Methodological guidelines for ODYSSEE data template for Brazil

Annex 1

Elaborado por:

Enerdata

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Para:

Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH

Grenoble, France – September 2012

Fontes Renováveis e Eficiencia Energética

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1. Objective of the report

Energy efficiency has become increasingly important in energy planning in Brasil. It was incorporated within the legal competences of EPE (*Empresa de Pesquisa Energética*), the state owned company bound to the Ministry of Mines and Energy (MME) and responsible for long term energy planning studies.

In the context of the technical cooperation program between Brazil and Germany, the EPE and GIZ (*Deutsche Gesellschaft für Internationale Zusammenarbeit mbH*) cooperate in order to refine energy efficiency related methodologies and instruments for energy planning.

The National Energy Plan 2030 assumes significant energy savings due to energy efficiency programs. Policies and measures on energy efficiency have to be accompanied by a sound monitoring and evaluation instruments. Therefore EPE is presently designing and implementing a national database on energy efficiency indicators.

As a step towards the successful implementation, completion and utilization of a Brazilian database on energy efficiency indicators, ENERDATA has been asked by GIZ in a first phase in September 2011 to train EPE staff on energy efficiency indicators (EE indicators) using the experience of the ODYSSEE project in Europe. In a second phase, Enerdata has been asked to customize a template for EE indicators for the Brazilian context and to prepare a manual including the detailed scope and definitions of EE indicators based on the ODYSSEE database.

This report corresponds to this manual. It provides a methodological guideline for the data necessary for the calculation of energy efficiency indicators for a data template to be used by EPE for Brazil.

This template is adapted from the ODYSSEE data template that all EU member countries fill in to update the ODYSSEE data base. This data base is part of the ODYSSEE MURE project that aims at evaluating energy efficiency progress through a large variety of indicators (ODYSSEE) and at describing energy efficiency policy and measures in EU countries (MURE)[1].

The data template cover all end-use sectors: industrial, households, services and transport sectors. For each sector, it indicates and describes the data used and the indicators that are derived from these data.

Compared to the ODYSSE template some adaptations have been made, mainly to account for the fact there is no space heating use in Brazil.

ODYSSEE uses the international classification to define and classify data by sector. A new classification from 2007 (NACE REV 2) is available and detailed on the Eurostat website[2]. An interactive menu for the detailed breakdown by branch in the industrial and tertiary sectors is also available on the Eurostat website[3] or on the UN website[4].

[1] http://www.odyssee-indicators.org/

[2] http://epp.eurostat.ec.europa.eu/cache/ITY_OFFPUB/KS-RA-07-015/EN/KS-RA-07-015-EN.PDF.

[3] http://ec.europa.eu/eurostat/ramon/nomenclatures/index.cfm?TargetUrl=LST_NOM_DTL&StrNom=NACE_REV2&StrLanguageCode=EN&IntPcKey=&StrLayoutCode=HIERARCHIC

[4] http://unstats.un.org/unsd/cr/registry/regcst.asp?Cl=27&Lg=1

This manual contains all definitions useful to complete the template on energy efficiency called "ODYSSEE template Brazil.xls".

2. Overview of ODYSSEE data template

The data template is presented on Excel. It is made of 10 sheets:

- 5 sheets for data by sector:
  - Macro economy_energy balances
  - Industry
  - Transport
  - Households
  - Services

- 5 sheets for the calculation of the energy efficiency index, called "ODEX) for each main sector (industry, transport, households, services) and the whole economy (all final consumers);

- 1 sheet ("Divisia") for the calculation of the energy intensity of industry at constant structure using the Divisia approach (see the definition in the "Industry" chapter).

Each data sheet has the same structure (**Table 1**):

- Column 1: Identification code of the dataserie
- Column 2: Title
- Column 3 : Country code (bra for Brazil)
- Colum 4 : Unit
- Columns 5 to n: data (one column per year)
- Colum n+1: source (short source to characterize each dataserie)
- Colum n+2: Note (used to detail the source).

Each data sheet is organised in 3 parts:

- A part dedicated to input data

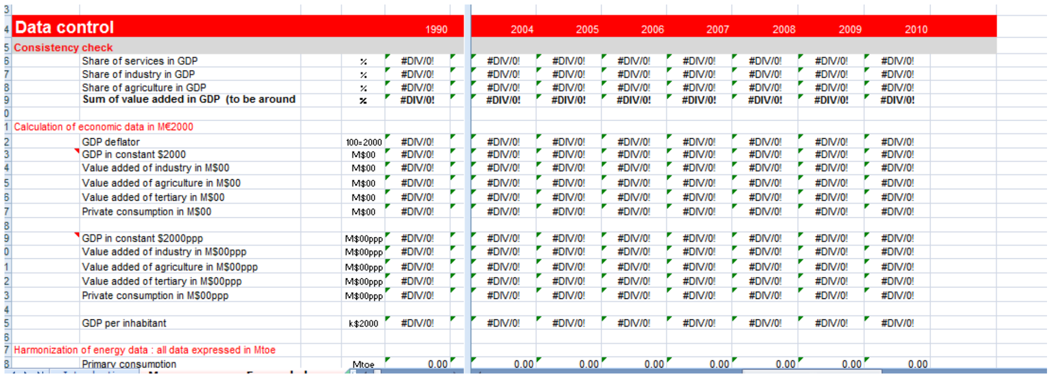
Table 1 : Example: organization of the sheet dedicated to macro-economic data

A	B	C	D	E	Q	R	S	T	U	V	W	X	Y	Z	AA
Macro economic data and energy ba															
Gross Domestic Product		country	units	1990	2002	2003	2004	2005	2006	2007	2008	2009	2010	source	notes
pib	GDP in current national currency 2	prt	Ml												
pibxx	GDP at constant prices, national c	prt	Ml2006												
Exchange rate															
txchgecu	Exchange rate: national currency	prt	1												
txchgppp	Exchange rate in ppp: national cur	prt	1												
Value Added, Private consumption at current and constant prices															
vadagr	VA at current prices of agriculture	prt	Ml												
vadind	VA at current prices of industry (:	prt	Ml												
vadter	VA at current prices of tertiary se	prt	Ml												
vadagrxx	VA at constant market prices of a	prt	Ml2006												
vadindxx	VA at constant market prices of ir	prt	Ml2006												
vadterxx	VA at constant market prices of te	prt	Ml2006												
cpr	Private consumption of household	prt	Ml												
cprxx	Private consumption of household	prt	Ml2006												
Population															
pop	Resident population	prt	k												
Energy balances															
Total energy consumption															
petcp	Total primary oil products consum	prt	ktoe												

Introduction | Macro economy_Energy

- A part for data controls

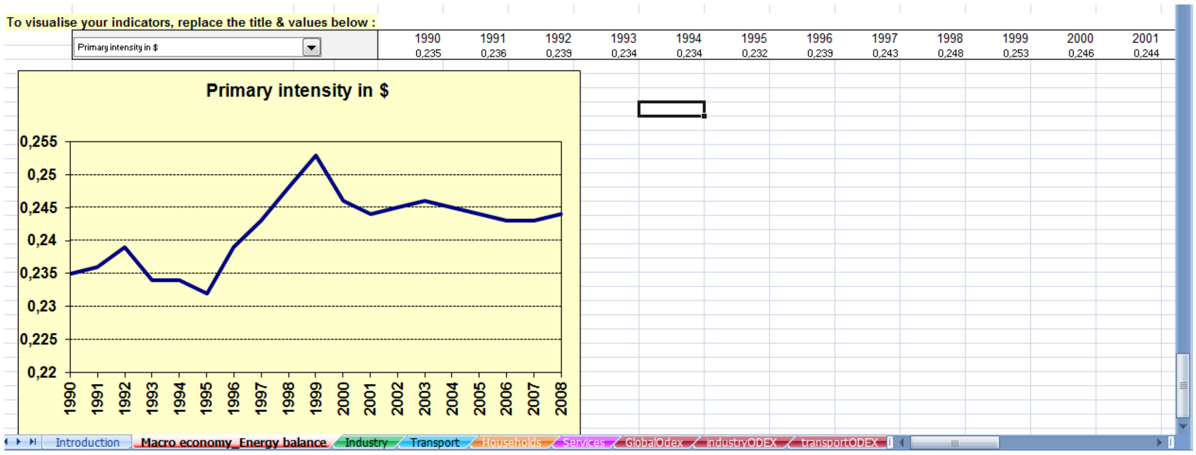
Table 2 : Example: automatic data control by sector



Data control		1990	2004	2005	2006	2007	2008	2009	2010
Consistency check									
Share of services in GDP	%	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
Share of industry in GDP	%	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
Share of agriculture in GDP	%	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
Sum of value added in GDP (to be around	**%**	**#DIV/0!**	**#DIV/0!**	**#DIV/0!**	**#DIV/0!**	**#DIV/0!**	**#DIV/0!**	**#DIV/0!**	**#DIV/0!**
Calculation of economic data in M€2000									
GDP deflator	100=2000	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
GDP in constant $2000	M$00	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
Value added of industry in M$00	M$00	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
Value added of agriculture in M$00	M$00	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
Value added of tertiary in M$00	M$00	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
Private consumption in M$00	M$00	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
GDP in constant $2000ppp	M$00ppp	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
Value added of industry in M$00ppp	M$00ppp	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
Value added of agriculture in M$00ppp	M$00ppp	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
Value added of tertiary in M$00ppp	M$00ppp	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
Private consumption in M$00ppp	M$00ppp	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
GDP per inhabitant	k$2000	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
Harmonization of energy data : all data expressed in Mtoe									
Primary consumption	Mtoe	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

- A part for the calculation of indicators

Table 3 : Example: automatic graphs by sector



Data collections

Data have to be filled in the predefined template. No additional lines should be added. The user can add a separate sheet to enter all the data needed and link these data to the data requested in the different Excel sheets.

Units have been predefined in the template; it is important not to change them to allow the calculation of the indicators at the end of each sectoral sheet.

Data controls

Data controls are very useful to check rapidly the quality of the data. Simple and automatic procedures have been predefined to test the data quality such as :

- Data coherence between detailed data and aggregate ones (for example the sum of energy consumption by end uses in households compared to total consumption of households)

- Harmonization of data : economic data calculated in foreign currencies (e.g. constant $ and $ ppp[5])

Calculation of indicators

Simple indicators are directly calculated in the Excel file to allow users to check the data and visualize them through graphs. Predefined graphs are available at the end of each sheet to check trends and detect possible data disruptions.

[5] ppp for purchasing power parities

3. Macro economy and energy balance data

The macro economy and energy balance data sheet contains:

- Macro-economic data: GDP by sector, exchange rates
- Demography (population)
- Energy balances data: primary and final energy consumption by sector : industry, transport, households, services, et agriculture (non energy uses are excluded)
- Degree-days for climatic corrections (cooling degree-days)

It also contains macro indicators:

- Primary intensity (national currency, constant $, constant $ at ppp)
- Final intensity: total and by sector (national currency, constant $, constant $ at ppp)
- Ratio final/primary intensity

3.1. Definition of data

3.1.1. Economic data

- **GDP**

The GDP, Gross Domestic Product is the usual indictor to measure the economic output of a country. It is generally measured at market prices

The GDP (at market prices) is equal to the sum of value added (VA) of the 3 main economic sectors (agriculture and fishing activities, industry and services[6]) + indirect taxes (about 10%)[7].

The GDP is defined at current and constant price in the template. The values at current price are not used to calculate the indicators but to calculate and check the values at constant price; the latter are corrected from the effect of inflation. Usually such data are available from official statistics. In case they are not available, they can be calculated from price deflators[8] of from index of volume, as explained in **Box 1**.

- **Exchange rates**

The exchange rate of the national currency into US$ is defined as the yearly average.

[6] The service sector, also called tertiary sector, include administrations and commercial activities.

[7] It is also measured at factor cost; in that case, the GDP is strictly equal to the sum of value added (VA) of the 3 main economic sectors (agriculture and fishing activities, industry and services).

[8]The price deflator (DEF) is a price index used to convert a monetary value in nominal price (PRX) into a value at constant price (PRC); it equals 100 for the reference year (e.g. = 100 in 2005 if values are measured at constant 2005 prices and 120 in 2010 if prices increased by 20% between 2005 and 2010); PRC = PRX/DEF x 100.

The purchasing power parities are similar to exchange rates but accounts for differences in the cost of living between countries. It is calculated by international organisations, such as World Bank or IMF[9].

To calculate economic indicators in an international currency, such as $ or €, the GDP or value added should be converted into $ or €. **Box 1** explains how to do the conversions.

- **Value Added and Private Consumption of Households**

The value added are defined at current and constant price in the template. Usually such data are available from official statistics. In case they are not available, they can be calculated from price deflators[10] of from index of volume, as explained in **Box 1**.

The private consumption of households is the main component of the GDP expenditure: it usually represents about 60-70% of GDP; the other components being the gross investment, the government consumption and the balance import – export.

- **Population**

The total **population** usually corresponds to the mid-year population

[9] http://www.imf.org/external/pubs/cat/longres.cfm?sk=24344.0

[10] The price deflator (DEF) is a price index used to convert a monetary value in nominal price (PRX) into a value at constant price (PRC); it equals 100 for the reference year (e.g. = 100 in 2005 if values are measured at constant 2005 prices and 120 in 2010 if prices increased by 20% between 2005 and 2010); PRC = PRX/DEF x 100.

Box 1: How to convert economic values from current to constant prices?

Conversion using deflators (price index)

Example : $GDP\ xx_{(t=2005)} = GDP / DEFL * DEFL_{(t=2005)}$
with XX base year constant prices; DEFL: GDP deflator

There exist different deflators for each macroeconomic aggregate: GDP deflator, private consumption (inflation), agriculture, etc. ...

Conversion based on an annual rate of change in volume

The rate of change in volume is often given as an index compared to the previous year existence:

We start from the VA at current prices for the base year of constant price and we construct the series of constant price year after year from the rate of change in volume (TCVOL)

To convert value added in 2000 prices:

$VA_i\ xx_{(2000)} = VA_{i\ (2000)}$

For the next years :

$VA_i\ xx_{(2001)} = VA_i\ xx_{(2000)} * (1+TCVOL_{2001}/100)$

$VA_i\ xx_{(2002)} = VA_i\ xx_{(2001)} * (1+TCVOL_{2002}/100)$

....

$VA_i\ xx_{(t)} = VA_i\ xx_{(t-1)} * TCVOL_t$

with $TCVOL_t$ = variation in volume of the VA from t-1 to t

Before 2000 : $VA_i\ xx_{(t-1)} = VA_i\ xx_{(t)} / TCVOL_t$

Box 2 : Conversion of national currency into international currency

To convert monetary values in national currency at constant prices into $ or € for comparisons, only one value should be used for the exchange rate for all years: the value of the base year of constant price

Example: GDP_t €2005= GDP_t xx / txchg $€_{(t=2005)}$
XX with base year of constant price
txchg €: exchange rate of national currency in €

3.1.2. Energy consumption data[11]

- The **primary energy consumption** represents the total consumption of a country (total consumption of coal, oil, gas, primary electricity (nuclear, hydro), electricity production from renewable (wind, solar, solar heat, geothermal), import / export of electricity and biomass).

[11] Compared to ODYSSEE templates, some simplifications have been introduced in the list of fuels to match the Brazilian situation: removal of heat from district heating, lignite.

The **final energy consumption** measures the needs of the final consumers of the country. They are broken down into several sectors: industry (non energy uses are excluded), transport, residential, tertiary, agriculture.

- **Final consumption of industry** covers all industrial sectors, e.g. iron and steel industry, chemical industry, food, drink and tobacco industry, textile, leather and clothing industry, paper and printing industry, etc., with the exception of transformation and/or own use of the energy producing industries. It excludes the fuel consumption of all modes of transport, and also excludes energy products employed for non energy uses (e.g. raw materials, lubricants).

- The **final consumption of transport** is the total consumption of all modes of transportation regardless of to whom they belong, and to what purpose the transport serves. International air transport is included in energy consumption of transport.

- The **final energy consumption of residential, tertiary, agriculture** includes the final consumption of energy products used for energy uses, excluding industry and transport sectors. It is broken down into three sub-sectors: residential, tertiary, agriculture (including fishing activities).

According to international definitions (eg IEA, Eurostat), fuels used for autoproduction of electricity (Distributed Generation) should be excluded from the final consumption and are include in transformations. The electricity produced from Distributed Generation (DG) and consumed in the premises of the consumer should be added: therefore the consumption of electricity should include both purchased + self generated electricity.

To do so surveys on DG are necessary, which is the common practice in EU countries.

However, in most non OECD countries, such surveys do not exist and in practice:

- fuels used for DG are included from the final consumption
- and the electricity consumed only include purchased electricity

3.1.3. Cooling degree days

The number of cooling degree days is an indicator of the summer temperature, and thus of the cooling requirement. It is calculated as the sum over each day of the cooling period of the difference between the average daily temperature and a reference indoor temperature (usually 20°C[12]).

The number of cooling degree days correspond to the national average. It is used to correct national data on the electricity consumption; this climatic adjustment is only useful if the need for cooling can change a lot from one year to the other and explains variations in the electricity consumption from one year to the other[13].

The national average can be calculated from average of different homogenous climatic areas and should be a population weighted average.

In the US, cooling degree-days are published by States and for the whole country. They are deviations above the mean daily temperature of 65° F. For example, a weather station recordin g a mean daily temperature of 78° F would report 13 cooling degree-days. Temperatures, recorded by weather stations, are used to calculate State-wide degree-day averages based on resident State population. The population-weighted State figures are then aggregated into Census divisions and the national average[14] (see table below).

The mean cooling degree days , also called normal degree days represents the number of degree-days for a normal summer; it is based on a long-term average of degree-days value (e.g.30 years in the US) ((see table below).

Cooling degree –days in the US

Year	New England	Middle Atlantic	East North Central	West North Central	South Atlantic	East South Central	West South Central	Mountain	Pacific	United States
2009	362	587	547	720	2 025	1 497	2 570	1 504	884	1 229
2010P	657	997	975	1 123	2 267	2 004	2 750	1 450	655	1 457
Normal2	441	665	731	949	1 982	1 564	2 477	1 308	755	1 242

[12] The calculation of cooling degree days is common in the US where they used 20°C as a reference, which may be too low for other countries and should be adapted taking into account the present comfort habits and living style; a higher temperature would be more relevant (e.g. 26°C).

[13] In France climatic correction is done on space heating; as electric heating is significant (12% of the total electricity consumption), climatic corrections are necessary to get the real trend in electricity use. For instance in 2010, electricity consumption increased by almost 6%. At normal climate, i.e. with climatic corrections, the growth is only 4% as 2010 winter was rather cold: thus the climate explains 2% point of growth (i.e. one third of the growth).

In 2011, this is the reverse phenomenon: consumption dropped by almost 6% but with climate corrections it only dropped by 2.4% as 2011 was exceptionally warm. Thus in 2011, almost 60% of the drop in the electricity consumption is explained by the mild winter.

[14] http://www.eia.gov/totalenergy/data/annual/index.cfm#summary

3.2. Data controls

3.2.1. Harmonization of data

Final energy consumptions by branches are all expressed in the same unit to be comparable, ie Mtoe.

GDP, main value added by sector (industry, agriculture and tertiary), private consumption of households are expressed in constant prices, in $ 2000.

3.2.2. Data controls

Calculations of the share of each value added in GDP (for tertiary, industry and agriculture); the sum of these 3 value added should represent around 90% of the GDP.

3.2.3. Controls of indicators trends

The main indicators are calculated directly in the sheet using data previously entered (see below the list of indicators and their definitions).

Two types of control are available:

i. Check the annual variation (%/year) over the 5 last years for each indicator ;
ii. Visualisation of trends in these indicators through graphs to easily identify breakdown in data series (need to select an indicator in the pre-defined list to visualise the graph).

To better visualise the variations over the last five years, colours have been added. If the difference (between t and t-1) is less than 5%, no colour is seen (only the variations of % is available); if the difference observed is 5-15%, the cell is green; if the difference is between 15-30%, the cell is orange, and red if the difference is more than 30%.

3.3. Definition of macro indicators

3.3.1. Primary energy intensity

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

3.3.2. Final energy intensity ratio final /primary energy intensity

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

The **ratio final/primary energy intensity** is obtained by dividing the final energy intensity by the primary energy intensity: it is the same as the ratio final to primary energy consumption.

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 energy transformations and distribution, and mainly in power generation which usually represents most of these losses (about 3/4), 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.

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

i. changes in the energy supply mix, mainly linked to changes in the electricity generation mix: an increase in the share of thermal power generation increases the gap between the two intensities; in contrast, an increasing share of hydropower or wind narrows this gap.
ii. 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.
iii. changes in the share of secondary energies (mainly electricity) in final consumption.
iv. changes in the percentage of energy for non-energy uses, as these consumptions are included in the primary intensity but excluded from the final intensity.
v. finally, changes in the share of imported secondary energies: any increase, for instance, in electricity imports will decrease transformation losses and narrow the gap between the two intensities.

4. Industry

The industry data sheet contains the following types of data:

- Value added at constant price by industrial branch;
- Production index by industrial branch;
- Physical production for energy intensive products;
- Final energy consumption by industrial branch;

4.1. Data for industry

4.1.1. Classification of industrial branches

The definition and classification of industrial branches follows the international classification (e.g NACE or ISIC[15]). Industry is broken down into 4 main sectors:

- Section B: Mining and quarrying
- Section C: Manufacturing
- Section D: Electricity, gas, steam and air conditioning supply
- Section E: Water supply; sewerage, waste management and remediation activities
- Section F : Construction

The classification manufacturing industry by branch also follows the international classification. In ODYSSEE, the classification is based on the 2 digits level as follows:

- Mining and quarrying (ISIC 07-08 and 099)
- Manufacturing industries (ISIC 10-33, excluding ISIC 19)
    - Food and tobacco (ISIC 10-12)
    - Textile and leather (ISIC 13-15)
    - Wood and wood products (ISIC 16)
    - Paper and paper producs, and printing (ISIC 17-18)
    - Chemical and petrochemical (ISIC 20 and 21)
    - Other non-metallic minerals (ISIC 23)
    - Basic metals (ISIC 24)
        - Iron and steel (ISIC 241, 242, 243, 2451, 2452)
        - Non-ferrous metals (ISIC 244, 2453, 2454)
    - Machinery (ISIC 25-28, 33)
    - Transportation equipment (ISIC 29-30)
    - Other (not included above), of which rubber and plastics (ISIC 22)
- Construction (ISIC 41 to 43)

[15] ISIC, NACE rev 2

Table 1: Statistical classification of industrial branches (ISIC NACE REV2)

Manufacturing

Nace rev 2	
Section/Division	Details
Section C (division 10-33)	**details by sector (see below)**

Food, beverage and tobacco

Nace rev 2	
Section/Division	Details
Section C (division 10-12)	Division 10 - Manufacture of food products and beverages
	Division 11 - Manufacture of beverages
	Division 12 - Manufacture of tobacco products

Textiles, clothing, leather

Nace rev 2	
Section/Division	Details
Section C (division 13-15)	Division 13 - Manufacture of textiles
	Division 14 - Manufacture of wearing apparel
	Division 15 - Manufacture of leather and related products

Wood, wood products

Nace rev 2	
Section/Division	Details
Section C (division 16)	Division 16 - Manufacture of wood and of products of wood and cork, except furniture; manufacture of articles of straw and plaiting materials

Paper, pulp and printing products

Nace rev 2	

Section/Division	Details
Section C (division 17-18)	Division 17 - Manufacture of paper and paper products
	Division 18 - Printing and reproduction of recorded media

Chemicals

Nace rev 2	
Section/Division	Details
Section C (division 20-21)	Division 20 - Manufacture of chemicals and chemical products
	Division 21 - Manufacture of basic pharmaceutical products and preparations

Non metallic minerals

Nace rev 2	
Section/Division	Details
Section C (division 23)	Division 26 - Manufacture of other non-metallic mineral products

Iron and steel

Nace rev 2	
Section/Division	Details
Section C (division 24.1)	Division 24.1 - Manufacture of basic iron and steel and of ferro-alloys
Section C (division 24.2)	Division 24.2 - Manufacture of tubes, pipes, hollow profiles and related fittings, of steel
Section C (division 24.3)	Division 24.3 - Manufacture of other products of first processing of steel
Section C (division 24.51)	Division 24.51 - Casting of iron
Section C (division 24.52)	Division 24.52 - Casting of steel

Non ferrous metals

Nace rev 2	
Section/Division	Details

Section C (division 24.4)	Division 24.4 - Manufacture of basic precious and other non-ferrous metals
Section C (division 24.53)	Division 24.53 - Casting of light metals
Section C (division 24.54)	Division 24.54 - Casting of other non-ferrous metals

Machinery and metals products

Nace rev 2	
Section/Division	Details
Section C (division 25)	Division 25- Manufacture of fabricated metal products, except machinery and equipment
Section C (division 28)	Division 28- Manufacture of machinery and equipment n.e.c.
Section C (division 26)	Division 26- Manufacture of computer, electronic and optical products
Section C (division 27)	Division 27- Manufacture of electrical equipment
Section C (division 33)	Division 33- Repair and installation of machinery and equipment

Transport equipement

Nace rev 2	
Section/Division	Details
Section C (division 29)	Division 29 - Manufacture of motor vehicles, trailers and semi-trailers
Section C (division 30)	Division 30 - Manufacture of other transport equipment

Other manufacturing*

Nace rev 2	
Section/Division	Details
Section C (division 22)	Division 22- Manufacture of rubber and plastics products
Section C (division 32)	Division 32- Other manufacturing
Section C (division 31)	Division 31- Manufacture of furniture

Source : Eurostat

http://ec.europa.eu/eurostat/ramon/nomenclatures/index.cfm?TargetUrl=LST_NOM_DTL&StrNom=NACE_REV2&StrLanguageCode=EN&IntPcKey=18496334&StrLayoutCode=HIERARCHIC&IntCurrentPage=1

The energy intensive products include in ODYSSEE: steel, aluminum, cement, clinker, pulp, paper, sugar and glass. These branches correspond to international classification at a more detailed level (3 or 4 digits level): cement for instance, which is part of branch 23 (Division 23.5, corresponds to ISIC 23.51).

4.1.2. Economic data

- **Value added at current price**

Value added at current (or nominal) prices are asked either to calculate the value added at constant price or to check the values at constant price (for the reference year of price value added at current and constant prices are equal). Value added at current prices is not corrected from the effect of inflation.

- **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 (in constant $). It is less well covered by national statistics[16]. Value added at constant price are derived from values at current price, using price deflators[17]. 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 and 2 to calculate value added at constant prices).

- **Production index**

The **production index** by sub-sector is the most common indicator used to measure the industrial output[18]; it is usually measured in relation to a base year (e.g. index base 100 in 2005 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)

[16] Value added should be preferred to output value (i.e. turn over) as its variation is closer to the physical output

[17] See above definition of price deflators in footnote 10.

[18] Production index are measured at a very detailed level (4 to 5 digits) on the basis of physical production in different units (e.g. number of litres of milk processed, of tons of meat produced for the food industry). To get the production index of a two digits branch (e.g. food), detailed index are aggregated on the basis of the weight of each sub-branch in the value added of the branch in the base year (2000).

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 (2005).

- **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).

4.1.3. Final energy consumption by branch

The **final energy consumption** of industry in energy statistics excludes :

- energy transformation industries
  - In section B (mining), energy mining, such as coal mining (Division 5), oil and gas extraction (Division 6);
  - In section C (manufacturing), refineries and coking plants;
  - In section D (electricity, gas and water): electricity power plants and gas processing plants (Division 35).
- Fuel consumption of vehicles (diesel, LPG, NG), that is included in the transport sector;
- fuels used for autoproduction of electricity or cogeneration (own production of electricity on industrial sites); they are included in energy transformations under production of electricity

The fuels considered in ODYSSEE are the following:

- Electricity
- Natural gas
- Diesel/heating oil
- Heavy fuel oil
- Other petroleum products (LPG, kerosene, petroleum coke)
- Hard coal
- Other (wood, charcoal, bagasse, black liquor and other wastes)

4.2. Data controls

4.2.1. Harmonization of data

Final energy consumptions by branches are all expressed in the same unit to be comparable, ie Mtoe.

Value added by branches are expressed in constant prices, in $ 2000.

Harmonised data are directly linked to the ODEX sheet (“IndustryODEX”, lines 64-105). So all the calculations for the ODEX are automatic and based on data previously entered by EPE.

4.2.2. Data controls

Three controls are provided:

i. Control of annual variations of harmonised data over the 5 last years (%/year) (see above &) in columns 31-34.

ii. Control of the coherence between the sum of data provided by branch and the data provided for the total of industry and manufacturing industry:
   - Control of the sum of the energy consumption by branch with the total consumption of industry;
   - Control of the sum of value added by branch and total value added.
   - Control of energy consumption of non metallic for main products (cement, glass) compared to total non-metallic

The difference between the sum of branches and the total of industry is expressed in %. If the deviation is too important (> 5%), the data need to be checked and revised.

iii. Control of the share of non-conventional fuels in energy consumption; the test is done for total manufacturing industries, cement, paper industries (these 2 branches should have the highest share of non conventional fuels).

4.2.3. Controls of indicators trends

The main indicators are calculated directly in the sheet using data previously entered (see below the list of indicators and their definitions). Two types of control are available:

iii. Check the annual variation (%/year) over the 5 last years for each indicator ;
iv. Visualisation of trends in these indicators through graphs to easily identify breakdown in data series (need to select an indicator in the pre-defined list to visualise the graph).

4.3. Definition of industry indicators

The following types of indicators are included in the indicator section:

- Energy intensities by industrial branch (i.e. energy consumption per unit of value added in constant prices);
- Specific energy consumption for energy intensive products (energy consumption of industrial sub-sectors per unit of physical production
- Intensity at constant structure

The **energy intensity** of an industrial branch is defined as the ratio between the final energy consumption of the branch and its value added at constant price.

The specific energy consumption relates the energy consumption to the output of measured in physical units (toe/tonne GJ/t, kWh/t).

The **energy 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. Detailed calculations are available in a separate Excel sheet (see chapter Divisia).

Changes in this intensity at constant structure result from variations in the energy intensities of each individual branch; such a trend provide a good proxy of the overall energy efficiency trend in industry or manufacturing.

The difference in the variations of the intensity and the intensity at constant structure is due to structural changes, i.e. change in the contribution of each branch in the total value added of industry or manufacturing: the larger is the discrepancy the greater are the structural effects.

5. Transport

5.1. Data in transport

5.1.1. 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[19]. It should refer to the number of vehicles really on the road (i.e. in circulation and that consume motor fuels)[20].

Cars should also include taxis. Light duty vehicles also called light commercial vehicles have < 3 t useful load. Trucks correspond to heavy trucks (generally > 3 t useful load); trucks should also include road tractors (articulated vehicles, also called trailer truck) .

5.1.2. 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.

The traffic in vehicle-km is equal to the number of vehicles (for example cars) multiplied by the average distance driven by vehicle (cars for example) per year.

5.1.3. Passenger traffic

The **passenger rail traffic** is measured in passengers-km. It is a usual transport statistics covered by national and international statistics.

Traffic data on passenger–km by car are not available in all countries. They are usually based on vehicles traffic in vehicle-km and an estimate of the average rate of occupancy of cars (i.e. person per vehicle).

5.1.4. Traffic of goods

The **road traffic of goods** measured in tonne-km is not a usual transport statistics and is derived from specific surveys.

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

[20] Official data sometimes relate to all registered vehicles (i.e. including vehicle 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.

The **rail traffic of goods** measured in ton-km is a usual transport statistics.

The **inland waterways traffic** (from domestic freight ships) measured in ton-km is a usual transport statistics.

5.1.5. Energy consumption of transport

Energy consumption of transport is usually split in the energy balance by main transport infrastructures:

- Road transport
- Rail transport
- Water transport
- Air transport

The fuels considered in transport are the following in ODYSSEE:

- LPG
- CNG (Compressed Natural Gas)
- Motor spirit (gasoline)
- Diesel oil
- Electricity
- Biofuels (bioethanol and biodiesel)
- Jet fuel
- Fuel oil

The official energy statistics provide the **energy consumption of rail transport**, as a whole, without a differentiation between passenger and goods. If no data is available on the consumption of passenger rail transport separately, one approximation can be to express the traffic of passengers and goods in the same unit, in gross ton-km hauled (gtkh), reflecting the total weight to be moved, including the weight of locomotives and carriages. For this purpose, a coefficient is used that express the average gross weight per passenger and per ton of goods[21]. The total energy consumption of rail transport is then allocated between passenger and goods traffic according to the share of passenger and goods traffic respectively in the total traffic in gross ton-km hauled[22].

The **energy consumption of water transport** corresponds to domestic transport by ships on sea or rivers; it excludes the fuel used for international see transport include in a specific category in the energy balance called “marine bunkers” . The consumption of water transport is currently available from official energy balance statistics.

The **energy consumption of air transport** is currently available from official energy balance statistics. I should include domestic and international energy consumption.

[21] A default value can be used as follows: 1.7 gtkm per passenger-km and 2.5 gtkm per ton-km for goods.

[22] Depending on the definition of energy consumption statistics the electricity consumption of metro and tram may be included in rail transport. Therefore the calculation of the gross ton-km should be consistent with the coverage of the energy consumption. Ideally, it would be better, if the information is available to well separate the consumption of trains from that of metro and tramways.

The **total energy consumption** of road transport is available from the energy balance. It is the sum of energy consumption of cars, trucks, light vehicles, bus and motorbikes.

The energy consumption of cars is not available in usual energy balance statistics. They are derived from specific data processing combining official statistics on motor fuel sales (e.g. gasoline, diesel), stocks of vehicles and results of survey on vehicle use in km per year or traffic in vehicle –km, as well as on specific fuel consumption (litre/100km), through simple modelling. Generally, the estimation is not done for cars only but is part of a general allocation of motor fuel consumption by type of road vehicle (e.g. cars, trucks, light duty vehicles, buses, motorcycles).

The conversion coefficient from litre to toe for gasoline and diesel takes into account the average density (i.e. 0.75 for motor gasoline and 0.85 for diesel[23]) of the products and their average heat content (i.e. 1.051 toe/t for motor gasoline and 1.017 toe/t for diesel)[24]. The coefficients are therefore: 0.788 koe/ litre for motor gasoline and 0.88 koe/ litre for diesel)[25]. These coefficients have to be adapted to reflect the penetration of biofuels[26].

The fuel consumption of trucks and light-duty vehicles is based on the breakdown of motor fuel sales by type of road vehicles.

5.1.6. 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.

5.1.7. 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

[23] Range of 0.70-0.78 for motor gasoline and 0.82-0.90 for diesel

[24] For instance for Europe: 1.051 toe/t for motor gasoline (44000 kJ/kg) and 1.017 toe/t for diesel (42600 kJ/kg) (Eurostat and IEA).

[25] Respectively 33000 kJ/l and 36210 kJ/l.

[26] There are two ways to measure gasoline consumption in energy statistics, depending on the data source: i.e. by referring to the oil part only (e.g. in the energy balance) or to the sum of oil and biofuels (case of oil companies sales statistics). If biofuels are included in fuel data, the coefficient to be used should be adapted to reflect the average density and heat content of the mix gasoline/biofuels. The average calorific value proposed by the European Commission for biofuels is 0.78 koe/l for bioethanol and 0.51 koe/ l for biodiesel.

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.

5.2. Data controls

5.2.1. Harmonization of data

Final energy consumption by mode are all expressed in the same unit to be comparable, ie Mtoe.

5.2.2. Data controls

Five main controls about data coherence are provided:

i. Control of the sum of modes (road, rail, air, water) with the total consumption of transport;
ii. Control of the sum of fuel by modes with the total consumption of transport by fuel;
iii. Control of the sum of road modes (cars, trucks, bus, light-duty vehicles, motorbikes) with the total consumption of road transport;
iv. Control of the sum of cars by fuel with the total stock of cars;
v. Control of the coherence between energy consumption of cars, distance travelled in kilometres and specific consumption in litre/100km ➔ this control is important to guarantee the coherence of all the data. For that, we calculate in a first step an average annual coefficient in toe/litre based on the energy consumption by fuel multiplied by the average coefficient toe/litre based on the coefficient by fuel given by IEA (in GJ/1000 litres) and weighted by the consumption of the different fuels. We then recalculate the specific consumption of cars as following and compare the specific consumption calculated with the one directly given.

csvpc = toccfvpc/ COEF/nbrvpc/kmvpc *100 *1000 *1000 (l/100km)

with csvpc: specific consumption in l/100 km

toccfvpc : energy consumption of cars in Mtoe

COEF : average annual coefficient toe/l (see above)

nbrvpc: number of cars

kmvpc: number of kilometres driven by cars

This calculation can also be used if the specific consumption of the cars is none available at country level.

A more general control consists in analysing the annual variations of harmonised data over the 5 last years (%/year) (see above &) in columns 31-34.

5.2.3. Controls of indicators trends

The main indicators are calculated directly in the sheet using data previously entered (see below the list of indicators and their definitions). Two types of control are available:

i. Check the annual variation (%/year) over the 5 last years for each indicator ;
ii. Visualisation of trends in these indicators through graphs to easily identify breakdown in data series (need to select an indicator in the pre-defined list to visualise the graph).

5.3. Indicators in transport

The following key indicators are usually considered in transport:

- Unit consumption of road transport per car equivalent (total, gasoline, diesel)
- Unit consumption of cars in toe per car
- Specific energy consumption of cars in litre per 100 km
- Unit consumption of cars in goe per passenger-km
- Specific energy consumption of freight transport in goe per ton-km
- Unit consumption of trucks and light-duty vehicles in toe per vehicle
- Unit consumption of rail transport in koe per gross ton-km
- Unit consumption of passenger rail transport in goe per passenger-km
- Unit consumption of rail transport of goods in goe per ton-km
- Specific energy consumption of inland waterways transport in koe per ton-km
- Unit consumption of air transport per passenger

- **Unit consumption of road transport per equivalent car**

The unit consumption of road transport per equivalent car relates the total consumption of road transport to a fictitious stock of all road vehicles, measured in terms of a number of equivalent cars. It is measured in toe/car equivalent[27].

The data required are the following:

- The total energy consumption of road transport.
- The stock of road vehicles by type.
- Coefficients reflecting the difference in average yearly consumption between each type of vehicle and a car.

The coefficients of conversion of each type of vehicle in terms of car equivalent reflect the difference in average yearly consumption between each type of vehicle and the car. If, for instance, a bus consumes on average 15 toe/year and a car 1 toe/year, one bus is equal to 15 equivalent cars.

These coefficients can be derived from surveys (or estimates) of distance travelled and specific consumption (l/100km) for selected years; they can also be adapted from similar countries in terms of vehicle characteristics and patterns of use[28]. This indicator, calculated for each type of fuel, can be used to estimate the energy consumption per type of vehicle.

- **Unit consumption of cars in toe per car**

The unit consumption of cars in toe per car is calculated by dividing the total consumption of cars by the stock of cars.

- **Specific consumption of cars in litre/100km**

The average specific consumption of cars in litre/100km can either be calculated by dividing the total consumption of cars by the stock of cars and the average distance travelled by year by car. This indicator can also be given obtained directly from surveys (see above).

- **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.

[27] This indicator was selected as a recommended indicator to measure energy savings for road transport in the absence of detailed data by type of road vehicle.

[28] Default values can be: 1 truck and light vehicle = 4 cars equivalent; If trucks and light vehicles are considered separately, a truck=15 car equivalent and a light vehicle= 1.8 car equivalent; 1 bus = 15 car equivalent and 1 motorcycle = 0.15 car equivalent

- **Unit consumption of road goods transport**

The unit consumption of road goods transport is the ratio between the consumption of trucks and light-duty vehicles and the road traffic of goods measured in tonne-km; this indicator provides information on the energy efficiency of the overall transport services.

- **Unit consumption of rail transport**

The **energy consumption of rail transport in koe per gross ton-km** is calculated as the ratio between the energy consumption of rail transport and the total traffic, measured in gross ton-km.

The **total rail traffic in gross tonne-km** is calculated by converting the traffic of passengers and goods in the same unit, in gross ton-km hauled (gtkh), reflecting the total weight to be moved, including the weight of locomotives and carriages. For this purpose, a coefficient is used that express the average gross weight per passenger and per ton of goods[29].

The **unit consumption of passenger rail** is calculated as the ratio between the energy consumption of passenger trains and the passenger traffic, measured in passenger-km (pkm).

The **unit consumption of rail transport of goods** is calculated as the ratio between the energy consumption of goods trains and the traffic of goods, measured in ton-km (tkm).

- **Unit consumption of water transport**

The energy consumption of inland waterways transport in koe per ton-km is calculated as the ratio between the energy consumption of domestic freight ships and the inland waterways traffic, measured in ton-km.

- **Unit consumption of air transport**

The energy consumption of air transport per passenger is the ratio between the energy consumption of air transport (international + domestic) divided by the total number of air passenger (embarked + disembarked). We can also calculate this indicator just for the domestic air transport.

[29] A default value can be used as follows: 1.7 gtkm per passenger-km for passengers and 2.5 gtkm per ton-km for goods.

6. Household sector

6.1. Data for households[30]

6.1.1. Dwellings and characteristics

- **Number of households**

The number of households is 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 (NSO) either for years of housing surveys (every 10 years) 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.

- **Stock of dwellings, construction and electrification**

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

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 electrification rate is the percentage of dwellings or households with electricity. It is available from household surveys and/or energy administration.

- **Dwelling size**

The average dwelling size (m2) corresponds to the living area as usually defined in household survey and construction statistics; it should not include the cellar and attic. Such information is common in OECD countries and based on housing surveys; it is less common in non OECD countries and may be estimated from housing surveys based on the number of rooms

[30] Compared to the ODYSSEE template for EU countries some adaptations have been introduced to account for the fact there is no heating use. The following data have been removed: stock of dwelling by type of dwelling, stock of dwelling by heating fuel and heating type ,specific consumption for new dwellings. In addition te lsit of appliance has been simplified .

6.1.2. Household electrical appliances and lighting

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

The household electrical appliances considered are refrigerators, washing machines, air conditioners and TV[31].

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).

Equipment ownership ratios should include multi equipment i.e. the fact that for example some households have 2 TV).

- **It is** usually available from the National Statistical Office (NSO) either for years of housing surveys (every 10 years) or on a yearly basis ;
- if not available on a yearly basis can be linearly interpolated/extrapolated as it is changing slowly and smoothly;
- yearly statistics may also come from surveys sponsored by equipment manufacturers associations (e.g. GIFAM in France with TNS Sofres) or by the energy administration;
- It may also come surveys from electric utilities (e.g. Tunisia) (every 4 years)

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

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 (e.g. GFK).

For **CFL** different information are asked: sales, number of CFL per household and % of households that at least one CFL: all aim at quantifying the penetration of CFL. **Sales of CFL** may come from industry associations (e.g. association of lighting manufacturers/importers/distributors. The equipment ownership for CFL may come from the monitoring of programme, from survey of the energy administration (e.g. ADEME i France) or from housing survey of NSO (new question to be added**).** The stock of CFL can be calculated from the equipment ownership and number of households or from a modelling based on annual sales and average life time (e.g. Tunisia).

- **Specific electricity consumption by electrical appliance**

The **specific electricity consumption by electrical appliances is** calculated by dividing the total electricity consumption of each large appliance by the stock of appliances. This total consumption of the stock is available from national estimates; it is not covered by usual energy statistics.

[31]Depending on the countries, other large appliances may be considered, such as: freezers, dishwashers or dryers.

Specific consumption of appliances (kWh per appliance) are 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[32]; 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 is simulated from data on new appliances split by energy efficiency label.

6.1.3. Household energy consumption by end-use

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

The **energy consumption of cooking** is not available in usual energy statics and is part of more detailed data or estimates. The consumption for cooking includes oil products, gas, electricity, 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 conditiong - electricity consumption for cooking – electricity for water heating.

The electricity consumption for lighting is for some countries available from national estimates; it is not covered by usual energy statistics. It is usually estimated from calculation procedures that take into account the number of lighting points, or the average lighting power and an average number of hours of lighting per year[33].

[32] Default value in the EU is for instance 220 cycles per year for washing machines.
[33] A default value can be 1000 hours per year.

6.2. Data controls

6.2.1. Harmonization of data

Final energy consumptions by end uses (for total and for electricity) are all expressed in the same unit to be comparable, ie Mtoe.

Harmonised data are directly linked to the ODEX sheet ("HouseholdsODEX", lines 50-79). So all the calculations for the ODEX are automatic and based on data previously entered by EPE.

6.2.2. Data controls

Two main data controls are performed:

i. Control of annual variations of harmonised data over the 5 last years (%/year) (see above &) in columns 31-34.

ii. Control of the coherence between the sum of energy consumption by end-uses (for total and for electricity) and overall energy consumption of households (total, electricity).

6.2.3. Controls of indicators trends

The main indicators are calculated directly in the sheet using data previously entered (see below the list of indicators and their definitions). Two types of control are available:

i. Check the annual variation (%/year) over the 5 last years for each indicator ;
ii. Visualisation of trends in these indicators through graphs to easily identify breakdown in data series (need to select an indicator in the pre-defined list to visualise the graph).

6.3. Indicators for households

- **Unit consumption per dwelling**

The unit consumption per dwelling relates the energy consumption of the household sector to the number of permanently occupied dwellings. This indicator can also be calculated for the electricity consumption only.

The **unit consumption per dwelling and end-use** (water heating, cooling, cooking, electrical appliances) relates the energy consumption by end-use to the number of permanently occupied dwellings.

The **unit consumption for air conditioning per m2** is obtained by dividing the unit consumption per dwelling for air conditioning by the average size of dwellings.

7. Service sector

This sector is also called tertiary sector. It includes the public sector and commercial sector.

The energy consumption of the sector only includes the energy used in buildings and excludes the consumption of vehicles. It includes the energy consumption of transport buildings.

In the sector is also included the electricity consumption for **public lighting** and public **water distribution.**

The energy consumption of services is often defined by difference between total final consumption, minus industry, transport, households and agriculture. It may include military, some SME's etc.

7.1. Data for service sector

7.1.1. Classification of branches

The classification by branch follows international classifications. The ISIC code correspondence for these different sub–sectors is indicated below[34]:

- Whole and retail trade (Section G),
- Transportation and storage[35] (Section H);
- Hotels and restaurant (Section I):
- Information and Communication (Section J);
- Financial and insurance (Section K);
- Real estate (Section L);
- Professional, scientific and technical activities (Section M);
- Administration and support services (Section N);
- Public administration and defence (Section O)
- Education (Section P)
- Health and social work activities (Section Q)
- Arts, entertainment and recreation (Section R)
- Other services (Sections S).

7.1.2. Energy consumption

Energy consumption of services is split into 7 branches:

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

[34] ISIC rev 4

[35] The energy consumption of transport buildings only is included in services.

Energy consumption is also split in 5 end-uses and by fuel:

- Water heating
- Cooking
- Air cooling
- Lighting
- Other (by difference)

7.1.3. Activity data

The activity data required in services are :

- The number of employees[36] by branch
- The floor area size (m2) by branch
- Or for some sub-sectors, physical indicator of activity characteristic of the sub-sector: 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 for all the service sector buildings or by type of buildings by branch.

The **annual construction of tertiary** buildings represents the number of 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).

7.2. Data controls

7.2.1. Harmonization of data

Final energy consumptions by sub branches and by end-uses are all expressed in the same unit to be comparable, ie Mtoe.

Harmonised data are directly linked to the ODEX sheet (“ServicesODEX”, lines 21-29). So all the calculations for the ODEX are automatic and based on data previously entered.

7.2.2. Data controls

Three controls are provided:

i. Control of annual variations of harmonised data over the 5 last years (%/year)
ii. Control of the coherence between the sum of data provided by sector/end uses and the data provided for the total tertiary.

[36] Usually in full time equivalent

7.2.3. Controls of indicators trends

The main indicators are calculated directly in the sheet using data previously entered (see below the list of indicators and their definitions). Two types of control are available:

i. Check the annual variation (%/year) over the 5 last years for each indicator ;
ii. Visualisation of trends in these indicators through graphs to easily identify breakdown in data series (need to select an indicator in the pre-defined list to visualise the graph).

7.3. Indicators in service sector

The **energy intensity** of the service sector is defined as the ratio between the final energy consumption of the sector (or by branch) and the value added measured in constant prices.

The **unit consumption per employee** is defined as the ratio between the final energy consumption of the sector (or by branch) and the number of employee (total or by branch).

In hotel-restaurant, the **electricity consumption per person-night** is the ratio between the electricity consumption and the number of person-night.

In education, the **electricity consumption per pupil or student** is the ratio between the electricity consumption and the number of students or pupils.

In the health sector, the **electricity consumption per bed** is the ratio between the electricity consumption and the number of beds occupied in hospitals.

8. Global ODEX

The global ODEX for the whole economy is just an aggregate of the ODEX by sector. It is calculated as a weighted average of the energy efficiency gain of each sector, as measured with their ODEX, with their share in the final energy consumption.

The index of energy efficiency progress, called **"ODEX**", has been introduced in ODYSSEE. It is defined at the level of sectors (industry, transport, households, services) 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, services) is calculated as a weighted average of the unit consumption index of each sub-sector or end-use, with a weight based on the relative consumption of each sub-sector in the base year. For instance, considering two sub-sectors with a share of the consumption of 60% and 40% respectively in the base year and a change in the unit consumption from 100 to 85 for the first sub-sector and 100 to 97.5 for the second, the weighted average index is 0.6*(85/100)+0.4* (97.5/100) = 90.

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

Using relevant physical parameters, the ODEX indicator provides a good "proxy" of the energy efficiency progress from a policy evaluation viewpoint. ODEX is an alternative to the aggregate monetary energy intensities to monitor energy efficiency trends by sector, as intensities include many factors that are not directly linked to energy efficiency.

The energy efficiency index has been defined in such a way that it is also equal to the 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. In other words, energy savings can be easily derived for ODYSSEE.

The trends observed in the ODEX for some sectors or end-use are very irregular, which difficult to understand as energy efficiency progress should normally change smoothly (incremental technical change). Such fluctuations can be linked to various factors: imperfect climatic corrections, especially with warm winters, behavioural factors, influence of business cycles, imperfection of the statistics, especially for the last year. To reduce the fluctuations, the ODEX is calculated as a **3 years moving average**. The value used for year t is the average of t-1, t and t+1. This method is traditionally used in statistics[37].

[37] For the last year, the average is based on 2years only as well as for the second year. A second method could have been to take for year t the average of t-2, t-1, and t. This method, which is used officially in the Netherlands, however always underestimates the gains achieved.

Energy efficiency indices by sector are calculated in the respective sheets “IndustryODEX”, TransportODEX”, “HouseholdsODEX”, “ServicesODEX”. See below for the definitions of ODEX in each sector.

9. Industry ODEX

Data used to calculate ODEX are directly linked to the data entered in the sheet “Industry”. In principle all the data and indicators used in the ODEX have been validated in the sheet “industry” according to the different “data control procedure” (lines 286-361).

All the calculations are automatic in the sheet ODEX.

Energy efficiency index of industry (ODEX) is a weighted average of the specific consumption index of 10 manufacturing branches; the weight being the share of each branch in the sum of the energy consumption of these branches in year t and the sum of the implied energy consumption from each underlying industrial branches in year t (based on the unit consumption of the sub-sector with a moving reference year). The 10 branches considered in the calculation are: chemical, steel, non ferrous, cement, other non metallic, paper, food, machinery, transport equipment and textile. For steel, cement and paper, energy savings are calculated using specific consumption per tonne produced; for the other branches, the indicator used is the ratio on energy consumption related to production index.

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

$$I_{t-1}/I_t = \sum_i EC_{i,t}.*(UC_{i,t}/IUC_{i,t-1})$$

with UC_i : unit consumption index of sub-sector i

and EC_i: share of sub-sector i in total consumption.

The value at year t can be derived from the value at the previous year by reversing the calculation:

$I_t / I_{t-1} = 1/(I_{t-1}/I_t)$

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

ODEX is equivalent to the ratio between the actual energy consumption of the sector in year t and a fictive consumption without energy savings in the 10 branches.

These energy savings can also be calculated from the sum of the energy savings in the 10 branches; for each branch, the energy savings is calculated from the reduction in the specific energy consumption.

10. Transport ODEX

Data used to calculate ODEX are directly linked to the data entered in the sheet “Transport”. In principle all the data and indicators used in the ODEX have been validated in the sheet “transport” according to the different “data control procedure” (lines 185-224).

All the calculations are automatic in the sheet ODEX.

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

For cars, the energy efficiency is measured by the specific consumption, expressed in litre/100km.

For the transport of goods (trucks and light vehicles), the unit consumption per ton-km is used, as the main activity is to move goods.

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

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

11. Household ODEX

Data used to calculate ODEX are directly linked to the data entered in the sheet “Households”. In principle all the data and indicators used in the ODEX have been validated in the sheet “Households” according to the different “data control procedure” (lines 93-109).

All the calculations are automatic in the sheet ODEX.

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

For households, the evaluation is carried out at the level of 3 end-uses (cooling[38], water heating, cooking) and 3 large appliances (refrigerators, washing machines and TVs).

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

- Cooling: unit consumption per m2 (toe/m2)
- Water heating: unit consumption per dwelling with water heating
- Cooking: unit consumption per dwelling

12. Services ODEX

Data used to calculate ODEX are directly linked to the data entered in the sheet "Services".

All the calculations are automatic in the sheet ODEX.

The energy efficiency ODEX aggregates the trends in the different branches on the basis of their weight in the total consumption. For country with a limited number of data, the ODEX is calculated from the change in energy consumption per employee.

13. Divisia

The Divisia method is the 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 of manufacturing between year t and t-1 into two growth rates. 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

In ODYSSEE, the calculation is performed as follows:

- the weight wi is taken as the average weight over the 2 years : $(w_{i,t}+w_{i,t-1})/2$ to reduce further the residue
- only the growth rate of the intensity due to structural changes is calculated (vitocimasd in ODYSSEE equations) and the other growth rate is obtained as a difference
- the calculation is made over 10 manufacturing branches (i=1 to 10)
- 2000 is the reference year, referred to as (-1) in ODYSSEE

[38] For Brazil, heating is not relevant, so not taken into account in the ODEX calculation (in Europe space heating represent more than 70% of the consumption).