Evaluation and Monitoring for the EU Directive on Energy End-Use Efficiency and Energy Services

Annex to the summary report on top-down evaluation methods: ODYSSEE and ODEX indicators that can be used in top-down evaluation of energy savings (Work package 5)

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ENERDATA

EIE_06_128 EMEEES

December 2007
Update March 2009

coordinated by Wuppertal Institute for Climate, Environment and Energy

supported by Intelligent Energy Europe

The Project in brief

The objective of this project is to assist the European Commission in developing harmonised evaluation methods. It aims to design methods to evaluate the measures implemented to achieve the 9% energy savings target set out in the EU Directive (2006/32/EC) (ESD) on energy end-use efficiency and energy services. The assistance by the project and its partners is delivered through practical advice, technical support and results. It includes the development of concrete methods for the evaluation of single programmes, services and measures (mostly bottom-up), as well as schemes for monitoring the overall impact of all facilitating measures implemented in a Member State (combination of bottom-up and top-down).

Consortium

The project is co-ordinated by the Wuppertal Institute. The 21 project partners are:

Project Partner	Country
Wuppertal Institute for Climate, Environment and Energy (WI)	D
Agence de l'Environnement et de la Maitrise de l'Energie (ADEME)	F
SenterNovem	NL
Energy research Centre of the Netherlands (ECN)	NL
Enerdata sas	F
Fraunhofer-Institut für System- und Innovationsforschung (FhG-ISI)	D
SRC International A/S (SRCI)	DK
Politecnico di Milano, Dipartimento di Energetica, eERG	I
AGH University of Science and Technology (AGH-UST)	PL
Österreichische Energieagentur – Austrian Energy Agency (A.E.A.)	A
Ekodoma	LV
Istituto di Studi per l'Integrazione dei Sistemi (ISIS)	I
Swedish Energy Agency (STEM)	S
Association pour la Recherche et la Développement des Méthodes et Processus Industriels (ARMINES)	F
Electricité de France (EdF)	F
Enova SF	N
Motiva Oy	FIN
Department for Environment, Food and Rural Affairs (DEFRA)	UK
ISR – University of Coimbra (ISR-UC)	P
KE Marked A/S (KEM)	DK
Centre for Renewable Energy Sources (CRES)	GR

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ODYSSEE and ODEX indicators that can be used in top-down evaluation of energy savings (Work package 5)

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1 Introduction

Work Package 5 of the EMEEES project focuses on top-down evaluation methods for energy efficiency facilitating measures. It includes three main tasks:

- Task 5.1: Definition of the process to develop a harmonised top-down evaluation method
- Task 5.2: Development of up to 15 concrete methods
- Task 5.3: Definition of concrete values and benchmarks for 2008 and 2009

This report deals with the first task and explains how the top-down method will be developed to monitor the Energy Service Directive (ESD)[1]. The starting point will be the existing ODYSSEE indicators and the explanation of how they can be adapted to fit the requirements of the EMEEES project. The main target group will be all experts in charge of monitoring the ESD, at the EU level (European Commission and Parliament, Eurostat and JRC) and the member state level (national Ministries and agencies in charge of energy efficiency and environment).

Top-down methods refer to methods relying on statistical indicators defined by sector and/or type of end-use from national averages. The use of top-down methods to evaluate energy savings means that "the amount of energy savings or energy efficiency progress are calculated using national or aggregated sectoral levels of energy savings as the starting point"[2]. Top-down methods rely on "**energy efficiency indicators**", also called "top-down indicators", such as the indicators developed at the EU level for the last 15 years within the ODYSSEE project[3]. These indicators will be later referred to as ODYSSEE indicators.

The ESD refers explicitly to ODYSSEE indicators, in particular the composite ODEX indicator developed in the frame of the ODYSSEE-Project, to measure energy savings through top-down methods: "In developing the top-down calculation method used in this harmonised calculation model, the Committee shall base its work, to the extent possible, on existing methodologies such as the ODEX model".

This report will therefore attempt to understand how ODYSSEE indicators can be adapted to the requirement of monitoring the Directive. If we refer to the text of the Directive it is specified that "Adjustments (need) to be made for extraneous factors, such as degree-days, structural changes, product mix, etc. to derive a measure that gives a fair indication of energy efficiency improvement". The question will be to review

1 Directive 2006/32/EC on end-use efficiency and energy services, later referred to as "ESD" or "Energy Service Directive"
2 Source: ESD Directive
3 ODYSSEE covered initially the EU-15 countries and Norway. Indicators for the new member countries and Bulgaria have been added recently to the ODYSSEE data base under an on going EIE-project called EEE-NMC.

what adjustments are already made in ODYSSEE, what new adjustments should be added and whether some of the existing adjustments should be modified.

This paper will first of all focus on the existing ODYSSEE indicators. It will present the different indicators available in ODYSSEE, then review what adjustments are already made and finally discuss the data availability. In a second part, we will discuss further additional adjustments that could be made and are not dealt with in the main text body of the summary report on top-down evaluation methods.

2 ODYSSEE indicators and the existing adjustments

2.1 ODYSSEE indicators

ODYSSEE indicators include on the one hand indicators expressed in terms of energy units (e.g. toe, GJ, kWh)[4] to monitor trends in energy efficiency or to compare the energy efficiency "performance" of countries ("adjusted indicators") and on the other hand indicators of diffusions that measure the market penetration of efficient technologies, equipment and practices.

Energy efficiency indicators are of four different types:

- Energy intensities (economic ratios in monetary units)
- Unit energy consumption (physical indicators) by sub-sector or end-use and specific energy consumption of appliances or vehicles
- Index of energy efficiency progress (ODEX)
- Energy savings (Mtoe, PJ) to provide aggregate evaluation by main end-use sector (industry, households, transport)

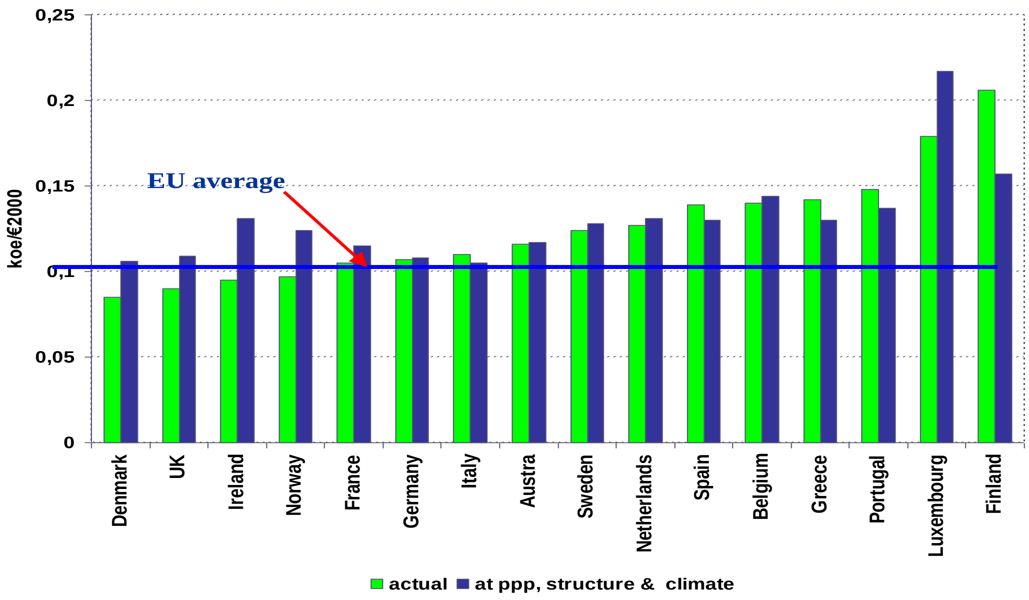
Energy intensities relate the energy used in the economy or a sector to macro-economic variables (e.g. GDP, value added); they are expressed in toe/€ at constant price (e.g. toe/€2000). They are defined by sub-sector (branch) in industry and service, for the industry, transport, household, and services sectors as a whole and, finally, for the economy as whole.

To allow the comparison of energy intensities, they are adjusted in ODYSSEE to account for differences in the climate, in the general price level (using purchasing power parities), and in the industry and economic structures (**Figure 1**). These indicators are referred to in ODYSSEE as **"adjusted indicators".** Annex 1 explains how these adjustments are made.

Unit energy consumption relates the annual energy consumption to physical indicators (e.g. toe per ton of steel, per car or per dwelling, kWh/ refrigerator, l/100km for vehicles); they are usually defined at a more detailed level than energy intensities. If the physical indicator is an appliance or vehicle, we call the result a **specific energy consumption**. Unit or specific consumption in the household and service sector are adjusted for differences in the climate and fuel mix. They can be used for benchmarking indicators by comparing them to reference values, corresponding to several definitions: best country values within the EU, best 3 values, best practice at the micro level (best plant, most efficient buildings).

[4] All indicators are also available in terms of CO2. As the focus of the report is on energy savings, we will no longer mention CO2 indicators.

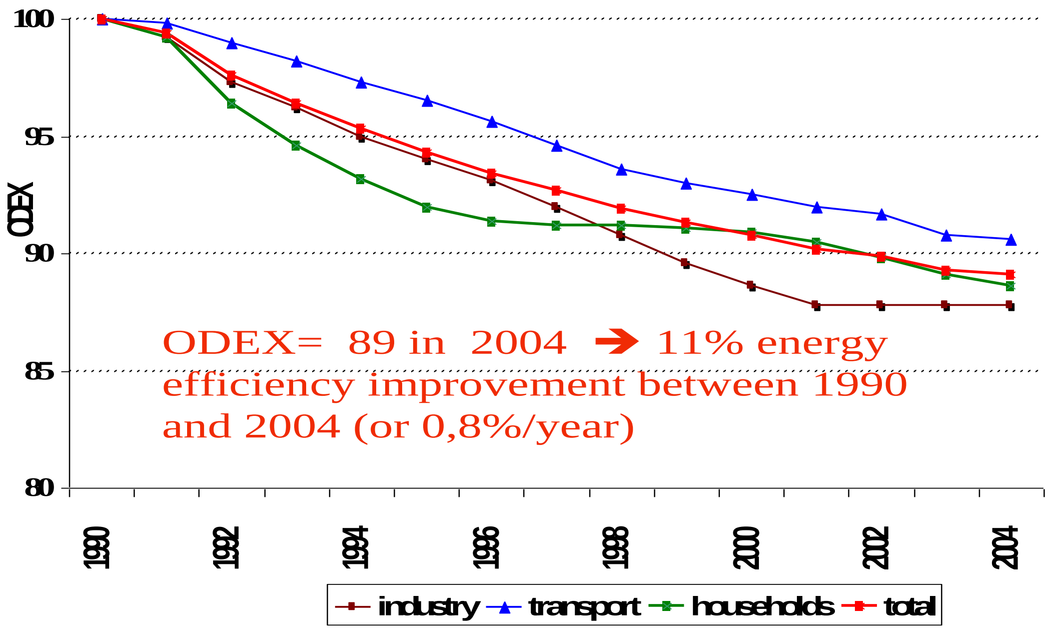
Figure 1: Adjusted energy intensities in the EU-15



Aggregated **energy efficiency indices**, referred to as **ODEX**, are calculated to provide a synthetic evaluation on energy efficiency improvement by main sectors and for the whole economy. ODEX "**aggregates"** the trends in the unit consumption by sub-sector or end-use into one index by sector on the basis of the weight of each sub-sector/end-use in the total energy consumption of the sector. Unit consumption data by sub-sector are expressed in different physical units so as to be as close as possible to energy efficiency evaluation (e.g., toe/ m2, kWh/appliance, toe/ton, litre/100km). The overall ODEX for final consumers is calculated on the basis of about 30 sub- sectors (7 modes in transport, 9 end-uses for households, 11 branches in industry)[5]. The energy efficiency is measured in relation to the previous year and not to a fixed base year. In addition, ODEX is calculated as a 3 years moving average to remove the effect of short term fluctuations due to business cycles or imperfect climate corrections. **Figure 2** shows the trend of the ODEX indicators for the EU-15: energy efficiency of final consumers improved by 11% over the period 1990-2004.

5 This corresponds to the situation of countries with good data availability. For some countries, without data by end-use in the household sector, or by type of vehicle for road transport, ODEX is calculated at a more aggregated level.

Figure 2: ODEX indicators for the EU-15



ODEX is calculated to measure energy efficiency progress or savings at the level of final consumers, using the conventional conversion of electricity into toe (i.e. the calorific value) (1 TWh = 0.086 Mtoe = 3.6 PJ). However to show the impact of electricity savings in terms of primary energy, a "**primary ODEX"** is also calculated, using an average coefficient of 2.5 to convert electricity into toe (1 TWh = 0.25 Mtoe = 10.5 PJ).

Both will be needed for the ESD evaluation, depending on which conversion factor for electricity (1.0 or 2.5, or even another, national value) the Member States will use.

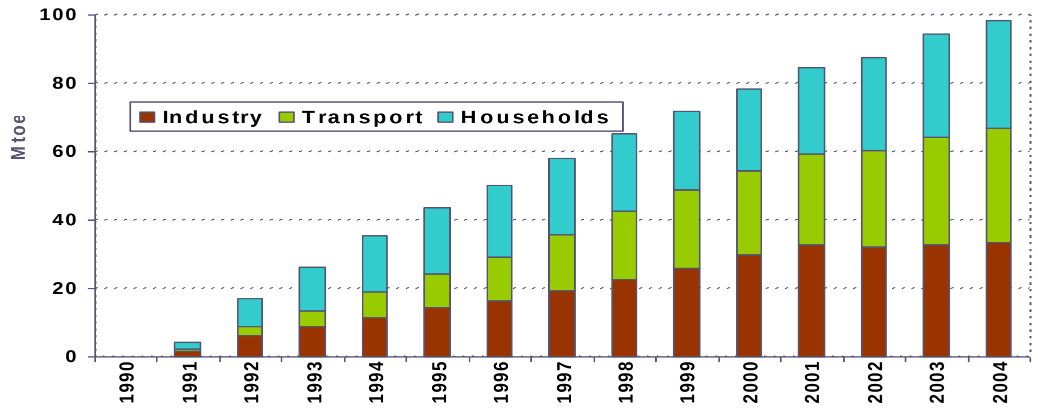
ODEX enables a first estimate of all energy savings[6] for a sector (e.g. households). For the purpose of ESD, ODEX should only be used as such if for the whole sector no other method is available. If energy savings have to be calculated for a given end-use or sub-sector, detailed ODYSSEE indicators of unit energy consumption will be used to calculate the energy savings and not ODEX.

[6] "All" energy savings are those resulting from all technical, organisational or behavioural actions taken at the end-use level to improve energy efficiency whatever their driving factor (energy services, polices, market forces, or autonomous technical progress). Chapter 5 of the main text body of the summary report on top-down methods presents more detail on the distinction between 'all' and 'apparent total' energy savings.

Like for individual indicators, it is easy to calculate ‘apparent total’ energy savings from ODEX. Since ODEX averages out many structural changes and fluctuations inherent in the individual indicators, the ‘apparent total’ energy savings calculated with ODEX are positive and may be in the same order of magnitude as all energy savings. Still, they should not be taken as a substitute for all energy savings, since the error can also be large due to the high aggregation level.

‘Apparent total’ energy savings are directly derived from ODEX indicators, taking into account that ODEX also represents the ratio between the energy consumption and a fictive consumption that would have happened without energy savings[7]. They are expressed in volume of energy savings (e.g. Mtoe or PJ saved/year) (**Figure 3**). These savings, as discussed later, include all sources of energy savings (autonomous progress, price change and policy facilitating measures): they indicate how much energy has been saved as a result of the reduction in unit energy consumption in the various sub-sectors and end-uses.

Figure 3: Energy savings in the EU-15[8]



Indicators of diffusion aim at monitoring the diffusion of energy-efficient technologies and practices as well as of end-use renewables, so as to complement the existing energy efficiency indicators with indicators that are easier to monitor and are more rapidly updated than energy efficiency indicators that depend on the availability of data on end-use consumption. **Figure 4** gives an example of a diffusion indicator. Such indicators include different types of market shares:

[7] If for year t energy consumption = 50 Mtoe and ODEX =80, the ‘apparent total’ energy savings at year t =50* ((100/80)-1)=12.5 Mtoe. Note that these savings are based on unit consumption measured in different units, as opposed to other methods that will use the same unit (e.g. savings for passenger transport based on the reduction of the toe/passenger-km).

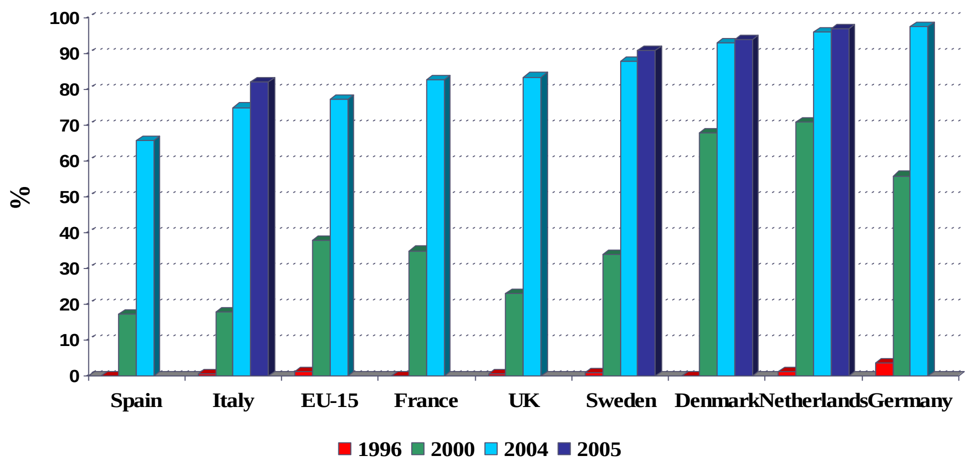
[8] Energy savings are measured on a yearly basis in relation to the efficiency of the previous year. Then they are cumulated from 1990. In other words, the calculation does not assume a “frozen efficiency” at the level of 1990.

Energy efficient technologies and equipment: number of efficient lamps sold, % of label A or A++ in new sales of electrical appliance…

Energy efficient practices: % of passenger transport by public modes, % of transport of goods by rail by combined rail-road transport, % of efficient processes in industry.

End-use renewable: % of solar water heaters, % of wood boilers for heating, % of biofuels.

Figure 4: Market share of label A and A+ for washing machines



Indicators such as those developed in the ODYSSEE database for the EU-25 countries, Bulgaria and Norway are now becoming a reference, both at the level of countries and at the international level, as they enable to monitor trends in energy efficiency in a harmonised way among countries. They are in particular increasingly used as a reference by the European Commission as well as by several international organisations:

- DG-TREN: EMOS database (Energy Market Observatory) that includes about 20 indicators from ODYSSEE; reference in the Energy Service Directive.
- DG- ENV has also taken into account the experience of the ODYSSEE indicators to design its own indicators for GHG monitoring and is also considering using some ODYSSEE data and indicators for the monitoring of demonstrable progress with GHG abatement within its climate change task force.
- EUROSTAT has also taken into account the experience of the ODYSSEE indicators to design its own indicators, and regular cooperation exists with Eurostat to exchange data and harmonised methodologies.

- EEA (European Environmental Agency): the TERM report[9] makes use every year of a set of data and indicators extracted from the ODYSSEE database; EEA also used ODYSSEE indicators to prepare the fourth pan-European environment assessment report in the 'Environment for Europe' process in the framework of UNECE.
- JRC Ispra and IPTS are also making use of ODYSSEE data for different studies for the Commission, including the reference system SRS for energy efficiency monitoring.
- IEA: ODYSSEE data are used by IEA to build its own indicators for European countries.
- WEC (World energy Council) and the energy Charter Secretariat are regularly relying on these indicators in publications and workshops.
- Several models used by the European Commission are also using ODYSSEE data, such as PRIMES, POLES, MEDEE, or MURE.

2.2 The existing adjustments

The assessment of energy savings from top down indicators is not direct but is usually done by cleaning or adjusting indicators of energy use from the influence of the different factors that are not linked to energy efficiency. The degree of adjustment depends on the definition of the energy savings and on data limitations. In ODYSSEE some adjustments are already made and will be described here.

In ODYSSEE, energy savings are measured at two levels: on the one hand, at the level of end-uses/sub-sector, through the variations of unit energy consumption, on the other hand, at the level of the whole economy (total savings), through the ODEX indicator.

2.2.1 Existing adjustments by end-use/sub-sector

2.2.1.1 Households

In the household sector, up to 11 end-uses or appliances are considered in ODYSSEE[10]: space heating, water heating, cooking, 6 “large appliances” (refrigerators, freezers, washing machine, dishwashers, dryers and TV), lighting and the other small electrical appliances, considered as a whole, (e.g. ICT, coffee machines, video).

Five types of adjustments are presently considered for the household sector in ODYSSEE, to clean the effect of the following factors:

- Change in the size of dwellings (for space heating)

[9] TERM monitors indicators tracking transport and environment integration in the European Union
[10] ODEX indicator for households is calculated with up to 8 end-uses: small appliances, lighting and dryers are not yet included. For some countries, the number of indicators considered in ODEX is lower (see below section 2.3 on data availability by country)

- Climate variations from one year to the other (space heating)
- Penetration of central heating (space heating)
- Change in the fuel mix (space heating)
- Change in the number of large appliances per household

For space heating, the unit energy consumption considered is expressed per m2 to correct for the increase in the size of dwellings.

Then, a second adjustment is made for space heating to leave out the effect of year-to-year variations in the winter severity[11]. In other words the unit energy consumption for space heating is calculated **at normal climate** (i.e. with climate corrections).

A third adjustment for space heating is to account for the penetration of central heating[12]. In the southern European countries, there is an increasing penetration of central heating, reflecting improved comfort in winter, with all the rooms of a dwelling well heated, as opposed to room heating where only some rooms are heated with stoves[13]. It is estimated that the replacement of room heating by central heating increases the energy required for space heating by about 50 % on average[14]. Therefore a unit energy consumption per equivalent dwelling with central heating is calculated, the value of which is not influenced by change in the proportion of dwellings with central heating and is therefore more influenced by energy savings considerations.

A fourth adjustment for space heating is to remove the influence of change in the fuel mix due to the different end-use efficiency of fuels. For that purpose, the unit consumption is expressed in terms of useful energy, using conventional reference values for the end-use efficiencies. These values are kept constant, so as to account for the improvement in the end-use efficiency as energy savings[15]. Depending on the definition of energy savings, the resulting saving from fuel substitution may or may not be included in the overall savings. ODYSSEE enables if necessary to identify the impact of fuel substitutions[16].

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11 The winter severity is measured with an index relating the actual a number of degree days to a reference value corresponding to a long-term average (30 years usually, but 20 years in some countries); an index of 0,9 means that the year was 10% warmer than a normal year. Eurostat provides harmonised data on degree –days by country, which are used for comparison. For annual climatic corrections, the harmonisation of definition among countries is less important.

12 Central heating includes district heating, block heating, individual boiler heating and electric heating.

13 This was also important in Ireland over the nineties.

14 This value of 50% is presently used by default in ODYSSEE but could be calibrated according to countries.

15 The values used are the same for all countries and are the official values used by the Danish Energy Authority, the only organisation to publish data in useful energy.

16 In the calculation of energy savings with ODEX, the savings from fuel substitutions are presently included in the overall energy savings.

No adjustment is made for space heating to account for the impact of the change in the mix between single-family dwelling (houses) and multi family dwellings (apartments) (apart from what is covered by the change in the average dwelling size). The main reason is that over short periods, the impact is quite negligible: for instance, over the past 15 years the share of multi-family houses as compared to single family houses was rather constant in the EU15.

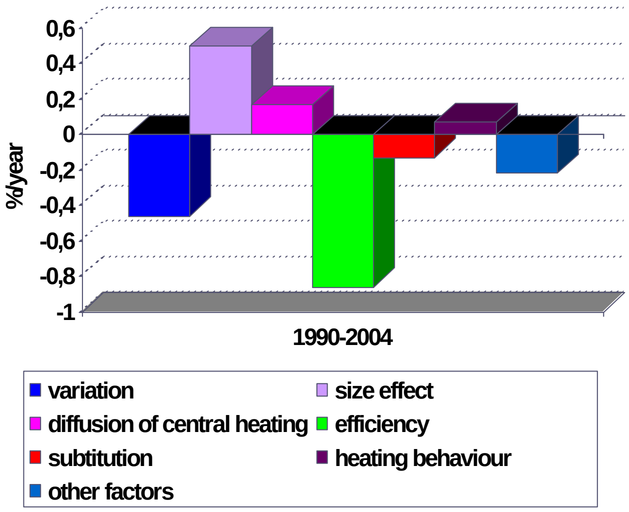
For water heating and cooking, the unit energy consumption is measured per dwelling and no adjustment is done, due to the limited data availability.

For large electric appliances, the unit electricity consumption is expressed per appliance to correct for the increase in the ownership of large appliances. No adjustment is made for the change in the size of the large appliances, due to lack of data.

For the other electrical appliances and lighting, the unit consumption is measured per dwelling and no adjustment is done for the impact of the diffusion of more lamps or appliances. For all the small appliances and lighting, energy savings are not presently calculated in ODYSSEE.

These different corrections are important to relate the energy savings to the overall change in energy consumption and to understand, for instance, the reasons for an increase in the energy consumption while there are energy savings. Even though energy efficiency of buildings is increasing - expressed in kWh per m2 – the energy consumption will keep on increasing if the total area is increasing faster than energy efficiency improves (or kWh/m2 decreases). According to ESD definition of savings, if the consumption in kWh per m2 decreases this will be accounted as energy savings even if there are more square meters. ESD does not look at the impact of lifestyle changes. In ODYSSEE, combining ODEX with other indicators we are able to measure the impact of all these factors on the energy consumption and it is up to the user of the indicators to define the energy savings. Figure 5 indicates what is done in ODYSSEE to relate energy efficiency changes and the other drivers of the energy consumption. The graph decomposes the variation of the energy consumption per dwelling, but the decomposition can be easily calculated in terms of energy savings or negative savings, (e.g. in Mtoe, PJ).

Figure 5: Drivers of the variation in heating consumption per dwelling in the EU 15



In summary, the following unit energy consumption indicators are considered in ODYSSEE to measure energy savings for households[17]:

- Heating: unit consumption per m2 at normal climate per equivalent dwelling with central heating (toe/m2, toe/m2/dwelling equivalent with central heating, toe/m2 in useful energy)
- Water heating: unit consumption per dwelling
- Cooking: unit consumption per dwelling
- Large electrical appliances: specific consumption per appliance (kWh/year)

2.2.1.2 Transport

For the transport sector, up to 11 transport modes or vehicle types are considered in ODYSSEE: cars, trucks, light vehicles, trucks and light vehicles[18], motorcycles, buses, total air transport, domestic air transport, rail transport of goods, rail transport of passengers and water transport[19].

For cars, which represent about half of the energy consumption, three indicators are considered to separate out improvements with the energy efficiency of vehicles, the influence of changes in the average distance travelled per vehicle ("behavioural effect") and change in the car occupancy: the average specific consumption of cars in litres /100km and the unit consumption per car in toe/car and the unit consumption of cars in

[17] The data by end-use and type of appliance are provided by national teams. They rely on national statistics or estimate; their level of accuracy is assessed in a qualitative way. The availability of data by end-use for each EU member country is discussed in section 2.3.

[18] This category is necessary, as many countries do not have a breakdown of energy consumption data between heavy trucks and light duty vehicles.

[19] Domestic water transport (waterways and domestic marine transport).

toe/passenger-km. The first one is presently used to calculate the energy savings of cars.

The impact of fuels substitution between gasoline and diesel can be calculated in the analysis to assess how much fuel substitutions contribute to energy efficiency progress or goes against energy efficiency; however, no systematic indicator is yet provided in ODYSSEE[20]. In the same way, the energy savings brought about by the dissemination of new, more efficient cars, and their substitution for old, less efficient ones, could be calculated but is not explicitly available in ODYSSEE[21].

For trucks and the category “trucks and light vehicles”, two indicators are calculated (litres/100 km and toe/tonne-km) to separate out technological energy savings, due to reductions in the specific consumption of vehicles, and on the other hand, managerial energy savings, due to better management of the vehicle fleet (increased load factors, reduced empty running). However, both are accounted for in the ODEX.

No adjustment is made to account for changes in the average size of vehicles, either between different types of truck (medium, large, etc), or between different sizes of cars (in terms of weight, or horse power or engine size in cm3), due to limited data availability on the specific fuel consumption of these different categories of vehicles by country[22]as stock data by horse power and engine size are, however, available for each country.

For countries without data on the breakdown of the energy consumption of road transport by type of vehicle, an indicator of unit consumption by car equivalent is calculated[23].

For each mode, the following indicators of unit energy consumption have been selected in ODYSSEE to measure energy savings:

- cars: specific energy consumption in litres/km and toe/car
- trucks: specific energy consumption in litres/km or toe/ton-km
- light vehicles: specific energy consumption in litres/km
- trucks & light vehicles : unit energy consumption per ton-km

[20] The calculation is mainly made to report at the EU level. It is done systematically for all member countries, but could be easily implemented. One possibility to better account for that issue would be to calculate the savings by type of motor fuel and not directly for the whole stock.
[21] This impact is implicitly taken into account in the average specific consumption of the car stock.
[22] Reference values could possibly be used based on data averaged for the countries for which they exit. The data sources would be car manufacturers or their associations.
[23] The unit consumption of road transport per equivalent car is calculated as the ratio between the total consumption of road transport and a fictitious stock of all road vehicles measured in terms of numbers of equivalent cars. Converting the actual stock of each type of vehicles into a stock of equivalent cars is based on a coefficient reflecting the difference in the average yearly consumption between each type of vehicle and a car. If, for instance, a truck consumes 15 toe/year on average and a car 1 toe/year, one truck is considered to be equivalent to 15 cars.

- buses: toe/vehicle
- motorcycles: toe/vehicle
- total air transport: unit energy consumption per passenger
- domestic air transport: unit energy consumption per passenger-km
- rail transport of passengers: unit energy consumption/passenger-km;
- rail transport of goods: unit energy consumption/tonne-km
- water transport of goods: unit energy consumption/tonne-km

2.2.1.3 Industry

For industry, up to 16 subsectors are considered:

- 12 main subsectors: chemicals, transformation of rubber & plastics, food, textile & leather, fabricated metals, machinery, transport vehicles and equipment goods[24], primary metals, non metallic minerals, paper and printing, construction, mining
- 4 energy intensive products: steel, cement, glass and pulp & paper[25]

For cement and steel, information is collected to adjust for the impact of changes in the process mix; however, due to limitations of data on the specific energy consumption by process, such impacts can only be assessed in a qualitative way (e.g. through graphics). Anyway, these subsectors are covered by the Emission Trading (ETS) Directive and are not included in the energy savings of the ESD.

No adjustment is done to clean indicators by subsector from structural changes *within* the subsector; this is mainly a problem in the chemical industry, with a shift from heavy chemicals to light chemicals (e.g. cosmetics, pharmaceuticals)[26].

In industry, the following unit energy consumption indicators are selected in ODYSSEE to measure energy savings:

- energy used per ton produced for energy intensive products (steel, cement, glass and paper)[27]

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24 Equipment goods includes fabricated metals, machinery and transport vehicles

25 In most countries printing is included; this does not fact the assessment of savings at the country level but may have a bias in cross-country comparisons. This is why when comparing countries in ODYSSEE, the comparison is not done directly in terms of energy consumption per ton of paper, but relates this unit consumption to the pulp production.

26 According to an analysis carried out by Wolfgang Eichhammer from Fraunhofer-ISI for Germany the problem is even at a lower level, e.g. within the basic chemicals or within the light chemicals.

27 The reduction in the unit consumption, that is used to calculate energy savings, may be due to change in process mix (e.g. increase share of recycling, use of an electric process). The question is whether such process changes should be really accounted as energy savings. In ODYSSEE, they are presently accounted as energy savings.

- energy used related to the production index for the other subsectors

2.2.1.4 Services (tertiary sector)

For services, up to 7 subsectors (administrations or public sector, wholesale/retail trade, private offices, hotels/restaurants, education /research and health/social action) and 5 end uses are considered (space heating, water heating, cooking, office equipment, lighting and air conditioning). However, very few countries have such a breakdown and the energy savings have in most countries to be calculated at the sectoral level (cf. Annex 2 to this Annex).

The unit energy consumption is expressed per m^2 and/or per employee[28] to assess energy savings. For heating and air conditioning, energy used per square meters of floor area is more relevant.

2.2.2 'Apparent total' energy savings as a proxy for all energy savings

'Apparent total' energy savings are calculated, first for the main sectors (households, transport, industry and services), then for all sectors, using the ODEX indicators. As explained in chapter 2.1, they can serve as an indicator of the likely size of all energy savings. Chapter 5 of the main text body of the summary report on top-down methods presents more detail on the distinction between these two concepts of energy savings.

The ODEX indicators by sector rely on the unit energy consumptions presented above and include the same adjustments, as described above. However, it includes some additional adjustments that only exist at the sector level:

- Calculation as a 3 years moving average[29]
- Calculation of a short-term ODEX
- Calculation of a technical ODEX for households

2.2.2.1 Calculation as a 3 years moving average

First of all, for all sectors, ODEX is calculated as a 3 years moving average to remove the impact of short-term fluctuations, due to imperfect climatic corrections, especially with warm winters[30], to business cycles, to imperfect statistics (for the most recent

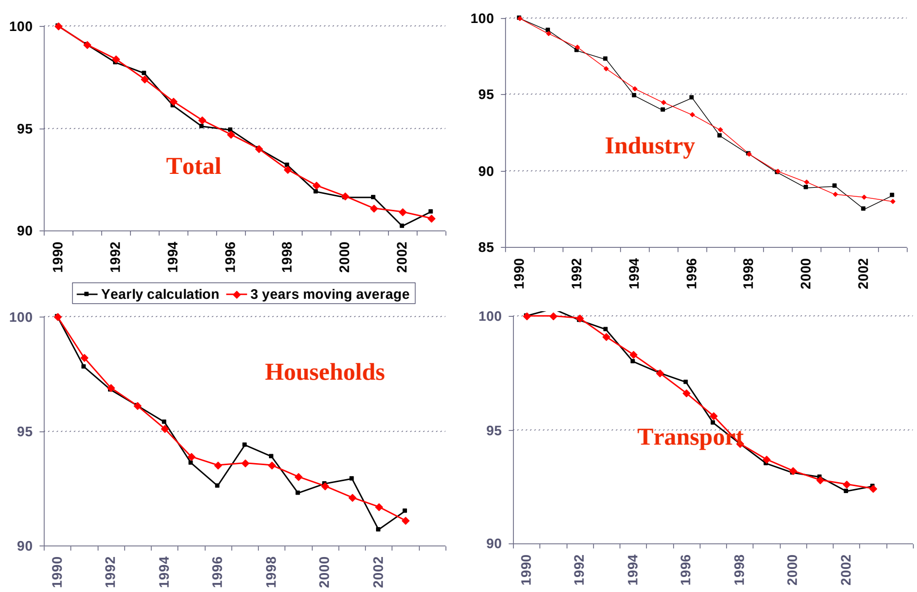
[28] The energy used per employee is considered as a proxy for the energy used per m2, which is more relevant to monitor energy efficiency trends but cannot be used in most countries because of a lack of data on floor area.

[29] In the communication of results on energy efficiency trends, the moving average value is now used in ODYSSEE. However, the gross value is still calculated and available.

[30] For warm winters, the climatic corrections tend to overcorrect the consumption; this is due to the fact that households do not reduce their heating consumption proportionally to the lower outside

years). The method used to calculate the 3 years moving average is to take for year t the average of t-1, t and t+1 (red line), which is the method traditionally used in statistics **(Figure 6)**[31]. This calculation of 3 years average is mainly done for aggregated indicators, but could be done for any of the sectoral indicators mentioned in the previous section.

Figure 6: ODEX calculation as a 3 years moving average: case of the EU-15



2.2.2.2 Calculation of a short-term ODEX

To evaluate energy savings in real time, national decision makers and Commission staff need timely updated indicators. However, as ODEX relies on very disaggregated data that are available with two years delay (e.g. 2004 in 2006), ODEX can be extrapolated to estimate the values up to year t (e.g. 2006 in 2006), using econometric forecasting techniques.

2.2.2.3 Calculation of technical savings for households

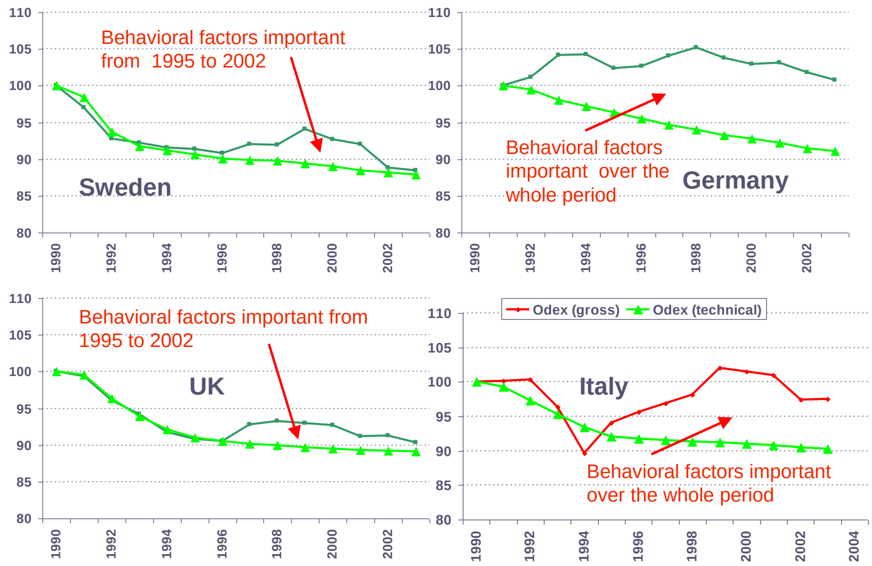
For the household sector, a second adjustment is made for space heating and water heating that attempts to separate out technical savings from changes linked to short term behavioural changes (heating temperature, increase use of hot water). For that reason, a technical ODEX is calculated, that is cleaned from the impact of behavioural

temperature (behavioural factors), but also that other external factors, such as the humidity level and wind velocity, are not reflected in the evaluation of the heating requirements.

[31] For the second year and the last year, the average is based on two years only.

changes. This technical ODEX is calculated by assuming that technical efficiency cannot reverse on the short term (i.e. from one year to the other): it may not improve from one year to the other but cannot be “worse”. The difference between the technical ODEX and the gross ODEX, corresponding to a standard calculation, shows the influence of behavioural factors (e.g. higher heating temperature, increase in the duration of the heating period) (**Figure 7**).

Figure 7: Technical ODEX versus gross ODEX for households



In industry, the way the ODEX is calculated (i.e. by measuring energy savings at sub-sector/ branch level) is cleaned from the influence of changes in the structure of industrial activities[32]. In the same way, the overall ODEX is cleaned from other changes in the structure of the economic activity

In summary, the energy savings derived from ODEX are cleaned from the following influences that are not linked to energy efficiency: climate fluctuations, short term business cycles, changes in economic and industry structures, lifestyle changes (increase in the dwelling size, in the appliance ownership) and behavioural changes for households.

For transport, ODYSSEE provides indicators to calculate energy savings brought about by modal shift towards less energy intensive modes by comparing the variations of two unit energy consumption values for passenger transport (toe/passenger-km) and transport of goods (toe/tonne-km) as a whole: the actual value and a value at constant modal split. A more rapid decline of the actual value of the unit consumption compared

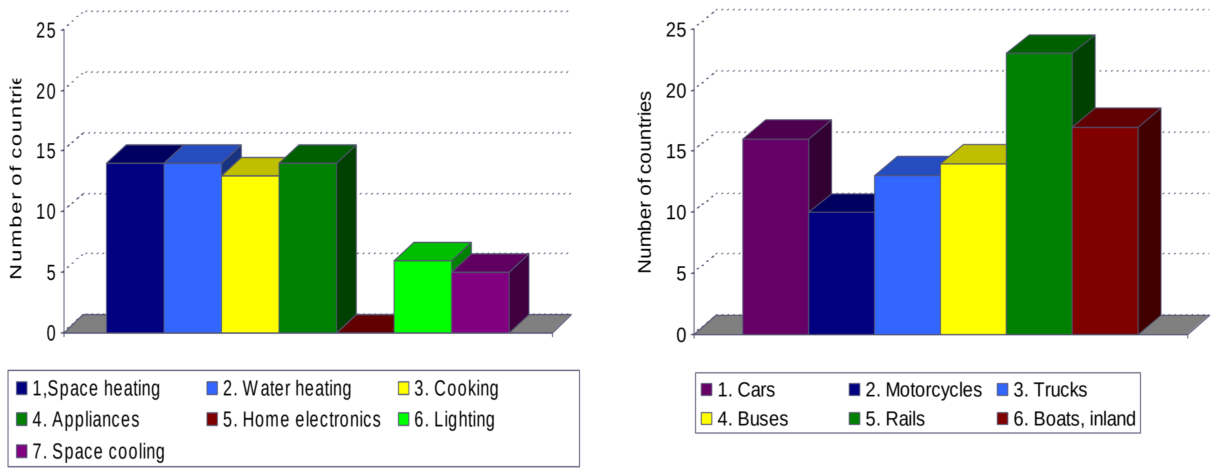
[32] As explained earlier, intra –branches structural changes are still embedded in ODEX.

to a value at constant modal split means that there have been energy savings from modal shift. Energy savings linked to modal shift are not included in ODEX, but could be added and separated; in that case the energy savings would include technological savings from vehicles and the modal shift savings; actually, over the past years, modal shift led to negative 'apparent total' energy savings.

2.3 Status of national indicators and data

Many countries have still limited data in the building and transport sector by end-use/type of road vehicle: about half of EU countries, on average, do not have such data, as shown in **Figure 8**[33].

Figure 8: Availability of data in the household and transport sectors



As a consequence, ODEX cannot be calculated at the level of 30 sub-sectors/end-uses for all countries and alternative calculations are used for countries with limited data[34]. To cope with this lack of data, one could consider for some end-uses to assess directly by simple modelling the energy savings on the basis of diffusion indicators (e.g. market sales[35]) ("deemed savings").

For the EU as a whole, EUROSTAT data only enable to calculate very general indicators, which are not sufficient for a good evaluation of energy savings. Therefore, indicators for the EU-25 as a whole are calculated by Enerdata as a weighted average of indicators on the sample of countries for which they exist (e.g. specific consumption of cars, energy use per m^2)[36].

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33 The detail by country is given in Annex 2

34 In the household sector, it is calculated on 2 end-uses (heating , water heating) for Spain, Finland and Greece and the total fuel consumption (without end-use) for Belgium, Ireland, Portugal, Luxemburg and all new EU member countries. For transport, it is calculated on 4 modes only (road, air, rail, water), without the breakdown by type of road vehicle for Belgium, Ireland, Portugal, Spain and Luxemburg and in most new EU member countries (except Poland and Latvia).

35 Market sales data are first of all obtained from centralised sources covering all EU countries at the same time (e.g. industrial associations such as CECED or Eurima) or from market survey companies (e.g. GFK). They are then completed by national data if necessary.

36 The weighting is based on the importance of each country in the total stock of dwellings/appliance for household, in the total stock of vehicles for road transport and traffic for other transport and in the total production in industry. Therefore the weighted average is mainly influenced by the largest country for each activity, for which data are available. This weighted average is usually calculated on more than 80% of the consumption of each sub-sector.

The comparability of data in terms of quality is also important. For that reason, a method for evaluating the quality of all key indicators in ODYSSEE has been developed. This should enable to know for each time of indicators their degree of reliability, which is important when making cross-country comparisons. Two types of grades are used (see **Box 1**):

- one to qualify the data source (A, B,C), to show how official is the indicator;
- one to qualify the data quality (1,2,3), to show the range of uncertainty

Box 1: Qualification of data and indicators in ODYSSEE

Qualification of sources

A: Official statistics
•Official statistics/surveys (national statistical office, Eurostat/AIE, Ministries statistics
•Model estimations used as official statistics
•Data “stamped” by Ministries
B: Surveys/ modelling estimates: consulting, research centres, industrial associations
C: Estimations made by national teams (for the project)

Quality grades

1 Good: low uncertainty
2 Medium: medium uncertainty
3 Poor: large uncertainty

Although the method has been developed, we have not yet received all qualification by national teams and are not able to give an overview of the data quality. Combining all grades on the quality of the data used for a given indicator can serve to qualify each indicator, assuming that the lowest grade will apply to the whole indicator.

The uncertainty of the energy savings will depend first of all on the uncertainty on the indicators, but also on the approximation made in deriving the savings from the variation of the indicator; the latter uncertainty is however quite difficult to assess.

3 ESD adjustments and harmonisation

To identify the new adjustments to be made, we need to refer to the ESD, as to what should be accounted for in the energy savings and what should be excluded from these savings.

First of all, the Directive *"shall not apply to those undertakings involved in categories of activities listed in Annex I to Directive 2003/87/EC of the European Parliament and of the Council of 13 October 2003 establishing a scheme for greenhouse gas emission allowance trading within the Community".* In other words, the Directive excludes in the industry sector the energy savings in undertakings covered by the Emission Trading (ETS) Directive. This implies to work in ODYSSEE with an industrial energy consumption, which excludes the sites concerned by ETS. From the methodological viewpoint, this adaptation is rather straightforward[37]. The main difficulty relates to the data availability. Indeed, the energy consumption statistics are available by branch (e.g. steel, paper, non metallic minerals) and there is not a direct correspondence between these branches and the ETS establishments, even if for some branches most of the consumption is covered by the ETS. It is up to the countries to provide the necessary data as to the energy consumption of industry included in the field of ESD. If this is not the case, some approximations could be proposed[38].

Secondly, the Directive specifies that, with respect to top-down methods, "*adjustments of the annual data are then made for extraneous factors such as degree-days, structural changes, product mix, etc. to derive a measure that gives a fair indication of total energy efficiency improvement*". As explained in the previous part of this report, most of the required adjustments are already made in ODYSSEE, even if some improvements could be made for residual structural effect that are still embedded in ODYSSEE indicators: the so-called "hidden structure effects"[39]. However, such improvements have to take into account that data are available in a sufficient number of countries.

Finally, the question is how to calculate only additional energy savings due to facilitating measures. This is dealt with in the main text body of the summary report on top-down evaluation methods of energy savings.

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37 In fact ESD probably excludes "companies", not "sites", which makes the adaptations more difficult

38 A simplified approach could consist in calculating the energy consumption of ETS plants from the CO_2 emissions gathered in the ETS registries by using average emission factors for a given sub-sector in a country.

39 Hidden structure effects are structural effects, which due to lack of statistical data, are still mixed up in the evaluation of energy savings. For instance, a smaller size of refrigerators, due the decreasing size of households, will be accounted as "savings". Hidden structural effects can act in two directions: contribute to energy savings or minimize the actual savings. In the first case, their effect should be removed; in the other case it should be added. In some fields of application, hidden structural effects might be substantial. Therefore, it might be useful to conduct EU surveys on a regular basis to estimate data not available. However, before deciding on how additional data could be obtained, first, the most important hidden effects have to be identified with regard to the different fields of application. This has to be done in the course of the development of detailed top-down methodologies.

Annex 1: Adjusted energy intensities in ODYSSEE

Primary or final energy intensity at purchasing power parities

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

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

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

with:

toccp: primary consumption in Mtoe

toccf: final consumption in Mtoe

pibxx: GDP in national currency (in constant prices)

txchgppp: coefficient of purchasing parities to convert national prices into purchasing parities

The purpose of purchasing power parities is to eliminate the difference in price level, so as to improve the comparison of volumes. For example, the per capita GDP was almost 3 times greater in Germany than in Portugal in 2000. However the difference represents not just a greater volume of activity on Germany, but also a higher general price level. Expressed in purchasing power parities, the difference between Germany and Portugal is only a factor of 1.7.

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

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

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

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

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

Final energy intensity at reference climate

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

Final energy intensity at reference economic structure

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

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

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

ietoctfcaj=(vadindxx.eu-vadimaxx.eu)*(toccfind-toccfima)/(vadindxx.-vadimaxx.)

+(vadimaxx.eu/(txchgppp*1000))*ietocimaaj

+vadagrxx.eu*toccfagr/vadagrxx

+(vadterxx.eu*toccfter/vadterxx.+pibxx.eu*toccftra/pibxx.)

+(cprxx.eu*toccfres/cprxx.))/(pibxx.eu/txchgppp)*1000 [koe/€ppp]

Note: in this example, the European Union average is the reference (eu); vad: value added; xx: constant price of year xx (eg 2000); pib: gdp; ima: manufacturing; agr: agriculture; ter: services (tertiary sector); res: residential sector; txchgppp: rate of purchasing power parities

Annex 2: Data availability by country in ODYSSEE