Definition of data and energy efficiency indicators in ODYSSEE data base

Project: ODYSSEE-MURE
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1. **Introduction**

This report provides a methodological guideline for the data necessary for the calculation of energy efficiency indicators for the ODYSSEE database. An Excel template is used by energy agencies or their representatives (partners of the ODYSSEE-MURE project) to provide all the data useful for the calculation of energy efficiency indicators, following the classification of EUROSTAT.

This methodological report explains how the ODYSSEE indicators are calculated, with a full description of all the indicators by sector with all the equations and necessary explanation for the interpretation of their trends. The raw data useful for the calculations of energy efficiency indicators are also clearly identified and defined in the different sectors.

1.1. **Why energy efficiency indicators?**

Energy efficiency indicators have several objectives:

- **monitoring** of the targets set at the national and international levels in energy efficiency and CO₂ abatement programmes.

- **evaluation** of the energy efficiency policy and programmes. Ministries, energy agencies or organisations in charge of the implementation of energy efficiency programmes need to provide regular evaluations to justify their action and the large amounts of public money that have been spent to support these programmes or to operate the energy efficiency agencies.

- **planning** of future actions, including R&D programmes,

- feeding the energy demand **forecasting** models and improving the quality of forecasts; technico-economic models, that are characterised by a high level of desegregation (end-uses), make use of energy efficiency indicators to account for future changes in energy efficiency.

- and, finally, **cross-country comparisons**, a crucial question in connection with international negotiations on climate change.

The set of indicators presented here have been selected and defined so as to enable countries to review their achievements in the field of energy efficiency and CO₂ emissions, in a comparable manner among countries, and to compare their energy efficiency performance among EU countries.

To reach this objective of harmonisation, the indicators are set up as follows:

- The data collection is decentralised and carried out by national teams, in general the national energy efficiency agency associated with the national statistical organisation, so as to get the best data available.

- The data are centralised in a common data base managed by Enerdata

- The control of the harmonisation of data definition and disaggregation is carried out by Enerdata.
The energy efficiency and CO2 indicators are calculated for all countries with a common methodology, both in a central database and in the data sheet used by national teams to fill in the data.

1.2. What are the energy efficiency indicators

Energy efficiency indicators considered here are macro-indicators, defined at the level of the economy as a whole, of a sector, or a sub-sector (industrial process, mode of transport, or end-use or in the household sector).

Three types of indicators are considered according to their role:

- Indicators to monitor trends in energy efficiency and CO2 abatement by country: descriptive and explanatory indicators
- Indicators to compare the energy efficiency “performance” level of a country with other countries
- Diffusion indicators to measure the diffusion (i.e. the market penetration) of efficient technologies and practices

1.2.1. Indicators to monitor energy efficiency trends

Four types of indicators are considered to monitor energy efficiency trends:

- Energy/carbon intensities, relating an energy consumption (measured in energy units: toe, Joule ...), or CO2 emissions to an indicator of activity measured in monetary units (Gross Domestic Product, value added ...).

- Technico-economic ratios or unit consumption/unit CO2 emission, relating energy consumption or CO2 emission to an indicator of activity measured in physical terms: (l/100 km for car, toe per ton of cement, kWh per refrigerator, goe per m² for space heating in dwelling etc.).

- Index of energy efficiency progress, called “ODEX”, defined at the level of sectors (industry, transport, households) or of the whole economy (all final consumers). This index is obtained by aggregating the unit consumption changes at detailed levels, by sub-sector or end-use, observed over a given period. The unit consumption variation is measured in terms of index, which enable the use of various units for the detailed indicator (kWh/appliance, toe/m²...). Using relevant physical parameters, the ODEX indicator provides a good “proxy” of the energy efficiency progress from a policy evaluation viewpoint. ODEX is an alternative to the aggregate monetary energy intensities to monitor energy efficiency trends by sector, as intensities include many factors that are not directly linked to energy efficiency. In a similar way, a CO2 index can be calculated.

- Energy/CO2 savings, expressing the variations of the ODEX, in terms of amount of energy saved (in Mtoe) or CO2 saved (in Mt), in comparison to a situation without energy efficiency progress.
These indicators can be gathered in 3 groups, according to their level of complexity and their capacity to explain the trends observed:

- **Headline/ descriptive indicators** that mainly **describe** overall energy efficiency trends, from a macro-economic point of view; these descriptive indicators are calculated from usual **official** economic and energy **statistics**, as a **direct ratio** between an energy consumption and a macro-economic variable.

- **Explanatory/issue indicators**, that go into more details (end-use, mode of transport) and aims at explaining trends observed for the headline indicators; such issue indicators may rely on usual statistics but also may be **estimated** or derived from **surveys**; they usually imply some **calculation procedures** using a conventional methodology ("calculated ratios"). Intensities at constant structure, ODEX or energy savings are explanatory indicators.

### 1.2.2. Comparison indicators

Two types of indicators are proposed to compare energy performances across countries:

- **Adjusted indicators**, that are **adjusted** for structural differences between countries to enable more accurate cross-country comparisons; the adjustments correct for differences in the countries’ economic (general price level, economic and industry structure), geographic or climatic situations. The EU average is usually taken as the reference for the adjustments. The adjustment to the same price level is done by using power purchasing parities. To be meaningful, the comparison should be made on the most recent year available and at current purchasing power parities or at constant power parities, with a recent base year (e.g. at 2010 ppp)

- **Benchmark or target indicators**, that indicates for a given country the gap between the actual values of some indicators and benchmark/target values. They are calculated for each country with the countries characteristics and the energy performance of “target countries” (e.g. the best EU performance) or benchmark values. The gap between the observed value for a given indicator and the target/benchmark value can show a feasible potential of energy efficiency improvement.

### 1.2.3. Diffusion indicators

These indicators aim at complementing the existing energy efficiency indicators. They are in principle easier to monitor and more rapidly updated than energy efficiency indicators that depend on the availability of data on end-use consumption.

Three types of indicators are considered:

- Market penetration of efficient technologies: number of efficient lamps sold, % of label A in new sales of electrical appliance, …
- Diffusion of energy efficient practices, % of passenger transport by public modes, by non motorised modes; % of transport of goods by rail by combined rail-road transport, % of efficient process in industry, …
- Market penetration of end-use renewable (number of solar water heaters, % of wood boilers for heating, …)
These indicators can then be used for to complement the evaluation of the sectoral trends in energy efficiency.

1.3. List of indicators by sector

Altogether, about 200 energy efficiency indicators are proposed by country. Three reasons explain the necessity to rely on such a large variety of indicators:

- First of all, each indicator answers to a specific question. Questions can be raised from a policy, economic or, technical viewpoint. Depending on the exact question, one or several indicators can be considered.

- Finally, energy efficiency has different meaning and frontiers (economic efficiency, technical efficiency). Depending on the perspective, some indicators may be more appropriate than others. Energy intensities provide for instance an assessment of energy efficiency from an economic point of view whereas unit consumption are more focused on technical energy efficiency.

The selected indicators are presented below by sector in Tables 1 to 5.

Table 1: List of macro indicators

<table>
<thead>
<tr>
<th>Indicator</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Energy efficiency index (ODEX)</td>
<td>index</td>
</tr>
<tr>
<td>• Headlines indicators</td>
<td></td>
</tr>
<tr>
<td>Primary energy intensity</td>
<td>koe/€2010</td>
</tr>
<tr>
<td>Final energy intensity</td>
<td>koe/€2010</td>
</tr>
<tr>
<td>Primary &amp; final energy intensity with climatic corrections</td>
<td>koe/€2010</td>
</tr>
<tr>
<td>Ratio final/primary intensity</td>
<td>%</td>
</tr>
<tr>
<td>• Issue indicators</td>
<td></td>
</tr>
<tr>
<td>Final energy intensity at constant GDP structure (with climatic corr.)</td>
<td>koe/€2010</td>
</tr>
<tr>
<td>• Comparison indicators</td>
<td></td>
</tr>
<tr>
<td>Primary &amp; final energy intensity at purchasing power parities (ppp)</td>
<td>koe/€2010ppp</td>
</tr>
<tr>
<td>Primary energy intensity by sector</td>
<td>koe/€2010ppp</td>
</tr>
<tr>
<td>Final energy intensity at reference climate (EU average) at ppp</td>
<td>koe/€2010ppp</td>
</tr>
<tr>
<td>Final energy intensity at reference economic structure at ppp</td>
<td>koe/€2010ppp</td>
</tr>
<tr>
<td>Final energy intensity at reference economic structure and climate at ppp</td>
<td>koe/€2010ppp</td>
</tr>
</tbody>
</table>
### Table 2: List of indicators for industry

<table>
<thead>
<tr>
<th>Indicator</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Energy efficiency index of industry (ODEX)</td>
<td>index</td>
</tr>
<tr>
<td>• <strong>Headlines indicators</strong></td>
<td></td>
</tr>
<tr>
<td>Energy intensity of industry</td>
<td>koe/€2010</td>
</tr>
<tr>
<td>Energy intensity of manufacturing</td>
<td>koe/€2010</td>
</tr>
<tr>
<td>Energy intensity of primary metals</td>
<td>koe/€2010</td>
</tr>
<tr>
<td>Energy intensity of chemicals</td>
<td>koe/€2010</td>
</tr>
<tr>
<td>Energy intensity of non-metallic minerals</td>
<td>koe/€2010</td>
</tr>
<tr>
<td>Energy intensity of machinery &amp; fabricated metals</td>
<td>koe/€2010</td>
</tr>
<tr>
<td>Energy intensity of transport vehicles</td>
<td>koe/€2010</td>
</tr>
<tr>
<td>Energy intensity of food and tobacco</td>
<td>koe/€2010</td>
</tr>
<tr>
<td>Energy intensity of paper, pulp and printing</td>
<td>koe/€2010</td>
</tr>
<tr>
<td>Energy intensity of textiles and leathers</td>
<td>koe/€2010</td>
</tr>
<tr>
<td>Unit consumption of steel</td>
<td>toe/t</td>
</tr>
<tr>
<td>Unit consumption of cement</td>
<td>toe/t</td>
</tr>
<tr>
<td>Unit consumption of paper</td>
<td>toe/t</td>
</tr>
<tr>
<td>Unit consumption of glass</td>
<td>toe/t</td>
</tr>
<tr>
<td>• <strong>Issue indicators</strong></td>
<td></td>
</tr>
<tr>
<td>Energy intensity of manufacturing at constant structure</td>
<td>koe/€2010</td>
</tr>
<tr>
<td>• <strong>Comparison indicators</strong></td>
<td></td>
</tr>
<tr>
<td>Energy intensity of industry at reference structure at ppp</td>
<td>koe/€2010ppp</td>
</tr>
<tr>
<td>Energy intensity of manufacturing at reference structure at ppp</td>
<td>koe/€2010ppp</td>
</tr>
<tr>
<td>Unit consumption of steel as a function of share of electric steel</td>
<td>toe/ton</td>
</tr>
</tbody>
</table>
### Table 3: List of indicators for transport

<table>
<thead>
<tr>
<th>Indicators</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Energy efficiency index of transport (ODEX)</td>
<td>index</td>
</tr>
<tr>
<td>• <strong>Headline indicators</strong></td>
<td></td>
</tr>
<tr>
<td>Energy intensity of transport related to GDP</td>
<td>koe/€2010</td>
</tr>
<tr>
<td>Unit consumption of gasoline vehicles</td>
<td>toe/vehicle</td>
</tr>
<tr>
<td>Unit consumption of rail transport: passenger, goods</td>
<td>koe/tkbr</td>
</tr>
<tr>
<td>Unit consumption of air transport</td>
<td>koe/pass</td>
</tr>
<tr>
<td>Unit consumption of domestic air transport</td>
<td>koe/pkm</td>
</tr>
<tr>
<td>Unit consumption of water transport</td>
<td>koe/tkm</td>
</tr>
<tr>
<td>Unit consumption of urban transport</td>
<td>koe/pkm</td>
</tr>
<tr>
<td>• <strong>Issue indicators</strong></td>
<td></td>
</tr>
<tr>
<td>Unit consumption of road transport per equivalent car</td>
<td>toe/car</td>
</tr>
<tr>
<td>Specific consumption of new cars (test values)</td>
<td>l/100km</td>
</tr>
<tr>
<td>Specific consumption of cars</td>
<td>l/100km</td>
</tr>
<tr>
<td>Unit consumption of cars</td>
<td>toe/car</td>
</tr>
<tr>
<td>Unit consumption of cars per passenger-km</td>
<td>koe/pkm</td>
</tr>
<tr>
<td>Unit consumption of diesel heavy vehicles</td>
<td>toe/pkm</td>
</tr>
<tr>
<td>Unit consumption of trucks (or trucks and light vehicles)</td>
<td>toe/vehicle</td>
</tr>
<tr>
<td>Unit consumption of road transport of goods</td>
<td>koe/tkm</td>
</tr>
<tr>
<td>Unit cons. of passenger transport</td>
<td>koe/pkm</td>
</tr>
<tr>
<td>Unit consumption of goods transport</td>
<td>koe/tkm</td>
</tr>
<tr>
<td>Unit cons. of passenger transport at constant modal split</td>
<td>koe/pkm</td>
</tr>
<tr>
<td>Unit cons. of goods transport at constant modal split</td>
<td>koe/tkm</td>
</tr>
<tr>
<td>• <strong>Comparison indicators</strong></td>
<td></td>
</tr>
<tr>
<td>Unit cons. of passenger transport at reference modal split</td>
<td>koe/pkm</td>
</tr>
<tr>
<td>Unit cons. of goods transport at reference modal split</td>
<td>koe/tkm</td>
</tr>
</tbody>
</table>
### Table 4: List of indicators for households

<table>
<thead>
<tr>
<th><strong>Headline indicators</strong></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Unit consumption per dwelling</td>
<td>toe/dw</td>
</tr>
<tr>
<td>Unit consumption of electricity per dwelling</td>
<td>kWh/dw</td>
</tr>
<tr>
<td>Unit consumption per dwelling with climatic corrections</td>
<td>toe/dw</td>
</tr>
<tr>
<td>Unit consumption per m² with climatic corrections</td>
<td>koe/m²</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Issue indicators</strong></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Unit cons. per dwelling for space heating with climatic corrections</td>
<td>toe/dw</td>
</tr>
<tr>
<td>Unit cons. per m² for space heating with climatic corrections</td>
<td>koe/m²</td>
</tr>
<tr>
<td>Specific cons. of new dwellings (multifamily/single family dwellings)</td>
<td>toe/dw</td>
</tr>
<tr>
<td>Unit cons. per dwelling for lighting and electrical appliances</td>
<td>kWh/dw</td>
</tr>
<tr>
<td>Specific cons. of electricity of new refrigerators &amp; freezers</td>
<td>kWh/dw</td>
</tr>
<tr>
<td>Energy efficiency index of households (ODEX)</td>
<td>index</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Comparison indicators</strong></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Space heating cons per m² (or dwelling) per degree-day</td>
<td>koe/dw/dd</td>
</tr>
<tr>
<td>Useful space heating cons per m² (or dwelling) per degree-day</td>
<td>koe/dw/dd</td>
</tr>
<tr>
<td>Unit cons. per dwelling (or m²) scaled to European average climate</td>
<td>toe/dw</td>
</tr>
</tbody>
</table>

### Table 5: List of indicators for services and agriculture

<table>
<thead>
<tr>
<th><strong>Services</strong></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Energy intensity of services sector : total, electricity</td>
<td>koe/€2010</td>
</tr>
<tr>
<td>Unit cons. of services sector per employee : total, electricity</td>
<td>toe/emp</td>
</tr>
<tr>
<td>Unit cons. of services sector per m² with climatic corr. : total &amp; electricity</td>
<td>koe/m²</td>
</tr>
<tr>
<td>Energy intensity of services sector at ppp</td>
<td>koe/€ppp</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Agriculture</strong></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Energy intensity of agriculture</td>
<td>koe/€2010</td>
</tr>
</tbody>
</table>
2. **Macro Data and Indicators**

2.1. **Macro economy and energy balance data**

2.1.1. **Final and primary energy consumption**

**Final energy consumption**: it is equal by definition to the difference between the **primary energy consumption** and the consumption in energy transformations and losses. Its definition stems from the accounting rules used to present national energy balances. It represents the amount of energy that is required by final consumers. It is broken down into different sectors: industry, transport, households, services and agriculture.

The energy used by the energy industries is not included: for instance, the energy used in coal mining, power production, or in refineries as well as losses for transmission and distribution are excluded.

In particular, the final electricity consumption does not correspond to the total electricity consumption. Table 1 clarifies the differences between the final electricity consumption and other electricity consumption shown in energy statistics.

To calculate efficiency indicators, non-energy uses are excluded from the final consumption, as their utilization is not related to energy efficiency considerations, but rather to materials management.

**Table 1: Final electricity consumption and total electricity consumption**

<table>
<thead>
<tr>
<th>Final electricity consumption</th>
</tr>
</thead>
<tbody>
<tr>
<td>+ Consumption in energy industries</td>
</tr>
<tr>
<td>+ Self consumption of electricity sector</td>
</tr>
<tr>
<td>Water pumping</td>
</tr>
<tr>
<td>= <strong>Domestic consumption</strong> (or net consumption)</td>
</tr>
<tr>
<td>+ Losses and self consumption</td>
</tr>
<tr>
<td>= <strong>Gross availability</strong> (or gross consumption)</td>
</tr>
</tbody>
</table>

The usual conversion of electricity consumption into energy units in the final consumption (e.g. from kWh to toe or Joule) is based on the calorific value of electricity: 1 000 kWh = 0.086 toe or 1 kWh = 3.6 MJ.

**Primary energy consumption**: balance of primary production, external trade, marine bunkers and stock changes. It represents the total energy consumption of a country. It is called Gross Inland Consumption by Eurostat and Total Primary Energy Supply (TPES) by IEA.

2.1.2. **GDP, value added**

**GDP**: Gross Domestic Product: measures the economic activity of a country; it is usually measured at **market prices**. The GDP at market price is the sum of value added at **factor cost**, plus indirect taxes less subsidies.
**Private consumption**: total consumption in monetary units of goods and services by households.

**Value added**: usual mode of measurement of the net output of a branch or sector in monetary units; the value added equals the difference between the gross output and the value of inputs; the value added can be measured at **factor cost** or at **market prices**.

**Factor cost** (or factor values): measurement of value added or GDP that excludes all indirect taxes and includes all subsidies received. The GDP at factor cost is strictly equal to the sum of value added at factor cost of **agriculture, industry** and **services**.

**Market prices** (or producer prices): measurement of value added or GDP, that includes all indirect taxes but excludes all subsidies. The GDP at market price is the GDP at factor cost plus indirect taxes less subsidies.

**Agriculture** value added measures the activity of agriculture, fishing, and forestry.

**Industry** value added measures the activity of mining, manufacturing, construction and electricity, gas and water.

**Services** or **tertiary sector** value added measures the activity of all public and private services: wholesale and retail trade, banking, public administration...

### 2.1.3. Deflator and constant prices

**Deflator**: price index used to convert a monetary value given in current price into a value at **constant price**; it equals 100 for the reference year of measurement of constant prices (e.g. = 100 in 2010 if the values are measured at constant 2010 prices); current price (PRX) divided by the deflator (DEF) and multiplied by 100 gives constant price (PRC), as follows.

\[
PRC = \frac{PRX}{DEF} \times 100
\]

Each macro-economic variable (e.g. GDP, private consumption, value added) has its own deflator. The consumer price index is the deflator of private consumption.

**Constant price**: to leave out the inflation, monetary values are measured at constant price of a given reference year e.g. constant price of 2010. Constant prices are obtained by dividing current (or normal) prices by a **deflator**.

The methodology to calculate constant prices based on current prices is explained below.

**Use of price deflators** (price index) and **exchange rate** (national currency to €)

\[
GDP_{xx} = \frac{GDP}{DEFL_{xx}} \times \frac{DEFL_{xx}}{TXCHG_{xx}}
\]

- **GDP_{xx}**: GDP at constant price of year xx (e.g. 2010);
- **DEFL_{xx}**: price deflator of the GDP with xx as base year (= 100 for base year)
- **TXCHG**: Exchange rate of the base year (eg 2010)

**Use of rate of change in volume** (TCVOL) compared to the previous year, which measures the increase in the volume of activity (i.e. by definition the variation of constant prices)
We start from the GDP (or VA) at current prices for the reference year of the constant prices (e.g. 2000) and build the series of constant price year by year from the rate of change in volume (TCVOL$_t$)

\[
\begin{align*}
\text{GDP}^{xx}_{(2000)} &= \text{GDP}_{(2000)} \\
\text{GDP}^{xx}_{(2001)} &= \text{GDP}^{xx}_{(2000)} \times (1 + \frac{\text{TCVOL}_{2001}}{100}) \\
\text{GDP}^{xx}_{(2002)} &= \text{GDP}^{xx}_{(2001)} \times (1 + \frac{\text{TCVOL}_{2002}}{100}) \\
&\vdots \\
\text{GDP}^{xx}_{(t)} &= \text{GDP}^{xx}_{(t-1)} \times \text{TCVOL}_{t}
\end{align*}
\]

Before 2000, \[
\begin{align*}
\text{GDP}^{xx}_{(t-1)} &= \frac{\text{GDP}^{xx}_{(t)}}{\text{TCVOL}_{t}}
\end{align*}
\]

### 2.1.4. Index, annual growth rate

**Index** : mode of expression of a variable (e.g. consumption, intensity) reflecting the variation compared to a reference year, for which the index equals 100 by definition : \( I = \frac{X_t}{X_0} \times 100 \).

If the reference year is 1980, the index of 1980 = 100 (1980 = 100) ; an index of 150 in 1985 means that the variable has increased by 50 % between 1980 and 1985 ; an index of 80 means a reduction of 20 % between 1980 and 1985.

**Annual growth rate** : mode of measurement of the average annual variation of a variable (X) over a period ; it is calculated as follows between year m and n :

\[
((\frac{X_m}{X_n})^{1/m-n} - 1) \times 100
\]

### 2.1.5. Exchange rate, purchasing power parity

**Exchange rate** (of €) : coefficient used to convert a monetary value expressed in national currency into €; it measures the average value over a year of 1 € in national currency ; the conversion in € is obtained by dividing the value in national currency by the exchange rate.

To convert in € of a given year (e.g. €2010), it is necessary to express first the values in national currency at **constant price** of 2010, then to divide by the 2010 exchange rate.

**Purchasing power parity** (PPP) : measures the rate of currency conversion that equalises the purchasing power of different currencies.

The purpose of purchasing power parities is to eliminate the difference in price level, so as to improve the comparison of volumes.

### 2.2. Headline Indicators

#### 2.2.1. Primary energy intensity

The primary energy intensity is the ratio between the total energy consumption of a country and the GDP. It measures the total amount of energy necessary to generate one unit of GDP.

\[\text{ieotocpe} = \frac{\text{toccp}}{(\text{pibxx/txchg€(2010)}) \times 1000} \quad \text{(koe/€ 2010)}\]

with:

- toccp: primary energy consumption in Mtoe
- pibxx: GDP at constant prices in national currency (base year 2010)
- txchg€(2010): coefficient to convert constant prices in national currency in € of 2010
This total consumption has different names depending on the organisation in question: it is called "total primary energy supply" (TPES) by IEA, "gross inland consumption" by EUROSTAT or, in short, "primary consumption" by many institutions (this name is used in ODYSSEE).

Electricity is converted from kWh to a common energy unit (toe or Joule) according to the EUROSTAT/IAE conventions: respectively 0.26 toe/MWh for nuclear power (10.9 MJ/kWh), 0.086 toe/MWh (3.6 MJ/kWh) for hydroelectricity, 0.86 toe/MWh (36 MJ/kWh) for geothermal.

### 2.2.2. Final energy intensity

The final energy intensity is the ratio final energy consumption over GDP.

\[
\text{fetocf} = \frac{\text{toccf}}{(\text{pibxx} . \text{txchg€(2010)})} \times 1000 \quad \text{(koe/€2010)}
\]

with:
- toccf: final consumption in Mtoe
- pibxx: GDP at constant prices in national currency (base year 2010)
- txchg€(2010): coefficient to convert constant prices in national currency in € of 2010

Basically, the definition of final consumption is the same as the “final consumption for energy uses” from EUROSTAT. It differs however from IEA who includes the non-energy uses in the final consumption. Non-energy uses are excluded in ODYSSEE, as their utilization is not related to energy efficiency considerations, but rather to materials management.

Electricity is converted from kWh to a common energy unit (toe or Joule) according to the EUROSTAT/IAE conventions: 0.086 toe/MWh or 3.6 MJ/MWh (calorific value)

**Interpretation**

Final energy intensities involve all types of factors which help to change the amount of final energy required to produce one unit of GDP: economic, technical, managerial and behavioural. More precisely, five types of factors can be identified:

- first of all, changes in the GDP structure between sectors: for instance, the tertiarisation of the economy, all things being equal, decreases final energy intensity; a decreasing contribution of energy-intensive branches, such as steel, non metallic minerals or chemicals, will also result in a decrease in final energy intensity; this first factor is usually referred to as structural changes in the economy;

- secondly, the spread of energy efficient techniques and equipment or else of more efficient behaviours and practices;

- thirdly, energy substitutions favouring energies with high end-use efficiency (e.g. district heating, natural gas, electricity);

- fourthly, other structural changes, such as an increasing share of bigger cars in the stock of cars or of single family dwellings in the stock of dwellings, or else of cars in urban traffic;

- finally, an improvement in living standards (i.e. greater confort), with a wider distribution of energy-consuming appliances: electrical appliances, central heating, cars, for instance.
All these factors usually have contradictory influences: the first three factors have usually drawn final energy intensities downward, whereas the last two factors tend to increase intensities, all things being equal. The contribution of the last factor is all the more decisive as the country is less developed: it probably plays a decisive role in the countries of Central and Eastern Europe.

2.2.3. Ratio final/primary intensities

It is the ratio final energy intensity/primary energy intensity (i.e. the ratio of final to primary energy consumption). Divergent trends between the two intensities will be reflected by changing values for the ratio over time.

For most countries there is a slight decrease in this ratio, indicating that, on average, more and more primary energy is needed per unit of final energy consumption.

Losses in transformation and distribution are responsible for most of the difference between primary and final energy consumption; the rest is explained by non energy uses, that are excluded from the final consumption in ODYSSEE

Interpretation

Different trends in primary and final energy intensities can be explained by five factors:

- changes in the energy supply mix, mainly linked to changes in the electricity generation mix, since most of the losses (about 3/4) come from electricity generation: an increase in the share of nuclear power generation increases the gap between the two intensities; in contrast, an increasing share of hydropower or cogeneration narrows this gap.

- changes in the efficiency of transformations: for instance, greater efficiency of thermal power plants (e.g. development of gas combined cycle power plants), reduces the ratio of primary to final intensity.

- changes in the share of secondary energies (mainly electricity) in final consumption.

- changes in the percentage of energy for non-energy uses, as these consumptions are included in the primary intensity but excluded from the final intensity.

- finally, changes in the share of imported secondary energies: any increase, for instance, in electricity imports will decrease transformation losses and narrow the gap between the two intensities.

2.2.4. Primary or final energy intensity with climatic corrections

The primary or final energy intensity with climatic corrections is a fictive value of these intensities where the space heating part of the consumption is corrected so as to correspond to a normal winter (climatic corrections)

The purpose of these climatic corrections is to leave out the influence of cold winter. This is particularly important when there are large climatic variations from one winter to the other.
For instance, 2010 was a mild winter as well as 1997 leading to a reduction in energy consumption compared to a normal winter.

If a winter is colder, the consumption will increase more than for a normal winter, and vice versa for a milder winter. Energy efficiency indicators without climatic corrections would increase during cold years and decrease during mild winters, all things being equal. Climatic corrections provide a measurement of the consumption over time, and thus of energy efficiency indicators, that is independent of yearly climatic variations.

The climatic corrections are made only for the part of the final consumption corresponding to space heating. Climate corrections are only made in the residential and service sectors.

For countries without yearly regular data on the space heating consumption, the correction is made with the heating share approach, by using an assumed share of space heating; this methodology is exactly the same as the one adopted by EUROSTAT.

\[
\text{ietoctpccc} = \text{toccfcc} / (\text{pibxx} / \text{txchg}(2010) * 1000) \\
\text{ietocffcc} = \text{toccfcc} / (\text{pibxx} / \text{txchg}(2010) * 1000)
\]

with:

- \(\text{ietocppccc}\) : primary intensity with climatic corrections
- \(\text{ietocffcc}\) : final intensity with climatic corrections

\[
\text{toccpc} = \text{tocepc} - \text{tocfres} - \text{tocter} + \text{tocfrescc} + \text{toctercc}
\]

\[
\text{toccfcc} = \text{toccf} - \text{tocfres} - \text{tocter} + \text{tocfrescc} + \text{toctercc}
\]

- \(\text{tocccpc}\) : primary consumption with climatic correction
- \(\text{toccfcc}\) : final consumption with climatic correction
- \(\text{tocfres}\) : final consumption of household sector
- \(\text{tocter}\) : final consumption of service sector
- \(\text{tocfrescc}\) : final consumption of household sector with climatic corrections
- \(\text{toctercc}\) : final consumption of service sector with climatic corrections

The formula used to calculate the consumption with climatic corrections is for instance for households:

\[
\text{tocfrescc} = \text{tocfres} / (1 - (\text{pchfres} * 0.9) * (\text{dj} / \text{djref} - 1)).
\]

- \(\text{pchfres}\) : share of space heating in household consumption

### 2.3. Issue Indicators

#### 2.3.1. Final energy intensity at constant GDP structure

The final energy intensity at constant structure is a theoretical intensity that would result from all sectors growing at the same rate as the GDP (i.e. constant GDP structure and constant structure of industry) and using the actual values of sectoral intensities. The calculation is carried out at the level of the main sectors (industry, agriculture, tertiary, transport and residential) and major industrial branches.

The final energy intensity at constant GDP structure is a fictitious value of the final energy intensity \(I\), calculated by assuming that the structure by sector \((S_j)\) is unchanged from the base year and by taking into account the actual variation in energy intensity of sector \((I_j)\).
The calculation is based on the **Divisia method** which is a usual method to separate out what is due to structural changes from what is due to changes in sectoral intensities in the variation of the final intensity (see the detailed equations in part 3.3.1 *Energy intensity of manufacturing at constant structure*).

For the industry, tertiary and agriculture sectors, the sectoral energy intensities are calculated as the ratio of final energy consumption to value added. For these sectors, a constant GDP structure means that their value added increases at the same rate as GDP. In industry, the intensity is measured at constant structure of industrial at value added, among the usual 10 branches.

For transport, the sectoral energy intensity is calculated as the ratio of transport energy consumption to GDP.

For the residential sector, finally, the intensity is calculated as the ratio of household energy consumption to private consumption; for this sector, a constant GDP structure means that private consumption increases at the same rate as GDP.

This energy intensity at constant structure provides an assessment of energy efficiency trends cleared of the influence of structural changes. A comparison of I and Is over time shows the influence of structural changes.

### 2.3.2. Energy efficiency index

The index of energy efficiency progress, called **“ODEX”** is defined at the level of sectors (industry, transport, households, tertiary) or of the whole economy (all final consumers). This index is obtained by aggregating the unit consumption changes at detailed levels, by sub-sector or end-use, observed over a given period. The unit consumption variation is measured in terms of index, which enable the use of various units for the detailed indicator (kWh/appliance, toe/m²…).

The ODEX for a sector (e.g. industry, transport or households, tertiary) is calculated as a weighted average of the unit consumption index of each sub-sector or end-use, with a weight based on the relative consumption of each sub-sector in the base year. For instance, considering two sub-sectors with a share of the consumption of 60% and 40% respectively in the base year and a change in the unit consumption from 100 to 85 for the first sub-sector and 100 to 97.5 for the second, the weighted average index is 0.6*(85/100)+0.4*(97.5/100) = 90.

Initially, all variations in unit consumption were measured in relation to a base year (e.g. 1990: in other words, all energy efficiency progress were measured compared to the situation of 1990 (i.e. the energy performance of 1990). The variation of the ODEX was obtained by weighting the gains of each sector between t and 1990. The drawback of this approach is that the results are influenced by the situation of the reference year. Therefore, in the present calculation, energy efficiency gains are measured in relation to the previous year (“sliding ODEX”). The sliding ODEX cumulates the incremental energy savings from one year to the other.

Annex 2 gives more details on the calculation of ODEX.

Energy saving can be easily derived from the index. Indeed, the energy efficiency index can also be defined as a ratio between the actual energy consumption of the sector in year t and the sum of fictive energy consumption of each underlying sub-sector /end-use that would have been observed in year t had the unit consumption of the sub sector been that of a
reference year. For instance, if the actual consumption of the sector is 90 Mtoe and if the unchanged unit consumption in all sub-sectors/end-uses should lead to a sector’s consumption of 100 Mtoe, the index is equal to 90/100 = 0.9 or 90, if expressed as an index. Such an index of 90 means a 10% energy efficiency gain.

The ODEX-indicator represents a better proxy for assessing energy efficiency trends at an aggregate level (e.g. overall economy, industry, households, transport, services) than the traditional energy intensities cited above, as they are cleaned from structural changes and from other factors not related to energy efficiency (more appliances, more cars…). The detailed calculation of the ODEX will be presented sector by sector. The global ODEX calculated for the whole economy is just an aggregate of the ODEX by sector.

2.4. Comparison Indicators

2.4.1. Primary or final energy intensity at purchasing power parities

It is an energy intensity, in which the current GDP is converted into a common currency, in € using purchasing power parities instead of exchange rates.

\[
\text{ietocfcpp} = \frac{\text{toccp}}{\left(\frac{\text{pibxx}}{\text{txchgppp}}\right)} \times 1000 \quad (\text{koe/€ppp})
\]

\[
\text{ietocfcpp} = \frac{\text{toccf}}{\left(\frac{\text{pibxx}}{\text{txchgppp}}\right)} \times 1000 \quad (\text{koe/€ppp})
\]

with:
- \(\text{toccp}\): primary consumption in Mtoe
- \(\text{toccf}\): final consumption in Mtoe
- \(\text{pibxx}\): GDP in national currency (in constant prices)
- \(\text{txchgppp}\): coefficient of purchasing parities to convert national prices into purchasing parities

The purpose of purchasing power parities is to eliminate the difference in price level, so as to improve the comparison of volumes. For example, the per capita GDP was almost 3 times greater in Germany than in Portugal in 2010. However the difference represents not just a greater volume of activity on Germany, but also a higher general price level. Expressed in purchasing power parities, the difference between Germany and Portugal is only a factor of 1.7.

Expressed in purchasing power parities, the GDP of Germany has decreased by 15% and that of Portugal increased by 50%.

To convert macro-economic data from national currencies to €, it is necessary to divide by the purchasing power parity.

The use of purchasing power parities instead of exchange rates has two consequences:

- it increases the evaluation of GDP and, thus, decreases the intensity of countries with the lowest cost of living, which generally correspond to those with the lowest incomes; conversely, it increases the intensity of the richest countries;

- it narrows the differences between countries.

Therefore, the use of purchasing power parities affects the ranking of intensities among countries, but does not affect the trends (at constant price the ratio of purchasing power parities is the same for every year). As economies develop the gap between the two intensities narrow.
2.4.2. Final energy intensity at reference climate

The final energy intensity at reference climate represents a fictitious value of the final intensity of a country calculated by taking for the household and service sector a consumption adjusted to a reference climate (see below the definition for households). It is measured at current purchasing power parities.

2.4.3. Final energy intensity at reference economic structure

The final energy intensity at reference economic structure represents a fictitious value of the final intensity of a country calculated by taking for each economic sector and industrial branch the actual sectoral intensity of the country and the economic structure (ie the share of each sector and branch in the GDP) of a reference country (eg the EU average for instance).

The structure adjustment is made for the following sectors and branches: service, agriculture, mining, construction, and the usual 10 manufacturing branches.

For transport, the sectoral energy intensity is calculated as the ratio of transport energy consumption to GDP.

\[ \text{ietocfcaj} = \frac{(\text{vadindxx.ueur}-\text{vadimaxx.ueur})((\text{toccfind}-\text{toccfima})/(\text{vadindxx.ueur}-\text{vadimaxx.ueur}))}{\text{txchgppp}} \]

Note: in this example, the European Union is the reference (ueur)
3. Industry

3.1. Data for industry

3.1.1. Final energy consumption of industry

**Final energy consumption of industry** includes all the fuels used for mining, manufacturing of industrial goods and construction. It excludes however the energy consumption of the energy transformation industries (e.g. energy mining, refineries, power plants, gas plants).

The fuels used by industrial factories for transport purposes, e.g. for their fleet of vehicles (“transport for own-account”) are not included in industry, but in the transport sector.

The fuels used in industrial boilers to produce steam are included but not the heat generated. Only the heat purchased by industrial consumers is considered as a final consumption of heat.

The fuels used for electricity generation and cogeneration of heat and electricity are excluded from the final energy consumption of industry. The electricity consumption of industry combines both purchased and self generated electricity. This mode of accounting is such that changes in the share of electricity self generated and electricity purchased do not affect the final energy consumption of industry. This problem has become especially important now with the priority given in many countries to private generation (or self generation) by industrial autoproducers. In this accounting, the fuels inputs for self generation of electricity appear in the line “autoproducers”. In case of CHP, only the part corresponding to the electricity production is included in this line ; the part of fuels corresponding to the heat produced appears in the final consumption. For instance, with a cogeneration in industry with an overall efficiency of 80 % and an output mix of 25 %/75 % for electricity and heat respectively, 25 % of the fuel input goes into transformations and the rest goes into the final consumption of fuels of industry. Table 3 illustrates the methodology of accounting of industrial self-generation and cogeneration.

In case the final consumption is not available, the fuels used for transportation can be estimated from the gasoline and diesel consumption. The fuels used for electricity generation can be derived from the electricity self generated, information that is usually available. Thus the diesel consumption needs to split into three parts : transportation, self generation of electricity and the rest, that corresponds to the final consumption.

Energy products used as a raw materials or chemical products are generally separated or at least identified in the item **non energy uses**.

**Non energy uses** : consumption of energy products in the petrochemical sector (fabrication of organic materials), in the fabrication of ammonia (natural gas), in furnaces as electrode (carbon), as well as products used for their physico-chemical properties (asphalt, wax, engine oils, etc...)
3.1.2. Classification of industry by industrial branch

**Classification of industry**: in economic statistics, the output of the industry sector is measured by the **value added**. It is broken down into various industrial **sectors**, or industrial **branches**. According to the International Standard Industrial Classification (ISIC) of economic activity, the industry sector is split into four major branches: mining, manufacturing, electricity, gas and water, and construction. Manufacturing is further broken down into various individual branches: the most usual disaggregation, the two digit one, encompasses 9 branches in the old classification (ISIC Rev 2) and 23 in the new NACE classification (Rev 3) (see table 4) Energy intensive industries such as steel, cement, correspond to 3 to 5 digits level.

The energy transformation industries (i.e. the energy production and transformation activities), appear at different levels:

- in mining (coal mining, oil and gas production) (NACE code 10 and 11);
- in manufacturing (e.g. chemicals for refineries) (NACE 23);
- in electricity, gas... (including district heating) (NACE 40-41).
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### Other manufacturing*

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### Mining and quarrying

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Sectors: corresponds to the grouping of industrial activities into sub-categories on the basis of establishments (e.g. enterprises). Sectors correspond to all establishments having the same main activity.

Branches: corresponds to the grouping of industrial activities on the basis of the activity: branches correspond to all enterprises or part of enterprises having the same activity.

- **Value added at constant price**

The value added at constant price by branch (also called in real terms) measures the industrial output in monetary value. It is less well covered by national statistics\(^1\). Value added at constant price are derived from values at current price, using price deflators\(^2\). In some case data at constant price have to be calculated from production index, assuming that the change in the value added at constant price, i.e. in volume, follows the change in production index (see Box 1 to calculate value added at constant prices).

- **Production index**

The production index by sub-sector is the most common indicator used to measure the industrial output; it is usually measured in relation to a base year (e.g. index base 100 in 2010 for instance) or in relation to the previous year. It is well covered in national statistics. This index usually measures the changes in the volume of physical production: it is calculated from index of change in physical production at a very detailed level (4 to 5 digits) measured with different units (e.g. number of litres of milk processed, of tons of meat produced for the food industry) and aggregated at the branch level (e.g. food) into a production index on the basis of the weight of each sub-branch in the value added of the branch in the base year (2010).

- **Physical production**

The physical production corresponds to a dominant output of the branch and is usually measured in ton (e.g. crude steel, cement, clinker).

### 3.2. Headline Indicators

#### 3.2.1. Energy intensity of industry, manufacturing, primary metals …

The energy intensity of industry, of manufacturing or of an industrial branch is defined as the ratio between the final energy consumption of the branch (measured in energy units: toe, Joule, etc) and the value added measured in constant monetary units.

\[
\text{ietocin}_{\text{d}} = \frac{\text{toccfind}}{\text{vadindxx} \times \text{txchg}€(2010)} \times 1000 \quad \text{(koe/€2010)}
\]

with:
- toccfind: final consumption of industry in Mtoe
- vadindxx: value added of industry at constant prices of 2010 in national currency
- txchg€(2010): coefficient to convert constant prices in national currency into € of 2010

\[
\text{ietocim}_{\text{a}} = \frac{\text{toccfima}}{\text{vadimaxx} \times \text{txchg}€(2010)} \times 1000 \quad \text{(koe/€2010)}
\]

\(^1\) Value added should be preferred to output value (i.e. turn over) as its variation is closer to the physical output.

\(^2\) See above definition of price deflators in footnote 6.
3.2.2. Unit consumption of steel, cement, paper and glass

These unit consumption are calculated as the ratio between the final energy consumption of the branches and their output measured in tons.

\[
\begin{align*}
\text{cutocach} & = \frac{\text{toccfsid}}{\text{prdach}} \times 1000 \text{ [toe/t]} \\
\text{cutocccim} & = \frac{\text{toccfcim}}{\text{prdcim}} \times 1000 \text{ [toe/t]} \\
\text{cutoover} & = \frac{\text{toccver}}{\text{prdver}} \times 1000 \text{ [toe/t]} \\
\text{cutocpap} & = \frac{\text{toccfppp}}{\text{prdp}} \times 1000 \text{ [toe/t]} \\
\end{align*}
\]

With:
- toccfsid: energy consumption of steel
- prdach: production of crude steel
- toccfcim: energy consumption of cement
- prdcim: production of cement
- toccver: energy consumption of glass
- prdver: production of glass
- toccfppp: energy consumption of paper & printing
- prdp: production of pulp and paper

3.3. Issue indicators

3.3.1. Energy intensity of manufacturing at constant structure

The intensity at constant structure of industry or manufacturing reflects the variation of the energy intensity assuming a constant structure of value added, between the various branches or sub-branches, for a reference year, so as to leave out the influence of structural changes.

**Structural effects**: represents the influence of structural changes in the industry sector (or manufacturing or within an industrial branch) on the energy intensity of industry (or of manufacturing, or of an industrial branch). Structural effects are important each time the structural changes take place between branches with different sectoral intensities.

The structural effects are usually calculated with the **Divisia method**.

**Structural changes** in industry: changes in the share (in %) of each branch or sub-branch in the value added of industry (or manufacturing, or of an industrial branch).

**Sectoral intensities**: see energy intensity of an industrial branch.

**Intensity at constant structure** of industry or manufacturing reflects the variation of the energy intensity assuming a constant structure of value added, between the various branches or sub-branches, for a reference year, so as to leave out the influence of structural changes. Changes in this intensity at constant structure result from variations in the sectoral intensities; they provide a good indicator of the overall energy efficiency trend in industry or manufacturing (or within a branch).
**Divisia method**: usual method to separate out what is due to structural changes from what is due to changes in sectoral intensities in the variation of the energy intensity of industry or manufacturing sector (or of an aggregate branch).

The Divisia method is applied on a yearly basis and decomposes the growth rate of the intensity between year \( t \) and \( t-1 \) into two components. The first one measures the influence of structural changes, and the second one measures the influence of changes in the sectoral intensities.

\[
\ln \left( \frac{ie_t}{ie_{t-1}} \right) = \sum_i W_i \ln \frac{S_i}{S_{i-1}} + \sum_i W_i \ln \frac{ie_t}{ie_{t-1}}
\]

\[w_i = \text{energy consumption weight} = \frac{E_i}{E}\]

The variation of the intensity over a period can be expressed in index (I) as follows:

\[I = Is \times Ie\]

\(Ie\): index of sectoral intensity effect, which represents the index of the intensity at constant structure.

\(Is\): index of structural effect which represents the variation of the intensity due to structural changes.

\[Ie = \exp\left( \sum_i \sum_j W_i \ln \frac{ie_j}{ie_{j-1}} \right) \times 100 \quad Is = \exp\left( \sum_i \sum_j W_i \ln \frac{S_j}{S_{j-1}} \right) \times 100\]

**Interpretation**

Changes in this intensity at constant structure result from variations in the sectoral intensities; they provide a good indicator of the overall energy efficiency trend in industry or manufacturing (or within a branch).

The difference in the variations of the intensity and the intensity at constant structure is due to intensity changes: the larger is the discrepancy the greater are the intensity effects

### 3.3.2. Energy efficiency index in industry

For each branch, the indices are based on unit consumption expressed in terms of energy used per unit of physical output (tons produced for steel, cement, glass and paper and production index for the other branches) (see Box 2). Indices capture the energy efficiency development better than traditional energy intensities (per unit of value added). For some branches the trends shown include also some non-technical changes, especially in the chemical industry the shift to light chemicals, due to the fact that this sector is not sufficiently disaggregated.

**Box 2: Energy efficiency index for industry**

For industry, the evaluation is carried out at the level of 10 branches:

4 main branches: chemicals, food, textile & leather and equipment goods;

3 energy intensive branches: steel, cement and pulp & paper

3 residual branches: other primary metals (i.e. primary metals minus steel), other non-metallic minerals (i.e. non-metallic mineral minus cement) and other pulp, paper and printing (i.e. mainly printing).

The unit consumption is expressed in terms of energy used per ton produced for energy intensive products (steel, cement, glass and paper) and in terms of energy used related to the production index for the other branches.
3.4. Indicators of comparisons

3.4.1. Energy intensity of industry at reference structure

The final energy intensity of industry at reference structure represents a fictitious value of the final intensity of a country calculated by taking for each industrial branch the actual sectoral intensity of the country and the industrial structure (i.e., the share of each branch in the value added of industry) of a reference country (e.g., the EU average for instance).

Calculation of a fictitious energy consumption (“adjusted energy consumption”)\(^3\)

For the other branches: 
\[ E_f = IE_j \times (VA_j / VA)_{EU} \times VA \]

Note: the European union is the reference

With:
- \( VA \): value added of manufacturing
- \( IE_j \): Energy intensity of a branch \( j \)
- \( VA_j \): Value added of a branch \( j \)

For the industry as a whole, we get the energy intensity at reference structure by compiling the information for the different branches: 
\[ IE_{total} = \sum Ef / VA \]

\(^3\) For the branches such as steel, cement, paper, using the ratio “production per value added” instead of the sectoral intensity can be better. In this case the adjusted energy consumption would be: 
\[ E_f = UC_i \times (P_i / VA)_{EU} \times VA \]

* \( VA \): unit consumption of an intensive branch \( i \)
* \( P_i \): physical production of an intensive branch \( i \)
4. Transport

4.1. Data on transport

4.1.1. Final energy consumption of transport sector

Final energy consumption of transport sector: includes all the energy consumed for transport activities except bunkers. It should not include the energy used in buildings of transport companies (railways station, airport, ports...) that are considered in the tertiary sector. The energy consumption of the transport sector is broken-down by transport mode. The definition of this sector in energy consumption statistics is quite different from its definition in economic statistics.

Transport mode represents a classification of transport activities by type of infrastructure: air transport, rail transport, road transport, water transport, pipeline transport.

Road transport includes all the energy consumed by road vehicles, including agriculture and industrial trucks, household cars and motorcycles, commercial and government vehicles.

Road vehicles are usually classified in the following categories: two-wheels, motorcycles (and mopeds), tricycles, cars, light vans (or pick-ups), buses and trucks (or lorries). This last category can be broken-down by size between light trucks, medium trucks, heavy trucks and road tractors.

Rail transport only includes the energy consumption of trains (i.e. for traction); the consumption of railway stations and other buildings (workshops) should in principle be included in the tertiary sector; the main sources of energy consumed will be electricity and diesel (coal for countries still using steam trains).

Air transport only includes the energy used by all domestic and foreign aeroplanes (i.e. private, commercial, military or agricultural planes). The energy consumption of airport should not be accounted for in the transport sector but in the tertiary sector. The treatment of international air transport is not systematic. Some international organisations include it in transport (e.g. IEA or EUROSTAT); others consider it as exports which means that is does not appear in the transport sector (e.g. UN or ADB). In addition, the definition of international air transport varies among the countries: sometimes it covers all international flights, sometimes only international carries. The main source of energy for air transport is jet fuel.

Water transport only includes the energy used for domestic transport (river transport, coastal maritime transport). The consumption of energy for international water transport or bunkers is excluded from the transport sector and is considered in the same way as exports in the energy balance, and is shown as a separate line.

Bunkers, or international marine bunkers, represent the fuel used for sea: going ships, including warships and fishing vessels in international waters (domestic and foreign flags).

Pipeline transport: the energy consumed for pipeline transport may either be fully considered in transport (i.e. IEA) or partly, excluding oil and gas pipe-line (i.e. pipelines transporting energy commodities), that are then included in the energy transformation sector (item “own-use”).
4.1.2. Traffic in ton-km, pass-km, or gross-ton-km

**Ton-km**: unit of traffic for goods transport obtained as the multiplication of a volume of goods carried, in tons, and the average distance of transport, in km.

**Passenger-km**: unit of traffic for passenger transport obtained as the multiplication of a number of trips (i.e. a number of passenger) and an average distance per trip (in km).

**Gross ton-km (gtkm)**: unit of measurement of the traffic of goods and passenger in ton-km, including the weight of locomotives and carriages; it is mainly used for rail transport (“gross ton-km hauled”) to aggregate the passenger and goods traffic and to allocate the consumption between passenger and goods traffic.

4.1.3. Stock and sales of vehicles

The **stock of road vehicles by type** (cars, trucks, light-duty vehicles, buses, two-wheels or motorcycles) is available from national statistics. It corresponds to the number of road vehicles registered at a given date (usually at the end of the year or the middle of the year) in a country and licensed to use roads open to public traffic. It should refer to the number of vehicles really on the road (i.e. in circulation and that consume motor fuels). Official data often relate to all registered vehicles, i.e. including vehicles that have been scrapped and are not used any more, as they cumulate all the new registrations to the existing stock of vehicles without retiring the vehicles that are no longer used. This often overestimates the real stock of vehicles in use by some 30%.

To get the real stock on the road, several approaches are possible:

- Use other sources that better correspond to vehicles in use (from fiscal registry if annual fees are paid);
- Or modelling using a survival law;

Cars should also include taxis. Light duty vehicles also called light commercial vehicles have a useful load below a certain threshold (e.g. < 3 t). Trucks correspond to medium and heavy trucks (generally > 3 t useful load); trucks should also include road tractors that pull trailers (articulated vehicles, also called trailer truck)

Annual sales of vehicles represent the yearly new vehicles produced or imported. It generally corresponds to the vehicles registered in the country.

Both stock and sales should be available by fuel type to ease the allocation of motor fuels (e.g. gasoline and diesel) consumption by type of vehicles.

4.1.4. Average distance by type of vehicle or traffic of vehicles

The **average distance travelled by year by car** is usually available from household or transport surveys. It should be based on observed annual data and should not be extrapolated, as it can fluctuate quite a lot from one year to the other depending on the economic situation.
and fuel prices level. They may also be obtained from panel of representative vehicle owners or from surveys at gas stations.

### 4.1.5. Specific consumption of vehicles

The **average specific consumption of cars in litre/100km** is calculated from the total consumption of cars, the stock of cars and the average distance travelled by year by car. This indicator can also be obtained directly from surveys.

The same approach can be followed for the other road vehicles.

### 4.1.6. Specific consumption of new cars

The specific consumption of new cars represents the average normalized specific consumption. It is derived from fuel consumption test. These test values are provided each year by energy administrations or associations of car manufacturers to monitor energy efficiency trends with new cars. They are obtained as follows.

The test specific consumption is traditionally measured for each type of car following standardised test procedures in terms of driving cycles. In the European Union, passenger vehicles are commonly tested using two drive cycles, and corresponding fuel economies are reported as 'urban' and 'extra-urban', in litres per 100 km. The urban economy is measured using the test cycle known as ECE-15, introduced by the EEC Directive 90/C81/01 in 1999. It simulates a 4 km urban trip at an average speed of 20 km/h and at a maximum speed of 50 km/h. The extra-urban cycle or EUDC lasts 400 seconds (6 minutes 40 seconds) at an average speed 62.6 km/h and a top speed of 120 km/h.

An average specific consumption for each car is then calculated and a national sales weighted average is obtained for all cars sold or from a representative sample of cars, possibly with a distinction by category of cars (based on size or horsepower) and/or by type of fuel (gasoline, diesel, LPG).

The accuracy and comparability of data on test specific consumption depends on:
- the quality of the testing procedure and a degree of control by outside authorities;
- the accuracy of the weighting between driving cycles to reflect the average conditions of driving;
- finally, the size of the sample used to get a national average: comprehensive in France, sample of the most popular models (about 10) in other countries.

### 4.2. Headline Indicators

#### 4.2.1. Energy intensity of transport

The energy intensity of the transport sector is calculated as the ratio of the transport energy consumption to the GDP. It is not related to the value added of the sector as this value added only reflects the activity of transport companies, which only represent a part of the total consumption of the sector (about less than 60% usually in the EU countries).

\[
\eta_{\text{toctra}} = \frac{\text{tocctra}}{\text{pibxx/txchg\text{\$2010}}} \times 1000 \quad (\text{Koe}/\text{\$2010})
\]

with:
- toccfra: final consumption of the transport sector in Mtoe
- pibxx: GDP at constant prices in national currency
- txchg\text{\$2010}: coefficient to convert constant prices in national currency in \text{\$} of 2010

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4.2.2. Unit consumption of gasoline vehicles

The unit consumption of gasoline of road vehicles is obtained by dividing the total gasoline consumption for road transport by the total stock of gasoline vehicles.

**Interpretation**

Using this unit consumption to interpret and compare the energy efficiency of light vehicles may be misleading due to the heterogeneity of the fleet of gasoline vehicles among countries and, within one country, over time. Indeed, motorcycles, cars and commercial light vehicles are added together: one motorcycle counts for one vehicle, as does one car. Therefore, if the number of commercial light vehicles is increasing more rapidly than the number of cars, for instance, the unit consumption will increase, since on average a commercial light vehicle uses more fuel than a car (by a factor of between 1.5 and 2). Any change in the composition of the stock of vehicles will affect the unit consumption, even if the vehicles do not change from a technical point of view.

4.2.3. Unit consumption of rail transport

The unit consumption of rail transport represents the average energy consumption per unit of traffic. For rail transport, the total traffic is measured in gross ton-km (gtkm). The unit consumption is thus expressed in GJ or koe/ gtm.

The traffic in gross ton-km is the usual unit of measurement of the total traffic of goods and passenger in ton-km, including the weight of locomotives and carriages; it is used to aggregate the passenger and goods traffic. The energy consumption is usually allocated between passenger and goods traffic according to the share of passenger and goods traffic respectively in the total traffic in gtmk.

\[
\begin{align*}
tocff & = tocce/tkBfer \quad \text{[koe/tkBfer]} \\
tocffPkm & = tocce*1.7 \quad \text{[koe/pkm]} \\
tocfertkm & = tocce*2.5 \quad \text{[koe/tkm]}
\end{align*}
\]

with:
- tocffpkm: unit consumption of rail transport of passengers per passenger-km
- tocferkm: unit consumption of rail transport of goods per ton-km
- tocfer: unit consumption of rail transport per ton-km (gross tkm)
- tocce: consumption of rail transport
- pkmf: passenger rail traffic in pkm
- tkmf: rail traffic of goods in tkm
- tkbfer: total rail traffic in gross ton-km \((1.7*pkmf + 2.5 * tkmf)\)

4.2.4. Unit consumption of water transport

The unit consumption of water transport represents the average energy consumption of water transport per unit of traffic, measured in ton-km

\[
\begin{align*}
tocf & = tocff/tkmflv \quad \text{[koe/tkm]}
\end{align*}
\]

with:
- tocff: energy consumption for domestic water transport
- tkmflv: traffic of goods for domestic water transport
4.2.5. Unit consumption of air transport

The unit consumption of air transport represents the average energy consumption of air transport per unit of traffic, measured in passengers (passengers embarked and disembarked).

\[ \text{cutocair} = \frac{\text{carcfair}}{\text{pasair}} \, \text{[toe/pas]} \]
with:
- \text{carcfair}: energy consumption for air transport
- \text{pasair}: traffic of airport (number of passengers embarked and disembarked).

4.2.6. Unit consumption of domestic air transport

The unit consumption of domestic air transport represents the average energy consumption of domestic air transport per unit of traffic, measured in passenger-km.

\[ \text{cutocavd} = \frac{\text{carcfado}}{\text{pkmavd}} \, \text{[toe/pkm]} \]
with:
- \text{carcfado}: energy consumption for domestic air transport
- \text{pkmavd}: domestic traffic in passenger-km.

4.3. Issue Indicators

4.3.1. Unit consumption of gasoline vehicles per equivalent car

The unit consumption of gasoline per equivalent car relates the total consumption of gasoline to a fictitious stock of gasoline vehicles, measured in terms of a number of equivalent cars.

Converting the actual stock of gasoline vehicles into a stock of equivalent cars is based on a coefficient reflecting the difference in average yearly consumption between each type of vehicle and the car. If, for instance, a motorcycle consumes on average 0.15 toe/year and a car 1 toe/year, one motorcycle is considered to be equal to 0.15 equivalent cars.

These coefficients can be derived from surveys (or estimates) of distance travelled and specific consumption (1/100km) for selected years; they can also be adapted from similar countries in terms of vehicle characteristics and patterns of use; in ODYSSEE they are taken to be equal to constant reference values for countries for which data are not available.

\[ \text{cuesseq} = \frac{\text{esscfrou}}{\text{nbrvpcess} + \text{nbrmot} \times \text{coefvpcmot} + \text{nbrcamvless} \times \text{coefvpcamvlr} + \text{nbrbusess} \times \text{coefvpcbus}} \, \text{[toe/veh]} \]
with:
- \text{esscfrou}: consumption of gasoline of road transport
- \text{nbrvpcess}: stock of gasoline cars
- \text{nbrvlless}: stock of gasoline light vehicles
- \text{nbrmot}: stock of motorcycles
- \text{nbrcamess}: stock of gasoline trucks
- \text{nbrbusess}: stock of gasoline buses
- \text{coefvpcmot}: coefficient of conversion of one motorbike in terms of an equivalent car (=0.15)
- \text{coefvpcbus}: coefficient of conversion of one bus in terms of an equivalent car (=15)
- \text{coefvpcamvlr}: coefficient of conversion of one truck/light vehicles in terms of an equivalent car( =4) or 15 if we only consider trucks, 1.8 if we consider only light vehicles
Interpretation

This indicator allows to determine what, in the variations in unit consumption of gasoline light vehicles, may be attributed to structural changes in the composition of the stock of light vehicles.

This indicator is more relevant than the average gasoline consumption per gasoline vehicle, for which all types of vehicles are put on the same level.

4.3.2. Unit consumption of road transport per equivalent car

The unit consumption of road transport per equivalent car relates the total consumption of motor fuels to a fictitious stock of all road vehicles, measured in terms of a number of equivalent cars.

The stock of road vehicles is converted into a stock of equivalent cars on the basis of coefficients reflecting the difference in average yearly consumption between each type of vehicle and the car. If, for instance, a truck consumes on average 15 toe/year and a car 1 toe/year, one truck is equal to 15 equivalent cars.

\[
cutocvpc = \frac{toccfvpc}{nbrvpc} \quad \text{[toe/veh]}
cuemsvpc = \frac{esscfvpc}{nbrvpc\text{ess}} \quad \text{[toe/veh]}
cugzlvpc = \frac{gzlcfvpc}{nbrvpc\text{gzl}} \quad \text{[toe/veh]}
\]

with:

- toccfrou: total consumption of road transport
- tocfvpc: total consumption of cars
- esscfvpc: consumption of gasoline of cars
- gzlcfvpc: diesel consumption of cars
- nbrvpc: stock of cars
- nbrrvpc\text{ess}: stock of gasoline cars
- nbrrvpc\text{gzl}: stock of diesel cars
- coefvpcmot: coefficient of conversion of one motorbike in terms of an equivalent car (=0.15)
- coefvpcbus: coefficient of conversion of one bus in terms of an equivalent car (=15)
- coefvpcamvlr: coefficient of conversion of one truck/light vehicles in terms of an equivalent car (=4) or 15 if we only consider trucks, 1.8 if we consider only light vehicles

4.3.3. Unit consumption of cars

The average unit consumption of cars is calculated as the statistical division of the yearly motor fuel consumption of cars divided by the stock of cars. This unit consumption is the easiest indicator to calculate with the currently available statistics.

\[
cutocvpc = \frac{toccfvpc}{nbrvpc} \quad \text{[toe/veh]}
cuemsvpc = \frac{esscfvpc}{nbrvpc\text{ess}} \quad \text{[toe/veh]}
cugzlvpc = \frac{gzlcfvpc}{nbrvpc\text{gzl}} \quad \text{[toe/veh]}
\]

with:

- toccfpc: total consumption of cars
- esscfpc: consumption of gasoline of cars
- gzlcfpc: diesel consumption of cars
- nbrvpc: stock of cars
- nbrrvpc\text{ess}: stock of gasoline cars
- nbrrvpc\text{gzl}: stock of diesel cars

Interpretation

This indicator may be considered as an indicator of efficiency if a decrease in the use of cars is considered as an energy efficiency improvement: in other words, it indicates whether cars
are used more or less efficiently, without indicating whether this is due to reduced mobility, improved technical efficiency or changes in driving behaviour.

4.3.4. Unit consumption of cars per passenger-km

The average unit consumption of cars per passenger-km is calculated as the statistical division of the yearly motor fuel consumption of cars divided by the traffic of cars expressed in passengers-km

cutovpcpkm=toccfvpc/pkmvpc
with:
toccfvpc: total consumption of cars
pkmvpc: traffic of cars in pkm

4.3.5. Unit consumption of trucks and light vehicles

The average unit consumption of trucks and light vehicles is calculated as the statistical division of the yearly motor fuel consumption of trucks and light vehicles divided by the stock of trucks and light vehicles.

cutoccamvlr=toccfcamvlr/nbrcamvlr*1000 [toe/veh]
with:
toccfcamvlr: total consumption of trucks and light vehicles
nbrcamvlr: stock of trucks and light vehicles

4.3.6. Unit consumption of diesel of heavy vehicles

The unit consumption of diesel of heavy vehicles is equal to the ratio (total diesel oil consumption by road transportation - diesel oil consumption by cars and light vehicles) / (number of diesel trucks + number of diesel buses).

If diesel oil consumption by cars and light vehicles is not available, it will be estimated from the stock of diesel cars and diesel light vehicles and the average diesel consumption per vehicle; the latter being estimated on the basis of the average gasoline consumption per equivalent car for cars, as defined above, and, for light vehicles, on the basis of the coefficient of conversion into equivalent cars.

Heavy vehicles include trucks and buses. As the consumption of buses is usually small in comparison to that of trucks, the indicators related to heavy vehicles will mostly reflect the situation of trucks, and can be considered as an approximation for them.

➔ Interpretation

Indicators related to trucks or heavy vehicles should be interpreted with care, as there may be limitations in the quality of diesel consumption data for these vehicles, for two reasons:

-The consumption of diesel by heavy vehicles or trucks is usually obtained as the difference between the total consumption of diesel and estimates of diesel consumption by cars and light vehicles; in recent years, most countries have experienced a rapid increase in the proportion of cars and light vehicles using diesel fuel, that may not always be fully reflected in these consumption estimates.
- In some countries, an increasing amount of diesel may be used by foreign trucks (transit traffic), which are not accounted for in the indicators. These two factors may lead to an overestimation in recent years of the consumption of diesel by trucks and heavy vehicles.

cugzlhv=(gzlcfrd- gzlfcvpc-gzlcfvtr) /(nbrcamgzl+nbrbusgzl)*1000 [toe/veh]

with:
gzlcfrou, gzlcvp, gzlcfvtr: diesel consumption of road, cars & light vehicles
nbrcamgzl: stock of diesel trucks
nbrbusgzl: stock of diesel bus

4.3.7. Unit consumption of road transport of goods (per ton-km)

It is the ratio between the consumption of trucks and the traffic of goods measured in tonne-km performed by trucks; This indicator provides information on the energy efficiency of the overall transport services.

cugzltgr=gzlcfrpkm/tkmrou. [koe/tkm]

➔ Interpretation

The unit consumption per ton-km: enables to assess whether freight transport by road is becoming more energy-efficient: a shift towards bigger trucks, while increasing the specific consumption, certainly decreases the unit consumption per ton-km: in other words trucks on average look less efficient but the transport of goods by road becomes more energy efficient

4.3.8. Unit consumption of passenger transport

It is the ratio of the consumption for domestic transport and the traffic expressed in passengers-km; international air transport is excluded as usually it the traffic is not measured in pkm

cutocpkm=toccfpc/kpm [koe/pkm]

with:
toccfpc: consumption of passenger transport (cars, buses, railway and domestic air transport)
pkm: domestic traffic for passenger transport in pkm

4.3.9. Unit consumption of passenger transport at constant modal split

It is the weighted average of the unit consumption of each mode weighted with the share of each mode in the traffic in the base year.

cutocpkmst=(cutocfrpkm*pkmfer.(2010)+cutocbus*pkmbus.(2010)+cutocvpcpkm*
pkmavd.(2010))

with:
cutocfrpkm: unit consumption for rail transport of passengers
pkmfer: traffic for rail transport of passengers
cutocbus: unit consumption for public road transport (buses)
pkmbus: traffic by public road transport (buses)
cutocvpcpkm: unit consumption of cars per passenger-km
Energy efficiency indicators definition

pkmvp: traffic of cars in passenger-km

cutocavd: unit consumption for domestic air transport

pkmavd: traffic for domestic air transport

➔ Interpretation

A comparison of the variation of the average unit consumption for passenger transport (cutocpkm) and the unit consumption at constant modal split (cutocpkms) shows the influence of modal substitutions

4.3.10. Unit consumption of goods transport

It is the ratio of the consumption for goods transport (road, rail and water) and the traffic expressed in ton-km

\[
\text{cutocmch} = \frac{\text{toccfmch}}{\text{tkm}} \ [\text{koe/tkm}]
\]

with:
where:
- toccfmch: consumption of goods transport (trucks, light duty vehicles, railway and water transport)
- tkm: domestic traffic for goods transport in tkm

4.3.11. Unit consumption of goods transport at constant modal split

It is the weighted average of the unit consumption of each mode weighted with the share of each mode in the traffic in the base year.

\[
\text{cutocmchs} = \frac{\text{cutocfertkm} \cdot \text{tkmfer} (2010) + \text{cutocflv} \cdot \text{tkmflv} (2010) + \text{cugztgr} \cdot \text{tkmrou} (2010)}{\text{tkmfer} (2010) + \text{tkmflv} (2010) + \text{tkmrou} (2010)}
\]

With:
- cutocfertkm: unit consumption for rail transport of goods
- tkmfer: traffic for rail transport of goods
- cutocflv: unit consumption for water transport of goods
- tkmflv: traffic for water transport of goods
- cugztgr: unit consumption for road transport of goods
- tkmrou: traffic for road transport of goods

Note: Difference between unit consumption and specific consumption

Unit consumption: ratio between the energy consumption of a sector (E), and an indicator of activity (A) measured in physical terms (e.g. tons of steel, number of passenger-km) or a consumption unit (e.g. vehicle, dwelling, appliance). A unit consumption is a statistical concept that is a result of a calculation reflecting the average energy performance at the national level by opposition to specific consumption that are direct data derived from surveys.

Specific consumption: energy required per unit of output or per unit of service measured in standard conditions (e.g. kWh/ton, l/100 km). A specific consumption is an engineer’s concept. The specific consumption can be measured at different level of performance of the technologies, in particular the best practice will characterise the lowest specific consumption achieved in a country.
4.3.12. Energy efficiency index for transport

This overall energy efficiency index aggregates the trends for each transport mode in a single indicator for the whole sector. For cars, the energy efficiency is measured by the specific consumption, expressed in litre/100km. For the transport of goods (trucks and light vehicles), the unit consumption per ton-km is used, as the main activity is to move goods. For other modes of transport various indicators of unit consumption are used, taking for each mode the most relevant indicator given the statistics available: toe/passenger-km for air transport, goe/pass-km for passenger rail, goe/t-km for transport of goods by rail and water, toe per vehicle for motorcycles and buses (see Box 3).

Box 3: Energy efficiency index for transport

For the transport sector, the evaluation is carried out at the level of 8 modes or vehicle types: cars, trucks, light vehicles, motorcycles, buses, domestic air transport, rail, and water transport. For each mode, the energy efficiency indicators considered are the following:

- **cars**: specific consumption in litres/km
- **trucks & light vehicles**: unit consumption per ton-km
- **air transport**: unit consumption per passenger
- **rail, water**: unit consumption/pkm or tkm **motorcycles, buses**: toe/vehicle

4.4. Comparison indicators

4.4.1. Unit consumption of passenger transport at reference modal split

\[
cutocpkmaj = \frac{(cutocvpckm*pkmvp.ueur+cutocferpkm*pkmfer.ueur+cutocflvpkm*..)}{(pkmvp.ueur+pkmfer.ueur+pkmflv.ueur+pkmavd.ueur)} [koe/pkm]
\]

Note: reference country : ueur (for example European Union as a whole)

4.4.2. Unit consumption of goods transport at reference modal split

\[
cutocmchaj = \frac{(cutocfertkm*tkmfer.ueur+cutocflvtm*tkmflv.ueur+cutocgztgr*tkmrou.ueur)}{(tkmfer.ueur+tkmfer.ueur+tkmrou.ueur)} [koe/pkm]
\]
5. **Households**

5.1. **Data**

5.1.1. **Dwellings and characteristics**

A **household** includes all the persons who occupy a housing unit as their usual place of residence\(^5\). A housing unit is a house, an apartment, a mobile home, a group of rooms, or a single room. The occupants may be a single family, one person living alone, two or more families living together, or any other group of related or unrelated persons who share living arrangements.

The **number of households** is by definition similar to the number of occupied dwellings and can be a proxy for that variable; the main difference being people living in community (military, religious). It is usually available from the National Statistical Office either for years of housing surveys or on a yearly basis. If not available on a yearly basis can be interpolated/extrapolated from the population and an average number of persons per household, indicator that is changing slowly and smoothly.

There exists different statistics related to the **stock of dwellings**. The most common ones relate to the total stock and to the stock of **permanently occupied dwellings**. The difference between the two data corresponds to summer/week-end residences plus vacant dwellings. For energy consumption analysis, the relevant data to handle is the stock of permanently occupied dwellings. Such statistics are usually available from the national statistical office.

The **annual construction of dwellings** represents the number of dwellings which are built every year. Such statistics are usually available from the national statistical office.

The **average dwelling size** (m\(^2\)) corresponds to the living area as usually defined in household survey and construction statistics. Such information is generally based on housing surveys; if none available, it can be estimated from housing surveys based on the number of rooms.

The **residential building floor areas** correspond to the useful floor area; it is different from the gross floor area which includes common areas in multifamily buildings (e.g. corridors, etc.), attics, basement or verandas. It is expressed in million m\(^2\).

5.1.2. **Household electrical appliances and lighting**

- **Stock, ownership, and sales of household electrical appliances**

**Equipment ownership ratios** for refrigerators and washing machines correspond to the % of household with the appliance. For TV and fans equipment ownership ratios should include multi equipment and correspond to the average number per household.

Equipment ownership ratios are usually available from the National Statistical Office either for years of housing surveys or on a yearly basis; they may also come from surveys carried

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\(^5\) It is also defined as a group of persons who commonly live together and would take their meals from a common kitchen.
out by electric utilities. If they are not available on a yearly basis they can be linearly interpolated/extrapolated as they are changing slowly and smoothly. Yearly statistics may also come from surveys sponsored by equipment manufacturers associations (or by the energy administration);

The sales of electrical appliances represent the number of appliances sold every year. The information comes from equipment manufacturers associations.

The annual stock of appliance can be estimated in two ways:
- Either with a stock model from annual sales and an average lifetime.
- Or from annual household survey on equipment ownership (i.e. % of households owning one or several appliances).

The market share of efficient appliances represent the percentage of appliances sold corresponding to the most efficient label class (A and higher). The source of information may be the monitoring of programme, survey from the energy administration, or consumer panels.

- Specific electricity consumption by electrical appliance

The specific electricity consumption by electrical appliances (kWh per appliance) is usually estimated from calculation procedure that are specific to each appliance type: for instance, for washing machines, dishwashers and cloth dryers, it is calculated as the electricity consumption per cycle multiplied by a number of cycles per year; for TV it is calculated as the average power of the TV stock (in Watts) multiplied by an average number of hours of use per day and multiplied by 365 days. For refrigerators, it is calculated as the specific electricity consumption per litre multiplied by the average size of the stock in litre and multiplied by 365 days.

The specific electricity consumption per litre or per cycle for the stock average can be simulated from data on new appliances split by energy efficiency label.

5.1.3. Household energy consumption by end-use

The energy consumption for heating represents the total energy consumption of households for space heating. It is usually not a statistics published by national statistical organization. It is estimated by specialised organisation on the basis of surveys and modelling and endorsed by national energy agencies or institutions.

The energy consumption for water heating is not available in usual energy statistics and is part of more detailed data or estimates. The consumption for water heating includes oil products, gas, coal and lignite, electricity, biomass and solar.

The energy consumption of cooking is not available in usual energy statistics and is part of more detailed data or estimates. The consumption for cooking includes oil products, gas, electricity and biomass.

The energy consumption for air conditioning represents the electricity consumption of households for space cooling. Such information is estimated on the basis of surveys on the diffusion of space cooling appliances (i.e. air conditioners) and modelling, taking into account the intensity of use (number of hours) and their average rated power.

---

6 Default value in the EU is for instance 220 cycles per year for washing machines.
The energy consumption of electrical appliances (including lighting) can be calculated by difference between total electricity consumption – electricity consumption for air conditioning - electricity consumption for cooking – electricity for water heating.

The electricity consumption for lighting is for some countries available from national estimates; it is not covered by usual energy statistics. It is usually estimated from modelling taking into account the number of lighting points, or the average lighting power and an average number of hours of lighting per year.

5.2. Headline Indicators

5.2.1. Unit consumption of households per dwelling

It relates the energy consumption of the household sector to the number of permanently occupied dwellings.

\[ \text{cutoclog} = \frac{\text{toccfres}}{\text{nbrlpr}} \times 1000 \quad [\text{toe/dw}] \]

with:
- \( \text{toccfres} \): energy consumption of households in energy balance unit (toe, Joule...) (including wood,...)
- \( \text{nbrlpr} \): number of permanently occupied dwellings

**Interpretation**

This is the most usual indicator considered to measure energy efficiency improvements in dwellings. However, changes in this indicator do not only reflect the influence of better insulation or more efficient appliances, but result from different factors:

- genuine energy efficiency improvements, from more efficient buildings, space heating appliances or electrical appliances, on the one hand;
- better living standards (larger dwellings, more appliances, greater comfort of heating, etc), on the other hand;
- finally, substitutions between energies with different end-use efficiencies (e.g. switch from oil or coal to district heating, electricity, or gas).

5.2.2. Unit consumption of electricity of households per dwelling

\[ \text{cuelelog} = \frac{\text{elccfres}}{\text{eleun.fix}} \times \frac{1}{\text{nbrlpr}} \times 1000 \times 1000 \quad [\text{kWh/dw}] \]

with:
- \( \text{elccfres} \): electricity consumption of households in energy balance unit (toe, Joule...)
- \( \text{eleun.fix} \): coefficient to convert the energy balance unit in kWh (1 toe = 11628 kWh)
- \( \text{nbrlpr} \): number of permanently occupied dwellings

5.2.3. Unit consumption of households per dwelling with climatic corrections

\[ \text{cutoclogcc} = \frac{\text{toccfrescc}}{\text{nbrlpr}} \times 1000 \quad [\text{toe/dw}] \]

with:
- \( \text{toccfrescc} \): energy consumption of households with climatic corrections
- \( \text{nbrlpr} \): number of permanently occupied dwellings

\[ \text{toccfrescc} = \frac{\text{toccfres}}{1 - (\text{pchfres} \times 0.9)^n} \times (1 - \text{dj/djref}) \]

\[ ^7 \] A default value can be 1000 hours per year.
Energy efficiency indicators definition

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The actual number of heating degree days is an indicator of the winter severity, and thus of the heating requirement. It is calculated as the sum over each day of the heating period (e.g. October to April) of the difference between a reference indoor temperature (usually 18°C) and the average daily temperature\(^8\). The number of degree-days in EU countries is in a range from 700-800 degree-days for Cyprus and Malta to 4000-5000 degree-days in Nordic and Baltic countries; the EU-27 average stands around 2800 degree-days. The daily outside temperature is measured from the various meteorological stations existing in the country. The national average can be just calculated as an arithmetic average or as a population weighted average. The second approach should be used as it is more representative of the heating requirement in the country. Eurostat calculates these two values for all EU countries, but only the arithmetic national average is published and available on its web site.

The mean number of heating degree days represents the number of degree-days for a normal winter or an average winter; it is based on a long-term average of degree-days values. Eurostat uses a 25 years average (1980-2004)\(^9\).

5.2.4. Unit consumption of households per m\(^2\)

It is obtained by dividing the unit consumption per dwelling by the average size of dwellings (floor area).

\[
cutocsur = \frac{\text{toccfres}}{\text{surlog} \times \text{nbrlpr}} \times 1000000 \quad [\text{koe/m}^2]
\]

\[
cutocsurcc = \frac{\text{toccfrescc}}{\text{surlog} \times \text{nbrlpr}} \times 1000000 \quad [\text{koe/m}^2]
\]

with:
- toccfres : energy consumption of households
- toccfrescc : energy consumption of households with climatic corrections
- nbrlpr: number of permanently occupied dwellings
- surlog: average size of dwellings in m\(^2\)

5.3. Issue Indicators

5.3.1. Unit consumption for space heating

It relates the energy consumption of the household sector for space heating to the number of permanently occupied dwellings.

\[
cutoclogchf = \frac{\text{toccfreschf}}{\text{nbrlpr}} \times 1000 \quad [\text{toe/dw}]
\]

with:
- toccfreschf : energy consumption of households for space heating in energy balance unit (toe, Joule..) (including wood,…) 
- nbrlpr: number of permanently occupied dwellings

\(^8\) If the average temperature of a day in winter is 5°C, the number of degree day of that day is 13 degree days (18-5).

\(^9\) Some countries have however shortened the reference period and are calculating the average since 1990 to account for the fact that winters have been warmer since 1990. Some countries are in addition changing the period (moving reference period), which means that the number of normal degree-days is not fix.
5.3.2. Specific consumption of new dwellings

The specific consumption of new dwellings is a theoretical specific consumption, i.e. the specific consumption corresponding to energy efficiency standards and a conventional (or reference) heating behaviour.

These standards are expressed in different ways depending on the country and may refer to space heating only or to other uses as well as (e.g. water heating). This makes it difficult to compare insulation standards among countries. What can be compared is a theoretical specific consumption derived from the standard (in toe or GJ/m2).

5.3.3. Unit consumption per dwelling for lighting and electrical appliances

This unit consumption is calculated by dividing the electricity consumption for all appliances and lighting, by the number of permanently occupied dwellings. The electrical appliances considered here are all those with specific (captive) uses of electricity. Space heating systems, water heaters or cooking appliances are not included.

Interpretation

This unit consumption is changing over time under the influence of four factors:

- more households equipped with each of the usual electrical appliances (behavioural factor), i.e. increase in the household ownership of appliances;

- changes in the technology, i.e. in the energy efficiency of these appliances (technical factor);

- changes in the size (trend to smaller households) and characteristics of appliances (more combi-refrigerator compared to simple refrigerators, colour instead of black and white TV, etc), (behavioural factors);

- changes in the intensity of use, mainly for washing machines, TV and also for freezers or dish-washers (behavioural factors).

5.3.4. Specific consumption of new refrigerators and freezers

The specific consumption of new appliances is usually calculated from an average power capacity and an assumed duration of use in hours per year. It may also be referred to as “theoretical specific consumption” as it corresponds to a theoretical behaviour in terms of use.

The average power capacity is usually obtained as a “sales weighted average” taking into account the actual market shares of different brands and sizes of appliance.

This specific consumption can also be calculated in a different way on the basis of a standard size appliance (e.g. refrigerators of 180 litres with *** freezers, etc.).

5.3.5. Energy efficiency index of households

This index aggregates the trends in the different end-uses on the basis of their weight in the total consumption. For space heating, energy efficiency trends are calculated from the change in unit consumption per m² at normal climate, and for large electrical appliances from the change in specific electricity consumption, in kWh/year/appliance (Box 4). For water heating...
and cooking, energy efficiency trends are captured by the change in unit consumption per dwelling.

**Box 4: Energy efficiency index for households**

For households, the evaluation is carried out at the level of 3 end-uses (heating, water heating, cooking) and 5 large appliances (refrigerators, freezers, washing machines, dishwashers and TVs).

For each end-use, the following indicators are considered to measure efficiency progress:

- Heating: unit consumption per m2 at normal climate (toe/m2)\textsuperscript{10}
- Water heating: unit consumption per dwelling with water heating
- Cooking: unit consumption per dwelling

**5.4. Comparison indicators**

**5.4.1. Unit consumption (per m2 or dwelling) for space heating per degree-day**

It is equal to the unit space heating consumption per dwelling or m2 divided by the number of degree-days

**5.4.2. Unit consumption (per m2 or dwelling) for space heating scaled to the average european climate**

It is obtained, for each country, by multiplying the heating consumption of households per m2 with climatic corrections by the ratio mean number of heating degree days of the country over mean number of heating degree days of the EU average.

\[ \text{cusurche (i)} = \frac{\text{cusurche (i)}}{\text{djref (i)/djref (eu)}}. \]

with:

- \( \text{cusurche (i)} \): heating consumption per m2 of households in country (i) with climatic corrections (i.e. at normal climate)
- \( \text{djref (i)} \): mean number of heating degree-days of country i
- \( \text{djref (eu)} \): mean number of heating degree-days of the EU average

**5.4.3. Unit consumption (per m2 or dwelling) scaled to the average european climate**

It is calculated by scaling the space heating consumption to the average climate in the European Union on the basis of a relative number of degree days.

This indicator is more relevant to compare countries with different space heating requirements.

\[ \text{cutocsursce} = \left( \frac{\text{toccfrescoe}}{\text{surlog*nbrlpr}} \right) \times \text{djref.ueur/djref} + \left( \frac{\text{toccfrescoe}}{\text{surlog*nbrlpr}} \right) \times 1000000 \text{[koe/m2]} \]

\[ \text{cutoclogce} = \frac{\text{toccfrescoe}}{\text{nbrlpr}} \times 1000 \]

*Note: djref.ueur refers to the degree of reference of the whole EU as reference.*
5.4.4. Useful consumption (per m2 or dwelling) for space heating per degree-day

The unit consumption is measured in useful terms by multiplying the final consumption for each fuel by the end-use efficiency for that fuel. Reference end-use efficiency values are used.

6. Service sector

6.1. Data

The energy consumption of services is usually split into 8 branches that somehow correspond to homogenous categories of buildings:

- Wholesale and retail trade (Section G)
- Hotel and restaurant (Section I)
- Private offices (Sections H, J, K, L, M, and N).
- Public offices (Section O)
- Education (Section P)
- Health and social work (Section Q)
- Other branches (Section R-S)
- Public lighting;

Energy consumption can be split by fuel and by end-use:
- Space heating
- Water heating
- Cooking
- Air cooling
- Lighting
- ICT’s and other (by difference)

The activity data required in services are:
  o The value added by branch;
  o The number of employees by branch;
  o The floor area size (m2) by branch;
  o Or for some sub-sectors, sectoral indicators of activity, such as number of beds for hospitals, number of person-nights for hotels, number of pupils/students in education.

The floor area represents the floor space that needs to be heated, cooled or illuminated; it is measured in m2.

The annual construction of tertiary buildings represents the floor area of new buildings which are built every year.

The employment in tertiary represents the total employment in services, usually expressed in full-time equivalent (Full-time equivalent employees equal the number of employees on full-time schedules plus the number of employees on part-time schedules converted to a full-time basis).
6.2. **Headline Indicators**

6.2.1. **Energy intensity of service sector**

The energy intensity of the service sector is defined as the ratio between the final energy consumption of the sector (measured in energy units: toe, Joule, etc) and the value added measured in constant monetary units.

\[
\text{ieoeter} = \frac{\text{toccfter}}{\text{vadterxx} \cdot \text{txchg}\left(2010\right)} \times 1000 \quad \text{[koe/EC2010]}
\]

\[
\text{ieeleter} = \frac{\text{elccfter} \cdot \text{eleun}.\text{fix}}{\text{vadterxx} \cdot \text{txchg}\left(2010\right)} \times 1000 \times 1000 \quad \text{[kWh/employee]}
\]

with:
- toccfter: final consumption of service sector in Mtoe
- vadterxx: value added of services at constant prices in national currency
- txchg\left(2010\right): coefficient to convert constant prices in national currency into € of 2010
- elccfter : electricity consumption of service sector in energy balance unit (toe, Joule..)
- eleun.fix: coefficient to convert the energy balance unit in kWh (1 TWh = 0.086 Mtoe)

6.2.2. **Unit consumption of service sector**

The unit consumption of service sector is calculated as the ratio between the final energy consumption or electricity consumption of the sector and the number of employees.

\[
\text{cutocter} = \frac{\text{toccfter}}{\text{empter}} \quad \text{[toe/emp]}
\]

\[
\text{cuuleter} = \frac{\text{elccfter} \cdot \text{eleun}.\text{fix}}{\text{empter}} \times 1000 \quad \text{[kWh/emp]}
\]

with:
- toccfter: final consumption of service sector in Mtoe
- empter: total employment in services in Millions
- elccfter : electricity consumption of service sector in energy balance unit (toe, Joule..)
- eleun.fix: coefficient to convert the energy balance unit in kWh (1 toe=11628 kWh)

7. **Agriculture**

**Energy intensity of agriculture**

The energy intensity of agriculture is defined as the ratio between the final energy consumption of the sector (measured in energy units: toe, Joule, etc) and the value added measured in constant monetary units.

\[
\text{ietocagr} = \frac{\text{toccagr}}{\text{vadagrx}.\text{xx} \cdot \text{txchg}\left(2010\right)} \times 1000 \quad \text{[koe/EC2010]}
\]

with:
- toccagr: final consumption of agricultural in Mtoe
- vadagrx.xx: value added of agriculture at constant prices in national currency
- txchg\left(2010\right): coefficient to convert constant prices in national currency into € of 2010
8. **Energy efficiency index ODEX**

ODEX is the index used in the ODYSSEE-MURE project to measure the energy efficiency progress by main sector (industry, transport, households) and for the whole economy (all final consumers).

For each sector, the index is calculated as a weighted average of sub-sectoral indices of energy efficiency progress; sub-sectors being industrial or service sector branches or end-uses for households or transport modes.

- The sub-sectoral indices are calculated from variations of unit energy consumption indicators, measured in physical units and selected so as to provide the best “proxy” of energy efficiency progress, from a policy evaluation viewpoint. The fact that indices are used enables to combine different units for a given sector, for instance for households kWh/appliance, koe/m², tep/dwelling…
- The weight used to get the weighted aggregate is the share of each sub-sector in the total energy consumption of the sub-sectors considered in the calculation.

A value of ODEX equal to 90 means a 10% energy efficiency gain.

**Box 1: Principle of calculation of ODEX**

Considering two sub-sectors with a share of the consumption of 60% and 40% respectively in the base year and a change in the unit consumption from 100 to 85 for the first sub-sector and 100 to 97.5 for the second, the weighted average index with a simple weighting system is:

\[
0.6 \times \left(\frac{85}{100}\right) + 0.4 \times \left(\frac{97.5}{100}\right) = 90
\]

ODEX indicators represent a better proxy for assessing energy efficiency trends at an aggregate level (e.g. overall economy, industry, households, transport, services) than the traditional energy intensities, as they are cleaned from structural changes and from other factors not related to energy efficiency (more appliances, more cars…).

### ODEX and energy savings

- **Energy savings**

Top-down energy savings are derived from the multiplication of the variation of a unit energy consumption by an indicator of activity over a reference period. For instance, the energy savings of a given appliance (e.g. refrigerators) are derived from the variation in the average specific energy consumption per appliance (in kWh/year) multiplied by the stock of refrigerators; for example, a reduction of the specific consumption of refrigerators from 400 to 300 kWh in a country with one 1 million of refrigerators will result in total electricity savings equal to 100 GWh (Figure 1).

---

11 As explained below the exact weighting system is slightly different to guarantee a convergence with the mode of calculation of energy savings in top-down methods.

12 For market diffusion indicators, the energy savings are derived from the increase in the market share; for instance, energy savings from solar water heaters will be calculated from the diffusion of solar water heaters (in terms of installed stock in m²) multiplied by a coefficient expressed in terms of kWh/m².
Figure 1: Example of calculation of top-down energy savings (refrigerators)

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Choice of the weighting system

The weighting system used to calculate ODEX has been defined in such a way that ODEX is equal to a rate of energy savings, i.e. the ratio between the actual energy consumption (E) of the sector in year t and actual energy consumption (E) without energy savings (ES):

\[ \text{ODEX} = \frac{E}{E + ES} \times 100 \]

The energy savings are calculated as the sum of energy savings of each underlying sub-sector without:

\[ \text{ODEX} = \frac{E}{E + ES} \times 100 \]

For instance, if the actual consumption of the sector is 50 Mtoe and if the energy savings are 10 Mtoe, ODEX is equal to \((50/60)\times100 = 83.3\). Such an index of 83.3 is thus equivalent to a rate of energy savings of 16.7%.

Energy savings (ES) can be easily derived from the index from the previous formula:

\[ \text{ES} = E \times (100/\text{ODEX}) - 1 \]

For instance, if the actual consumption of the sector is 50 Mtoe and if the ODEX is equal to 90, the energy savings are equal to \(50\times(100/90)-1 = 5.56\) Mtoe.

Table 1 illustrates the calculation in the case of the cement industry.

| Table 1: Energy efficiency index and energy savings: case of cement |
|---------------------------------|------------------|------------------|
|                                 | t_o = 2000       | t_t = 2010       |
| Production (A)                  | Mt               | 25               | 30               |
| Consumption (E)                | Mtoe             | 1.9              | 2.1              |
| Unit consumption (UC)           | toe/t            | 0.076            | 0.070            |
| Energy savings                  | Mtoe             | 0.18             | 0.18             |
| Energy efficiency index         | index            | 92               |                  |

The energy savings measures the impact of the variation of the unit energy consumption per tonne of cement. It is calculated by multiplying the cement production by the variation of unit consumption (UC) between the base year 2000 and year t= 2010: \(A_t \times (UC_t/UC_o) = (0.076-0.07)\times30= 0.18\) Mtoe. The energy efficiency index of the cement industry in 2000 is then \(2.1/(2.1+0.18)=92\), which means that energy efficiency improved by 8%.
Weighting system in ODEX

The variation of the weighted index of the unit consumption between t-1 and t is defined as follows:

$$I_{t-1}/I_t = \sum_i EC_i \times (UC_{i,t} / IUC_{i,t-1})$$

with $UC_i$: unit consumption index of sub-sector i and $EC_i$: share of sub-sector i in total consumption.

The value at year t can be derived from the value at the previous year by reversing the calculation: $I_t/I_{t-1} = 1/(I_{t-1}/I_t)$.

ODEX is set at 100 for a reference year and successive values are then derived for each year t by the value of ODEX at year t-1 multiplied by $I_t/I_{t-1}$.

Table 2 illustrates the calculation in a simple example of two transport modes.

Table 2: Weighted energy efficiency index: simplified case of industry with 2 branches

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Chemicals</td>
<td>100</td>
<td>98</td>
<td>96</td>
<td>96</td>
</tr>
<tr>
<td>Steel</td>
<td>100</td>
<td>97</td>
<td>87</td>
<td>83</td>
</tr>
<tr>
<td>Total</td>
<td>100</td>
<td>97.4</td>
<td>90.9</td>
<td>88.6</td>
</tr>
</tbody>
</table>

$IE_{91} = IE_{1990} \times (98 \times 0.48 + 97 \times 0.52) = 97.4$

$IE_{92} = IE_{1991} \times (96/98 \times 0.44 + 87/97 \times 0.56) = 90.9$

$IE_{93} = IE_{1990} \times (96/96 \times 0.46 + 83/87 \times 0.54) = 88.6$

➔ gains of 11.4% in 1993 compared to 1990

Annex 1 gives more details on the convergence between the ODEX and the rate of energy savings.

Calculation of ODEX as a 3 years moving average

The trends observed for some sectors or end-uses, especially for space heating, are very irregular, which results in strong fluctuations in the ODEX, that are difficult to understand as energy efficiency progress should normally change smoothly (incremental technical change). Such fluctuations can be linked to various factors: imperfect climatic corrections, especially with warm winters, behavioural factors, influence of business cycles, imperfection of statistics, especially for the last year.

To reduce the fluctuations, ODEX is calculated as a 3 years moving average. The value used for year t is the average of t-1, t and t+1. This method is traditionally used in statistics.

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13 For the last year, the average is based on 2 years only as well as for the second year. A second method could have been to take for year t the average of t-2, t-1, and t. This method, which is used officially in the Netherlands, however always underestimates the gains achieved.
- **How to manage negative energy efficiency improvement**

A decrease in the specific energy consumption indicators indicates that energy efficiency has been improving. However, in some cases the observed indicator trend shows an increase, resulting in negative energy efficiency improvement.

This increase in the specific consumption may be due to an inefficient use of the equipment, as it is often observed during economic recession; this is particular true in industry or transport of goods. For instance in industry, in a period of recession, the energy consumption does not decrease proportionally to the activity as the efficiency of most equipment drops, as they are not used at their rated capacity, and, in addition, part of this consumption is independent of the production level. In that case, the technical energy efficiency does not decrease as such, as the equipment is still the same, but it is used less efficiently. It is therefore suggested to separate the technical efficiency from the observed (or apparent) energy efficiency. The apparent energy efficiency index can be replaced by a technical energy efficiency index, by considering that if the specific consumption for a given sub sector increases its value will be kept constant in the calculation of the technical index.

When publishing results for the index, it should be specified if it measures the apparent or technical energy efficiency and what end-uses may have been removed for the calculation because of hidden structural changes.

- **Energy efficiency index in industry**

For industry, the evaluation is carried out at the level of 10 branches:

- 4 main branches: chemicals, food, textile & leather and equipment goods;
- 3 energy intensive branches: steel, cement and pulp & paper
- 3 residual branches: other primary metals (i.e. primary metals minus steel), other non-metallic minerals (i.e. non-metallic mineral minus cement) and other pulp, paper and printing (i.e. mainly printing ).

The unit consumption is expressed in terms of energy used per ton produced for energy intensive products (steel, cement and paper) and in terms of energy used related to the production index for the other branches.

Unit energy consumption captures the energy efficiency development better than traditional energy intensities (per unit of value added). For some branches the trends shown include also some non-technical changes, especially in the chemical industry the shift to light chemicals, due to the fact that this sector is not sufficiently disaggregated.

- **Energy efficiency index in transport**

For the transport sector, the evaluation is carried out at the level of 8 modes or vehicle types: cars, trucks, light vehicles, motorcycles, buses, total air transport, rail, and water transport. The overall energy efficiency index aggregates the trends for each transport mode in a single indicator for the whole sector.

For cars, the energy efficiency is measured by the specific consumption, expressed in litre/100km.
For the transport of goods (trucks and light vehicles), the unit consumption per ton-km is used, as the main activity is to move goods.

For other modes of transport various indicators of unit consumption are used, taking for each mode the most relevant indicator given the statistics available:

✓ toe/passenger for air transport,
✓ goe/pass-km for passenger rail,
✓ goe/t-km for transport of goods by rail and water,
✓ toe per vehicle for motorcycles and buses.

- Energy efficiency index in households

For households, the evaluation is carried out at the level of 3 end-uses (heating, water heating, cooking) and 5 large appliances (refrigerators, freezers, washing machines, dishwashers and TVs).

For each end-use, the following indicators are considered to measure efficiency progress:

- Heating: unit consumption per m2 at normal climate (toe/m2) $^{14}$
- Water heating: unit consumption per dwelling with water heating
- Cooking: unit consumption per dwelling
- Large electrical appliances: specific electricity consumption, in kWh/year/appliance

In some countries, there is a slow down or even a deterioration of energy efficiency progress for heating since the mid-nineties. In a few other countries, there is even an overall increase in the ODEX since 1990. Such changes should not be interpreted as a reduction of energy efficiency, as technical savings have not actually stopped, with all the extra policy measures implemented in the late nineties and the continuous addition of new dwellings that are much more efficient. This situation rather reflects negative behavioural savings, due to higher indoor temperature. This means that the actual energy efficiency progress is underestimated, with the standard calculation of the ODEX, as proposed above.

To separate out the influence of behavioural factors, a technical ODEX is calculated and used to measure the energy efficiency progress.

- First of all, by accounting for energy efficiency gains linked to the penetration of more efficient new dwellings
- Secondly, by separating behavioural and technical changes by assuming that technical efficiency cannot reverse: it may not improve from one year to the other but cannot be “worse”

The difference between the technical ODEX and the gross ODEX shows the influence of behavioural factors (see Figure below). This calculation of a technical ODEX could even be further improved by estimating the technical gains associated to the diffusion of efficient technologies (eg CFL, condensing boilers).
“Heating behaviour” (higher temperature, duration of heating…), more hot water