ODYSSEE-MURE

Definition of data and energy efficiency indicators in ODYSSEE data base

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Content

1. Introduction

This report explains how the ODYSSEE indicators are calculated by sector, with a full description of their definition and equations. It provides also the necessary explanation for the interpretation of their trends. The data used for their calculations are also clearly identified and defined in the different sectors.

1.1. What are the energy efficiency indicators?

Energy efficiency indicators are used to assess the progress in energy efficiency and to measure energy savings.

The most common indicators are rather simple and relate the energy consumption to an indicator of economic activity (or consumption unit) measured in physical values (tons, employee, m2): they are called in ODYSSEE specific or unit energy consumption (see Table 1). Such indicators are also expressed in terms of CO_2 emissions in ODYSSEE.

They are complemented with indicators of market penetration of energy saving technology or practice. These indicators 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. They include:

- Market penetration of efficient technologies: number of efficient lamps sold, % of label A^{++} in new sales of electrical appliances, …
- Diffusion of energy efficient practices: % of passenger traffic by public mode, by non-motorised mode; % of transport of goods by rail, % of efficient motors in industry, …
- Market penetration of end-use renewable (% of dwellings with solar water heaters, % of efficient wood boilers for heating, …)

At an aggregate level, energy indicators relate the energy consumption to indicators of activity measured in monetary values (GDP, Value Added: they are called energy intensities in ODYSSEE (e.g. kWh/€, toe/€2015)

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).

Table 1 : Various types of energy efficiency indicators

Types of indicator	Examples
Specific/ unit energy consumption	litre/100km, household electrical appliance (kWh/year), heating consumption per m^2 or household (eg kWh/m^2 or household), consumption per employee or m2 in services (eg kWh/m^2 or /employee)
Market penetration of energy saving technology or practice	Share of public transport for passengers, of rail/water for goods, of solar water heaters, of cogeneration, of LED etc…
Energy intensity	Indicators in monetary value related to GDP or value added (e.g. toe/€2015)

Usual indicators as described above are useful to describe trends, but cannot explain the observed trends. For instance the energy consumption per household shows how the overall energy efficiency of households is changing but a decrease does not necessary mean that energy efficiency is improving from a technical viewpoint.

To enrich the interpretation and better monitor energy efficiency trends, more complex indicators are needed, the so called “**advanced indicators**”. These indicators do not need additional data: they just use the same data as the usual indicators but include additional calculations.

Six types of advanced indicators are considered in ODYSSEE:

1. Energy efficiency index to measure EE improvements at sector level.
2. Energy savings to quantify the amount of energy saved over a period or for given year .
3. Financial indicators to show the financial benefit of energy savings for households.
4. Benchmarking indicators to assess how each country performs compared to other countries?
5. Decomposition of energy consumption variation to show how energy efficiency improvements have impacted the energy consumption of the country?
6. Avoided CO2 emissions to show what is the effect of energy efficiency improvement on CO2 emissions.

1.2. Why so many indicators are needed?

Altogether, about 200 energy efficiency indicators are proposed by country. For a given sector or end-use several indicators can be considered, for different reasons:

- Energy efficiency has different meaning and frontiers (economic efficiency versus 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.

- 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.

- EE P&Ms are designed and implemented at the level of end-use and equipment (e.g. labels or standards on heating, lighting), or branch (e.g. voluntary agreements, audits). Therefore the monitoring of each P&M requires detailed indicators (eg kWh/m2 for new buildings with building codes; kWh per refrigerators for labels/standards; gCO2 or toe per km for Bonus-malus).

- Interpretation of indicators is more powerful when combined; for instance comparing trend in energy use per household and per m2 will show the impact of change in dwelling size.

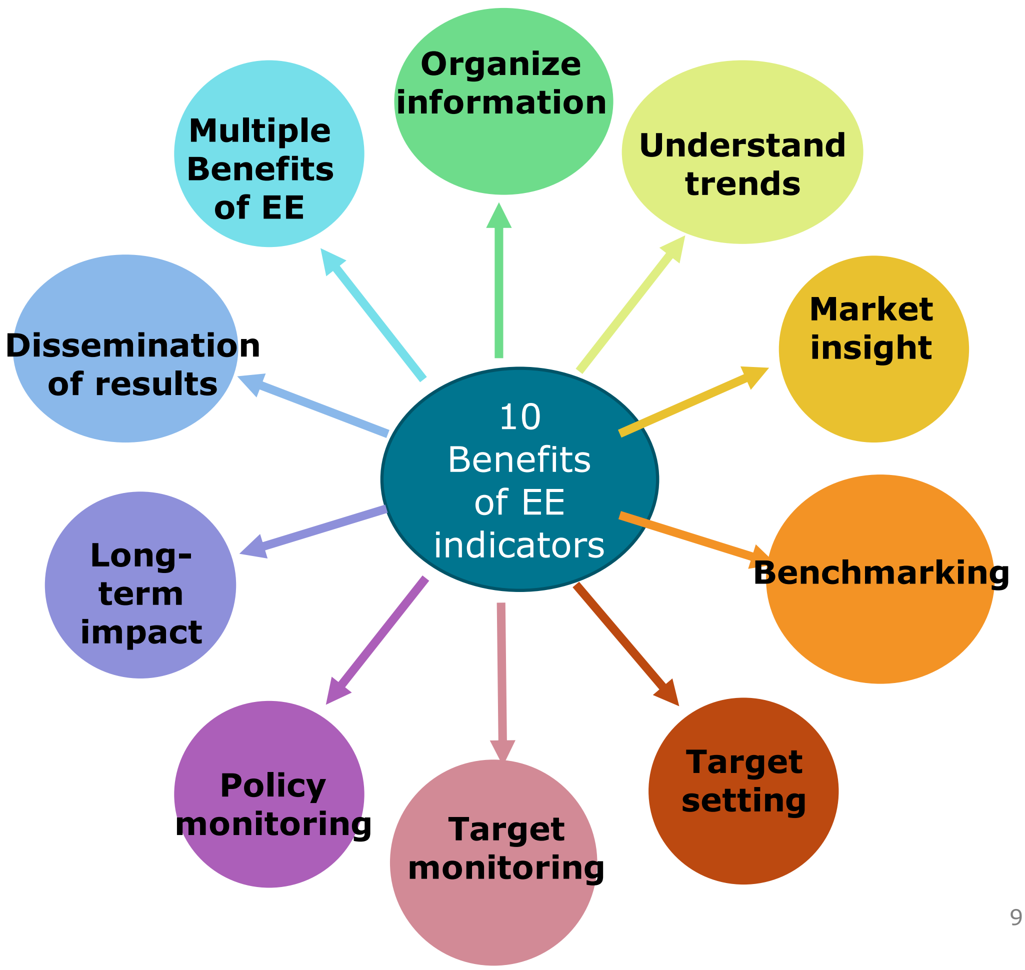
- Finally, alternative indicators are often necessary to cope with possible data gaps.

1.3. Use of energy efficiency indicators

Energy efficiency indicators have multiple objectives, among which the 10 most important are:

i. **Organise information** on energy consumption, through the data template and ODYSSEE data base gathering all the data needing to monitor energy efficiency in a country.
ii. Help to **understand trends** on energy consumption and energy efficiency.
iii. Provide **market insights** on the penetration of end-use equipment and energy efficient technologies.
iv. **Benchmarking** of energy efficiency performance of countries through cross-country comparisons**,** a crucial question in international negotiations on climate change**.**
v. **Setting energy efficiency targets**
vi. **Monitoring of the targets** set at the national and international levels in energy efficiency and CO2 abatement programmes.
vii. **Policy monitoring** to evaluate the impacts of measures so as to justify the public money spent to support these programmes and to **plan** future measures and actions.
viii. Measure the **long term impact** of measures as these energy efficiency indicators can feed the technico-economic demand forecasting models needed, that are characterised by a high level of disaggregation (end-uses).
ix. Improve the **dissemination** of the progress achieved on energy efficiency, through dedicated indicators and tools .
x. Finally, help measuring the **multiple benefits** of energy efficiency

Figure 1: Multiple use of ODYSSEE indicators



1.4. Source of data and energy efficiency indicators

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 CO_2 emissions, in a comparable manner among countries, and to compare their energy efficiency performance among EU countries. To reach the 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 data base and in the data sheet used by national teams to fill in the data.

1.5. List of indicators by sector

Table 5: List of indicators for services and agriculture

• **Services**	
Energy intensity of services sector : total, electricity	koe/€2015
Unit cons. of services sector per employee : total, electricity	toe/emp
Unit cons. of services sector per m2 with climatic corr. :total & electricity	koe/m2
Energy intensity of services sector at ppp	koe/€ppp
• **Agriculture**	
Energy intensity of agriculture	koe/€2015

2. Macro Data and Indicators

2.1. Indicators

Table 1 gives the list of macro indicators .

Table 1: List of macro indicators

Indicator	Unit
Energy efficiency index (ODEX) -Technical: total and by sector -Gross: total and by sector	index
Rate of energy savings: total and by sector	%
Annual savings (technical): total and by sector	Mtoe
Annual savings (gross): total and by sector	Mtoe
Primary energy intensity	koe/€2015
Final energy intensity	koe/€2015
Primary& final energy intensity with climatic corrections	koe/€2015
Ratio final/primary intensity	%
Final energy intensity at constant GDP structure (with cc[1])	koe/€2015
Primary & final energy intensity at purchasing power parities (ppp) (with cc)	koe/€2015ppp
Final energy intensity at EU average climate at ppp	koe/€2015ppp
Final energy intensity at EU average economic & industry structure at ppp	koe/€2015ppp
Final energy intensity at EU average economic structure and climate at ppp	koe/€2015ppp

2.1.1. 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.

ODEX is calculated with two definitions:

- Technical ODEX that do not takes into account negative energy efficiency trends, which means it can only decrease (i.e. which means energy efficiency improvements) or remained stable
- Gross ODEX that takes into account negative energy efficiency trends and that can increase over some periods.

A separate document gives more details on the calculation of ODEX.

[1] cc: climatic corrections

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 below, as they are cleaned from structural changes and from other factors not related to energy efficiency (more appliances, more cars…).

2.1.2. Rate of energy saving

2.1.3. Energy savings

Energy saving are derived from ODEX. 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.

2.1.4. 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.

ietoctpc=toccp / (pibxx/txchg€(2015))*1000 (koe/€ 2015)

with:
toccp: total energy consumption in Mtoe
pibxx: GDP at constant prices in national currency (base year 2015)
txchg€(2015)**:** coefficient to convert constant prices in national currency in € of 2015

This total consumption has different names depending on the organisation (see below definition in section 2.3.1): it is called "total energy supply" by Eurostat, "total primary energy supply"(TPES) by IEA 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.

2.1.5. Final energy intensity

The final energy intensity is the ratio final energy consumption over GDP.
ietoctfc=toccf / (pibxx./txchg€(2015))*1000 (koe/€2015)

with:
toccf: final consumption in Mtoe
pibxx: GDP at constant prices in national currency (base year 2015)
txchg€(2015): coefficient to convert constant prices in national currency in € of 2015

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.

2.1.6. 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 several 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.

- finally, changes in the share of imported secondary energies: for instance, if a country reduces its electricity generation and imports more, this will decrease transformation losses and narrow the gap between the two intensities.

2.1.7. 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, 2015 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.

ietoctpccc=toccfcc /(pibxx./txchg€(2015)*1000
ietoctfccc=toccfcc /(pibxx./txchg€(2015)*1000

with:
ietoctpccc : primary intensity with climatic corrections (
ietoctfccc : final intensity with climatic corrections

toccpcc=toccp-tocfres-tocfter+toccfrescc +toccftercc
toccfcc =toccf-tocfres-tocfter+toccfrescc +toccftercc

toccpcc:primary consumption with climatic correction
toccfcc:final consumption with climatic correction
tocfres: final consumption of household sector
tocfter: final consumption of service sector
tocfrescc: final consumption of household sector with climatic corrections
tocftercc: final consumption of service sector with climatic corrections

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

toccfrescc = toccfres / (1- (pchfres*0.9)* (1-(dj/djref)))

pchfres :share of space heating in household consumption

2.1.8. 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 (Sj) is unchanged from the base year and by taking into account the actual variation in energy intensity of sector (Ij).

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.

2.1.9. 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.

ietoctfcpp=toccp / (pibxx./txchgppp)*1000 (koe/€ppp)
ietoctfcpp=toccf / (pibxx./txchgppp)*1000 (koe/€ppp)

with:
toccp: primary consumption in Mtoe
toccf: final consumption in Mtoe

pibxx: GDP in national currency (in constant prices)
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 2015. 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.

2.1.10. 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.

2.1.11. 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.

ietoctfcaj=(vadindxx.ueur-vadimaxx.ueur)*(toccfind-toccfima)/(vadindxx.-vadimaxx.)
+(vadimaxx.ueur/(txchgppp*1000))*ietocimaaj
+vadagrxx.ueur*toccfagr/vadagrxx
+(vadterxx.ueur*toccfter/vadterxx.+pibxx.ueur*toccftra/pibxx.)
+(cprxx.ueur*toccfres/cprxx.))/(pibxx.ueur/txchgppp)*1000 [koe/€ppp]

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

2.2. Macro economy and energy balance data

2.2.1. Final and primary energy consumption

Given the different definitions of energy consumption between Eurostat statistics and EU directives and targets, ODYSSEE consider two definitions for the total, final and transport consumption.

Indeed, to harmonise with IEA accounting rules, Eurostat recently made a change in its statistics by removing international air transport from the transport consumption, which affected the transport , final and primary consumption.

However as the targets set in the various EU Directives, and in particular in the Energy Efficiency Directives, were based on the old definition, which included international transport in transport consumption, ODYSSEE will consider two definitions for the total, final and transport consumption.

For the **total energy consumption,** the two definitions are :

- "Total energy supply" (same as TPES IEA)
- "Primary energy consumption *(Europe 2020-2030)*" = total energy supply +air international - non energy uses - ambient heat[2].

The **final energy consumption** 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 final energy consumption is equal to the difference between the total energy supply (or primary energy consumption) and the consumption in energy transformations and losses. 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. Its definition stems from the accounting rules used in national energy balances.

The two definitions of the final energy consumption are as follows:

- "Final consumption (excl air bunkers)" (=final consumption of IEA - non energy uses)

"Final consumption (incl air bunker) *(Europe 2020-2030)"*= Final consumption -non energy uses +air bunker- ambient heat[3]

Note 1: air bunker= consumption for international aviation;

Note 2: the final energy consumption in ODYSSEE corresponds to the final energy consumption for energy uses: it excludes non energy uses, as their utilization is not related to energy efficiency considerations, but rather to materials management.

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.

[2] The corresponding data are displayed in the ODYSSEE tool called "Energy saving" at https://www.indicators.odyssee-mure.eu/energy-saving.html in the item primary consumption.

[3] The corresponding data are displayed in the "Energy saving" tool called in the item final consumption.

Table 1: Final electricity consumption and total electricity consumption

Final electricity consumption + Consumption in energy industries + Self consumption of electricity sector + Water pumping = **Domestic consumption** (or net consumption) + Losses and self consumption = **Gross availability** (or gross consumption)

The usual conversion of electricity consumption into energy units in the final energy 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.

2.2.2. 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...

2.2.3. 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 2015 if the values are measured at constant 2015 prices) ; current price (PRX) divided by the deflator (DEF) and multiplied by 100 gives constant price (PRC), as follows.

PRC = PRX/DEF x 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 2015. 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 = GDP / DEFL * DEFL xx/TXCHG xx with:

- GDPxx: GDP at constant price of year xx (e.g. 2015);
- DEFLxx: price deflator of the GDP with xx as base year (= 100 for base year)
- TXCHG : Exchange rate of the base year (eg 2015)

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 ($TCVOL_t$)

$GDPxx_{(2000)} = GDP_{(2000)}$
$GDPxx_{(2001)} = GDPxx_{(2000)} * (1+TCVOL_{2001}/100)$
$GDPxx_{(2002)} = GDPxx_{(2001)} * (1+TCVOL_{2002}/ 100)$
………
$GDPxx_{(t)} = GDPxx_{(t-1)} * TCVOL_t$
Before 2000, $GDPxx_{(t-1)} = GDPxx_{(t)} / TCVOL_t$

2.2.4. 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 : $I = X_t/X_0 \times 100$.

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 :
$((Xm/Xn)^{1/m-n} -1) \times 100$

2.2.5. 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. €2015), it is necessary to express first the values in national currency at **constant price** of 2015, then to divide by the 2015 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.

3. Industry

3.1. Indicators

Table 2 gives the list of indicators for industry

Table 2: List of indicators for industry

Indicator	Unit[4]
Energy efficiency index of industry (ODEX) : technical and gross	index
Energy efficiency index of manufacturing (ODEX) : technical and gross	index
Energy saving rate of industry (ODEX) : technical and gross	%
Energy saving rate of manufacturing (ODEX) : technical and gross	%
Annual energy savings of industry (technical)	Mtoe
Energy intensity of industry	koe/€2015
Energy intensity of industry at constant structure	koe/€2015
Energy intensity of industry at ppp	koe/€2015p
Energy intensity of manufacturing	koe/€2015
Energy intensity of manufacturing at constant structure	koe/€2015
Energy intensity of manufacturing at ppp	koe/€2015p
Energy intensity of manufacturing at constant structure	koe/€2015
Energy intensity of primary metals	koe/€2015
Energy intensity of chemicals	koe/€2015
Energy intensity of non-metallic minerals	koe/€2015
Energy intensity of machinery & fabricated metals	koe/€2015
Energy intensity of transport vehicles	koe/€2015
Energy intensity of food and tobacco	koe/€2015
Energy intensity of paper, pulp and printing	koe/€2015
Energy intensity of textiles and leathers	koe/€2015
Unit consumption of steel	toe/t
Unit consumption of cement: total, electricity and fuels	
Unit consumption of clinker: fuels	toe/t
Unit consumption of paper and pulp: total, electricity and fuels	toe/t
Unit consumption of glass: total, electricity and fuels	toe/t

3.1.1. 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.

ietocind=toccfind/(vadindxx./txchg€(2015))*1000 (koe/€2015)

with:
toccfind: final consumption of industry in Mtoe
vadindxx: value added of industry at constant prices of 2015 in national currency
txchg€(2015)**:** coefficient to convert constant prices in national currency into € of 2015

ietocima=toccfima/(vadimaxx./txchg€(2015))*1000 (koe/€2015)

[4] Units can be changed by the user to joule or kWh in the on line ODYSSEE data base.

with:
toccfima: final consumption of manufacturing industry in Mtoe
vadimaxx: value added of manufacturing industry at 2015 prices in national currency

ietocmpr=toccfmpr/(vadmprxx./txchg€(2015))*1000 (primary metals)
ietocchi=toccfchi/(vadchixx./txchg€(2015))*1000 (chemical industry
ietocmnm=toccfmnm/(vadmnmxx./txchg€(2015))*1000 (non-metallic minerals)
ietocmac=toccfmac/(vadmacxx./txchg€(2015))*1000 (machinery)
ietocveh=toccfveh/(vadvehxx./txchg€(2015))*1000 (transport equipment)
ietociaa=toccfiaa/(vadiaaxx./txchg€(2015))*1000 (food, tobacco,..)
ietocppp=toccfppp/(vadpppxx./txchg€(2015))*1000 (paper industry)
ietoctex=toccftex/(vadtexxx./txchg€(2015))*1000 (textiles)

3.1.2. 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.

cutocacb=toccfsid/prdacb*1000 [toe/t]
cutoccim=toccfcim/prdcim*1000 [toe/t]
cutocver=toccfver/prdver*1000 [toe/t]
cutocpap=toccfppp/prdppp*1000 [toe/t]

With:
toccfsid: energy consumption of steel, prdacb: production of crude steel
toccfcim: energy consumption of cement, prdcim: production of cement
toccfver: energy consumption of glass, prdver: production of glass
toccfppp: energy consumption of paper & printing, prdppp: production of pulp and paper

3.1.3. 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.

$$\ln\left(\frac{ie_t}{ie_{t-1}}\right) = \sum_i w_i \ln\frac{s_{it}}{s_{t-1}} + \sum_i w_i \ln\frac{ie_{it}}{ie_{t-1}}$$

w_i = energy consumption weight = E_i / E

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

$$Ie = \exp\left(\sum_t \sum_i w_i \ln\frac{ie_{it}}{ie_{it-1}}\right) \times 100$$

$$Is = \exp\left(\sum_t \sum_i w_i \ln\frac{s_{it}}{s_{it-1}}\right) \times 100$$

➔***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

3.1.4. Energy efficiency index in industry

For manufacturing industry, the evaluation is carried out at the level of 12 branches:

- 7 main branches: chemicals, food (beverage and tobacco), textile (and leather), wood, machinery (and metal products), transport vehicles and other manufacturing.
- 3 energy intensive branches: steel, cement and pulp & paper.
- 2 residual branches: other primary metals (i.e. primary metals minus steel) and other non-metallic minerals (i.e. non-metallic mineral minus cement).

For industry, two other branches are added: mining and construction.

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, since this sector is not sufficiently disaggregated.

3.1.5. 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 (ie the share of each branch in the value added of industry) of a reference country (eg the EU average for instance)

Calculation of a fictitious energy consumption ("adjusted energy consumption")[5]
For the other branches : $E_f = IEj_i * (VA_j / VA)_{EU} * VA$

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 **ietocimaaj= Σ Ef / VA**

3.2. Data for industry

3.2.1. 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

[5] 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:
$E_f = UC\ i * (P_i / VA)_{EU} * VA$; with UC_i: unit consumption of an intensive branch I and P_i : physical production of an intensive branch i

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...).

3.2.2. 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).

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.

Table 3 : Classification of industrial branch

Section	NACE	Detail
C	NACE 10-32 : Manufacturing industry	
C	*NACE 10-11-12 : Food, beverage and tobacco*	
C	*NACE 13-14-15 : Textiles, clothing, leather and footwear*	
C	*NACE 16 : Wood products*	
C	*NACE 17-18 : Paper, pulp and printing products*	17: Pulp, paper and board 18: Printing industry
C	*NACE 19 : Refining and coking*	
C	*NACE 20-21 : Chemicals*	20: Chemicals and chemicals products 21: Pharmaceutical products
C	*NACE 23 : Non metallic minerals*	
C	*NACE 24 : Primary metal*	24.1-24.2-24.3-24.51-24.52: Steel 24.4-24.53-24.54: Non ferrous metals
C	*NACE 25-28 : Machinery and metal product*	25: Manufacture of metallic articles 26-28: Machinery and equipment
C	*NACE 29-30 : Transport equipment*	
C	*NACE 22-31-32 : Other manufacturing*	
B,D,E,F	Other industries	
B	*NACE 05-06-07-08-09 : Mines and quarrying*	
D and E	*NACE 35-39 : Electricity, gas and water*	
F	*NACE 41-43 : Construction*	

- **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[6]. Value added at constant price are derived from values at current price, using price deflators[7]. 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).

- **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 2015 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 (2015).

- **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).

[6] Value added should be preferred to output value (i.e. turn over) as its variation is closer to the physical output.
[7] See above definition of price deflators in footnote 6.

4. Transport

4.1. Indicators for transport

The list of indicators for transport is given in Table 4.

Table 4: List of energy efficiency indicators for transport

Indicators	Unit
Global indicators	
Energy efficiency index (technical)	index
Energy efficiency index (gross)	index
Energy saving rate (technical)	%
Energy saving rate (gross)	%
Energy savings (technical)	Mtoe
Energy savings (gross)	Mtoe
Energy intensity of transport related to GDP	koe/€2015
Unit cons. of passenger transport	koe/pkm
Unit consumption of goods transport	koe/tkm
Road transport	
Unit consumption of road transport per equivalent car	toe/car
Unit consumption of gasoline of road transport per equivalent car	toe/car
Unit consumption of cars per vehicle	
Unit consumption of cars per passenger-km	koe/pkm
Specific consumption of cars (fleet average)	l/100km
Specific consumption of new cars (test values)	l/100km
Specific consumption of motorcycles	l/100km
Unit consumption of diesel heavy vehicles	toe/vehicle
Unit consumption of trucks and light vehicles: total, diesel, gasoline	toe/vehicle
Unit consumption of road transport of goods	koe/tkm
Unit consumption of trucks per vehicle	toe/vehicle
Specific consumption of trucks	l/100km
Specific consumption of light duty vehicles (fleet average)	koe/km
Specific consumption of new light duty vehicles (test values)	l/100km
Unit cons. of buses per vehicle	toe/vehicle
Unit cons. of buses per passenger-km	
Rail transport	
Unit consumption of rail transport	koe/gtkm
Unit consumption of rail transport of passengers	koe/pkm
Unit consumption of rail transport of goods	koe/tkm
Air transport	
Unit consumption of domestic air transport per passenger	toe/pass
Unit consumption of domestic air transport per passenger-km	koe/pkm
Water transport	
Unit consumption of domestic water transport	koe/tkm
Modal split	
Share of public transport in passenger transport	%
Share of rail & water in good transport	%

Table 4b: List of CO_2 indicators for transport

Indicators	Unit
CO2 intensity	
Fuels	kgCO2/€2015
Electricity included	kgCO2/€2015
CO2 emissions	
Passenger transport	kgCO2/pkm
Good transport	kgCO2/tkm
New cars (average)	gCO2/km
New cars (gasoline)	gCO2/km
New cars (diesel)	gCO2/km
Cars (stock average)	tCO2/vehicle
Cars (stock average)	gCO2/km
Motorcycles	tCO2/vehicle
Good transport	kgCO2/tkm
Total	kgCO2/tkm
Total (including electricity)	kgCO2/tkm
Road transport	kgCO2/tkm
Rail transport	kgCO2/tkm
Rail transport (including electricity)	kgCO2/tkm
Passenger transport	
Total	kgCO2/pkm
Total (including electricity)	kgCO2/pkm
Road transport	kgCO2/pkm
Rail transport	kgCO2/pkm
Rail transport (including electricity)	kgCO2/pkm
Air transport (domestic)	kgCO2/pkm

4.1.1. 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)

ietoctra=toccftra / (pibxx./txchg€(2015))*1000 (koe/€2015)

with:
toccftra: final consumption of the transport sector in Mtoe
pibxx: GDP at constant prices in national currency
txchg€(2015)**:** coefficient to convert constant prices in national currency in € of 2015

4.1.2. 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.

4.1.3. 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/ gtkm .

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 gtkm.

cutocfer=toccfer/tkbfer . [koe/tkbfer]
cutocferpkm=cutocfer*1,7 [koe/pkm]
cutocfertkm=cutocfer*2,5 [koe/tkm]

with:
cutocferpkm : unit consumption of rail transport of passengers per passenger-km
cutocfertkm : unit consumption of rail transport of goods per ton-km
cutocfer : unit consumption of rail transport per ton-km (gross tkm)
toccffer :consumption of rail transport
pkmfer : : passenger rail traffic in pkm
tkmfer : rail traffic of goods in tkm
tkbfer : total rail traffic in gross ton-km **(1.7*pkmfer + 2.5 * tkmfer)**

4.1.4. 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

cutocflv=toccfflv/tkmflv [koe/tkm]

with:
tocfflv: energy consumption for domestic water transport
tkmflv: traffic of goods for domestic water transport

4.1.5. 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).

cutocair=carcfair/pasair [toe/pas]
with :
carcfair : energy consumption for air transport
pasair : traffic of airport (number of passengers embarked and disembarked).

4.1.6. 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

cutocavd=carcfado/pkmavd [toe/pkm]
with :
carcfado : energy consumption for domestic air transport
pkmavd : domestic traffic in passenger-km.

4.1.7. Unit consumption of gasoline vehicules 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.

cuesseqc=esscfrou / (nbrvpcess + nbrmot*coefvpcmot+nbrcamvlress*coefvpccamvlr+nbrbusess*coefvpcbus) [toe/veh]

with:
esscfrou: consumption of gasoline of road transport
nbrvpcess: stock of gasoline cars
nbrvlress: stock of gasoline light vehicles
nbrmot: stock of motorcycles
nbrcamess: stock of gasoline trucks
nbrbusess: stock of gasoline buses
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

➔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.

4.1.8. 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.

cutoceqc=toccfrou/(nbrvpc+ nbrmot*coefvpcmot+nbrcamvlr*coefvpccamvlr+nbrbus*coefvpcbus) [toe/car]

with :
toccfrou
nbrvpc: stock of cars
nbrvlr: stock of light vehicles
nbrmot: stock of motorcycles
nbrcam: stock of trucks
nbrcamvlr: stock of trucks and light vehicles
nbrbus: stock of buses
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

4.1.9. 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=toccfvpc/nbrvpc [toe/veh]
cuessvpc=esscfvpc/nbrvpcess [toe/veh]
cugzlvpc=gzlcfvpc/nbrvpcgzl [toe/veh]

with:
toccfvpc: total consumption of cars
esscfvpc consumption of gasoline of cars
gzlcfvpc: diesel consumption of cars
nbrvpc : stock of cars
nbrvpcess : stock of gasoline cars
nbrvpcgzl : 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.

4.1.10. 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

4.1.11. 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

4.1.12. 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.

cugzlhvv=(gzlcfrou-gzlcfvpc-gzlcfvlr) /(nbrcamgzl+nbrbusgzl)*1000 [toe/veh]

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

4.1.13. 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=gzlcfcam/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

4.1.14. 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=toccfpas/pkm [koe/pkm]

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

4.1.15. 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=(cutocferpkm*pkmfer.(2015)+cutocbus*pkmbus.(2015)+cutocvpcpkm*
pkmvpc.(2015)+cutocavd*pkmavd)/(pkmfer.(2015)+pkmbus.(2015)+pkmvpc.(2015)+
pkmavd.(2015))

with:
cutocferpkm: 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
pkmvpc: 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 (cutocpkmst) shows the influence of modal substitutions

4.1.16. 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

cutocmch=toccfmch/tkm [koe/tkm]

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

4.1.17. 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.

cutocmchst=(cutocfertkm*tkmfer.(2015)+cutocflv*tkmflv.(2015)+cugzltgr*
tkmrou.(2015))/(tkmfer.(2015)+tkmflv.(2015)+tkmrou.(2015))

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
cugzltgr: unit consumption for road transport of goods
tkmrou: traffic for road transport of goods

4.1.18. Energy efficiency index for transport

For the transport sector, the energy efficiency index is calculated at the level of 8 modes or vehicle types: cars, trucks, light vehicles, motorcycles, buses, domestic 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 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 the transport of passengers (cars, buses, train) the unit consumption per passenger-km is used.

For motorcycles and light duty vehicles the indicator used is the unit consumption (toe) per vehicle.

4.1.19. Unit consumption of passenger transport at reference modal split

cutocpkmaj=(cutocvpcpkm*pkmvpc.ueur+cutocferpkm*pkmfer.ueur+cutocflvpkm*..
pkmflv.ueur+cutocairpkm*pkmavd.ueur)/(pkmvpc.ueur+pkmfer.ueur+pkmflv.ueur+pkmavd.ueur) [koe/pkm]

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

4.1.20. Unit consumption of goods transport at reference modal split

cutocmchaj=(cutocfertkm*tkmfer.ueur+cutocflvtm*tkmflv.ueur+cutocgzltgr* tkmrou.ueur.)/
(tkmfer.ueur+tkmfer.ueur+tkmrou.ueur) [koe/pkm]

4.2. Data on transport

4.2.1. 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”).

4.2.2. 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.

4.2.3. 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[8].

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.

4.2.4. 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

4.2.5. 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 given obtained directly from surveys.

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

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[8] Military vehicles are usually excluded from the statistics.

4.2.6. 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.

5. Households

Table 5 list the indicators considered in the household sector.

Table 5: List of indicators for households

Energy efficiency index and savings	
Energy efficiency index (technical)	index
Energy efficiency index (gross)	index
Energy saving rate (technical)	%
Energy saving rate (gross)	%
Energy savings (technical)	Mtoe
Energy savings (gross)	Mtoe
Unit consumption all dwellings (all uses)	
Unit consumption per dwelling	toe/dw
Unit consumption per dwelling with climatic corrections	toe/dw
Unit consumption of electricity per dwelling	kWh/dw
Unit consumption of electricity per dwelling with climatic corrections	toe/dw
Unit cons. per dwelling scaled to European average climate	toe/dw
Unit consumption per m2 with climatic corrections	koe/m2
Unit consumption per m2 scaled to European average climate	koe/m2
Space heating and water heating	
Unit cons. per dwelling for space and water heating with climatic corrections	toe/dw
Unit cons. per dwelling for space heating with climatic corrections	toe/dw
Unit cons. per dwelling in useful energy for space heating with climatic corrections	toe/dw
Unit cons. per dwelling for space heating scaled to European average climate	toe/dw
Unit cons. per dwelling for space heating per degree day	toe/dw
Unit cons. per dwelling for space heating in useful energy per degree day	toe/dw
Unit cons. per m2 for space heating with climatic corrections	koe/m2
Unit cons. per m2 in useful energy for space heating with climatic corrections	koe/m2
Unit cons. per m2 for space heating scaled to European average climate	koe/m2
Unit cons. per m2 for space heating per degree day	goe/m2/dj
Unit cons. per m2 for space heating in useful energy per degree day	goe/m2/dj
Unit cons. per dwelling for water heating	toe/dw
Other end -uses	
Unit cons. per dwelling for cooking	toe/dw
Unit cons. per dwelling for cooling	toe/dw
Unit cons. per dwelling for lighting and electrical appliances	kWh/dw
Unit cons. per dwelling for lighting	kWh/dw
Unit cons. per m2 for lighting	kWh/m2
Unit cons. per dwelling for electrical appliances	kWh/dw
Unit cons. per dwelling for large electrical appliances	kWh/dw
Unit cons. per dwelling for refrigerators	kWh/dw
Unit cons. per dwelling for freezers	kWh/dw
Unit cons. per dwelling for washing machines	kWh/dw
Unit cons. per dwelling for dishwashers	kWh/dw
Unit cons. per dwelling for TV	kWh/dw
Unit cons. per dwelling for clothes dryers	kWh/dw
Space heating cons per m2 (or dwelling) per degree-day	koe/dw/dd
Unit consumption single /multi family dwellings	
Unit cons. of single family dwellings for space heating	toe/dw
Unit cons. of single family dwellings for space heating with climatic corrections	toe/dw

Unit cons. of multifamily dwellings for space heating	toe/dw
Unit cons. of multifamily dwellings for space heating with climatic corrections	toe/dw
Unit cons. of multifamily dwellings for space heating with climatic corrections	toe/dw
Unit cons. of multifamily dwellings for space heating with climatic corrections	toe/dw

Table 4b: List of CO_2 indicators for households

Indicators	Unit
CO2 emissions per dwelling	
Fuels	tCO2/dw
Fuels with climatic corrections	tCO2/dw
Total (electricity included)	tCO2/dw
CO2 emissions per dwelling for space heating	
Fuels	tCO2/dw
Fuels with climatic corrections	tCO2/dw
Total (electricity included)	tCO2/dw

5.1. Headline Indicators

5.1.1. Unit consumption of households per dwelling

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

cutoclog=toccfres/nbrlpr*1000 [toe/dw]

with:
toccfres : energy consumption of households in energy balance unit (toe, Joule..) (including wood,…)
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).

5.1.2. Unit consumption of electricity of households per dwelling

cuelelog=(elccfres/eleun.fix)/nbrlpr*1000*1000 [kWh/dw]

with:

elccfres : electricity consumption of households in energy balance unit (toe, Joule..)
eleun.fix: coefficien to convert the energy balance unit in kWh (1 toe = 11628 kWh)
nbrlpr: :number of permanently occupied dwellings

5.1.3. Unit consumption of households per dwelling with climatic corrections

cutoclogcc=toccfrescc/nbrlpr*1000 [toe/dw]
with:
toccfrescc : energy consumption of households with climatic corrections
nbrlpr: :number of permanently occupied dwellings
toccfrescc = toccfres / (1-(pchfres*0.9)* (1-dj/djref)).
pchfres :share of space heating in household consumption
toccfres : energy consumption of households in energy balance unit (toe, Joule..) (including wood,...)
dj: actual number of degree days
djref: degree days of reference or mean degree-days

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[9]. 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)[10].

5.1.4. Unit consumption of households per m2

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

cutocsur=toccfres/(surlog*nbrlpr)*1000000 [koe/m2
cutocsurcc=toccfrescc/(surlog*nbrlpr)*1000000 [koe/m2]

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 m2

5.2. Issue Indicators

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[9] 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).

[10] 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.

5.2.1. 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=toccfreschf/nbrlpr*1000 [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

5.2.2. 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).

5.2.3. 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).

5.2.4. 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.).

5.2.5. Energy efficiency index of households

The energy efficiency index of households is calculated at the level of 11 end-uses or large appliances: heating, water heating, cooking, cooling, lighting, refrigerators, freezers, washing machines, dishwashers, dryer, 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), with a separation between new and existing dwellings.
- Water heating: unit consumption per dwelling with water heating
- Cooking: unit consumption per dwelling.
- Large electrical appliances, cooling and lighting: specific electricity consumption, in kWh/year/appliance.

5.2.6. 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

5.2.7. 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.

cusurche (i) = cusurchc (i) * (djref (i)/djref (eu)).

with:

cusurchc (i): heating consumption per m2 of households in country (i) with climatic corrections (i.e. at normal climate)

djref (i): mean number of heating degree-days of country i

djref (eu): mean number of heating degree-days of the EU average

5.2.8. 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.

cutocsurce=(toccfreschc/(surlog*nbrlpr)*(djref.ueur/djref)+(toccfrescc-toccfreschc)/(surlog*nbrlpr))*1000000 [koe/m2]

cutoclogce=toccfresce/nbrlpr*1000

Note: djref.ueur refers to the degree of reference of the whole EU as reference.

5.2.9. 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.

5.3. Data

5.3.1. Dwellings and characteristics

A **household** includes all the persons who occupy a housing unit as their usual place of residence[11]. 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 <u>permanently occupied dwellings</u>. 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** (m2) 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 m².

5.3.2. 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 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.

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[11] It is also defined as a group of persons who commonly live together and would take their meals from a common kitchen.

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[12]; 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.

5.3.3. 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.

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.

[12] Default value in the EU is for instance 220 cycles per year for washing machines.

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[13].

6. Service sector

6.1. Indicators of the services sector

6.1.1. 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.

ietocter=toccfter/(vadterxx./txchg€(2015))*1000 [koe/EC2015]
ieelcter=(elccfter/eleun.fix)/(vadterxx./txchg€(2015))*1000*1000 [kWh/employee]
with:
toccfter: final consumption of service sector in Mtoe
vadterxx: value added of services at constant prices in national currency
txchg€(2015)**:** coefficient to convert constant prices in national currency into € of 2015
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)

6.1.2. 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.

cutocter=toccfter/empter [toe/emp]
cueleter=(elccfter/eleun.fix)/empter*1000 [kWh/emp]

with:
toccfter: final consumption of service sector in Mtoe
empter: total employement 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)

6.1.3. Energy efficiency index for services

For services, the evaluation is carried out separately for thermal uses fuel and captive electricity uses at the level of 6 branches if data by branch are available[14] : offices (public and private), health (and social work), wholesale (and retail trade), hotels and restaurants, education, and others. Thermal uses are approximated by the consumption of fuels and heat (i.e. all energies outside electricity). For countries with a large share of electricity used for space heating (mainly France, Sweden and Norway), the consumption of electricity for space heating is included in the thermal uses

[13] A default value can be 1000 hours per year.
[14] Case of 12 countries and the EU: Croatia, Denmark, France, Germany, Italy, the Netherlands, Norway, Romania (>2010), Portugal (only electricity and since 2008), Spain, Sweden, UK (since 2005).

The overall energy efficiency index aggregates the trends by branch.

For electrical uses, the indicator used is the unit consumption (toe) per employee.

For thermal uses, the indicator is the unit consumption (toe) per m² (buildings surface area) when floor area data is available[15], otherwise it is the same as for electrical uses: toe per employee.

If data detailed by branch is not available, the evaluation is carried out using the aggregated indexes of fuel (as a proxy for thermal uses" and electricity for the whole service sector. Similarly to the more detailed approach, if the overall floor area is available, it will be used to calculate the indicator of unit consumption for fuels[16] ; if it is not available , employment is used.

6.2. 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).

[15] Case of Germany, Spain, France, the Netherlands, Sweden, UK and Norway.
[16] Countries where the overall floor area is available: Finland, Greece.

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.

ietocagr=toccfagr/(vadagrxx./txchg€(2015))*1000 [koe/EC2015]

with:
toccfagr: final consumption of agriculture in Mtoe
vadagrxx: value added of agriculture at constant prices in national currency
txchg€(2015)**:** coefficient to convert constant prices in national currency into € of 2015