

Sectoral Resource Maps

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Introduction

Economy-wide Material Flow Accounts (EW-MFA) provide information about an economy's material resource use¹. The accounts track annual extraction of raw materials as well as the physical flows of imports and exports. The framework for EW-MFA is compatible with the system of national accounts (SNA) in that material use can be related to Gross Domestic Product (GDP). By relating material use to economic activity, one can derive an indicator that can inform whether an economy is becoming more resource efficient.

An issue with EW-MFA is that currently national economies are treated as a black box where only inputs and outputs are considered. Material flows within the economy are not accounted for. When trying to develop policies to encourage resource efficiency, it is necessary to understand the resource use and efficiency of individual economic sectors. This document provides a first overview of the resource use of economic sectors in the EU based on a multi-regional input-output (MRIO) model developed by SERI².

The resource use of economic sectors is calculated for 1997 and 2007 using a consistent framework for the EU-27 and each of its Member States.

The “driving questions” in the analyses are:

- What is the material resource use of economic sectors in the EU and its Member States?
- What is the resource efficiency (amount of economic value generated per unit of resources used) of the economic sectors in the EU and its Member States and how is it developing?

Although MFA accounts for all materials used within an economy, we would like to caution its use to directly derive policy conclusions. MFA provides an aggregated view of material resource use that can hide specific issues for certain materials, e.g. critical raw materials such as rare earths which are only used in small quantities.

¹ Bringezu, S. & Bleischwitz, R. (editors) (2009) Sustainable Resource Management. Global trends, visions and policies. Greenleaf Publishing.

² Bruckner, M., Giljum, S., Lutz, C., Wiebe, K.S. (2012) Materials embodied in international trade - Global material extraction and consumption between 1995 and 2005. Global Environmental Change 22(3), 568-576.

Chapter 1: Data and methodology

1.1 Material Flow Analysis

Material Flow Analysis (MFA) is an established framework³ for documenting and analysing an economy's material resource use. MFA keeps track of all materials that enter and leave the economy within one year by applying the mass balance principle. MFA therefore provides a biophysical account of the level of material flow in national economies analogue to the concept of GDP in national economic accounting. These flows incorporate extracted or imported materials to be used within the national economy, and all material released to the environment as wastes, emissions or exports to other economies or added to societal stocks.

In MFA, the economy is usually treated as a black box where only inputs and outputs are considered. A number of flow aggregates (typically biomass, fossil fuels, metal ores and non-metallic minerals) can be derived from the MFA framework for a national economy and for a certain time period (usually one year), expressed in metric tonnes. In order to measure the resource use of the EU at an aggregated level, an economy-wide Material Flow Analysis can be used to account for the material flows in the whole region.

Domestic Material Input (DMI) and Domestic Material Consumption (DMC) are commonly used but they are restricted to consumption of economically valued primary materials, without taking into account unused domestic extraction⁴ or indirect flows associated with imports and exports. Taking only these indicators as a measure of resource use can be misleading, as a part of the resource use and environmental pressures in other parts of the world might not be accounted for, shifting the consequences of domestic consumption to other regions. Whenever it is possible, Raw Material Inputs (which includes all materials used in imports) or Total Material Requirements (which includes all materials used and unused in the economy) should be used.

So far economy-wide Material Flow Accounts (EW-MFA) from Eurostat have only been able to track materials entering and leaving the economy and not the material resource consumption of sectors within the economy. This report presents a first estimate of Raw Material Inputs to individual economic sectors in the EU and all Member States.⁵

³ Bringezu, S. & Bleischwitz, R. (editors) (2009) Sustainable Resource Management. Global trends, visions and policies. Greenleaf Publishing.

⁴ Unused domestic extraction is the part of the materials extracted that does not enter into the economy.

⁵ The analysis performed in this report is similar to what was done by ETC/SCP in their working paper "Key messages on material resource use and efficiency in Europe. Insights from environmentally extended input-output analysis and material flow accounts". (ETC/SCP working paper 3/2011). The ETC/SCP analysis was performed only for DMI and TMR in selected EU Member States. In this study RMI is used as an indicator and the analysis is performed for all Member States.

Note that it is not possible to add up all the Raw Material Inputs of individual sectors in an economy to get the entire economy's Raw Material Input. This is because economic sectors are linked by supply chains, where one sector uses materials from one or more other sectors.

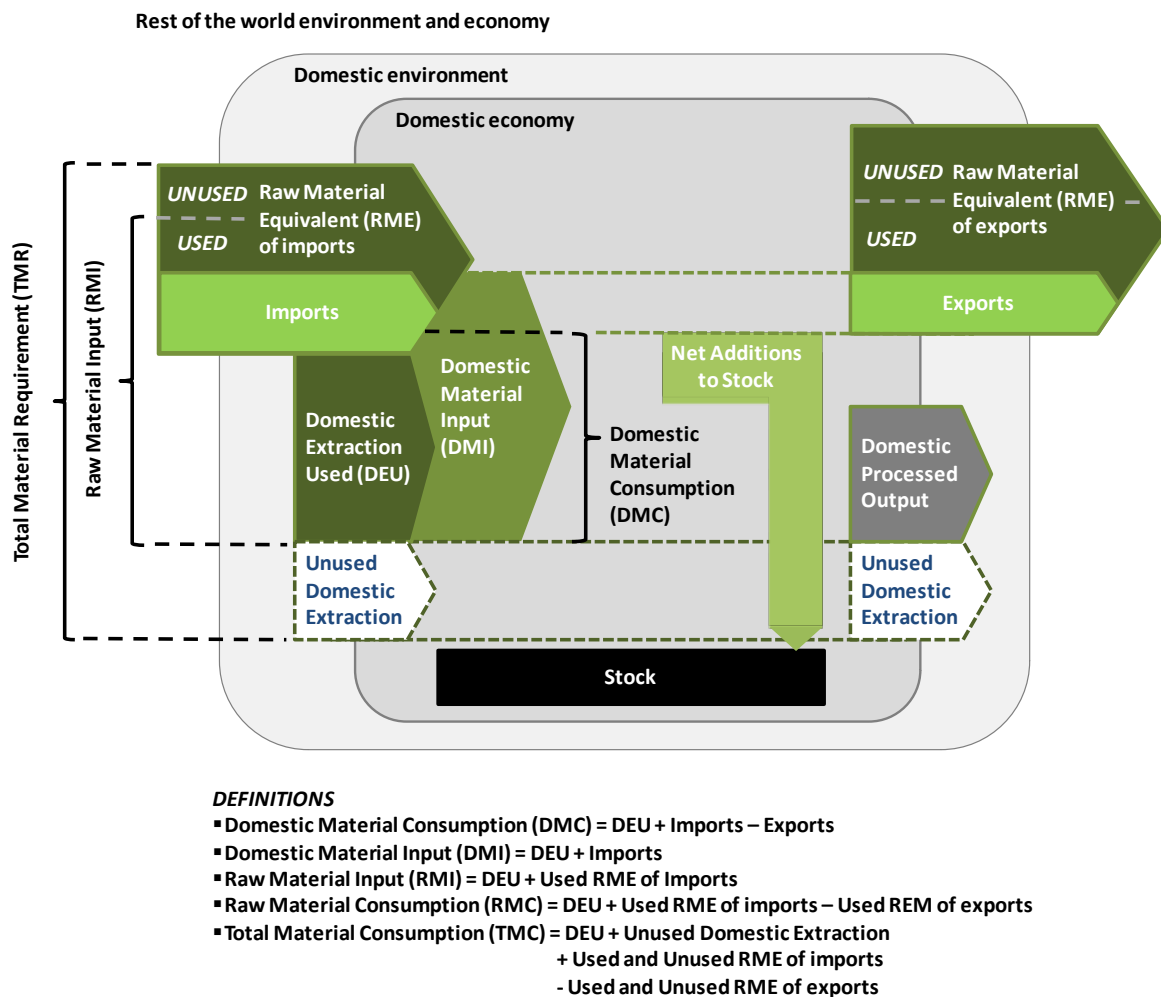


Figure 1-1: A visualisation of the common material flow indicators used⁶

1.2 Multi-regional input-output (MRIO) modelling

MRIO models allow for the quantification of the direct and indirect resource use for the production of a sector's output, e.g. in kilograms per €, for a large number of countries, considering their specific economic structures and levels of technological development. SERI's MRIO model is based on data from the Global Trade Analysis Project (GTAP). This model comprises 129 countries and country groups with 57 economic sectors each, of which 25 are sectors engaged in resource processing and manufacturing. The model links the 129 countries through detailed bilateral trade data and thus reflects the global interdependencies of sectors and economies.

⁶ <http://www.materialflows.net/background/accounting/indicators-on-the-economy-wide-level/>

SERI's MRIO model can be used to calculate the indirect resource use of a sector, e.g. all material requirements embodied in intermediate products, which the respective sector purchases from other sectors. Thereby, the model can illustrate the sectoral interlinkages in an economy and between economies and identify the most resource-intensive value chains. This perspective is equivalent to the so-called Raw Material Input (RMI) approach known from material flow analysis, i.e. all resources that are directly and indirectly used by a sector, expressed in Raw Material Equivalents (RMEs).

The dataset has data for two years (1997 and 2007) and consists of:

- Raw Material Input (the natural material resources extracted domestically as well as those embodied in imports and final use products.)
- Material intensity
- Country/world region/continent of origin
- Material categories
 - Agriculture (9 categories)
 - Forestry
 - Fishing
 - Coal
 - Oil
 - Gas
 - Metals and industrial minerals
 - Construction minerals
- Sectors (see Table 1-1)

Table 1-1: Overview of sectors used in the MRIO model

Main sector used in this analysis	Sector name	Description of products
Agriculture and fishery	Agriculture	Paddy Rice: rice, husked and unhusked
		Wheat: wheat and meslin
		Other Grains: maize (corn), barley, rye, oats, other cereals
		Veg & Fruit: vegetables, fruitvegetables, fruit and nuts, potatoes, cassava, truffles,
		Oil Seeds: oil seeds and oleaginous fruit; soy beans, copra
		Cane & Beet: sugar cane and sugar beet
		Plant Fibres: cotton, flax, hemp, sisal and other raw vegetable materials used in textiles
		Other Crops: live plants; cut flowers and flower buds; flower seeds and fruit seeds; vegetable seeds, beverage and spice crops, unmanufactured tobacco, cereal straw and husks, unprepared, whether or not chopped, ground, pressed or in the form of pellets; swedes, mangolds, fodder roots, hay, lucerne (alfalfa), clover, sainfoin, forage kale, lupines, vetches and similar forage products, whether or not in the form of pellets, plants and parts of plants used primarily in perfumery, in pharmacy, or for insecticidal, fungicidal or similar purposes, sugar beet seed and seeds of forage plants, other raw vegetable materials

Main sector used in this analysis	Sector name	Description of products
		Cattle: cattle, sheep, goats, horses, asses, mules, and hinnies;
		Other Animal Products: swine, poultry and other live animals; eggs, in shell (fresh or cooked), natural honey, snails (fresh or preserved) except sea snails; frogs' legs, edible products of animal origin n.e.c., hides, skins and furskins, raw , insect waxes and spermaceti, whether or not refined or coloured
		Raw milk
		Wool: wool, silk, and other raw animal materials used in textile
	Fishery	Fishing: hunting, trapping and game propagation including related service activities, fishing, fish farms; service activities incidental to fishing
Forestry	Forestry	Forestry: forestry, logging and related service activities
Mining of fossil fuels	Coal	Coal: mining and agglomeration of hard coal, lignite and peat
	Oil	Oil: extraction of crude petroleum and natural gas (part), service activities incidental to oil and gas extraction excluding surveying (part)
	Gas	Gas: extraction of crude petroleum and natural gas (part), service activities incidental to oil and gas extraction excluding surveying (part)
Mining of minerals (incl. metal ores)	Minerals nec	Other Mining: mining of metal ores, uranium, gems. other mining and quarrying
Manufacture of food products and beverages	Manufacture of food products	Cattle Meat: fresh or chilled meat and edible offal of cattle, sheep, goats, horses, asses, mules, and hinnies. raw fats or grease from any animal or bird.
		Other Meat: pig meat and offal. preserves and preparations of meat, meat offal or blood, flours, meals and pellets of meat or inedible meat offal; greaves
		Vegetable Oils: crude and refined oils of soya-bean, maize (corn),olive, sesame, ground-nut, olive, sunflower-seed, safflower, cotton-seed, rape, colza and canola, mustard, coconut palm, palm kernel, castor, tung jojoba, babassu and linseed, perhaps partly or wholly hydrogenated,inter-esterified, re-esterified or elaidinised. Also margarine and similar preparations, animal or vegetable waxes, fats and oils and their fractions, cotton linters, oil-cake and other solid residues resulting from the extraction of vegetable fats or oils; flours and meals of oil seeds or oleaginous fruits, except those of mustard; degreas and other residues resulting from the treatment of fatty substances or animal or vegetable waxes.
		Milk: dairy products
		Processed Rice: rice, semi- or wholly milled
		Sugar
		Other Food: prepared and preserved fish or vegetables, fruit juices and vegetable juices, prepared and preserved fruit and nuts, all cereal flours, groats, meal and pellets of wheat, cereal groats, meal and pellets n.e.c., other cereal grain products (including corn flakes), other vegetable flours and meals, mixes and doughs for the preparation of bakers' wares, starches and starch products; sugars and sugar syrups n.e.c., preparations used in animal feeding, bakery products, cocoa, chocolate and sugar confectionery, macaroni, noodles, couscous and similar farinaceous products, food products n.e.c.
	Beverages and tobacco products	Beverages and Tobacco products
Manufacture of wood products	Wood products	Lumber: wood and products of wood and cork, except furniture; articles of straw and plaiting materials
Manufacture of paper products and publishing	Paper products and publishing	Paper & Paper Products: includes publishing, printing and reproduction of recorded media
Manufacture of petroleum and coke products	Petroleum and coke	Petroleum & Coke: coke oven products, refined petroleum products, processing of nuclear fuel
Manufacture of chemical, rubber, plastic products		Chemical Rubber Products: basic chemicals, other chemical products, rubber and plastics products
Manufacture of mineral products nec		Non-Metallic Minerals: cement, plaster, lime, gravel, concrete
Manufacture of ferrous metals		Iron & Steel: basic production and casting
Manufacture of metals nec		Non-Ferrous Metals: production and casting of copper, aluminium, zinc, lead, gold, and silver
Manufacture of metal products		Fabricated Metal Products: Sheet metal products, but not machinery and equipment
Manufacture of vehicles		Motor vehicles and parts: cars, lorries, trailers and semi-trailers

Main sector used in this analysis	Sector name	Description of products
and other transport equipment		Other Transport Equipment: Manufacture of other transport equipment
Manufacture of electronic equipment		Electronic Equipment: office, accounting and computing machinery, radio, television and communication equipment and apparatus
Manufacture of machinery and equipment nec		Other Machinery & Equipment: electrical machinery and apparatus n.e.c., medical, precision and optical instruments, watches and clocks
Textiles, leather products and other manufacturing	Textiles	Textiles: textiles and man-made fibres
	Wearing apparel	Wearing Apparel: Clothing, dressing and dyeing of fur
	Leather products	Leather: tanning and dressing of leather; luggage, handbags, saddlery, harness and footwear
	Other manufacturing	Other Manufacturing: includes recycling
Energy and water supply		Electricity: production, collection and distribution
		Gas Distribution: distribution of gaseous fuels through mains; steam and hot water supply
		Water: collection, purification and distribution
Construction		Construction: building houses factories offices and roads
Wholesales and retail (incl. restaurants and hotels)		Trade: all retail sales; wholesale trade and commission trade; hotels and restaurants; repairs of motor vehicles and personal and household goods; retail sale of automotive fuel
Transport		Other Transport: road, rail ; pipelines, auxiliary transport activities; travel agencies
		Water transport
		Air transport
Communication and other services		Communications: post and telecommunications
		Other Financial Intermediation: includes auxiliary activities but not insurance and pension funding (see next)
		Insurance: includes pension funding, except compulsory social security
		Recreation & Other Services: recreational, cultural and sporting activities, other service activities; private households with employed persons (servants)
Business services nec	Business services nec	Other Business Services: real estate, renting and business activities
Public sector	Public administration	Other Services (Government): public administration and defense; compulsory social security, education, health and social work, sewage and refuse disposal, sanitation and similar activities, activities of membership organizations n.e.c., extra-territorial organizations and bodies
Private ownership of dwellings ⁷	Dwellings	Dwellings: ownership of dwellings (imputed rents of houses occupied by owners)

► Limitations

Note that the raw material inputs cannot always be summed across sectors as there is a risk of double counting. The material resources in one sector can serve as an input to other sectors, e.g. the manufacture of textiles and leather products produce outputs that are used in the manufacture of wearing apparel. In the presentation of results, we have, however, grouped some of the less material intensive economic sectors together in order to reduce the number of sectors.

⁷ NB! This only covers the economic activity of ownership of dwellings, not total final household consumption.

1.3 Calculation methodology

In the analysis, a multi-regional input-output (MRIO) model is applied to calculate the direct and indirect (embodied) material resources used by an industry. MRIO analysis is a methodology to assess the upstream resource use along supply chains of single sectors. It combines economic data (i.e. data on the sectoral structure of economies linked via international trade data) with physical information (e.g. material resource extraction).

For constructing MRIO-based environmental accounting models, global harmonised sets of input-output (IO) tables and bilateral trade data are required. Those data were taken from the Global Trade Analysis Project (GTAP v5 and v8, see Narayanan et al. 2012), a data set covering 57 economic sectors for the years 1997 and 2007, and up to 129 countries and world regions, including all European Union (EU-27) Member States, the Organisation for Economic Co-operation and Development (OECD) countries, the major emerging economies, and a significant number of developing countries in Asia, Africa and Latin America. In GTAP, all countries not represented by a country model are grouped in regions (e.g. Rest of East Asia, Rest of South-East Asia). In line with data availability, the calculations in this study cover the two years 1997 and 2007, distinguishing 66 countries and regions for 1997, and 129 for 2007.

This monetary model is then extended by material extraction data from the Global Material Flow Database⁸ and differentiates 16 material categories according to the primary industries in the model: (1) paddy rice; (2) wheat; (3) other cereal grains; (4) vegetables, fruit, nuts; (5) oil seeds; (6) sugar cane, sugar beet; (7) plant-based fibres; (8) other crops; (9) grazing; (10) wood; (11) fish; (12) coal; (13) crude oil; (14) natural gas; (15) metals and industrial minerals; and (16) construction minerals. All material extraction data are allocated to the corresponding primary industry, with the exception of construction minerals which are directly assigned to the construction sector.

► Limitations

Although the latest data is from 2007, please note that the underlying economic structure (the input-output tables) is actually for the year 2000. This has to be kept in mind when reading the results.

⁸ SERI (2011) Global Material Flow Database. 2011 Version. Sustainable Europe Research Institute, Vienna.

Available at www.materialflows.net.

Chapter 2: Sectoral resource use in the EU-27

2.1 What is the material resource use of the economic sectors in the EU?

Raw Material Input includes natural material resources extracted domestically as well as those embodied in imports and final use products. Figure 2-1 shows the annual Raw Material Input of the main sectors in the EU-27 for the year 2007. Due to the large proportion of minerals, sand and gravel of the overall material flows in the economy, the construction sector uses by far the greatest amount of materials in the economy, about 5.4 billion tonnes annually. The majority of this is minerals – sand and gravel in particular. The agriculture and fishery sector is the second most material resource intensive sector, with 1.4 billion tonnes annually. Over 90% of this sector's resource use is biomass. Just after agriculture and fishery is the manufacture of food products and beverages, which uses 1.35 billion tonnes of material resources annually. Most of this is biomass, but a significant portion (15%) is fossil fuels (energy and plastics). The manufacture of coke and refined petroleum products is the fourth most resource intensive sector in the economy – almost all of this are fossil fuels. Energy supply follows closely behind as the fifth most resource intensive economy sector in the EU.

The construction sector is the most material resource intensive economic sector in the EU. Next are the sectors related to food production (agriculture, fishery, food and drink manufacturing). Then come the sectors that produce and consume the most fossil fuel products (manufacture of coke and refined petroleum products, and energy supply).

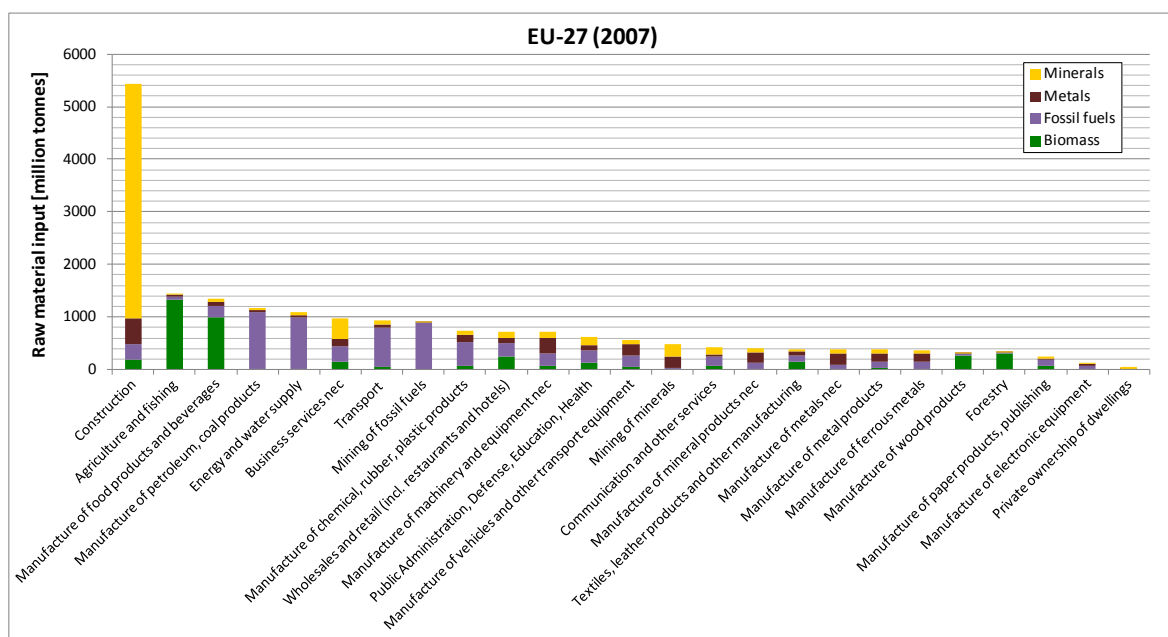


Figure 2-1: The annual material resource use of economic sectors in the EU-27 in 2007

The composition of materials consumed varies considerably across the economic sectors (see Figure 2-2). The EU average material composition of the entire economy is about 44% minerals, 24% fossil fuels, 18% biomass and 14% metals⁹. As expected the construction sector uses mostly minerals; the food- and wood-related sectors use mostly biomass; and the fossil energy related industries (mining of fossil fuels, coke and petroleum products, chemical and plastic products, energy supply, transport) use fossil fuels. What is interesting is the share of fossil fuel that is used in various manufacturing industries such as pulp and paper, manufacture of vehicles and electronic equipment, as well as the amount of fossil fuel used in the service sectors.

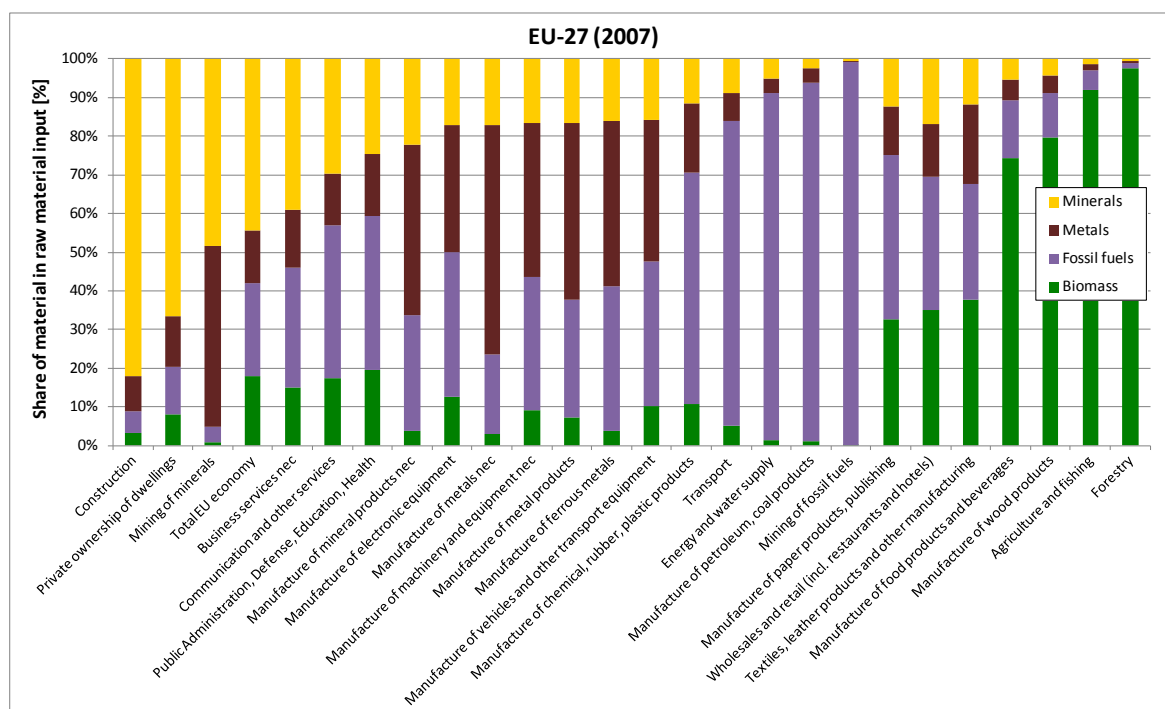


Figure 2-2: The main components of material resource use in relation to their share of total Raw Material Input for each economic sector in the year 2007

2.1.1 Resource use by material category

The following sections investigate the material resource use of the economic sectors by main material category.

2.1.1.1 Biomass

When only considering the use of biomass resources in the economy - unsurprisingly - the agriculture, fishery, food products, forestry and wood manufacturing sectors use the most biomass. Further down the value chain, the wholesale and retail sector (including hotels and restaurants) also use large amounts of biomass. It is not possible to determine how much of the

⁹ Based on direct input (domestically extracted and imports) of EU-27 measured in Raw Material Equivalents which includes the upstream (or indirect) material flows of internationally traded products.

biomass resources are food, paper or packaging. The construction sector uses significant amounts of biomass, which presumably is mostly wood. Business services seem to use a lot of biomass too, but it is unclear whether all of this is paper. The use of biomass in the manufacture of textiles, leather products and wearing apparel is expected to be animal skins, cotton and other fibres. Although not primary users of biomass, the manufacture of machinery, equipment, transport vehicles and other metal and electronic products uses relatively large amounts of biomass. It is not known whether this is food, paper, packaging (cardboard or wood) or biofuel.

Sectors based on agricultural and forestry products use the most biomass, but other sectors also use not insignificant amounts of biomass resources.

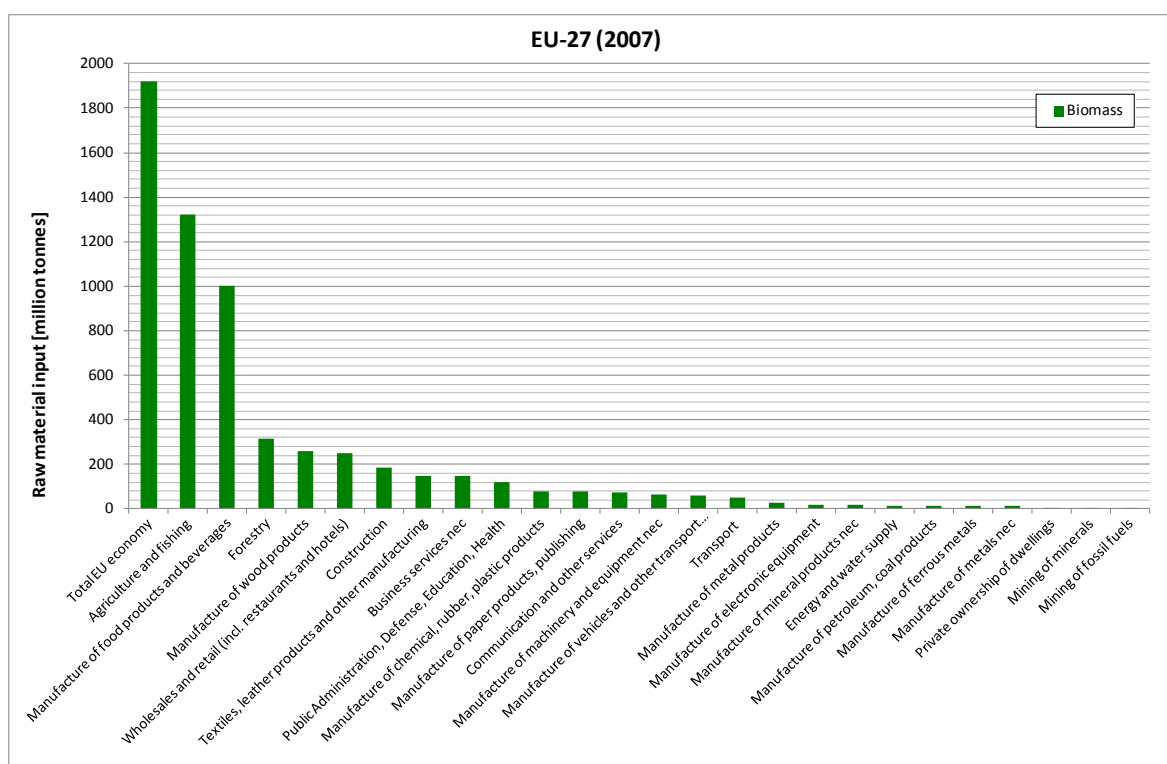


Figure 2-3: The annual biomass resource use of economic sectors in the EU-27 in 2007 ¹⁰

¹⁰ NB! The data for the 'Total EU economy' is based on Eurostat's economy-wide estimates and not from the MRIO analysis. As the sectors use material resources from other sectors, it is not possible to sum up the raw material inputs of all sectors.

2.1.1.2 Fossil fuels

The majority of fossil fuels used in the EU economy are imported. Only about a third of fossil fuels are extracted within the EU (mining of fossil fuels). Large quantities of fossil fuel are processed (coke and petroleum products) and consumed (energy supply and transport) in the EU. Significant amounts of fossil fuels are used in chemical, rubber and plastic manufacturing, but it is uncertain what share of this is for energy or petrochemical products¹¹. As fossil fuel is generally mostly used for energy use, Figure 2-4 shows a similar pattern when comparing with statistics of the various sectors' (fossil fuel) energy consumption.

The majority of fossil fuels used in the EU economy are imported. The fossil fuel resource use of EU sectors follows the general energy intensity of economic sectors.

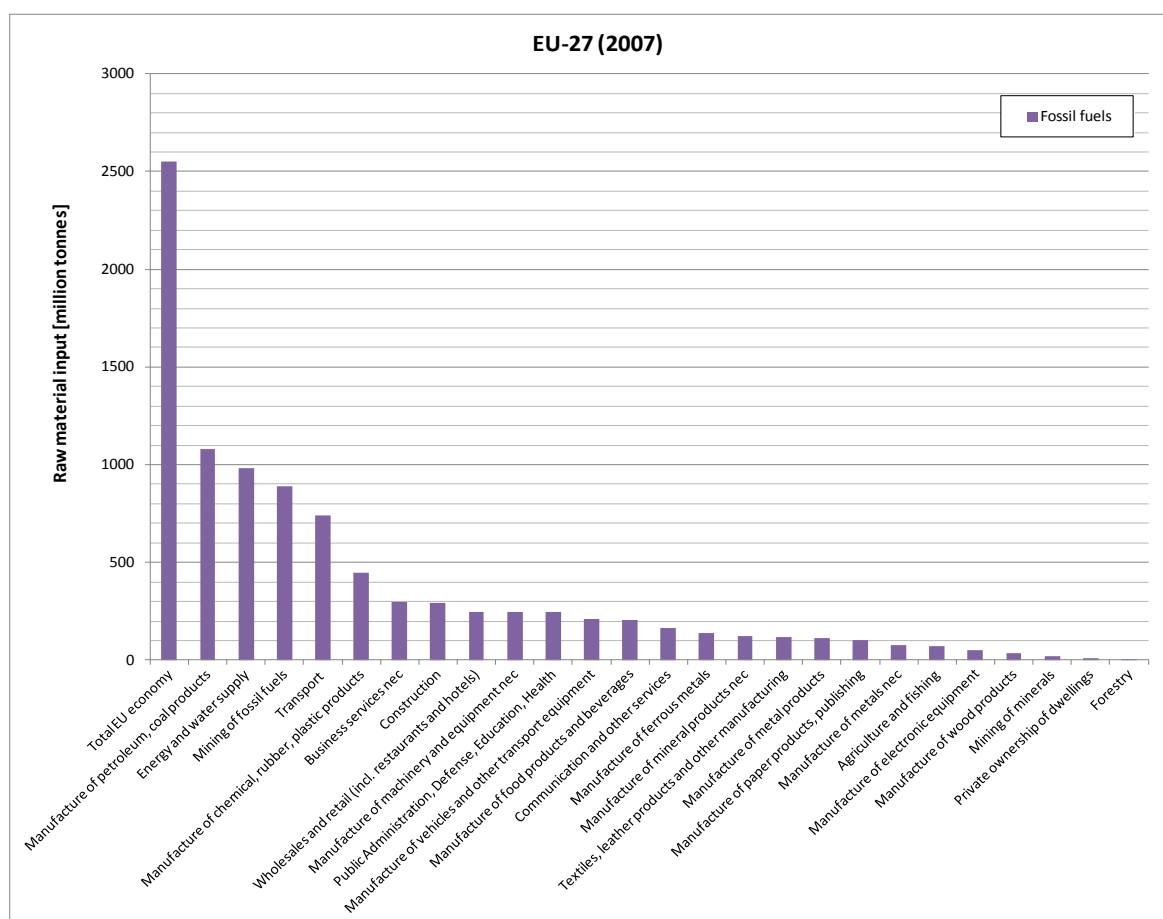


Figure 2-4: The annual use of fossil fuels of economic sectors in the EU-27 in 2007 ¹²

¹¹ Ecofys estimated that 9% of oil, natural gas and coal resources in the economy are used for materials such as plastics and chemicals: Ecofys (2010) The Ecofys Energy Scenario. Collaborative venture with WWF.

¹² NB! The data for the 'Total EU economy' is based on Eurostat's economy-wide estimates and not from the MRIO analysis. As the sectors use material resources from other sectors, it is not possible to sum up the raw material inputs of all sectors.

2.1.1.3 Metals

The majority of metals used in the EU economy are imported. Less than 10% of metal ores are extracted within the EU (mining of metal ores). Large quantities of metals are processed (machinery and equipment) in the EU and then exported. Significant amounts of metals are used in construction, machinery and equipment and motor vehicles and other transport equipment and parts. Figure 2-5 shows the pattern of use of metals in the various sectors’.

The majority of metals used in the EU economy are imported.

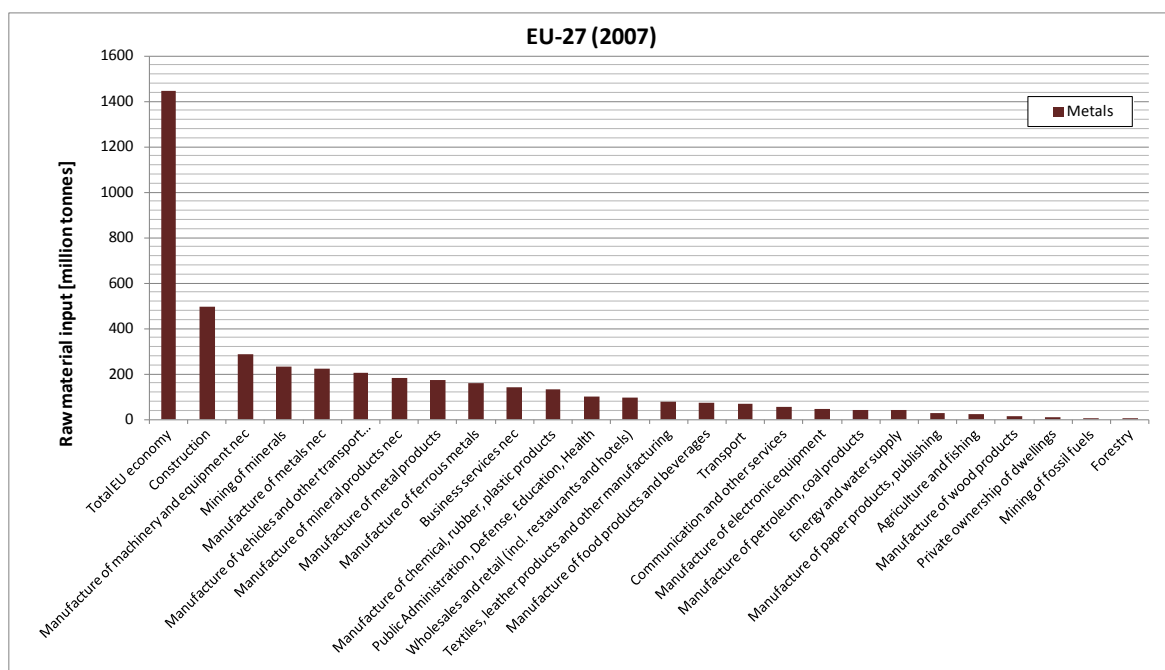


Figure 2-5: The annual resource use of metals (ores) of economic sectors in the EU-27 in 2007

13

¹³ NB! The data for the 'Total EU economy' is based on Eurostat's economy-wide estimates and not from the MRIO analysis. As the sectors use material resources from other sectors, it is not possible to sum up the raw material inputs of all sectors.

2.1.1.4 Minerals

Both construction and industrial minerals are included under this resource category. Minerals are mostly domestically extracted by the construction sector itself. As minerals are mostly used for construction, Figure 2-6 shows the construction sector as the greatest consumer of minerals.

The construction sector uses most of the minerals. The use of mineral resources by other sectors in the EU is small compared to construction minerals.

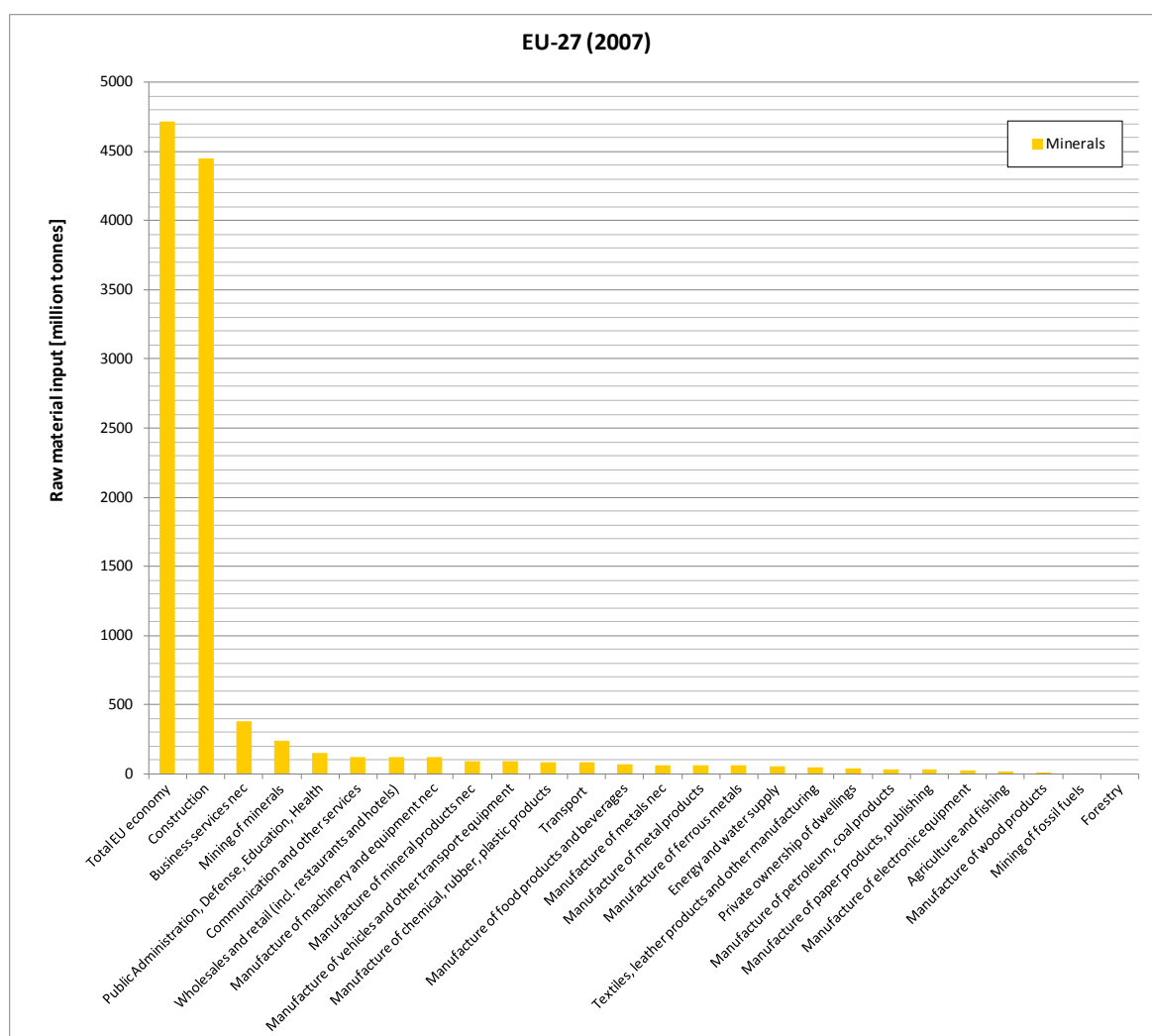


Figure 2-6: The annual resource use of minerals of economic sectors in the EU-27 in 2007 ¹⁴

¹⁴ NB! The data for the 'Total EU economy' is based on Eurostat's economy-wide estimates and not from the MRIO analysis. As the sectors use material resources from other sectors, it is not possible to sum up the raw material inputs of all sectors.

2.2 How has the resource use of the most material intensive sectors developed?

The following sections provide a more detailed view of the resource use of the most material resource intensive sectors in the EU. The graphs show the change in total amounts of materials between 1997 and 2007, as well as the change in type of materials used.

It must be emphasized that the underlying economic data are represented in prices from 1997 and 2007 respectively, i.e. in current prices. They are therefore not corrected for inflation (input-output tables in constant prices, i.e. prices of a certain base year, are unfortunately not yet available on the global level). Direct comparisons of the two years thus need to be interpreted with caution, as price changes over the 10-year period can have a substantial impact on the overall results.

2.2.1 Construction

Figure 2-7 shows that the quantities of all types of resources used in the construction sector increased over the period 1997-2007. The contribution (% share) of minerals to overall resource use in the construction sector decreased in 2007 compared to 1997, while the share of metals and biomass increased over the same period.

The quantities of all four types of resources used in the construction sector in the EU were higher in 2007 than in 1997.

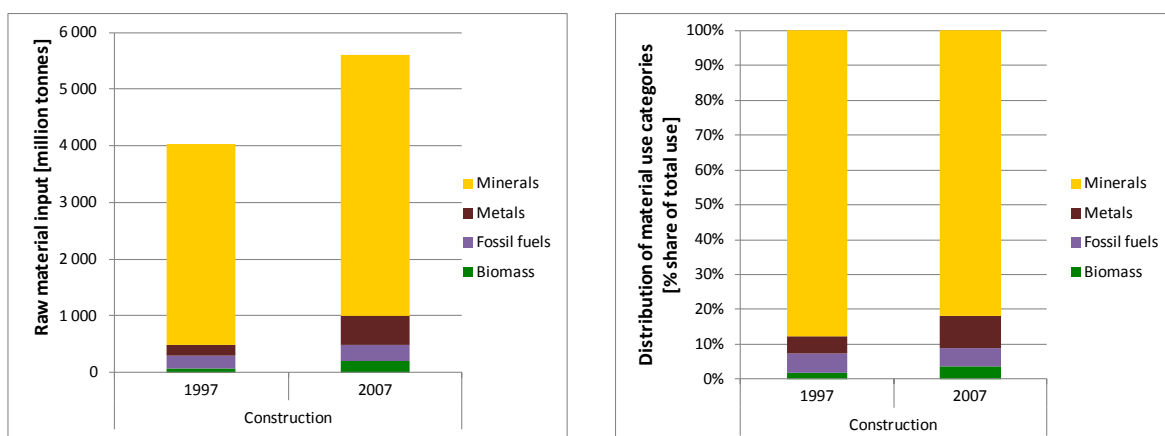


Figure 2-7: The change in resource use (absolute quantity and type of material resources) in the EU-27 construction sector over ten years

2.2.2 Agriculture and fishing

Figure 2-8 shows that the quantities of all types of resources used in the agriculture and fishing sector decreased over the period 1997-2007. The contribution (% share) of biomass to overall resource use in this sector was higher in 2007 than in 1997, while the share of metals, minerals and fossil fuels decreased over the same period.

The quantities of all four types of resources used in the agriculture and fishing sector in the EU were lower in 2007 than in 1997.

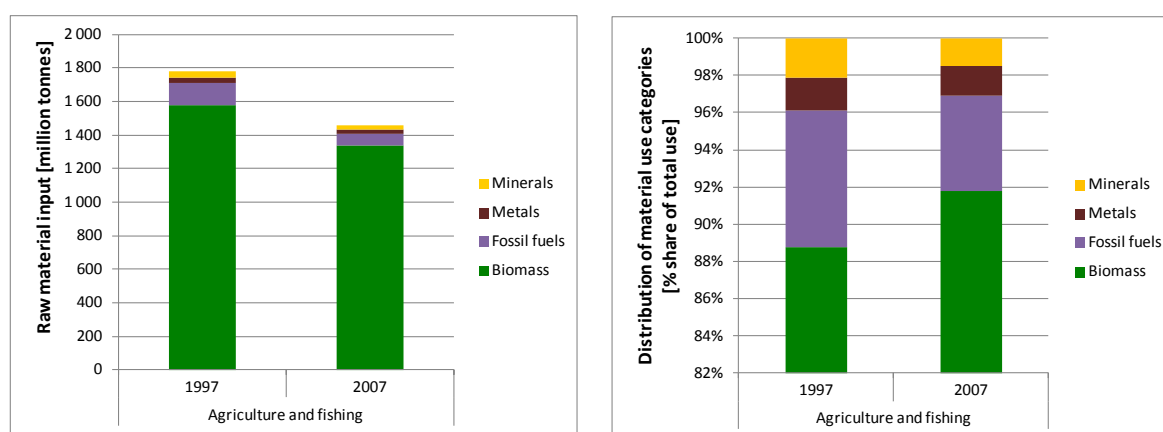


Figure 2-8: The change in resource use (absolute quantity and type of material resources) in agriculture and fishery in the EU-27 over ten years

2.2.3 Manufacture of food products and beverages

Figure 2-9 shows that while the quantities of biomass and fossil fuels used in the food products and beverages manufacturing sector decreased over the period 1997-2007, the quantities of minerals and metals used in this sector increased slightly over the same period. The overall resource consumption of this sector was lower in 2007 than in 1997. The contribution (% share) of metals and minerals to the overall consumption of resources in this sector increased slightly in 2007 as compared to 1997.

The quantities of biomass and fossil fuels used in the manufacture of food products and beverages decreased over the period 1997-2007, whereas use of minerals and metals increased slightly over the same period.

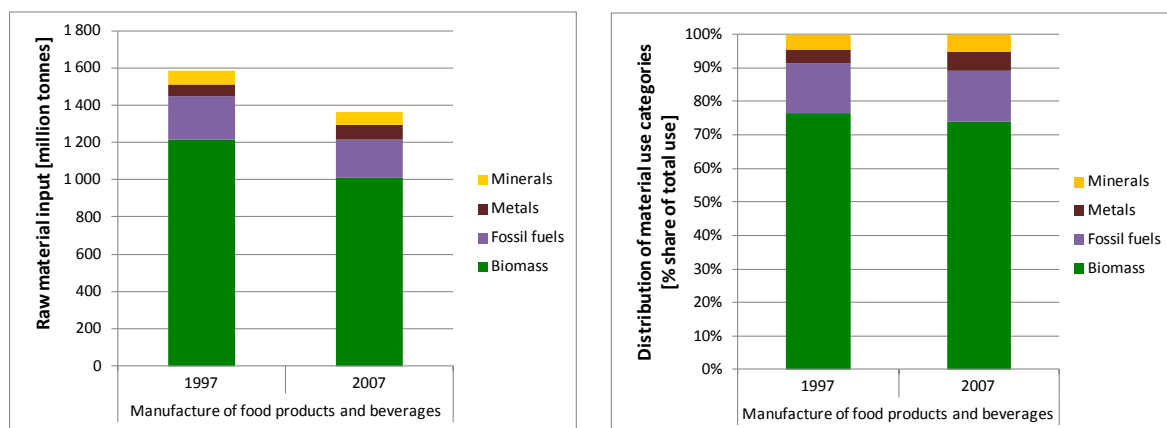


Figure 2-9: The change in resource use (absolute quantity and type of material resources) in the EU-27 food and drink manufacturing sector over ten years

2.2.4 Manufacture of coke and refined petroleum products

Figure 2-10 shows that the quantities of all types of resources used in the coke and refined petroleum products manufacturing sector increased over the period 1997-2007. The contribution (% share) of fossil fuels to the overall resources used in this sector slightly decreased in 2007 compared to 1997, while the share of minerals, metals and biomass increased over the same period.

The quantities of all four types of resources used in the manufacture of coke and refined petroleum products in the EU were higher in 2007 than in 1997.

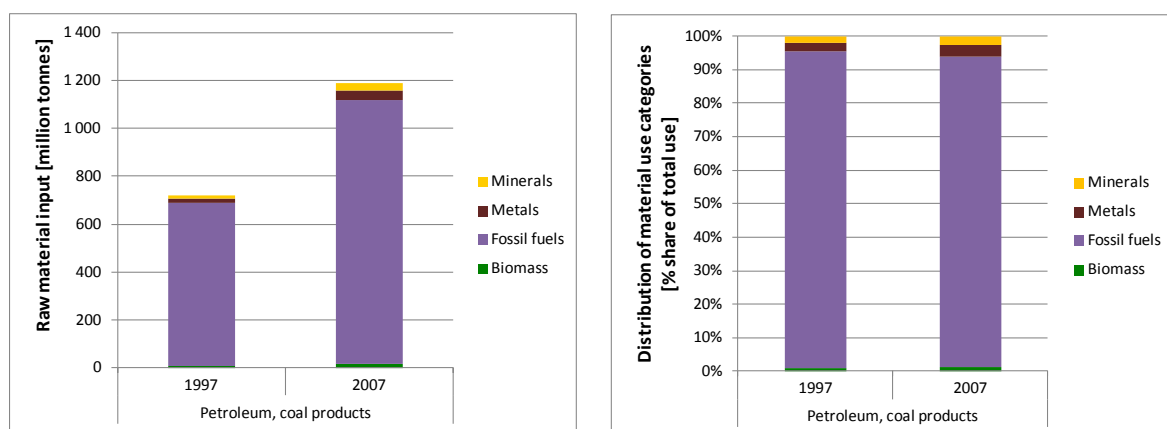


Figure 2-10: The change in resource use (absolute quantity and type of material resources) in the EU-27 manufacture of coke and refined petroleum products over ten years

2.2.5 Energy and water supply

Figure 2-11 shows that while the quantities of biomass, metals and minerals used in the energy and water supply sector increased over the period 1997-2007, the quantity of fossil fuel use in this sector decreased over the same period. The overall resource consumption of this sector was lower in 2007 than in 1997. The contribution (% share) of metals and minerals to the overall consumption of resources in this sector increased slightly in 2007 compared to 1997.

The quantities of biomass, metals and minerals used in the energy and water supply sector increased over the period 1997-2007, whereas use of fossil fuels decreased over the same period

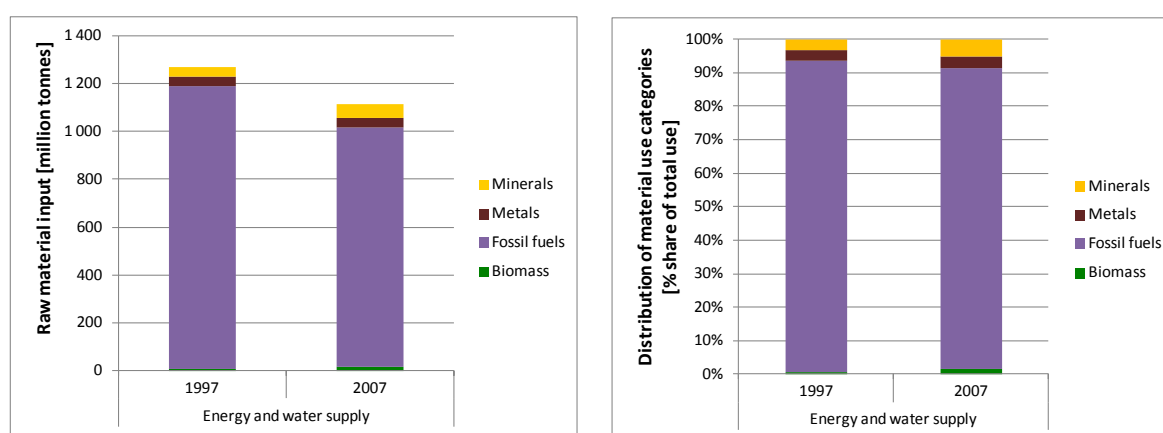


Figure 2-11: The change in resource use (absolute quantity and type of material resources) in the EU-27 energy and supply sector over ten years

2.2.6 Business services

Figure 2-12 shows that the overall resource consumption of this sector more than doubled in 2007 as compared to 1997. There was a large increase in the contribution (% share) of metals to the overall consumption of resources in this sector in 2007 versus 1997.

The quantities of all four types of resources used in business services in the EU were higher in 2007 than in 1997. The overall resource consumption of this sector more than doubled during this period.

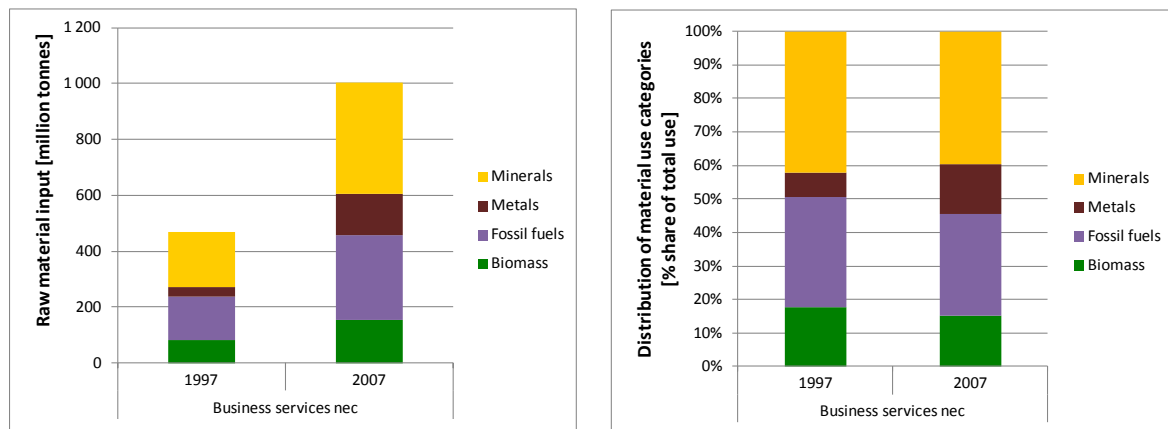


Figure 2-12: The change in resource use (absolute quantity and type of material resources) in the EU-27 business service sector over ten years

2.2.7 Transport

Figure 2-13 shows that the overall resource consumption of this sector more than doubled in 2007 compared to 1997. There was a large increase in the contribution (% share) of fossil fuels to the overall consumption of resources in this sector in 2007 compared to 1997, whereas the share of the other three resource types decreased over the same period.

The quantities of all four types of resources used in business services in the EU were higher in 2007 compared to 1997. The overall resource consumption of this sector more than doubled during this period.

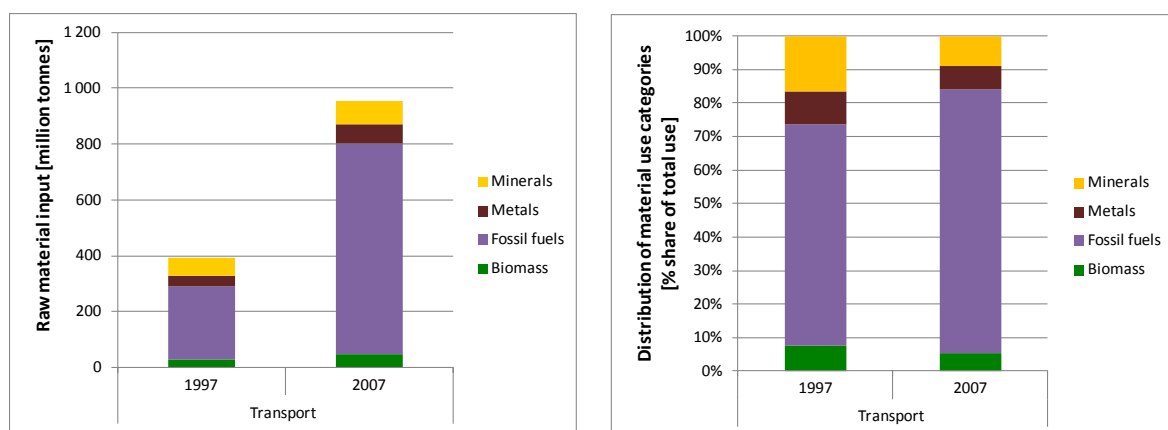


Figure 2-13: The change in resource use (absolute quantity and type of material resources) in the EU-27 transport sector over ten years

2.2.8 Mining of fossil fuels

Figure 2-14 shows that the fossil fuels extracted in the EU in 2007 are lower than in 1997.

Fewer fossil fuels were extracted in the EU in 2007 compared to 1997

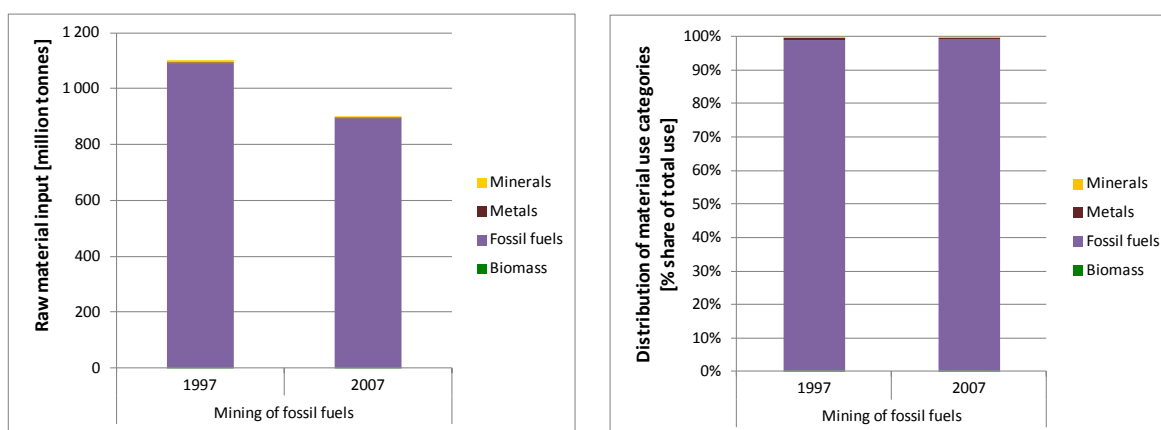


Figure 2-14: The change in resource use (absolute quantity and type of material resources) in mining of fossil fuels in the EU-27 over ten years

2.2.9 Manufacture of chemical, rubber and plastic products

Figure 2-15 shows that there was a slight decrease in total amount of resources used in this sector in 2007 compared to 1997. The total contribution (% share) of different resource types to the overall consumption, however, is similar in 2007 to that of 1997.

The overall quantity of resources used in this sector in the EU was slightly lower in 2007 compared to 1997.

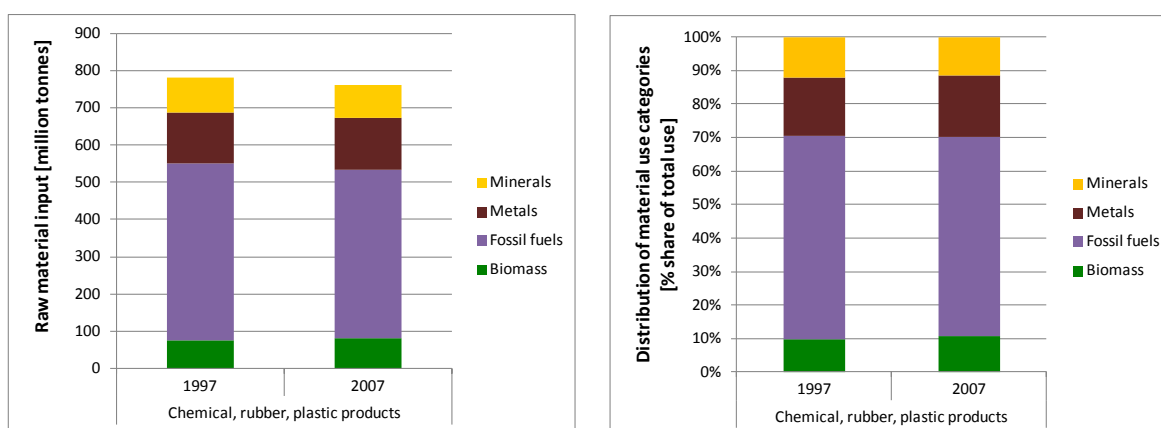


Figure 2-15: The change in resource use (absolute quantity and type of material resources) in the manufacturing of chemical, rubber and plastic products in the EU-27 over ten years

2.2.10 Manufacture of machinery and other equipment (excl. transport)

Figure 2-16 shows that the quantities of all types of resources used in this sector increased over the period 1997-2007. The contribution (% share) of metals and biomass to overall resource use in this sector increased in 2007 compared to 1997, while the share of fossil fuels decreased over the same period.

The overall quantity of resources used in this sector in the EU was higher in 2007 compared to 1997.

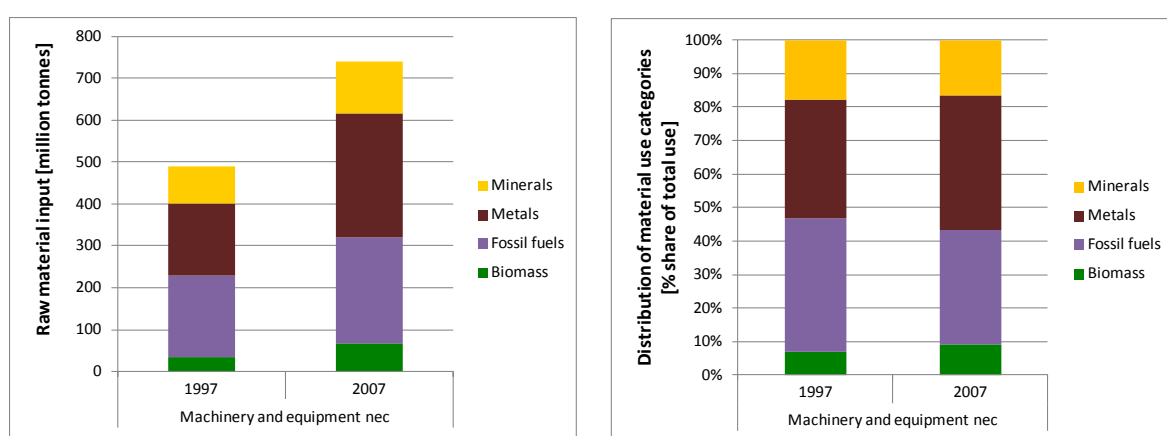


Figure 2-16: The change in resource use (absolute quantity and type of material resources) in the manufacturing of machinery and other equipment (excl. transport) in the EU-27 over ten years

2.2.11 Wholesale and retail (incl. hotels and restaurants)

Figure 2-17 shows that the quantities of all types of resources used in this sector increased over the period 1997-2007. The contribution (% share) of metals and biomass to overall resource use in this sector increased in 2007 compared to 1997, while the share of fossil fuels decreased over the same period.

The overall quantity of resources used in this sector in the EU was higher in 2007 than in 1997.

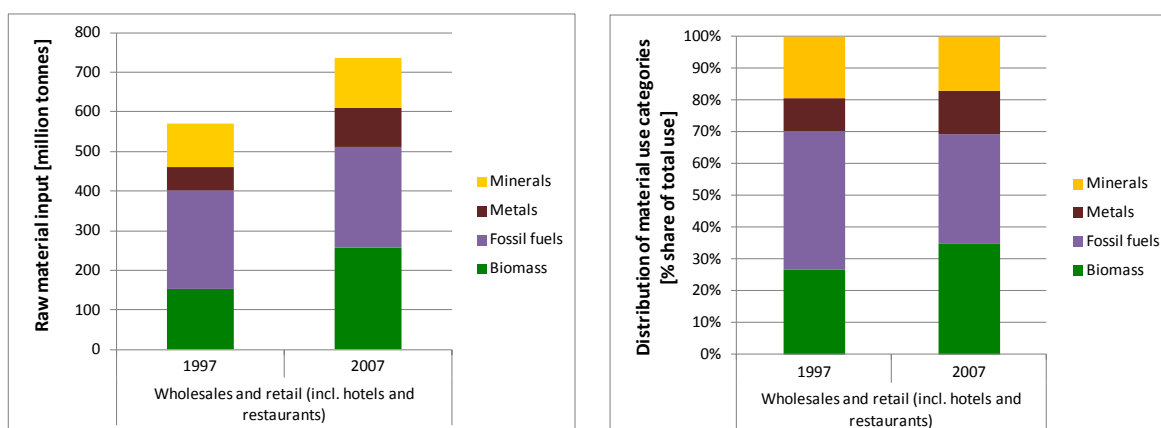


Figure 2-17: The change in resource use (absolute quantity and type of material resources) in the wholesales and retail sector (including hotels and restaurants) in the EU-27 over ten years

2.2.12 Public sector

Figure 2-18 shows that there was a slight increase in total amount of resources used in this sector in 2007 compared to 1997. The contribution (% share) of metals and biomass to overall resource use in this sector increased in 2007 compared to 1997, while the share of minerals decreased over the same period.

The overall quantity of resources used in this sector in the EU was slightly higher in 2007 than in 1997.

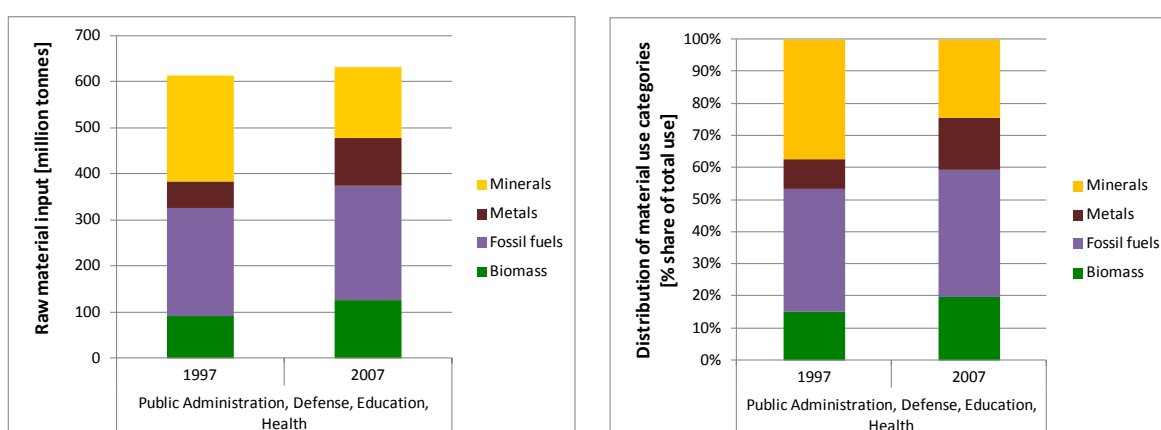


Figure 2-18: The change in resource use (absolute quantity and type of material resources) in the public sector in the EU-27 over ten years

2.2.13 Manufacture of vehicles and other transport equipment

Figure 2-19 shows that the quantities of all types of resource used in this sector increased over the period 1997-2007. The contribution (% share) of metals and biomass to overall resource use in this sector increased in 2007 compared to 1997, while the share of fossil fuels decreased over the same period.

The overall quantity resources used in this sector in EU was higher in 2007 compared to 1997.

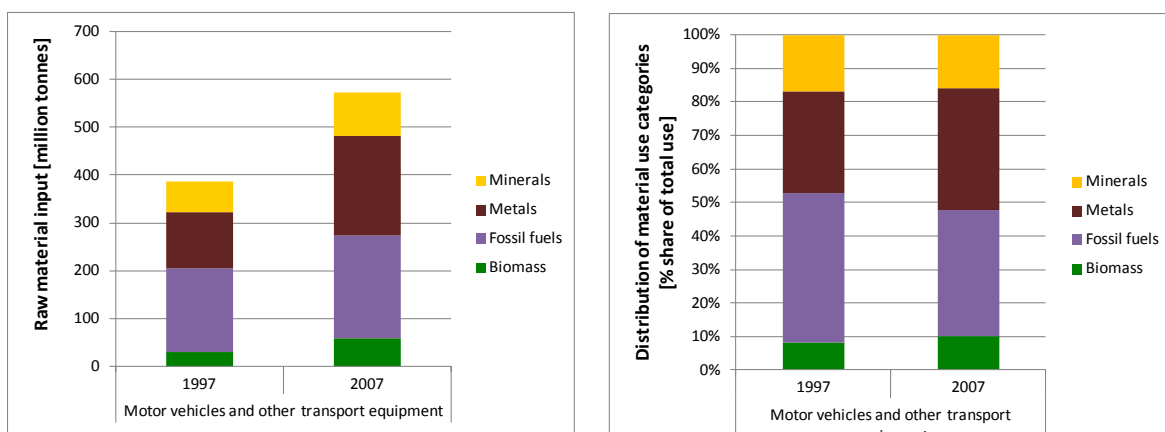


Figure 2-19: The change in resource use (absolute quantity and type of material resources) in manufacturing of vehicles and other transport equipment in the EU-27 over ten years

2.2.14 Mining of minerals

Figure 2-20 shows that the overall quantities of minerals mined in the EU decreased over the period 1997-2007. This was in particular due to a reduction in mining of metals.

Less mining of minerals in the EU in 2007 compared to 1997, mostly due to decrease in mining of metals.

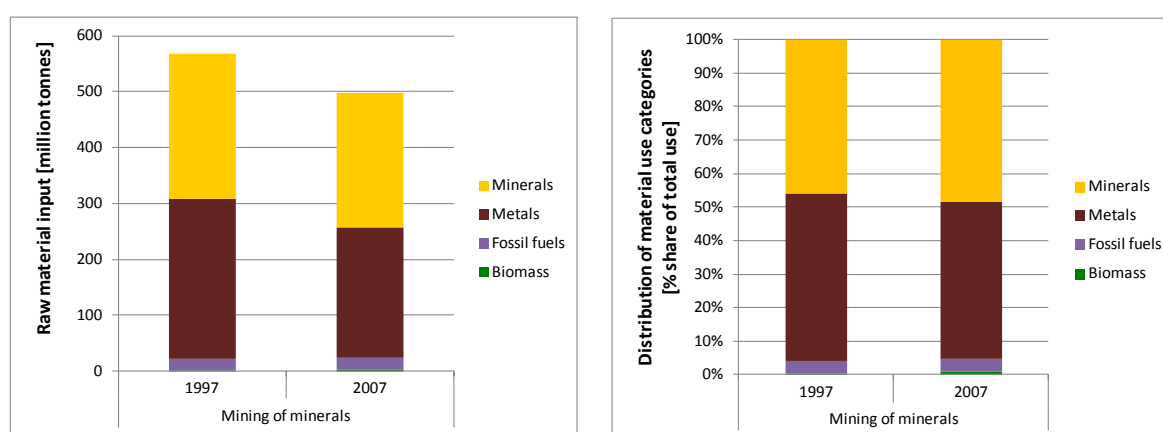


Figure 2-20: The change in resource use (absolute quantity and type of material resources) in the EU-27 mining of minerals (metals ores and non-metallic minerals) sector over ten years

Chapter 3: Material resource productivity

3.1 How productive is the EU's economic sectors' use of material resources?

Figure 3-1 shows that material productivity increased significantly in all economic sectors in the EU-27 except for in transport, where there was a slight decrease in productivity. Resource intensity is the inverse of resource productivity. As one would expect, the service sectors are the least resource intensive, whilst the extractive industries are the most resource intensive. Due to the large amounts of materials, the construction sector is also very material intensive. There is a clear trend that economic sectors further downstream in the value chain are most resource productive (least resource intensive), whilst upstream sectors are the least resource productive (most resource intensive), e.g. compare basic metals, mineral and wood products with vehicles, equipment and machinery.

Besides transport, all economic sectors experienced an increase in material resource productivity between 1997 and 2007.

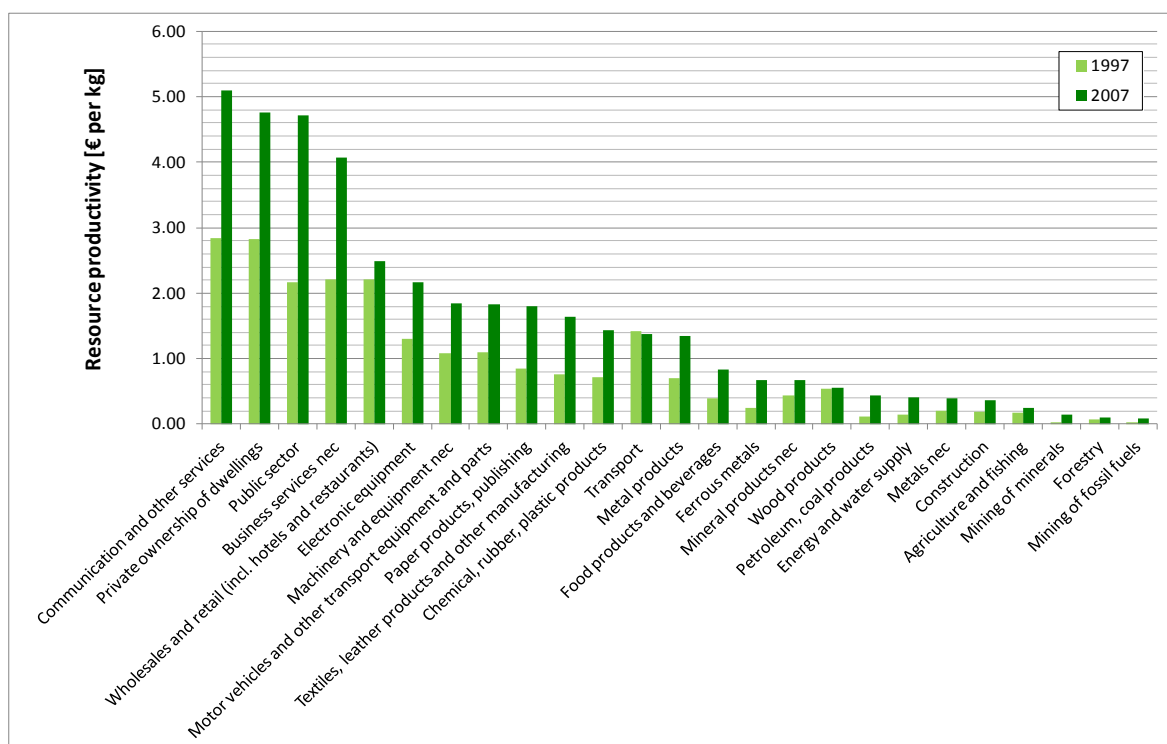


Figure 3-1: Material resource productivity of the economic sectors in the EU-27 for the years 1997 and 2007¹⁵

¹⁵ NB! The datasets for 1997 and 2007 have not been adjusted for inflation

For about half of the economic sectors analysed, total Raw Material Input decreased while the economic value of production increased. This could indicate that these sectors had decoupled their economic growth from resource use. This is the case for all the extractive industries except forestry (agriculture, fishery, mining), but this could also be a result of greater imports of materials over the past decade.

For the other half of EU-27 sectors, economic growth has been accompanied by an increase in material resource use. With the exception of the transport sector, the growth in material use was lower than the economic growth, which could indicate relative decoupling.

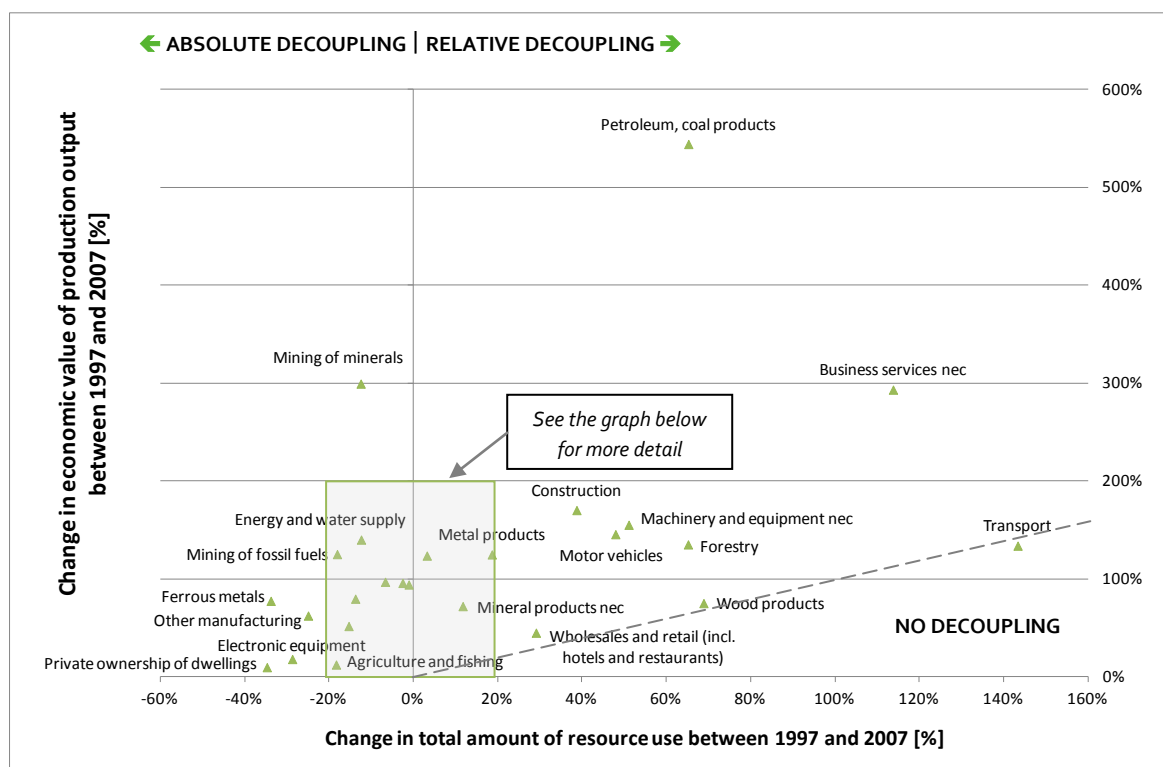


Figure 3-2: The change of material resource use over ten years compared with the change in economic value of each sector over the same period.

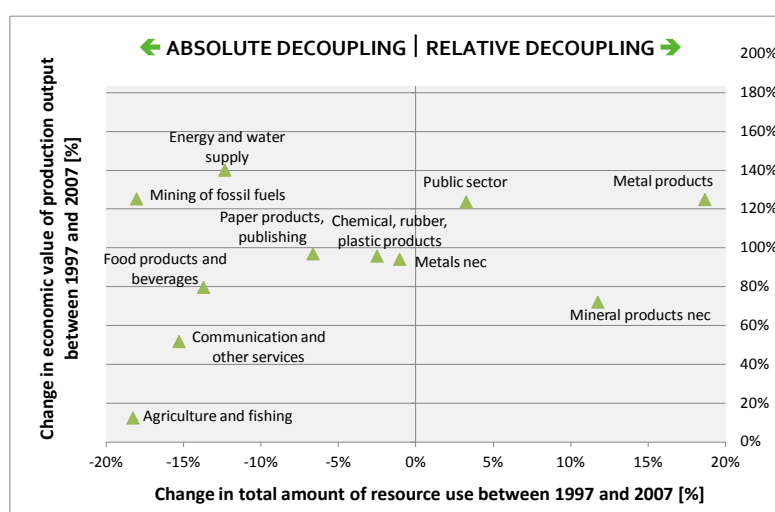


Figure 3-3: Detailed view of Figure 3-2

Chapter 4: Sectoral resource use by Member State

The following sections present the material resource use of the various economic sectors in individual Member States. The presented results are a first estimate based on MRIO analysis, which needs to be verified using other sources.

4.1 Austria

The construction sector uses by far the most raw materials (mostly minerals) in Austria. The agriculture, transport, petroleum and coal products, food manufacturing and forestry sectors also have relatively high material demands.

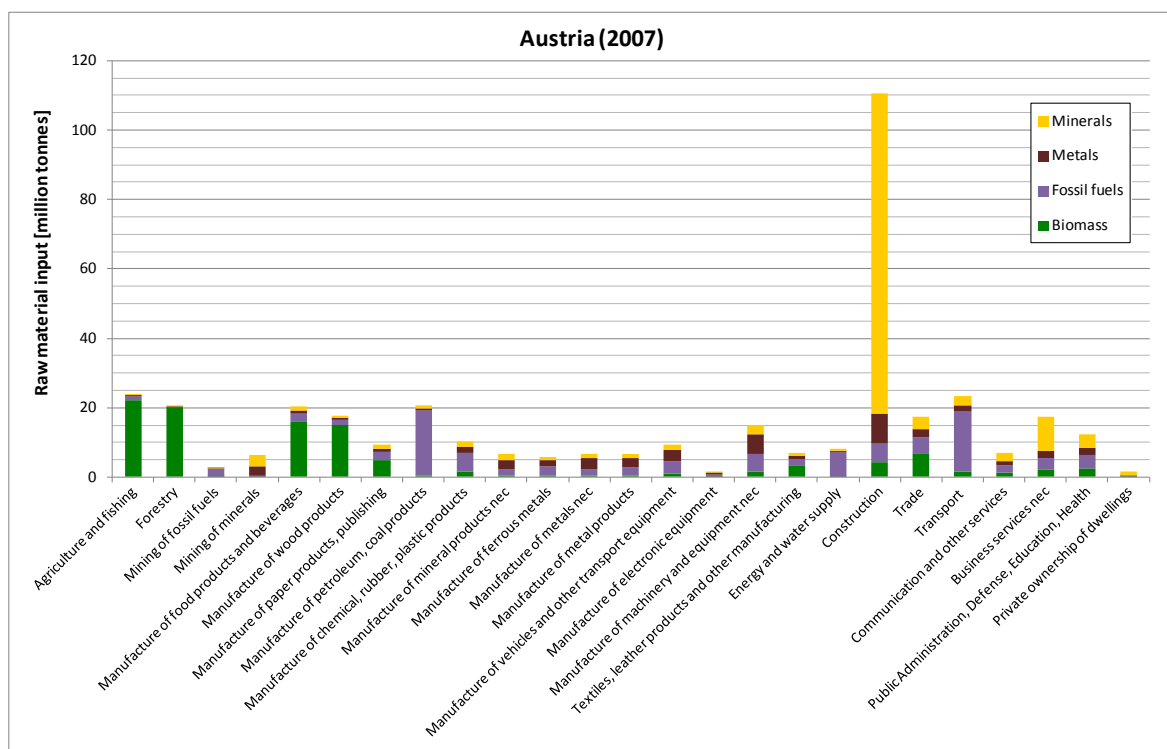


Figure 4-1: Material resource use of economic sectors in Austria in 2007

4.2 Belgium

The construction sector uses by far the most raw materials (mostly minerals, but a relatively high amount of metal ores) in Belgium. The chemical, rubber and plastic product, and, petroleum and coal products industries are the next greatest consuming sectors in Belgium.

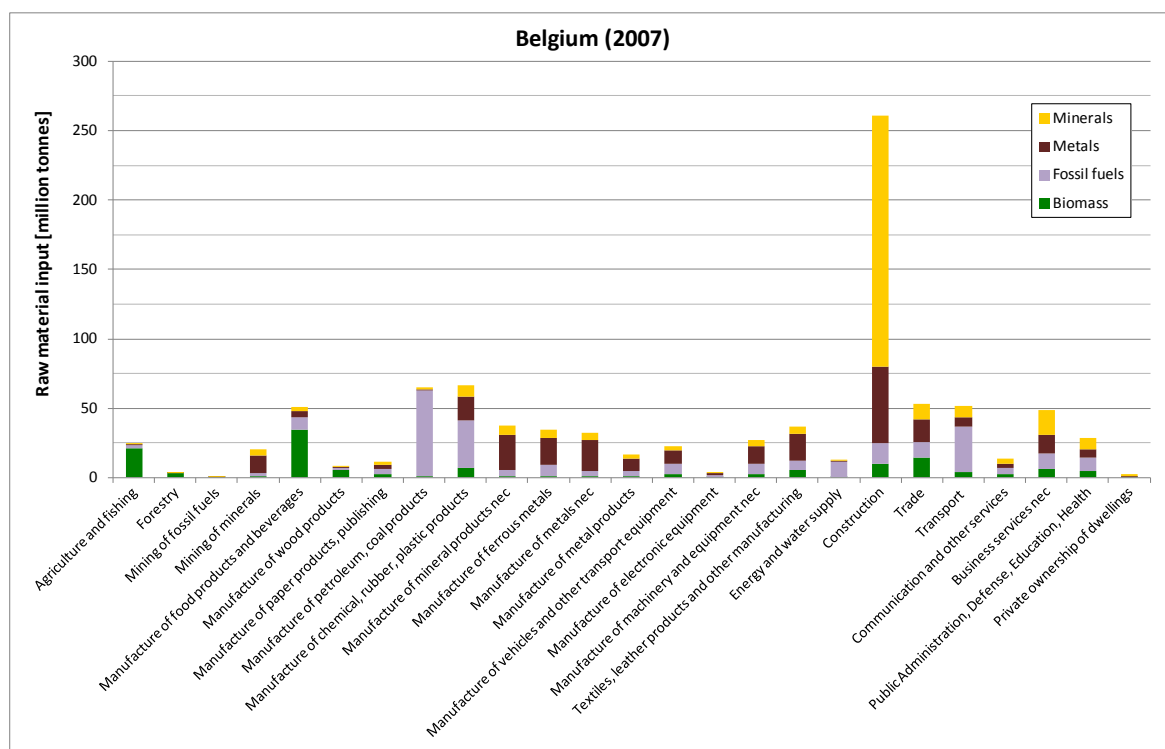


Figure 4-2: Material resource use of economic sectors in Belgium in 2007

4.3 Bulgaria

In Bulgaria, the mining of minerals, metal ores and fossil fuels represent the greatest material use. The construction sector in Bulgaria uses large amounts of materials, but this is not significantly higher than other sectors as is the case in most Member States. However the share of metals used in the construction sector is relatively large. It is evident that the metal related industries also represent significant amounts of resource use. The fossil fuel consumption related to energy and water supply in Bulgaria is relatively high compared to other Member States.

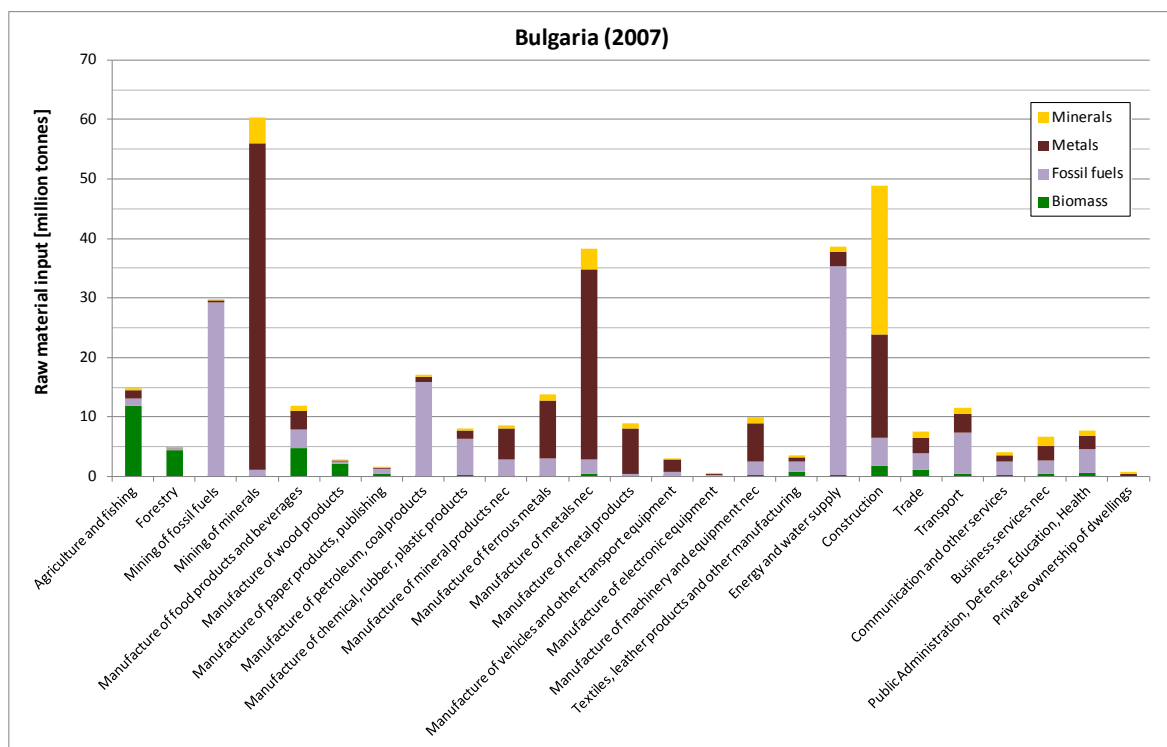


Figure 4-3: Material resource use of economic sectors in Bulgaria in 2007

4.4 Cyprus

The construction sector in Cyprus seems to be by far the most material intensive sector, or it could be that the other economic sectors are not very resource intensive. In the (traditional) Economy-Wide Material Flow Accounts from Eurostat, Cyprus has one of the largest shares of sand and gravel in relation to its total domestic material inputs (DMI). Sand and gravel constitute 60% of (DMI) domestic material input compared to the EU average of about 30%. The transport sector and business services are the next largest material consuming sectors in Cyprus, mainly for fuel (fossil fuels) and buildings (minerals), respectively.

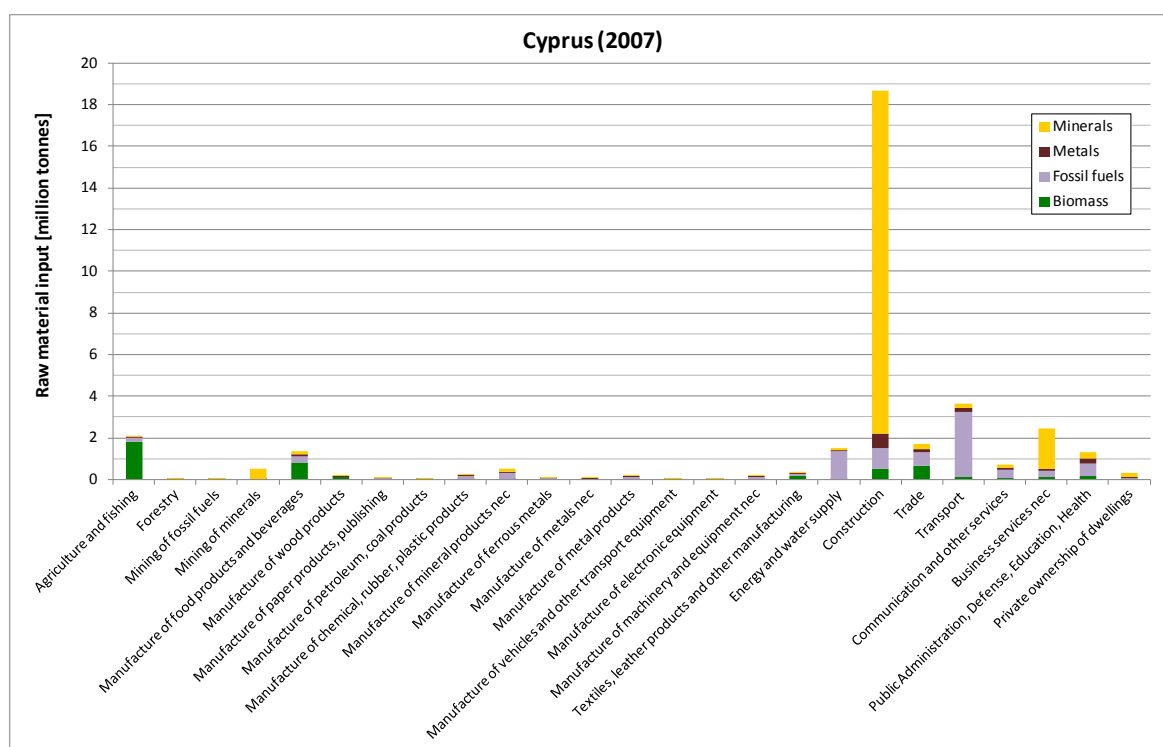


Figure 4-4: Material resource use of economic sectors in Cyprus in 2007

4.5 Czech Republic

As in most other Member States, the construction sector in the Czech Republic is the most material intensive sector in the country. Mining of fossil fuels (mostly coal) is the sector with the second largest material consumption. The energy and water supply sector comes next, with a relatively high consumption of fossil fuels compared to other Member States.

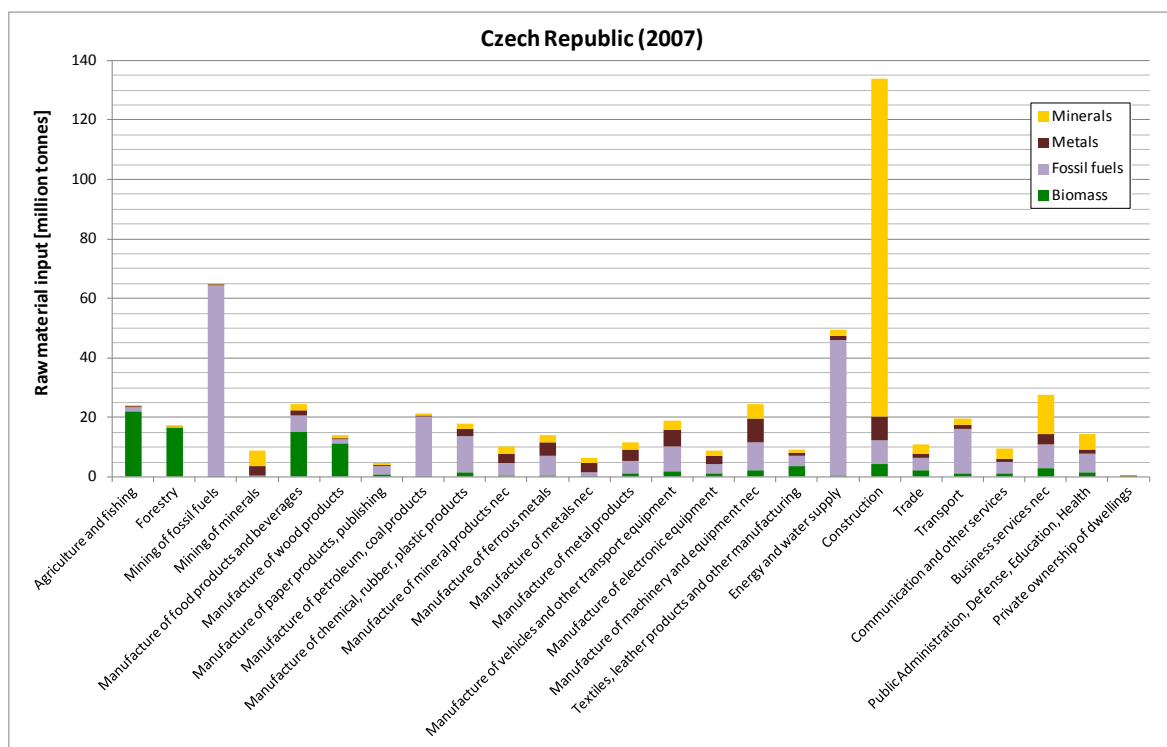


Figure 4-5: Material resource use of economic sectors in the Czech Republic in 2007

4.6 Denmark

The construction sector uses by far the most raw materials (mostly minerals) in Denmark. The next greatest material consuming sectors are the agricultural sector and the food and drink industry (mostly biomass). Denmark also extracts relatively large amounts of oil from the North Sea.

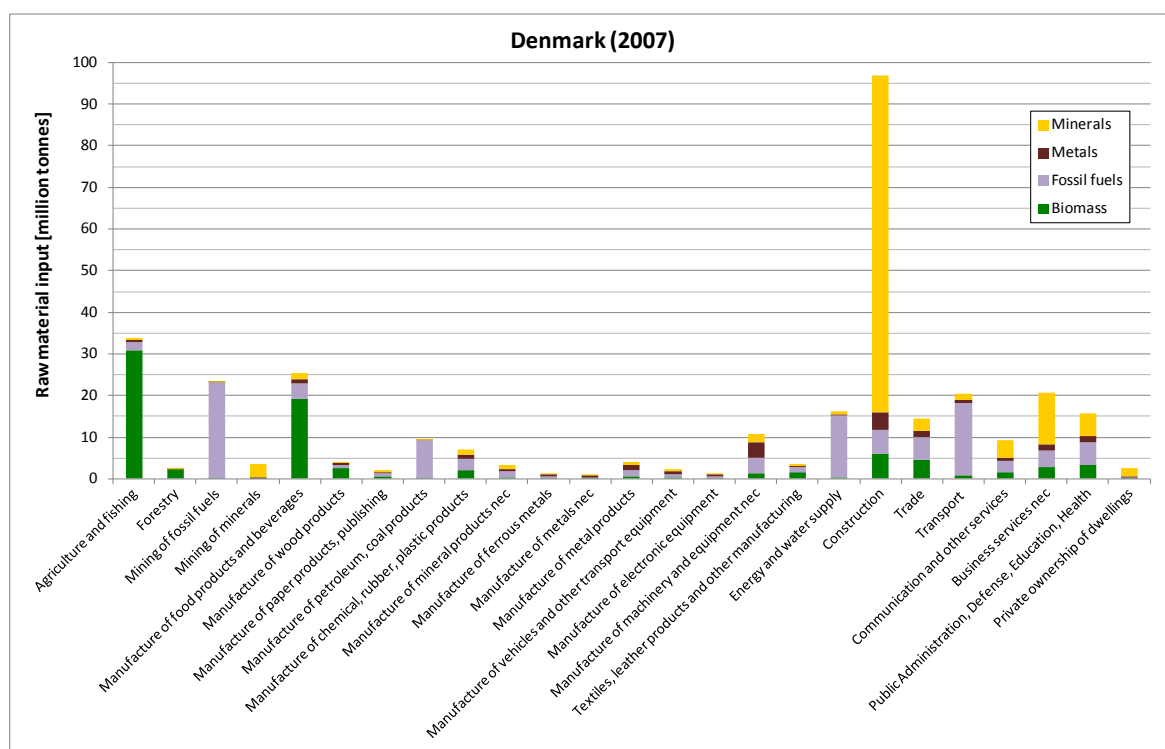


Figure 4-6: Material resource use of economic sectors in Denmark in 2007

4.7 Estonia

While the construction sector in Estonia is the most material intensive, the mining of fossil fuels (mostly oil shale) and energy and water supply (mostly fossil fuels) are the sectors that come close to requiring the largest amounts of resources in Estonia. The transport sector in Estonia seems to also have a relatively high consumption of fossil fuels.

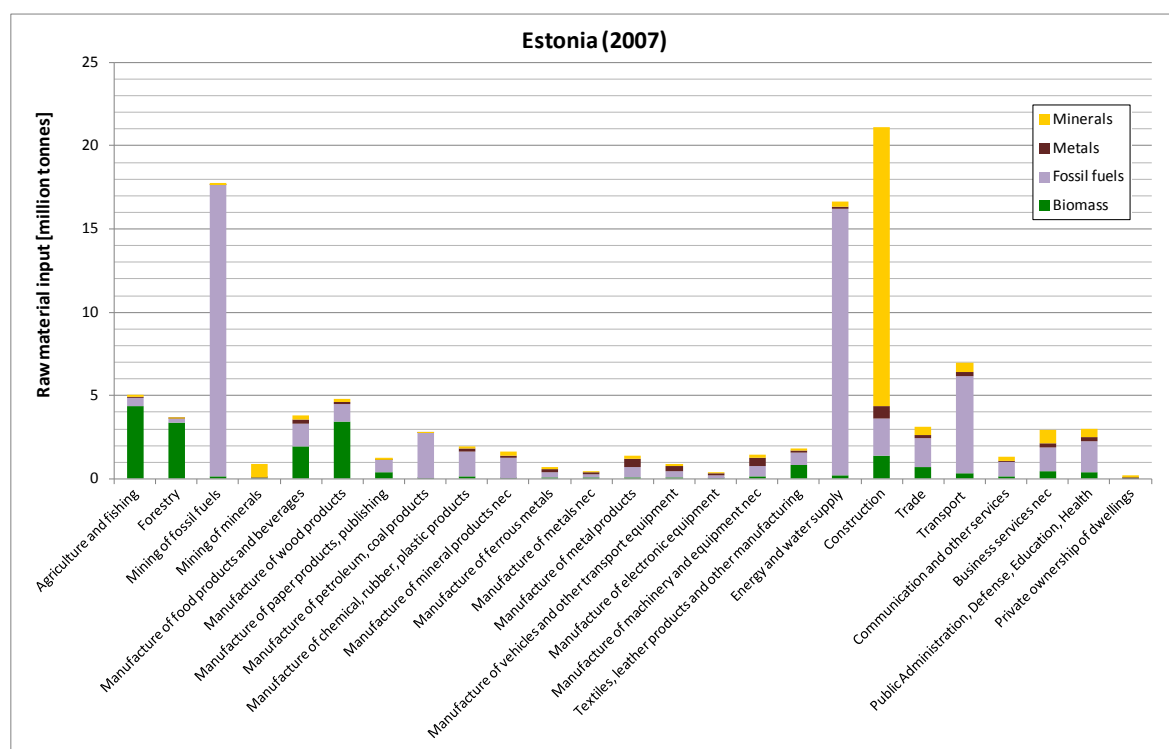


Figure 4-7: Material resource use of economic sectors in Estonia in 2007

4.8 Finland

The construction sector in Finland has by far the highest consumption of materials (mostly minerals). The forestry, wood and paper product sectors are also very material intensive in Finland (mostly wood). Business services seem to also consume relatively large amounts of materials.

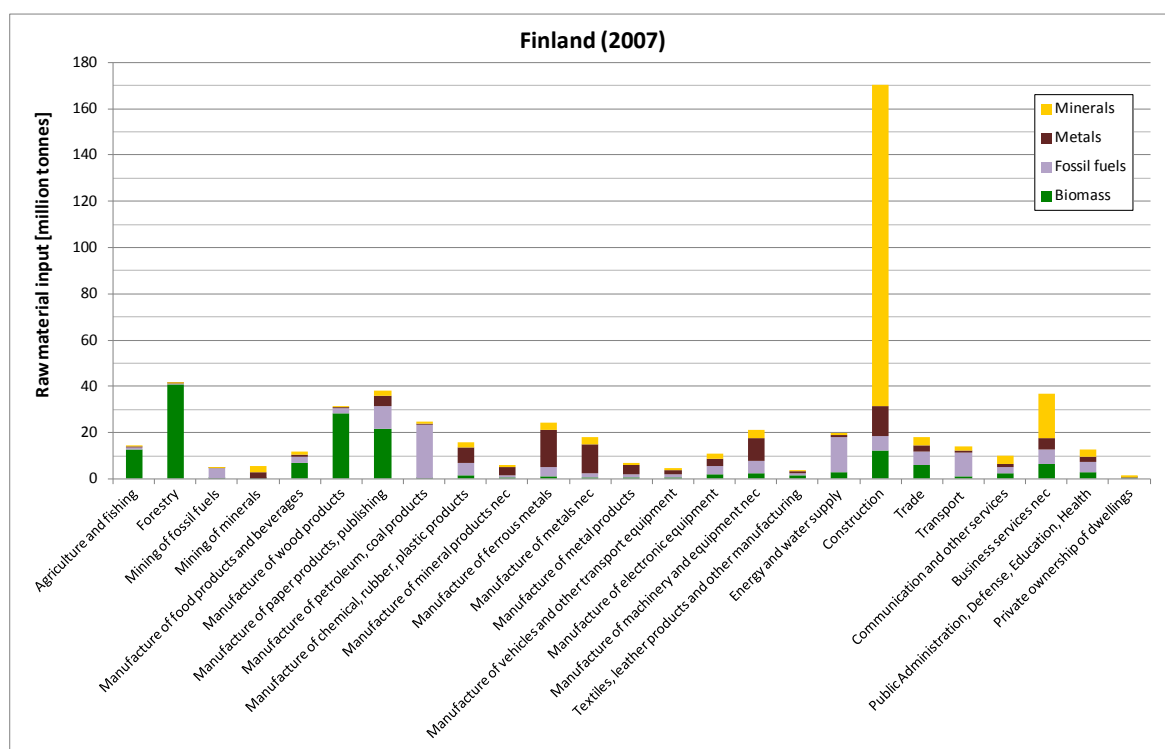


Figure 4-8: Material resource use of economic sectors in Finland in 2007

4.9 France

In France the construction sector uses the most raw materials (mostly minerals). The agricultural sector and the food and drink industry are the next most intensive sectors (mostly biomass). Business services and the manufacturing of petroleum products are also sectors with high material consumption.

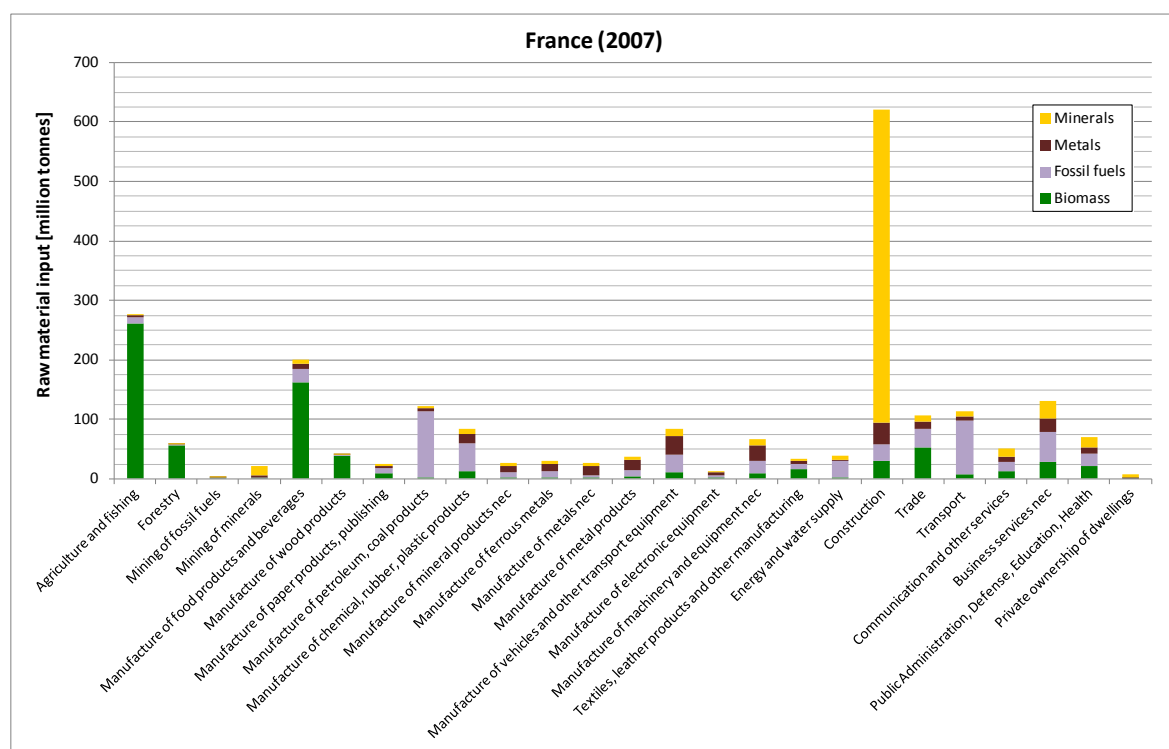


Figure 4-9: Material resource use of economic sectors in France in 2007

4.10 Germany

The construction sector uses the most raw materials (mostly minerals) in Germany. The energy and water supply sector is the second largest resource intensive sector (mostly fossil fuels). Fossil fuel extraction and refineries consume the next greatest amounts of resources. The agriculture and food and drink industries consume the largest amounts of biomass, while the manufacturing industries consume most of the metal ores.

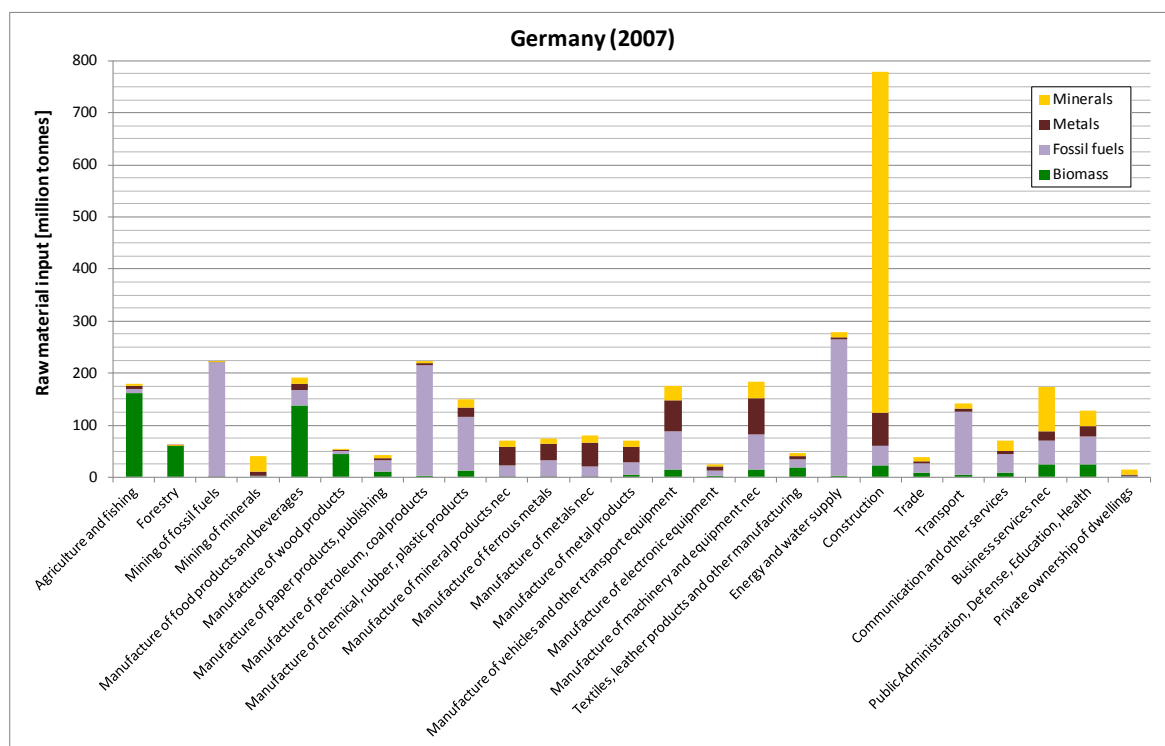


Figure 4-10: Material resource use of economic sectors in Germany in 2007

4.11 Greece

While the construction sector in Greece uses the most raw materials (mostly minerals), it uses only slightly more (in terms of weight) than the energy and water supply sector (mostly fossil fuels). The mining of fossil fuels represents the third greatest raw material use in Greece. The agriculture and food and drink industries are also large consumers of materials (mostly biomass). The transport sector in Greece seems to also have a relatively high consumption of fossil fuels.

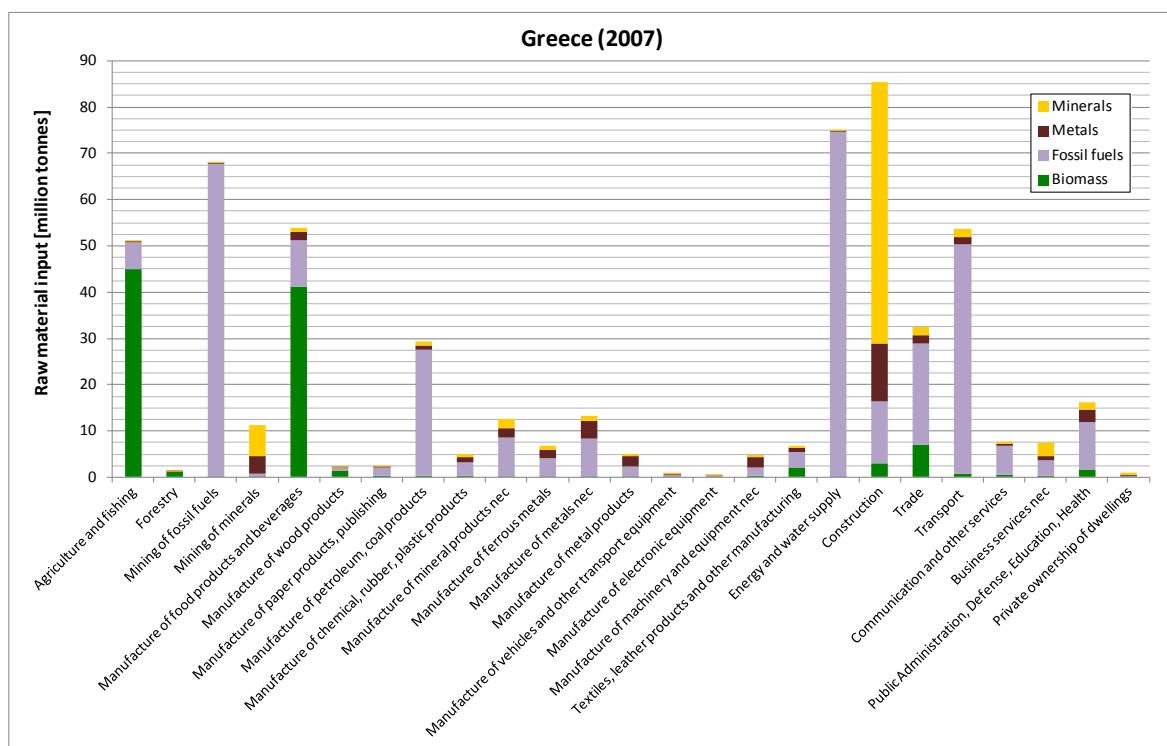


Figure 4-11: Material resource use of economic sectors in Greece in 2007

4.12 Hungary

The construction sector uses the most raw materials (mostly minerals) in Hungary. The agriculture sector consumes the next-highest quantity of materials (mostly biomass). The manufacturing of coke and refined petroleum products is the third most resource intensive sector in Hungary.

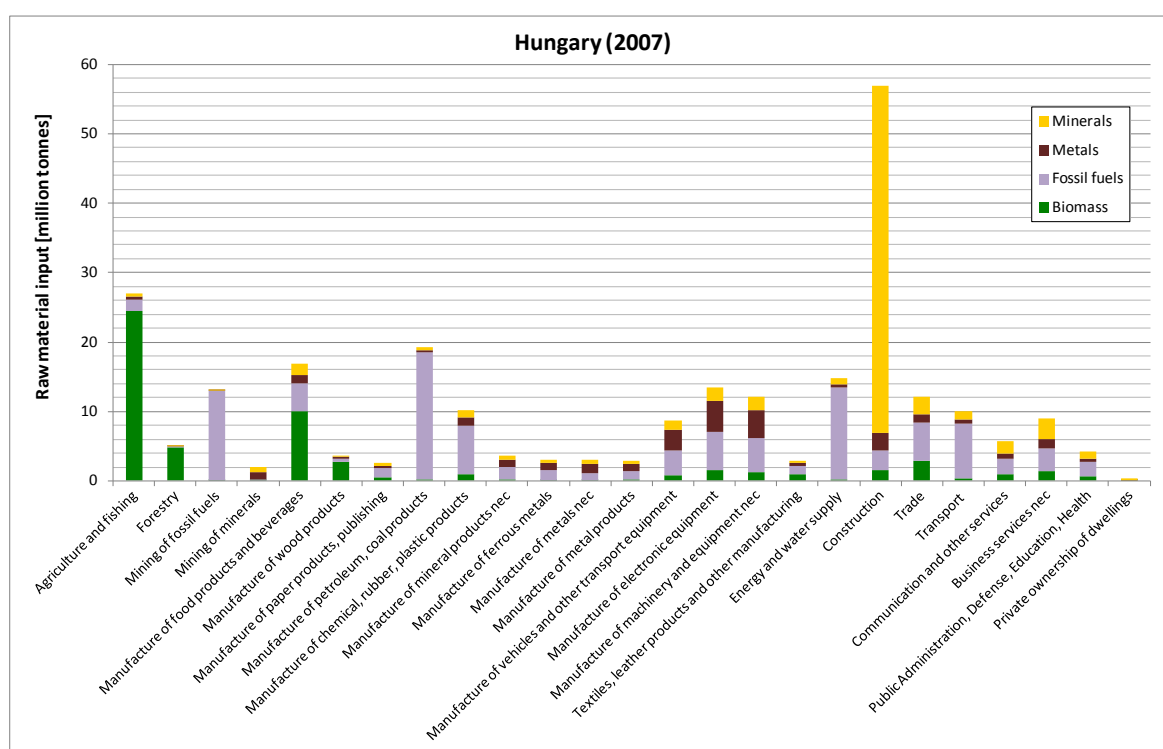


Figure 4-12: Material resource use of economic sectors in Hungary in 2007

4.13 Ireland

The construction sector uses by far the most raw materials (mostly minerals) in Ireland. The next largest material consuming sectors are the food and drink industry and the agriculture sector (mostly biomass). Business services and the manufacture of chemical, rubber and plastic products consume relatively large amounts of materials in Ireland.

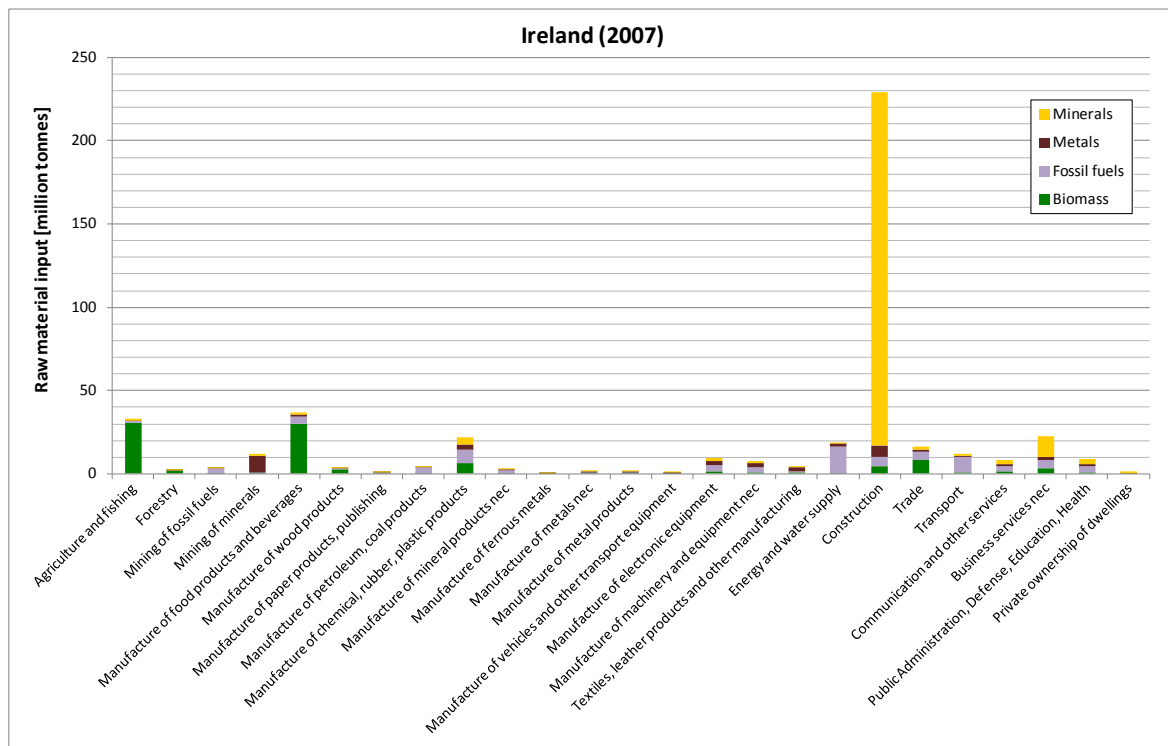


Figure 4-13: Material resource use of economic sectors in Ireland in 2007

4.14 Italy

As with most EU Member States the construction sector uses by far the most raw materials (mostly minerals) in Italy. The food and drink industry and agriculture sector (both mostly biomass) consume significant amounts of materials, but the manufacturing industries represent high levels of material consumption. Trade also seems to be relatively material intensive in Italy.

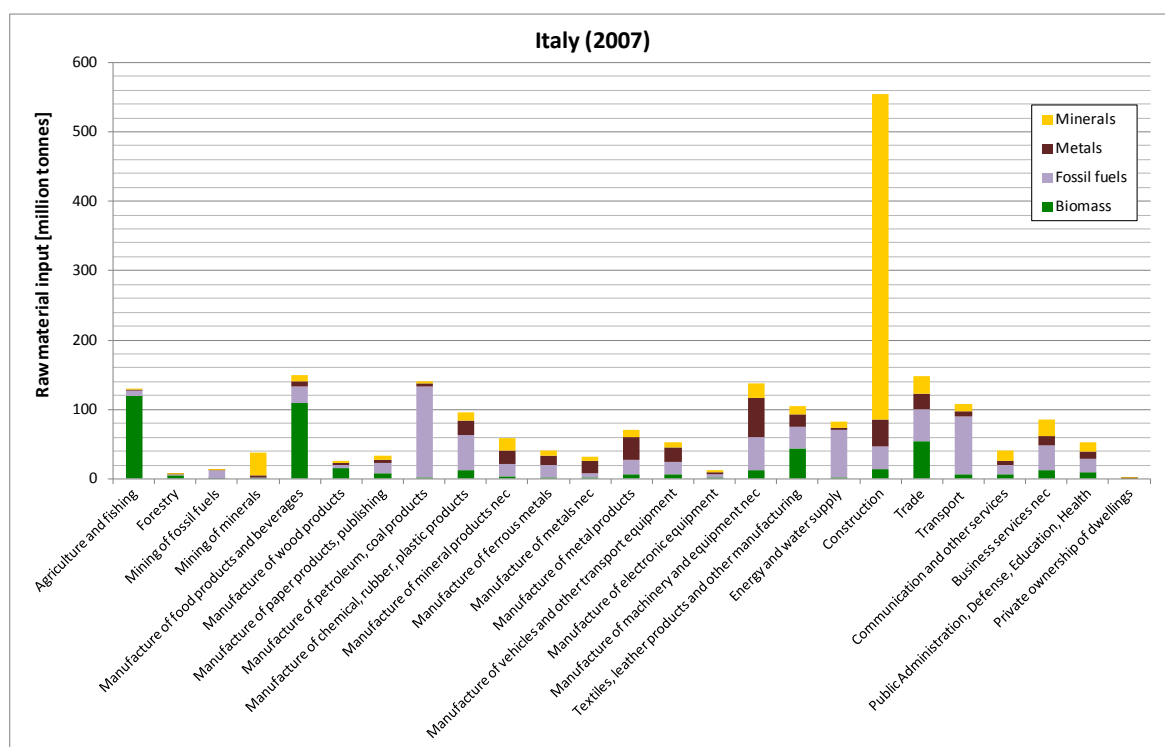


Figure 4-14: Material resource use of economic sectors in Italy in 2007

4.15 Latvia

The construction sector uses the most raw materials (mostly minerals) in Latvia. The agriculture, forestry, manufacturing of wood products, and food manufacturing and forestry sectors are the next most resource intensive sectors (all mostly biomass).

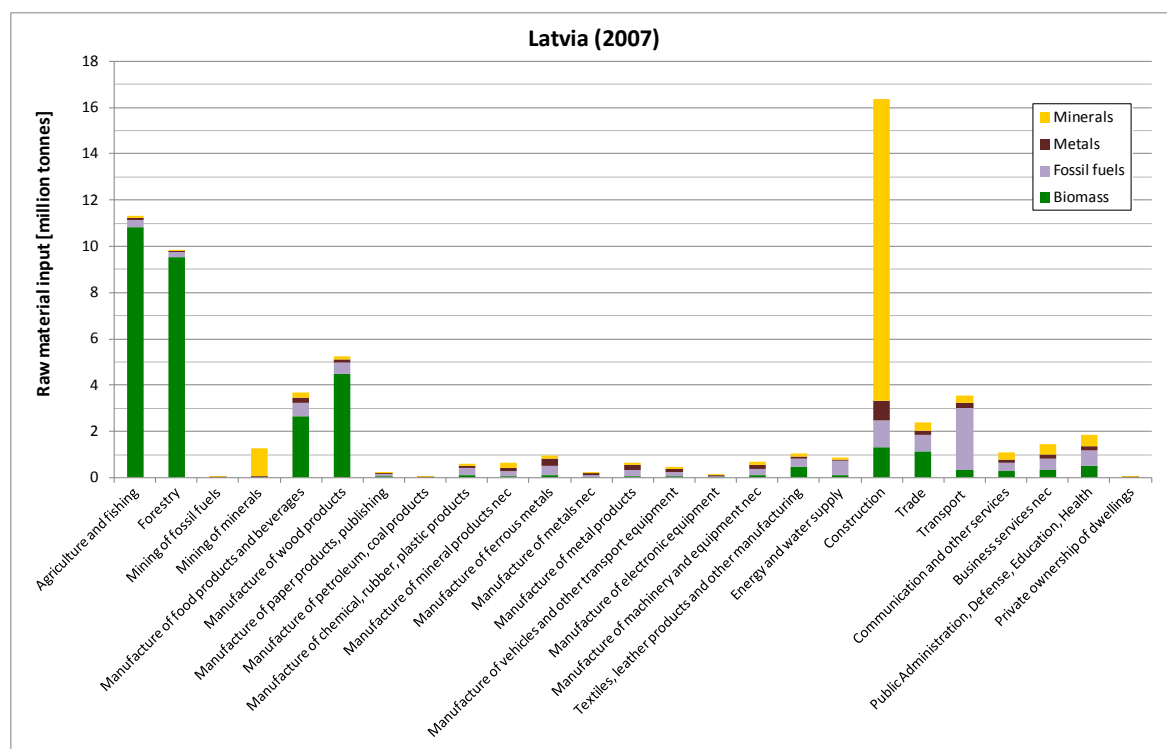


Figure 4-15: Material resource use of economic sectors in Latvia in 2007

4.16 Lithuania

The construction and agricultural sectors are the most material intensive in Lithuania. The manufacturing of coke and refined petroleum products is the third most resource intensive sector in the country, despite not having a large fossil fuel extraction sector.

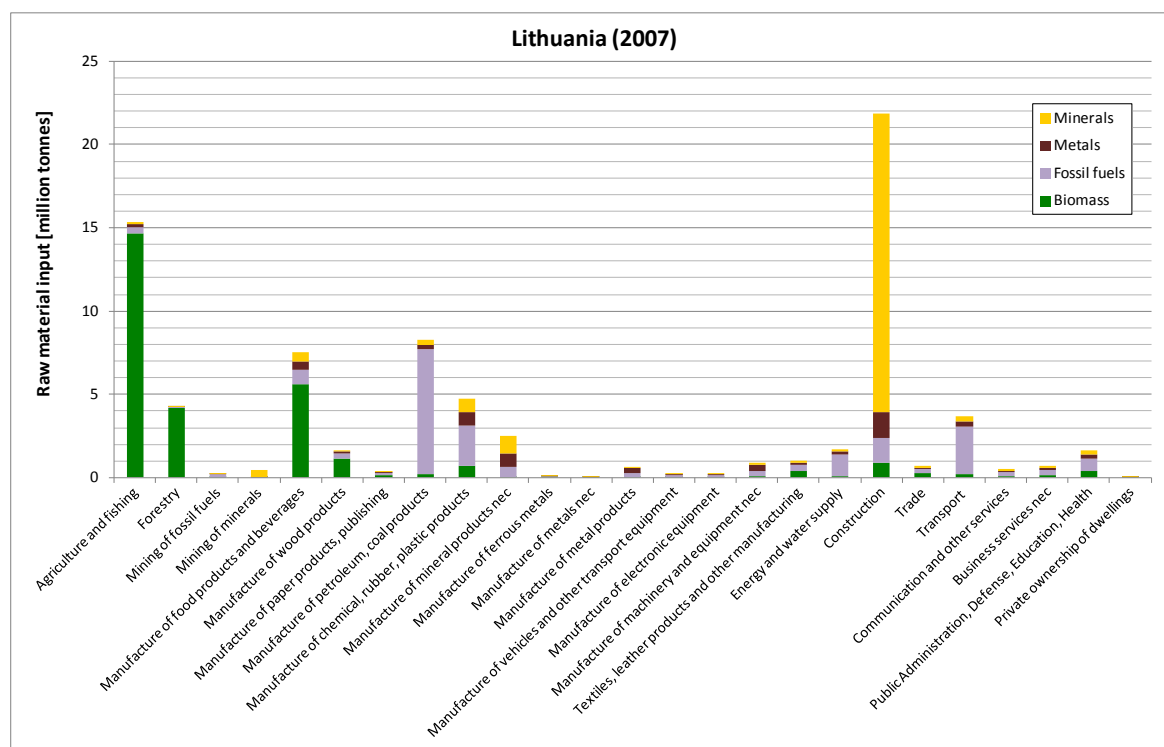


Figure 4-16: Material resource use of economic sectors in Lithuania in 2007

4.17 Luxembourg

The resource consumption profile of sectors in Luxembourg is different from most EU Member States. This is most probably due to the small size of the country. While the construction sector is the sector that consumes most (mineral) materials in terms of weight, the transport and communication and other service sectors seem to be the next most resource intensive sectors. A large part of the raw materials are fossil fuels, which could be due to Luxembourg's low petrol taxes that draw customers from neighbouring countries. Also remarkable is the ferrous metal industry, which is the country's fourth largest resource consumer.

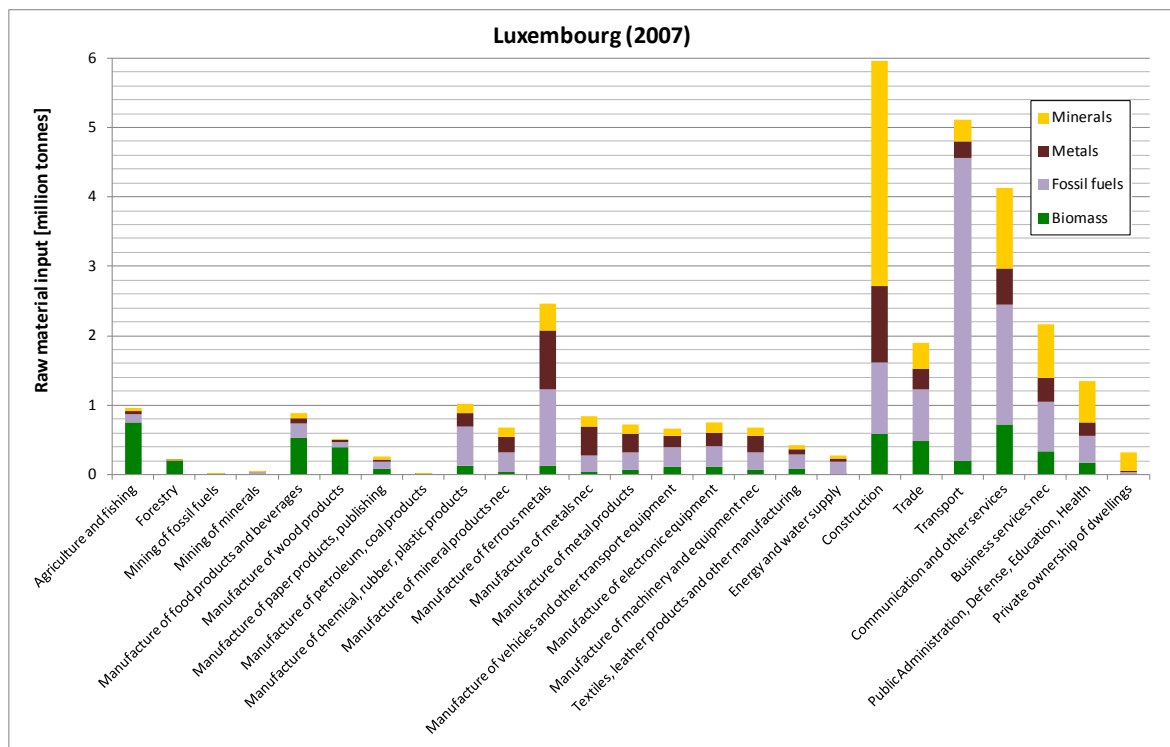


Figure 4-17: Material resource use of economic sectors in Luxembourg in 2007

4.18 Malta

The construction sector uses by far the most raw materials (mostly minerals) in Malta. The transport and the energy and water supply sectors are the next most resource intensive sectors (mostly fossil fuels).

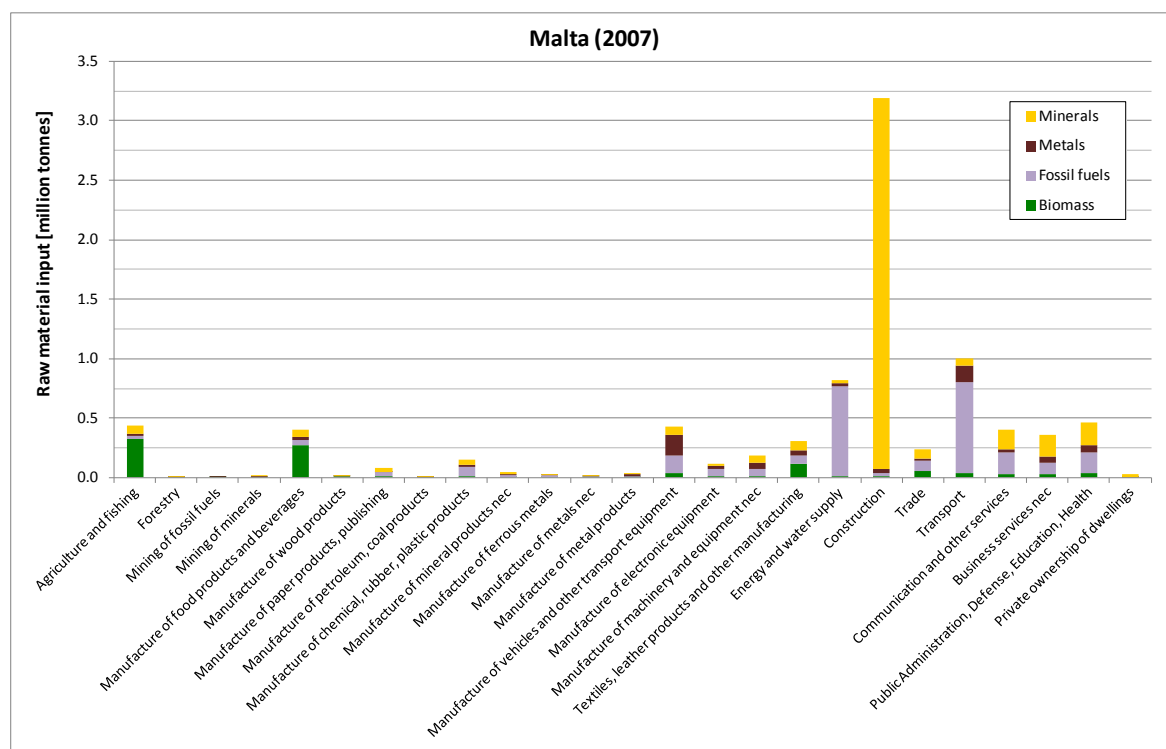


Figure 4-18: Material resource use of economic sectors in Malta in 2007

4.19 Netherlands

The manufacturing of coke and refined petroleum products is the most resource intensive sector in the Netherlands. Most of the raw materials are imported, as the resource consumption of the domestic mining activities for fossil fuels is significantly lower, but still represents the fourth most intensive sector in the Netherlands. The construction sector consumes the next-highest quantity of materials. Compared to other construction sectors, the Dutch construction sector uses a lot of metal ores. The agricultural sector and the food and drink industry are the next highest material consuming sectors.

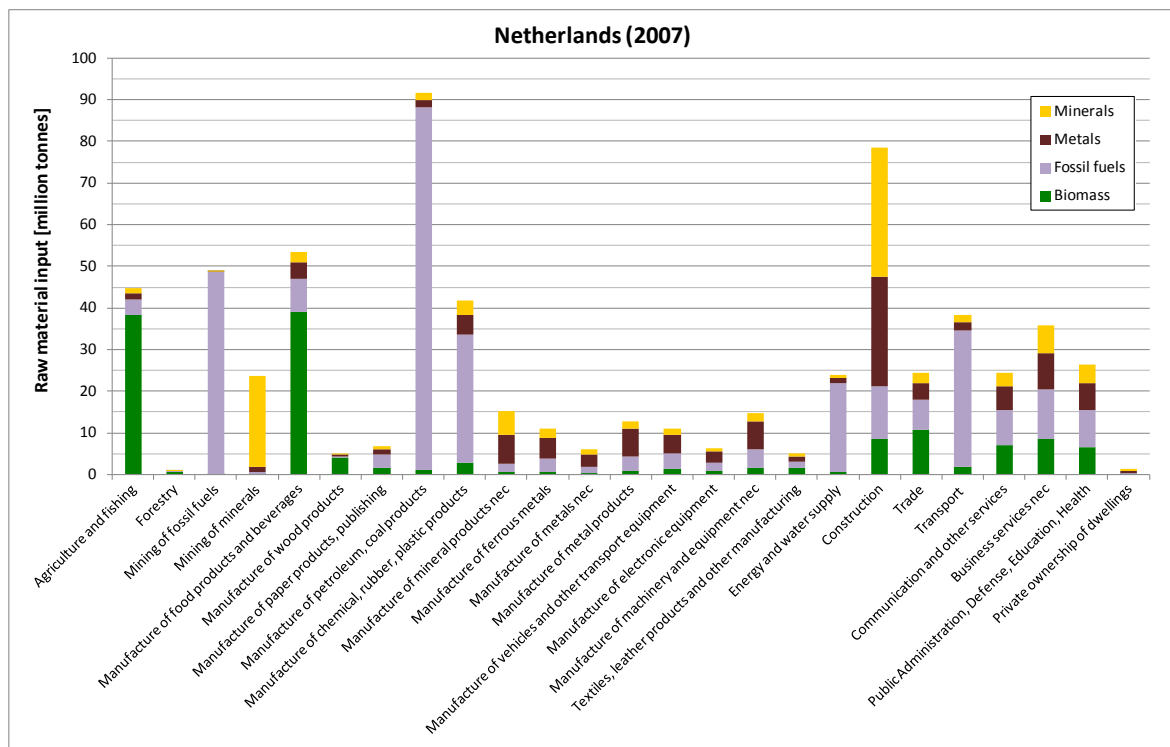


Figure 4-19: Material resource use of economic sectors in the Netherlands in 2007

4.20 Poland

The construction sector uses by far the most raw materials (mostly minerals) in Poland. Coal mining is the second largest consumer of resources, with the agricultural sector in third place.

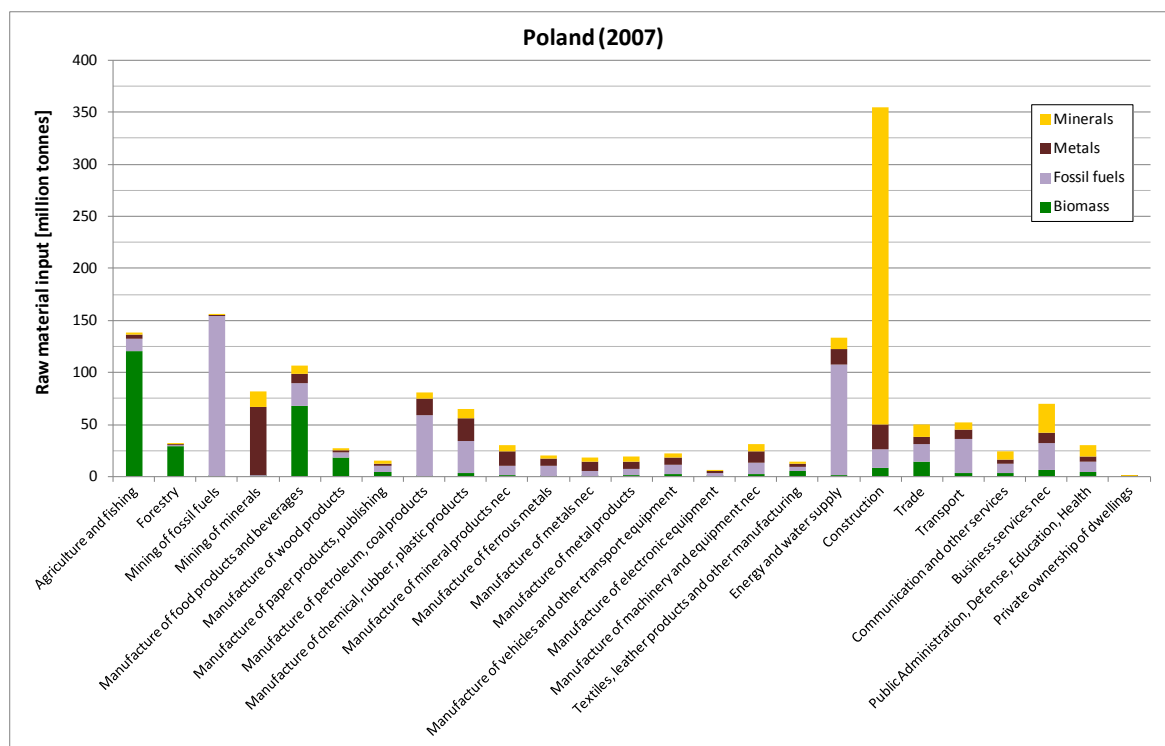


Figure 4-20: Material resource use of economic sectors in Poland in 2007

4.21 Portugal

In Portugal, the construction sector uses by far the most raw materials (mostly minerals). In the (traditional) Economy-Wide Material Flow Accounts from Eurostat, Portugal has one of the largest shares of sand and gravel in relation to its total domestic material inputs (DMI). Sand and gravel constitute 50% of total domestic material input (DMI) compared to the EU average of about 30%. Agriculture and food manufacturing are the sectors with the next greatest resource consumption in Portugal.

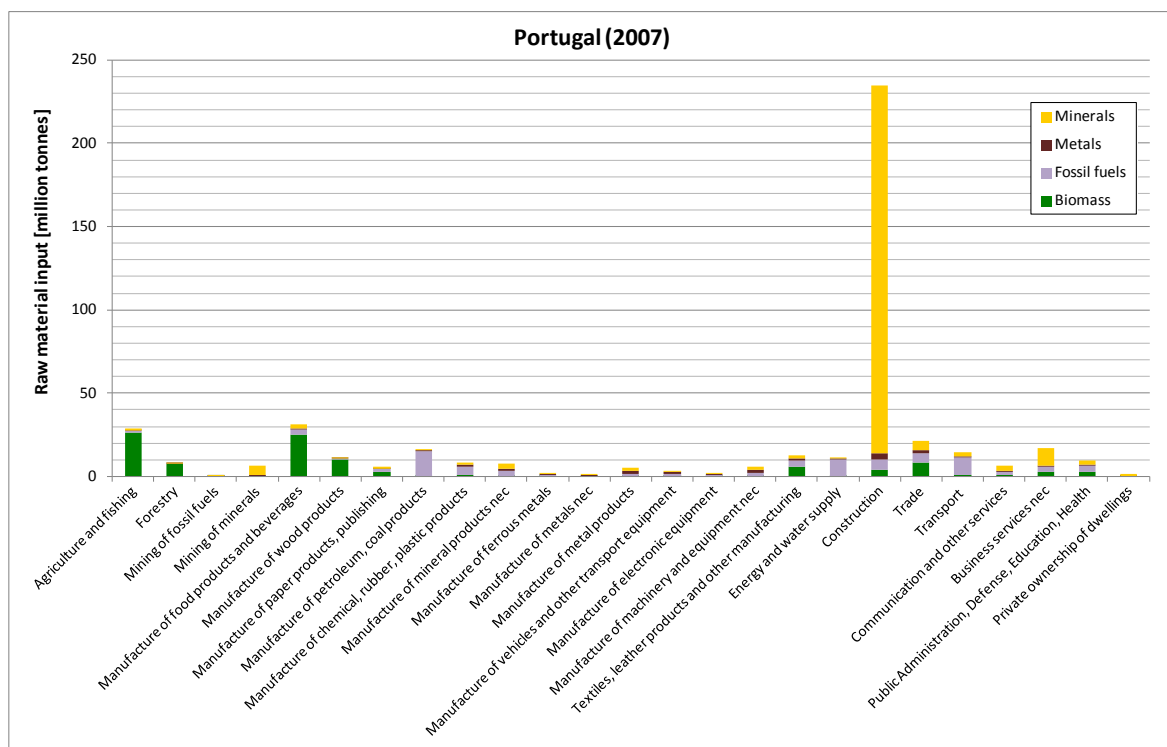


Figure 4-21: Material resource use of economic sectors in Portugal in 2007

4.22 Romania

The construction sector uses the most raw materials (mostly minerals) in Romania. The mining of fossil fuels is the second greatest consumer of resources, while the agricultural sector is third. Next are the energy and water supply sector and the manufacturing of coke and refined petroleum products.

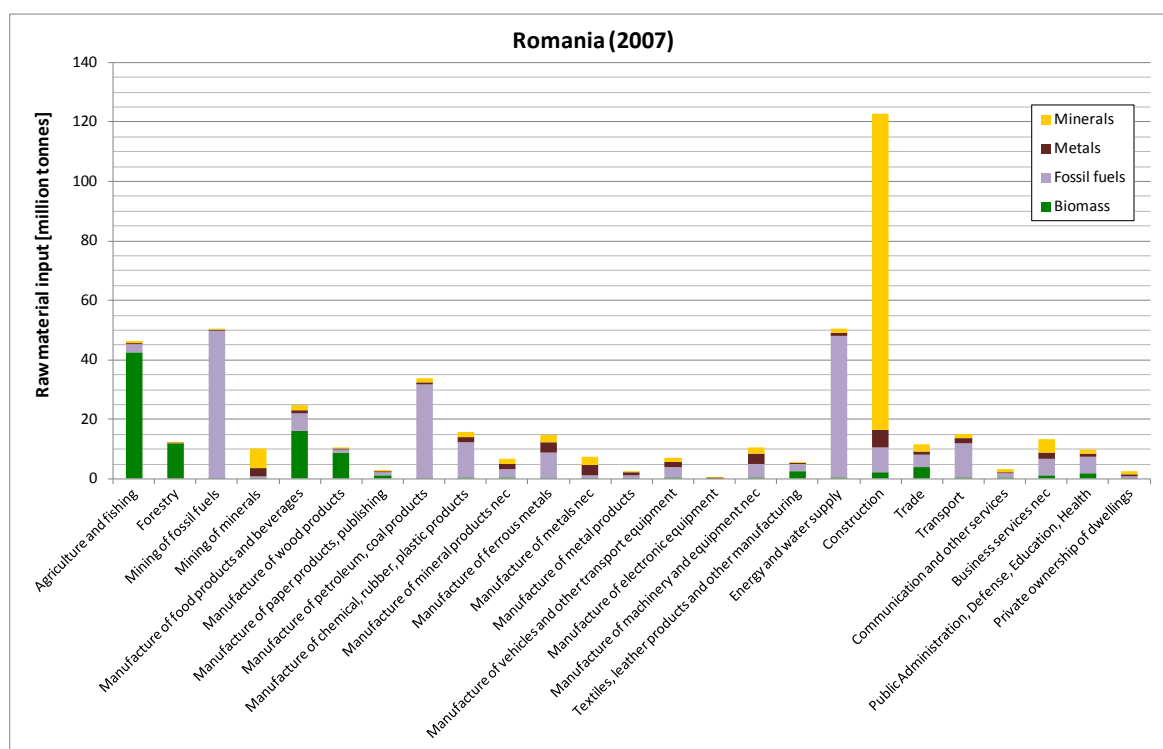


Figure 4-22: Material resource use of economic sectors in Romania in 2007

4.23 Slovakia

The construction sector uses by far the most raw materials (mostly minerals) in Slovakia. The manufacturing of coke and refined petroleum products is the next most resource intensive sector. The manufacturing industries also represent relatively high levels of material consumption (high share of metal ores).

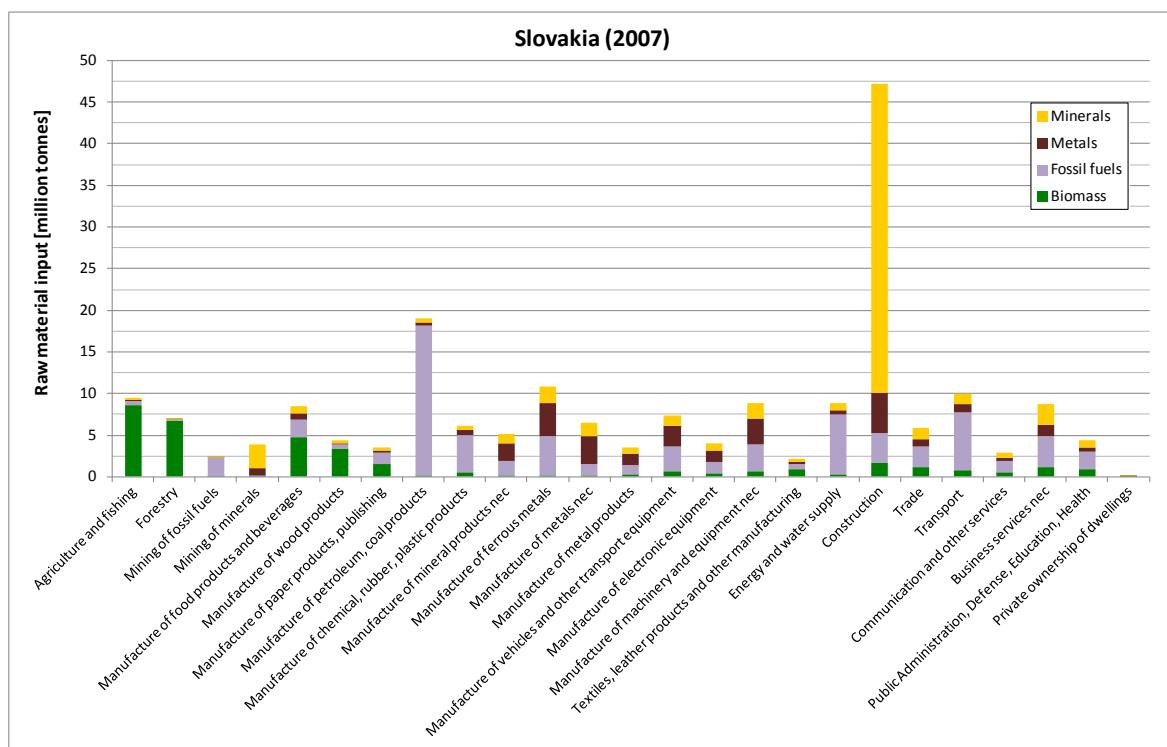


Figure 4-23: Material resource use of economic sectors in Slovakia in 2007

4.24 Slovenia

In Slovenia, the construction sector uses by far the most raw materials (mostly minerals). This could be due to a high use of sand and gravel. Otherwise the energy and water supply and business service sectors seem to be the next most resource intensive sectors in the country.

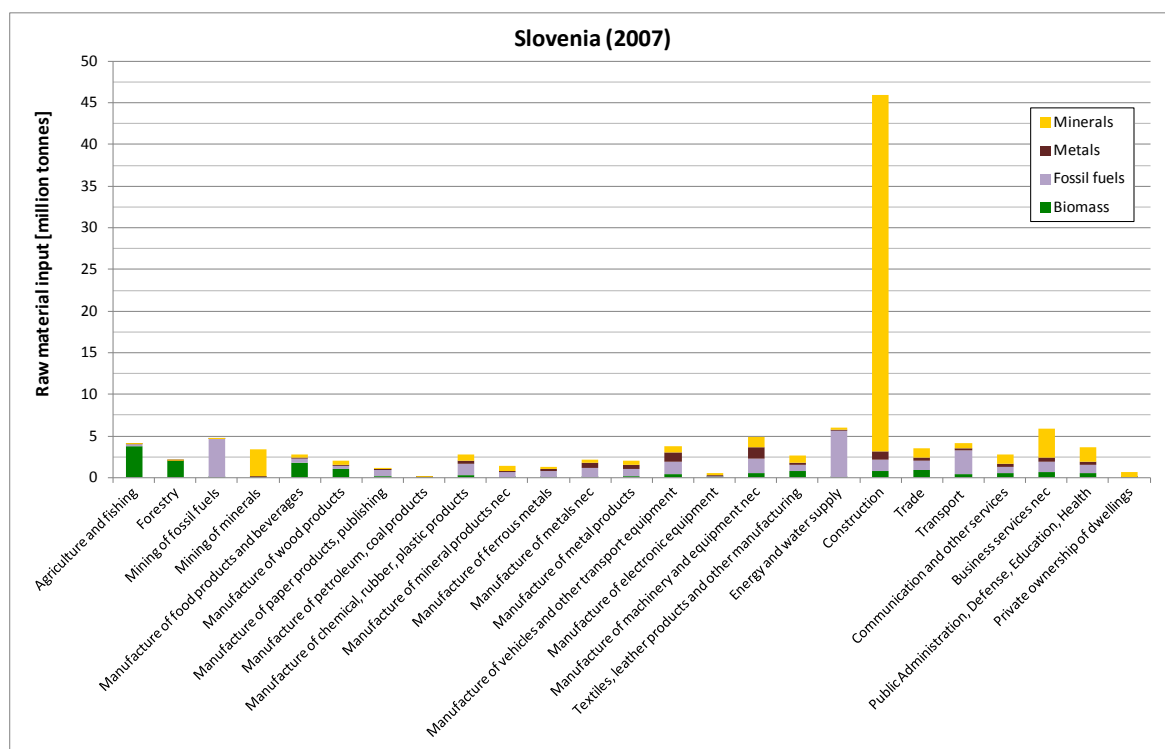


Figure 4-24: Material resource use of economic sectors in Slovenia in 2007

4.25 Spain

The construction sector uses by far the most raw materials (mostly minerals) in Spain. The food manufacturing and agricultural sectors are the next greatest material consuming sectors in the country. The manufacturing industries also generally represent relatively high levels of material consumption (high share of metal ores).

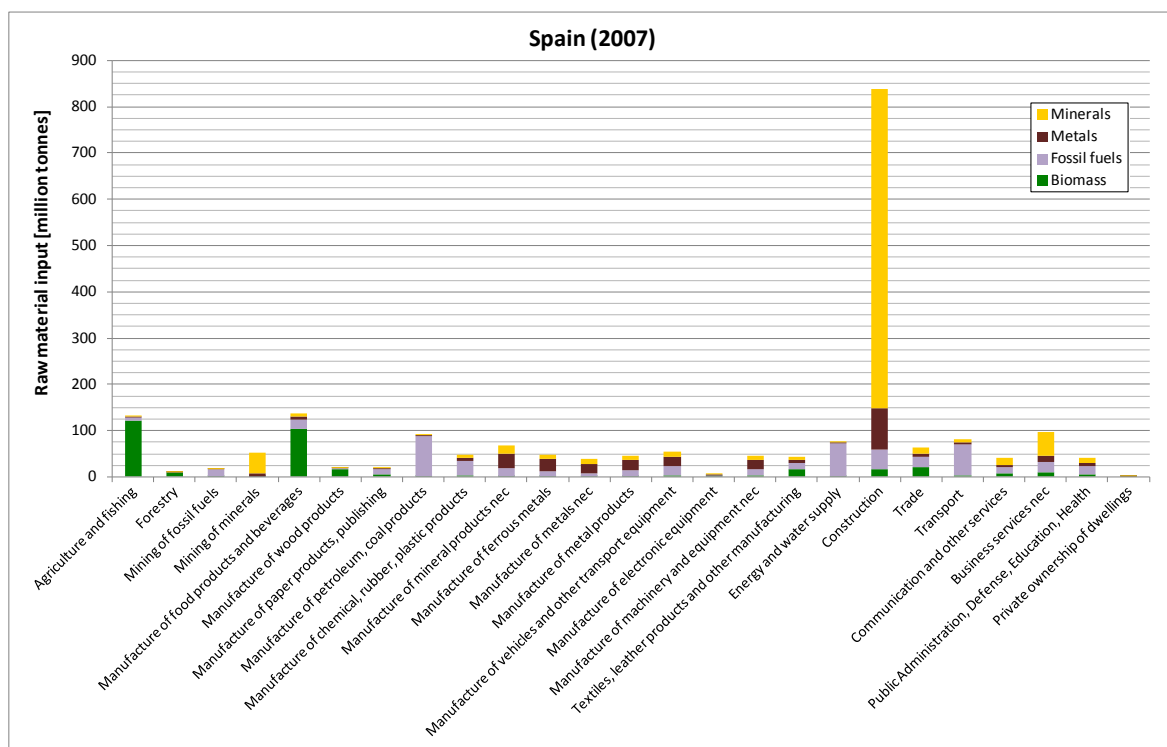


Figure 4-25: Material resource use of economic sectors in Spain in 2007

4.26 Sweden

The construction sector uses the most raw materials (mostly minerals) in Sweden. Unlike other EU Member States, the business service sector seems to represent the next most resource intensive sector in the country. Iron ore mining represents the third largest material consuming sector. Forestry, wood product and paper manufacturing are the next most material intensive sectors.

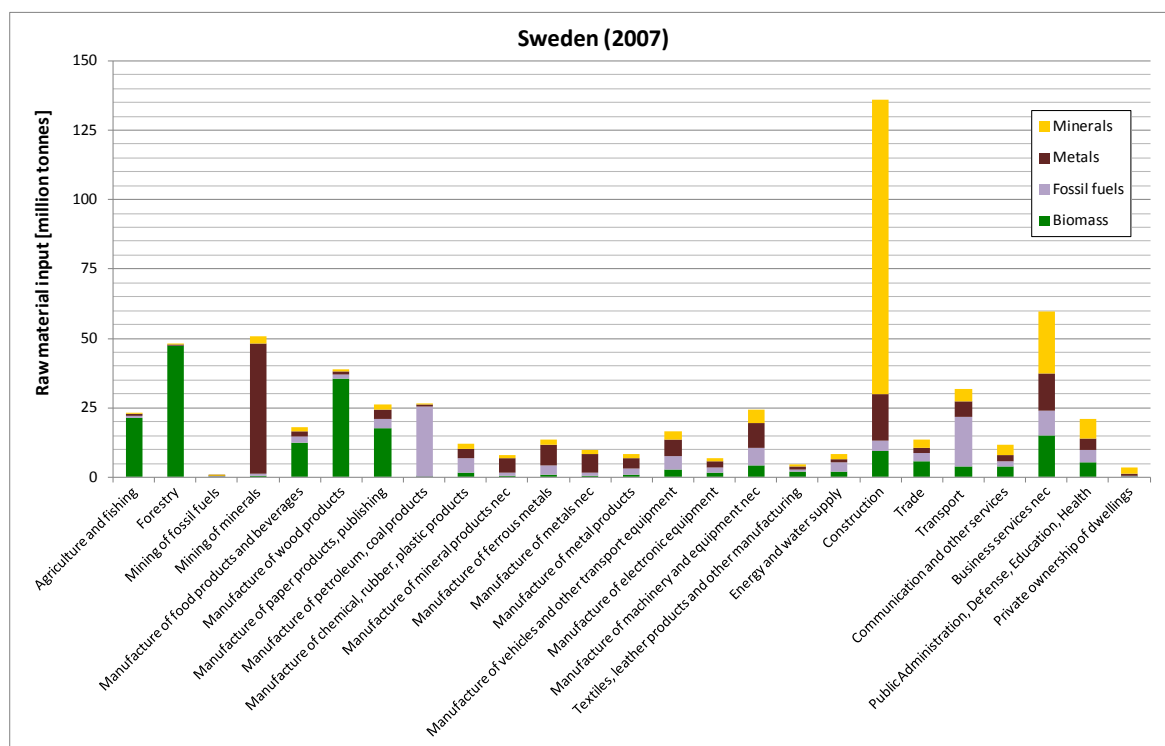


Figure 4-26: Material resource use of economic sectors in Sweden in 2007

4.27 United Kingdom

The construction sector uses by far the most raw materials (mostly minerals) in the UK. The agriculture sector and food and drink manufacturing represent the next greatest material consuming sectors. The mining of fossil fuels (mostly oil and gas) and the refinery of petroleum products are the third and fourth most material intensive sectors in the country.

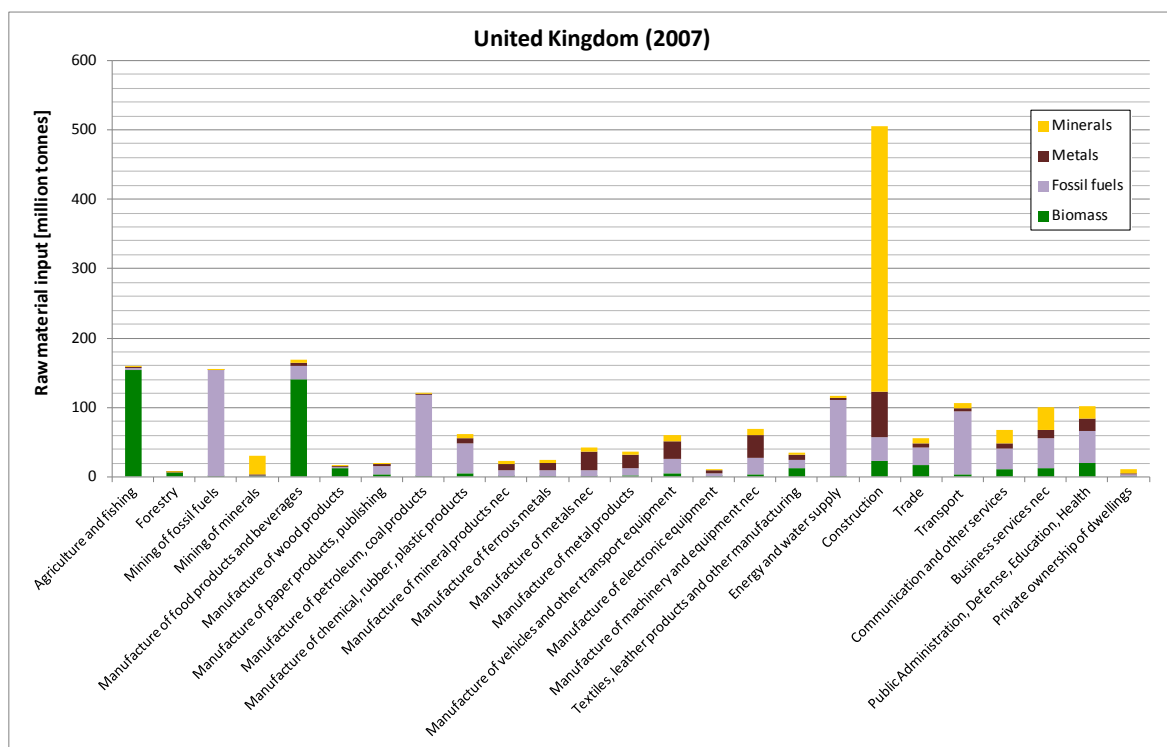


Figure 4-27: Material resource use of economic sectors in the United Kingdom in 2007

Chapter 5: The sectors in the EU with highest material consumption

The following sections provide an overview of the sectors in EU Member States that have the greatest material consumption. The presentations of results are a first estimate based on MRIO analysis, which remains to be verified using other sources. Only the ten most material resource intensive sectors are presented.

As one could expect that the largest economies would also have the sectors with the greatest material consumption, Figure 5-1 presents the relative differences in size of the EU Member States for comparison. Both in terms of GDP and population, Germany, the United Kingdom, France, Italy and Spain are the largest Member States in the EU.

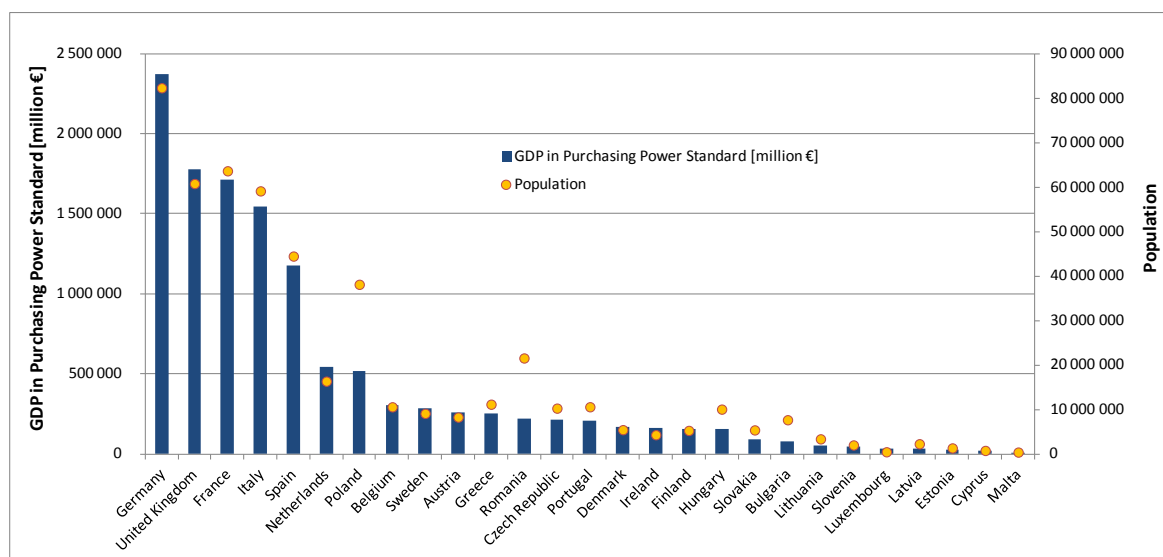


Figure 5-1: The relative differences between EU Member States in terms of GDP and population in 2007

5.1 The most material intensive construction sectors

The five biggest Member States also have the construction sectors that use the most raw materials. The construction sector in Spain, which is normally the fifth largest economy, uses the most materials compared to construction sectors in the other Member States. Interestingly, relatively small Member States such as Portugal, Ireland and Finland have construction sectors that use a lot of materials. The construction sector in Belgium uses a relatively large share of metal ores (21% of total RMI – measured in weight), while the Finnish construction sector uses the largest share of biomass (7% of total RMI – measured in weight).

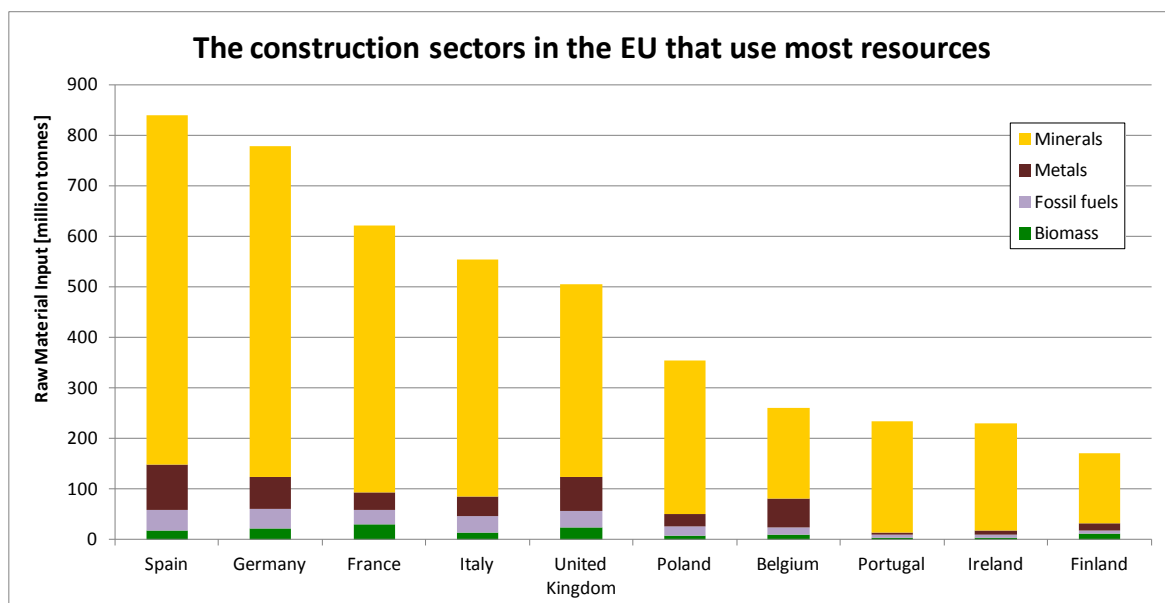


Figure 5-2: The EU Member States with construction sectors that used the most material resources in 2007

5.2 The most material intensive agricultural sectors

France has the agricultural sector that uses by far the most raw materials. Considering its size, the agricultural sector in Denmark appears to be one of the most material intensive in the EU. It is not known whether the differences in shares of fossil fuel consumption are due to energy or fertilisers.

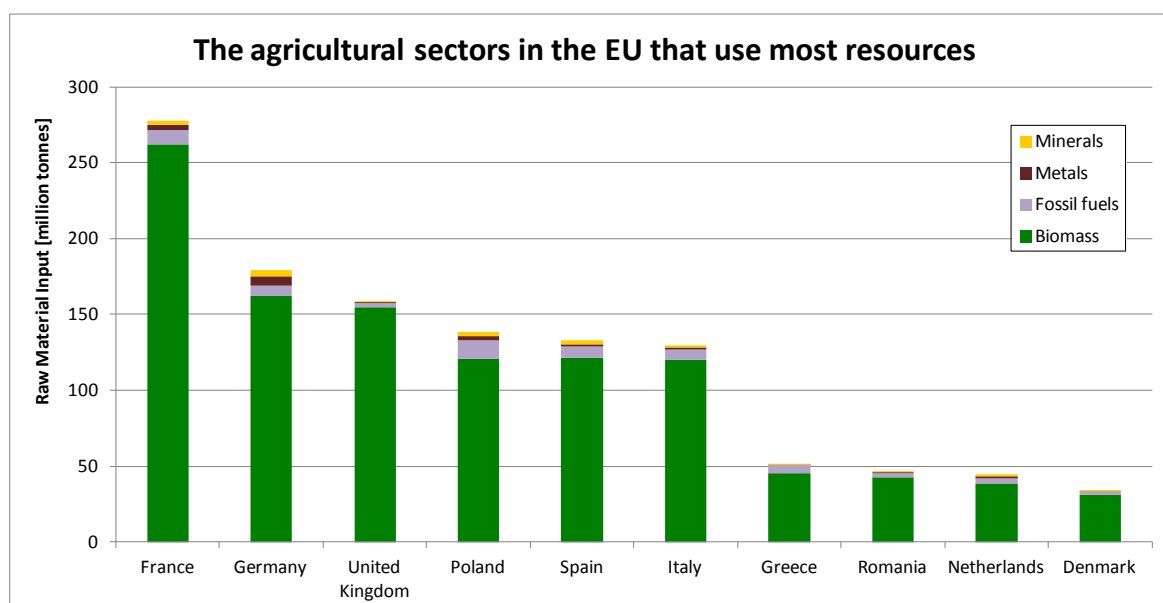


Figure 5-3: The EU Member States with agricultural sectors that used the most material resources in 2007

5.3 The most material intensive food and drink manufacturing sectors

Even though France's agricultural sector uses the most raw materials in the EU, there is not much difference in the total raw material inputs between the food and drink manufacturing sectors in France and Germany. Interestingly, Ireland appears have one of the EU's most material consumptive food and drink manufacturing sectors. There are large differences in the relative share of metal ores in the different food and drink sectors, but it is unknown whether this is due to differences in uses of metal for buildings, equipment or packaging in the sector.

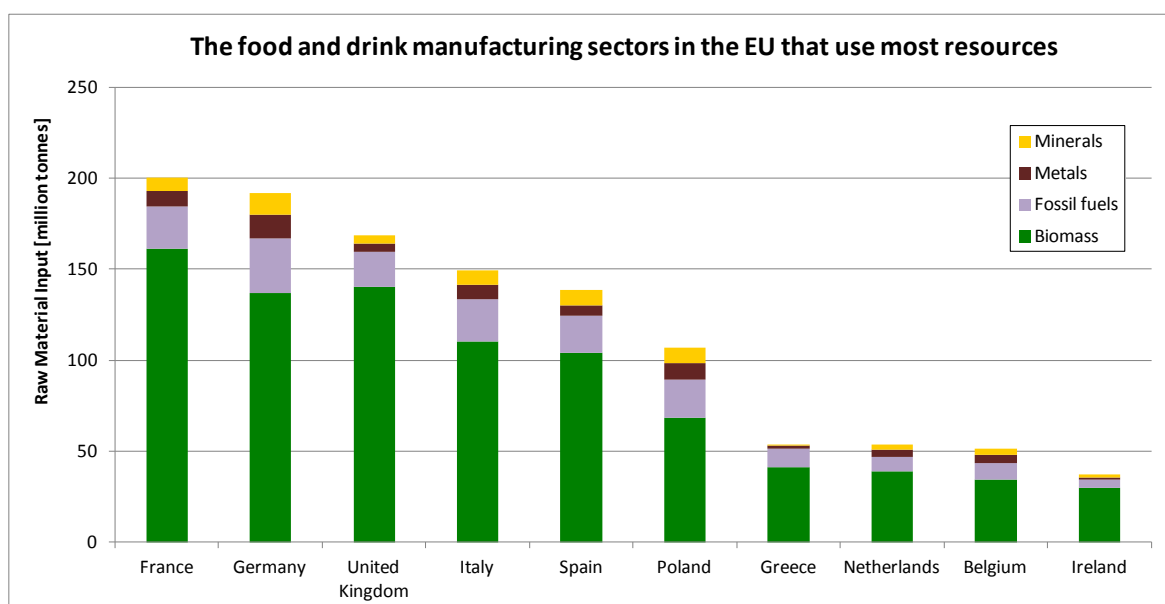


Figure 5-4: The EU Member States with food and drink manufacturing sectors that used the most material resources in 2007

5.4 The most material intensive coke and refined petroleum manufacturing sectors

The coke and refined petroleum manufacturing sector in Germany consumes the most material resources in the EU, as compared to the same sector in other countries. The sector in Poland seems to consume the most metal ores.

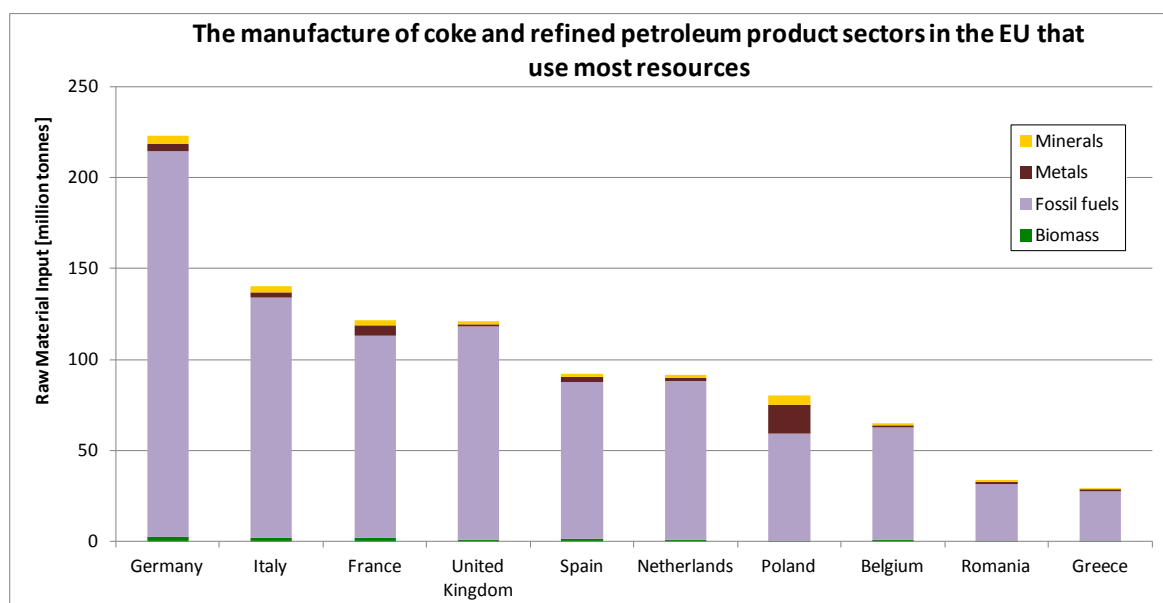


Figure 5-5: The EU Member States with coke and refined petroleum manufacturing sectors that used the most material resources in 2007

5.5 The most material intensive energy and water supply sectors

The material consumption of the energy and water supply sectors in the EU is largely determined by the energy mix of the country. Poland, the Czech Republic and Bulgaria all use large amounts of coal and other solid fuels. Despite its large size, France's energy and water supply sector does not consume large amounts of fossil fuels as most of its electricity is generated by nuclear power.

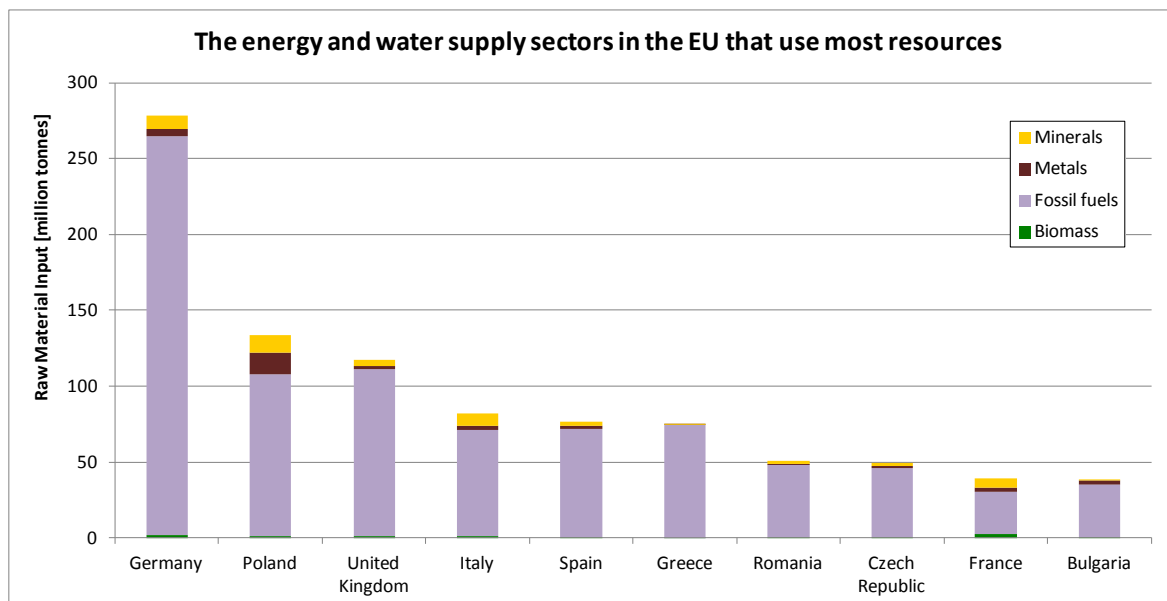


Figure 5-6: The EU Member States with energy and water supply sectors that used the most material resources in 2007

5.6 The most material intensive business service sectors

It is not clear what drives the raw material consumption in the various business service sectors in the EU. Interestingly, the business service sector in Finland seems to be among the most material resource intensive in the EU.

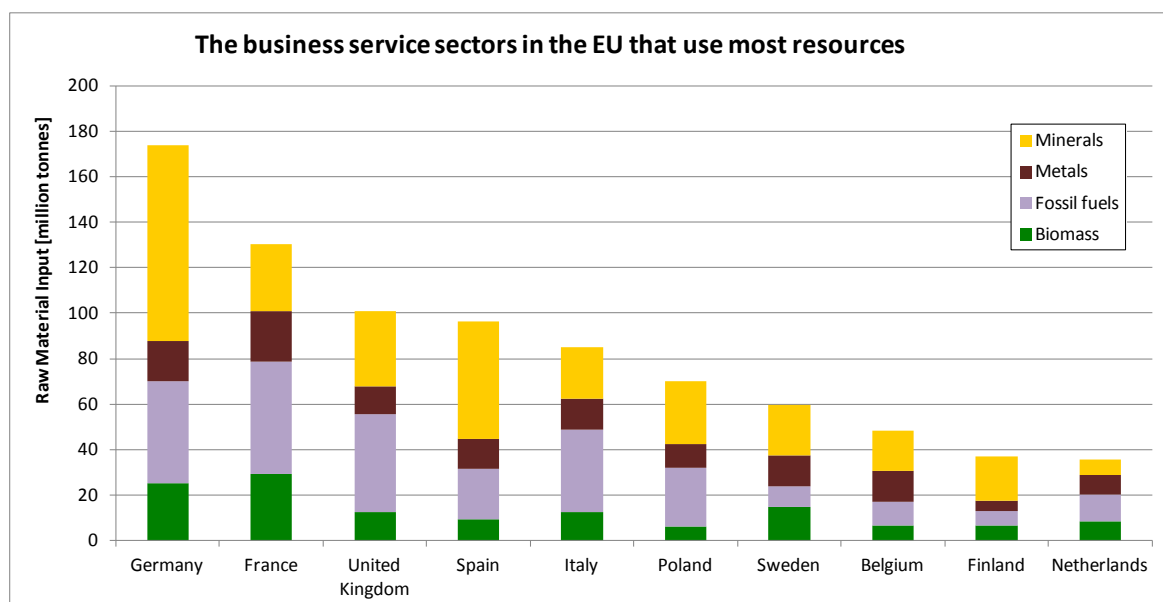


Figure 5-7: The EU Member States with business service sectors that used the most material resources in 2007

5.7 The most material intensive transport sectors

The material consumption of the different transport sectors in the EU corresponds well to the size of the Member State. Greece does however seem to have a relatively high consumption of fossil fuels compared to the size of its economy. The share of biomass varies between the transport sectors. The transport sector in Sweden has highest amount of biomass (over 12% of total raw material input). It is not known whether this is due to biofuels, infrastructure or buildings.

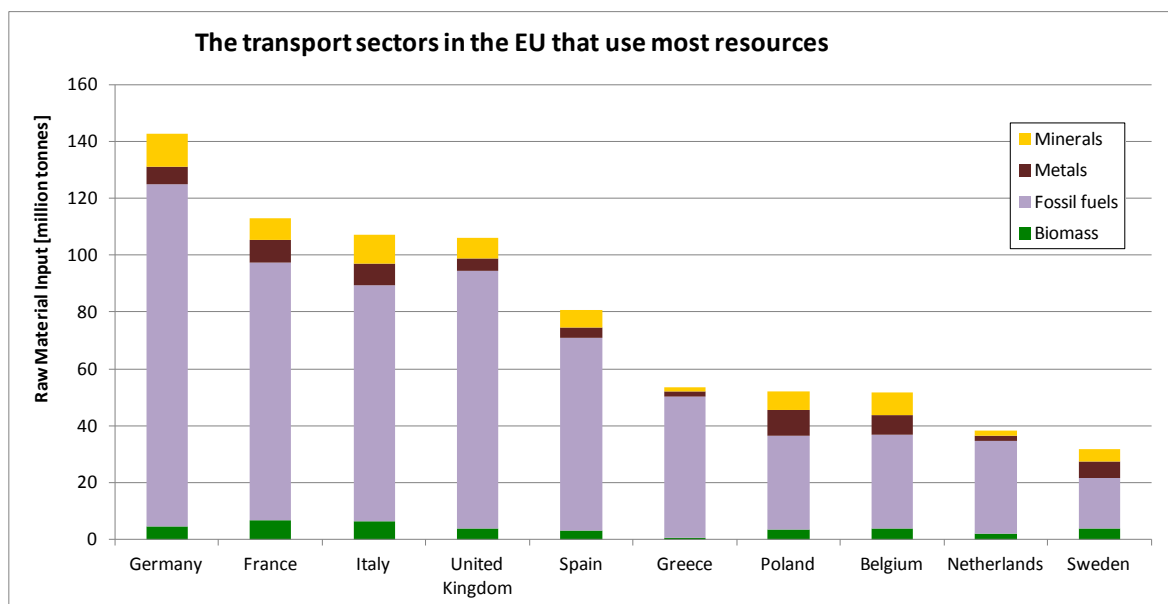


Figure 5-8: The EU Member States with transport sectors that used the most material resources in 2007

5.8 The most material intensive fossil fuel mining sectors

The fossil fuel mining sectors that extract and use the most material resources are found in the Member States that still have extensive coal, oil and gas extraction activities. Despite being among the biggest economies in the EU, France and Italy do not have large (domestic) fossil fuel mining sectors. Denmark's oil and gas extraction in the North Sea explains why it is among the fossil fuel mining sectors in the EU that have the largest raw material input.

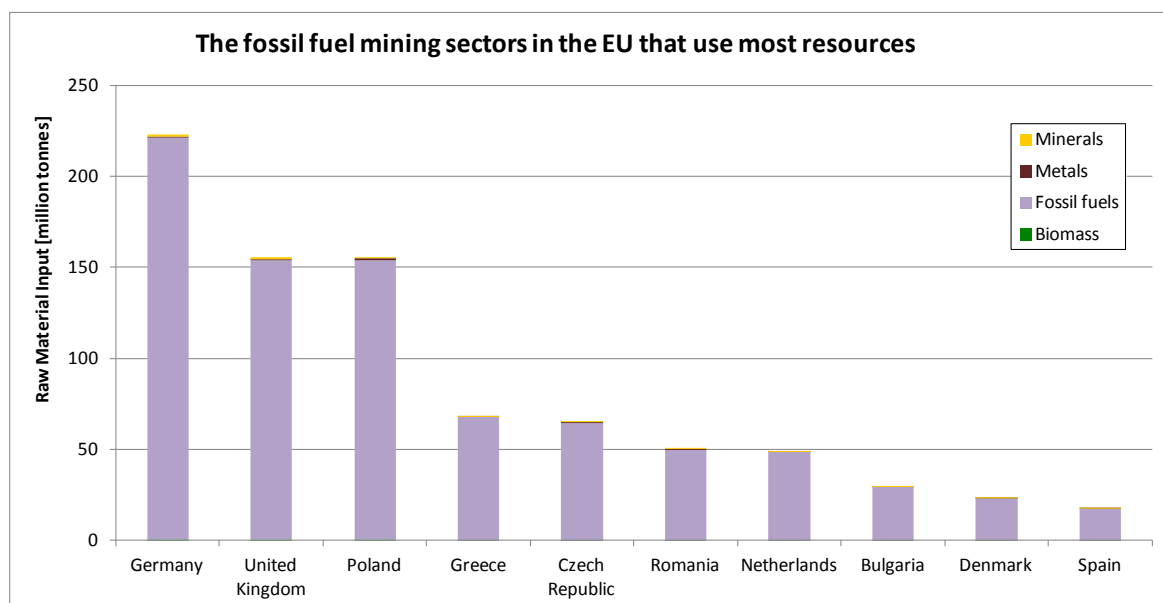


Figure 5-9: The EU Member States with fossil fuel mining sectors that used the most material resources in 2007

5.9 The most material intensive chemical, rubber and plastic product manufacturing sectors

The chemical, rubber and plastic production manufacturing sector in Germany consumes the most material resources, as compared to the same sector in other EU Member States. Belgium, Ireland and the Czech Republic have sectors with relatively large material consumption. The share of biomass, fossil fuels and metals vary considerably between sectors in different Member States.

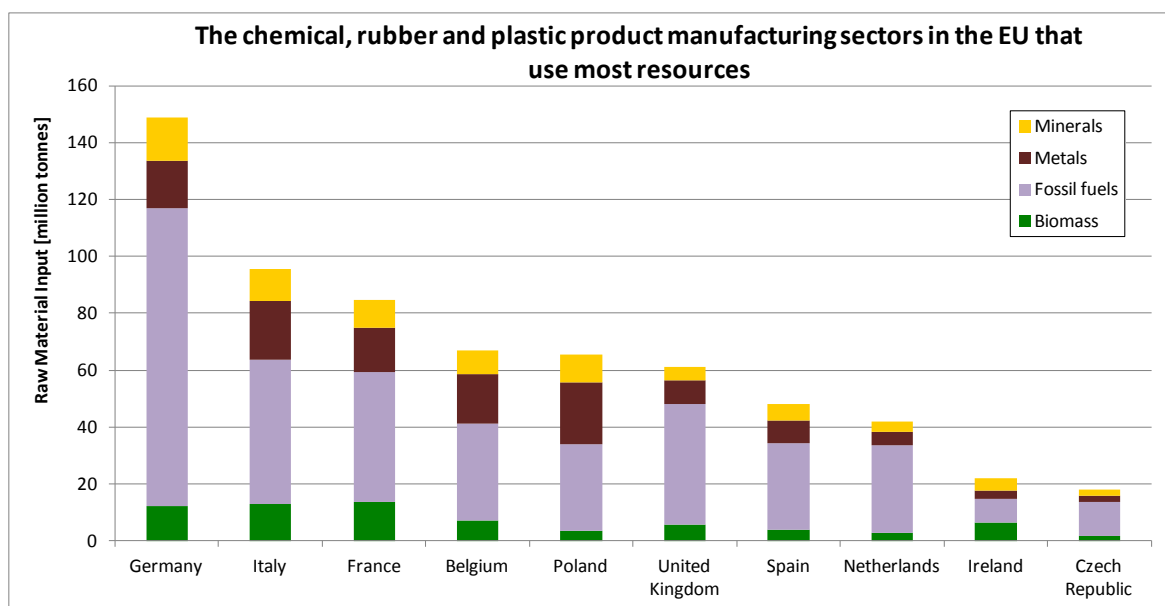


Figure 5-10: The EU Member States with chemical, rubber and plastic product manufacturing sectors that used the most material resources in 2007

5.10 The most material intensive machinery and equipment manufacturing sectors

Germany and Italy's machinery and equipment manufacturing sectors (excluding electronic equipment, motor vehicles and other transport equipment manufacturing) require the most raw materials in the EU, as compared to the same sector in other Member States. The machinery and equipment manufacturing sectors in Belgium, the Czech Republic, Sweden and Finland seem to be among the most resource intensive in the EU.

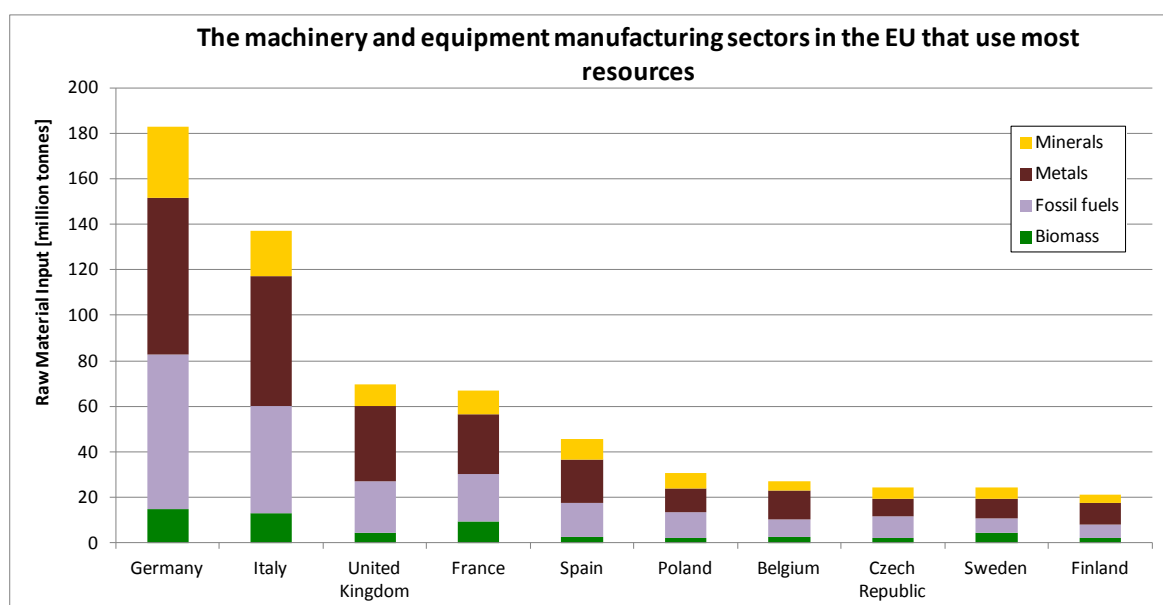


Figure 5-11: The EU Member States with machinery and equipment manufacturing sectors (excluding electronic equipment, motor vehicles and other transport equipment) that used the most material resources in 2007



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