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A methodology for early estimates of year N-1 in the ODYSSEE database

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Introduction: why early estimates ?

National teams only update the ODYSSEE data base once a year when the necessary data are available, generally towards the middle of year T for the update at T-2. This means that there is a significant delay to monitor the most recent trends, which does not meet the need of policy makers.

Indeed, they need to have up-to-date information on the most recent energy efficiency trends and on the interpretation of changes in final and primary energy consumption.

It is therefore important to provide more rapid updates, at year T-1 in year T, of advanced energy efficiency indicators developed in the project, such as energy savings and the explanatory factors behind the variation of the energy demand ("decomposition analysis").

This is why the project will prepare *early estimates* of the energy efficiency index (ODEX), of energy savings and of the decomposition analysis in complement to the annual updating done by national teams.

The objective is to estimate the data needed to calculate the ODEX by sector, energy savings and decomposition analysis rather than to estimate all data and indicators for year T-1.

Such estimates will be produced by the technical coordination (Enerdata) in the Excel template in a new sheet to be added and will only serve to update energy savings and decomposition factors.
Such estimates will appear in the online data base in italic and in colour (red) to well distinguish them from the normal update made by national teams with national sources to avoid confusion. In the data base and decomposition tool clear explanations will indicate that the data have been estimated for the last year.

The estimates at year T-1 will only include what is necessary to calculate the key energy efficiency indicators:

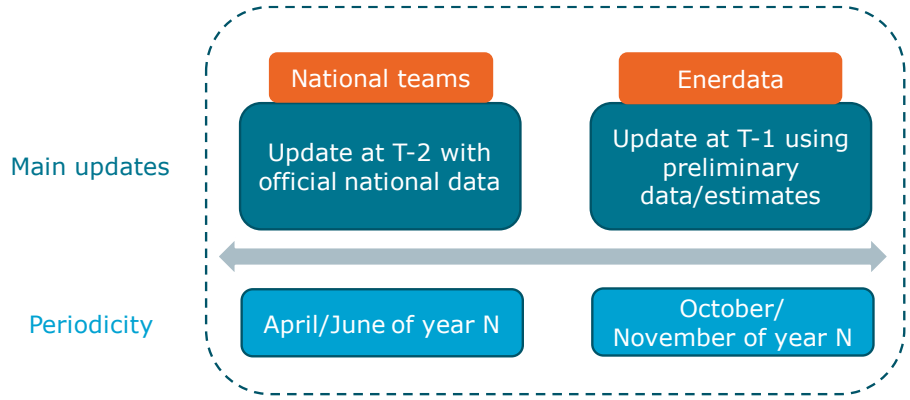
- Final energy consumption by sector
- Final energy consumption by sub sector and end-use (e.g. by vehicle type for road transport, by end-use for households, by branch in industry and services).
- Main economic drivers.

The ODEX and decomposition will then be calculated applying the estimated data to the existing methodology.

As a result, the ODYSSEE database will be updated twice a year, as shown in Figures 1 and 2:

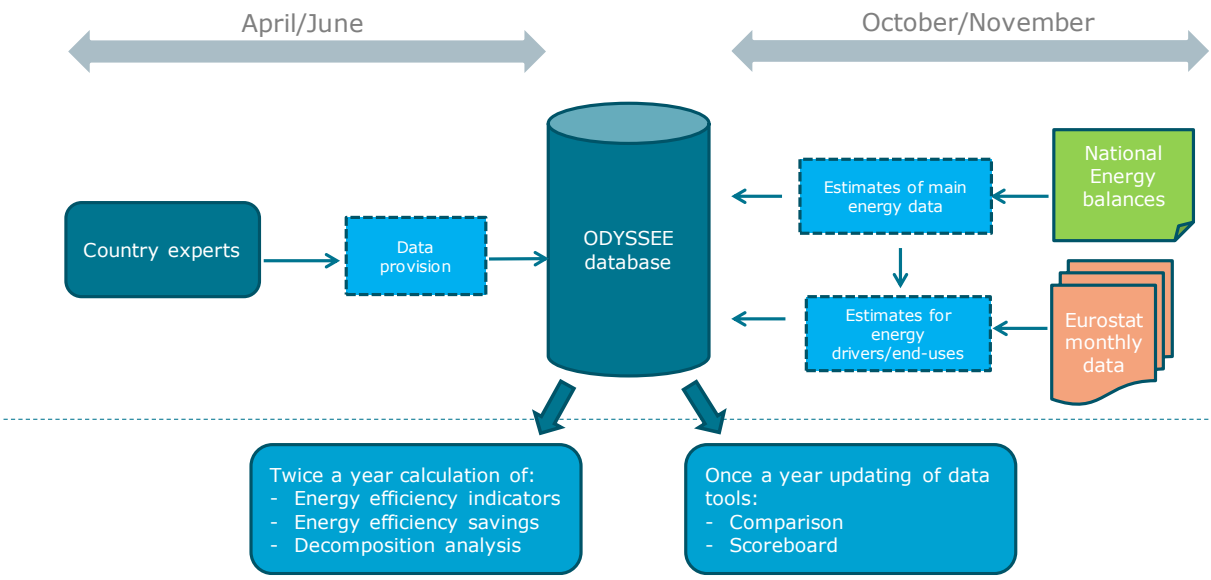
- First update at year T-2 with official national data as soon as they are available (April-June);
- Second update for main data and indicators at year T-1 in October/November using early estimates.

Figure 1 Sequence of ODYSSEE database updating



1

Figure 2 Annual process of ODYSSEE database updating



Methodology of early estimates

The methodology relies on various experiences:

- On the so-called short-term indicators developed with ECN/TNO in 2013 in a previous ODYSSEE MURE project.
- On a project of DG ENER to provide early estimates of different types of data and indicators *"Early Estimates of Main Energy Balance Sheets Components in 2015 and for the Production and Visualisation of Indicators to Monitor Energy Union Implementation"*[1].
- On the methodology of Enerdata to estimate:

[1] https://ec.europa.eu/energy/en/studies/early-estimates-main-energy-balance-sheets-components-methodology-and-2015-results

- The final consumption by sector in its Global Energy Statistics[2].
- The energy consumption of transport by mode and of buildings by end-use in its EnerDemand[3] data base for G20 countries

General principles

The methodology will depend on the countries and sectors.

For the country it will depend on when the required information is produced and on the level of updating in the data base. In case of data already updated at T-1, no estimate will be needed.

The estimation will be done for missing data so that there is no break in existing time series already provided by national teams in the ODYSSEE data base. The estimates will be consistent with the data provided for T-2 by national teams, as the estimates will be done on the variation from T-1 to T-2.

The estimates will be done in two steps:

- First production of an early estimate at year T-1 (EA_{T-1}) based on different sources, as much as possible official, or from internal modelling/estimates;
- Applying the variation of the early estimate between T-2 and T-1 to the existing data in ODYSSEE data base.

In other words, the value of a given data A at year T-1 will be extrapolated by applying the variation of an estimated value of A to the existing value at T-1:

$$A_{T-1} = A_{T-2} * E(A_{T-1}) / E(A_{T-2})$$

With:
A_{T-2} : Data from normal updates by national team
EA_{T-1} , EA_{T-2}: Early estimate of A from other source, as much as possible official, or from internal calculations.
A_{T-1} : Extrapolation of A form early estimates

Table 1: Example: total heating consumption of households (Mtoe)

	2017	2018
ODYSSEE data	5.2	5
Data used for early estimates	5.1	4.9

Black: data ; in red extrapolation of ODYSSEE data with early estimates

In some case the early estimates will be taken directly as a growth rate (demography, GDP); in that case only the second step will be needed.

$$A_{T-1} = A_{T-2} * agrE(A_{T-1})$$

With: $agrE(A_{T-1})$: growth rate of A between T-1 and T-2

[2] https://www.enerdata.net/research/energy-market-data-co2-emissions-database.html
[3] https://www.enerdata.net/research/world-energy-efficiency-demand-database.html

Data to be estimated

Three types of data will need to be estimated:

- **Macro data**: population, GDP by sector, primary and final consumption by main sector, power generation by main source.
- **Detailed final consumption by sub-sector or end-use**, which will be produced using a specific methodology by sector.
- **Sectoral economic drivers** (e.g. stock of vehicles, traffic, production, index of production, number of households)

Macro-economic data and sectoral economic drivers will come as much as possible from horizontal sources (e.g. Eurostat, industry associations, etc.).

In some countries, final energy consumption by sector will be already provided in the update but for most countries it will need to be estimated in two ways, as explained below from:

- Preliminary of final national data published by national sources, when available;
- Or from estimates based on the allocation of total final consumption by sector (i.e. share by sector), extrapolated from the past year or trend over last 5 years.

Detailed final consumption data by sub-sector or end-use will be produced using a specific methodology by sector that is detailed below.

Macro data

The sources of data are the following:

- Demography: population growth from Eurostat.
- Macro-economic data: GDP growth by sector from Eurostat.
- Energy data: primary and final consumption growth by main sector, electricity consumption, power generation by main source, fuel input in thermal power plants:
  - data compiled by Enerdata in its data base GED from national sources (preliminary or final data) when available;
  - or estimated by Enerdata, especially for final consumption by sector, based on an extrapolation of the allocation of total final consumption by fuel type by sector from the previous year.
- Heating degree days: variation between T-2 and T-1 compiled by Enerdata from www.degreedays.net

Early estimates of final energy consumption by sector

In some countries such data will be already provided and will not need to be estimated. To check what is the exact situation country by country, an extensive review of the publication of data on the final consumption by sector at national level has been carried out.

It turns out that (Annex 1):

- 11 countries have official data by September of year T on the final energy consumption by sector at year T-1 (preliminary or final)

- 3 more countries have only data for some energy sources
- 4 countries have data published in October and November of year T
- 10 countries have only data published at year T-2 at year T

This overview could be improved or completed with contribution of national teams.

Early estimates of energy consumption by sub-sector or end-use

The estimate of final energy consumption by sub-sector or end-use will be produced using a specific methodology by sector as explained below.

Industry

The method used here is to estimate the energy consumption by branch at year T-1 from the variation of the production (index of production or physical production[4]) from T-2 to T-1, assuming the same change in the specific energy consumption per unit of production (IPI or physical production) by branch as for the whole sector.

This approach implicitly assumes the same rate of energy efficiency improvement for all branches at year T-1 but has the advantage to well take into account structural changes.

To be sure that the sum of the estimates by branch is strictly equal to the total consumption of the industry sector, the estimation is implemented as follows:

- Step 1: calculation of the consumption at constant specific consumption of each branch i ($E_{csc,\,i}$) :
  $E_{sec,i,T-1} = IPI_{i,T-1} \times SEC_{\,i,T-2}$
- Step 2: a fictive consumption of industry at constant specific consumption is calculated at T-1 as the sum of branches:
  $E_{sec,T-1} = \sum E_{sec,i,T-1}$
- Step 3: estimation of the consumption of branch i by scaling the consumption at constant specific consumption of each branch ($E_{csc,\,i}$) to the ratio $E_{T-1}/E_{sec,T-1}$:
  $E_{\,i} = E_{sec,i,T-1} \times (E_{T-1}/E_{sec,T-1})$

An example of application is given below with a limited number of branches and combining activities measured with an index of production and a physical production (in black data and in red estimates).

		2018 $Ei_{\,T-2}$	**2019** $Ei_{\,T-1}$		**2019 at constant specific consumption** $Ei_{\,cst\,T-1}$
Chemicals	Mtoe	0,90	0,87		0,89
Steel	Mtoe	1,85	1,77		1,80
Food	Mtoe	0,50	0,43		0,44
Machinery	Mtoe	0,60	0,65		0,66
Others	Mtoe	2,00	1,98		2,02
Total industry	Mtoe	**5,85**	**5,70**		**5,81**

[4] For steel, cement or paper.

Production

		2018 Pi_{T-2}	2019 Pi_{T-1}
Chemicals	index	121,7	120,9
Steel	kt	7500	7300
Food	index	107,3	105,8
Machinery	index	120,6	125,7
Others	index	114,4	115,3
Total industry	index	**114**	**116**

Specific energy consumption

		2018 CSi_{T-2}
Chemicals	toe/index	0,74
Steel	toe/t	0,25
Food	toe/index	0,41
Machinery	toe/index	0,52
Others	toe/index	1,75
Total industry	toe/index	5,13

Two types of data are necessary and are input in absolute values. The proposed sources are the following:

- Industrial production index by branch: Eurostat.
- Physical production for steel, cement, pulp and paper: Industry Associations, as follows:
    - Steel: World Steel Association
    - Cement: Cembureau, USGS, national sources
    - Pulp and paper: FAO

Transport

The objective is first to allocate the energy consumption of road transport by type of vehicle and then to estimate the traffic by mode.

Consumption of road transport by vehicle

The consumption of the different road vehicles (i.e. cars, trucks, buses, light duty vehicles and motorcycles) is based on the indicator of "unit energy consumption per car-equivalent"[5]. This indicator relates the total consumption of road transport to a fictitious stock of road vehicles, measured in terms of equivalent cars.

These coefficients of equivalence cars reflect the difference in specific consumption per year of the different types of vehicle. If over 1 year a bus consume 10 times more fuel (in litre/year) than a car; it is equivalent to 10 cars (COEFEQCbus=10). These coefficients can be calculated for each country from past data if a breakdown of consumption by vehicle type is available. If such a breakdown is not available, proxy default values are used (EU average coefficients for instance).

The estimation of the consumption by vehicle type v at T-1 is done in three steps:

i. Calculation of the stock of road vehicles at T-1, measured in equivalent cars ($SEQC_{T-1}$), using coefficient of conversion of vehicles in car equivalent at T-2 ($COEFEQCv_{T-2}$) or default values:

[5] It will be done for the total consumption and not by fuel to reduce the amount of data to be estimated.

$$SEQC_T = \sum Sv_{T-1} \times COEFEQCv_{T-2}$$

ii. Calculation of the unit energy consumption per car equivalent at T-1 ($UCEQC_{T-1}$) by dividing the total consumption of road transport to the total stock of road vehicles at T-1 (E_{T-1}), measured in equivalent cars ($SEQC_{T-1}$):

$$UCEQC_{T-1} = E_{T-1} / SEQC_{T-1}$$

iii. Calculation of the consumption by vehicle type v at T-1 (Ev_{T-1}) as the unit consumption per car equivalent at T-1 x coefficient of conversion of vehicles in car equivalent at T-2 ($COEFEQCv_{T-2}$) x stock of vehicles at T-1 by fuel type (Sv_{T-1}) .

$$Ev_{T-1} = Sv_{T-1} * UCEQC_{T-1} \times COEFEQCv_{T-2}$$

An example of calculation is given below.

- Step 1: Calculation of the stock of road vehicles (in 1000), measured in equivalent cars (SEQC)

	2017	2018
Stock of vehicles by type v (Sv)		
Cars	2391	2370
Buses	73	76
Light duty vehicles	1631	1737
Trucks	546	573
Total stock of vehicles in car equivalent (SEQC)	13718	14323

- Step 2: Calculation of unit consumption per equivalent car (UCEQC)

	2017	2018
Consumption (ktoe)	9189	10746
Total stock of vehicles in car equivalent (SEQC) (k)	13718	14323
Unit consumption per car equivalent (UCEQC) (toe/veh)	0.67	0.75

- Step 3: Calculation of consumption per vehicle type

Consumption (ktoe)	2017	2018
Cars	1602	1778
Buses	473	550
Light duty vehicles	3023	3607
Trucks	4091	4812

To implement this calculation, we need first to estimate the stock of vehicle at T-1.

Stock of road vehicles

The stock of cars is calculated from the registration of new vehicles ("sales" and an exogenous scrapping rate based on historical data); for countries for which a high proportion of new registration come from imported second-hand car, this approach is less relevant as the historical scrappage rate is closed to 0 or even negative[6]; in that case the stock of car will be calculated on the basis of an extrapolation of the number of cars per capita.
This second approach will also be used for the other vehicles (buses, truck, motorcycles).

Estimation of traffic

The total traffic of passengers in pkm and goods in tkm is estimated at T-1 by multiplying the GDP by the traffic intensity per unit of GDP; this intensity is extrapolated from past trends.

The traffic is calculated by mode by multiplying the total traffic by the share of each mode in the total traffic; the share of each mode is extrapolated from past trends.

Households

The energy consumption by end-use is first estimated at normal climate, then at real climate. This means that it is needed to start with an estimate of the total final consumption of households at normal climate.

The energy consumption by end-use is done separately for electricity and for all other fuels.

All fuels except electricity

For other fuels, water heating and cooking consumption are first calculated using a constant unit consumption if the unit consumption was rather stable over the last years or with an extrapolation of trend if it was changing.

Space heating is then calculated by difference.

Electricity

The water heating and cooking consumption are calculated from the unit consumption, which are extrapolated from past trends.

The consumption for lighting, cooling and large appliances by type of appliance are calculated from the stock of appliances and a unit consumption, which is extrapolated from past trends, as the main driver is the replacement of existing appliances with more efficient new appliances and the addition to the stock of new appliances.

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[6]The scrapping rate is calculated based on the registration of new cars only. So it is an apparent scrapping rate. In 9 countries it is closed to 0 or even negative (around 0% in Hungary, Bulgaria, Estonia and Slovakia; negative in Latvia, Poland, Romany): this figure reflects the fact that most of the new registrations are imported second-hand vehicles.

For countries with a limited share of electric heating[7], the consumption of electricity for space heating is extrapolated from the share of space heating at year T-2 at normal climate.

For countries with a significant share of electric heating, the space heating consumption of electricity is calculated from a trend in unit consumption, again to account for the fact that existing dwellings are replaced by more efficient new dwellings and new dwellings are added to the stock.

The data needed for these estimates are the following:

- Number of households, that is calculated from the number of persons per households (extrapolated from past trends and the population;
- The average size of dwellings in m2/dwelling that is extrapolated from past trends;
- The stock of large electrical appliances that is obtained by multiplying the number of households by an equipment ownership rate, that is extrapolated from pas trends.

Services

The energy consumption is estimated for the sector as a whole, with a separation between electricity and other fuels.

The employment data come from Eurostat. For countries for which the floor area is available, the area is estimated from an average ratio of m2/employee, that is extrapolated from past trends, and the employment.

Implementation

General organization

One sheet has been added in the data template for the estimates, after the sheet “global ODEX”; it is made of 5 parts:

- Macro (lines 5-66)
- Industry (lines 70-148)
- Transport (lines 152-252)
- Households (lines 156-369)
- Services (lines 373-381)

Historical values from data to be estimated are given in columns E to M, with a link to the data sheets.

The estimate is input from another source in columns S to T, either as a growth rate between T-2 and T-1 (i.e. 2018 and 2019) or in absolute values.

The estimation for T-1 (i.e. 2019) is calculated in column N:

[7] All countries, except France, Norway or Sweden

- either by applying the growth rate of column T to the value at T-2 (column M) from the updating source (indicated in column V) (Case 1)
- or by applying the variation of the absolute values between T-2 and T-1 (columns S and T) to the value at T-2 (column M) (Case 2).

Example of data estimation : case 1

B	C	D	L	M	N	O	P	Q	R	S	T	U	V
Title	Country code	Unit	2017	2018	2019	2020		Unit	2017	2018	2019	2020	Source
Gross inland consumption	fra	ktoe	246 348	245 055	247 261			%	-0,1%	-0,5%	0,9%	n.a.	Eurostat

Example of data estimation : case 2

B	C	D	L	M	N	O	P	Q	R	S	T	U	V
Title	Country code	Unit	2017	2018	2019	2020		Unit	2017	2018	2019	2020	Source
Annual sales of new cars	fra	k	2 142	2 209	2 074			k	2 220	2 290	2 150	n.a.	CCFA

A link is done between this new sheet used for early estimates and the sectoral sheets (Macro, Industry, Transport, Households and Services) for the estimated data. Then the ODEX and decomposition sheets are directly linked with early estimates data from sectoral sheets.

Macro data

The following macro data are considered and assumed to be available from national or international sources: demography, GDP total and by sector, energy consumption (primary and final by sector), i.e. around 30 data series (Table 5).

All macro data are input as growth rate between T-2 and T-1.

Table 5: List of macro data

Population
GDP
VA of agriculture, industry, services
Heating degree days
Total gross inland consumption (incl. non-energy uses)
Consumption for non-energy uses
Final electricity consumption
Total final consumption with international air transport (excluding non-energy uses)
Final consumption by sector: industry, transport (with international air transport and the detail road, rail , water, air (including and excluding international air)[8], agriculture, households, services (separately and as a whole[9])
Electricity consumption of households
Fuel consumption for power generation (oil, coal, gas, biomass).
Electricity generation: total, thermal, nuclear and renewables[10]

Industry data

The following industry data are considered and assumed to be available from national or international sources: industrial index of production for 13 branches (10 manufacturing branches, the total of manufacturing, mining, construction and the total of industry), physical production (in Mt for steel, cement, pulp and paper).

[8] The energy consumption by main mode (road, rail, water, air) is estimated either from national data, if the energy balance is available or on the basis of the final consumption of transport by fuel and allocation factors by type of fuel (100% of jet fuel allocated to air transport, 100% of gasoline to road transport, X% of diesel consumed in transport going to road, Y% to rail and z% to water based on historical data).

[9] The total agriculture, households, services is includes as in some case the sum of agriculture, households and services does not match the total due to a category “other non specified “.

[10] Non thermal renewables (hydro, wind, solar PV)

Transport data

The following transport data are considered:

- The stock and registration of new cars, stock of motorcycles, buses, light duty vehicles, trucks and/or the sum of trucks and light vehicles.
- Data on passenger traffic, as follows:
    - Modal shift : share of each mode in passenger traffic : cars, motorcycles, buses, rail, air (domestic).
    - Total traffic in pkm and by mode (as above)
    - Indicator of traffic intensity (traffic per unit of GDP), which is used to estimate the total passenger traffic at T-1.
- Data on traffic of goods, as follows:
    - Modal shift : share of each mode in freight traffic : road (trucks), rail, water.
    - Total traffic in tkm and by mode (as above)
    - Indicator of traffic intensity (traffic per unit of GDP), which is used to estimate the total traffic of goods at T-1.
- Energy consumption by type of road vehicles (cars, motorcycles, buses, light duty vehicles, trucks and/or the sum of trucks and light vehicles) and average unit consumption per road vehicle.

Household data

The following data are considered for households:

- Dwellings and their characteristics: number of person per household, total number of occupied dwellings (i.e. households), annual construction of new dwellings, share of dwellings with central heating, specific consumption of new dwellings.
- Appliances: equipment ownership rate (number of equipment per household) and stock for up to 6 appliances (refrigerators, independent freezers, TV, washing machines, dishwashers and dyers) and specific electricity consumption per appliance. The ownership and specific consumption are extrapolated to T-1, on the basis of the trend over the last 5 years.
- Unit consumption by main end-use, used below to estimate the consumption by end-use: space heating (electricity only), water heating (fuels and electricity separately)[11], cooking (fuels and electricity separately), AC, lighting.
- Consumption by main end-use: space heating (fuels and electricity, at normal climate and real climate), water heating (fuels, electricity and total)[12], cooking (fuels, electricity and total), AC, electrical appliances and lighting.

[11] Fuels refer to all energies except electricity (include oil, coal, gas, district heating, solar and biomass).
[12] Total is calculated as the sum of fuels and electricity.

Services data

The data required here are limited: they include employment, m2/employee, share of space heating in total consumption, share of electricity in space heating.

Annex 1: Date of publication of consumption data by sector

Country	Fuels	Preliminary data	Final data
Austria	All	May	December
Belgium	All	August (T-2)	
Bulgaria	All	February (T-2)	
Croatia	All	January T-2	
Cyprus	All	January T-2	
Czech Rep.	All	July T-2	
Denmark	All	April T-2	
Estonia	All	September	
Finland	Electricity	March	December
France	All	April	December
Germany	All	August	
Greece		April (T-2)	
Hungary		April (T-2)	
Ireland	All	October	
Italy	Gas, Elec	July	
Italy	All		April (T-2)
Latvia	All		End August
Lithuania	All		September
Luxembourg	All		November
Malta			April (T-2)
Netherlands	All	Monthly	
Poland	All	November	
Portugal			April (T-2)
Romania	All	November	
Slovakia		January T-2	
Slovenia	All	May	Octobre
Spain	Electricity		
Spain	Oil prod.		November
Spain	All		June (T-2)
Sweden	All		December
Switzerland	All		July
UK	All	July	