

## The hidden face of materials mobilised by the French economy

*The per capita material input of France's economy, 15 tonnes in 2010, rises to 22 tonnes per capita when considered in raw material equivalent terms (i.e. including resources used in other countries for imports) and to 40 tonnes per capita when movements of unused materials (excavated for construction, eroded agricultural soils, etc.) are taken into account. Thus, for a car, whose manufacture involves numerous stages, the total of raw materials extracted amounts to between 7 and 10 times the weight of the vehicle. Around 35% of the raw materials needed to satisfy all of France's consumption are mobilised in other countries.*

**E**conomic activity makes use of natural resources. Material flow accounting (*Methodology*) provides a description at national level of the materials related<sup>1</sup> aspects of this use. This form of accounting covers both *apparent flows* (i.e. materials used in the economy, extracted within national boundaries or imported) and *hidden flows* (i.e. materials moved during activity but not used as well as resources used in other countries for production of imported goods) (see Box 1). The mobilisation of these hidden flows by the economy exerts a pressure on the environment: risk of depletion of some natural resources, soil erosion and impacts on natural environments and habitats. In addition, movement of most of these materials, even unused, can also consume a great deal of energy.

### The manufacture of a car mobilises a weight of materials at least 7 to 10 times greater than the weight of the materials constituting the vehicle

Given the emblematic nature of the motor car in present-day industrial societies, its manufacture provides a good illustration of the different material flows mobilised by the French economy.

<sup>1</sup> Mobilisation of water is not included here. It is the object of an accounting process that is kept separate owing to the scale of the masses involved.

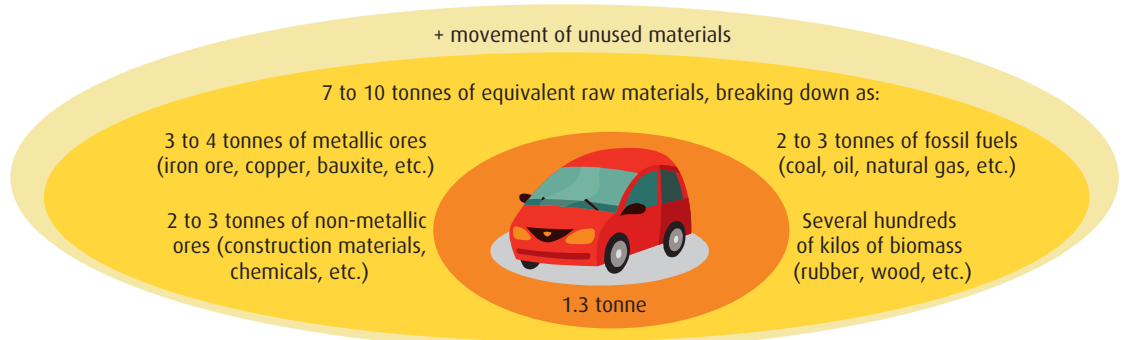
The average weight of a European private car is estimated at around 1,300 kg (700 to 800 kg of steel, 100 to 150 kg of aluminium, a few kilos of other metals, 50 to 70 kg of glass and 50 to 100 kg of other materials such as fluids and textiles).

#### Box 1 – What makes up the hidden flows?

There are hidden flows associated with each of the apparent flows of materials or products extracted within a given territory, imported, stored within a territory or exported. These flows are made up of the quantities of materials moved but not used (excavated material in the extractive and construction industries, soils eroded in connection with agriculture) or extracted but immediately discarded (mining overburden and tailings, crop residues). Where imports and exports are concerned, there are also indirect flows of raw materials used (notably fuels) that, since they are not incorporated into the materials used for the goods produced, do not cross territorial boundaries with the goods

**Raw material equivalents** (RME) express imported/exported goods in terms of their resource extraction equivalent, i.e. extracted ore, total biomass produced. The **hidden flows** also include materials mobilised but unused (excavated earth, eroded soils, etc.).

#### Apparent and hidden material flows associated with car manufacture



Source: Eurostat, Bio Intelligence Service, Wuppertal Institute. Modified SOEs, 2013

Extraction and transport of materials, their processing and then transport of the resulting manufactured products, as well as materials used for construction of the production facilities, all mobilise materials not entering into the composition of a vehicle. The weight of materials mobilised represents around 7 to 10 times that of the manufactured vehicle, not taking into account unused materials (excavated earth during construction of infrastructure, etc.).

### For France, the weight of hidden flows is at least equivalent to the apparent flows

In 2010, the (apparent) material input was estimated at 15 t/capita (*Graph 1*). In RME terms (*Methodology*), the input rises to 22 t/capita and to a minimum of 40 t/capita when the unused material flows are added (excavated earth, eroded agricultural soils, etc.).

After deduction of exports, apparent domestic consumption is 12 t/capita. In RME terms it is 15 t/capita and, with movements of unused materials, the weight reaches 26 t/capita, more than twice the apparent consumption.

Taking account of the material flows mobilised in other countries to satisfy French consumption, in addition to domestic material consumption, approaches the notion of “environmental footprint” (see Box 2).

Metals predominate in the composition of hidden flows. In their case, the weight of the hidden flows is, on average, 10 times that of the apparent flows, whereas for the other material categories the hidden flows represent, on average, from one to four times the apparent flows. This difference is a determining factor for France, which virtually no longer extracts any metals within its territory (including in its overseas departments and territories).

The weight of earth excavated during construction activities (housing and transport infrastructure, *Methodology*) is estimated to be at least 200 million tonnes (Mt), that is to say 3 tonnes/capita. In addition, mineral waste (unpolluted soils and pebbles) arising from construction and public works is estimated at around 180 Mt<sup>2</sup>. The difference is accounted for by reuse of earth on the work sites on which they are excavated (fill material, landscaping, etc.).

The hidden flows associated with biomass (excluding eroded agricultural soils) consist of agricultural crop residues left in the fields (around 60 Mt) and wood harvest residues (10 Mt). Agricultural residues consist mainly of straw (50%); it should be borne in mind that these also contribute to fertilisation of the soil.

Erosion of agricultural soils is usually assessed in terms of risk rather than as weight of soil. For France this is, nonetheless, estimated to be 100 to 150 Mt per year (1.5 to 2.5 t/capita), depending on whether or not farming techniques, growing without ploughing and the presence of intermediate crops, are taken into account.

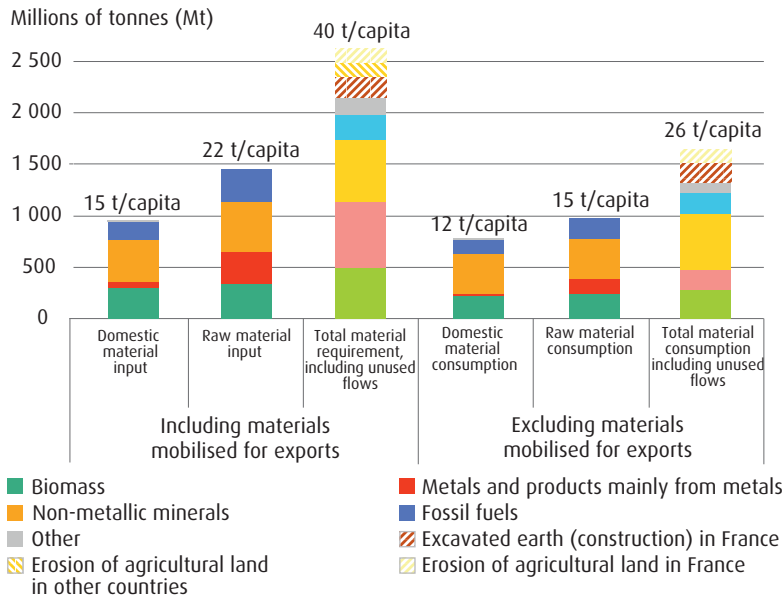
### A net physical imports trade balance

Accounting for the indirect flows associated with imports/exports enables estimation of the mobilisation/consumption of materials by the French economy at the global level. In other words, this is equivalent to estimating the scale as if all of the resources mobilised issued from French territory.

In terms of apparent flows, France's net imports (imports minus exports) represent hardly 20% of its material consumption. As RME, they represent around 35%, that is to say when the associated indirect material flows are taken into account.

<sup>2</sup> Unpolluted soils and pebbles from construction and public works were estimated at 175 million tonnes for 2008 (CGDD/SoeS, 2011, Chiffres & statistiques, n° 230 & 231) and all mineral wastes increased by 2% between 2008 and 2010 (CGDD/SoeS, Chiffres & statistiques, n° 385).

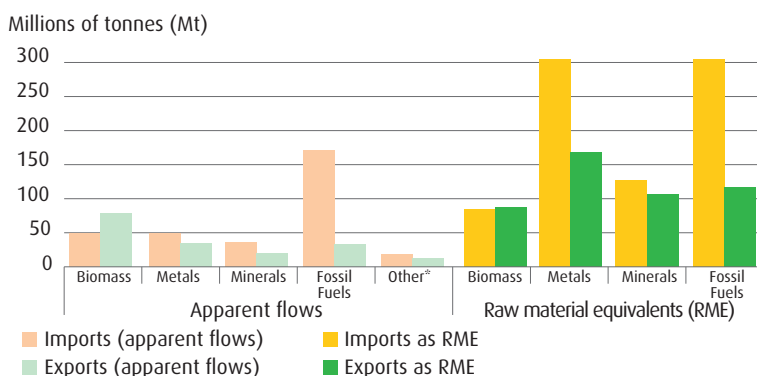
**Graph 1 – Apparent material input and consumption and hidden flows of materials mobilised by the French economy (2010)**



Note for readers: for flows given as RME, the weights correspond to categories indicated (biomass, metals, etc.); for total mobilisation of materials (light colours), each of these categories covers the apparent flow plus all of the associated hidden flows, including materials of different types mobilised in the different economic stages (e.g. fuels associated with production of imported biomass).

Source: Agreste (SSP), Bio Intelligence Service, French Customs and Excise, Eurostat, Insee, Unicem, Solagro, SOeS, Wuppertal Institut. Modified SOeS, 2013

**Graph 2 – Apparent material imports and exports for France and corresponding RME (2010)**



\* Various manufactured products, chemicals and textiles. In the as RME accounts, these products are spread over the different material categories.

Source: French Customs and Excise, Eurostat, SOeS. Modified SOeS, 2013

France's physical trade balance for 2010 showed a deficit of 145 Mt. Net imports of fossil products (136 Mt of which around 90 Mt were oil) are the main reasons for the deficit. Only the biomass category showed a positive trade balance (29 Mt).

In RME terms, the deficit was 340 Mt. Fossil fuels are responsible for over 50% of this since they are included as fuels used abroad for manufacturing and transport of imported goods and services. Metals contribute to 40% but are the main reason for doubling of the deficit in relation to the apparent flows alone, the ratio between the weight of ore extracted and metals used being particularly high (*Graph 2*).

When unused materials are taken into account, the deficit is close to that for apparent flows only, given France's positive trade balance in the area of agriculture: the estimate of the weight of eroded soil associated with France's agricultural exports exceeds that associated with imported agricultural products.

### The weight of hidden flows increases with the degree of product finishing

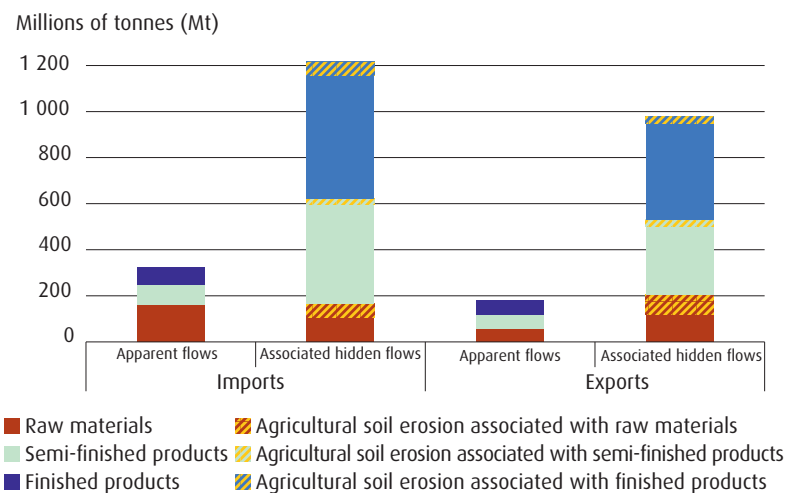
In addition to the nature of materials, the scale of hidden flows associated with imports and exports also depends on the degree to which the products are finished (raw materials, semi-finished products or finished products). The ratio between weight of hidden flows and that of the products with which they are associated tends to increase with stages of processing (*Graph 3*).

In 2010, 1 to 2 tonnes of hidden material flows (excluding eroded agricultural soils) were associated with each tonne of raw materials imported to/exported from France (agricultural and forestry products, ores and raw minerals). The ratio rises to an average of 5 for semi-finished products (agricultural products that have undergone initial processing; cut wood; metal ingots, bars, wires or sheets; etc.) and to 7 for finished products (processed foods, furniture, industrial equipment or household appliances, etc.).

For raw materials, the ratio is markedly higher for exports (around 2) than for imports (less than 1). This is, first, because of oil, which predominates in French raw material imports at 70%, and for which the ratio of hidden flows to apparent flows is less than 1. Second, agricultural products, for which ratios are between 2 and 3, also represent a high proportion (70%) of France's raw material exports.

Since 1990, no significant change has been observed in the distribution of the weight of French imports/exports between the three levels of degree of finishing of products.

**Graph 3 – Imports and exports by degree of product finishing and corresponding hidden flows (2010)**



Note for readers: in 2010, the hidden flows corresponding to the 150 Mt of raw materials imported into France were estimated at 165 Mt, of which around 60 Mt were erosion of agricultural soils (brown shading on yellow background). For exports, the figures are respectively 60 and 210 Mt (of which 90 Mt for erosion).

Source: Bio Intelligence Service, French Customs and Excise, Eurostat, Insee, SOEs, Wuppertal Institute. Modified SOEs, 2013

### Box 2 – Other flows associated with imports and environmental footprints

Other hidden flows associated with imports are also taken into account, representing the environmental pressures exerted abroad by manufacture and transport of imported goods and services. This is, notably, the case for calculation of the footprint representing the consumption related pressures exerted on the environment, either directly by households or indirectly by industrial, trade or administrative activities producing (in France or elsewhere) the goods and services that meet domestic demand (excluding exports).

In addition to the Global Footprint Network's "Ecological Footprint" (<http://www.footprintnetwork.org/en/>), other footprints are now being calculated in different areas: greenhouse gas emissions (carbon footprint)<sup>3</sup>, energy<sup>4</sup> or water<sup>5</sup> consumption.

The terminology used to designate the indirect flows associated with imports varies depending on the area: expressions such as "grey energy" or "virtual water" are used (with "embodied" or "embedded" energy/water being more common in the international arena).

<sup>3</sup> CGDD/SOEs, 2012. L'empreinte carbone de la consommation des Français: évolution de 1990 à 2007 (*carbon footprint and French consumption: development between 1990 and 2007*), Orléans, Service de l'observation et des statistiques, Le Point sur n° 114, March 2012, 4 p.

<sup>4</sup> Pourouchottamin P, Barbier C., Chancel, Colombier M., 2013. Nouvelles représentations des consommations d'énergie (*new representations of energy consumption*), Ademe/Cired/EDF/Idri, Les cahiers du Club d'ingénierie prospective énergie et environnement (CLIP) n° 22, April 2013, 76 p.

<sup>5</sup> CNE, 2013. « Quels sont les usages de l'empreinte eau ? » (*what are the uses of the water footprint?*) in Comment améliorer le financement et la durabilité des services publics d'eau et d'assainissement français ? (*how can financing and sustainability of France's public water and sanitation services be improved?*), Comité national de l'eau/Comité consultatif sur le prix et la qualité des services publics d'eau et d'assainissement, December 2013, pp. 223-225.

## Methodology

The Service de l'observation et des statistiques (SOeS) draws up annual accounts of material flows at the national level. Eurostat collects information covering the so-called "apparent" flows in the European Union countries per Annex III of European Regulation No. 691/2011 on European environmental economic accounts, and has also undertaken work to draw up accounts on an RME (raw material equivalents) basis, with the aim of:

- estimating the flows of imported/exported materials in a manner that is in line with that used to estimate domestic extraction. In the accounts drawn up under Reg. 691/2011, domestic extraction is expressed in RME (e.g. weight of extracted ore, total weight of biomass produced, etc.), whereas most products are imported/exported after at least one processing stage (the difference is particularly great for metals);
- improving coherence with national accounting. In the accounts drawn up under Reg. 691/2011, intermediate consumption abroad (vs. consumption in France) associated with production of imported (exported) goods and services is not included in (deducted from) domestic material consumption (difference affecting, notably, fuels);
- breaking down all of the flows by categories of materials, including after spread of the weights of finished products over the different categories of materials comprising them. In the accounts under Reg. 691/2011, the entire weight of finished products is included in the category of their principal constituent.

Calculation of flows in RME terms is based on an input-output type of method combining input-output tables (sometimes altered to allow inclusion of physical information) and material flow accounts broken down by sector. For imports, life cycle analysis (LCA) data are also used to take account of products not manufactured locally, of the metal content of original ores and of the energy mixes in countries of origin. On this basis, the quantity of raw materials mobilised to satisfy the demands for goods and services of a given economy is calculated. Estimates for imports in RME terms are based on European-average coefficients calculated for Eurostat (see Eurostat 2012); for exports, the structure of France's economy is taken into account (input-output tables for 60 sectors/products).

The total hidden flows associated with imports/exports are calculated with coefficients relating the weights of hidden flows to those of apparent flows. The set of coefficients currently available (in 2010) covers 58% of the Customs and Excise codes corresponding to products imported into France and to 57% of codes corresponding to products exported from France, leading to an under-estimation of the hidden flows. Establishing coefficients is based on

LCA results, from which the weight of materials mobilised from raw material extraction through processing to sale of the final product is estimated. Domestic extraction of unused materials (excavation of material for extractive or construction activities, erosion of agricultural soils) is estimated using technical coefficients applied to the physical statistics for the activities in question (extracted or harvested materials, length of transport network or surface area of dwellings built). To date, SOeS has relied exclusively on coefficients developed by the Wuppertal Institut für Klima, Umwelt, Energie GmbH (EEA, 2001) based on the German situation. SOeS has now had additional work carried out to refine knowledge of the hidden flows.

### For further information

- CGDD/SOeS, 2013. « Matières mobilisées par l'économie française de 1990 à 2011 : une relative stabilité perturbée par la crise économique », *Chiffres & statistiques*, n° 410, April 2013, 8 p. <http://www.statistiques.developpement-durable.gouv.fr> > Click on Chiffres & statistiques > Environnement
- EEA, 2001. *Total material requirement of the European Union*, Prepared by Stefan Bringezu and Helmut Schütz (Wuppertal Institute), European Environment Agency, Technical report n° 55, 37 p. [http://www.eea.europa.eu/publications/Technical\\_report\\_No\\_55](http://www.eea.europa.eu/publications/Technical_report_No_55)
- Eurostat, 2012  
*Project: Estimates for Raw Material Consumption (RMC) and Raw Material Equivalents (RME) conversion factors*, 3 p.  
*In physical terms the EU-27 imports three times more than it exports*, Statistics in Focus, n° 51/2012, Office for Official Publications of the European Communities, Luxembourg, 8 p. [http://epp.eurostat.ec.europa.eu/portal/page/portal/environmental\\_accounts/introduction](http://epp.eurostat.ec.europa.eu/portal/page/portal/environmental_accounts/introduction) > Click on Economy wide material flow accounts (left column)

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le point sur

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