- Which economic sectors are least resource efficient i.e. cause the highest material extraction and use and environmental pressures per euro of production? Which are most resource efficient?
- How successful have key economic sectors been in reducing environmental pressures while increasing resource efficiency?
- To what extent has decoupling of direct environmental pressures from total economic output of EU industries been led by resource efficiency improvements in individual sectors, and to what extent by changes in economic structure?

**2. Downstream drivers of direct pressures from a sector**

- To what extent are direct pressures from key EU economic sectors caused by final demand in the EU and production for export?
- Which other sectors are driving the demand for intermediate products from key EU sectors with high environmental pressures?

**3. Upstream pressures caused by a sector's demand for intermediate products**

- Which EU sectors cause greatest global environmental pressures via their demand for intermediate goods?
- To what extent do economic sectors in the EU cause environmental pressures in other countries due to their demand for intermediate products?

**4. Pressures caused by final demand for products**

- Which broad product groups dominate the total material resource and environmental pressure footprints exerted by the EU?
- Which broad product groups cause the highest direct and indirect global material resource use and environmental pressures during their production per euro of expenditure?
- How successful has industry been in improving the resource efficiency of the production chains of key products?
- To what extent are global environmental pressures caused by the consumption clusters of Food, Housing and Mobility being reduced?
- To what extent have reductions in global environmental pressures caused by EU consumption been led by resource efficiency improvements in production and to what extent by changes in consumption patterns? Are these trends complimenting or competing with one another?

## 2.2 Data sources

The data inputs for the EE-IOTs used in the analysis presented in this report are provided in Table 2.1. The analysis makes use of EE-IOTs for the EU-27 as a single economy. The economic element of the symmetrical input-output tables was compiled by Eurostat based on the so-called 'supply and use input-output' accounts for the EU-27 as a single region. For the environmental extensions Eurostat's NAMEA Air database has been used which includes 8 emissions to air from 59 aggregated economic sectors ([3]) covering the entire EU-27 economy. It also includes Economy-wide Material Flow Accounts (EW-MFA) also compiled by Eurostat but which have been disaggregated to sector/product group level and supplemented with additional data by the European Topic Centre for SCP. These supplementary data were necessary to account for unused domestic extraction (i.e. overburden of mines etc.) and hidden flows associated with imports (see Box 2.4).

The eight air emissions are combined into three main environmental pressures: Greenhouse gas emissions,

([3]) NACE Rev. 1.1. More recent data in NACE Rev. 2 are also available on the Eurostat website.

**Box 2.4 How to measure resource use**

Eurostat has applied an accounting methodology and a number of indicators that describe the material throughput and material stock additions in a (national) economy expressed in tonnes. EW-MFAs account for all extraction of biomass, fossil fuels, metal ores and metals, and industrial minerals, as well as the imports and exports of all goods, but exclude water and air. From the input side the most frequently used MFA indicators are:

a) **Direct Material Input (DMI)** which includes the materials extracted in the EU (domestic extraction used — DEU) plus the weight of imports.

b) **Raw Material Input (RMI)** which accounts for DEU plus the imports expressed as the raw materials needed in their production. RMI is considered to provide a more complete picture of the used fraction of the materials required in an economy. Although the different methods used to calculate RMI have shown relatively manageable differences at aggregate levels, there are significant discrepancies for specific material categories (Schoer et al., 2013).

c) **Total Material Requirement (TMR)** which includes all resource flows induced by the production of all products consumed in the EU, i.e. the used and unused fraction of the materials extracted domestically, as well as imports and associated hidden flows ([4]).

Due to current discrepancies in RMI, only DMI and TMR have been used in the present assessment. The next report will consider using RMI based on the conclusions reached by the latest comparisons between the different methods and databases used to estimate it.

Both data sets (DMI and TMR) for EU-27 were calculated by the ETC/SCP. For this purpose some core MFA and international trade data from Eurostat were used.

Acidifying emissions and Emissions of tropospheric ozone precursors (i.e. ground ozone precursors).

The material flow accounts have been used to produce two main MFA indicators for this study, namely Direct Material Input (DMI) and Total Material Requirement (TMR) (see Box 2.4).

EE-IOTs have been compiled for the EU-27 for the period 2000–2007. 2008 and 2009 SUIOTs have since been finalised by Eurostat. However, as mentioned earlier, since they use a different classification of economic activities, it would be necessary to develop a bridging system before EE-IOA results at detailed product group level obtained from 2008 and 2009 data can directly be compared with the results using 2007 data presented in this report.

In the future, data suitable for additional environmental extensions to the air emissions and material flow accounts included here may be gathered from Member States. Environmental accounts on energy supply and use are currently at a high level of development. However, the extensions included in the report are the only ones currently available from national sources and Eurostat to date.

A number of projects, some of which have been funded by the European Commission, have created EE-IOTs which include more environmental pressures and use of resources than those described in Table 2.1. These include eutrophication, more air pollutants (e.g. heavy metals and other toxic pollutants), energy, land and water use, etc. These have made use of a wide variety of assumptions and data sources and none of the models have as yet been adopted by Eurostat.

The methodology used for compiling EE-IOTs and carrying out analyses of types 1 and 4 in Box 2.2 is described in detail in the EEA Technical report (EEA, 2013).

([4]) Hidden flows refer to the movements of the unused materials associated with the extraction of raw materials, domestically and abroad.

**Table 2.1 Data inputs to the EE-IOTs used for this analysis, and its further processing**

| | |
|---|---|
| **Economic data** | |
| Data type | Supply/Use Tables and Symmetrical IO Tables, breakdown by 59 economic sectors (NACE Rev 1.1) |
| Country coverage | EU-27 (aggregated) |
| Data source | Eurostat National Accounts 2012 |
| Time series | 2000–2007 |
| **Environmental accounts — air emissions** | |
| Environmental variables | Eight air emissions ($CO_2$, $CH_4$, $N_2O$, $SO_2$, $NO_X$, $NH_3$, NMVOC, CO) further aggregated to 3 pressures by 59 economic sectors (NACE Rev 1.1) :<br>• emissions of GHGs (tonnes $CO_2$-equivalent)<br>• acidifying emissions (kg $SO_2$-equivalent)<br>• emissions of tropospheric ozone forming precursors (kg NMVOC-equivalent) |
| Country coverage | EU-27 (aggregated) |
| Time series | 2000–2007 |
| Data source | Eurostat Air Emissions Accounts by Activity ([a]) 2011 |
| **Environmental accounts — material flows** | |
| Environmental variables | EW-MFA, breakdown by 59 economic sectors (NACE Rev 1.1) covering:<br>• Direct Material Input (DMI) developed from Domestic Extraction Used (DEU) plus (direct) imports<br>• Total Material Requirement (TMR) developed from DEU and (direct) imports plus estimates of hidden flows (unused domestic extraction plus indirect material flows associated with imports) |
| Country coverage | EU-27 (aggregated) |
| Time series | 2000–2007 |
| Data source | The data on DEU and imports in physical units were taken from the ew-MFA ([b]) and ComExt ([c]) databases of Eurostat respectively (Eurostat MFAs 2010, and ComExt 2010). The datasets used for this purpose refer to data that are available at disaggregated levels.<br><br>For the estimation of the two other main components of the TMR, i.e. the Unused Domestic Extraction (UDE) and the Hidden flows associated to the imports, the database of the Wuppertal Institute was used.<br><br>The breakdown of the import component of DMI and TMR by product group was carried out by the ETC/SCP using the monetary import structure given in the SIOT for EU-27 in absence of a use structure in physical units.<br><br>All the material categories in DMI and TMR (namely biomass, metal ores and metals, fossil fuels and industrial minerals) have been represented as a single aggregate extension. |

**Note:** ([a]) http://epp.eurostat.ec.europa.eu/portal/page/portal/environmental_accounts/data/database (env_acc_ ainacehh).
([b]) http://appsso.eurostat.ec.europa.eu/nui/show.do?dataset=env_ac_mfa&lang=en.
([c]) http://epp.eurostat.ec.europa.eu/newxtweb.

The results of EE-IOA analyses should always be used with caution since the method, in order to remain practicable, includes assumptions that may cause uncertainties for example in the environmental pressures allocated to a particular product group. Each EE-IOT and EE-IOA method includes its own set of uncertainties depending on the background data used to produce the EE-IOT, the assumptions made in its compilation and the assumptions used in the EE-IOA. Box 2.5 describes the key sources of uncertainty in the assessment used for this report.

The following chapters of this report present some key results from the EE-IOA calculations for the EU-27 in the context of policy relevant questions. The results are presented according to the four broad types of analyses presented in Box 2.3.

**Box 2.5 Uncertainties in EE-IOA results**

The results of the EE-IOA presented in this report should be treated with some caution. There are three main sources of potential inaccuracy.

**1) High level of aggregation:** industries and products in the SUIOT used in the current assessment are aggregated to 59 industry groups and 59 product groups. As such, this is a macro- and meso-scale method Environmental profiles of individual companies or products can only be created using micro-scale methods such as lifecycle analysis (LCA) and environmental auditing. The EU Commission's Building the Single Market for Green Products communication describes environmental footprint methods developed by the JRC for individual products and organisations (EC, 2013).

**2) Assumption of homogenous products and prices:** the model makes the assumption that the delivery of one euro of value from, for example, the chemical industry to agriculture involves exactly the same products and quantities of products as the delivery of one euro of value from the chemical industry to any other industry or final use category, e.g. the vehicle manufacturing industry or exports. This will often not completely reflect reality since for instance agriculture and the car industry use different chemicals with different production processes and also may pay different prices for the same product. The errors caused by this assumption increase with increasing aggregation of industries and products (see Point 1).

**3) Technology assumption:** for the estimation of the global air emissions caused during the production of imports a 'Domestic Technology Assumption' (DTA) has been used for the calculation presented in this report. This assumption is often used when working with a single-region EE-IOT. When estimating pressures associated with the production of imports to the EU, the DTA method assumes that imports have been produced using the same production methods as if they had been produced in the EU i.e. with the same air emissions per euro of output.

The use of DTA can result in an underestimation or overestimation of air emissions associated with imported goods.

The DTA is not applied in the same way to estimate the material (DMI) and resource use (TMR) caused by domestic final use in the model used here. This is because material use and movements caused during the production of imports are quantified using non EE-IOA methods which are described in detail in the EEA technical report. However, these methods also make assumptions on the material use per euro of imported product based on Life Cycle Assessment (LCA) process data that are most often based on European technologies.

In the European case, both assumptions (same emission per euro of globally produced output or same material or resource use per euro imported product) tend to lead to an underestimate of the exerted pressures. With respect to air emissions this is because the EU imports a significant share of goods from countries with less eco-efficient industries. In the case of material resource use, LCA based estimation may be limited by cut-off criteria and specificity of lifecycle analysis. Solving these inaccuracies requires the use of multiregional input-output (MRIO) models which link EE-IOTs for the main regions of the world through trade ([5]). Some of these models have been developed in Europe, for example under projects commissioned by the European Commission but have not yet been adopted by Eurostat.

**4) Production stage only**. This is not a source of inaccuracy but rather a limit to the scope of the method. EE-IOA methods can only be used to estimate the environmental pressures caused during the production stage of the lifecycle of product groups (with respect to the fourth type of analysis in Box 4). The emissions caused during the consumption phase as shown under Message 9 are allocated using other, rather coarse methods. The end-of-life phase is not included at all in this report.

([5]) A few MRIO databases have been built in the last years, e.g. EXIOBASE, WIOD, EORA, GTAP-MR EE-IO and GRAM. The main differences between these databases concern the number of industries included in the tables, the country and time coverage, the environmental extensions and methods used for constructing the tables

# 3 Direct pressures from EU production

| Message 1 | **Agriculture, the electricity industry and transport services dominate direct air emissions from EU production. The same economic sectors contribute a lower share to the EU's economic output and employment. The primary sectors (agriculture, forestry, fishing, mining etc.) dominate material demand caused by EU production.** |
|---|---|

**Policy relevance**

Identification of resource intensive economic sectors on which the following 2020 goal under Priority Objective 2 of the 7EAP should focus: 'the overall environmental impact of all major sectors of the Union economy is significantly reduced, and resource efficiency has increased.'

**Policy questions**

Which key sectors in the EU cause most domestic environmental pressures including resource extraction and use?

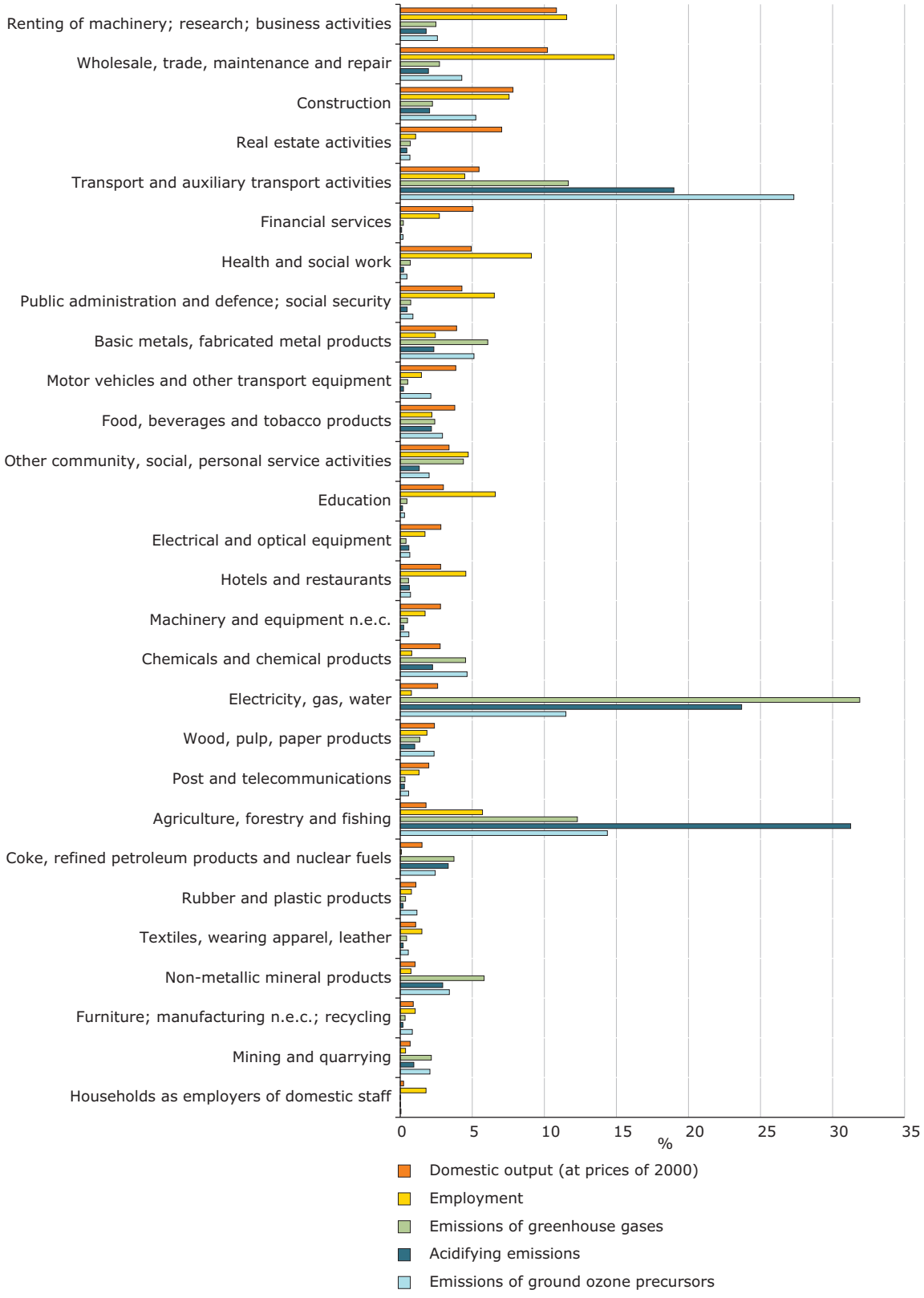
Which economic sectors are least resource efficient i.e. cause the highest material extraction and use and environmental pressures per euro of production? Which are most resource efficient?

## Related trends and observations

(See Figures 3.1 and 3.2 on the following pages)

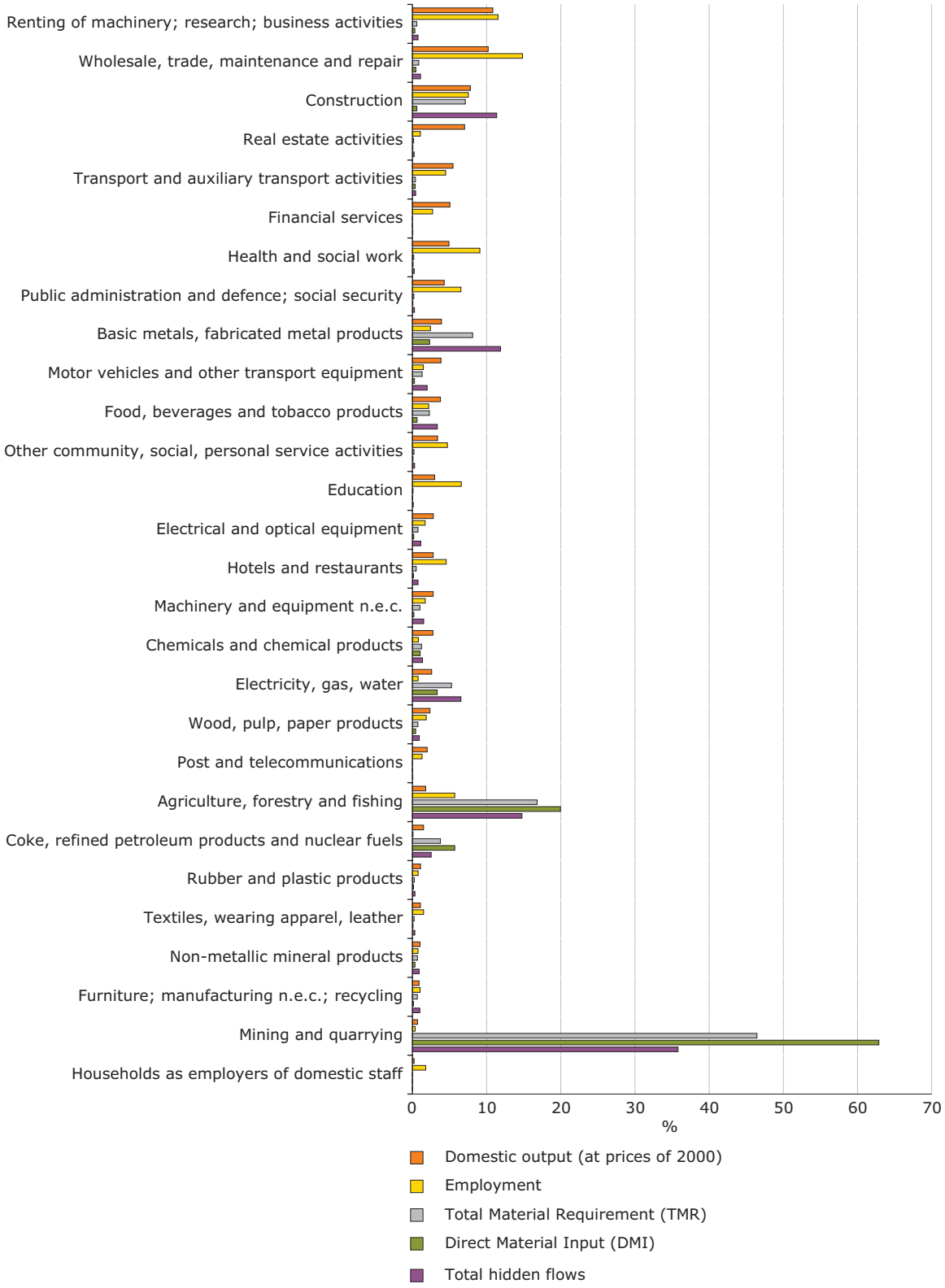
- The graphs and analysis here consider direct environmental pressures caused by individual industries (economic sectors) of the EU.
- Agriculture, the electricity industry and transport services dominate air emissions from EU production but contribute a lower share to the EU's economic output and total employment. Together they represent 56 % of total GHGs, 74 % of acidifying emissions and 53 % of tropospheric ozone forming emissions emitted by the EU-27 economy, yet contribute only 11 % to employment and 10 % to gross output.
- A number of manufacturing sectors contribute at a lower but still significant level to air emissions. The basic metal industry, the chemical, the refined petroleum, the non-metallic mineral (i.e. cement), the car, the wood and paper and the food manufacturing industries together cause 24 %, 14 % and 23 % of all GHGs, acidifying emissions and tropospheric ozone precursors from EU-27 production respectively. They also contribute to a similar degree to gross economic output (19 %) though to a lesser extent to employment (10 %).
- The primary sectors of mining and quarrying and agriculture, forestry and fishing demand by far the highest quantities of raw materials from the natural environment. A few non-primary sectors — construction, basic metals, electricity and refined petroleum industries — are responsible for a smaller but not insignificant Direct Material Input.
- The industries named under the first two bullet points merit the focus of resource efficiency drives required under the RE Roadmap and the 7EAP. Even moderate improvements in resource efficiency of these sectors will lead to noticeable reductions in emissions cause by EU production (and consumption) as a whole. The degree to which these sectors already have achieved improvements is illustrated under Message 2. From a material perspective, policy should focus on reducing the unused extraction of the primary industries which also exerts a pressure on the environment, but is currently overlooked by the headline indicator on resource efficiency: Domestic Material Consumption/GDP.

**Figure 3.1 Contribution (%) of each economic sector to domestic (*) economic output, employment and direct air emissions pressures in the EU-27, 2007**




**Note:** (*) 'Domestic' when used in this document means internal to EU-27. 'Domestic economic output' means the economic output of all companies/organisations registered in the EU.

**Figure 3.2 Contribution of economic sectors to domestic economic output, employment and Direct Material Input and resource requirement (*) in the EU-27, 2007**




**Note:** (*) The DMI of each industry refers to the % of the EU-27's total DMI that can be allocated to that industry according to its demand for imports and its own extraction of materials. The TMR of the industry also takes account of total hidden flows associated with its demand for material inputs. Hidden flows comprise the used extraction in other countries for the creation of imports and the unused extraction both domestically and abroad, caused during the extraction of materials.

- It should not be forgotten that some of these resource intensive sectors — e.g. agriculture and the electricity industry — are essential to human society, health and well-being. However, if sectors downstream also become more efficient at using the outputs of the resource intensive industries, the output of those industries could be reduced without impinging on human well-being. This is considered further under Message 4.

- Many service sectors are relatively resource efficient, contributing significantly more to employment and economic output than their direct contribution to environmental pressures. However, lying at the downstream end of the economy they may also be significant demanders of the outputs of resource-intensive industries such as agricultural products and electricity and therefore should not be ignored in drives for improved resource efficiency. This is also considered further under Message 4.

- An increase in the share of the services in the EU economy at the expense of heavy industry will in general reduce total environmental impacts caused directly by the economy. However, if this has resulted from an increase in imports of outputs from heavy industry from abroad rather than resource efficiency improvements within the EU economy then global pressures caused by the EU may actually have increased. This is considered further under Message 2.

**Description of Figures 3.1 and 3.2**

Figure 3.1 shows the contribution of each economic sector to total economic output of the EU-27 alongside the contribution of the same sector to employment and aggregated air emissions related environmental pressures. Production is aggregated at the 28 economic sector level. Sectors are presented in order of share in gross economic output.

Figure 3.2 shows the same comparison of economic sectors contribution to the economy and to environmental pressures but this time from a material resource perspective.

| Message 2 | **Direct air emissions and material demand of EU production have been decoupled from economic output, though in some cases are still growing. Decoupling has been achieved through resource efficiency improvements in individual sectors rather than changes in the structure of the economy.** |
|---|---|

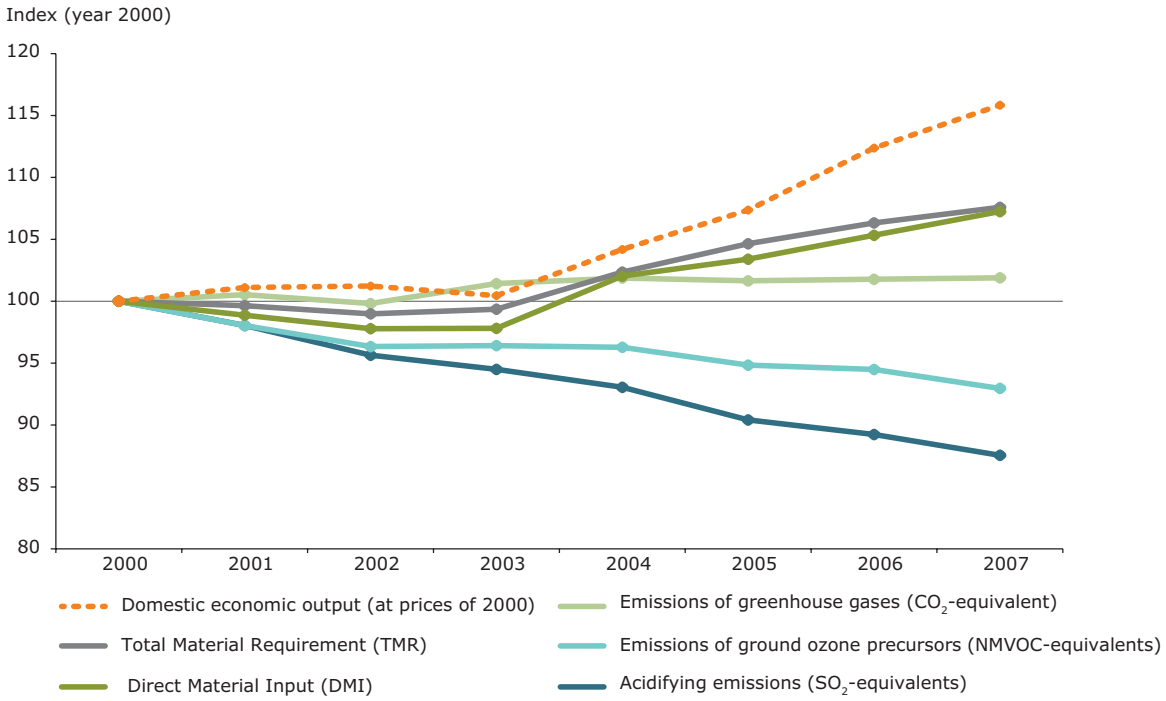
**Policy relevance**

A 2020 goal under Priority Objective 2 of the 7EAP is 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'. Decoupling of resource use and accompanying environmental pressures from economic growth is also a central element of the RE Roadmap.

**Policy questions**

To what extent has decoupling of direct environmental pressures from total economic output of EU industries been led by resource efficiency improvements in individual sectors, and to what extent by changes in economic structure?

**Figure 3.3 Developments in the domestic economic output and direct air emissions and material resource use resulting from production in the EU-27, 2000–2007**




## Related trends and observations

- Decoupling of pressures from growth is a key element of the RE Roadmap, and, as can be seen above, all direct pressures from production were decoupled from production output during 2000–2007. However, decoupling is not sufficient in itself to meet the objectives of the 7EAP. Here the goal is to reach absolute reductions in environmental impacts while achieving growth i.e. absolute decoupling.

- Only the emissions of acidifying gases and tropospheric ozone precursors have seen absolute decoupling from economic growth. The increasing used and unused material demand of production (DMI and TMR respectively) is a particular challenge. Material extracted within

the EU for direct use (DEU) rose by 6 %, while the weight of imported resources grew as rapidly as economic output over the same period, leading to a 7 % overall increase in DMI.

- It is important to note that environmental impacts caused by material resource extraction and processing are not entirely dependent on the weight of the material used. Environmental impacts of extraction vary dramatically from material to material and from place to place. Total weight of material extraction and use can potentially increase while environmental impacts reduce depending on the changing composition and sources of materials demanded (ETC/SCP 2011).

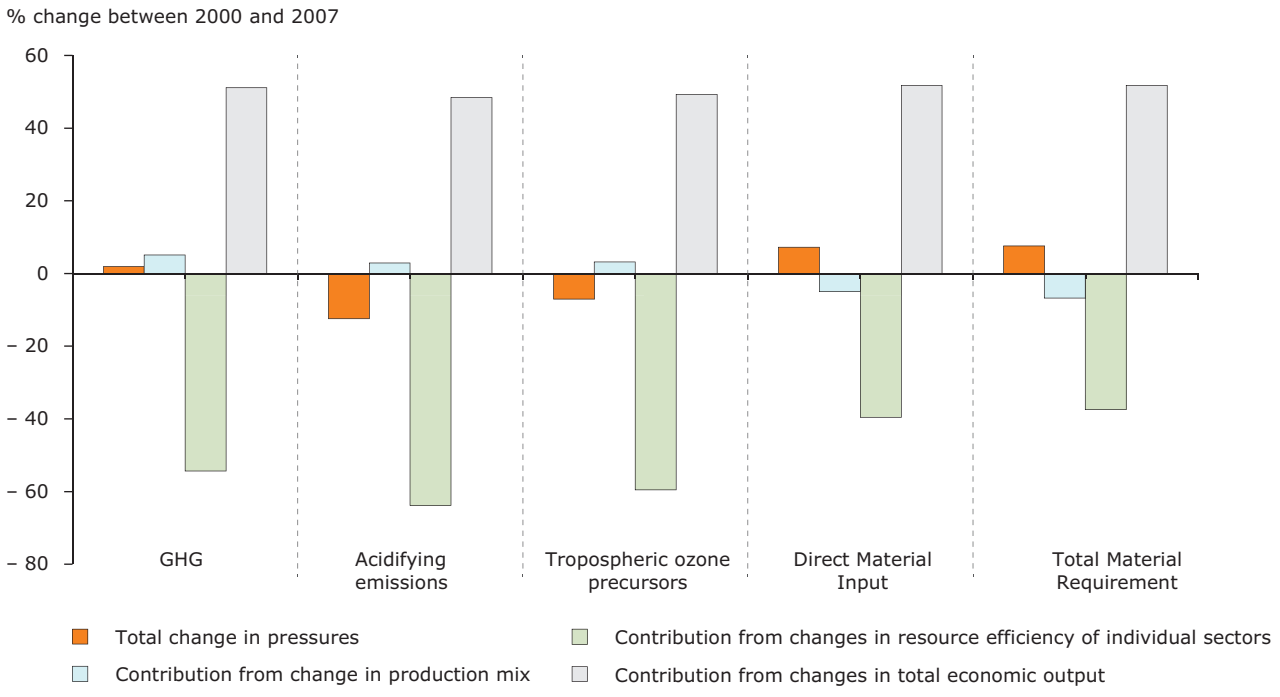
- Decoupling can be achieved via improvements in resource efficiency of key sectors but also via change in the structure of the economy i.e. a reduction in the share of resource intensive industries in the economy as a whole. The relative influence of these two factors is investigated below.

- Decoupling for all five pressures from growth in EU production output appears to have resulted almost entirely from improvements in resource efficiency within individual branches (i.e. reductions in air emissions and material demand per unit economic output). Changes in the structure of the economy only had a minor complementary decoupling effect for material demand and actually worked against resource efficiency improvements for air emissions.

- Importantly though, increases in total economic output have almost or more than completely (depending on the particular pressure) offset the significant resource efficiency improvements seen across industries between 2000 and 2007.

- The dominance of the resource efficiency effect can be interpreted positively. As noted under Message 1, if decoupling had primarily been caused by a change in the production mix — e.g. reductions in the share of heavy industries in the EU economy — this might not bring improvements from a global perspective. The development could potentially be a result of an 'outsourcing' of industrial production to countries outside the EU. From a global viewpoint, such a development could actually lead to increases in total pressures. Resource

**Figure 3.4 Contribution of different factors to changes in environmental pressures from production in the EU-27, 2000–2007**



efficiency improvements within industries, on the other hand, will have a decoupling effect at all scales — national, regional and global.

- The graphs and analysis given under Message 3 indicate which economic sectors have contributed most positively to decoupling in the whole economy via the intensity effect.

**Description of Figures 3.3 and 3.4**

Figure 3.3 shows indexed trends in air emissions related pressures and material resource use caused directly by production in the EU-27 for domestic use and export, together with trends in economic output from all sectors, 2000–2007. Economic output has been measured on the basis of constant prices of 2000, i.e. inflation has been removed. The graph allows progress in decoupling of pressures from economic growth to be assessed.

As described in Box 2.2, decoupling can be relative or absolute. **Absolute decoupling** describes a situation where environmental pressures are stable or reducing, despite economic growth. **Relative decoupling** describes the case where environmental pressures are still growing but less rapidly than the economy or alternatively where they are reducing more rapidly than the economy is shrinking.

Figure 3.4 shows how three main factors have contributed to changes in GHG emissions, acidifying emissions, tropospheric ozone precursor emissions, TMR and DMI between 2000 and 2007. An EE-IOA method called structural decomposition analysis (SDA) allows trends in environmental pressures to be broken down into various contributing factors. Under Message 10, Figure 6.6 later in this report SDA is used to analyse trends in decoupling of direct and indirect pressures caused along the full production chain of products consumed in the EU, from growth in consumption expenditure. In Figure 3.4, on the other hand SDA is used to analyse trends in decoupling of direct pressures from industry from growth in economic output. The methodologies for carrying out these two types of SDA are described in the 2013 EEA Technical report (EEA, 2013).

Three broad factors can be identified behind changes in direct pressures from production. These are:

- intensity effect — reductions in environmental pressure intensity within individual economic sectors;
- production mix effect — changes in the structure of the economy;
- output effect — changes in total economic output of the economy.

The **intensity effect** is beneficial to decoupling when individual economic branches become less pressure intensive over time through improvements in production processes, energy savings, substitution of fuels and other inputs, and end-of-pipe technology to reduce the output of harmful substances. The intensity effect can also be considered as a resource efficiency effect and has been termed as such in the graph and analysis for communication purposes.

The **production mix effect** is related to the composition of the economy, i.e. changes in the contribution of individual branches to the total economic output. If a branch with lower pressure intensity than average increases its share in the economy, this will have a positive decoupling effect. Conversely, if a pressure intensive branch expands its share in the economy, this will act against decoupling.

The **output effect** is simply the growth or reduction in total economic output of EU production in real terms (i.e. constant prices).

The three right-hand bars for each pressure in Figure 3.4 show how economic output, changes in emissions intensity of individual industries and changes in the production mix would individually have affected the given environmental pressure between 2000 and 2007. The left hand bar shows the sum of the changes in pressure caused by these factors i.e. actual developments in the environmental pressure. If this has increased to a lesser extent than the economic output effect, then relative decoupling has been achieved. If it has reduced, then absolute decoupling has been achieved.

| Message 3 | **11 out of 28 EU economic sectors that had achieved absolute decoupling of GHG emissions from growth in economic output, 2000–2007. GHG emissions from the transport services industry, however, increased even more rapidly than output. Not a single industry achieved absolute reductions in material demand.** |
|---|---|

**Policy relevance**

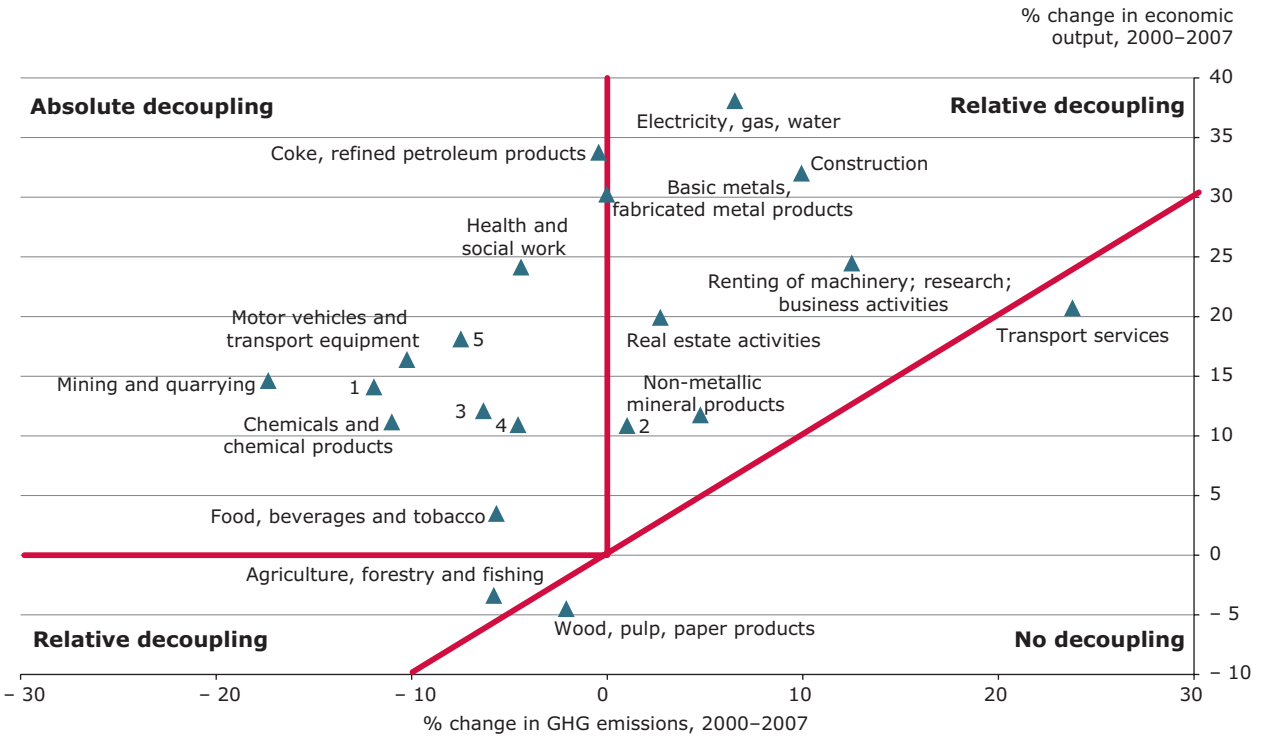
2020 milestone of the RE Roadmap: 'Economic growth and well bring is decoupled from resource inputs and come primarily from increases in the value of products and services.'

A 2020 goal under Priority Objective 2 of the 7EAP: 'the overall environmental impact of all major sectors of the Union economy is significantly reduced, and resource efficiency has increased.'

**Policy questions**

How successful have key economic sectors been in reducing environmental pressures while increasing resource efficiency?

**Figure 3.5 Developments in direct GHG emissions and domestic economic output of the 20-most GHG-emitting economic sectors (at 28-sector aggregation level) in the EU-27, 2000–2007**



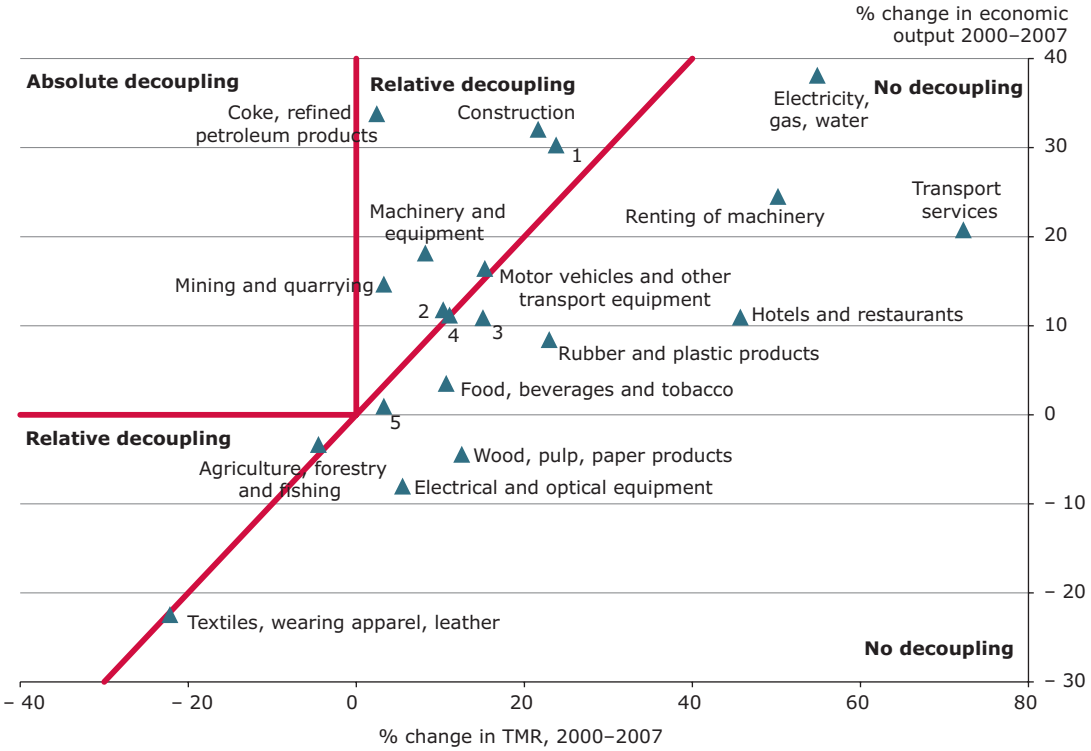

**Legend:** 1) Other community, social, personal service activities; 2) Wholesale, trade, maintenance and repair; 3) Public administration, defence and social security; 4) Hotels and restaurants; 5) Machinery and equipment.

## Related trends and observations

- Individual sectors have shown very mixed performances in decoupling. Some such as the food, chemical and motor vehicle manufacturing industries and the mining and quarrying industries saw absolute reductions in GHG emissions despite growth in output ([6]).

([6]) Note that decoupling of direct pressures from output can sometimes be misleading. If a manufacturing sector switches from gas to electricity, for example, this will reduce the direct pressures from the industry itself but may have led to an increase in pressures from domestic production as a whole. Note also that apparent decoupling may also result from changes in price structures although this risk is reduced by looking at output trends in constant prices rather than in current prices.

**Figure 3.6 Developments in TMR and domestic economic output of the 20 most material-demanding economic sectors (at 28 sector aggregation level) in the EU-27, 2000–2007**




**Legend:** 1) Basic metals, fabricated metal products; 2) Chemicals and chemical products; 3) Wholesale, trade, maintenance and repair; 4) Non-metallic mineral products; 5) Furniture manufacturing; recycling.

The transport service industry and the paper industry achieved no decoupling of GHG emissions at all.

- The degree of decoupling in sectors with high overall GHG emissions (see Message 1) will strongly influence decoupling in the economy as a whole. Of these, agriculture, forestry and fishing saw overall reductions in GHG emissions though accompanied by a contraction in the economic output of the sector. The electricity sector, however, saw only relative decoupling. Most of the sectors which achieved strongest decoupling and also those which achieved no decoupling are medium scale GHG-emitters.

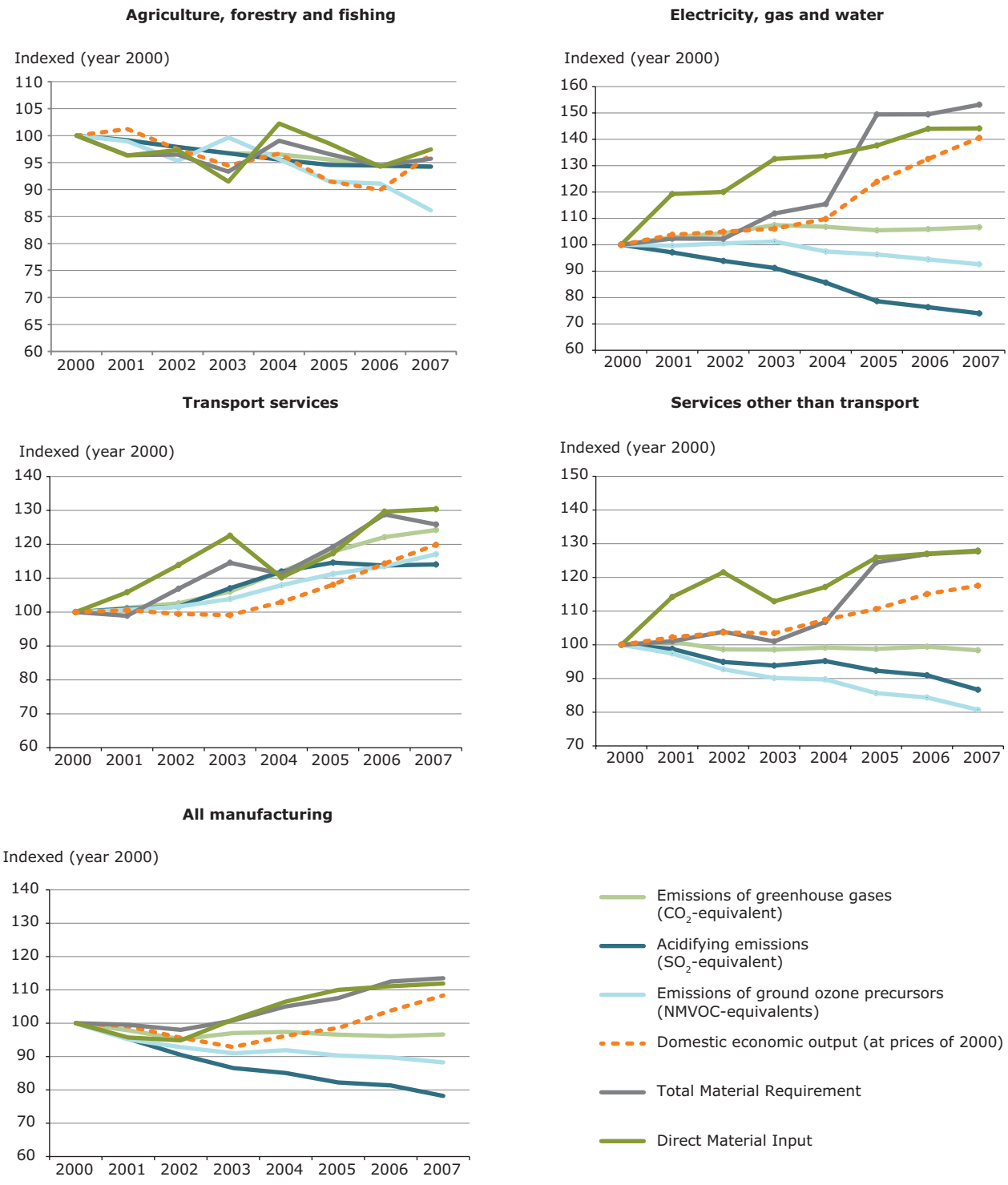
## Related trends and observations

(See Figure 3.6 above)

- Sectors have had much less success in decoupling material demand from growth than GHG emissions. Not one of the 20 most material demanding sectors achieved absolute decoupling in material requirement, though the mining and quarrying sector and refineries (coke, refined petroleum products) came close. A total of 15 out of the 20 most material demanding sectors saw no, or almost no, decoupling at all. These trends need to be reversed during the coming decade if the objectives of the RE Roadmap and the 7EAP are to be achieved. Similar conclusions can be drawn using DMI as an indicator.

- The worst performer was again the transport service industry with a material demand growing over three times more rapidly than economic output (72 % and 21 % respectively). Hotels and restaurants fared little better with a 46 % increase in TMR compared to an 11 % increase in output. These are relatively insignificant demanders of materials, however. On the other hand, the close to absolute decoupling achieved by the mining and quarrying sector should be viewed very positively due to the dominance of this sector in total TMR of the economy (see Message 1).

**Figure 3.7 Developments in direct environmental pressures and economic output of some individual sectors in the EU-27, 2000–2007**



## Related trends and observations

- Decoupling progress for some key economic sectors is shown in Figure 3.7. This includes the three industries identified as causing most air emissions related pressures under Message 1, one of which — agriculture, forestry and fishing — has a high DMI and TMR. The aggregated manufacturing industries and all service industries excluding transport are also shown. Together these five sector groupings constituted 91 % of the EU economy in 2007.

- In general, sectors have shown significant progress in decoupling acidifying emissions and emissions of tropospheric ozone precursors from economic output. This has largely resulted from end-of-pipe abatement techniques along with fuel substitutions and efficiency improvements (EEA, 2010). Decoupling of GHG emissions has also been achieved, though to a lesser extent.

- For four out of five sectors and sector groupings shown, material demand has increased more rapidly than growth. Agriculture has not seen growth.

- The agricultural sector did not achieve a significant decoupling of pressures from economic output. A decline in output by 5 %, led, nevertheless, to an absolute reduction in pressures from this industry.

**Description of Figures 3.5, 3.6 and 3.7**

Figures 3.5 and 3.6 show developments in economic output of individual EU sectors and their direct GHG emissions and Total Material Requirement between 2000 and 2007. Trends in expenditure are shown in volume i.e. based on constant prices. The graphs show three areas. On the upper left hand side pressures have been reduced despite growth in output of the sector. On the upper right hand side pressures have grown but at a slower rate than growth in output — hence relative decoupling. Relative decoupling also applies to the bottom left corner, in which pressures have decreased at a higher pace than the output volume has decreased. Towards the bottom right, pressures have either grown more rapidly than output, or decreased less rapidly than output — hence no decoupling.

Figure 3.7 compares indexed trends in economic output, GHG emissions, acidifying emissions, tropospheric ozone forming precursors, TMR and DMI for selected economic sectors for the years 2000–2007. Again, economic output is shown in real terms (with inflation removed). These graphs can be used to assess whether an economic sector has achieved decoupling of environmental pressures from economic output. Absolute decoupling describes a situation where environmental pressures are stable or reducing, but output is increasing. Relative decoupling describes the case where environmental pressures are still growing but less rapidly than economic output or alternatively when they are decreasing more rapidly than economic output is decreasing.

# 4 Downstream intermediate drivers of direct pressures from EU industries

| | |
|---|---|
| **Message 4** | **Two thirds of direct GHG emissions and three quarters of DMI and TMR of EU economic sectors are driven by the direct demand for products by other industries and services. Policies promoting increased efficiency in the use of products for intermediate use can be a key tool in driving down pressures. Green business procurement also has a role to play.** |

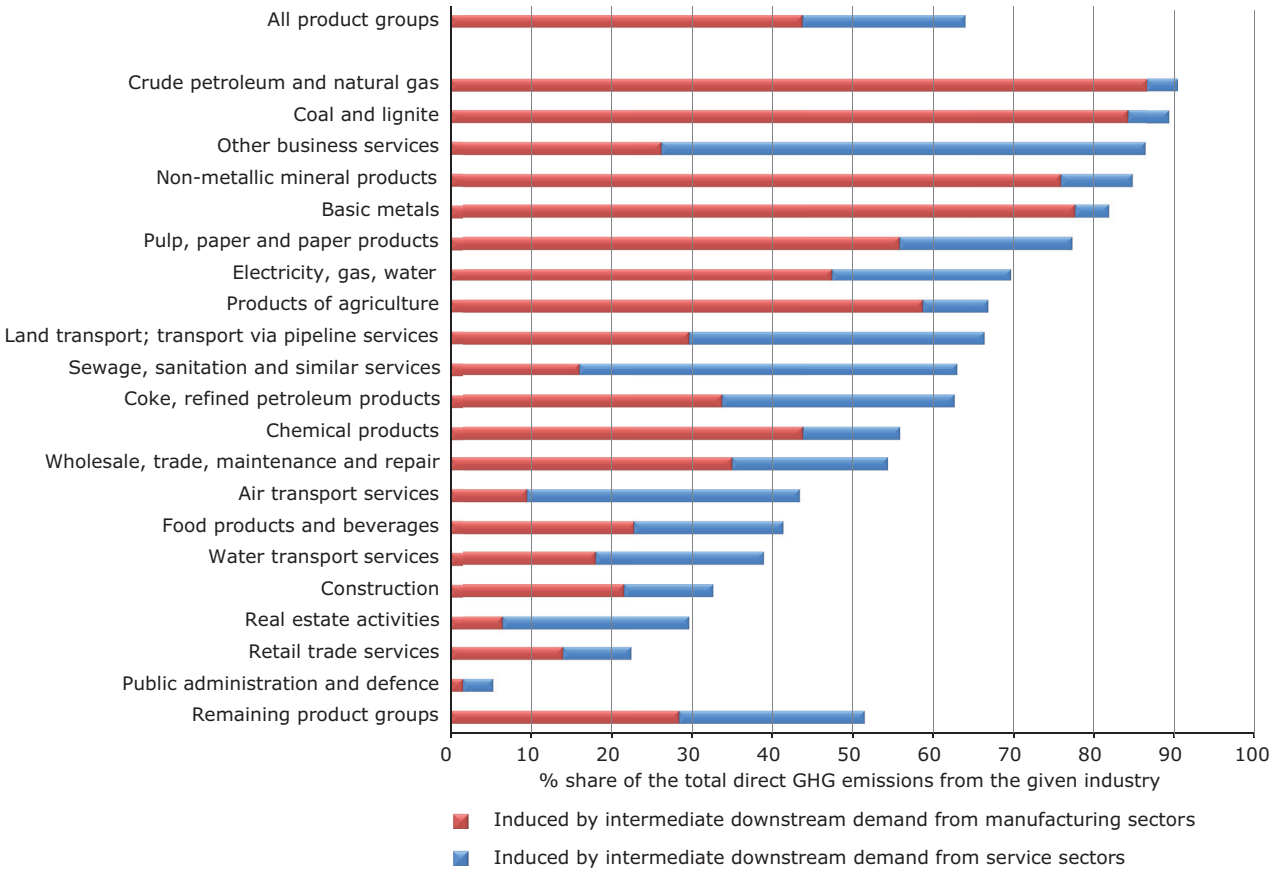
**Policy relevance**

A 2020 goal under Priority Objective 2 of the 7EAP: 'the overall environmental impact of all major sectors of the Union economy is significantly reduced, and resource efficiency has increased.

**Policy questions**

Which other sectors are driving the demand for intermediate products from key EU sectors with high environmental pressures?

**Figure 4.1 Share of direct GHGs emitted by EU-27 economic sectors (at 59-sector aggregation level) which are induced by intermediate downstream demand (single step downstream), 2007**



## Related trends and observations

- Figure 4.1 shows the degree to which direct GHG emissions from each production sector in the EU is induced by intermediate demand from manufacturing and service sectors as opposed to final demand i.e. how much of GHGs from the chemical industry, for example, are directly caused by the intermediate demand by other industries for its products. Here the full downstream chain is not considered, only the actors immediately downstream.

- As described under Message 1, increasing resource efficiency and reducing pressures at the whole economy level is not only about improving resource efficiency of individual sectors. It can also be achieved by reducing demand for the output of the more resource-intensive sectors without reducing human well-being. It is therefore useful to identify the key drivers of high emitting industries so that focus can be placed on decreasing this demand through improving the efficiency of the intermediate demanders downstream.

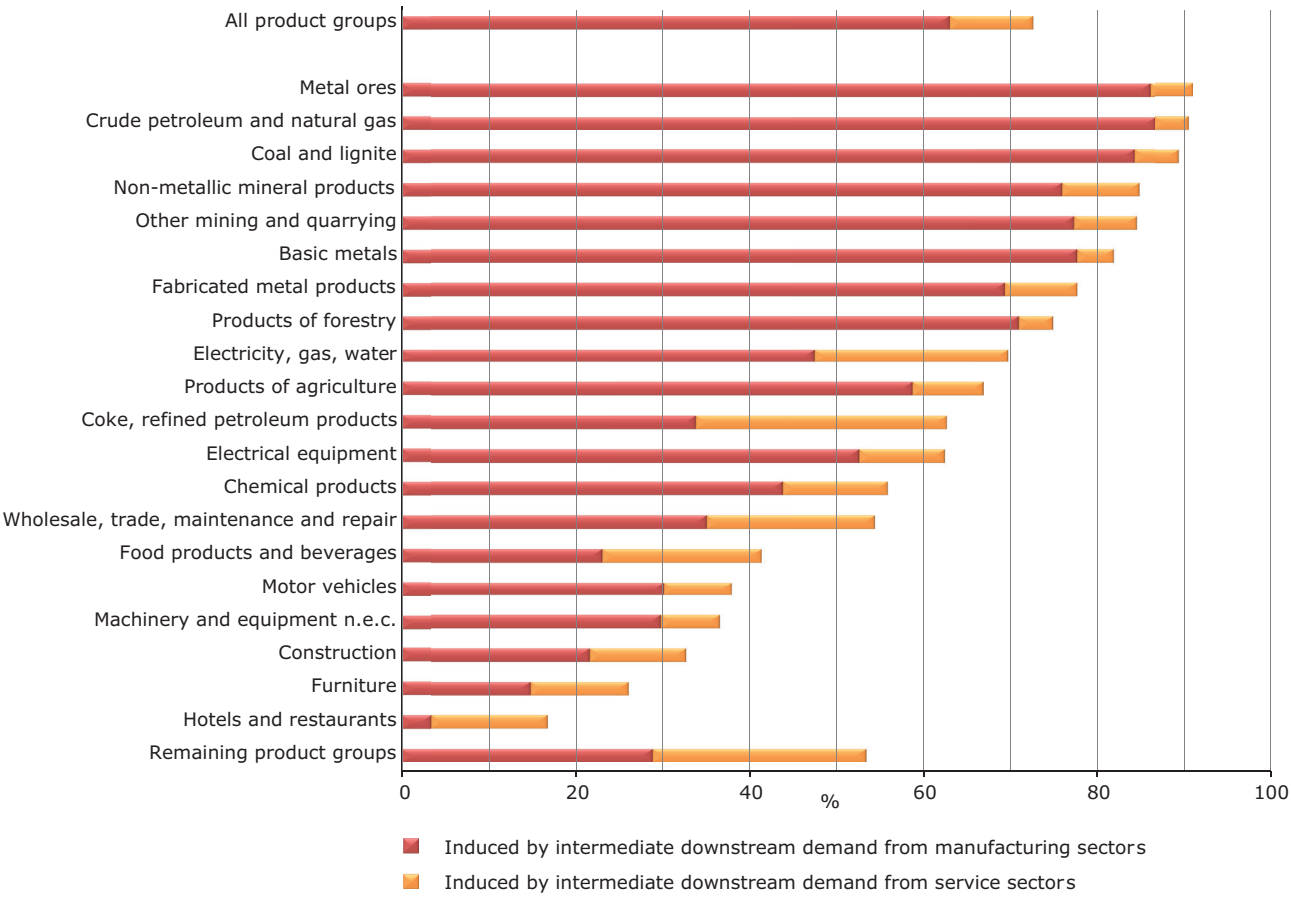
- This can be a particularly important means for reducing pressures from the extractive industries where intermediate demand is the dominant cause of direct pressures. Approximately 90 % of GHGs from the oil and coal industries, for example, are caused by intermediate demand from other sectors.

- Service sectors are not normally seen as environmental hotspots in the economy. However, 20 % of all direct emissions of GHGs from EU production are driven by demand from services (upper bar in figure). Improving the efficiency by which services make use of their inputs can reduce demand on pressure-intensive sectors upstream and have a significant effect in reducing GHG emissions from the economy as a whole.

- As an example, the intermediate demand for electricity by services is almost as high as final demand by households ([7]). This suggests that eco-design policy including energy labelling of energy related products should be just as much focused on electrical and electronic equipment for businesses as it is on equipment for use in the home. Policies promoting green business procurement are also of key importance.

([7]) GHG emissions caused by the demand for electricity by industry are greater than for services and households put together. However Message 5 shows that this is partly caused by the way the electricity sector is aggregated in national accounts.

**Figure 4.2 Share of Total Material Requirement (TMR) associated with EU-27 economic sectors (at 59-sector aggregation level) which are induced by intermediate downstream demand (single step downstream), 2007**




## Related trends and observations

- Intermediate demand in the economy as a whole dominates TMR even more than it did for GHG emissions. Nearly ¾ of TMR is directly induced by demand for intermediate goods and services within the EU.
- Intermediate demand by services is of less importance as an inducer of TMR than it was for GHGs. Exceptions are TMR of the refined petroleum products industry where (transport) services are an important driver plus TMR of retailers and the food industry.
- For some sectors intermediate demand is not an important driver of pressures. Examples are hotels and restaurants, the furniture industry and construction. For these sectors, reducing material requirement must primarily be tackled via material productivity improvements in the sectors themselves and policy aimed at influencing consumer behaviour, i.e. avoidance of food waste in the home and perhaps measures to curb increases in the demand for living space.

**Description of Figures 4.1 and 4.2**

Economic sectors to a varying extent produce goods and services for intermediate consumption by other sectors, or for final consumption by households, government or the export market. The share represented by intermediate demand depends on the type of sector. Analysis of this share using EE-IOA can give an overview of the degree to which pressures can be tackled by addressing intermediate demand of other sectors. This perspective is not often considered in policy development.

Figure 4.1 presents the proportion of direct GHGs emitted by each sector in the EU which are induced by the intermediate demand of other production sectors immediately downstream of that sector, i.e. the proportion of total GHGs emitted by the electricity industry due to demand for electricity from manufacturing industries, service industries etc. Immediately downstream means those industries which directly purchase the sectors' products.

Figure 4.2 presents the same result for Total Material Requirement (TMR) by each sector demonstrating the share of TMR which is attributable to immediate intermediate downstream demand by other production sectors.

| Message 5 | The export market is an important driver of GHG emissions and material requirement of the shipping industry, the chemical industry and the basic metals industry, but drives only 18–20 % of GHGs and TMR from EU production as a whole. |
|---|---|

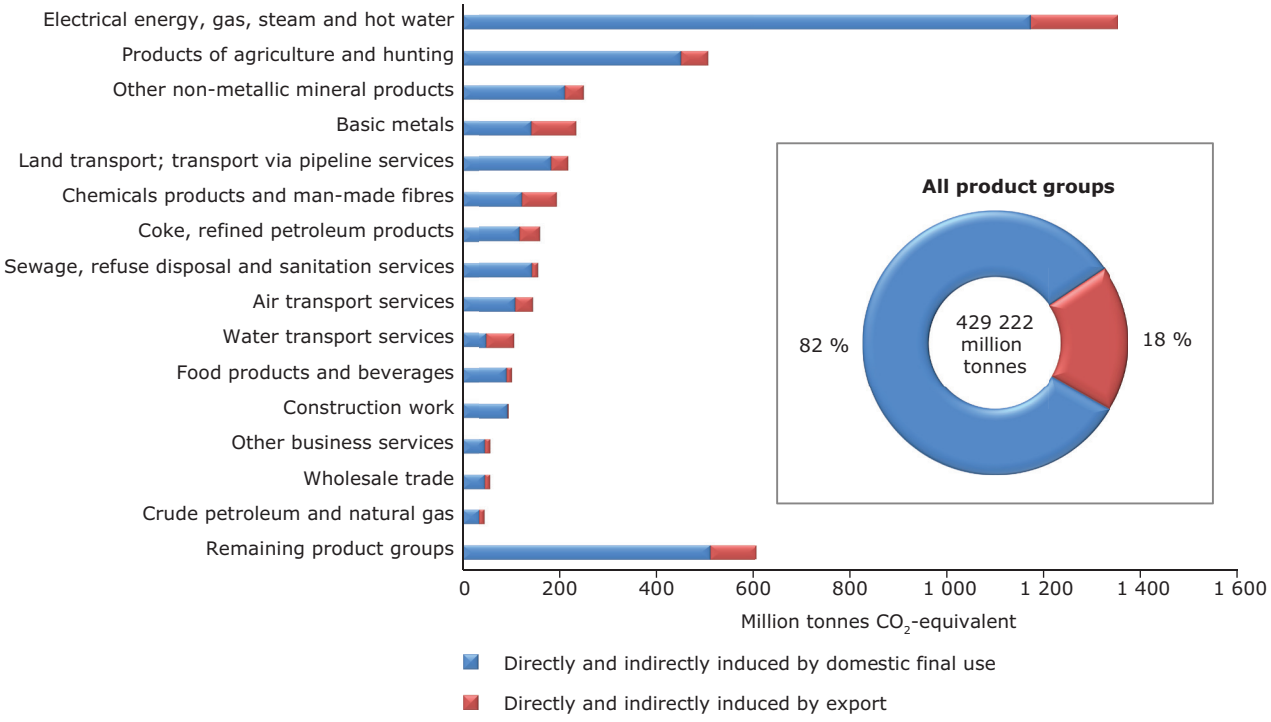
**Policy relevance**

A 2020 goal under Priority Objective 2 of the 7EAP: 'the overall environmental impact of all major sectors of the Union economy is significantly reduced, and resource efficiency has increased.'

**Policy questions**

To what extent are direct pressures from key EU economic sectors caused by final demand in the EU and production for export?

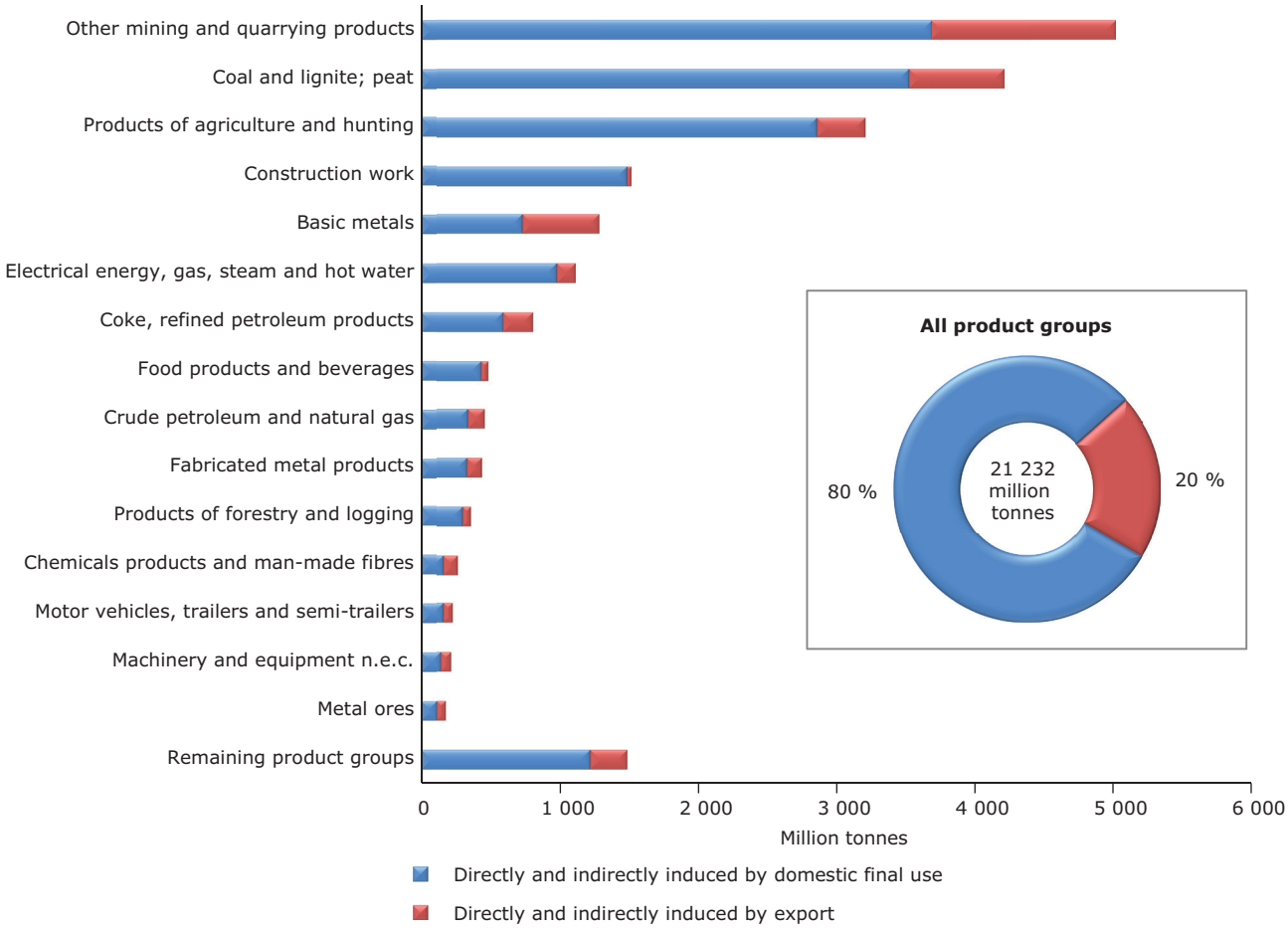
**Figure 4.3 Direct GHG emissions from EU-27 economic sectors (at 59-sector aggregation level) split by type of final demand, 2007**




## Related trends and observations

- Figure 4.3 shows how much of the direct GHG emissions from each production sector in the EU is induced by final domestic use by households and government, and how much by the export market. Here the full production and consumption chain from the industry to the final user is considered.
- Perhaps surprisingly in an era increasingly defined by international trade, only 18 % of direct GHGs from EU production are caused by the production of goods and services which end in the export market. This is perhaps a sign that trade between the EU and other regions is not as important as internal trade within the EU. The importance of the export market as an inducer of production-based GHGs is likely to be considerably higher for individual, particularly smaller, Member States.
- Even at EU level the extra-EU export market is an important driver of GHGs for some industries. Key examples are water transport services (54 % induced by exports), the basic metals industry (39 %) and the chemical industry (37 %).

**Figure 4.4 Total Material Requirement (TMR) of EU-27 economic sectors (at 59-sector aggregation level) split by type of final demand, 2007**




## Related trends and observations

- The picture is similar for TMR as for GHG emission with 20 % of TMR of total EU-27 production having been induced by the export market in 2007. Again the export market is of much greater significance as a driver of TMR for the basic metals industry (43 %) and the chemicals industry (39 %).

**Description of Figures 4.3 and 4.4**

Figure 4.3 presents the direct GHGs emitted by each sector in the EU which are directly and indirectly induced by domestic final use (i.e. government and household expenditure in the EU plus capital investments) and those which are directly and indirectly induced by the export market. The full downstream chain is considered up to the point of final use.

Figure 4.4 presents the same analysis for Total Material Requirement (TMR) of each sector and the extent to which this is induced by domestic final use and by export.

# 5 Upstream pressures caused by EU industries' demand for inputs

| Message 6 | **Economic sectors cause significant indirect pressures through their demand for inputs from other sectors. Significant environmental gains can potentially be achieved if businesses impose minimum environmental standards on their suppliers.** |
|---|---|

**Policy relevance**

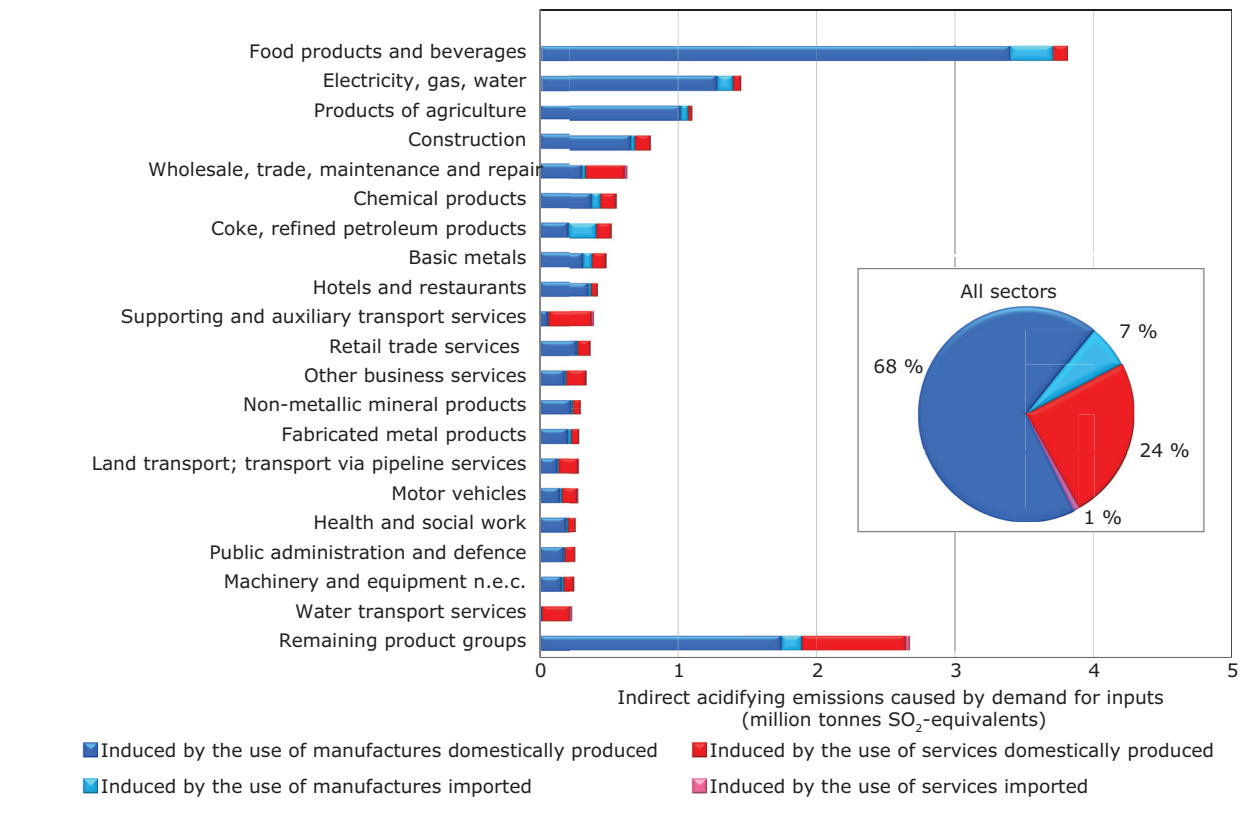
A 2020 goal under Priority Objective 8 of the 7EAP: 'the impact of consumption in the Union on the environment beyond its borders is reduced', i.e. that the global environmental impacts of EU consumption and key industrial sectors are reduced.

**Policy questions**

To what extent do economic sectors in the EU cause environmental pressures in other countries due to their demand for intermediate products?

Which EU sectors cause greatest global environmental pressures via their demand for intermediate goods?

**Figure 5.1 Acidifying emissions caused indirectly by each EU economic sector (at 59-sector aggregation level) via its demand for inputs from EU and global industries immediately upstream, 2007**



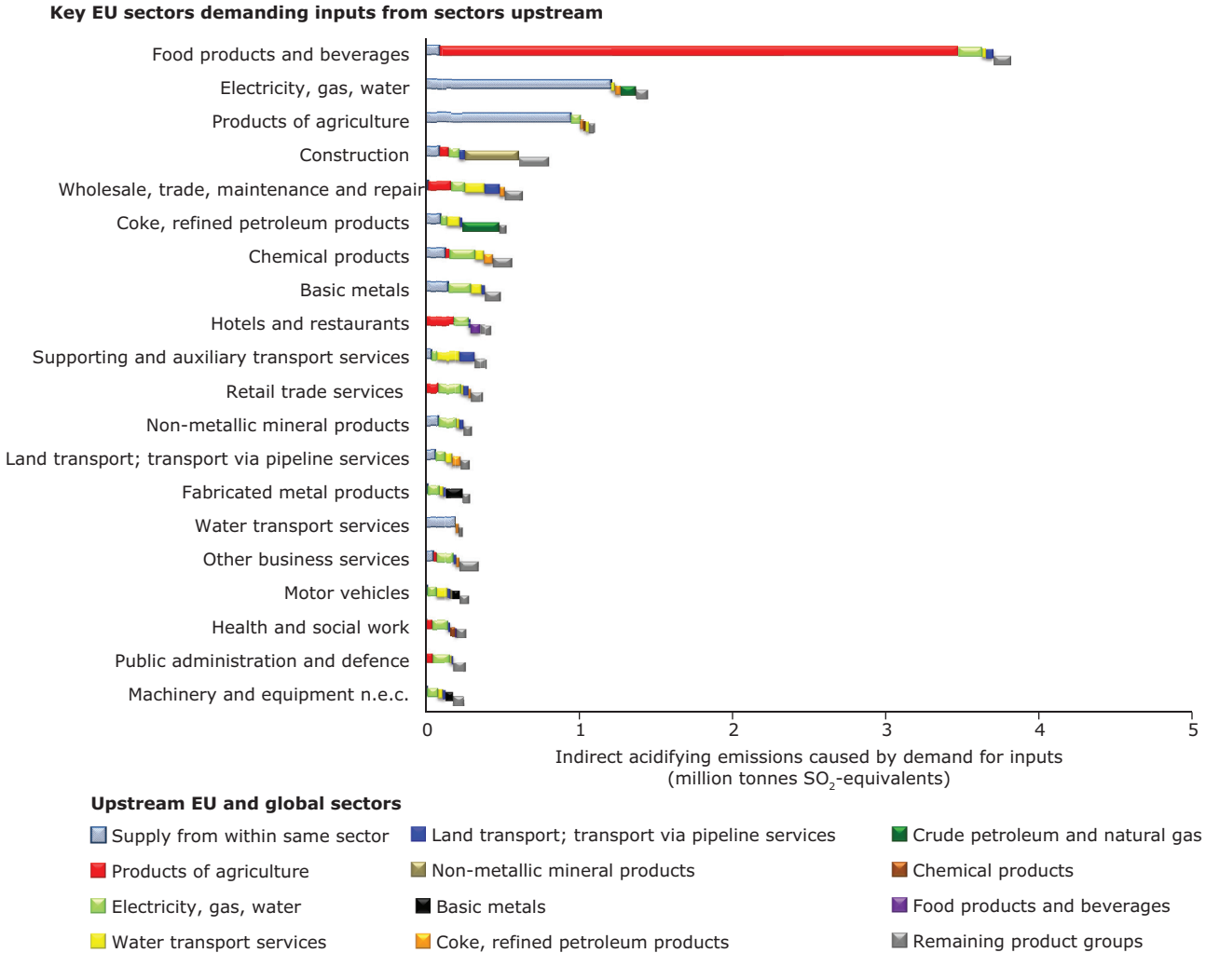
## Related trends and observations

- Figure 5.1 shows the indirect emissions caused by EU sectors demand for inputs from economic sectors immediately upstream. This is described in more detail in Box 2.3 in the introduction to this report. This type of analysis is used to illustrate that not only EU households but also EU economic sectors cause environmental pressures overseas.

- The food manufacturing industry causes more than twice as many indirect acidifying emissions as any other sector indirectly causes via its immediate upstream suppliers. This is caused via its demand for agricultural products (see under Figure 5.2).

- Perhaps surprisingly, only 8 % of acidifying emissions caused indirectly by sectors due to their demand for inputs are emitted in non-EU countries although this share is much higher (38 %) for the oil industry (ref: coke, refined petroleum industry). The share for EU production as a whole would be likely to be significantly higher if the full product chain of intermediate products demanded by EU sectors had been included. Another reason for such low value of acidifying emissions abroad is the Domestic Technology Assumption (see Box 2.5). The monetary value of the imports of agricultural goods is around 8–9 % of the domestic production but the quantities of imports may represent a significantly higher share.

**Figure 5.2 Acidifying emissions caused indirectly by each EU economic sector (at 59-sector aggregation level) via its demand for intermediate products, split by immediate upstream suppliers, 2007**



- Figures 5.2 shows the same indirect acidifying emissions of sectors as in Figure 5.1, but where emissions have been allocated to the EU and global sectors upstream.
- Many of the results are unsurprising: indirect acidifying emissions caused by the food industry are dominated by the demand for agricultural products; indirect acidifying emissions caused by the fabricated metal products, machinery/ equipment and motor vehicles industries are dominated by their demand for basic metals and electricity.
- The demand for electricity is an important contributor to almost all sectors indirect acidifying emissions. Therefore, eco-efficiency improvements in the electricity industry will have strong knock-on effects for the indirect pressures caused by all other elements of the economy. This is particularly the case for service sectors where the demand for electricity causes between a third and a half of all indirect acidifying emissions.
- The perspective shown in this graph highlights the potential for sectors to begin taking some responsibility for the environmental performance of their suppliers. This has not been a focus area for industrial policy to date. More widespread environmental footprinting of products and industries piloted under the EU Commission's Single Market for Green Products Initiative should encourage sectors to place more focus on their supply chains.

**Description of Figures 5.1 and 5.2**

In order to produce goods and products that it sells on for final or intermediate use, each economic sector buys intermediate products or inputs from other sectors. For example, the vehicle manufacturing industry buys electricity from the electricity industry, tyres from the rubber and plastics manufacturing industry, services from the financial services sector etc. Each of these upstream sectors releases air pressures while producing the inputs being demanded.

Figures 5.1 and 5.2 present the indirect acidifying emissions caused immediately upstream by each key sector's purchase of intermediate inputs.

In Figure 5.1 acidifying emissions are distinguished via two dimensions: 1) between those released during production of intermediate products in the EU and those released during production of intermediate products in the rest of the world and 2) between those released during the production of intermediate services demanded by the sector and those released during the production of intermediate manufactured goods demanded by the sector.

In Figure 5.2 the indirect acidifying emissions of each sector are split between the economic sectors from which it is demanding inputs. Whereas the demanding sectors (along the y-axis) are limited to the EU, the supplying sectors (those in the staggered bars) have a global scope i.e. the products of agriculture demanded by the EU food industry include agricultural products from the EU and from the rest of the world.

One complication is the 'supply from within same sector' element shown as an additional bar for some sectors. This is a result of the high aggregation level of industries: industries supplying each other with inputs can sometimes be included in the same aggregated industry group. For electricity for example, where the 'supply from within same sector' is particularly significant, power generators supply power distributors. The emissions associated with this supply are considered as indirect whereas in fact they emerge from the industry itself.

# 6 Global pressures caused by final demand for products in the EU

| Message 7 | **Six product groups are responsible for between half and two thirds of direct and indirect air emissions and material demand caused by the consumption of goods and services in the EU. The same six product groups make up less than one third of consumption expenditure.** |
|---|---|

**Policy relevance**

This analysis identifies the product groups on which there should be focus under the SCP 2020 milestone of the RE Roadmap 'citizens and public authorities have the right incentives to choose the most resource efficient products and services, through appropriate price signals and clear environmental information'.

**Policy questions**

Which broad product groups dominate total material resource and environmental pressure footprints exerted by the EU?

## Related trends and observations

(See Figures 6.1 and 6.2 on the following pages)

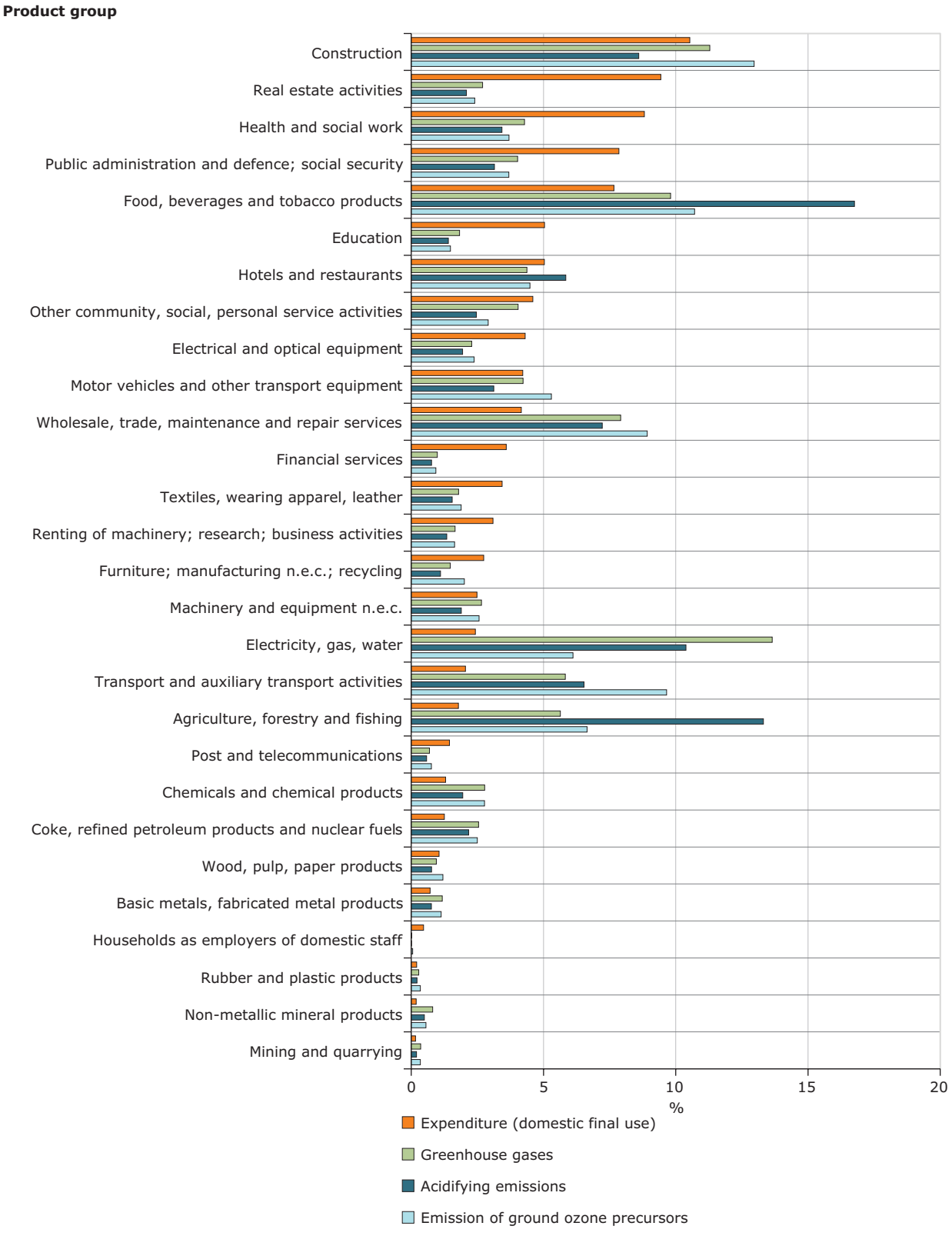
- The graphs and analysis here consider environmental pressures exerted along the global production chains of all final goods and services consumed in the EU (otherwise known as domestic final use and including household and government consumption and capital investments).

- Six product groups ([8]) together are responsible for the majority of environmental pressures and material demand (54 % of GHG emissions, 63 % of acidifying emissions, 55 % of tropospheric ozone precursors, 61 % of TMR and 64 % of DMI) caused by EU consumption. Their combined share in total consumption expenditure is considerably lower at only 29 %. Services (other than transport services) in general contribute less to environmental pressures than the volume of expenditure would suggest.

- This analysis provides useful guidance on which product groups should be focused on during first stages of implementation of the RE Roadmap objective that by 2020 'citizens and public authorities have the right incentives to choose the most resource efficient products and services'. However, note that these six product groups are not necessarily the least resource efficient — they could include products with medium resource efficiencies but which are consumed in very large quantities. The least resource efficient products are identified under Message 8.

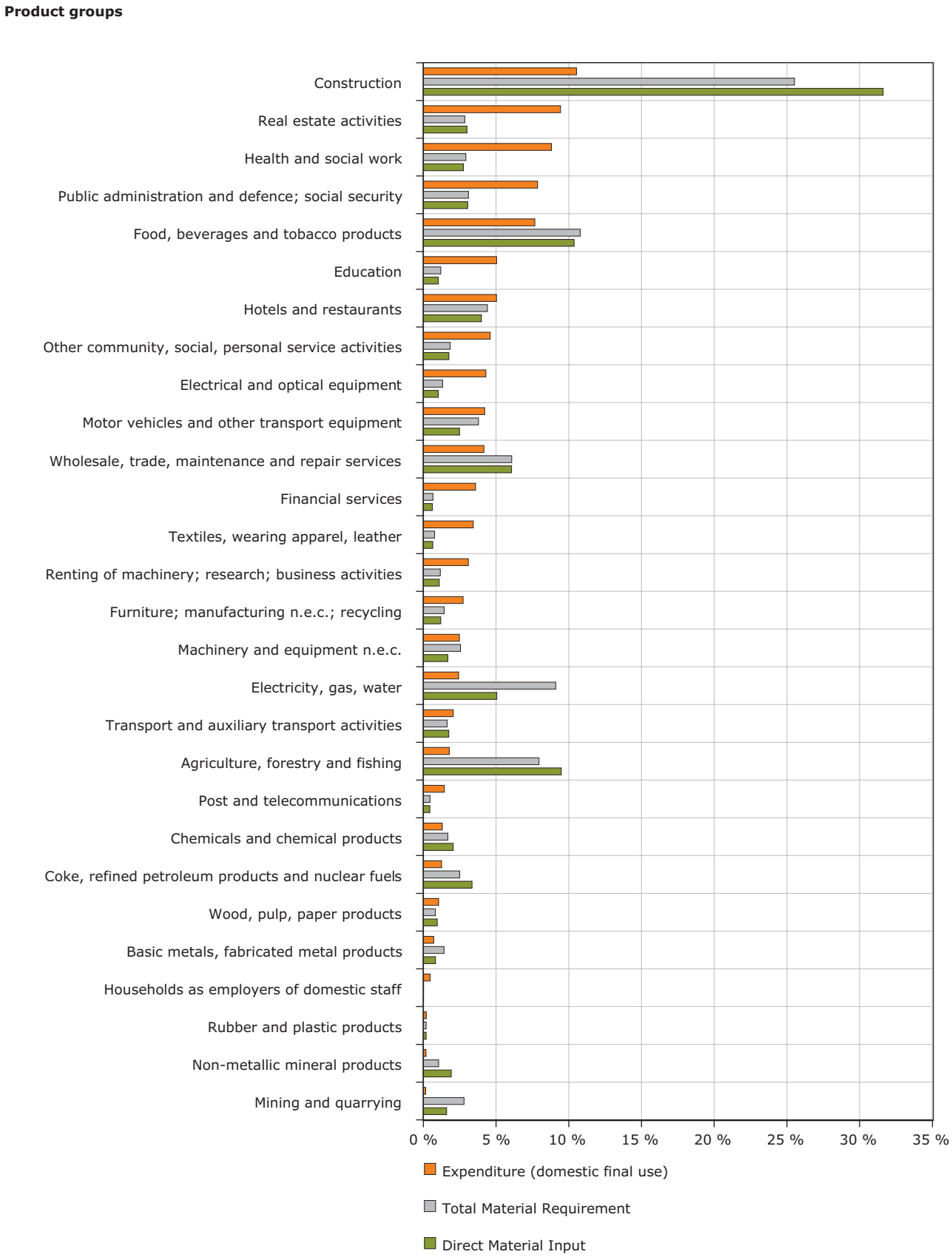
([8]) Construction works; Food products; Products of agriculture, forestry and fishing (mostly food products); Electricity, gas, steam and hot water (mostly electricity); Transport services and Wholesale trade, maintenance and repair services

**Figure 6.1 Share of product groups (at 28 product group aggregation level) in consumption expenditure (domestic final use) and in global air emissions caused by domestic final use in the EU-27, 2007**




**Note:** This graph shows emissions caused by total domestic final use (i.e. household and government consumption and capital investments). Direct environmental pressures resulting from household consumption are not included.

**Figure 6.2 Share of product groups (at 28 product group aggregation level) in consumption expenditure (domestic final use) and in material demand (TMR and DMI) caused by domestic final use in the EU-27, 2007**



**Description of Figures 6.1 and 6.2**

Figure 6.1 shows the air emissions caused along the global production chains of each of 28 final product groups sold in the EU for final consumption, as a share of total air emissions caused along the global production chains of these product groups (note that the word products when used here includes both material goods and services).

Figure 6.1 also presents each product group's share in final consumption expenditure in the EU. Consumption expenditure on product groups is at production prices not consumer prices i.e. they exclude VAT, and other taxes. Product groups are presented in order of share in consumption expenditure.

Figure 6.2 shows the same comparison of product groups' contribution to the economy and to environmental pressures but this time for material resource use.

**Message 8** **Spending one euro on most services causes far lower material demand and GHG-emissions than spending one euro on material goods. Reductions in environmental pressures can in part be achieved by shifting consumption expenditure from material goods to services where possible.**

**Policy relevance**

This analysis identifies the product groups on which there should be focus under the milestone of the RE Roadmap which states that 'citizens and public authorities have the right incentives to choose the most resource efficient products and services, through appropriate price signals and clear environmental information'.

The wider picture is provided by a 2020 goal under Priority Objective 2 of the 7EAP: 'structural changes in production, technology and innovation, as well as consumption patterns and lifestyles have reduced the overall environmental impact of production and consumption.'

**Policy questions**

Which broad product groups cause the highest direct and indirect global material resource demand and environmental pressures during their production per euro of expenditure?

**Figure 6.3 The 30 most GHG emissions-intensive product groups (at 59 product group aggregation level) for final use in the EU-27, 2007**

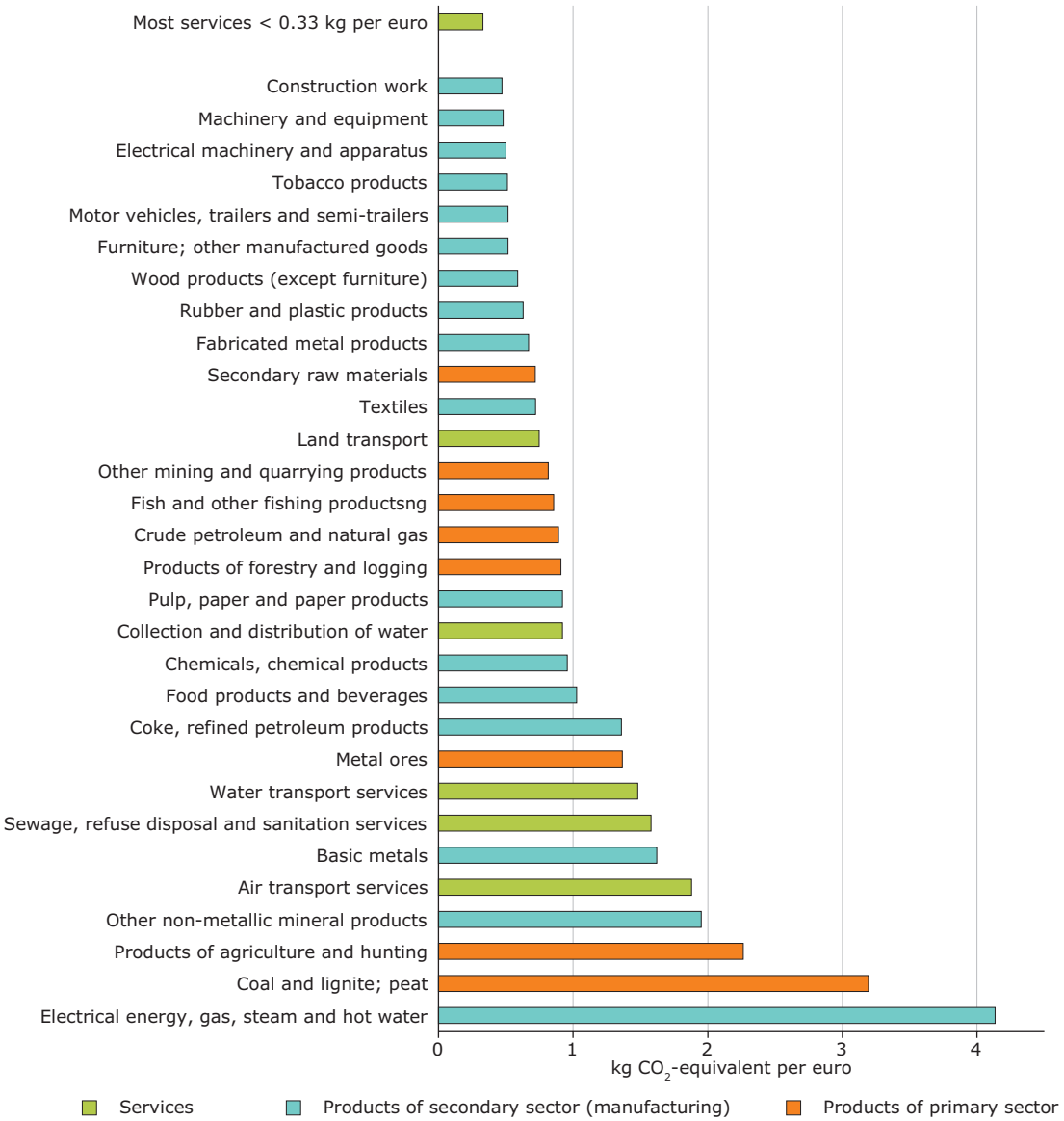
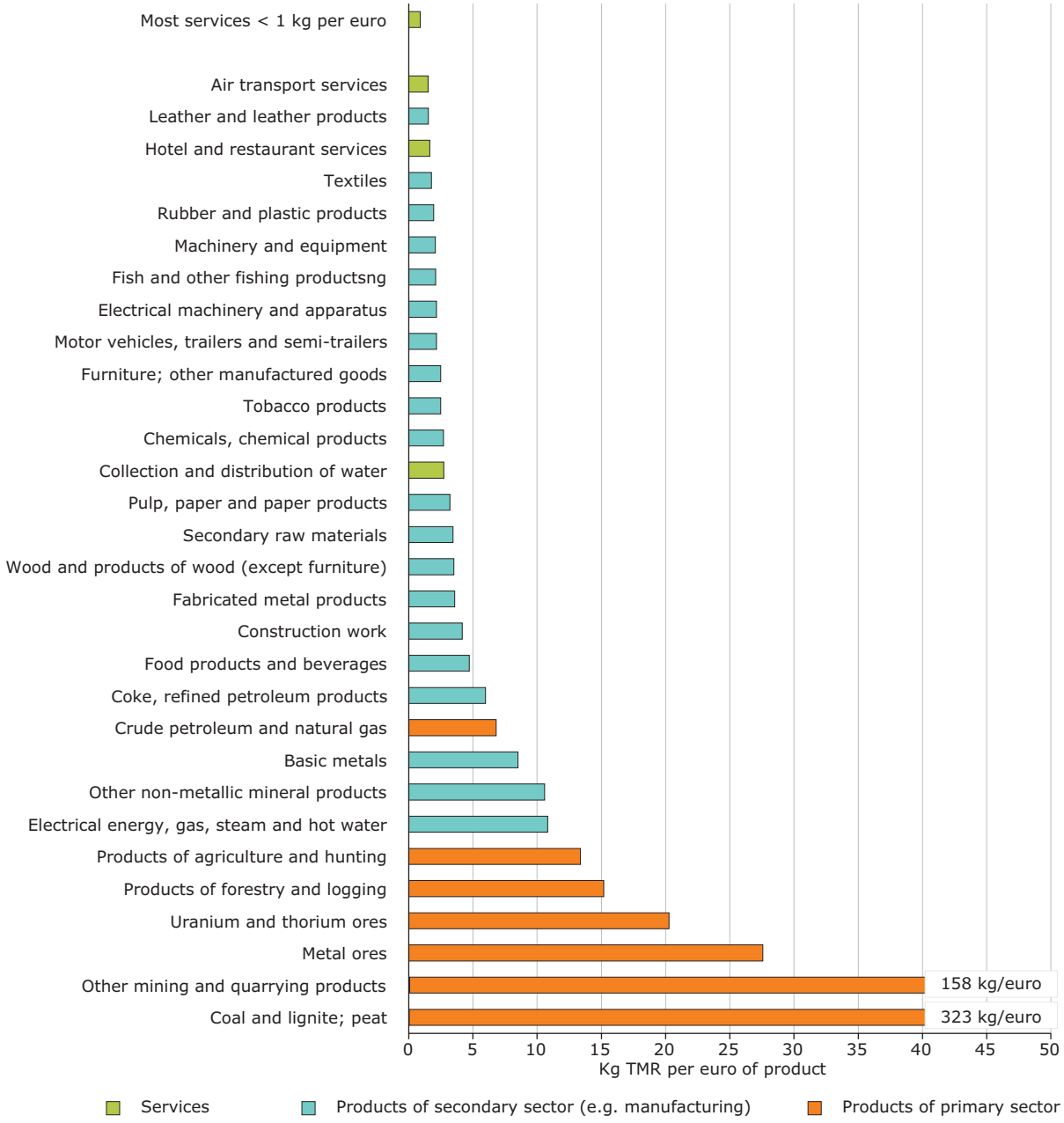


**Figure 6.4 The 30 most material-intensive (TMR per euro) product groups for final use in the EU-27, 2007**




## Related trends and observations

- Products of primary sectors (i.e. agriculture, forestry, mining etc.) have the highest material intensities across their production cycle, since they are the relatively raw result of material extraction and are sold at low price per kg. Products of manufacturing sectors have a medium material-intensity. Their manufacture includes considerable labour inputs which add value but not material content to the product. The majority of services have a low material-intensity since labour dominates the production costs.

- The pattern is more mixed for GHG-intensities. This is due to the high demand for energy by some manufacturing industries and some services. Most services, however, have a low GHG-intensity.

- Spending one euro on services (excluding transport) is more 'resource efficient' than spending one euro on say electricity, coal, textiles or metal products. Therefore reductions in environmental pressures can in part be achieved by shifting spending from non-essential material goods towards services where this is possible. They can also be achieved by shifting of spending to higher quality goods within the same product group that may be more expensive but give greater satisfaction or last longer.
- Green fiscal reform (GFR) ([9]) can encourage such a shift in spending. GFR and other policies aimed at 'getting the price right' increase the cost of pressure intensive goods and services, thereby reducing their demand. This provides monetary incentives for innovation and substitution of environmental intensive inputs used during the production phase of the goods.

**Description of Figures 6.3 and 6.4**

Figure 6.3 shows the GHG emissions caused along the global production chains of selected final product groups per euro of expenditure on that product group. Products are presented at the 59-sector aggregation level. However, only the 30 most GHG-intensive product groups are presented in the graph. Products of the primary, secondary and tertiary (services) sectors have been distinguished from one another.

Figure 6.4 shows the same type of comparison but for TMR induced along the production chain per euro of product sold. Again only the 30 most material-intensive product groups are presented in the graph.

([9]) Green Fiscal Reform describes a change in tax policy where tax on elements that are valued by society; like jobs, incomes and profits; are reduced and the lost revenue is replaced by taxes on elements society does not value, such as pollution and environmental degradation.

**Message 9** **Material demand and GHG emissions caused by the EU consumption areas of 'Food and lodging', 'Use of housing and infrastructure' and 'Mobility' showed no significant reductions between 2000 and 2007. These consumption areas are responsible for the majority of pressures caused by total EU consumption.**

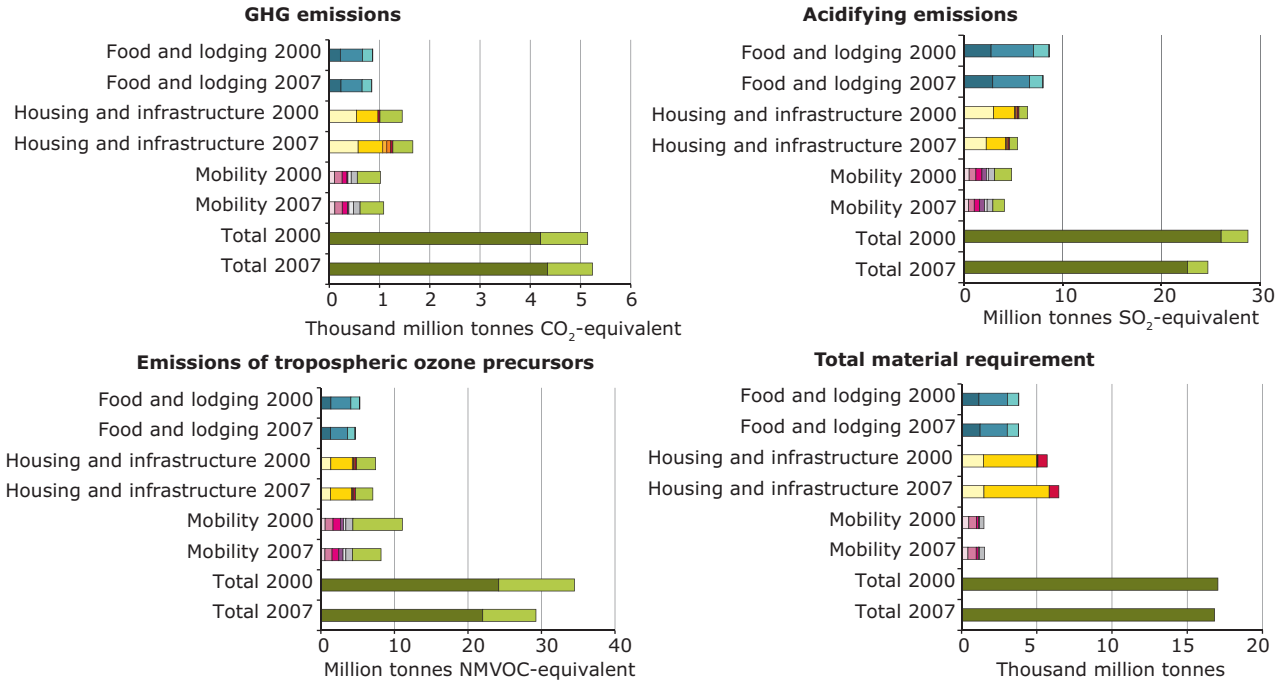
### Policy relevance

A 2020 goal under Priority Objective 2 of the 7EAP: '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.'

### Policy questions

To what extent are global environmental pressures caused by the consumption clusters of Food, Housing and Mobility being reduced?

## Figure 6.5 Changes in direct and indirect pressures caused by total EU consumption and by individual consumption clusters 'Food and lodging', 'Use of housing and infrastructure' and 'Mobility', EU-27, 2000–2007




**Note:** The key shows the products which have been allocated to the functional use clusters of 'Food and lodging', 'Housing and infrastructure' and 'Mobility'. The light green bars show direct emissions from households which can be allocated to the functional use clusters.

## Related trends and observations

- A significant part of environmental pressures caused along the production and use chains of all goods and services consumed in the EU, can be allocated to three broad functional consumption areas: 'Food and lodging', 'Use of housing and infrastructures' and 'Mobility'. The importance of these three consumption areas is by now well recognised. The RE Roadmap includes specific milestones and actions tackling environmental pressures from these three areas and the 7EAP also notes these clusters as being key focus areas where impacts of production and consumption need to be reduced ([10]).

- Acidifying emissions and emissions of tropospheric ozone precursors caused by all three consumption areas, and for total EU consumption, reduced between 2000 and 2007. Greenhouse gas emissions decreased slightly (– 2 %) for 'Food and lodging' but increased for 'Housing and infrastructures' (2 %), Mobility (6 %) and for total consumption (1 %). Total Material Requirement on the other hand saw strong increases from 'Housing and infrastructure' (13 %), smaller increases for 'Mobility' (3 %) and slight reductions for total consumption (– 1 %). TMR caused by 'Food and lodging' saw no change.

- These less than positive results strongly justify the inclusion of these consumption clusters as focus areas for resource efficiency policy in the RE Roadmap and the 7EAP.

**Description of Figure 6.5**

Direct pressures from EU households can be considered in combination with the indirect pressures accumulated along products consumed in the EU (i.e. by governments, households and capital investments) to give an overall picture of pressures caused by total EU consumption. Both the direct and indirect pressures can further be allocated to particular consumption activities or functions. Global pressures caused by purchase of food and beverages, products of agriculture and hotels and restaurants can largely be allocated to the function of Food and lodging.

Other functional activities to which final products can be allocated include: Use of housing and infrastructure, to which most final electricity use can be allocated, along with most construction works and real estate services, and Mobility to which product groups such as motor vehicles, coke and refined petroleum products, transport and auxiliary services, etc. can be allocated. A large part of the direct pressures from households can also be allocated to these last two function areas. Direct pressures from burning of fuel in private cars can be allocated to Mobility while direct pressures associated with burning of fuel in households can be allocated to Use of housing and infrastructures. Part of the latter could also be allocated to Food and lodging since some gas and oil burnt in households is for food preparation. This is, however, considered to be minor compared to the fuel burnt for heating.

Figure 6.5 presents this broad allocation to functional consumption areas for the 4 pressures of GHG emissions, acidifying emissions, emissions of tropospheric ozone forming precursors and TMR for the years 2000 and 2007.

([10]) Note that the clusters differ somewhat in the names given them. The RE Roadmap and the 7EAP refer to Food, Housing and Mobility. In this analysis Lodging is added to Food as pressures caused by Restaurants and Hotels could not be split between pressures caused by catering and pressures caused by lodging in hotels. Similarly Infrastructures were added to Housing as pressures caused by constructions could not be split between construction of housing and construction of other infrastructure such as offices, roads etc.

**Message 10** **Resource-efficiency gains in production chains have been strong drivers in reducing environmental pressures caused by EU consumption. However, these improvements have been partially (air emissions) or completely (material use) offset by increase in total consumption. Changes in the basket of goods and services consumed are not contributing to reducing pressures.**

**Policy relevance**

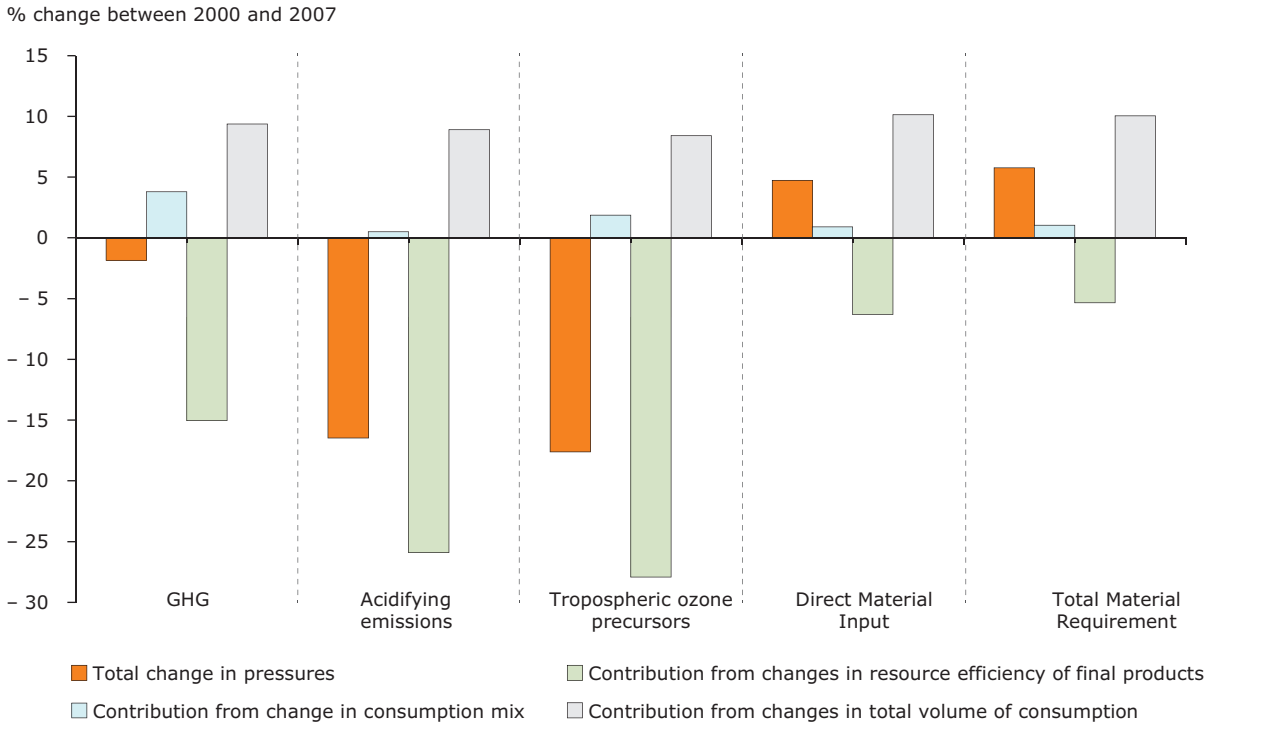
A 2020 goal under Priority Objective 2 of the 7EAP: 'structural changes in production, technology and innovation, as well as consumption patterns and lifestyles have reduced the overall environmental impact of production and consumption'.

The 2020 milestone for SCP in the RE Roadmap: 'By 2020, citizens and public authorities have the right incentives to choose the most resource efficient products and services […]. Their purchasing choices will stimulate companies to innovate and to supply more resource efficient goods and services […]. Consumer demand is high for more sustainable products and services'.

**Policy questions**

To what extent have reductions in global environmental pressures caused by EU consumption been led by resource efficiency improvements in production and to what extent by changes in consumption patterns? Are these trends complementing or competing with one another?

**Figure 6.6 Changes in pressures per capita caused by consumption (domestic final use) in the EU-27 between 2000 and 2007, and decomposition into contributing factors**




## Related trends and observations

- Per capita emissions to air caused by domestic final use of goods and services in the EU reduced between 2000 and 2007, despite growth in per capita expenditure. TMR and DMI, however, only saw relative decoupling from growth in consumption expenditure.
- For all five pressures, decoupling was achieved solely through improvements in the resource efficiency of the production of individual product groups. Changes in the basket of goods and services consumed in the EU have partially offset gains made in eco-efficiency of production. In other words, final demand has shifted, albeit to a relatively small extent, from

more resource-efficient to less resource-efficient groups of goods and services.

- Within the holistic vision of resource efficiency as presented in the RE Roadmap and the 7EAP, reductions in pressures and material resource demand should be achieved through complementary action across the economy as a whole. In other words this could be achieved via both improvements in products and via changes in the way EU citizens and government consume. The latter hadn't been observed between 2000 and 2007 and may therefore require significant attention from policymakers over the coming years.

**Description of Figure 6.6**

Structural decomposition analysis (SDA) allows different types of decoupling trends to be broken down into various contributing factors. Figure 3.4, Message 2, presented the results of SDA on trends in decoupling of direct pressures from industry from economic output. Figure 6.6 on the other hand uses SDA to analyse trends in decoupling of direct and indirect pressures caused along the full production chain of products consumed in the EU, from growth in consumption expenditure. The methodologies for carrying out these two types of SDA are described in the EEA technical report.

For Figure 6.6, three factors contributing to changes in pressures caused along production changes of consumed products (goods and services) were analysed:

- intensity effect — reductions in environmental pressure intensity of the full product chains of individual product groups;
- consumption mix effect — changes in the basket of product groups being 'purchased' in the EU;
- consumption volume effect — changes in total consumption expenditure in the EU (domestic final use).

The **intensity effect** is concerned with improvements within production chains, i.e. reductions in pressure intensity (environmental pressure per euro of consumption) along the production chains of a given product group. The intensity effect can also be considered as a resource efficiency effect of the production chain where resource efficiency is the inverse of pressure intensity. The effect has been termed as such in the graph and analysis for communication purposes.

The second factor — **changes in the consumption mix** — is concerned with changes in the types of products consumed domestically (i.e. by government, households and gross capital formation). When consumption expenditure shifts from groups of products with low eco-efficiency to groups of products with high eco-efficiency this has a positive decoupling effect.

The **consumption volume effect** is simply the growth or reduction in total consumption expenditure in real terms (i.e. constant prices).

The three right-hand bars for each pressure in Figure 6.6 show how changes in emissions intensity of individual product chains, changes in the consumption mix and growth in consumption volume (i.e. expenditure) would individually have affected the given environmental pressure between 2000 and 2007. The left-hand bar shows the sum of the changes in pressure caused by these factors, i.e. actual developments in the environmental pressure. If this has increased to a lesser extent than the consumption volume effect, then relative decoupling has been achieved. If it has actually reduced, absolute decoupling has been achieved.

**Message 11** **The global production chains of most products consumed in the EU became more resource efficient between 2000 and 2007.**

**Policy relevance**

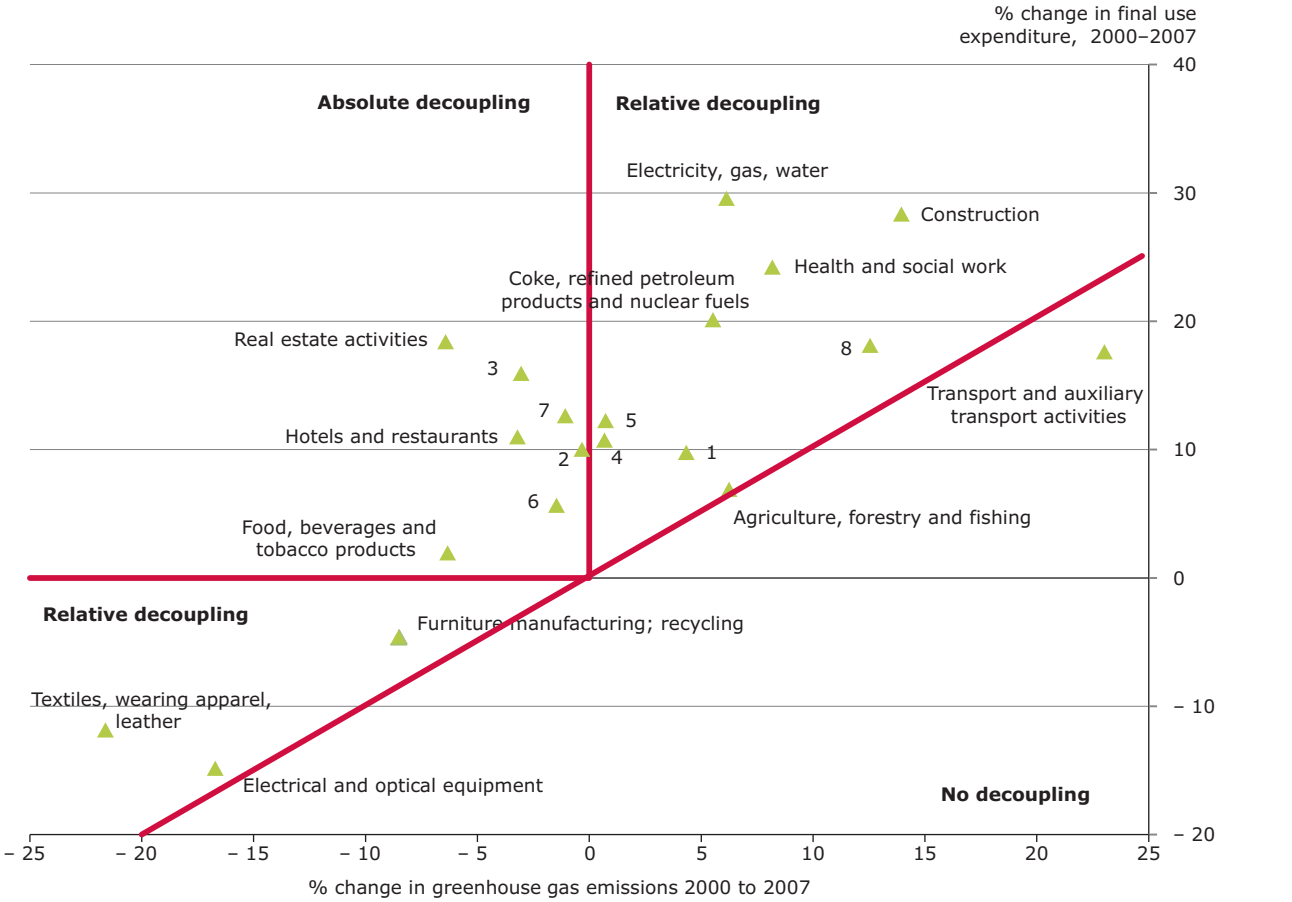
A 2020 goal under Priority Objective 2 of the 7EAP: 'structural changes in production, technology and innovation, as well as consumption patterns and lifestyles have reduced the overall environmental impact of production and consumption'.

The 2020 milestone for SCP in the RE Roadmap: 'By 2020, citizens and public authorities […] purchasing choices will stimulate companies to innovate and to supply more resource efficient goods and services….'

**Policy questions**

How successful has industry been in improving the resource efficiency of the production chains of key products?

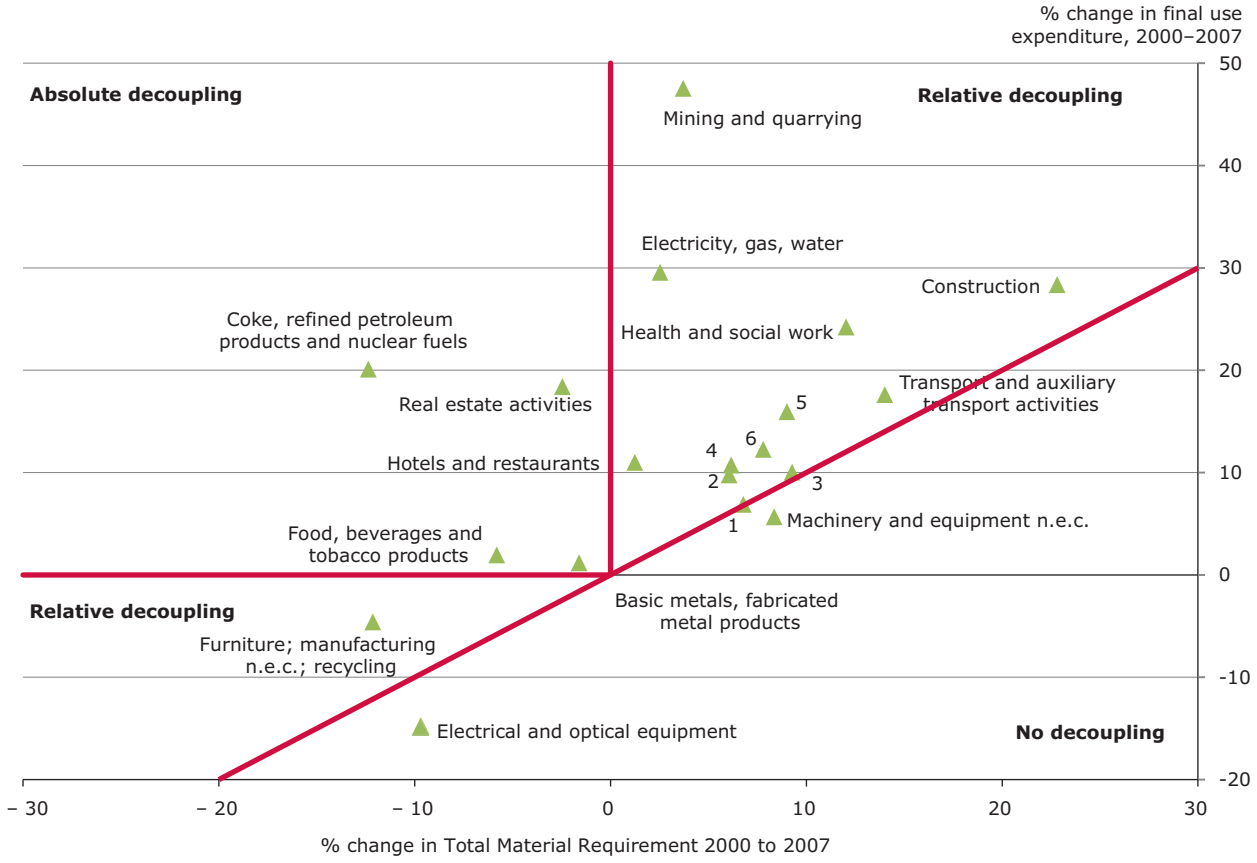
**Figure 6.7 Developments in GHG emissions of, and expenditure (domestic final use) on, the 20 product groups which cause most GHG emissions (at 28-sector aggregation level) in the EU-27, 2000–2007**




**Legend:** 1) Wholesale, trade, maintenance and repair services; 2) Motor vehicles and other transport equipment; 3) Other community, social, personal service activities; 4) Public administration and defence; social security; 5) Chemicals and chemical products; 6) Machinery and equipment n.e.c.; 7) Education; 8) Renting of machinery; research; business activities.

**Note:** Only 20 most GHG-emitting product groups shown at 28-product aggregation level.

**Figure 6.8 Developments in Total Material Requirement of, and expenditure (domestic final use) on, the 20 product groups with highest material requirement (at 28-sector aggregation level) in the EU-27, 2000–2007**




**Legend:** 1) Agriculture, forestry and fishing; 2) Wholesale, trade, maintenance and repair services; 3) Motor vehicles and other transport equipment; 4) Public administration and defence; Social security; 5) Other community, social, personal service activities; 6) Chemicals and chemical products.

**Note:** Only 20 most material demanding product groups shown at 28-product aggregation level.

## Related trends and observations

- For all but one of the 20 key product groups, indirect GHG emissions induced by their consumption have been relatively or absolutely decoupled from growth in consumption expenditure. As would be expected the more rapid the growth rates in consumption, the less the likelihood of absolute reductions in related GHG emissions.

- Seven product groups have seen absolute reductions in GHG emissions despite growth. These comprise four services and three types of goods: motor vehicles, food and machinery. Unfortunately only one of these, food products, is in the top five GHG-responsible products. The influence of the other six in reducing total GHG emissions caused by consumption activities will be relatively limited.

- Resource efficiency trends for TMR are also relatively positive though four products saw no decoupling in material resource use at all, and only four saw absolute decoupling. A similar trend can also be observed when using DMI.

- As was seen in Message 10 for both GHG emissions and TMR, gains made through resource efficiency improvements across all products have been completely or almost completely offset by growth in consumption.

**Description of Figures 6.7 and 6.8**

Figures 6.7 and 6.8 show developments in EU expenditure on individual product groups consumed in the EU and the GHG emissions and Total Material Requirement along their global production chains between 2000 and 2007. Expenditure growth is shown in volume, i.e. based on constant prices. The graphs show three areas. On the left-hand side pressures have been reduced despite growth in total consumption of the product group. On the upper right-hand side pressures have grown but at a slower rate than consumption expenditure on the product — hence relative decoupling. Relative decoupling also applies to the bottom left corner, in which pressures have decreased at a higher pace than the output volume. Towards the bottom right, pressures have grown more rapidly than consumption — hence no decoupling.

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European Environment Agency

**Progress on resource efficiency and decoupling in the EU-27**

2014 — 52 pp. — 21 x 29.7 cm

ISBN 978-92-9213-458-7
ISSN 1725-2237
doi:10.2800/17781

TH-AK-14-007-EN-N
doi:10.2800/17781

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