



D A T A L A B

Overview

General Commission for Sustainable Development

Material Footprint: an indicator reflecting actual consumption of raw materials

APRIL 2018

Following the example of other environmental footprints (such as the carbon footprint), the “material footprint” is an indicator that allows us to take into account the full amount of raw materials used to satisfy a given country’s level of domestic consumption. The results provide a better representation of the true impact of resource use, including both materials extracted within the country and those mobilized indirectly outside our borders in order to produce and transport imported products. The inclusion of indirect material flows raises significantly the level of the quantified apparent flows. These indirect flows involve, notably, imports of fossil fuels and metallic minerals, both of which contribute to increasing France’s material footprint. Our national footprint stood at 13.2 tonnes per capita in 2014, yet remains lower than the European average, and has fallen slightly since 2008.

MATERIAL FOOTPRINT: A BROADER SCOPE THAN THE APPARENT DOMESTIC MATERIAL CONSUMPTION

Domestic Material Consumption (DMC) is one of the indicators being monitored under France’s law on Energy Transition for Green Growth, as well as in the context of our sustainable development objectives. However, the DMC is insufficient to take into account the full range of raw materials actually being mobilized in order to satisfy domestic demand for goods and services from resident economic agents. Indeed, while DMC does take into account the tonnage of materials extracted domestically (to which imports are added and exports subtracted), this indicator does not include indirect flows of raw materials being mobilized, particularly during production processes overseas and transport towards our national borders. Recent work by international organisations has provided new data modelling for these indirect flows (see *Methodology*): these models provide us with a figure for *Raw Material Consumption* (RMC), expressed in “*Raw Material Equivalent*” (RME), otherwise referred to as the “Material Footprint”.

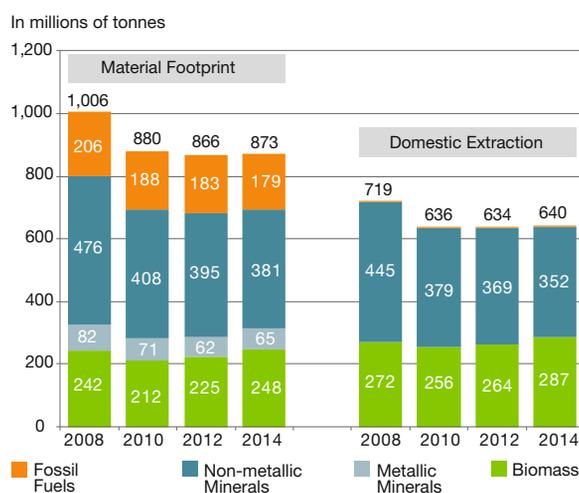
The Material Footprint follows the same concept as carbon or water footprints, and efforts are underway to apply this indicator on an international scale.

MATERIAL FOOTPRINT EXCEEDS DOMESTIC EXTRACTION BY ROUGHLY ONE THIRD

In 2014, domestic extraction in France stood at 640 million tonnes (Mt), or 9.7 tonnes per capita (t/cap). This figure is mostly comprised of non-metallic minerals (55%, down from 62% before the 2008 recession) and biomass (45%); in terms of RME, the relative proportion of these two material groups does not differ significantly from direct material flows (*graph 1*). However, as extraction quantities of metallic minerals and fossil fuels are very low in France (0.2% of domestic extraction), these material are essentially imported. In total, the material footprint is superior to domestic extraction by a factor of roughly one third.

The 2008 recession was followed by a some stabilization; the effects of the crisis were felt particularly in the construction sector, which led to a lower mobilization of mineral raw materials (especially gravel, sand and aggregate).

Graph 1: evolution of the material footprint and the domestic extraction

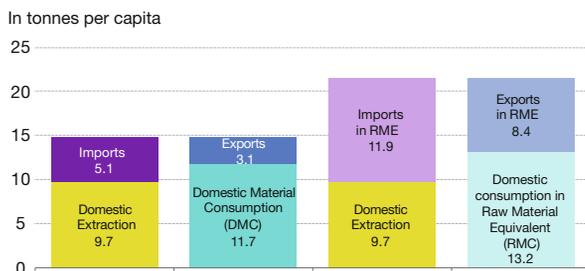


Sources: SDES; French Customs; Eurostat. Statistical processing: SDES, 2017

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Domestic material consumption (DMC) stood at 11.7 tonnes per capita in 2014. In terms of raw material equivalent (RME), however, this figure rises to 13.2 t/inhab (Graph 2).

Graph 2: material flows, apparent and in terms of Raw Material Equivalent, France 2014



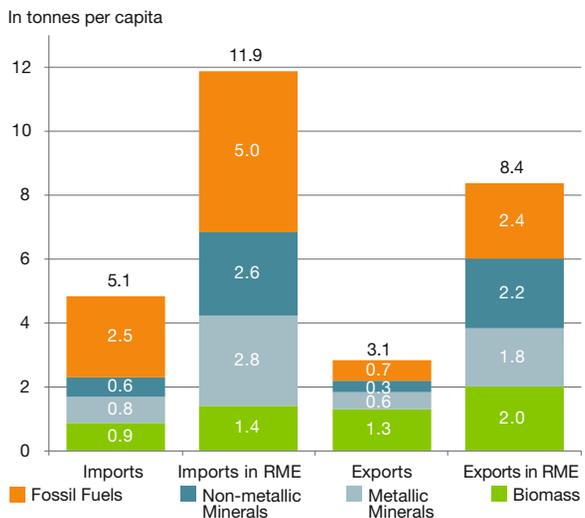
Sources: SDES; French Customs; Eurostat. Statistical processing: SDES, 2017

While total imports (340 Mt) reached 5.1 t/cap (accounting only for tonnages registered in customs statistics), the figure rises by a factor of 2.3 when expressed in terms of RME: 11.9 t/cap. Similarly, exports (202 Mt or 3.1 t/cap), when measured in terms of RME are multiplied by a factor of 2.7 (8.4 t/cap). This results in an increased trade balance, which in turns explains why the consumption level, when expressed as RME (the RMC, or material footprint, 873 Mt), is higher than the weight of apparent consumption (DMC, 777 Mt).

IMPORTS OF FOSSIL FUELS AND METALLIC MINERALS SIGNIFICANTLY HEAVIER WHEN EXPRESSED AS RME

The breakdown of trading flows by material type (graph 3) shows increased dependence on fossil fuel imports (petrol, natural gas, coal): a measurement of direct material flows gives us 2.5 t/cap in 2014 (half of total imports through

Graph 3: comparison between weight of goods exchanged and their Raw Material Equivalent levels, France 2014



Sources: SDES; French Customs; Eurostat. Statistical processing: SDES, 2017

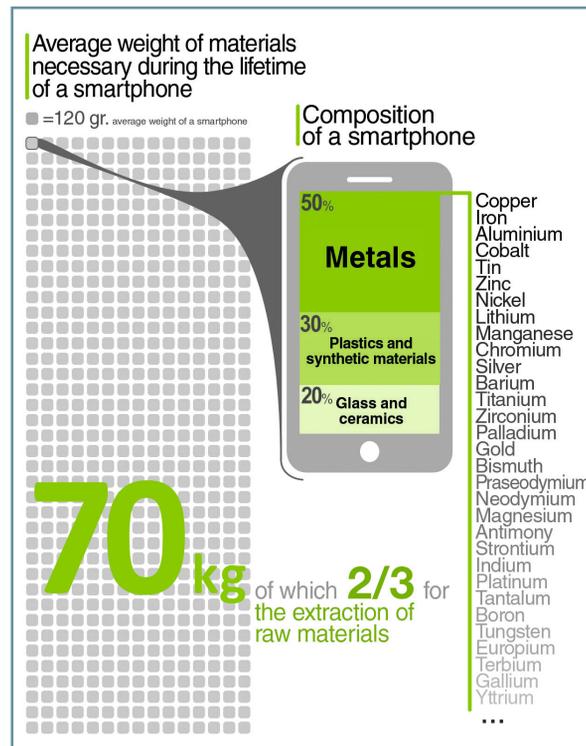
customs); when indirect flows are taken into account, this figure doubles to 5 t/cap in terms of RME. For metallic minerals, the relationship between direct material flows and RME rises to a factor of 3.

Regarding exports, biomass (1.3 t/cap, or 42% of total direct exports) only represents a quarter of total tonnage in terms of RME (2 t/cap). In effect, these materials (produced via agriculture and fishing) are widely available within the country, meaning that indirect flows are proportionally lower.

From the extraction of raw materials, through the development of semi-finished products, to the production of final products, tonnages of goods exchanged (expressed in RME) are higher than the weight of goods alone. The French material footprint (13.2 t/cap in 2014) is lower than the average across the EU's 28 countries (14.2 t/cap).

APPARENT LIGHTNESS FOR HEAVY IMPACTS

The material footprint can be calculated based on the life cycle analysis method (production, use, disposal) of a given product. According to the Wuppertal Institut, to produce, use and dispose of an average smartphone weighing 120 grams requires around 70 kg of materials and involves the use of over 70 different material types. These items contain significant amounts of precious (gold, silver, palladium, etc.) and rare metals (lithium, tantalum, cobalt, etc.), very costly and difficult to extract.



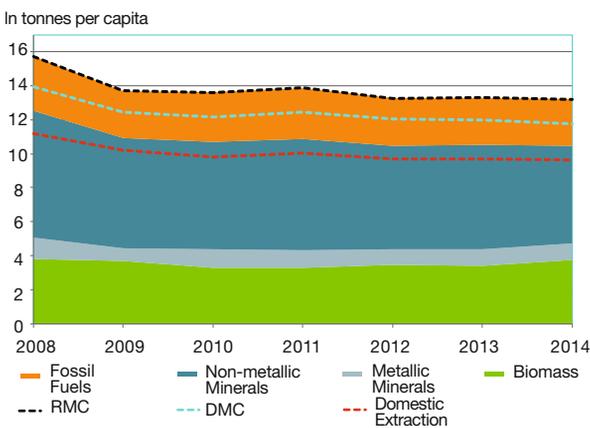
Sources: Ademe; French Senate (report n° 850, 09/2016); Wuppertal Institut (2012), assessment using the ecologist Friedrich Schmidt-Bleek's weight-material approach
 Infographics: Bertrand Gaillet

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SIMILAR EVOLUTION FOR MATERIAL CONSUMPTIONS IN THE POST-RECESSION PERIOD

The evolution of construction materials consumption is a determining factor in overall consumption, due to the fact that these materials account for a major proportion of apparent consumption (DMC) and Raw Material Equivalent consumption (RMC) (Graph 4). As domestic extraction represents 80% of DMC, trends observed over the period for these two indicators are similar, which is also the case for RMC.

Graph 4: domestic consumption in Raw Material Equivalent (RMC) by main materials categories, France



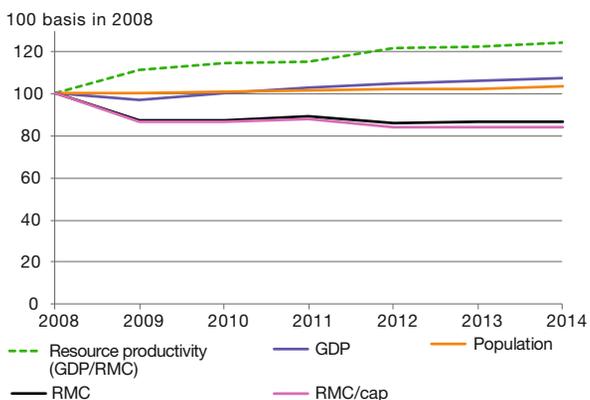
Sources: SDES; French Customs; Eurostat. Statistical processing: SDES, 2017

At the end of this period, the breakdown of the material footprint (by broad material types) remains the same as at the beginning of the period, though on a lower scale: 44% for non-metallic minerals, 28% for biomass, 21% for fossil fuels and 7% for metallic minerals.

RESOURCE PRODUCTIVITY CONTINUING TO INCREASE

Following the decrease in production activity in 2008, economic growth has recovered, as material consumption has stabilized. This has resulted in a rise in resource productivity, an indicator which links Gross Domestic Product to material consumption (GDP/RMC) (Graph 5).

Graph 5: evolution of resource productivity in France



Sources: SDES; French Customs; Eurostat. Statistical processing: SDES, 2017

The disproportion between the amount of construction materials represented in overall material consumption (50%) and the sector's representation in GDP (6%) plays a major role in the evolution of the material productivity indicator. Over the course of the 2008-2014 period, the upward trend of this indicator means for the national economy a lesser need for materials in order to create the same amount of wealth.

The development of resource productivity is similar in France and Europe, as is their respective material footprint: over the 2008-2014 period, the ratio in France rose from 2 to 2.5 €/kg while the EU-28 average rose from 1.5 to 2 €/kg.

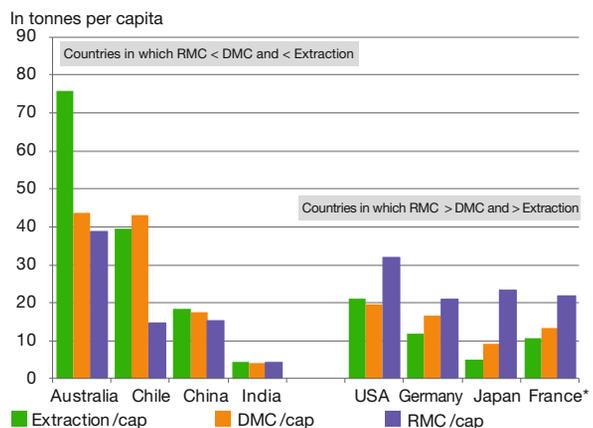
The environmental pressure exerted by the use of resources evolves less quickly than other factors which tend to increase this pressure (here, this refers to wealth creation, which is reflected by GDP). In terms of material consumption and economic growth, over the 2008-2014 period we observe a progressive decoupling of the two factors. However, this must be put into perspective by taking into account the significant weight of construction materials, as national consumption of materials will always follow trends in this sector.

HIGHER FOOTPRINT FOR COUNTRIES WHICH ARE IMPORTERS AND CONSUMERS OF MATERIALS

The International Resource Panel – United Nations Environment Program (UNEP-IRP), a group of scientific experts, alongside the Intergovernmental Panel on Climate Change (french GIEC) has published Material Footprint results for almost every country in the world: a certain typology stands out regarding countries material consumption (both DMC and RMC).

The material footprint reallocates the amount of materials effectively extracted to the countries which actually consume those materials. Countries which are net exporters of raw materials generally have an RMC that is lower than their DMC and their extraction (graph 6). In effect, when the footprint is calculated, the significant levels of indirect flows linked to exports (for example, materials necessary for the production of exported metals) being deducted, their RMC appears lower than their domestic materials consumption. Chile, for example, which is a major producer of copper, has a material footprint 2.5 times lower than its DMC. Conversely,

Graph 6: material footprint (RMC), domestic material consumption (DMC) and domestic extraction worldwide in 2010



*France: Eurostat (RME tool) estimates Extraction, DMC & RMC at 9.8, 12.1 and 13.6 t/cap. [see Methodology]

Source: UNEP – IRP (2016)

countries which import more raw materials than they export (such as France) have an RMC greater than their DMC, as indirect flows linked to imports are factored into the calculation of their material footprint. While for France the additional weight is over 50% (source: UNEP-IRP), Japan, which depends very heavily on imports, has a material footprint that is over double its level of direct consumption and almost 5 times its level of domestic extraction.

While industrialized nations tend to present a certain level of decoupling between growth and the use of materials, this is partially the result of the outsourcing of industrial and mining operations to emerging and developing countries.

Emerging nations, which were less affected by the 2008 crisis, are continuing to develop and catching up to the standards of living of western countries in terms of their levels of consumption and investments (*supported by their demography*) and are therefore extending their material footprint: in 2010, this had reached the global average (10 t/cap), which is lower by half than that of developed countries (20 t/cap).

Global extraction of materials has tripled since 1970. According to the IRP, 70 billion tonnes of materials were extracted in 2010 this could rise to 180 bn in 2050 if previously-observed trends continue. The average global footprint may reach 20 t/cap, or double its current level.

METHODOLOGY

Various methods exist for estimating the material footprint, depending on the entity for which the figure is being calculated (country, product, economic sector, etc.). These are based on technical production information (product life cycle analyses, see *smartphone infographic*), as well as data on activity sectors combined with macro-economic coefficients and statistics.

For France, in *graphs 1 - 5*, material flows linked to imports/exports are based on coefficients calculated by Eurostat on an EU-wide level, using an input-output method that combines input-output tables (IOTs) from national accounts and Material Flow Accounts (MFA). In the absence of similar data for exporting countries, Eurostat uses results of life cycle analyses in order to account for production conditions in other countries for certain products (metals, fossil fuels, etc.)

For international comparisons (*Graph 6*), UNEP-IRP uses results issuing from a multi-regional input-output model closed at global level, known as Eora. In monetary terms, the IOTs describe the economic and trade structure of each country, in addition to a physical accounting sheet for their domestic extraction. This model enables the production of material footprint data for a large number of countries.

France's material footprint, calculated using the Eurostat model, was 13.6 t/cap in 2010, as opposed to 20.2 t/cap based on the Eora model. Roughly 40% of the disparity between these two results (or 2.5 t/cap) may be attributed to biomass. In the data used by UNEP-IRP, the figure for biomass extraction in the EU is 25% higher than the Eurostat data. Furthermore, 30% of the disparity (1.7 t/cap) involves minerals used in construction.

The UNEP-IRP method tends to overestimate imports in this sector: for example, in China, the extraction of these minerals (notably for major infrastructure projects), should be attributed mostly to the footprint linked to final demand in China itself. However, this method could wrongly attribute the extraction of materials to a proportion of Chinese exports, which will have the knock-on effect of raising the footprint linked to the import of these materials into France.

FOR MORE INFORMATION:

- *10 key indicators for monitoring the circular economy, CGDD/SDES, Datalab n° 18, March 2017.*
- *Producing more with less materials, CGDD/SEEIDD, Théma, March 2017.*
- *MFA – Flows in Raw Material Equivalents, Eurostat.*
- *Comparison of footprints, results per sector of activity and material, K. Mohkam, SEEIDD; O. Simon, Insee. Théma Analyse (forthcoming).*

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Copyright: April 2018
ISSN: 2557-8510 (on-line)
ISSN: 2555-7572 (in print)
Printing: Bialec, Nancy (France),
on paper sourced from sustainable forests.

Publication Director: Sylvain Moreau
Head Editor: Anne Bottin
Editorial Coordinator: Claude Baudu-Baret
Layout and production: Chromatiques, Paris

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