Environment and energy

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Economy-wide material flows: European countries required more materials between 2000 and 2007

Economy-wide material flow accounts provide information in tonnes about the physical flows of materials through our economies. The accounts provide an aggregate overview of the annual extraction of raw materials as well as of the physical amounts of imports and exports.

Typically as economies grow, more materials such as fossil fuels, biomass, construction materials and metals are needed, but the rate of increase is less than that of GDP, a phenomenon known as "decoupling" which can also be observed for the EU-27.

A 'resource-efficient Europe' is an initiative the European Commission launched as part of the Europe 2020 strategy aiming to deliver smart, sustainable and inclusive growth. The initiative aims at decoupling economic growth from the use of resources.

In the EU-27, the average material consumption per inhabitant was 16.5 tonnes in 2007, an increase of 5% since 2000. The EU-27 is a net importer of materials. Net imports increased by over 25% from 2000 to 2007.

Resource productivity of the European Union

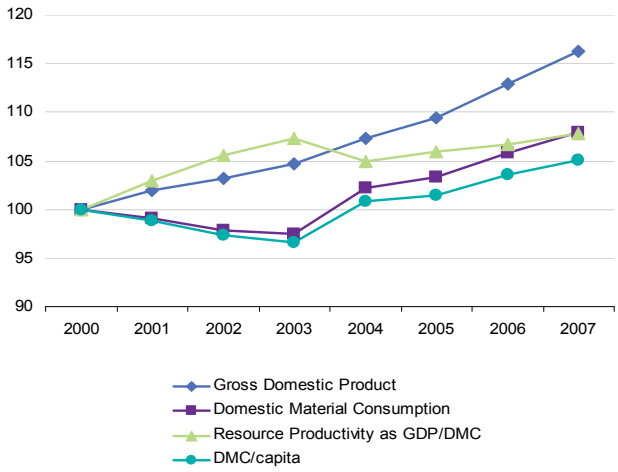
Resource productivity is the total amount of materials used by an economy in relation to economic activity. The development of resource productivity over time provides insights into whether decoupling between the use of natural resources and economic growth is taking place.

Resource use is measured as domestic material consumption (DMC). Resource productivity of the EU is expressed by the amount of GDP generated per unit of material consumed, i.e. GDP / DMC in euro per kg.

Resource productivity in the EU-27 rose 7 % from 2000 to 2003, then decreased in 2004 but increased to slightly above the 2003 level by 2007 (Figure 1). Over the entire period 2000 to 2007 an increase of resource productivity of almost 8 % was observed. While the EU-27 GDP has continuously increased during the 2000 to 2007 period, the DMC declined until 2003. When the economy grows, at the same time as DMC is decreasing, this is called 'absolute decoupling' of resource use from economic growth. We observe this type of situation for 2000 to 2003. From 2003 to 2007, however, DMC increased together with GDP at nearly the same rate (11 %).

In absolute terms, DMC increased by about 8 % from 2000 to 2007. Per capita, DMC increased somewhat less, by about 5% from 2000 to 2007.

Figure 1: Resource productivity for EU-27, 2000-2007 (Index 2000=100)



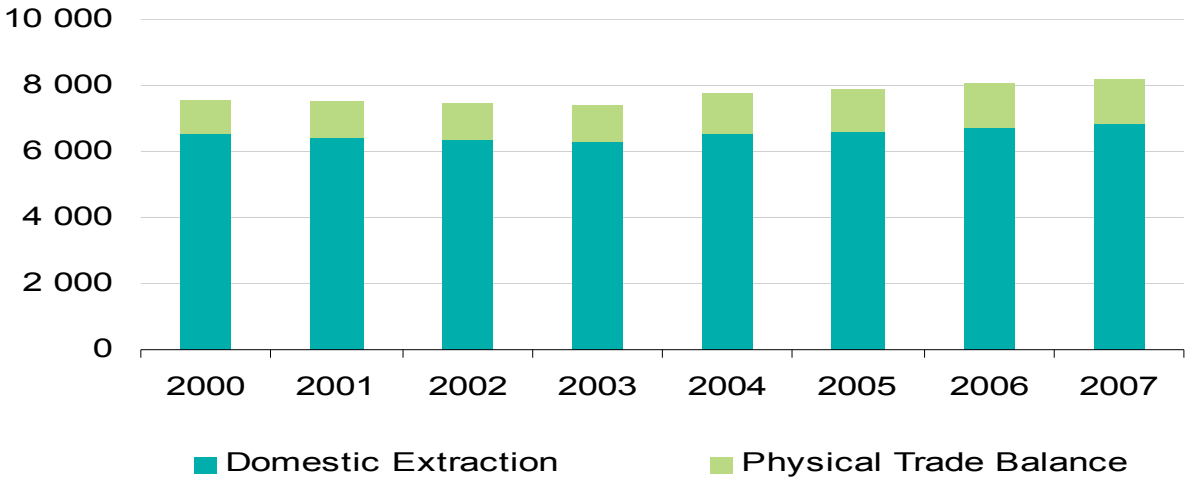
Source: Eurostat and GDP in volume with reference year 2000 (at 2000 exchange rates) (online data codes: env_ac_mfa, nama_gdp_k)

Domestic Material Consumption

Domestic material consumption (DMC) is a measure of the total amount of materials directly used by an economy. From 2000 to 2003 the DMC of the EU-27 declined slightly from 7.6 to 7.4 billion tonnes, but rose again to 8.2 billion tonnes by 2007, a 7.8 % increase from 2000 (Figure 2). Extraction of materials from nature within a country's territory, called domestic extraction, makes up the larger part of DMC, 85 %, with the physical trade balance (imports less exports) accounting for roughly 15 %.

From 2000 to 2003, domestic extraction decreased from 6.6 to 6.3 billion tonnes but then increased to 6.9 billion tonnes by 2007, which is 4.9 % higher than in 2000. In contrast, the Physical Trade Balance (PTB) rose constantly over 2000 to 2007 from 1.0 to 1.3 billion tonnes, an increase of 26.5 %. This means that the EU-27 is a net importer from the rest of the world. Since domestic extraction is increasing, it is interesting to see in the next section what the major components of this extraction are.

Figure 2: Domestic Material Consumption (DMC) by components - domestic extraction and Physical Trade Balance, EU-27 (million tonnes)



Source: Eurostat (online data code : env_ac_mfa)

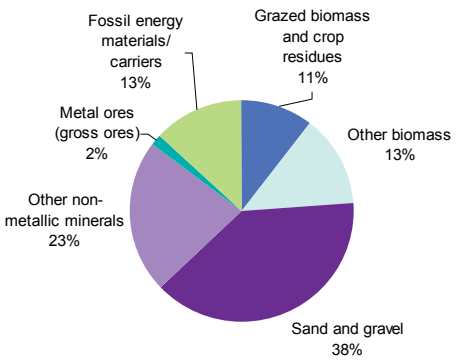
Construction materials account for more than half of domestic extraction

Figure 3 shows that in 2007, the main materials extracted from the national territories of the EU-27 are biomass (24 %) including grazed biomass and crop residues (11 %), non-metallic minerals including sand and gravel (61 %), metal ores (2 %), and fossil energy materials/carriers (13 %).

From this breakdown, the importance of the construction industry – which uses much of the sand, gravel and other non-metallic minerals to construct houses, other buildings, roads and bridges – can be seen. Sometimes even individual large construction projects such as building new airports, tunnels, dykes, highways, large buildings, etc. can have a visible impact on the figures.

Please note that water flows are excluded from economy-wide material flow accounts. The flows of water would be so large that data on all other materials would be of negligible size and not appropriate for analytical purposes.

Figure 3: Domestic extraction by materials in 2007, EU-27 (per cent)



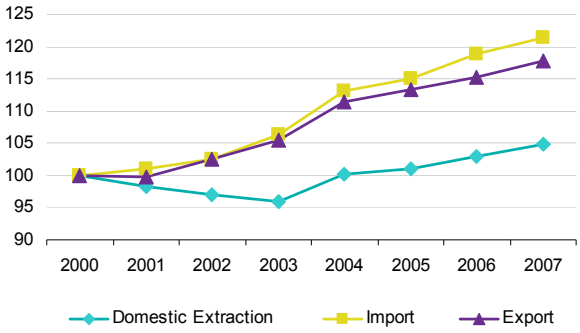
Source: Eurostat (online data code : env_ac_mfa)

Development of domestic extraction and foreign trade

From 2000 to 2007, the domestic extraction in the EU-27 has increased by a moderate 4.9 % (Figure 4). By contrast, international trade of the EU-27 has increased substantially, with imports increasing by 21 % and exports increasing by 18 %.

There are large differences between countries with respect to imports and exports – and this is examined in more detail below.

Figure 4: Domestic extraction, imports and exports, EU-27 (Index 2000=100)



Source: Eurostat (online data code : env_ac_mfa)

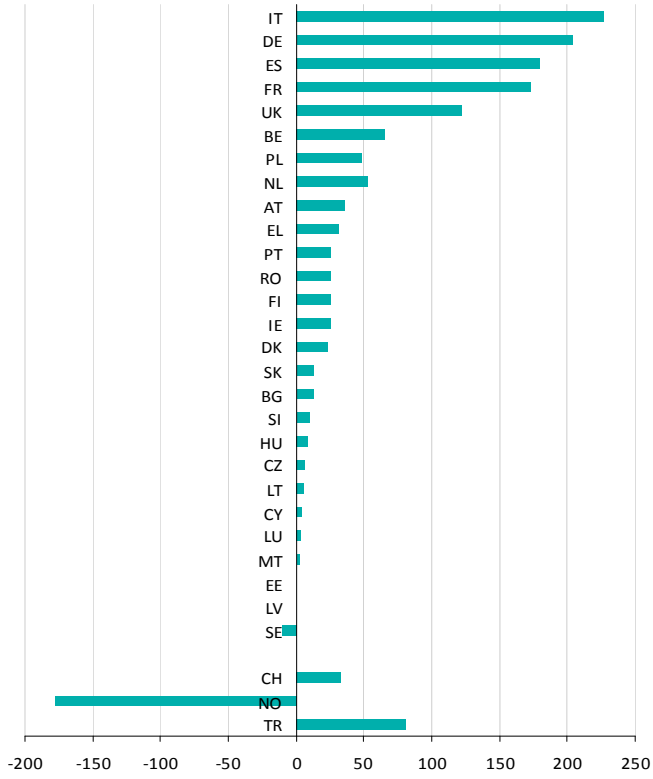
Domestic and foreign resources: Physical trade balances

For most countries, the material requirements for a country's economy are dominated by domestic raw material extraction, but the EU is not self-sufficient for all the materials needed. Materials that are not available or are too expensive to produce nationally are typically obtained through international trade. In this way the material requirements for a country are satisfied by foreign trade. The difference between imports and exports is called the physical trade balance (PTB).

Most European countries are net importers and require more resources from the rest of the world than they provide to the rest of the world (Figure 5). Among the EU countries in 2007 only Latvia and Sweden were net exporters of materials though at relatively low absolute amounts.

Norway, on the other hand, is at the other extreme to Italy and Germany and is the largest net exporter of the EU and EFTA countries. Norway has a largely natural resource based economy due to its high extraction and export of domestic oil and gas as well as fish and timber.

Figure 5: Physical trade balances in European countries, 2007 (million tonnes)



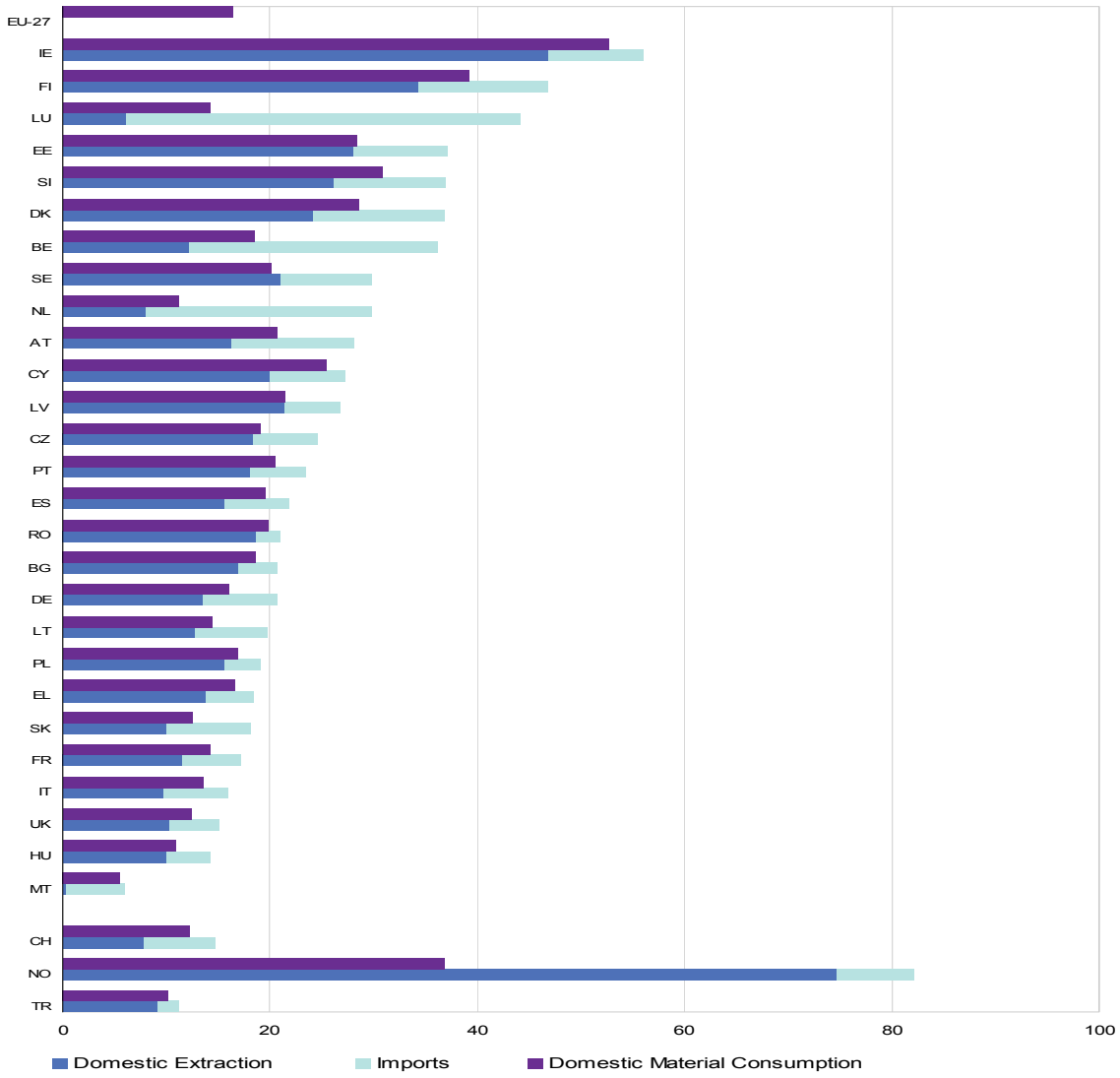
Negative values: Net exporters **Positive values: Net importers**

Source: Eurostat (online data code: env_ac_mfa) Trade data are estimated for EL, FI, MT, NO using COMEXT

Big differences between countries due to different types of economic structure

Another indicator often used is Direct Material Input (DMI) which measures the direct input of materials for use into the economy, i.e. all materials which are of economic value and are used in production and consumption activities (excluding water flows). DMI thus equals domestic extraction plus imports. The relation of DMC to DMI indicates to what extent material resources inputs are used for own domestic consumption or are exported for consumption in other economies. The difference between DMC and DMI (the two bars shown for each country in Figure 6) is exports.

Figure 6: Domestic Material Consumption (DMC) and Domestic Material Inputs (DMI) (shown as the addition of its two components: domestic extraction plus imports). European countries, 2007 (tonnes per capita).



Source: Eurostat material flow data and average population (online data codes: env_ac_mfa, demo_gind). All data are estimated for BE and CY; Trade data are estimated for EL, FI, MT, NO using COMEXT

Ten of the countries (9 EU Member States and Switzerland) had direct material inputs (DMI), between 6 and 20 tonnes per capita in 2007. Their share of direct material inputs (DMI) that was used for own domestic consumption (DMC) ranged from two thirds for Slovakia to 90 % for Greece and Malta.

A second group of eleven EU Member States had a DMI between 20 and 30 tonnes per capita. Their share of direct material inputs used for own domestic consumption ranged from 38 % for the

Netherlands to 95 % for Romania. Another group of seven EU Member States and Norway had a DMI higher than 30 tonnes per capita.
By making a side-by-side DMI and DMC comparison, three different types of economies can be characterised: (a) through-transport countries with both high imports and exports, (b) countries where domestic extraction is used mostly at home and (c) extraction exporting countries.
Belgium, the Netherlands and Luxembourg are economies with high DMI but significantly lower DMC due to a high level of imports that are again exported. In contrast, the economy of Ireland is characterised by high resource requirements (DMI is second highest per capita) which are predominantly for domestic use. Finland shows a similar pattern also due to a high use of extracted natural resources in their own economy. On the other hand, Norway shows a unique pattern with the highest DMI per capita of all European countries at 82 tonnes in 2007. Norway has a high resource extraction based economy with the majority of the material being largely exported. This is seen with DMC being only 45 % of DMI. Norway is the largest net exporter of natural resources in the EU and EFTA region.
Due to data availability only the DMC of the EU-27 can be derived which was at 16.5 tonnes per capita in 2007.

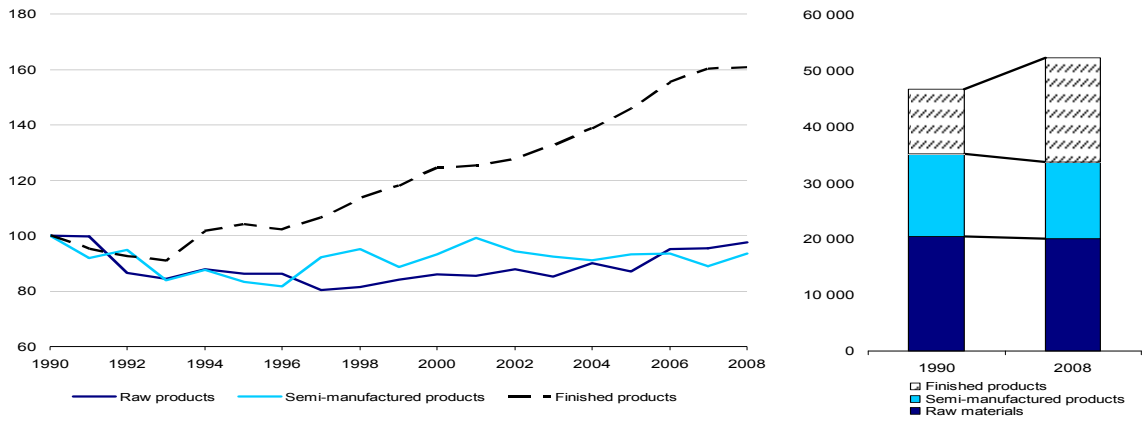
Resource use indicators – avenues for further development and improvement

Economy-wide material flow accounts provide insights into the material flows of economies at a very macro level. But the current methodology has an inherent asymmetry between trade data and domestic extraction data. This is especially the case for metals – where the trade data includes products that are refined into "metal concentrates" while the domestic extraction data includes "gross ores." The traded products are more highly processed than the gross ores and this makes a big difference in terms of mass of the rock removed from the ores to get to a metal concentrate. Two different approaches are being tried in order to improve the methodology. Both efforts focus on processing the trade data in different ways and a short description of these two different efforts to adjust the calculations are shown below.

Imported products according to level of processing

The economy-wide material flow accounts show that total imports are increasing in the EU-27 (see Figure 4) but the types of imported products that are making the largest contribution to this increase are not possible to determine from the data currently collected by Eurostat. However, if the traded products are classified into rough processing stages, some interesting information about imports can be obtained. Switzerland has differentiated their imports into finished products, semi-manufactured products, and raw products, and Figure 7 shows that the country is increasingly importing finished products. This may also lead to shifting the associated environmental burden abroad.

Figure 7: Imports by level of processing: raw products, semi-manufactured products and finished products, 1990-2008. Left: Index 1990=100; Right: Thousand tonnes



Source: Bfs 2008 and personal communication, Mr. Florian Kohler 2010

Converting imports and exports using Raw Material Equivalents (RME)

The data sources used for compiling domestic extraction include primarily agriculture, fishing, forestry, mining and energy statistics. We are measuring this extraction in tonnes of raw materials – before they are converted into products.

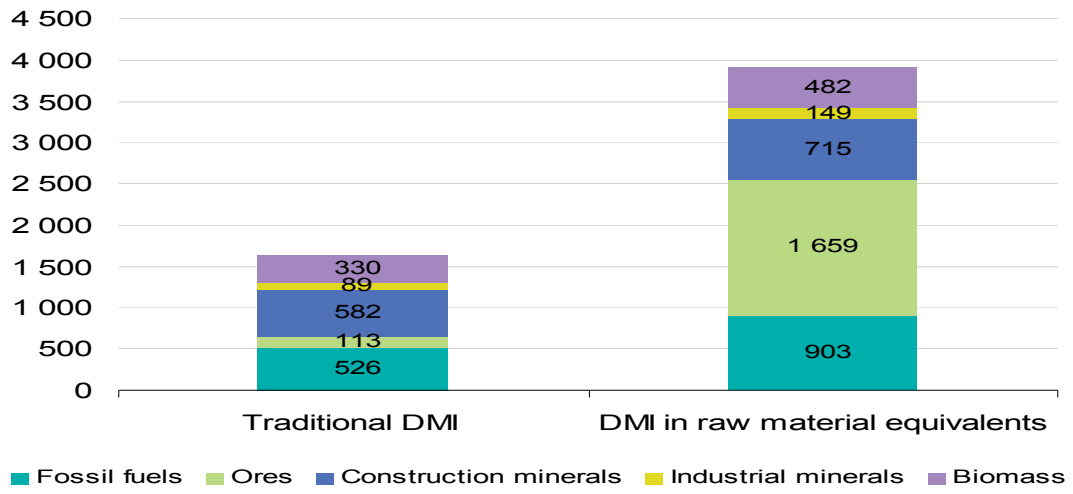
These figures for domestic extraction of raw materials are then combined with trade data to compile the input side of economy-wide material flow accounts.

This approach has an inherent asymmetry – domestic extraction is looking at raw materials while trade is looking at products. One way to overcome this is to estimate the total amount of raw materials extracted abroad that were needed to make the imported products.

Germany and the Czech Republic are testing this methodology. In Germany, the Federal Statistical Office is developing an indicator for the German national sustainability strategy that converts imports into the associated raw material equivalents - RME (Buyny et al., 2009).

As the following figure shows, the DMI in raw material equivalents for Germany in 2005 was about 2.4 times higher than DMI derived using the traditional approach. The most obvious difference was for metals which are often imported in a highly concentrated form or as pure metal, and therefore enormous amounts of raw materials extracted from nature in the countries of origin are left out.

Figure 8: Relation between traditional DMI and DMI in Raw Material Equivalents. Germany, 2005 (million tonnes)



Source: Buyny et al., Weiterentwicklung des direkten Materialinputindikators (2009)

Eurostat is following this work with interest and is supporting the improvement of material flow accounts in general. The work being done in Switzerland, Germany and the Czech Republic looks promising and could bring additional useful information about material flows in European economies.

METHODOLOGICAL NOTES

Sources of data:

Typically the data used to compile economy-wide material flow accounts are already available from production, consumption and trade data in combination with environment statistics. Eurostat is currently developing economy-wide material flow accounts which take an aggregated approach at tracking materials. At the current time the focus is on the input side of the accounts but it is worth noting that the accounts as a system covers both the input and the output sides of economic activity.

Eurostat data on material flows in Europe are available by country, material category, indicator and year. Data are published for the EU-27 (partly) and each of its Member States and for Norway, Switzerland and Turkey in units of 1000 tonnes.

The data for this SiF resulted from the second Eurostat Economy-Wide MFA Questionnaire launched in 2009 and represent data closest to quality standards set by the Eurostat compilation guide (Eurostat 2009).

If no data are available for a certain country, material and/or year, estimates are made by Eurostat. Currently all data are estimated for BE and CY. Only the trade data are estimated for EL, FI, MT and NO using Eurostat's COMEXT trade database.

Complete gap-filled data are available for 2000–2007. The data are available by detailed material categories for all 27 EU members plus Switzerland, Norway and Turkey. Some countries have reported figures before 2000 and are available in the Eurostat database but full gap-filling/estimations have not been performed for these data.

EU aggregates are calculated by summing up the gap-filled national figures. The EU-aggregates are only made available for the aggregated material categories (biomass, metallic minerals, non-metallic minerals and fossil energy materials/carriers) in order to preserve the detail in country data and respect confidentiality.

Since the figures for the materials sand and gravel and grazed biomass are estimated by countries using a number of different inputs to arrive at these estimates, there can be a fair amount of uncertainty in the figures and totals in this methodology. Also please note that water is excluded from this methodology.

Domestic extraction (used) is the input from the natural environment to be used in the economy. This is the annual amount of raw material (except for water and air) extracted from the natural environment.

Domestic Material Consumption (DMC) is defined as the total amount of material directly used in an economy. DMC does not include upstream hidden flows related to imports and exports of raw materials and products.

Domestic Material Inputs (DMI) is not additive across countries. For example, to calculate EU totals for DMI the intra-EU foreign trade flows must be subtracted from the DMIs of Member States. Theoretically, the exports from country A to country B should equal the imports to country B from country A and can be netted out. The quality of the intra-EU trade data does not easily allow for the netting out of these flows so aggregated EU DMI calculations have not been made at this time.

Physical Trade Balance (PTB) is calculated by taking the amount of imports in physical units minus exports in physical units.
Relationships between the different concepts:
DMC = Domestic extraction + Imports – Exports
DMI = Domestic extraction + Imports
PTB = Imports – Exports

Resource productivity is calculated by the ratio between gross domestic product (GDP) and domestic material consumption (DMC).

GDP is a monetary variable, which reflects both the volume of goods and services produced and their prices. For comparing one geographic area over time the GDP which excludes inflation needs to be used or, more precisely, volume series for GDP are used.

When comparisons of resource productivity between countries are going to be made, the GDP that removes the differences in price levels between countries needs to be used, i.e. GDP in purchasing power standards (PPPs).

Valuable comments and help provided by
colleagues from the environmental accounts and climate change unit (E7).

References:

Eurostat (2009): Economy-wide material flow accounts compilation guide
Weiterentwicklung des direkten Materialinputindikators (2009)
Besoins matériels de la Suisse (2008)
Commission Communication: A resource-efficient Europe – Flagship initiative under the Europe 2020 Strategy, COM(2011) 21, Brussels, 26.1.2011

Country codes:

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

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