Energy Efficiency Trends and Policies in the Household and Tertiary Sectors

An Analysis Based on the ODYSSEE and MURE Databases

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Didier Bosseboeuf

Project leader

[1] Alphabetic order of countries

KEY MESSAGES

OVERALL TRENDS

- The pace of energy efficiency improvements has slowed down since the beginning of the economic crisis in most countries and at EU level: 1.5%/year on average for the household sector at EU level since 2008, against 1.9%/year from 2000 to 2008.

- The electricity intensity is clearly increasing in most countries in services, despite the economic recession because of the growing number of new appliances, such as IT devices, linked to the development of internet and of new telecommunication types, as well as a spread of air conditioning.

  At the EU level, the increase of electricity consumption in services between 2008 and 2012 is mainly due to structural changes, and to a lesser extent, to increased comfort and productivity increases due to the diffusion of ICT[2] and air conditioning. Energy savings have contributed to reduce growth in electricity consumption.

TRENDS IN HOUSEHOLDS

- In summary, household energy efficiency has improved by 1.8%/year at EU level since 2000, thanks to the energy efficiency improvement for space heating and the diffusion of more efficient new electrical appliances (e.g. labels A+ to A++).

- The household energy consumption per dwelling has been decreasing regularly in most countries since 2000 (1.5%/year at EU level). Since 2008, electricity consumption per household has also decreased in many countries.

- The efficiency of household space heating, measured in kWh or GJ/m^2, has improved steadily since 2000, by around 2.3%/year at EU level. The reasons are the deployment of more efficient new buildings and heating appliances and the renovation of existing dwellings. The low volume of construction since 2009 has, however, limited the impact of new dwellings standards. As a result of these trends, the share of space heating in total household consumption is declining (4 percentage points less than in 2000).

- The consumption of small electrical appliances has been growing rapidly until 2007 so that they now represent a higher share of the total consumption of appliances than large appliances. Large appliances are more and more efficient, with efficiency gains around 35% for cold appliances (refrigerators and freezers), washing machines and dish washers since 1990, thanks to labeling and eco-design regulations.

- The specific consumption per dwelling for lighting has decreased since 2000 in half of EU countries and at the EU level thanks to the diffusion of CFLs and LEDs.

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[2] Increased ICT can increase the energy consumption of an individual office or service but in the society as a whole digitalization is reducing energy consumption by, e.g., reducing mobility needs and more efficient use of space.

- The increasing number of dwellings and appliances contribute to raise the household energy consumption. Their effect is however counter balanced by the energy efficiency improvements. Without these savings since 2000 the energy consumption of households would have been 60 Mtoe higher in 2012 at EU level.

TRENDS IN THE TERTIARY SECTOR

- Energy consumption in the tertiary sector increased rather rapidly until 2008, and has been decreasing since the economic downturn, by 1.5%/year.
- Electricity consumption has continued growing since 2008 but at a lower pace (1.1%/year, against +3%/year before).
- The energy intensity of services has decreased in almost three quarters of the countries, with a larger reduction for countries with high intensity in 2000; this also means that in one fourth of the countries it is still increasing.

POLICIES AND MEASURES

- EU legislation is a major driver in policies and measures implemented in the household and services sectors. New measures have mainly focused on the implementation of EU legislation which has required massive effort and resources. The introduction of purely national new measures has, therefore, been limited. Examples of areas where further attention to the implementation of EU legislation is needed are:
    - building renovation strategies: there is room for improving the existing strategies and all countries have not yet adopted them
    - energy certificates: there is still need for better visibility, databases need to be developed and consumer trust must be increased
    - public procurement: energy efficiency is not yet systematically integrated into public procurement processes
- Smart meters and informative billing are empowering consumers to make better decisions and change behaviour. However, these need to be backed up by other energy services such as tailored advice as well as financing opportunities to actually induce change.
- Renewable energy production in buildings is promoted by a multitude of policies and measures. As a result, production of heat by heat pumps and solar is increasing. However, there are still considerable barriers in sales of surplus electricity to the network.
- Sectorial policies do not suffice in the transformation towards low carbon economy. Increased focus needs to be given to system level improvements. Some of the prerequisites for the transformation are effective inter-ministerial co-operation to avoid silo mentality, better spatial planning, innovative exploitation of the possibilities of digitalization and

behavioural change.

- Energy efficiency and renewable energy entail multiple benefits beyond energy savings and CO_2 emission reductions. It is important to recognize them in programme design and evaluation in order to have a full view of the impacts. One example is economic gains which go well beyond savings in energy bills.

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INTRODUCTION

The objective of this brochure is to analyse energy efficiency in the household and tertiary sectors. The analysis includes both a review of energy efficiency trends and of the policy instruments currently implemented to improve energy efficiency in the two sectors, based on the ODYSSEE and MURE databases.

BACKGROUND

Buildings account for about 40% of total final energy consumption and around 55% of electricity consumption in the EU-28 in 2012. Buildings are the largest end-use sector, followed by transport (32%), industry (26%) and agriculture (2%). Buildings represent even more than 45% of final energy consumption in countries such as Estonia, Latvia or Hungary. At the EU level, around two thirds of the consumption of buildings is for residential buildings.

Most countries started pursuing energy efficiency policies and measures after the second oil crisis in the seventies. The focus was mainly on heating of (existing) dwellings. In some countries more efficient supply was sought after by developing district heating.

Only in the nineties energy efficiency policies for buildings and energy using goods (e.g. minimum performance standards and energy labelling) were introduced at EU level. Step by step the coverage and strength of EU policy has increased, e.g., through car standards (transport), the Emission Trading System (industry and energy production) and energy performance requirements for buildings (households and tertiary). More recently, the EU has started to require that countries meet certain targets for energy efficiency, and set up comprehensive overall policy packages. This is requiring significant implementing effort from the Member States reflected by the fact that purely national new measures, not driven by EU policy, are emerging at somewhat slower pace.

CONTENTS OF THE REPORT

The report summarises recent policies implemented to promote energy efficiency and renewable energy in buildings (residential and non-residential buildings) and pinpoints the most successful measures. The EU Member States have submitted their third National Energy Efficiency Action Plans (NEEAPs) in April 2014 and measures reported in them discussed.

The report analyses the trends since 2000 in energy use and energy efficiency and the use of renewable energy in buildings based on ODYSSEE data, with a separate analysis for residential buildings (i.e. households) and non-residential buildings (i.e. service or tertiary sector) (see Chapter 2).

Both the Energy Efficiency Directive and the Energy Performance of Buildings Directive pursue energy efficiency improvements in buildings (Chapters 3.2 and 3.3). In light of the measures in the MURE database, it appears that countries have relied quite heavily on these directives and there are not that many new national high-impact measures apart from subsidy schemes. Good supplementary information sources are the materials published by the European projects Concerted Action EED and Concerted Action EPBD.

A key theme in the report is the use of renewable energy in buildings (Chapters 3.7 and 6.2). The Renewable Energy Directive establishes numerous requirements concerning the use of renewable energy buildings. However, there is still a need for national initiatives to promote local energy production and to remove the barriers to their large diffusion, which remain considerable. Although the agricultural sector is relatively small in terms of energy consumption, it is quite interesting in terms of renewable energy policy.

In addition to renewable energy policy, the report discusses some other specific themes such as behavioural change of consumers, the role of the public sector, city planning and co-benefits of energy efficiency and renewable energy. Some other policies and measures touched upon, but not with such a specific focus, are the use of smart meters and feedback programmes (demand-response) and resilience policies (consumption capping schemes).

Consumer behaviour and measures addressing it get special attention. In addition to the traditional campaigns and energy advice, new energy services are empowering consumers (Chapter 4.2).

The exemplary role of the public sector receives some extra focus in the report (Chapter 5.2). Its role is underpinned by EU legislation but there are also various voluntary measures and networks supporting sustainable development, particularly in the municipalities.

Good spatial planning is in the foundation of sustainability, including energy efficiency and use of renewable energies (Chapter 6.1). This is also linked to growing digitalisation which, however, is not yet very visible in the measures loaded to the MURE database.

Recently, the co-benefits of energy efficiency have raised increasing attention, partly driven by recent work by the IEA on multiple benefits. The energy efficiency and RES measures in the MURE database have been scanned for direct references to co-benefits (Chapter 6.3).

Case studies from various countries are given based on information from the MURE database.

This brochure updates a previous report that had a special focus on financing[3]. To avoid repetition, as important as financing is, it has a lower focus in this new report.

In the report Chapter 2 analyses energy demand trends in the household and tertiary sectors in Europe. Chapter 3 discusses the EU policy context in the household and tertiary sectors. Chapters 4 and 5 analyses the characteristics of energy efficiency measures, respectively for the household and tertiary sectors, based on the MURE database. Chapter 6 discusses measures which are common to both sectors. Particular emphasis is put on the use and production of renewable energy in buildings.

[3] http://www.odyssee-mure.eu/publications/br/financing-energy-efficiency-transformation-building-sector.html

THE MURE AND ODYSSEE DATABASES

Both databases are regularly updated by a network of national correspondents from all EU Member States, generally from the energy efficiency agencies. They are managed by a technical coordination, namely Enerdata for ODYSSEE and Fraunhofer-ISI and ISIS for MURE. The two databases can be accessed at http://www.odyssee-mure.eu/.

BOX 1.1: THE MURE DATABASE

MURE (Mesures d'Utilisation Rationnelle de l'Energie) provides information on energy efficiency policies and measures that have been carried out in the EU Member States. The database is structured by end-use sector (household, tertiary, transport, industry) and allows browsing energy efficiency measures by sector. The database also contains information on general energy efficiency programmes and on general cross-cutting measures.

BOX 1.2: THE ODYSSEE DATABASE

***ODYSSEE** database contains data on energy efficiency indicators, energy consumption, activity indicators and energy-related CO_2 emissions. It includes the following types of indicators in buildings:*

- *Specific energy consumption (e.g. specific consumption per dwelling, m^2, employee); Energy efficiency index (ODEX) to evaluate energy efficiency progress at sector level.*
- *Energy savings measuring the energy saved through energy efficiency improvements.*
- *Adjusted indicators to improve the comparisons of indicators across countries (e.g. adjustments for differences in climate or fuel mix).*
- *Diffusion indicators to monitor the market penetration of energy-efficient technologies (e.g. heat pumps, solar water heaters).*

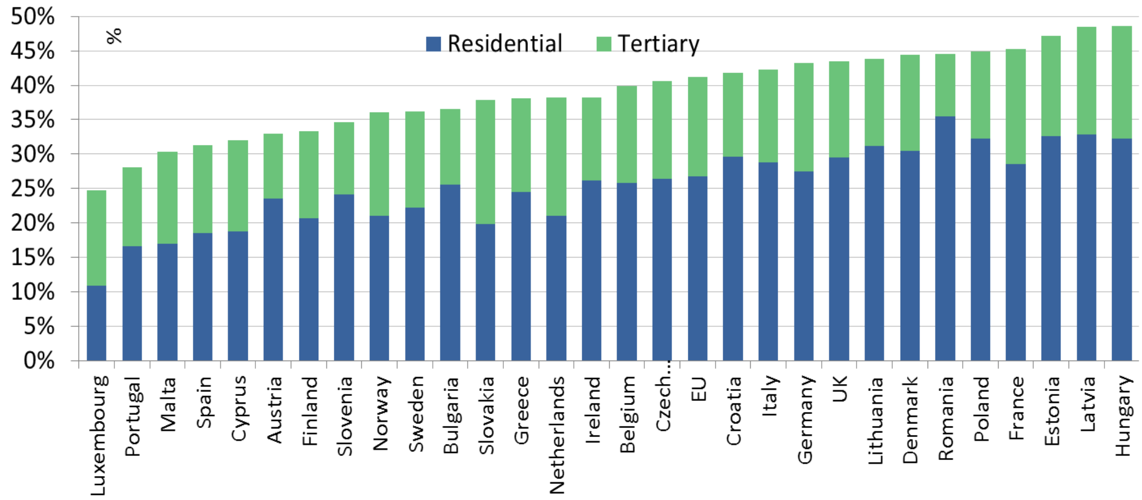
1. ENERGY TRENDS IN BUILDINGS IN EUROPE

1.1. RESIDENTIAL AND NON-RESIDENTIAL BUILDINGS

Buildings account for about 40% of total final energy consumption and around 55% of electricity consumption in the EU-28 in 2012. Buildings are the largest end-use sector, followed by transport (32%), industry (26%) and agriculture (2%). Buildings represent even more than 45% of final energy consumption in countries such as Estonia, Latvia or Hungary (**Figure 1**).

At the EU level, around two thirds of the consumption of buildings is for residential buildings. However, in some countries such as Luxembourg, Malta, the Netherlands, Italy or Portugal, non-residential buildings (i.e. services) are dominant and represent more than half of the total consumption of buildings. The share of residential buildings is above 70% in Denmark, Latvia, Poland and Austria and even reaches 80% in Romania.

Figure 1: Share of buildings in final energy consumption (2012)

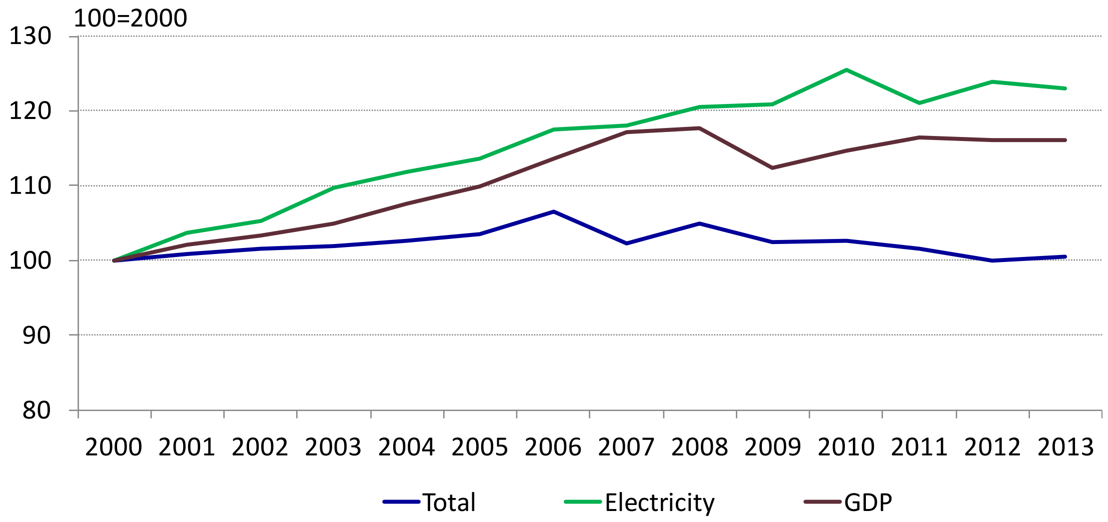


Source: ODYSSEE

The energy consumption of buildings has been decreasing since 2008 (-0.9%/year), after increasing by 0.6%/year from 2000 to 2008. This trend is not fully explained by the economic recession as the GDP contraction was lower (-0.3%/year). Electricity consumption has remained roughly stable since 2008, following a rapid increase until 2008, at the same rate as GDP (2.4%/year) (**Figure 2**).

The average consumption of buildings per capita is around 0.9 toe at EU level in a range of 0.3-0.4 toe/capita for Malta and Portugal to 2 toe for Luxemburg and 1.6 toe in Finland in 2012.

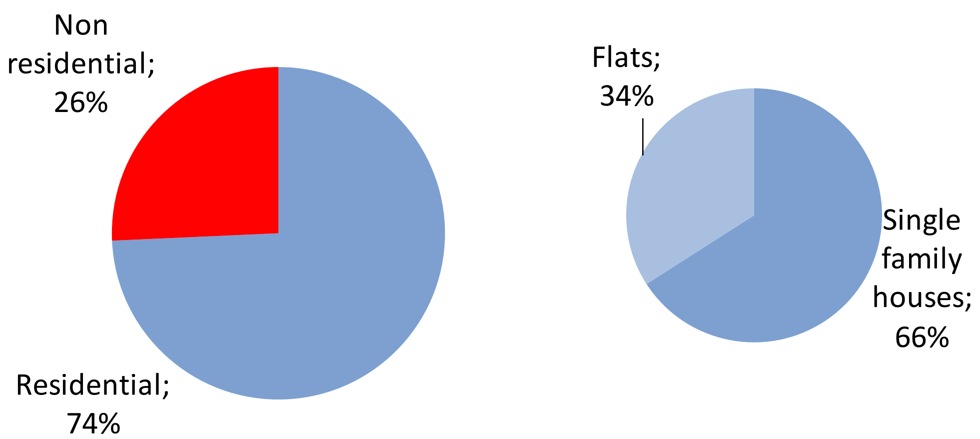
Figure 2: Energy consumption trends in buildings and GDP at EU level



Source: Eurostat

The total floor area of buildings is around 25 billion m^2 in the EU (2012), of which around ¾ in residential buildings. Single family houses represent two thirds of the residential floor space (**Figure 3**).

Figure 3: Floor area by type of building at the EU level (2012)



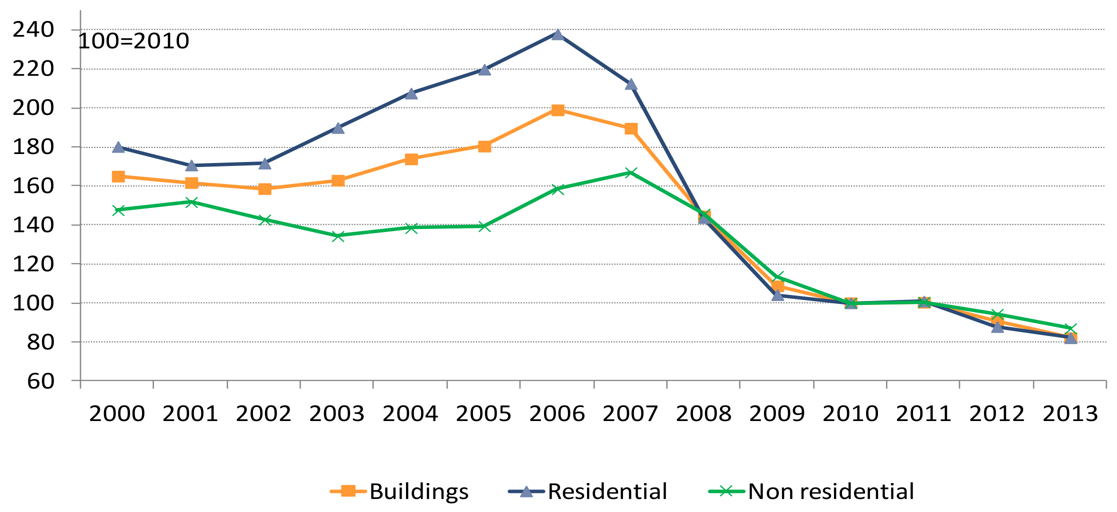
Source: ODYSSEE and estimates

Five countries (Germany, France, UK, Italy and Spain) account for approximately 2/3 of the total floor space of buildings. For non-residential buildings only, four countries (Germany, France, UK and the Netherlands) represent more than 60% of total floor area.

New construction, as monitored from the floor area with buildings permits[4], gives an indication of the impact of regulations on new buildings on energy use. It peaked in 2006 and has been decreasing since at the EU level; in 2013 it was 60% lower than in 2006 (**Figure 4**).

[4] A building permit is an authorization to start work on a building project, and as such is the final stage of authorization prior to start work. The building permits indices assess trends in construction activity.

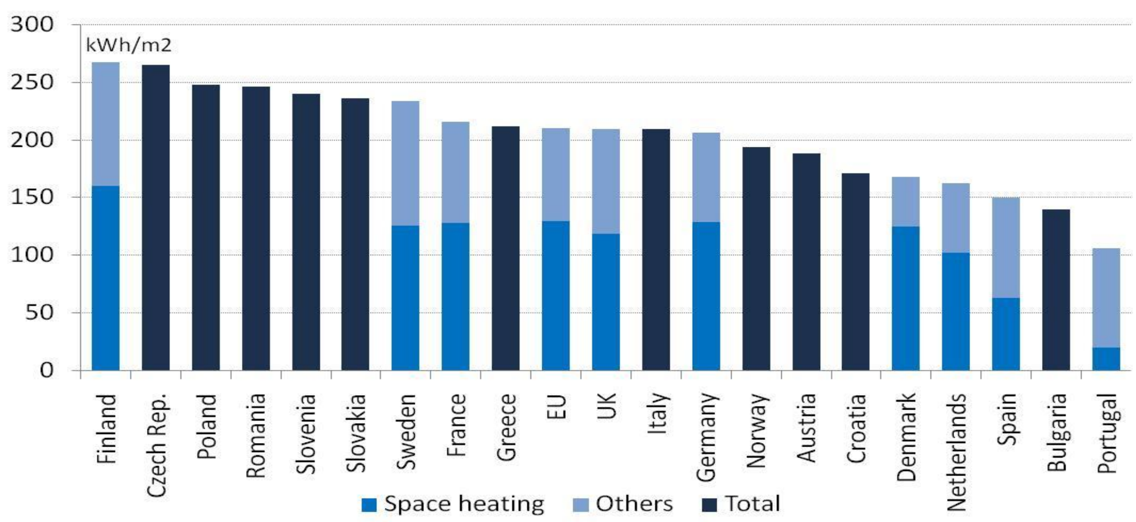
Figure 4: Trends in floor area of new buildings (indices)



Note: Useful floor area in m^2 based on building permits.
Source: Eurostat

At the EU level, the average annual specific consumption per m^2 for all types of buildings was around 210 kWh/m^2 in 2012 (**Figure 5**). Non-residential buildings are on average 55% more energy intensive than residential buildings (286 kWh/m^2 compared to 185 kWh/m^2). This specific consumption varies significantly among EU countries: for instance it is 80% lower in Bulgaria, Spain than in Finland. Such differences are partly explained by climatic conditions and statistical definitions[5].

Figure 5: Energy consumption in building (kWh/m^2) in 2012

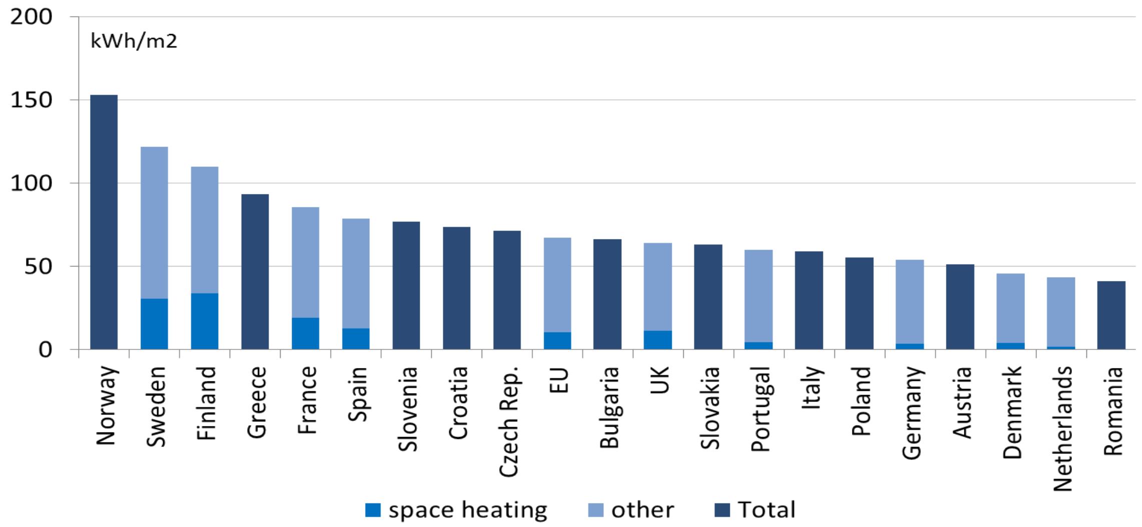


Source: ODYSSEE; consumption at normal climate

[5] For residential buildings, the floor area has been estimated by multiplying the number of dwellings by the average dwelling size. This does not usually include common areas in multi-family buildings, which can under-estimate the total floor area in cold countries with large number of multi-family dwellings with common heated areas (e.g. by 17% for the residential floor area in Finland, which overestimates the total specific consumption of buildings by around 12%).

The specific electricity consumption per m^2 varies significantly by countries (**Figure 6**). It is higher in the Nordic Countries (Norway, Sweden and Finland) and France, due the use of electricity for space heating (for instance, 32% for Finland, 25% for Sweden and 22% for France in contrast to only 9% for Denmark and 4% for the Netherlands in 2012). The high values for Greece and Spain are partly explained by space cooling.

Figure 6: Specific electricity consumption in buildings[6] (kWh/m^2) in 2012



Source: ODYSSEE

[6] For a selection of countries for which data are available on the floor area of residential and non-residential buildings.

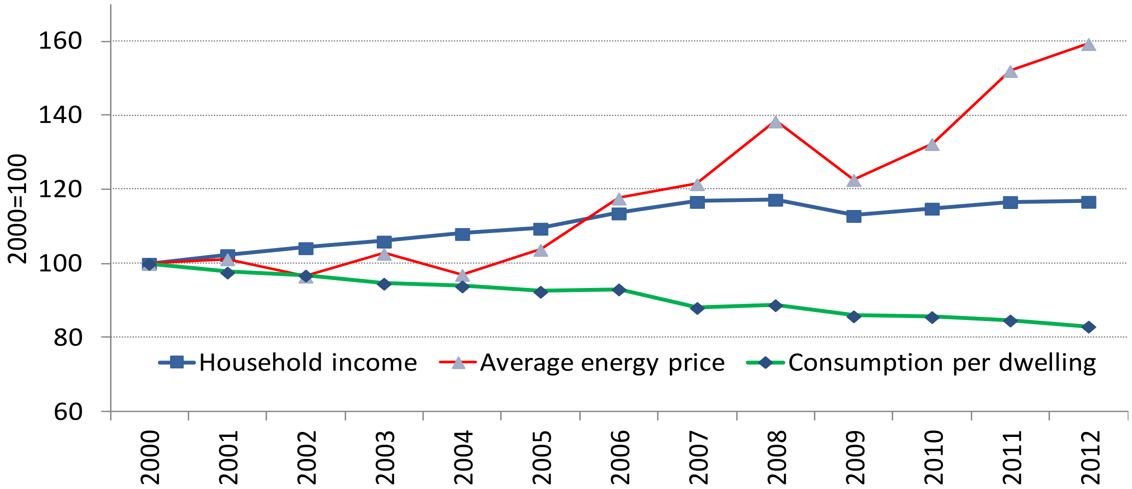
1.2. THE HOUSEHOLD SECTOR[7]

1.2.1. TRENDS IN ENERGY CONSUMPTION AND SAVINGS

Regular decrease in the energy consumption per dwelling

The household energy consumption per dwelling has been decreasing constantly at the EU level since 2000, at an average rate of 1.5%/year. This trend is explained by energy efficiency improvements driven by various types of policy measures and higher energy prices since 2004 (+64%) and, since 2008, by the recession (household income at the same level in 2012 as in 2008) (**Figure 7**).

Figure 7: Household consumption per dwelling, energy price and income (EU)[8]



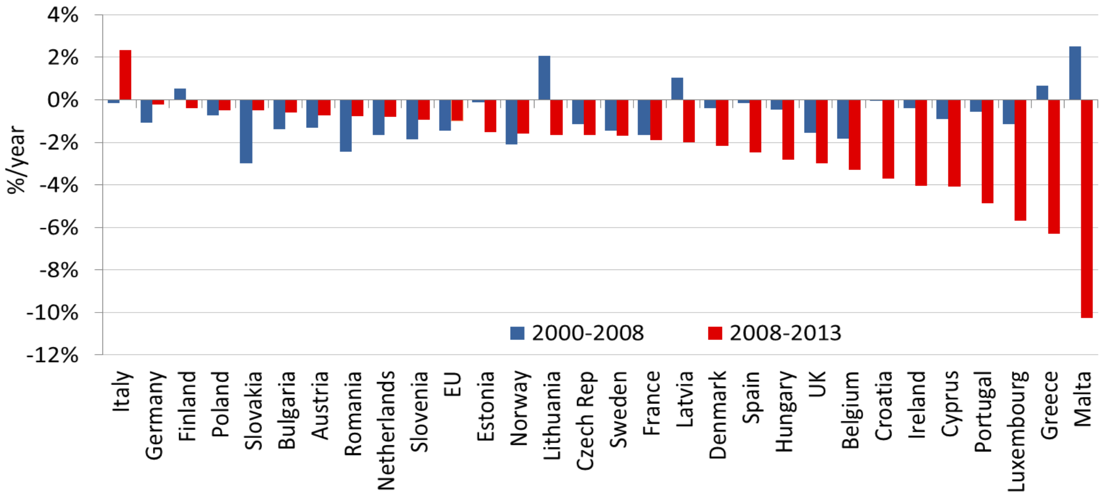
Source: ODYSSEE; consumption at normal climate

[7] All indicators on total energy use or on heating shown in the report are temperature corrected, i.e., at normal climate.

[8] Weighted average price of electricity, gas and heating oil.

The same decreasing trend in household energy consumption is observed in most EU countries, with a very strong reduction since 2008, by above 4%/year, in some countries (e.g. Ireland, Cyprus, Portugal, Luxembourg and Malta)[9] (**Figure 8**).

Figure 8: Trend in the household energy consumption per dwelling

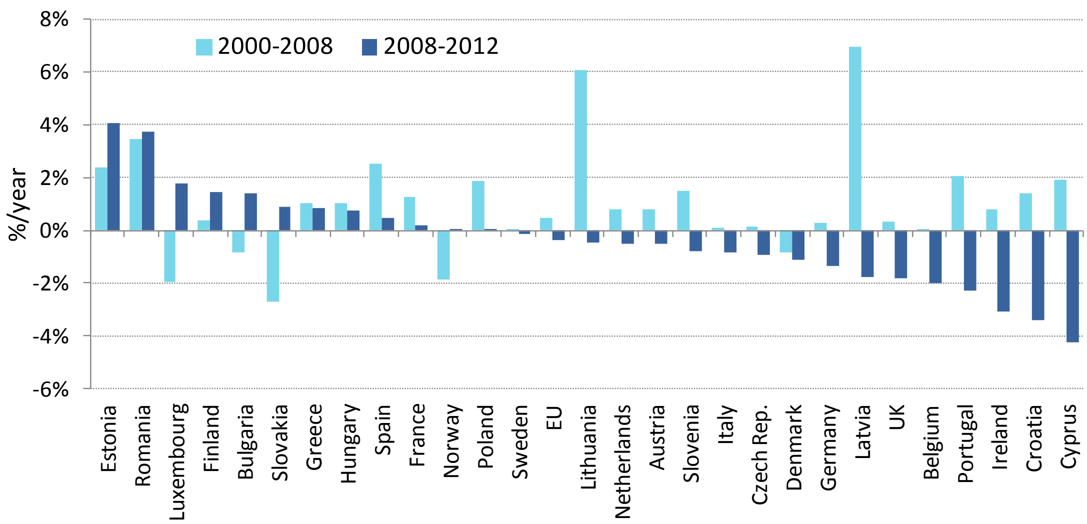


Source: ODYSSEE; consumption at normal climate

Since 2008, decrease of electricity consumption per household in many countries

Electricity consumption per household has decreased in 19 countries and at the EU level (-0.4%/year), with strong reduction in Cyprus, Croatia and Ireland (over 3%/year). In 10 countries, there has been a progression despite the recession, especially in some southern countries (Spain and Greece) due to air conditioning, as well as in Finland, Luxembourg, Romania, Bulgaria and Estonia (**Figure 9**).

Figure 9: Trends in electricity consumption per dwelling



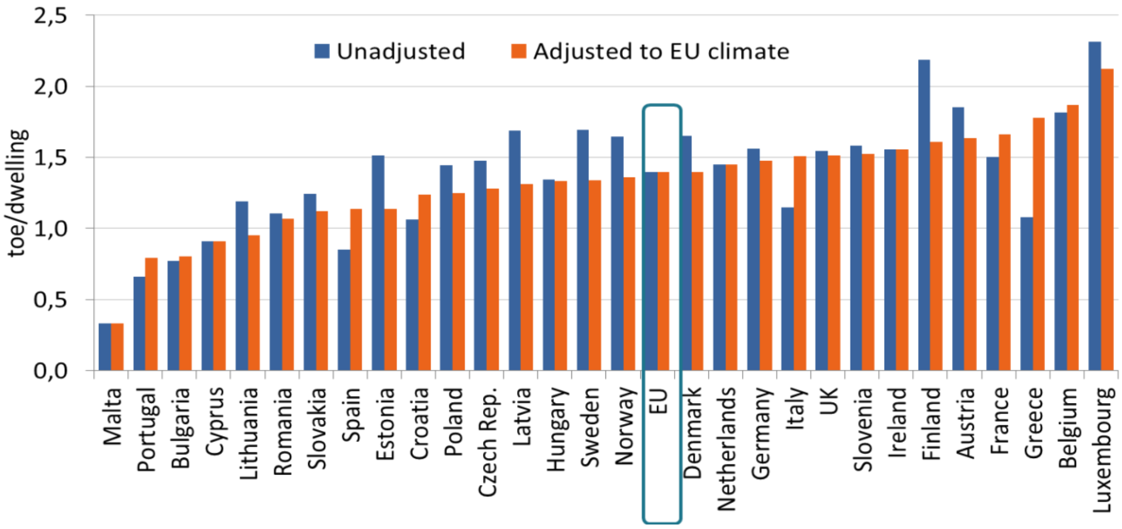
Source: ODYSSEE

[9] The increase in Italy is due to a revision of the biomass consumption in recent years.

Large differences in consumption per dwelling among countries

The comparison between countries is more relevant if the heating consumption is adjusted to the same climate. After adjustment to the EU average climate, Luxembourg and Belgium turn out to have the highest consumption, at around 2 toe/dwelling (i.e. 23 000 kWh), compared to 0.8 toe (9 300 kWh) in Portugal and Bulgaria and even 0.3 toe/dwelling (3 500 kWh) in Malta (**Figure 10**).

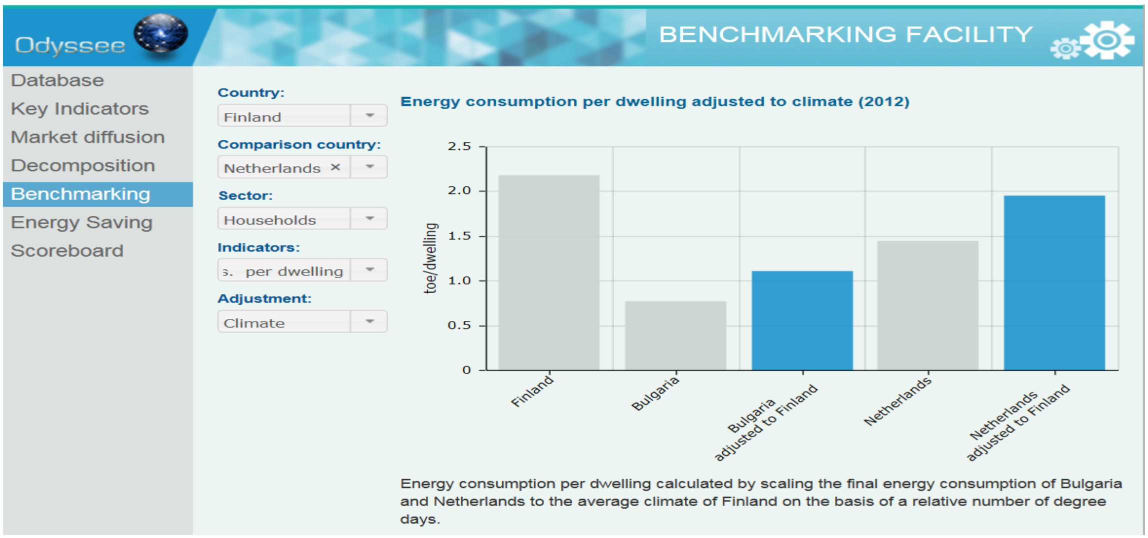
Figure 10: Household energy consumption per dwelling



Source: ODYSSEE; Malta and Cyprus no adjustment given their low number of degree days.

Benchmarking of countries should be made with comparable indicators

On the ODYSSEE web site there is available a benchmarking tool that enables to compare the specific energy consumption per household of a given country ("reference country") to selected other countries by adjusting these comparison countries to the characteristics of the reference country in terms of climate, dwelling size or fuel mix. In the example below, Finland is compared with Bulgaria and the Netherlands by adjusting these two countries to the climate of Finland, i.e. by applying the number of heating degree days of Finland to Bulgaria and the Netherlands.



Source: ODYSSEE benchmarking facility[10]

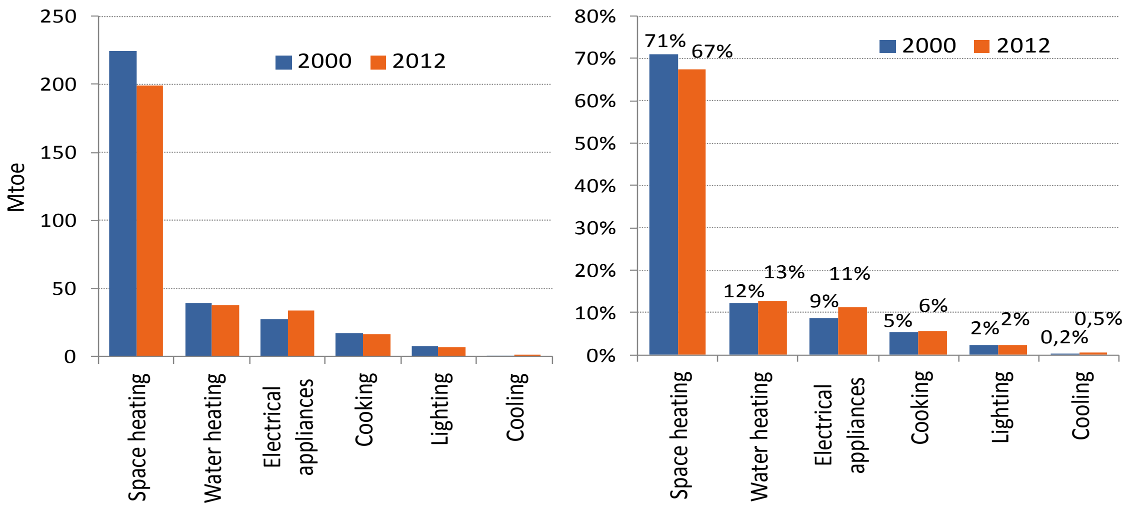
Decreasing share of space heating

Space heating is the most important end-use in the residential sector (67%), but its share has been slightly declining since 2000 (4 percentage points less than in 2000). Apart from the Mediterranean countries, the share of space heating is in a range of 60-80% of total energy consumption (**Figure 12**). In Malta, Cyprus and Portugal the share of space heating is below 30% and just below 50% in Spain. Water heating ranks second with a quite stable share (13%). Electrical appliances are having a greater importance: their share has increased from 9 to 11%. Cooking represents 6% of the total, lighting 2% and air conditioning only 0.5% (

[10] http://www.indicators.odyssee-mure.eu/benchmarking.html

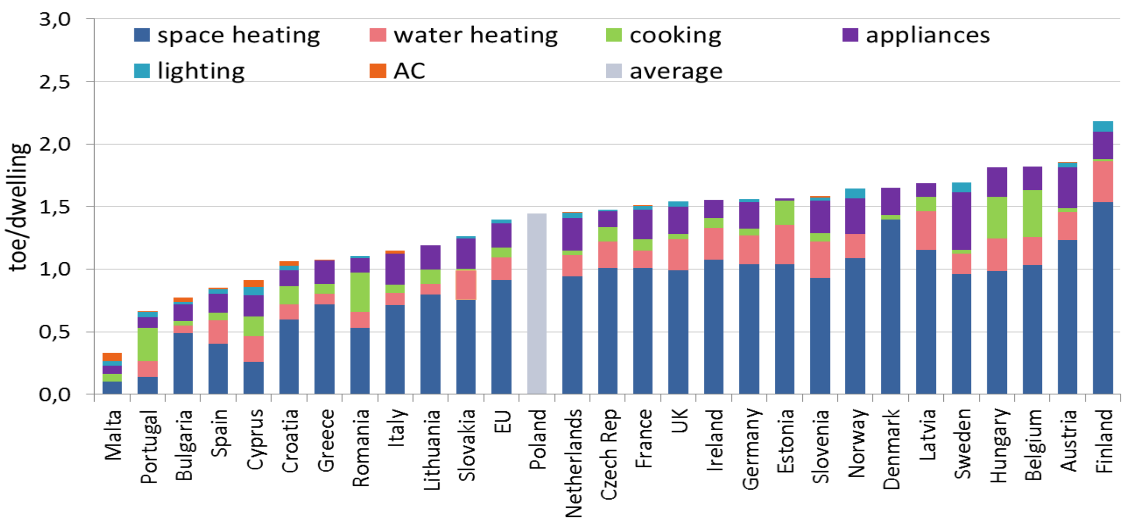
Figure 11).

Figure 11: Breakdown of household energy consumption by end-use in the EU



Source: ODYSSEE

Figure 12: Breakdown of household energy use by end-use (2012)[11]



Source: ODYSSEE

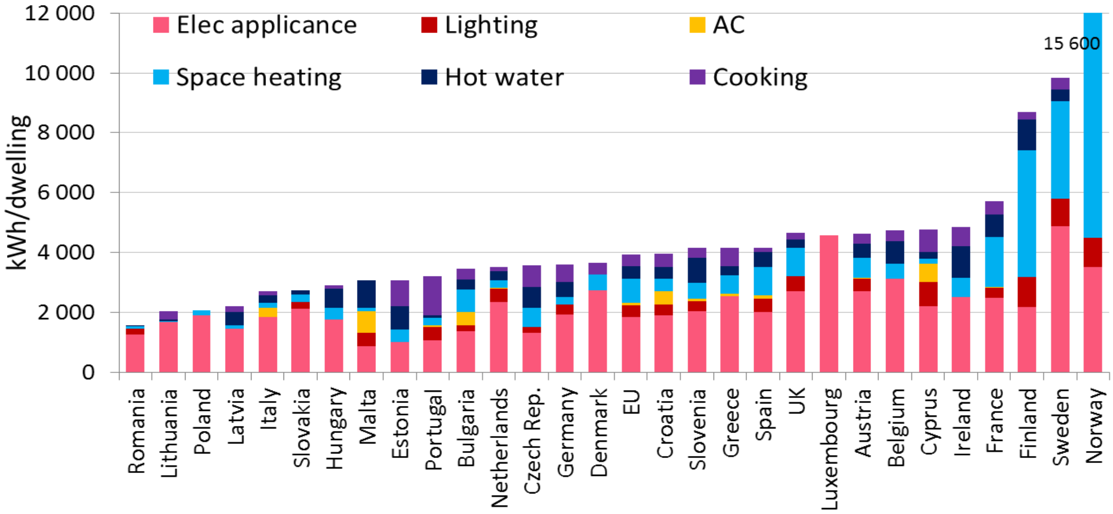
The highest share for electrical appliances and lighting is found in Sweden (about 32%), then in Malta, Cyprus, Spain, Netherlands, Italy and Slovakia with a share around 20%. In Baltic countries and Romania, the share of appliance is much lower than in the EU average (16% or below) due to a lower diffusion of appliances. Air conditioning still represents a marginal share of household consumption, except in Malta (almost 20%) and Bulgaria, Cyprus and Croatia (around 5%).

[11] Water heating is included in space heating in Denmark.

Large electricity consumption for some countries is due to space heating

The average electricity use of EU households is around 4000 kWh. The largest part, 2300 kWh (around 60%), concerns captive uses of electricity[12], i.e., electrical appliances[13], lighting and air conditioning. The consumption for captive uses varies significantly among countries, from around 1500 kWh for Romania and the Baltic countries to 3800 kWh for Cyprus, Malta, Sweden and Finland and even 4600 kWh in Norway.

Figure 13: Average electricity consumption per dwelling (2012)[14]



Source: ODYSSEE; consumption at normal climate for space heating

Thermal uses of electricity (space heating, cooking and water heating) are quite important in Norway, Finland, Estonia and the Czech Republic (over 60%), and to a lesser extent, in Portugal, France and Ireland (around 50%).

---

[12] Captive uses means end-uses for which only electricity is used; thus electricity uses are divided into two parts: thermal uses, where electricity compete with other fuels (space and water heating and cooking), and captive uses.

[13] Electrical appliances include cold and washing appliances, IT equipment (TV, PC, etc.) and all other small appliances.

[14] No data by end-use for Norway and Luxembourg.

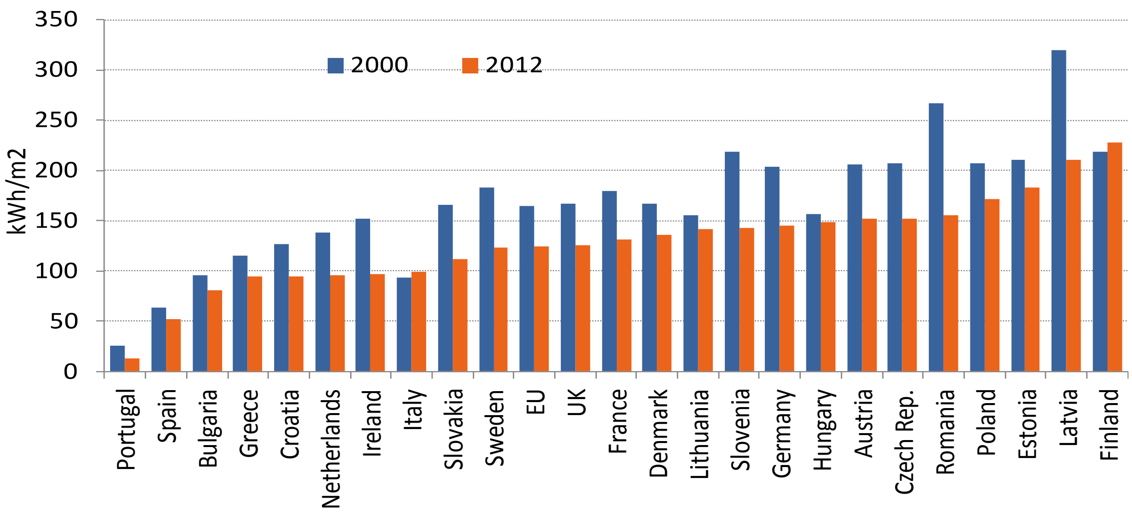
1.2.2. SPACE HEATING AND WATER HEATING

Steady improvement in space heating efficiency since 2000

The energy used per m^2 for space heating, which is the indicator used to assess energy efficiency trends for household heating, has decreased steadily in most countries since 2000; the rate of improvement reached around 2.3%/year at the EU level[15]. Some EU-15 countries, such as Sweden, the Netherlands and Germany, experienced a very strong reduction (around 3%/year), mainly explained by energy efficiency improvements. In Portugal, Ireland and some new member countries, such as in Romania, Slovenia, Latvia and Slovakia, the reduction was also very significant (over 3%/year) and was also triggered by behavioural savings linked to higher prices and lower income.

There exist significant disparities among EU countries from 60-90 kWh/m^2 in southern countries with lower heating needs (Malta, Spain, Bulgaria, Greece and Croatia) to 175-235 kWh/m^2 in colder countries such as Estonia, Latvia and Finland[16].

Figure 14: Energy use for space heating per m^2



Source: ODYSSEE

The low volume of construction limited the impact of standards on new dwellings

The reduction in the space heating consumption per m^2 is the result of several factors: the penetration of new dwellings, which are much more efficient than the average stock, the diffusion of more efficient heating appliances, the renovation of existing dwellings, and fuel substitution.

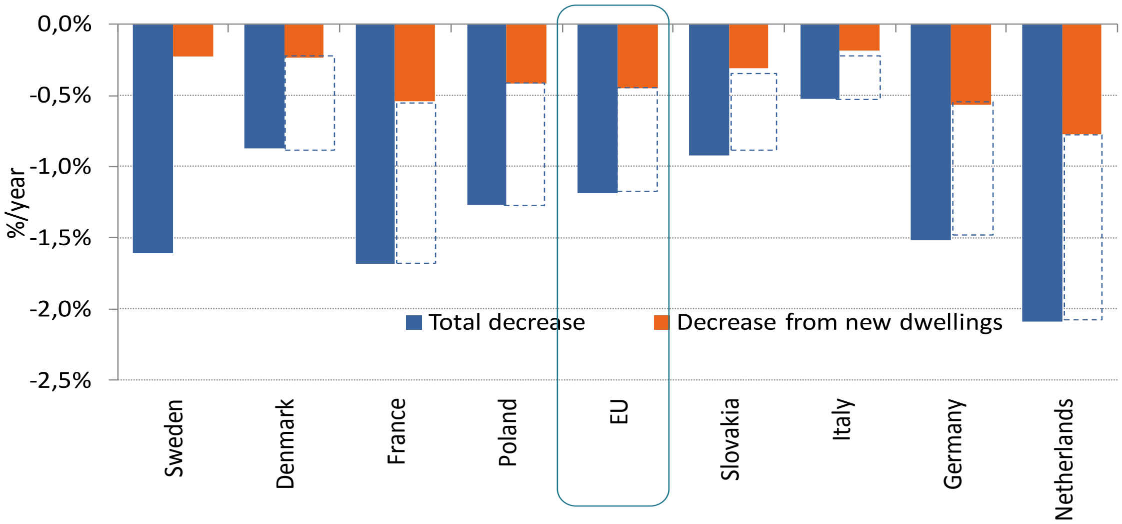
[15] Specific consumption per m² is more relevant to assess energy efficiency from a technical point of view than specific consumption per dwelling, as it is cleaned from the effect of change in the size of dwellings. If reducing the size of dwellings was considered as a measure to raise the energy efficiency in the household sector, the indicator per dwelling would be more adapted. However there is no real example of energy efficiency policies trying to limit the size of dwelling.

[16] By ODYSSEEE-definitions, the floor area corresponds to the average dwelling size. However, in some countries there is considerable amount of heated common areas in multi-family buildings. When this consumption is included in the heating consumption of the household sector, it overestimates the indicator (e.g. by 17% in Finland).

According to building regulations, new dwellings consume now in theory 40% less than dwellings built before 1990, on average at EU level[17]. The impact of new dwellings on the energy performance of the total stock is however still limited as the annual number of new dwellings built every year corresponds on average to 1.1% of the dwelling stock (average over 2000-2012). This ratio has even been decreasing since 2009 with the economic crisis. The annual construction of new dwellings has dropped to 0.8% of the dwelling stock at the EU level since 2009 and is even equal or below 0.5% in several countries (Baltic countries, Bulgaria, Denmark, Germany, Italy and Sweden). Dwellings built since 1990 now represent 23% of the total stock (2013).

The impact of regulations on new buildings on the decrease of the average energy consumption per dwelling over the period 1990-2012 varies according to the countries, depending on the number of building code upgrades, their stringency and the volume of construction. It is estimated to explain around 30 to 40% at the EU level as well as in France, Italy, Denmark, the Netherlands and Poland, but only 14% of the decrease in Sweden[18]. This modelling probably overestimates the impact of building regulations; indeed, it is well known, but not well quantified, that the actual specific consumption of new dwellings can be higher than this theoretical consumption because of non-compliance and rebound effects (i.e. the fact that in well insulated dwellings, occupants can afford to have a higher indoor temperature than in less insulated dwellings[19]).

Figure 15: Impact of building standards on heating consumption per m^2 (1990-2012)



Source: ODYSSEE

[17] Estimation is based on the relative performance by country of new buildings, taking into account the various updates in building regulations.

[18] Result of a modeling assuming a unit consumption of new dwellings as implied by the building codes.

[19] Room temperatures may, however, be lower in well insulated dwellings just because there is no sense of draft (better air tightness and well regulated ventilation).

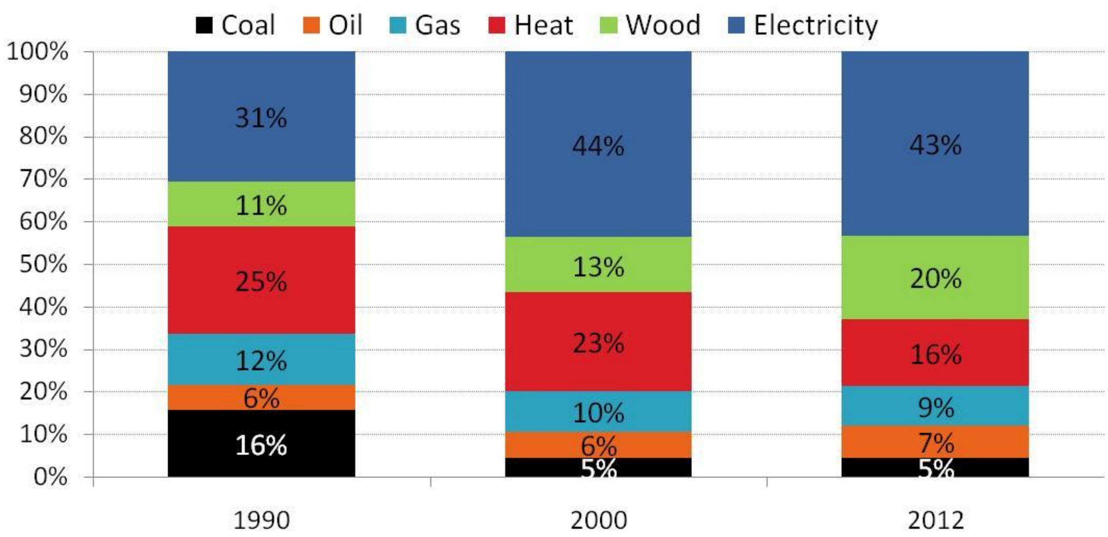
Heating systems are getting more efficient

The efficiency of heating appliances is increasing because of the replacement of old boilers with modern boilers and the penetration of more efficient heating systems, such as gas condensing boilers and heat pumps[20]. For condensing boilers the Netherlands have the highest penetration rate (above 70% of the dwelling stock), while UK has experienced a very large penetration from 3% in 2000 to 40% now. For heat pumps, Italy is the leading country (above 60%), followed by Sweden and Finland (around 20%) (see Chapter 6.1.1). The diffusion of pellet boilers or stoves instead of traditional wood heating systems also contributes to improve efficiency.

Fuel substitution contributed to energy savings in some countries

At the EU level, coal and oil for space heating have been replaced by electricity and to a lesser extent wood (-11 percentage points for coal and -9 points for oil between 2000 and 2012; +12 points for electricity, +9 points for wood). The gas market share remained roughly stable (9% in 2012) (**Figure 16**).The effect of these different substitutions on the specific energy consumption per m^2 was almost marginal as switches to more efficient fuels at end-use level (i.e. gas or electricity[21]) was balanced by an increasing share of biomass which reduce CO_2 emissions but decrease efficiency (**Figure 17**).

Figure 16: Household energy consumption for space heating by energy (EU)



Source: ODYSSEE

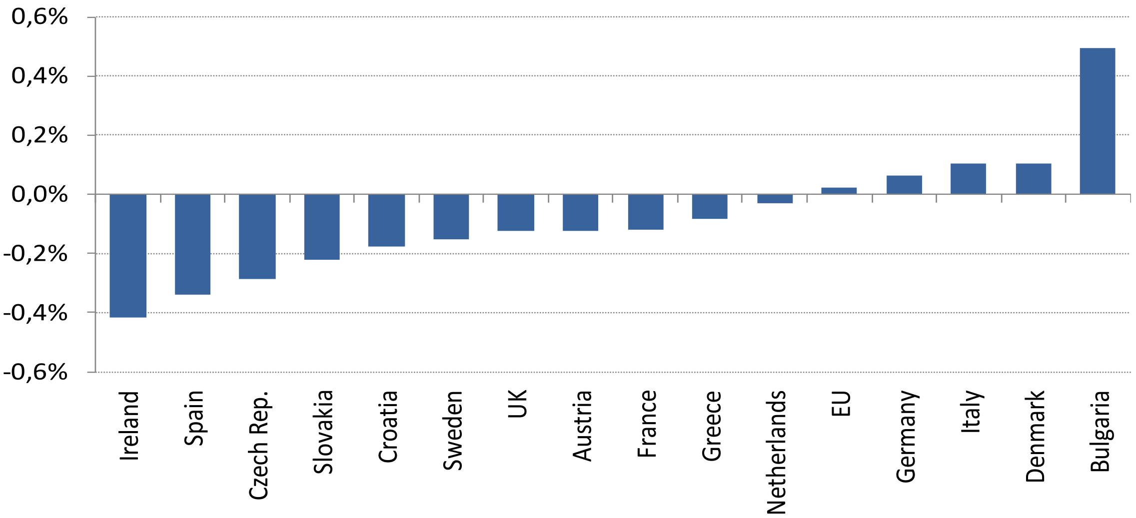
[20] Data on the penetration of efficient equipment are still scarce and only available for a few countries. Data are displayed in ODYSSEE market diffusion tool at http://www.indicators.odyssee-mure.eu/market-diffusion.html .

[21] At end –use level electricity is "efficient", as it is accounted for according to its calorific value. In terms of primary energy electricity is generally the least efficient fuel (unless produced dominantly from renewables, i.e. with 100% efficiency), as one has to take into account the losses in power generation.

In some countries, such as Ireland, Spain or the Czech Republic, solid fuels (i.e. peat, coal or biomass) have been replaced by more efficient fuels, such as oil and/or gas. As a result, this substitution contributed to efficiency improvements and reduced the specific consumption per m^2 by around 0.3-0.4%/year since 2000 (**Figure 17**).

In Bulgaria and Denmark, the share of wood has increased while the share of district heating has been reduced: in this case, fuel substitution resulted in increased consumption per m^2 (around 0.5%/year for Bulgaria).

Figure 17: Impact of fuel substitution on unit consumption trend (1990-2012)[22]



Source: ODYSSEE

The Netherlands: country with the best performance for heating

Comparison of heating energy use per m² should take into account country specificities in terms of climate and fuel mix. To do so, it is more meaningful to compare the consumption per degree-day (to account for differences in climate) in useful energy (to account for differences in fuel mix). To take into account the level of heating comfort, captured by the penetration of central heating[23], the comparison only makes sense for countries with similar levels of central heating penetration. The Netherlands turns out to be the country with the best performance among countries with a large diffusion of central heating: its specific useful space heating consumption per m² and degree-day is 40% lower than for France. Compared to another group of countries with similar levels of diffusion of central heating, namely Austria, Finland, Denmark, Ireland and Sweden, France is still 30% less efficient.

[22] The impact of fuel substitution on the energy use per m^2 was calculated as the difference in the annual variation of the final and useful energy use per m^2. The useful energy consumption is calculated by multiplying the final energy consumption of each fuel by its average energy efficiency. In order to harmonize countries' comparison, the same values of heating efficiencies are applied for all countries, based on data from the Danish Energy Authority (DEA).

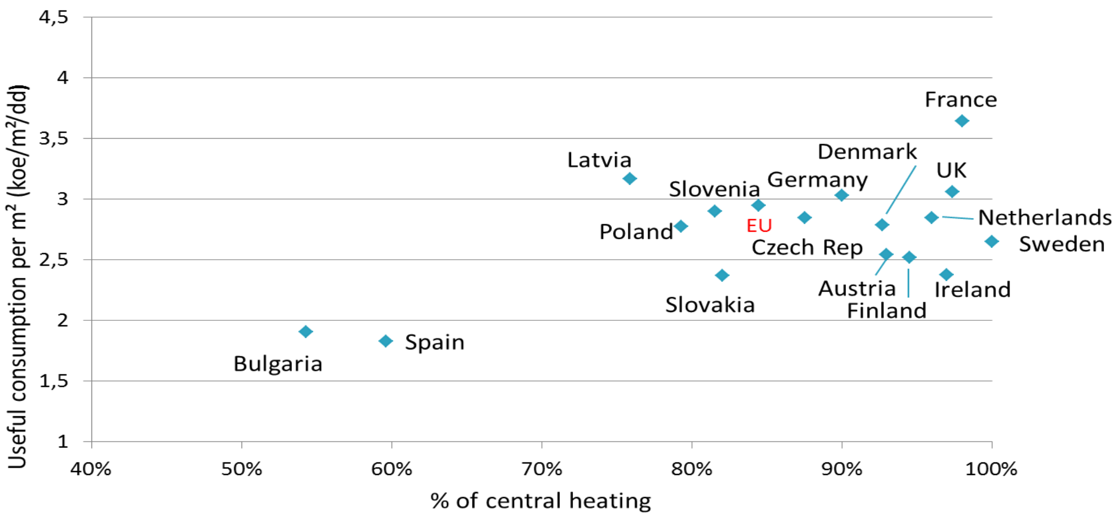
[23] Central heating includes all heating systems where all rooms are heated: it correspond to a higher comfort level than room heating where only the main room is heated by a stove or radiator. Countries with a low diffusion of central heating, such as Spain or Bulgaria, will have, all other things being equal, a level of consumption lower than countries with a high penetration of central heating, as the level of comfort is not the same.

Austria, Ireland, Finland and Sweden countries with the most efficient dwellings

If we take into account the diffusion of efficient heating systems (condensing boilers or heat pumps) and recalculate the useful energy taking into account the average actual efficiency for electric and gas heating, we get another benchmarking graph which shows the relative position of countries in terms of dwellings' efficiency, this time Austria, Ireland, Finland and Sweden turn out to be the most efficient dwellings. The good position of The Netherlands is mainly due to the very high penetration of condensing boilers (

Figure 18).

Figure 18: Energy use for space heating per m^2 and degree day (2012)[24]



Source: ODYSSEE

1.2.3. ELECTRICAL APPLIANCES

Rapid growth of the consumption of small appliances

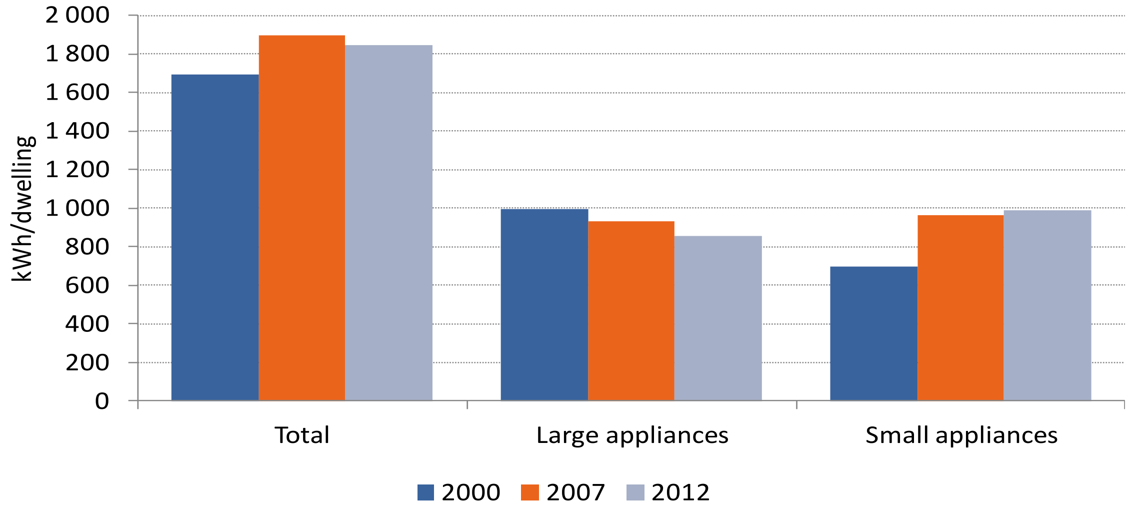
The average consumption of electrical appliances per dwelling has increased until 2007 and has been slightly decreasing since then, reaching around 1 850 kWh/dwelling in 2012. This trend is the result of two opposite trends: on the one hand, a regular decrease for large appliances[25] (- 1.3%/year since 2000) – driven partly by policies such as energy labelling and eco-design regulations - and a rapid

[24] Harmonised degree days from Eurostat.

[25] Large appliances include cold appliances (i.e. refrigerators and freezers), washing appliances (washing machines, dish washers and dryers) and TVs.

increase for small appliances until 2007 (by almost 5%/year), followed by a stabilisation since the economic crisis (**Figure 19**). As a result, in 2012, small appliances represent a higher share of the total consumption than large appliances (54% compared to 41% in 2000).

Figure 19: Consumption trend of electrical appliances



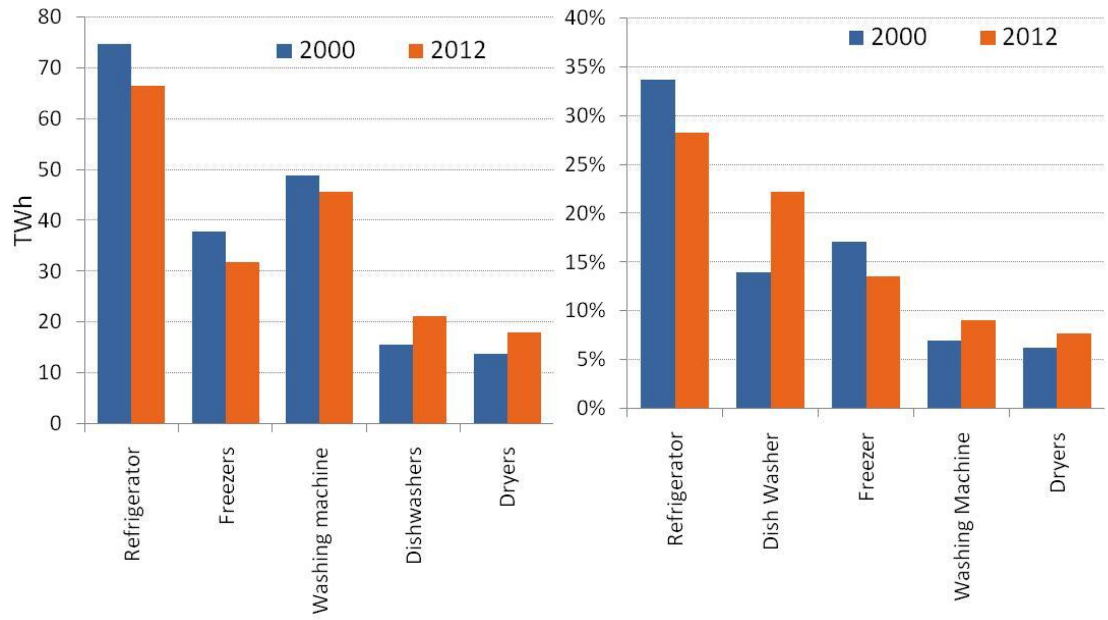
Source: ODYSSEE

Washing appliances drive the consumption of large appliances

Three large appliance groups, namely refrigerators, dish washers and freezers, represented almost 60% of electricity of the consumption of large appliances in 2012. Their electricity consumption has decreased by around 1%/year on average. On the other hand, the electricity consumption for dishwashers and dryers has increased due to higher penetration rates (**Figure 20**: Electricity consumption of large appliances

).

Figure 20: Electricity consumption of large appliances[26]



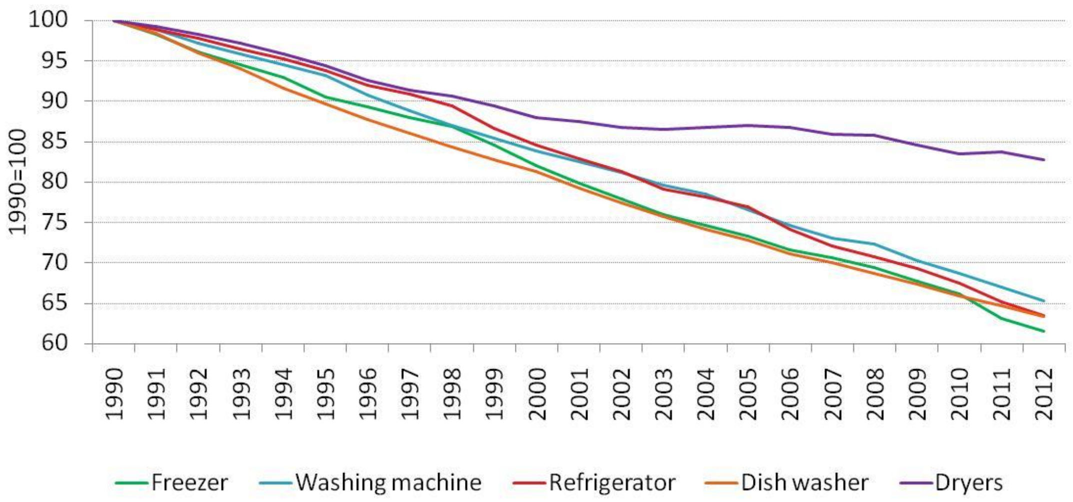
Source: ODYSSEE

[26] Index based on kWh/appliance, year.

More large appliances ... but more efficient

The specific consumption of large appliances (measured in kWh per appliance) has been decreasing steadily since 1990. Efficiency gains almost reached 35% for cold appliances (refrigerators and freezers), washing machines and dish washers); for dryers, gains are lower (around 15%) (**Figure 21**).

Figure 21: Change in specific consumption of large appliances

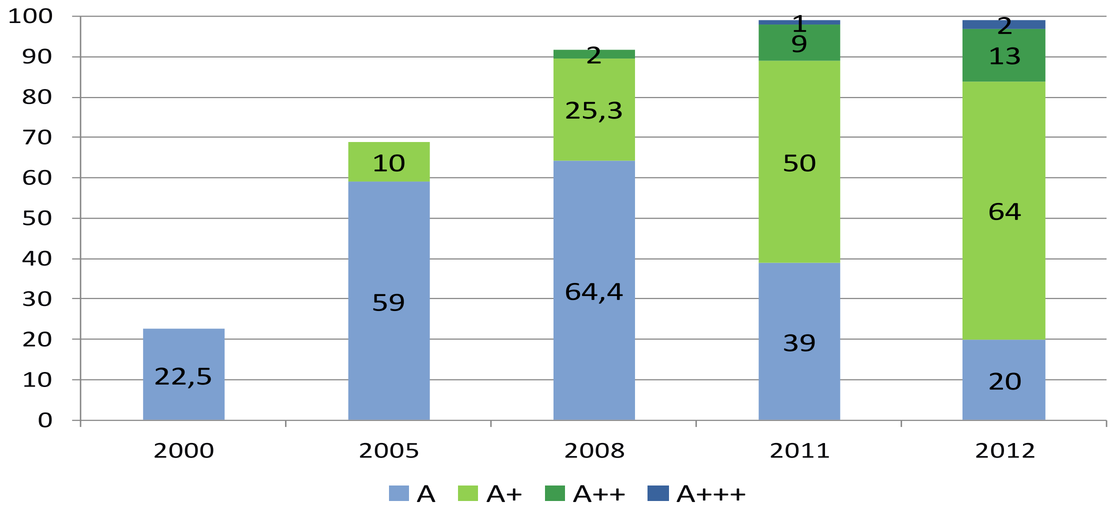


Source: ODYSSEE

The decreasing trend of the specific consumption of large appliances is linked to the diffusion of more efficient new appliances driven by labelling and eco-design regulations brought about by the respective directives described below.

The penetration of efficient appliances can be captured by the market share of the most efficient labels. For instance, on average, about 15% of new refrigerators sold in the EU in 2012 were in the highest efficiency classes (labels A++ or A+++) compared to only 2% in 2008 (**Figure 22**)[27].

Figure 22: Market share of label A, A+ and A++ for refrigerators (EU-15)



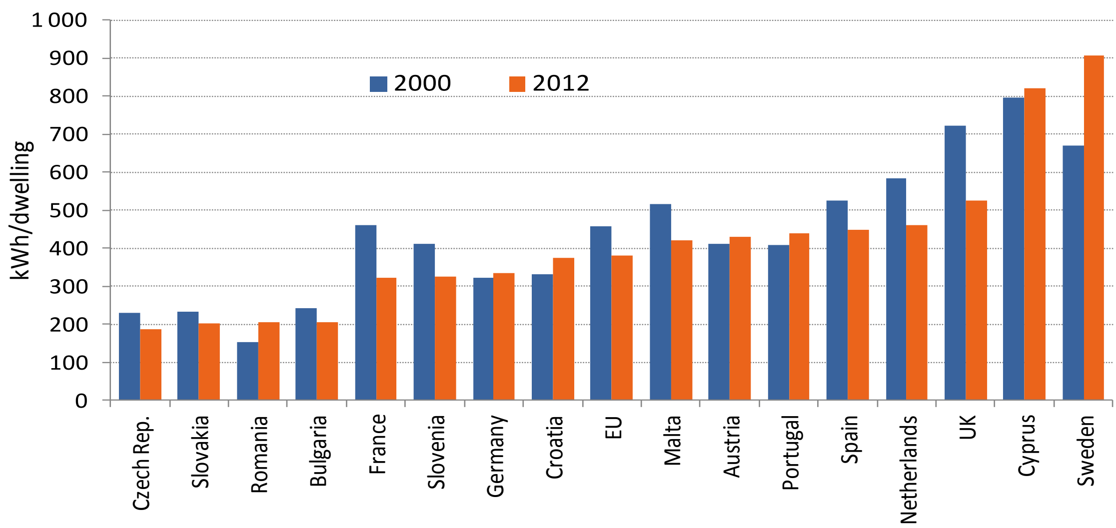
Source: ODYSSEE based on GfK, EEDAL

[27] An average A++ refrigerator consumes around 45% less than an A class; for energy class A+++ the saving is around 60%.

1.2.4. LIGHTING

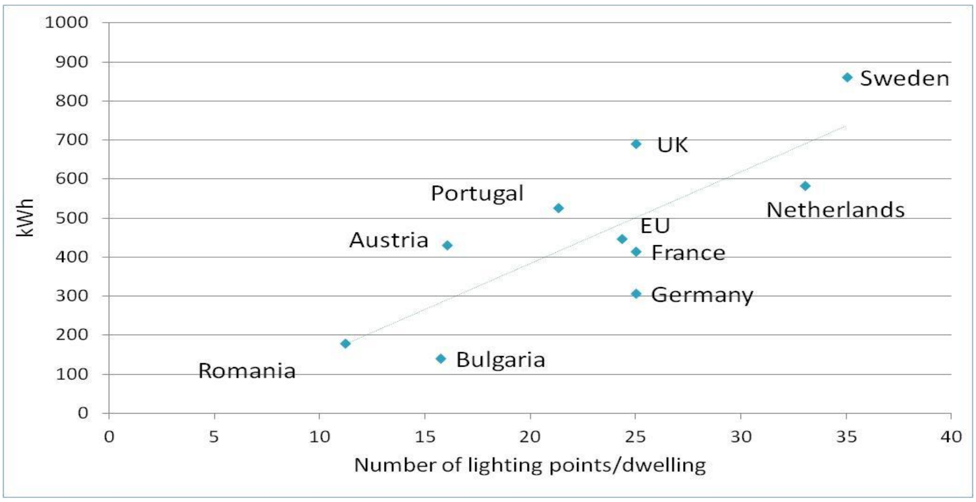
Consumption for lighting represented around 10% of total household electricity consumption in 2012 at EU level (12% in 2000). The specific consumption per dwelling for lighting has decreased since 2000 in half of the EU countries and at the EU level thanks to the diffusion of CFLs and LEDs (by 35% in Sweden, about 30% in France and UK, about 20% in the Netherlands and the Czech Republic, 17% at the EU level) (**Figure 23**). This trend will accelerate in the future with the phase out of incandescent lamps from the EU market[28]. The large differences between countries in the specific consumption for lighting are mainly explained by differences in the number of lighting points and annual usage hours: it varies from 200 kWh/year in the Czech Republic or Slovakia to 900 kWh/year in Sweden (**Figure 24**).

Figure 23: Electricity consumption per dwelling for lighting



Source: ODYSSEE

Figure 24: Electricity consumption per dwelling for lighting and lighting points



Source: Compiled by Enerdata from various sources (e.g. Remodece, JRC-Ispra)

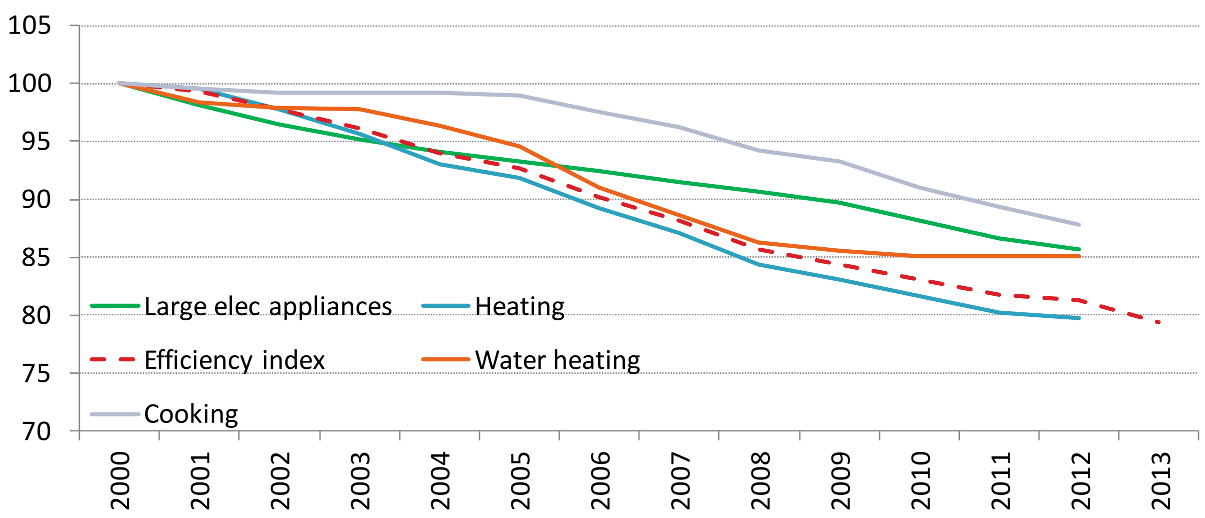
[28] Phase out started in 2009 for the largest lamps and concerned all incandescent lamps in September 2012.

1.2.5. ENERGY EFFICIENCY TRENDS IN THE HOUSEHOLD SECTOR

Household energy efficiency has improved by 18% at EU level since 2000

Energy efficiency for households, as measured with the energy efficiency index called ODEX, has improved by 21%, or 1.8%/year since 2000. Most improvements have been registered for space heating (20%), followed by water heating and large appliances (15%). This energy efficiency improvement is largely due to the deployment of more efficient new buildings, new heating appliances (e.g. high efficiency boilers and heat pumps) and new large electrical appliances (e.g. labels A+ to A++).

Figure 25: Energy efficiency trends for households at EU level based on ODEX[29]



Source: ODYSSEE

Slow-down of energy efficiency improvement for households since 2008

The pace of energy efficiency improvements has slowed down since the beginning of the economic crisis in most countries and at EU level: 1.5%/year on average at EU level since 2008, against 1.9%/year from 2000 to 2008. The energy efficiency improvement is above the target of 1%/year requested in the Energy Services Directive (ESD) over 2008-2016 for all final users, but in line with the new target of 1.5%/year additional savings included in Article 7 of the Energy Efficiency Directive[30]. More than half of the countries are above the ESD energy efficiency requirements.

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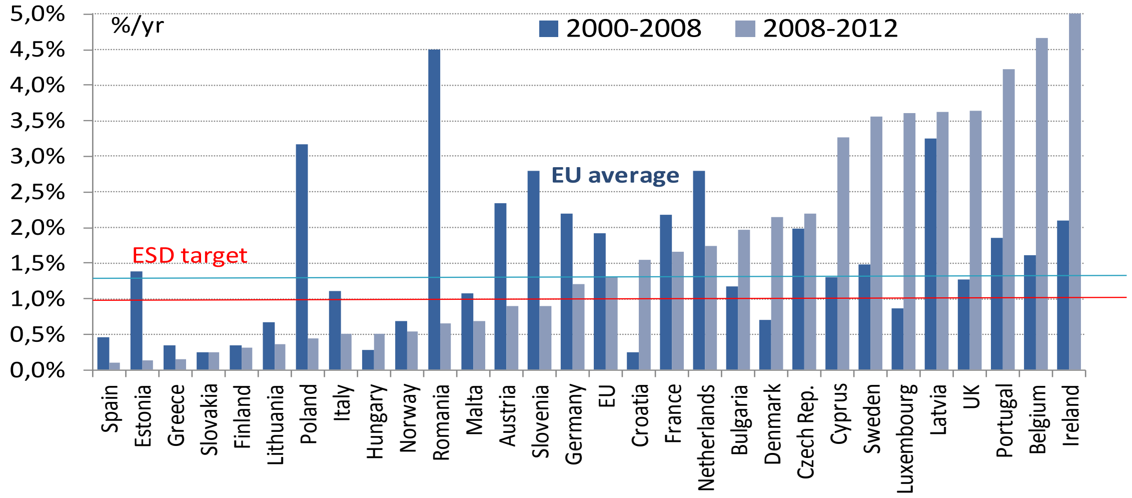
[29] ODEX is an index weighting the energy efficiency progress by end-use/appliance measured from changes in specific consumption measured in different units: heating (koe/m^2), water heating, cooking (toe/dwelling), refrigerators, freezers, washing machine, dishwashers and TVs (kWh/year).

[30] These targets and the trends given by ODEX are defined in different ways and cannot be fully compared; they are just given as indicative references.

Large improvements, twice higher than the EU average, can be seen in Cyprus, Sweden, Luxembourg, Latvia, UK, Portugal, Belgium and Ireland. In the case of Belgium and Ireland, it is worth recalling that their energy consumption per dwelling was the highest in Europe (**Figure 26**).

On the opposite, lower improvements are observed in southern countries[31] (Greece, Spain, Italy and Malta) because of the severe impact of the economic recession[32]. Most new Member States also do better than the EU average improvement.

Figure 26: Energy efficiency improvement by country based on ODEX



Source: ODYSSEE

[31] Low performances may be due to the fact that it is difficult to separate out for the indicators available changes in lifestyle that contribute to increase consumption from energy efficiency gains.

[32] For instance, for these countries, households' expenditure (measured in national accounts by the private consumption of households) has been reduced by 2.3%/year in Italy, 3.4%/year for Spain and 7%/year for Greece since 2008.

1.2.6. DRIVERS OF THE ENERGY CONSUMPTION TREND

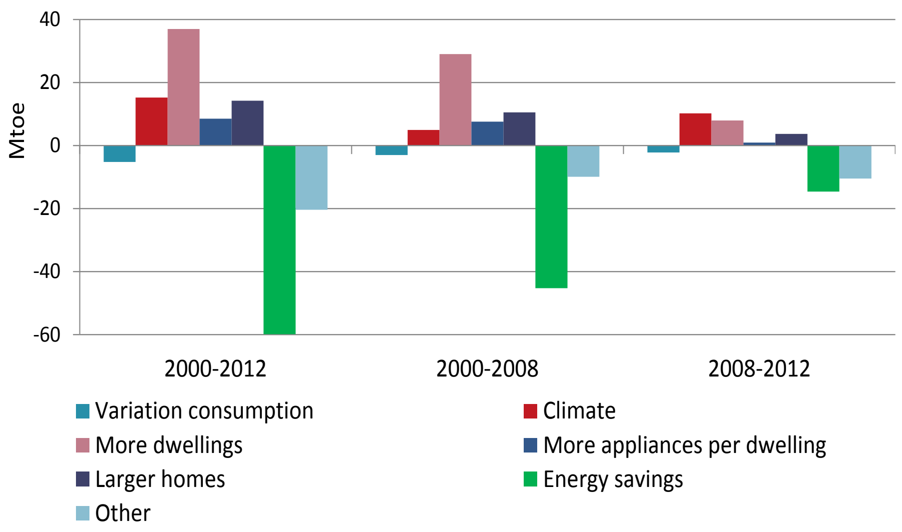
Two main factors contributed to increase the household energy consumption:

- Increasing number of dwelling due to population growth and the growing number of one person households in some countries;
- Growing comfort due to the increase in the number of household appliances and a move to larger homes.

These effects have contributed to increase the household energy consumption at the EU level by 75 Mtoe between 2000 and 2012, of which 52 Mtoe between 2000 and 2008. Since 2008, the impact of these effects was lower (equivalent to 23 Mtoe) (**Figure 27**).

On the other hand, energy savings, resulting from energy efficiency improvements in the various end-uses, contributed to decrease household energy consumption by 60 Mtoe between 2000 and 2012, i.e. by around 5 Mtoe/year. Without these savings the energy consumption of households would have been 60 Mtoe higher. The rhythm of savings has slowed down since the crisis for an average value of 5.7 Mtoe/year before 2008 to 3.6 Mtoe after 2008. In addition, changes in heating behaviour also had an impact on the energy consumption by reducing it by 20 Mtoe over the same period. This behavioural effect is mainly due to the combined effect of price increases and of the economic recession as consumers paid more attention to their heating expenses and have also reduced their level of comfort. Since 2008, the level of this behavioural effect has doubled since 2008, to 2.6 Mtoe/year compared to 1.2 Mtoe before.

Figure 27: Drivers of the energy consumption variations for households (EU)



Source: ODYSSEE decomposition tool (http://www.indicators.odyssee-mure.eu/decomposition.html); actual consumption

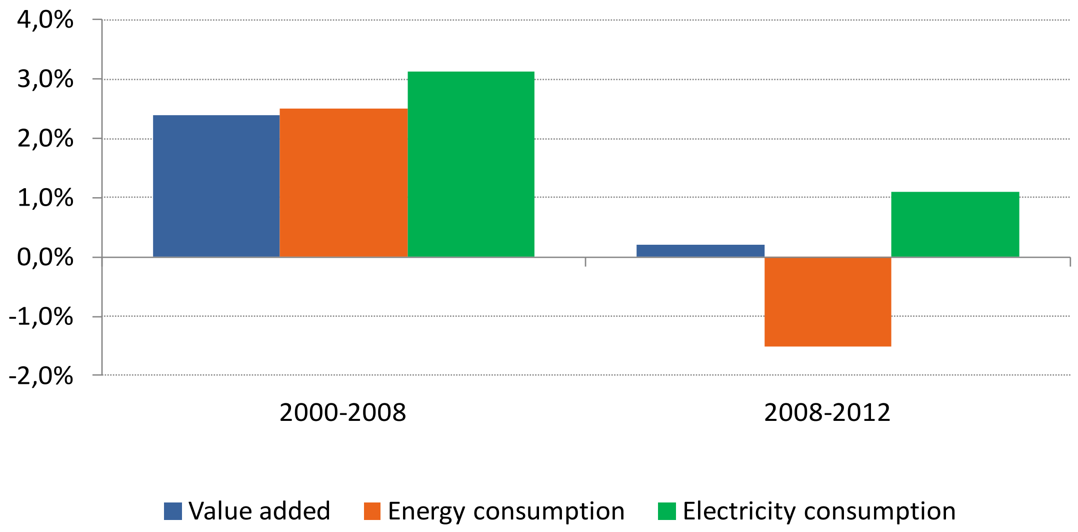
1.3. THE SERVICES SECTOR

1.3.1. ENERGY CONSUMPTION TREND AND PATTERN

The energy consumption of services (also called or tertiary sector) comprises the energy used in public and private buildings (e.g. public and private offices, shops, schools, hospitals). It also includes the energy used for public lighting.

Energy consumption in the tertiary sector increased rather rapidly until 2008, by 2.5%/year between 2000 and 2008 at the EU level; then it has been decreasing since the economic downturn, by 1.5%/year (**Figure 28**). Electricity consumption has continued growing since 2008 but at a slower pace (1.1%/year, against +3%/year from 2000 to 2008), despite a very limited value added growth.

Figure 28: Energy consumption trends and value added in services (EU)

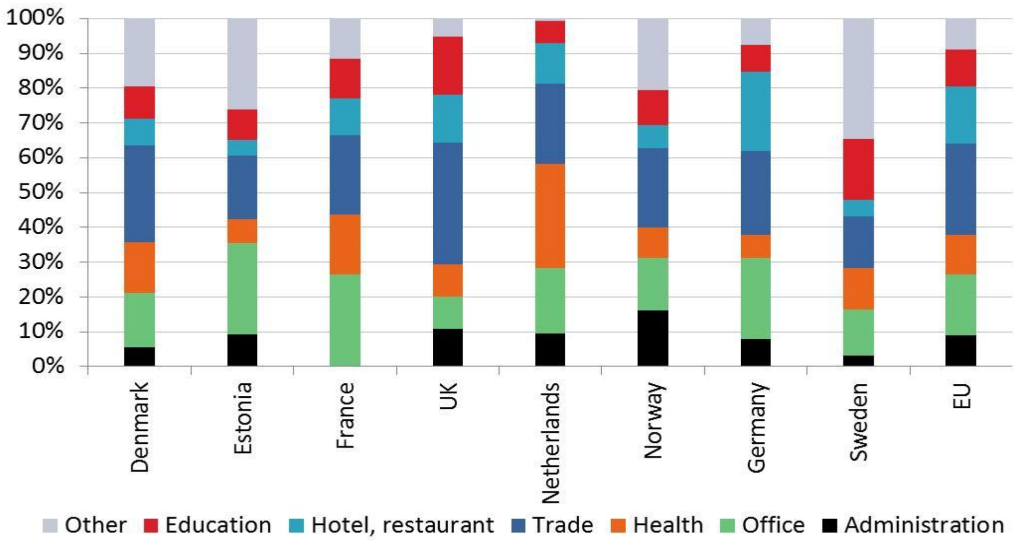


Source: ODYSSEE

More than half of the energy is consumed in the trade sector and offices

Data on energy consumption by sub-sector is available for a limited number of countries. The most important sub-sectors are the trade sector (wholesale and retail trade) and private and public offices, both contributing 26% of the total (**Figure 29**).

Figure 29: Energy consumption by subsector in services (2012)

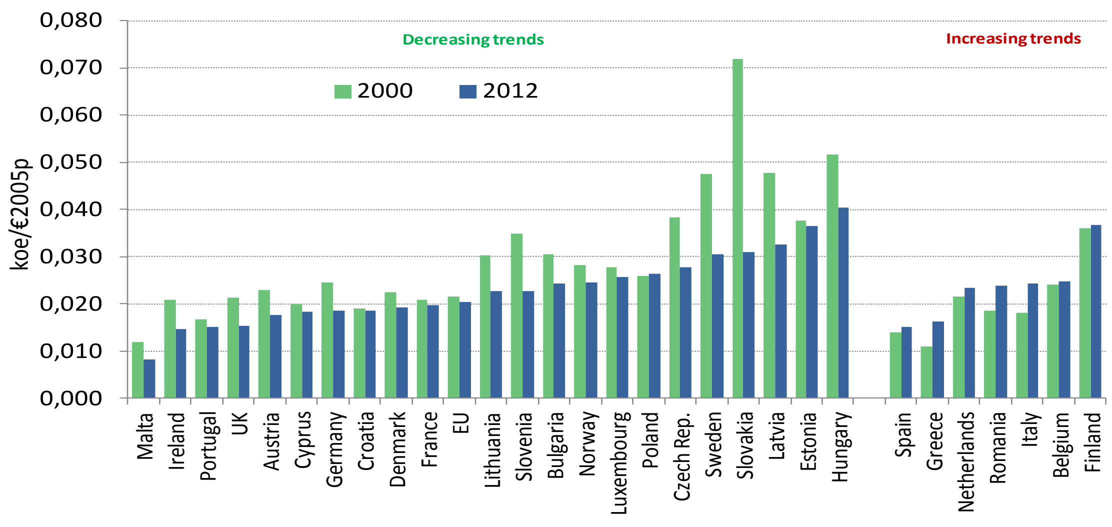


Source: ODYSSEE

Decrease in the energy intensity of services in most countries

The energy intensity, i.e. the ratio energy consumption to value added, has decreased in almost ¾ of the countries, with a larger reduction for countries with high intensity in 2000 (**Figure 30**). On the opposite, energy intensity has grown in Greece, Italy and Romania (by over 2%/year).

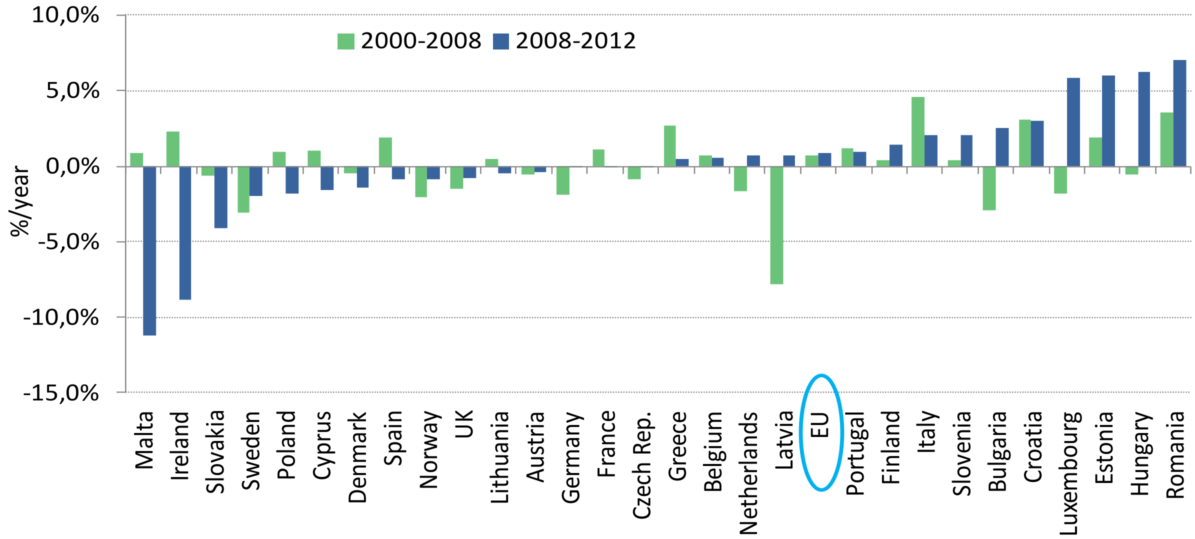
Figure 30: Energy intensity in services



Source: ODYSSEE

The electricity intensity, i.e. the electricity consumption per unit of value added, is clearly increasing in most countries, despite the economic recession because of the growing number of new appliances, such as IT devices, linked to the development of internet and of new telecommunication types, as well as a spread of air conditioning. At EU level, electricity intensity has increased by 0.9%/year since 2008. In about 10 countries electricity intensity is, however, decreasing (**Figure 31**).

Figure 31: Electricity intensity trends in services

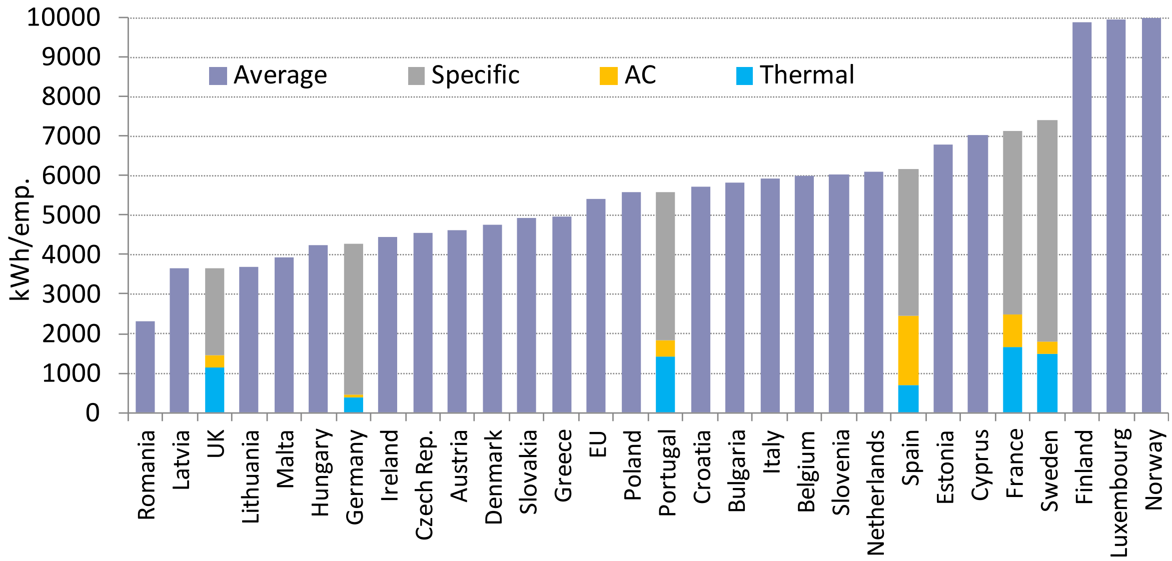


Source: ODYSSEE; space heating excluded

Large use of electricity for space heating in Nordic Countries

Norway, Sweden, Finland and Luxembourg use by far the largest amount of electricity per employee (more than twice the EU average); for Norway and Finland and, to a lesser extent, Sweden, it is has to do with electric heating (**Figure 32**). For the other countries, electricity consumption per employee is much more homogeneous than fuel consumption per employee: most countries use between 4000 and 7000 kWh per employee. Electricity consumption per employee is increasing in most countries. Large increases can be observed for all southern countries, because of the penetration of air conditioning. The high growth for East European countries is linked to their fast economic growth. This indicator is also influenced by the number of employees to provide services that tend to reduce rapidly everywhere and faster in some countries than in others.

Figure 32: Electricity consumption per employee in services by end use (2012)



Source: ODYSSEE

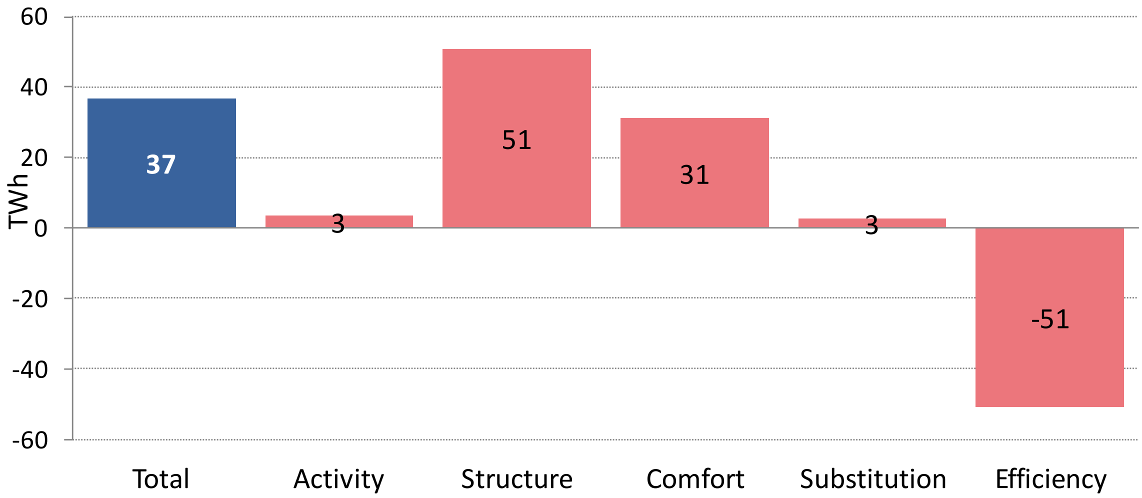
1.3.2. DRIVERS BEHIND CHANGES IN ELECTRICITY CONSUMPTION

Structural changes also contribute to change in energy use

Changes in electricity consumption in the service sector can be decomposed into various explanatory factors: growth in value added ("activity effect"), shift between subsectors with different electricity intensities ("structural changes"), increase in comfort and labour productivity, substitution between energies and energy efficiency gains. In the service sector, as in industry, some subsectors are more energy intensive than others, e.g. data centres, food retail are more electricity-intensive than schools (only used for a limited part of the year and day). If activities in these electricity-intensive subsectors grow faster than in the other subsectors it will increase total electricity consumption of services.

At the EU level, the increase of electricity consumption between 2008 and 2012 (+37 TWh) is mainly due to structural changes (51 TWh), and to a lesser extent, to increased comfort and productivity increases due to the diffusion of ICT[33] and air conditioning (31 TWh) (**Figure 33**). On the opposite, energy savings (-51 TWh) contributed to reduce growth in electricity consumption.

Figure 33: Decomposition of electricity use for services (2008-2012)



Source: Enerdata calculation based on ODYSSEE data

[33] Increased ICT can increase the energy consumption of an individual office or service but in the society as a whole this is reducing energy consumption by lesser mobility needs and more efficient use of space.

2. EU POLICIES IN THE HOUSEHOLD AND TERTIARY SECTORS

2.1. OVERVIEW OF THE EU POLICIES AND MEASURES

The 2030 Communications published by the European Commission in July 2014 underpin the key role of the building sector. The Commission is quite positive about the development towards 2020 stating that "Current forecasts imply that the current 2020 target for energy efficiency is on the way to being achieved. The Commission does not intend to propose new measures but calls on the Member States to step up their current efforts to ensure collective delivery of the 2020 target." (European Commission 2014a)

This Chapter discusses European energy efficiency measures[34].

Apart from sectoral measures there are directives with a broader scope, such as the Energy Efficiency Directive (2012), which stipulates the submission of National Energy Efficiency Action Plans (NEEAPs) by Member States, and requests to set a new energy saving target in its Article 7. The following directives are discussed in more detail in Chapters 3.2-3.7:

- The Energy Efficiency Directive
- Energy Efficiency in Buildings Directive
- Energy Labelling Directive
- Eco-design Directive
- Directive on Minimum Levels of Energy Taxation
- Renewable Energy Directive

2.2. ENERGY EFFICIENCY DIRECTIVE

2.2.1. THE DIRECTIVE

The Energy Efficiency Directive 2012/27/EU (EED) repealed both the Energy Services Directive (2006/32/EC) and the CHP Directive (2004/8/EC) on 4 December 2012. The EED establishes a common framework of measures for the promotion of energy efficiency within the Union in order to ensure the achievement of the 2020 20% target on energy efficiency and to pave the way for further energy efficiency improvements beyond that date. The energy efficiency target is that the Union's energy consumption should not exceed 1 474 Mtoe primary energy consumption or 1 078 Mtoe of final energy consumption in 2020. With the accession of Croatia the target was revised to 1 483 Mtoe primary energy consumption or 1 086 Mtoe of final energy consumption.

The EED addresses households and the services sector in several different ways and new measures are introduced. It gives the public sector an exemplary role and calls for an increased information of households (**Box 3.1**). In particular, consumers will have access to data on real-time and historical energy consumption through more accurate individual metering which will empower consumers to better manage their energy consumption.

[34] The MURE database includes both European measures (e.g. Directives) as well as national measures.

BOX 3.1: PROVISIONS FOR THE HOUSEHOLD AND TERTIARY SECTORS IN THE ENERGY EFFICIENCY DIRECTIVE

Building renovation

- Member States shall establish a long-term strategy for mobilising investment in the renovation of the national stock of residential and commercial buildings, both public and private. (Article 4) This strategy shall encompass:
  - an overview of the national building stock based, as appropriate, on statistical sampling;
  - identification of cost-effective approaches to renovations relevant to the building type and climatic zone;
  - policies and measures to stimulate cost-effective deep renovations of buildings, including staged deep renovations;
  - a forward-looking perspective to guide investment decisions of individuals, the construction industry and financial institutions;
  - an evidence-based estimate of expected energy savings and wider benefits.

Households

- Member States shall ensure that information on available energy efficiency mechanisms and financial and legal frameworks is transparent and widely disseminated to all relevant market actors, such as consumers, builders, architects, engineers, environmental and energy auditors, and installers of building elements as defined in Directive 2010/31/EU. (Article 17)
- Member States shall establish appropriate conditions for market operators to provide adequate and targeted information and advice to energy consumers on energy efficiency. (Article 17)
- Member States shall, with the participation of stakeholders, including local and regional authorities, promote suitable information, awareness-raising and training initiatives to inform citizens of the benefits and practicalities of taking energy efficiency improvement measures. (Article 17)

Public sector

- Member States shall ensure that, from 1 January 2014, 3% of the total floor area of heated and/or cooled buildings owned and occupied by its central government is renovated each year to meet at least the minimum energy performance requirements set by Directive 2010/31/EU. (Article 5)
- Member States shall ensure that central governments purchase only products, services and buildings with high energy-efficiency performance, insofar as that it is consistent with cost-effectiveness, economical feasibility, wider sustainability, technical suitability, as well as sufficient competition. (Article 6)
- Member States shall encourage public bodies, including regional and local levels to follow the exemplary role of their central governments to purchase only products, services and buildings with high energy-efficiency performance. (Article 6)
- Member States shall encourage public bodies, when tendering service contracts with significant energy content, to assess the possibility of concluding long- term energy performance contracts that provide long-term energy savings. (Article 6)

Cross-cutting with relevance to the household and tertiary sectors

- Member States shall evaluate and if necessary take appropriate measures to remove regulatory and non-regulatory barriers to energy efficiency (Article 19) and promote and support the energy services market (Article 18).
- Customers for electricity, natural gas, district heating, district cooling and hot water should have a meter that accurately reflects their individual energy consumption, they should also be billed for the energy they used and be able to compare energy deals on a like-for-like basis.
- Member States should ensure that national energy regulatory authorities are able to ensure that network tariffs and regulations incentivise improvements in energy efficiency and support dynamic pricing for demand response measures by final customers.

Source: European Commission 2012

2.2.2. NATIONAL ENERGY EFFICIENCY ACTION PLANS

The Member States submitted their third National Energy Efficiency Action Plans (NEEAPs) to the Commission in April 2014. Energy efficiency measures included in the NEEAPs have been updated into the MURE database. The database contains 387 measures (208 in the residential and 179 in the tertiary sector) included in the third NEEAPs. The database also contains altogether 583 measures (322 in the residential and 261 in the tertiary sector) reported in NEEAP-1 (2008) and NEEAP-2 (2011). The new features added to the MURE database during the ongoing project phase facilitate easy measure summaries by NEEAP and for EED Article 7.

Table 1: MURE measures according to NEEAP and for EED Article 7 implementation

	Households	Tertiary
NEEAP-1	119	91
NEEAP-2	203	170
NEEAP-3	208	179
EED Article 7 notification	97	84

Source: MURE database, as of 4 May 2015.

In January 2014 the European Commission published an analysis of the second National Energy Efficiency Action Plans (NEEAP-2) submitted to the Commission in June 2011. The analysis concludes that “in practice implementation of the ESD has resulted, above all, in measures targeting energy end use, for example, programmes to refurbish and renovate buildings”. The NEEAP-2s also suggests that the 9% indicative target for 2016 will be comfortably exceeded by most Member States. Furthermore, the overall evolution of electricity production from high efficiency cogeneration shows a moderate increase primarily due to the increase in district heating in buildings[35]. (European Commission 2014b)

[35] Cogeneration can only be efficient if there is adequate heat load, e.g. from district heating. The higher the heat load, the more electricity can be produced by co-generation.

In the MURE database there are two features for reporting the impact of measures. One reporting tool is a semi-quantitative labelling of measures to low, medium and high impact measures[36]. The other reporting tool is more detailed reporting of *ex post* (past) and *ex ante* (future) energy savings and/or CO_2 emission reductions. In the household sector impact assessments have been inserted for 222 measures and in the tertiary sector for 189 measures. In addition there is a new Interaction Facility (see **Box 5.1**) which helps to analyse the aggregate impact of policy packages in different countries.

2.2.3. ARTICLE 4 ON BUILDING RENOVATION STRATEGIES

According to Article 4 Member States shall establish a long-term strategy for mobilising investment in the renovation of the national stock of residential and commercial buildings, both public and private. The first version of the strategy was to be published by 30 April 2014 and updated every three years thereafter. Only half a dozen or so Member States met the official deadline and as of January 2015, six Member States have not yet published their strategies.

These strategies are part of their NEEAPs. They:

- provide an overview of the country's national building stock
- identify key policies that the country intends to use to stimulate renovations
- provide an estimate of the expected energy savings that will result from renovations

Article 4 complements other requirements within EU legislation concerning the renovation of buildings. In line with Article 9 of the Energy Performance of Buildings Directive (EPBD), Member States must develop policies and measures to stimulate the transformation of buildings that are refurbished into nearly zero energy buildings (nZEB) (see Chapter 3.3.1). In addition, Article 5 EED sets a 3% annual renovation target for buildings owned and occupied by central government (see Chapter 5.2.2).

The Buildings Performance Institute Europe (BPIE) published a review of the implementation status of Article 4 in November 2014 (BPIE 2014). It included a detailed appraisal of 10 Member State strategies, namely Austria, Brussels Capital Region (Belgium), Czech Republic, Denmark, France, Germany, the Netherlands, Romania, Spain and United Kingdom. Since in-depth analysis of the national strategies was not possible in the scope of this brochure, the following overview of the strategies is based on the BPIE review.

While the BPIE (2014) review found commendable features in most reviewed strategies, the overall conclusions were critical: “In summary, the strategies do not set a clear, strategic path for the renovation of national building stocks. There was a lack of bold, determined action on the part of Member States that could be expected to lead to a significant upturn in renovation activity. Whilst a number of Member States mentioned their long-term goals such as greenhouse gas reduction or switching to renewable energy supplies, their strategies did not set out how the building sector would contribute to that goal. Indeed, none of the strategies looked at policy or market requirements in the medium to long-term. Rather, the focus was very much on near term actions.”

[36] High impact = savings over 0.5% of sectorial consumption; medium 0.1% - 0.5%; low = under 0.1%.

The review chose best practice examples for each of the articles requirements. The UK strategy was commendable for its overview of national building stock. The cost-effective approaches to renovations were the best in the strategy of the Brussels Capital Region. The Danish strategy had strongest policies to stimulate deep renovation. The Spanish strategy was applauded for its forward-looking investment perspective. A unique feature of the Romanian strategy is that it has sought to quantify the wider benefits of building renovation. (BPIE 2014)

The BPIE review summarises some differences in the approach in the reviewed countries:

- Germany expects the majority of savings to 2020 to be achieved through the Energy Saving Ordinance, with most of the rest from the various KfW schemes.
- Romania, Czech Republic and Denmark have all presented a holistic approach with 15 or more individual measures. Denmark's approach is the most persuasive, with clear commitments to action for each of the 21 identified action areas.
- The French strategy is noteworthy by virtue of the Presidential level commitment in two areas. For the residential sector, François Hollande announced the target to renovate 500 000 dwellings a year, while for the non-residential sector, he committed to introducing a renovation obligation.
- Brussels Capital Region has, within its regional Plan Air-Climate-Energy (PACE), focused on regulatory measures. Improving the energy performance of rental properties will be encouraged by allowing rent to increase to cover renovation investment costs, while requirements for single-measure renovations will be strengthened in order to facilitate long-term staged deep renovations.
- The Netherlands aims to catalyse action by addressing barriers and fostering innovative approaches. One such approach consists of an agreement between construction companies and housing associations to deliver 100 000 net zero energy dwellings by 2020. By combining energy bills with rents, overall costs can be maintained or reduced in these highly efficient renovations when done at scale and in a strategic manner. The other noteworthy initiative is the so-called *Green Deals*, whereby the Government offers a type of brokering/consultancy service to unblock specific legal, regulatory or financial barriers to renovation initiatives.
- The UK relies on policies already in place, such as the Green Deal and Energy Company Obligation. The only new policy is the Energy Savings Opportunity Scheme (ESOS) aimed at large business, introduced to meet the energy auditing requirements in the EED.

BOX 3.2: STRATEGY FOR ENERGY RENOVATION FOR HOUSEHOLDS/DENMARK

The objectives of the Danish government are that the energy supply in 2050 must be based on renewable energy and that the electricity and heat supply must be independent of fossil fuels in 2035. As a major step towards the goals, the Strategy for Energy Renovation was adopted in May 2014. The strategy contains 21 initiatives which will promote the renovation of the Danish building stocks and ensure that energy efficiency measures are implemented on the buildings. These are expected to reduce the net energy consumption for heating and hot water by 35% by 2050.

The strategy includes following initiatives:

- Revision and upgrade of building regulations and energy requirements that applies to renovation and retrofitting of existing buildings

- New requirements to the energy efficiency of windows. These requirements will be tightened in 2015 and 2020. Furthermore new requirements will be defined for windows to be installed in buildings after 2020.
- Information to building owners, construction companies, financial institutions etc. on energy how to improve energy efficiency
- Revision of the energy certificates scheme to improve the efficiency of the scheme
- Promotion of the ESCO concept
- Promotion of energy efficiency in public buildings
- Measures to improve professional training to craftsmen and engineers in the building sector
- Development and demonstration of new technologies

Source: MURE database.

2.2.4. ARTICLE 7 NOTIFICATION

Member States had to notify by 5 December 2013 their plans, proposed measures and detailed methodologies for the implementation of Article 7 and Annex V of the Energy Efficiency Directive. In the database it is also possible to indicate which measures have been included in the Article 7 notification of the EED – including both energy efficiency obligation schemes as well as alternative measures.278 such measures are reported in the database in all sectors. However, it should be noted that the measures in the notification are sometimes titled differently or may be packages of measures composing of several measures in the MURE database.

16 countries have reported to rely on energy efficiency obligation schemes, generally combined with additional policy measures[37]. The other countries will only use other policy measures as authorised by the Directive, the so called “alternative policies”.

[37] Only 3 countries (Denmark, Poland and Luxembourg) rely solely on an energy efficiency obligation scheme.

2.3. ENERGY PERFORMANCE IN BUILDINGS DIRECTIVE

The recast of the Energy Performance of Buildings Directive (EPBD, 2010/31/EU) abrogated the corresponding earlier directive from 2002. The previous directive introduced energy efficiency certificates and required enhanced building regulations. The recast directive introduced new challenges such as moving towards new and retrofitted nearly-zero energy buildings, the application of a cost-optimal methodology for setting minimum requirements for both the envelope and the technical systems and inspections of heating and air-conditioning systems.

2.3.1. NEARLY-ZERO ENERGY BUILDINGS (NZEB)

The Member States are required to ensure that all new buildings will be nearly-zero energy buildings (nZEB) by the end of 2020 and by the end of 2018 in the case of public buildings. Nearly-zero buildings have been estimated to consume on average 40% less energy than buildings constructed in 2012 (in a range of 20-60%) (Concerted Action EPBD 2013).

However, the ambition of the directive is to extend nZEB requirements also to building renovation. According to Article 9, following the leading example of the public sector, the Member States shall develop policies and take measures such as the setting of targets in order to stimulate the transformation of buildings that are refurbished into nearly zero-energy buildings.

The trend towards nZEB will not just improve energy efficiency but also increases the use of renewable energy in buildings as the definition of nZEB (art. 2) says: "… The nearly zero or very low amount of energy required should be covered to a very significant extent by energy from renewable sources, including energy from renewable sources produced on-site or nearby."

2.3.2. ENERGY PERFORMANCE CERTIFICATES

Energy Performance Certificates (EPC) were introduced already by the EPBD Directive of 2002. Mandatory certification of new and existing buildings is required along with periodic certification of public buildings. When buildings are constructed, sold or rented out, EPCs must be given to the owner or by the owner to the prospective buyer or tenant. The EPC shall include recommendations for the cost-optimal or cost-effective improvement of the energy performance of a building or building unit. An example of innovative use of the EPC in addressing landlords can be found in the Netherlands (**Box 3.3**).

According to a recent study (European Commission 2013) the frequency of displaying the EPC varies between 10% (Cyprus) or 20% (Austria) and almost full coverage: around 95% (UK) and virtually 100% (Portugal, France). However, even in cases where a significant proportion of transactions are accompanied by an EPC, it is often provided only at the moment the contract is signed, i.e., too late in the decision-making process to have an impact. Trust is clearly still an issue and while the public generally understands the basic concept of the EPC, the details are not understood. The study also implies that the prices of more efficient homes are higher.

BOX 3.3: CHANGE IN THE HOME VALUATION SYSTEM/THE NETHERLANDS

The Home Valuation System sets the maximum rent on the basis of the characteristics of the home. Within this system, points are awarded for dwelling quality, such as floor space and facilities. The rental prices depend on the total number of points.

Energy efficiency measures such as insulation gave only limited rewarded in the system and the landlords could not earn back investments. The system was first revised in 2011 for social housing and extended in 2014 to all rental homes so that energy efficiency improvements – proven by the energy certificate - lead to more points enabling housing associations to earn their investments back by raising rental prices. The increasing rent will be compensated by lower energy costs for the tenants.

The scheme will be subject to evaluation after three years.

Source: MURE database

2.3.3. OTHER PROVISIONS

The Directive requires the Member States to assure that minimum energy performance requirements for buildings or building units are set with a view to achieving cost-optimal levels. The Member State shall also take the necessary measures to ensure that minimum energy performance requirements are set for building elements that form part of the building envelope and that have a significant impact on the energy performance of the building envelope when they are replaced or retrofitted, with a view to achieving cost-optimal levels.

The EPBD mandates inspections of heating, air-conditioning (A/C) and ventilation systems but permits alternative approaches such as advice and monitoring.

The obligation to renovate central government buildings in the EED complements the requirements in the EPBD, which require Member States to ensure that when existing buildings undergo major renovation their energy performance is upgraded so that they meet minimum energy performance requirements. Joint implementation of EED and EPBD encounters a common barrier in many Member States, namely the fact that the two directives are being implemented in different governmental organisational units and usually by two different ministers.

2.4. ENERGY LABELLING DIRECTIVE

The first Energy Labelling Directive entered into force in 1992. The recast Energy Labelling Directive (Directive 2010/30/EU) was adopted in May 2010. The energy classes have been subject to a review in 2014.

Energy labelling regulations are adopted as delegated acts given by the European Commission. At present, energy labels are applicable to the following product groups:

- Lamps
- Luminaires
- Televisions
- Tumble driers (household use)
- Washing machines (household use)
- Drying washing machines (household use)
- Dishwashers (household use)
- Refrigerating appliances (household use)
- Wine storage appliances (household use)
- Owens (household use)
- Vacuum cleaners
- Household air conditioners
- Space heaters
- Water heaters

The Energy Labelling Directive does not cover office equipment (e.g. computers, monitors and printers) for which the Energy Star label is applicable. The Regulation of the European Parliament and of the Council of 6 November 2001 establishes the rules for the Energy Star Program.

The European labelling regulation does not exclude the possibility of national governments to establish additional labelling schemes for products not covered by the European scheme (**Box 3.4**).

BOX 3.4: WINDOW ENERGY LABELLING/FINLAND

Energy efficiency of windows is significant for the total energy consumption of a building because the contribution of windows to total heat demand in a building is 15–25%. Windows are actually the weakest link in the thermal efficiency of buildings. Windows are also manufactured in large quantities because they are used both in new and renovated buildings.

The development of a national window energy labelling scheme in Finland started with studies and led to a pilot phase in 2004-2005 when 160 windows produced by eight manufacturers were rated. The actual voluntary labelling scheme started in 2006. First the label classes ranged from A to G but classes A+ and A++ were added in 2011. Today 12 manufacturers sell windows with an energy label.

The energy rating criteria has been altered in the course of time. The latest update took place in 2013.The classification rules and classification of individual products are decided by a designated Window Classification Board.

Source: MURE database.

2.5. ECO-DESIGN DIRECTIVE

The Eco-design Directive for energy-related products (Directive 2009/125/EC) was adopted on 21 October 2009. It is a framework directive which is implemented by regulations given by the Commission and by voluntary agreements with the manufacturers.

Most of the products covered by implementing decrees are used in households and the services sector making this an important policy in these two sectors. However, in some product groups and in some countries the minimum requirements are equal to or very close to the market averages meaning that they do not change much and more stringent regulations are needed to induce market changes.

The products groups with implementing decrees or voluntary agreements in force are:

- Food-preparing equipment (incl. range hoods), 66/2014 of 14 January 2014;
- Electric motors, 4/2014 of 6 January 2014;
- Standby and off Mode Electric Power Consumption of Household and Office Equipment, 801/2013 of 22 August 2013;
- Heaters and water heaters, 813/2013 of 2 August 2013;
- Vacuum cleaners, 666/2013 of 8 July 2013;
- Computers and computer servers, 617/2013 of 26 June 2013;
- Imaging equipment (Voluntary Agreement)[38], COM 2013/ 23 of 29 January 2013;
- Complex Set-Top Boxes (Voluntary Industry[39]), COM 2012/684 of 22 November 2012;
- Household tumble driers, 932/2012 of 3 October 2012;
- Lighting Products in the Domestic and Tertiary Sectors, 1194/2012 of 12 December 2012;
- Circulators, 622/2012 of 11 July 2012;
- Water pumps, 547/2012 of 25 June 2012;
- Air conditioners and comfort fans, 206/2012 of 25 June 2012;
- Industrial fans, 327/2011 of 30 March 2011;
- Household dishwashers, 1016/2010 of 10 November 2010;
- Household washing machines, 1015/2010 of 10 November 2010;
- Refrigerators and freezers, 643/2009 of 22 July 2009;
- Televisions, 642/2009 of 22 July 2009;
- External Power Supplies, 278/2009 of 6 April 2009;
- Simple Set-Top Boxes, 107/2009 of 4 February 2009.

[38] Industry Voluntary Agreement to improve the environmental performance of imaging equipment on the European Market; Report from the Commission to the European Parliament and the Council on the voluntary eco-design scheme for imaging equipment.

[39] Voluntary Industry Agreement to improve the energy consumption of Complex Set Top Boxes within the EU; Report from the Commission to the European Parliament and the Council on the voluntary eco-design scheme for complex set-top boxes.

National governments have had the possibility to establish minimum energy efficiency requirements for products not covered by the European regulation. However, only very few examples can be found (**Box 3.5**).

BOX 3.5: NATIONAL MINIMUM EFFICIENCY STANDARDS FOR CONDENSING BOILERS/IRELAND

Condensing boiler Installation Assessment Procedure is part of a guidance document on Heating and Domestic Hot Water Systems for dwellings – Achieving compliance with Part L. amendment – S.I. No. 847 of 2007. The measure set a minimum seasonal efficiency of 86% for boilers installed in existing or new dwellings from 2008 and 90% from 2011. For existing dwellings, if a boiler is replaced with an oil- or gas-fired boiler it must also meet this efficiency standard where practicable. The expected savings by the measure are 800 GWh/year by 2016 and 1200 GWh/year by 2020.

Source: MURE database.

2.6. MINIMUM LEVELS OF ENERGY TAXATION

Environmental taxes can be divided into four broad categories: energy, transport, pollution and resource taxes. Currently, roughly one euro out of every sixteen in revenue is raised from environmental taxes. Energy taxes are by far the most significant, representing around three quarters of environmental tax receipts in Europe. (Eurostat 2011, Eurostat 2013)

As a percentage of GDP, environmental tax revenues declined slowly during 2004-2008, first in the euro area and also progressively in the majority of Member States, reversing a previous clear progression. However, as of 2009 environmental tax revenue started increasing again. However, a high ratio of environmental tax revenue to total taxation as such does not necessarily represent an indication of a high priority being attributed to environmental protection. Energy taxes in transport have been originally used as revenue raising instruments, without environmental purposes. (Eurostat 2013)

Community framework for the taxation of energy products and electricity (Directive 2003/96/EC) sets minimum rates of taxation. The rates in Table 2 and Table 3 are applicable for buildings; further tax rates are applicable for motor use.

Table 2: Minimum levels of taxation applicable to fuels for commercial use

Fuel	Current minimum excise rates
Heating oil (€/1000 litres)	21
Kerosene (€/1000 litres)	21
LPG (€/1000 kg)	41
Natural gas (€/GJ)	0.3

Source: MURE database

Table 3: Minimum levels of taxation applicable to heating fuels and electricity

Fuel	Current minimum excise rates (business use)	Current minimum excise rates (non-business use)
Heating oil (€/1000 litres)	21	21
Heavy fuel oil (€/1000 kg)	15	15
Kerosene (€/1000 litres)	0	0
LPG (€/1000 kg)	0	0
Natural gas (€/GJ)	0.15	0.3
Coal and coke (€/GJ)	0.15	0.3
Electricity (€/MWh)	0.5	1.0

Source: MURE database

In addition to excise taxes also the value added tax applies to energy used by households. In many countries it is considerably higher than the minimum level required by EU legislation also having a steering effect on fuel consumption. The Council Directive 2006/112/EC of 28 November 2006 defines on the common system of value added tax. According to Article 97, the minimum value added tax is 15% until the end of 2015.

2.7. RENEWABLE ENERGY DIRECTIVE

The directive covers (large scale) renewable energy production, as part of the energy supply sector, as well as (small scale) production at the end-users place. Here the focus is on the end-user renewable production, also defined as "renewables-behind-the-meter". This renewable production decreases the delivery of (fossil) energy through the grid, in the same way as energy savings do.

Moreover, renewables can contribute to energy performance requirements for buildings. Therefore, end-user renewables are part of the analysis in this brochure.

Member States shall introduce in their building regulations and codes appropriate measures in order to increase the share of all kinds of energy from renewable sources in buildings.

In establishing such measures or in their regional support schemes, the Member States may take into account national measures relating to substantial increases in energy efficiency and relating to cogeneration and to passive, low or zero-energy buildings.

By 31 December 2014, Member States shall, in their building regulations and codes or by other means with equivalent effect, where appropriate, require the use of minimum levels of energy from renewable sources in new buildings and in existing buildings that are subject to major renovation (art 13.4). Member States shall permit those minimum levels to be fulfilled, inter alia, through district heating and cooling produced using a significant proportion of renewable energy sources.

Article 14.3 of the directive requires Member States to ensure that certification schemes or equivalent qualification schemes are were in place for installers of small-scale renewable technologies by 31 December 2012. They also need to recognize each other's certification. Information must be given on the certification/qualification schemes a list of certified/qualified installers may be published.

There are also other provisions for information dissemination. Guidance must be available for planners, architects and other relevant actors, so they are able to plan for and design the optimal combination of renewable energy, energy efficiency, district heating and cooling for new and renovated industrial and residential buildings and areas. The countries shall develop suitable information, awareness-raising, guidance and/or training programmes for citizens about the benefits and practicalities of acquiring and using renewable energy installations.

3. NATIONAL POLICY MEASURES FOR HOUSEHOLDS

3.1. OVERVIEW

The MURE database contains around 600 measures in the household sector[40], out of which two thirds are in operation[41]. Part of the measures are national, part of them are about national implementation of EU directives. However, the distinction is already getting difficult to make and it is becoming questionable whether it is always necessary. In the overview, both are addressed but Chapters 4.2 and 4.3 discuss mainly national measures.

Out of the ongoing measures, 137 are reported to have high impact, 132 medium impact and 119 low impact. A total of 23 recent high-impact measures have been reported (i.e. implemented after 2012), of which around half are related to the EPBD directive[42]. Two are related to energy metering, stipulated by EU directives too. Therefore it appears that only about ten national new high-impact measures have started in Europe over the last three years. Most of these are building renovation plans or programmes or subsidy schemes for energy efficiency or renewable energies.

The countries have reported 172 NEEAP-3 measures in the residential sector. 50 of them have started since 2011 which was the year when NEEAP-2 was submitted. This means that about 30% of measures reported in NEEAP-3 are new measures. A couple of the new measures have already been completed and six relate to the implementation of EU directives. Of the rest, 33 measures are in operation, 6 are proposed measures and the status of 3 measures is unknown.

Out of the 42 new national measures (with ongoing, proposed or unknown status) 26 are different financial (or fiscal) support schemes mainly for building renovation, installation of renewable energy systems and energy audits. Nine measures are primarily legislative issuing building regulations or mandatory audits. Five are information measures concerning consumer information, energy audits or smart metering.

Energy efficiency improvements are hindered by various barriers, each of which needs to be addressed by different types of measures. This is done best by developing a balanced policy mix which includes several types of measures. The adopted policy mix varies significantly from country to the other (**Figure 34**).

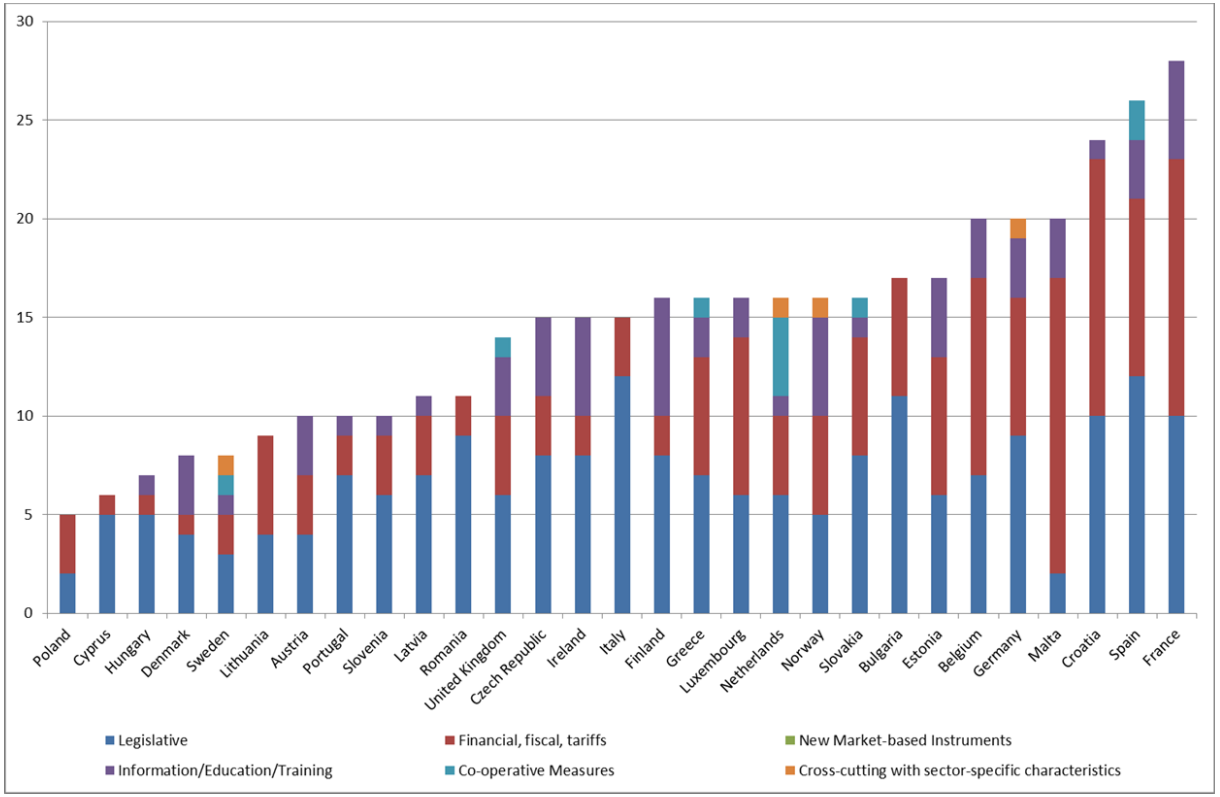
Legislative measures, i.e. regulations, dominate in the household sector. A notable exception is Malta where the majority of measures are economic. Economic measures are the second most common type of measures. Most countries have also reported at least one information based instrument but there are a few countries which have not reported measures of this kind.

[40] As the number of measures is constantly evolving we can only provide rounded numbers. As of 3 November 2014, the database contained 582 measures for households, of which 413 were in operation.

[41] The others are either no longer applied or being planned.

[42] Eight are indicated as related to the EPBD Directive and three of the others are related to the EPBD as well although this has not been indicated.

Figure 34: Number of measures by type and by country in the household sector[43]



Source: MURE database, November 2014

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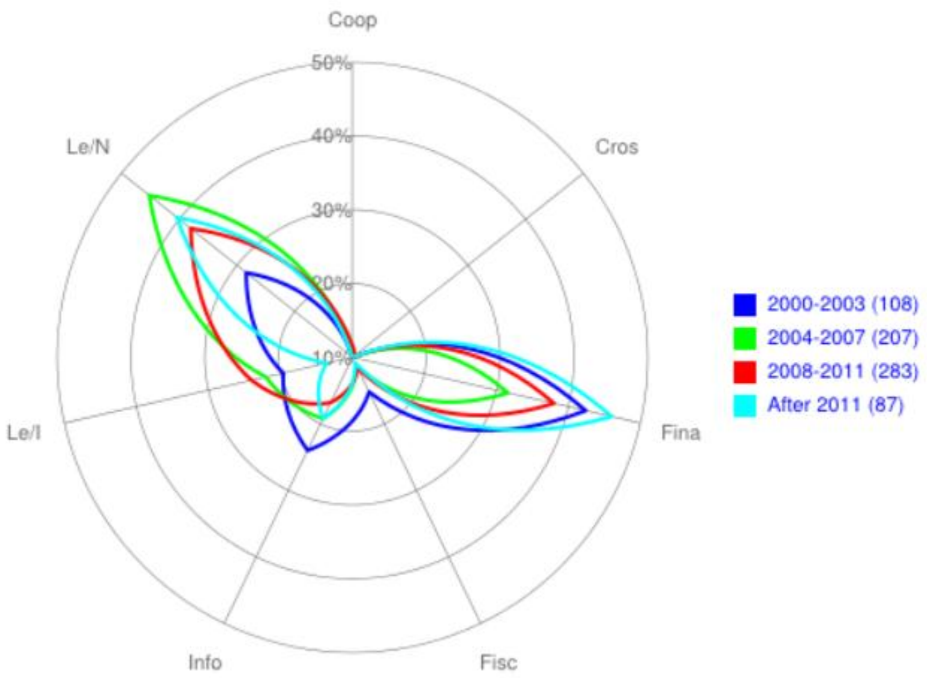
[43] The figure only includes on-going measures. Some caution is needed while analysing Figure 1 because there is some variety in how countries package their measures. Some countries have reported larger packages of measures as one measure while others split them into several independent measures. Measures of "unknown measure type" are excluded.

Figure 35 shows the changes in policy mix over time in terms of number of measures. In the recent years the major emphasis has been in financial measures but also legislative measures have had an important role. Perhaps surprisingly, only few new information measures have been launched in recent years.

Figure 35: Measures introduced by type and by period of time



Coop = Co-operative measures, Cros = Cross-sectoral measures, Fina = Financial measures, Fisc = Fiscal measures, Info = Information/education/training, Le/I = Legislative/Informative, Le/N = Legislative/Normative, Mark = New market-based instruments

Source: MURE database, November 2014

3.2. MEASURES AIMING AT BEHAVIOURAL CHANGE

In Chapter 4.2 the major focus is given to energy behaviour and different instruments used to influence it. Other major issues (e.g. building regulation, product policies and measures for renewable energies) are discussed in different parts of this report (Chapters 3 and 6).

3.2.1. ENERGY BEHAVIOUR

There are two types of behaviour having an impact on energy efficiency, **investment behaviour** and **habitual behaviour** related to daily usage patterns. Housing choices, procurement of appliances or replacement of more efficient light bulbs are typical examples of investment behaviour. Habitual behaviour concerns the way we carry out our daily lives, things we do in a routine way and little decisions we make often without paying much attention to them, such as switching of lights when leaving a room – or not doing that.

The most profound decision made by a household having impact on its energy consumption is the choice of housing (a form of investment behaviour). This choice is directly linked to possibilities to use different transport modes, walking and cycling, public transport, a private car or in the worst case, multiple private cars[44].

Regarding the dwelling itself, an important consideration is efficient use of space, i.e., how many m^2 there are per person. Different heating modes have dramatically different impacts on energy efficiency and CO_2 emissions. Third major factor are the energy efficiency characteristics of the building itself (e.g. thermal characteristics, air tightness, control and regulation). In new buildings these are effectively addressed by building regulation. In existing buildings fuel replacement or costly deep renovations are often needed in order to achieve savings or emission reductions in par with the two aforementioned factors. Consideration of all these factors is part of investment behaviour.

Investment behaviour is more rational than habitual behaviour, and therefore possibly easier to change. One success story is energy labelling which had transformed the markets already before eco-design regulation by enabling consumers to make informed decisions. Subsidies are widely provided by governments and eagerly used by households for energy efficiency investments and renewable energy applications.

The role of habitual behaviour is also very significant in energy efficiency and reduction of CO_2 emissions. There are various studies about the savings potential by changes in energy behaviour. A recent report of the European Environmental Agency (EEA 2013) investigated literature for the potential of different interventions (**Table 4**). It concluded that, e.g., a combination of policies and measures aiming at behavioural change can induce energy savings of 5–20%, presenting quite a large range[45].

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[44] An exemption might be the use of a small electric urban car in parallel to a conventional one. However, also in such a case the use of public transport or light transport is a more sustainable option.

[45] In addition, a recent study from the US estimated the savings potential of behavioural change at 16-20% of non-transport residential energy use (McKinsey 2013).

Table 4: Potential energy savings due to measures targeting behaviour[1]

Intervention	Range of energy savings
Feedback	5-15%
Direct feedback (including smart meters)	5-15%
Indirect feedback (e.g. enhanced billing)	2-10%
Feedback and target setting	5-15%
Energy audits	5-20%
Community-based initiatives	5-20%
Combination interventions (of more than one)	5-20%

Source: EEA 2013.

[1] The interventions in the table address mainly habitual behaviour but can also change investment behaviour. Particularly energy audits can directly lead to investments. However, also other interventions can have an impact when households make investment decisions.

Behavioural theories based on rational decision making have proven inadequate in explaining habitual behaviour. There is a multitude of internal (personal) and external (contextual) factors influencing behaviour (**Box 4.1**). Behavioural change only occurs if people are at the same time *motivated* and *enabled* to change. It should be noted that the same factors apply also to investment behaviour.

BOX 4.1: FACTORS INFLUENCING BEHAVIOUR

(1) Motivating factors are individual, internal drivers of behaviour. These factors are awareness, knowledge, social influence, attitude, perceived capabilities and intention. For people to intentionally change their energy behaviour, they must become aware of their energy use, pay notice to it, and be informed about the consequences. And, they must be motivated to use the available information and instruments to control their energy use.

(2) Enabling factors are the external constraints on behaviour. These factors allow new behaviour to be realized. Factors involve external financial, technical, organisational and judicial resources. Examples of instruments that influence these factors are subsidies, availability of products in shops, and the availability of specific advice. New skills may have to be acquired to realise the desired behaviour.

(3) Reinforcing factors are those consequences of actions that give individuals positive or negative feedback for continuing their behaviour. These include information about the impacts of past behaviour (e.g., lower energy bill), feedback of peers, advice, and feedback by powerful actors.

Source: IEE Behave Project (2009).

3.2.2. INTERVENTIONS

Due to the complexity, changing energy behaviour requires various types of instruments. Some measures, such as legislation, address all households. However, most others need to be carefully tailored to address the actual needs of target groups. In most cases, different instruments need to be used in combination to effectively alleviate energy efficiency barriers. For example, regulation and subsidies usually need to be underpinned by effective communication (information instruments).

Regulation can make something mandatory or forbidden to change consumer behaviour. For example, if inefficient appliances are banned (eco-design requirements), consumers have only efficient appliances to choose from. However, they are more likely to choose the most efficient ones among the good ones if they receive relevant good quality information (energy labels, advice, campaigns, search tools) and if salesmen have received training in energy efficiency. Energy performance certificates have become mandatory but they have not reached their full potential partly due to insufficient or unsuccessful information dissemination.

Theoretically, norms could be used to cap consumption (e.g. personal carbon allowances or maximum size of dwelling per person). However, they are politically challenging and practically very difficult to implement in an equitable way. Therefore, actual examples of operational measures of this type are difficult to find. In 2008, the UK government published studies on personal carbon trading but concluded that for the time being it was ahead of its time and that the expected costs for implementation would be high (e.g. Defra 2008). Norfolk Island in the Pacific is the world's first practical test on personal carbon trading programme on voluntary basis[46]. The trial started in 2012-2013 by background studies. However, it appears that the project has stalled.

As opposed to normative steering it is more common to use regulation to introduce new information instruments. The energy labelling of energy-using products, building energy performance certificates and the eco-label EU Flower are examples of such European policies; but national policies can also be found, such as the Austrian klima:aktiv building certificate.

Trying to change energy behaviour by communication is done by social marketing where the general marketing principles (e.g. segmentation, targeting, tailored communication instruments and reinforcing) apply.

The MURE database includes quite many examples of different information instruments, namely campaigns, guides and other written materials, web-based tools, theme weeks (general energy efficiency and school campaigns). Also voluntary energy and environmental labels (when energy criteria are included) fall into this category. Examples include the EU Flower, Norwegian Enova Recommends (**Box 4.2**), German Blue Angel and the Nordic Swan Label.

[46] http://www.sustainablenorfolk.com/nicheproject.html

BOX 4.2: "ENOVA RECOMMENDS" LABEL/NORWAY

"Enova Recommends" is a program that aims at helping the public choose energy efficient products and solutions. This program currently includes triple-glazed low energy windows and solutions for insulation and air tightness. Enova specially recommends solutions which have a higher performance than required by building regulations and standards.

1. Windows: Windows correspond to about 5-10% of the building surface, yet the energy losses may be as high as 40% of the total losses for the building. Windows were the first product targeted under Enova Recommends. The main criterion for earning the label was that windows had to have a U-value of 1.0 or lower. This criterion is tougher than the current building regulations requirement. Before label was launched, there was only one window manufacturer in Norway who could deliver this quality. Enova Recommends challenged the window industry, and the industry reacted to the challenge in a very positive way. At the end of 2008, around 15 Norwegian manufacturers could deliver windows which meet the Enova Recommends quality standards.

2. Insulation: This was the second product field under this program. Enova recommends the use of an insulation layer with a thickness of at least 25 cm for the walls and 30-35 cm for the roof – these values correspond to the ones in the current building regulations. There are currently three insulation producers who are Enova's partners in this programme.

3. Balcony doors: The lower the U-value, the less heat losses.

Source: MURE database.

Today information instruments partly converge or overlap with energy services. Energy services are a bunch of various private and public services and the concept "energy services" itself is still somewhat ambiguous. Energy services include energy audits, tools for consumption monitoring (smart homes), advanced measurement, billing and reporting (smart meters, web-tools, smart phone/tablet applications), energy advice and information dissemination. Development of energy services will be interlinked with the development of smart grids in the future. Also the providers of energy services are mixed: energy industry, associations, consulting companies, energy agencies, equipment suppliers and even hardware stores.

Ten countries have reported ongoing subsidy programmes for energy audits in the residential sector. Germany runs two schemes for subsidised on-site advice, the other being 100% subsidised and targeted for low-income households.

Energy advice is one of the oldest services provided to households. There are long-running programmes providing personal advice e.g. in Austria, France, Slovenia, Sweden and UK. One more recent and innovative example can be found in Denmark where a turn-key approach has been developed (**Box 4.3**). In 2013, France combined its energy efficiency and housing into a single network called Point Renovation Info Service to provide a one-stop-shop for advice. Advanced consumption measurement helps the household to recognise the reasons for its energy consumption but it is not enough to induce change. Households also need energy advice to understand the results and to carry out the changes. Furthermore, they need means to finance investments and information about existing supporting schemes (see Chapter 4.3).

BOX 4.3: BETTER HOMES PROGRAMME/DENMARK

Better Home is a new scheme (2014-) by the Danish Energy Agency to make it easier for homeowners to energy renovate their homes. Denmark wants to create a "one stop shop" for energy renovation for private home owners, where the owner only has to contact one certified building contractor and to get counselling on energy renovation of the entire building. The Agency educates and approves professionals like architects, engineers, craftsmen, energy consultants and building designers to advisors on energy renovation in private homes. A Better Home advisor can manage the process and can follow the project all the way from plan to completed renovation. The advisors can give homeowners the reassurance they lack today to engage in a major renovation project. There are educated Better Home advisers all over the country, but not yet in every municipality.

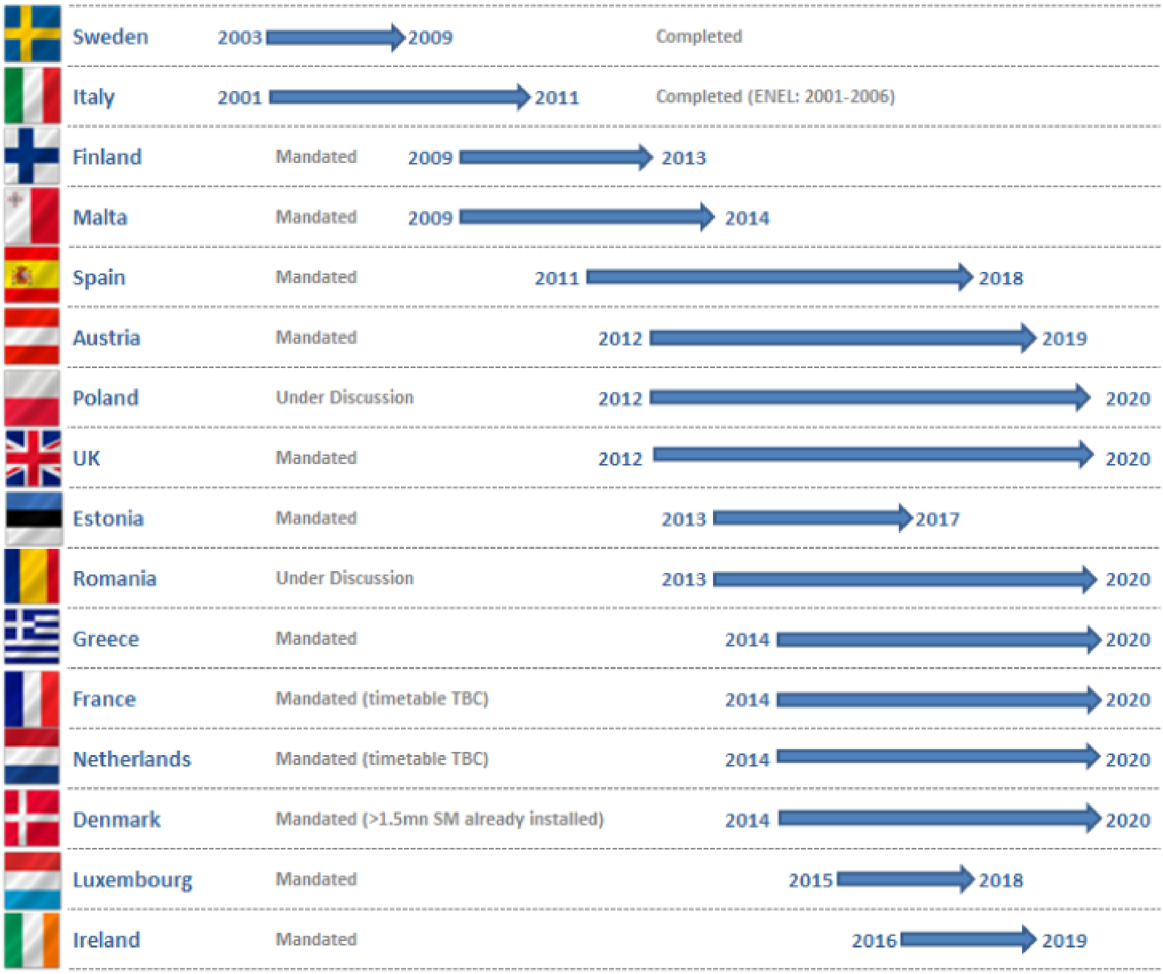
The purpose of the Better Home is to ensure that homeowners get the most out of their investments. The energy savings can help pay for the home improvements. This requires that the homeowner gets an overview of the entire house, i.e., climate shield as the roof and exterior walls as well as installations, such as heat pumps.

Source: MURE database.

Under the EED, customers for electricity, natural gas, district heating, district cooling and hot water should have a meter that accurately reflects their individual energy consumption. They should also be billed for the energy they used and be able to compare energy deals on a like-for-like basis. The Member States should also ensure that national energy regulatory authorities are able to ensure that network tariffs and regulations incentivise improvements in energy efficiency and support dynamic pricing for demand response measures by final customers.

The EED makes a reference to the electricity and gas market directives (2009/72/EC and 2009/73/EC) which also have requirements on smart metering. The implementation of smart metering may be subject to a long-term cost-benefit analysis (CBA). In cases where the CBA is positive, there is a roll-out target of at least 80% market penetration for electricity by 2020. The Commission has monitored the progress (Borchard 2014). Figure 36 shows the progress in countries with stated large-scale roll-out of electricity smart metering by 2020. 195 million electricity smart meters will be installed in 16 Member States covering 72% of consumers. The early actors have been Sweden and Italy, followed by Finland and Malta. For gas, 45 million smart meters will be installed in 7 Member States with wide roll-out announced by 2020. These meters will cover 40% of gas consumers. The Commission recognises that information campaigns are still needed to enhance consumers' trust and confidence.

Figure 36: Member States with wide-scale roll-out of electric smart meters by 2020



Source: European Commission (Borchard 2014).

Advanced metering enables good consumer feedback. There are various technologies and approaches available. Home displays and informative billing can be used. Energy suppliers provide increasingly services based on web-sites and tablet or smart phone applications. Combined with building automation these mobile systems can be used to take action also while not at home. Interestingly, evidence from several feedback studies suggests that most of the total energy savings achieved through feedback programs results from changes in behaviours (not investments). However, people who actually make investments tend to make larger individual savings (Ehrhardt-Martinez et. al. 2011).

3.3. FINANCIAL AND FISCAL MEASURES

This brochure updates a previous report that had a special focus on financing. As important as financing is, to avoid repetition, the following concentrates on a brief summary on the 40 new financial (39) and fiscal (1) measures launched in the household sector after 2012. Two of them were short term and have already been closed and three are in the planning stage.

It is notable that half of the new measures are launched by two countries. Malta has launched nine new financial measures and one fiscal measure while Croatia has issued nine. Germany has started four and Luxembourg three. The rest are distributed to several different countries.

Sixteen of the new schemes subsidise building renovation and four boiler replacement, in some cases to renewable fuels. Three promote energy audits. Eleven of the new measures promote investment to renewable energy by feed-in tariffs or by giving subsidies. These are not all additive because some schemes pursue several objectives. Soft loan schemes have not been issued much, possibly due to the prevailing low level of interests.

A brief update is given on the widely known innovative UK scheme, the Green Deal which, however, has faced some difficulties (**Box 4.4**).

BOX 4.4: GREEN DEAL/UK

The Green Deal scheme was launched in January 2013. It is based on the idea of attaching loans for low-carbon refurbishment of buildings not to the owner, but to the property itself. Repayment of the loan is done through a surcharge on the electricity bill, collected by the electricity supplier and paid on to the Green Deal provider. The Green Deal is subject to a 'golden rule', which prescribes that the estimated monetary savings must be greater than loan repayments. At least 45 different measures are eligible for funding, provided they are installed in packages that DECC's standardised assessment tools indicate will be compliant with the golden rule.

Households interested in the Green Deal pay a Green Deal adviser for the initial assessment which currently costs from £80-£175 (some councils, however, offer them for free and some Green Deal Providers refund them if a Green Deal Plan is signed). The adviser provides the household with recommendations on which measures could be installed and that are compliant under the Golden Rule. Based on this assessment households are supposed to shop around and find the Green Deal Provider with the best offer. Once a contract is signed with a Green Deal Provider, the Green Deal Provider will then order a Green Deal Installer to carry out the agreed measures.

Green Deal uptake has been much lower than expected. The government expected more than 10 000 homes being retrofitted in 2013. There were 1 612 Green Deal Plans in the system at the end of December 2013 with 626 properties where the measures had been completed. At the end of May 2014 2 828 households had Green Deal Plans in progress of which 372 had all measures installed. Another setback is that the scheme does not seem to lead to deep renovations (due to the golden rule) and the number of measures taken by household is low, on average 2.2. The Green Deal scheme is also very sensitive to the new subsidy schemes launched to incentivise the Green Deal, namely the Green Deal Cashback Scheme and the Green Deal Home Improvement Fund (GDHIF).

Source: MURE database and Enerdata.

4. NATIONAL POLICY MEASURES FOR THE TERTIARY SECTOR

4.1. OVERVIEW

Part of the measures are national, part of them are about national implementation of EU directives. However, the distinction is already getting difficult to make and it is becoming questionable whether it is always necessary. In the overview, both are addressed. The exemplary role of the public sector (Chapter 5.2) is established by directives but is also underpinned in national policies. Chapters 5.5 and 5.4 discuss mainly national measures.

The MURE database contains about 500 measures in the tertiary sector, out of which two thirds are in operation[47]. About 120 of the ongoing measures area evaluated to have high impact, 95 medium impact and 104 low impact.

Out of the ongoing measures, 19 new measures (i.e. since 2012) have been reported to have a high impact, of which nine are related to the EPBD directive and one to the EED. Therefore it appears that only about nine national new high-impact measures have started in Europe over the last three years. These are quite mixed including building codes, renovation plans for the public sector (possibly associated with directives although not indicated), mandatory audits, third-party financing and rules for outdoor lighting (**Box 5.5**).

The countries have reported 159 NEEAP-3 measures in the tertiary sector. 43 of them have started since 2011 which was the year when NEEAP-2 was submitted. This means that about 27% of measures reported in NEEAP-3 are new measures. Three of these new measures relates to the implementation of EU directives. Out of the 40 new national measures 21 are already ongoing, 7 are proposed measures and the status of 12 measures is unknown.

Of the 40 new national measures, 19 are financial, including support schemes for building renovation, efficient lighting and renewable energy investments, as well as promotion of third-party financing. Co-operative measures (11) are diverse including development of energy management, e.g. by using performance contracting, introduction of voluntary agreements and greener public procurement. Five measures are legislative involving, e.g., mandatory audits, mandatory energy management in the public sector or regulations for energy efficient lighting. While other measures also include information dissemination, two have been classified as pure information measures.

Different types of measures are needed to address the various barriers to energy efficiency improvements. This is done best by developing a balanced policy mix combining several types of measures. The adopted policy mix varies significantly from country to country (**Figure 37**)[48]. A new tool has been developed in the MURE database to further analysis of policy interaction (**Box 5.1**).

[47] As the number of measures is constantly evolving we can only provide rounded numbers. As of 3 November 2014, the database contained 501 measures in the tertiary sector, out of which 343 were in operation.

[48] Some caution is needed while analysing these policy mixes as some countries have reported packages of measures as one measure, while others have split them into several independent measures.

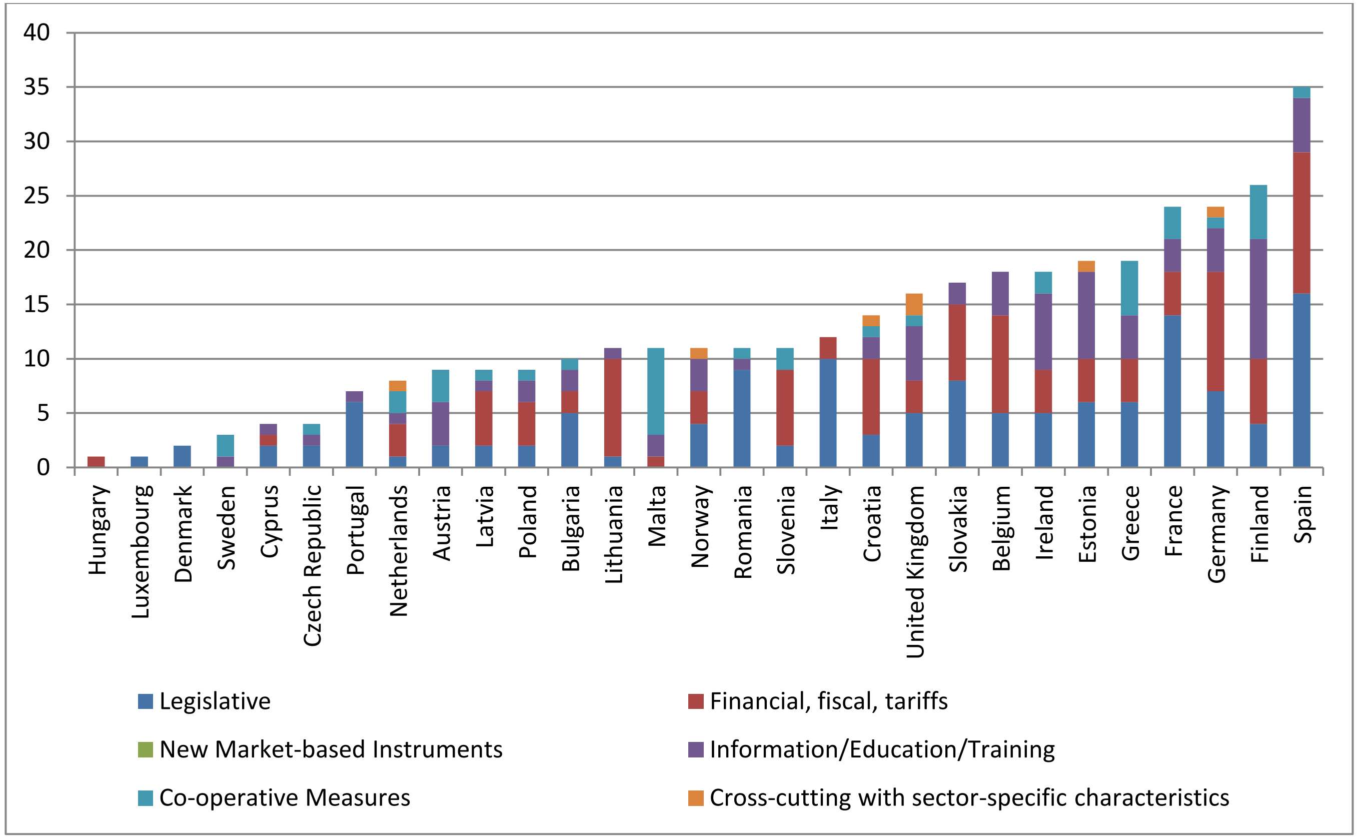
Legislative measures have a considerable role also in the tertiary sector but unlike in the household sector, their role is not quite as dominant. Economic measures are used commonly. In the tertiary sector also co-operative measures, typically voluntary agreements, have been reported. Some countries have not reported information measures in the tertiary sector.

BOX 5.1: MURE INTERACTION FACILITY

A new Interaction Facility was launched within the MURE database in 2014. It can be used to characterize packages of measures and their interaction in each sector. It is a tool for reporting savings taking into account policy overlap. The basis of the savings calculation is the impact label given to the measure (high = over 0.5% of sectorial consumption; medium 0.1% - 0.5%; low =under 0.1%). Another starting point is a matrix which is formulated of different types of measures and their interaction with the following options: strong reinforcing, reinforcing, some reinforcing, not interacting, some overlap, overlap and strong overlap. The summary savings between each measure in the same sector is then adjusted with interaction weights given to each type of interaction. It should be noted that the tool should not be used as a black box: the user always needs to review that the matrix is correct for the measures in a given country and make necessary adjustments. Because this can only be done nationally, any results from the facility are not reported here.

Source: MURE database.

Figure 37: Number of measures by type and by country in the tertiary sector[49]

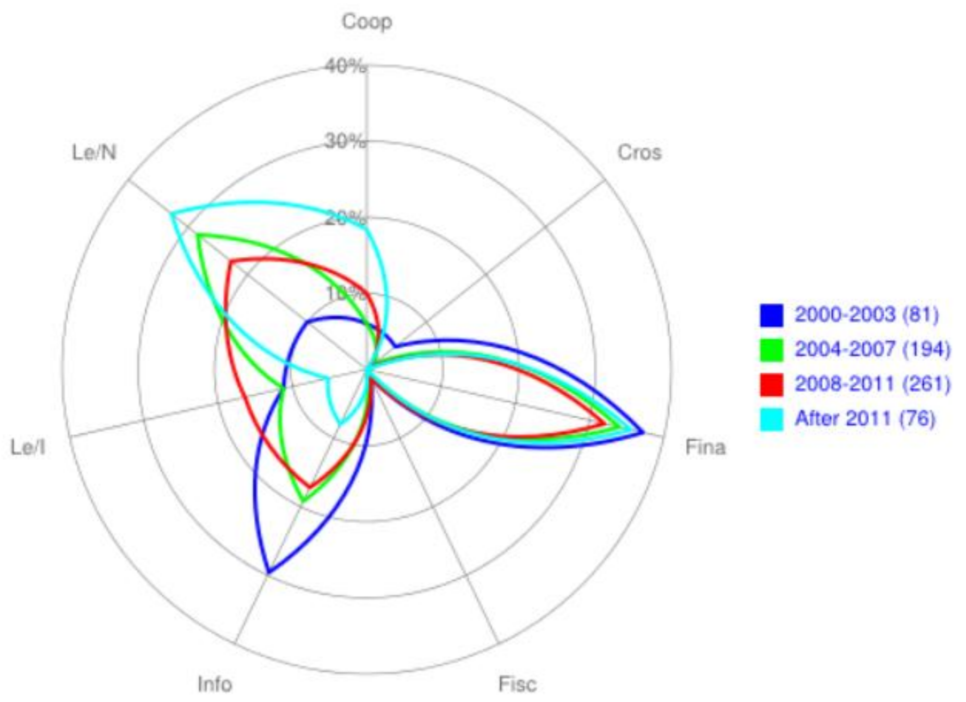


Source: MURE database, November 2014

[49] On-going measures only; unknown measure types excluded.

Figure 38 shows the changes in policy mix over time in terms of number of measures. Normative legislation (e.g. building regulation, eco-design) has had a very important role except in the early 2000s. Financial instruments have been constantly introduced since year 2000. Possibly due to declining public budgets also the introduction of new information instruments has dramatically declined since the period 2000-2003 and furthermore since the period 2008-2011. At the same time, co-operative measures are growing in importance.

Figure 38: Measures introduced by type and by period of time



Coop = Co-operative measures, Cros = Cross-sectoral measures, Fina = Financial measures, Fisc = Fiscal measures, Info = Information/education/training, Le/I = Legislative/Informative, Le/N = Legislative/Normative, Mark = New market-based instruments

Source: MURE database, November 2014

4.2. PUBLIC SERVICES

4.2.1. EXEMPLARY ROLE

The Energy Efficiency Directive (EED) sets explicitly that public bodies at national, regional and local level should fulfil an exemplary role as regards energy efficiency. The requirements fall basically into two categories - exemplary role of public bodies' buildings (see Chapter 5.2.2) and purchasing by public bodies (see Chapter 5.2.3). The central government should also have an exemplary role with respect to public bodies at regional and local levels.

Also the RES Directive puts the public sector in an exemplary role (Art 13.5). It (Art 13.3) encourages local and regional administrative bodies to include heating and cooling from renewable energy sources in the planning of city infrastructures, where appropriate. For example, the roofs of public or mixed private-public buildings could be used by third parties for installations that produce energy from renewable sources.

A few countries have introduced national measures beyond to the scope of the EED. For example, Greece and Slovenia (**Box 5.2**) are starting to require public authorities to adopt energy management systems.

BOX 5.2: ENERGY MANAGEMENT SYSTEMS IN MINISTRIES AND MUNICIPALITIES/SLOVENIA

Slovenia has required the introduction of energy management system in ministries and municipalities since 2012. Public sector organisations must, e.g., appoint energy managers, implement smart metering and, in public sector buildings larger than 500 m^2, carry out energy audits and initiate energy accounting. To increase motivation, criteria for a new reward system with an efficiency dividend, based on energy savings achieved, will be formulated and implemented.

Source: MURE database.

In addition to common European legal instruments and national legislation, various voluntary structured approaches have been developed to help local authorities on a voluntary basis to respond to climate challenges. Support has been given by associations or active networks such as the Covenant of Mayors, Local Governments for Sustainability (ICLEI) in the 1990's, Climate Alliance and Energy Cities. Energy Cities[50] is the European association of local authorities in energy transition. It was created in 1990 and represents now more than 1 000 towns and cities in 30 countries.

Some municipalities have become voluntarily involved in Local Climate Plans, energy-transition experiments, eco-district projects, voluntary agreements (**Box 5.3**), the European Sustainable Energy Week[51] and similar national activities, and more recently, the global forum "Resilient Cities"[52].

A new concept gaining momentum is 'post carbon cities'. Post carbon cities must reach a massive reduction of greenhouse gas emissions by 2050, a near self-sufficiency in fossil fuels and develop the

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[50] http://www.energy-cities.eu/

[51] Annual campaigning at local level in many European countries: http://www.eusew.eu/

[52] http://resilient-cities.iclei.org/

capacity to adapt to climate change. A national example of a post carbon initiative is the French foresight programme 'Rethinking cities in a post carbon society', launched in 2008 by the Ministry of Sustainable Development and the French Environment and Energy Management Agency (ADEME).

BOX 5.3: AGREEMENTS ON IMPROVING ENERGY EFFICIENCY IN MUNICIPALITIES/LATVIA

In its NEEAP-3 Latvi states that it will start a voluntary energy efficiency agreement for municipalities in 2016. The municipalities entering the agreements shall commit to at least 10% of energy efficiency improvements within five years after signing the agreement. The government will provide municipalities with methodological support in designing their sustainable development plans, energy audit support programmes, as well as financial support in the establishment of revolving funds in cities in the form of soft loans. The activities are subject to variations according to the size of municipalities as the agreement is planned to cover municipalities of different sizes.

Source: MURE database.

4.2.2. BUILDING RENOVATION

Article 5 of the EED stipulates that each Member State shall ensure that, from 1 January 2014, 3% of the total heated and/or cooled floor area of buildings owned and occupied by its central government is renovated each year to meet at least the minimum energy performance requirements set by Directive 2010/31/EU. The article permits two approaches, a "default" and an "alternative" approach.

The default approach means implementing the aforementioned 3% target in art 5(1) and establishing and making publicly available by 31 December 2013 an inventory of heated and/or cooled central government buildings with a total useful floor area over 500 m^2, and as of 9 July 2015 over 250 m^2, excluding some exempted buildings. Existing databases of public buildings have been available already in the Czech Republic, Croatia and the UK. However, the preparation of the inventory is a costly and complex task and there is a general shortage of information on the number of buildings belonging to central government that fall within the scope of the obligation, energy consumed and potential energy savings. (Concerted Action EED)

Under the "alternative" approach in art. 5(6), Member States may decide to take other cost-effective measures, including deep renovations and measures for behavioural change of occupants, to achieve, by 2020, an amount of energy savings in eligible buildings owned and occupied by their central government that is at least equivalent to that required in art. 5(1), reported on an annual basis. According to information collected in Concerted Action EED, in May 2014, 80% of the countries were still in the process of deciding which approach to take.

4.2.3. PUBLIC PROCUREMENT

Article 6 of the EED stipulates that Member States shall ensure that central governments purchase only products, services and buildings with high energy-efficiency performance, insofar as that it is consistent with cost-effectiveness, economical feasibility, wider sustainability, technical suitability, as well as sufficient competition. Furthermore, Member States shall encourage public bodies, including regional and local levels to follow the exemplary role of their central governments to purchase only products, services and buildings with high energy-efficiency performance. Member States shall encourage public bodies, when tendering service contracts with significant energy content, to assess the possibility of concluding long- term energy performance contracts that provide long-term energy savings. (Concerted Action EED)

Public authorities in Europe spend around 2 trillion euros per year, corresponding to almost 17% of the EU's gross domestic product. This significant purchasing power allows them to push for a greater adoption of sustainable measures, for instance, by including energy criteria in all public procurement procedures. Green public procurement raises awareness of environmental issues and creates incentives for the industry and citizens to innovate. Public procurement and service contracts can be used to boost emerging green markets.

According to information collected in Concerted Action EED, energy efficiency is not yet systematically integrated into public procurement processes. There are many resources to support energy efficient public procurement (EE PP), including legal frameworks, but the lack of provisions making it obligatory is preventing it from becoming mainstream. Other barriers include lack of knowledge; the fear of procurers engaging, with EE PP when they have limited experience; a lack of clear guidance and a shortage of practical toolkits, and unclear criteria for public procurement assessments. The lack of skills and practical knowhow of public procurers around EE PP remains one of the biggest barriers. (Concerted Action EED)

Despite the challenges, there already are numerous country cases on energy efficient public procurement in the MURE database. A new feature, the Policy by Topic Facility allows summarising all measures addressing public procurement (**Box 5.4**).

One example addressing the above mentioned information barrier is the information services in Finland (**Box 5.5**).

BOX 5.4: MURE POLICY BY TOPIC FACILITY/PUBLIC PROCUREMENT

The procurement topic is composed of three sub-topics, namely technology procurement for energy efficient appliances (14 reported national measures), energy efficient buildings/components (10 measures) and green vehicles (11 measures). In addition to national measures, the tool refers to four European measures. As many as 12 countries have not reported any measures on public procurement.

Source: MURE database.

BOX 5.5: NATIONAL FOCAL POINT FOR SUSTAINABLE PUBLIC PROCUREMENT/FINLAND

In June 2013 the Finnish Government made a Decision-in-principal on The Promotion of Sustainable Environmental and Energy Solutions (Cleantech solutions) in Public procurement. The decision repeals the previous Green Public Procurement action plan from 2009. The new decision, which is binding for central government authorities, sets targets for food, construction, transports, electricity, waste management and products and services with environmental impacts.

Procurement professionals are often in need of guidelines and tools on how to take sustainability aspects into account. To address this need, a service on sustainable procurement is run by the state owned company Motiva Oy. The service helps those carrying out public procurement to solve issues and problems related to sustainable procurement. Free-of-charge advice is given on the prioritisation of various environmental factors and taking them into account in the procurement of different goods and services. The service also develops national sustainable procurement criteria for public authorities together with both public procurers and suppliers.

Public procurement legislation, both European and national, has been developed to create a level playing field and improve efficacy. Yet, it can sometimes make it difficult to implement energy efficiency measures. Competition requirements may even disable energy efficiency measures when decisions cannot be made in the long run. While this may not be so evident anymore in the procurement of more common goods and services, it is still true particularly in relation to new technology.

The need for upfront capital investment can be a barrier for energy efficiency projects even in the public sector. While traditional financing market can be a viable option in many cases, energy services using new business models are emerging. These are used increasingly in public investments to energy efficiency but the markets are far from mature.

Energy Performance Contracting (EPC) is a form of 'creative financing' for capital improvement which allows funding energy upgrades from cost reductions. Under an EPC arrangement an external organisation (ESCO) implements a project to deliver energy efficiency, or a renewable energy project. It uses the stream of income from the cost savings or the renewable energy produced to repay the costs of the project, including the costs of the investment. Essentially the ESCO will not receive its payment unless the project delivers energy savings as expected.

EPC is not widely used across the EU yet because there are still problems in many Member States around public tendering for EPC, mainly due to its complexity and to various problems with legislative frameworks. The procurement and tendering process is very complex and heavy, requiring specific information and skill. Specification of EPC in tendering documents is much more difficult than specifying more "concrete" goods whose characteristics can be defined and quantified in detailed manner. There is still a degree of general confusion about definitions and contract provisions. There is even a lack of general awareness of the service. The number of service providers is still quite limited. When a public body has an existing operational organisation and staff for energy management it cannot instantly jump to outsourcing energy management. Yet another difficult area is accepting that a third-party will enjoy part of the monetary benefits arising from savings. (Concerted Action EED 2011)

A Public Private Partnership (PPP) is a long-term contractual relationship between public authorities and the private sector where risks are shared. Increased financing for energy efficiency is mobilised within the private sector to carry out modernisation projects in the public sector, with the public partner paying for delivered services in the long run. EPC can be also considered as a form of PPP, but only when both public and private partners are involved. This is a relatively common form of PPP with well established procedures in some countries. In less mature markets, governments can facilitate the availability of financing for energy efficiency in local financing institutions (e.g. banks) by establishing Dedicated Credit Lines or Risk-Sharing Facilities, which - in the case of public involvement - can also be considered as PPPs. Some Member States have experiences of PPP, most commonly at the local level in buildings and street/road lighting. Ten countries included a specific reference to PPP in their second NEEAPs. (Concerted Action EED 2012)

There are only 8 measures from 7 countries on third party financing in the MURE database (in the cross-sectoral part) while several other countries are known to use third-party financing extensively. It seems that most countries have not reported their activities. The Joint Research Centre (JRC 2014) reports that almost all of the European ESCO markets have grown since 2010, and only few of them remained stable or declined. Growth has been particularly strong since 2010 in Denmark, France, Ireland and Spain. One encouraging example is Romania, where the ESCO market is still at the embryonic state but the country is taking active steps to develop it (**Box 5.6**).

BOX 5.6: DEVELOPMENT OF ENERGY SERVICES MARKET/ROMANIA

At present, the ESCO market in Romania is arising; there are some Energy Services Companies, but their number is small comparing to those in other Member States. By 2016, the regulatory framework for the establishment and operation of ESCOs will be set up, along with the development of these energy services companies and promotion of energy performance contracts.

Source: MURE database.

There are large variations in office space per employee in Europe. According to a 2009 study by DTZ the range is from 11.0 m^2 in London or 12.5 m^2 in Luxembourg to 20.0 m^2 in Oslo/Düsseldorf and 23.4 m^2 in Helsinki. The average was 14.7 m^2. This indicates good possibilities for more efficient use of space and consequent energy efficiency improvements in some countries, recognised in the NEEAP measures. The sub-sector where efficient use of space is possibly easiest to pursue is public sector, where also the budgets are presently highly pressed.

4.3. PRIVATE SERVICES

Policies and measures addressing the private services sector are largely the same as those addressing the whole building sector: building codes, energy performance certificates, boiler and air-conditioning inspections, energy taxation, energy services (e.g. energy audits and smart metering and billing) and energy performance contracts. However, eco-design and energy labelling often focus on non-building devices or appliances, such as computers, food coolers in stores, bakery ovens, cleaning machines, etc.

There are also some specific sectoral measures for private services. Some of them work across sub-sectors as the French ban on for lighting during the night time (**Box 5.7**) and the UK Energy Efficiency Scheme (CRC) (**Box 5.7**).

Some measures address certain subsectors like the hotel industry: subsidies for efficiency improvements in Slovakia and Spain, eco-certificates and subsidies for CHP/tri-generation in Malta and a voluntary energy efficiency agreement for the hospitality industry in Finland. In Spain, there is a measure addressing energy efficiency in commercial refrigeration installations by subsidies and information dissemination.

There are unexpectedly few customized information measures (tailored campaigns, energy advice etc.) reported for the private services sector.

BOX 5.7: NIGHT-TIME SWITCHING-OFF OF LIGHTING IN OFFICES, SHOP WINDOWS AND NON-RESIDENTIAL BUILDING FACADES/FRANCE

According to regulation which took force on 1 July 2013, lighting installations of non-residential buildings have to be switched off during the night, in order to reduce both energy waste and light pollution.

Indoor lighting emitted outwards (offices, shops etc.) must be switched off at 1 am or one hour after closing time if this one occurs later, and can only be switched-on after 7 am or one hour before the activity begins if this occurs earlier. Outdoor lighting of building facades (shops, monuments, schools, city halls etc.) must be switched off at 1 am at the latest and cannot be switched-on before sunset. Indoor lightings of buildings for professional use must be switched off one hour after closing time.

Exceptions apply to the eves of public holidays, Christmas season, local events and certain tourist areas.

Source: MURE database.

BOX 5.8: ENERGY EFFICIENCY SCHEME (CRC)/UK

In the UK, 5000 large public and private sector organisations, covering about 10% of UK's CO_2 emissions, are mandated to participate in the Energy Efficiency Scheme (CRC) which requires them to monitor their emissions and purchase allowances for every tonne of CO_2 emitted. The scheme affects large public and private sector organisations meeting qualification criteria.

To avoid overlap with other measures, the CRC has exemptions for those emissions covered by Climate Change Agreements (CCAs) or direct emissions covered by the EU emissions trading.

Every two years an assessment is made on progress over the previous target period.

Source: MURE database.

4.4. AGRICULTURE

Information on the measures in the agricultural sector is somewhat scattered in the MURE database because "agriculture" was only recently added as a subsector into the database. However, it appears that financial measures are the most typical but also e.g. voluntary agreement (Finland, the Netherlands) and white certificates (Italy) are implemented.

An example of a German financing programme is given in **Box 5.9**. The agricultural sector can have a significant role both as a user and producer of renewable energy. The German example is not limited to promoting only energy efficiency but covers also feeding electricity produced from renewables to the public network, biomass co-generation and biofuel production.

Farms can be producers of various kinds of biomass, both as by-products (e.g. manure and crop residues) or primarily for energy purposes (e.g. energy crops). Altogether these are called agrobiomasses. In some countries, farms own considerable forest resources enabling them to use it for heating in their own processes or to become fuel suppliers or providers of energy services (e.g. heat entrepreneurs outside the farm).

Heat produced on the farm is usually consumed at the farm. At the European level electricity exported from farms is mainly produced by wind power. Wind energy is used most commonly in farms in Denmark followed by Spain. Despite its potential, use of solar energy is still quite negligible. (Pedroli&Langeveld 2011)

Some countries, e.g. Germany and Denmark, are using feed-in tariffs also for small farm-scale biogas facilities while in some other countries (e.g. Finland) feed-in tariffs are limited to larger scale production.

BOX 5.9: LOW-INTEREST LOANS FOR ENERGY EFFICIENCY AND RENEWABLE ENERGY INVESTMENTS IN AGRICULTURE/GERMANY

The Agricultural Bank provides low-interest loans for agriculture-related investment, including investments to improve energy efficiency. Eligible establishments are production plants in agriculture and forestry, viticulture and horticulture as well as producers of agricultural equipment, trade and service companies closely connected with agriculture. Up to 100% of the eligible investment costs can be financed with a cap of 10 million euros.

The bank finances investments in:

• Energy use of renewable raw materials and other organic compounds (e.g. biogas plants, biomass cogeneration plants and plants for the production of biofuels)

• Photovoltaic, wind and hydro power plants of companies in the agri-food sector including farming, whose power is fed into a public electricity network

• Wind turbines of wind energy companies, whose shares are mainly held by citizens, businesses and property owners on the spot ("civil and farmers' wind-farms") and whose power is fed into a public electricity network

Source: MURE database.

5. COMMON POLICIES FOR THE HOUSEHOLD AND TERTIARY SECTORS

This chapter focuses on common national measures that have an impact both on the household and tertiary sectors[53].

5.1. SMARTER CITIES WITH GOOD SPATIAL PLANNING AND DIGITALISATION

Energy conscious spatial planning is one of the corner stones in energy efficiency and increased use of renewables. Local and regional authorities can facilitate energy efficiency improvements and use of renewable energy of businesses and citizens in their geographical area. Planning should also have a view to digitalisation which is transforming the way we work, study, use services and carry out our daily lives.

One good practice is involving energy companies to the planning process from the beginning. Today, energy is purchased from energy companies by dwellers, housing companies and regions. In the future, this can be partly turned vice versa as a building can produce energy and sell it to the energy companies. An example of guidance based on information is in the city of Espoo in Finland, where the city plan indicates which areas are particularly suitable for using certain renewable energy (e.g. solar) but it is voluntary for the building owners to install renewable energy (RES).

According to the RES-directive (art 13.3), the Member States should recommend the installation of energy systems based on renewable energy and district heating and cooling when planning, designing, building and renovating industrial or residential areas. This is focussed in particular on the planning of city infrastructure.

Figure 39 shows the differences between countries in the use of district heating, measured by the proportion of population served by it. There are also major differences in the policy approach to district heating. While in some countries areas are designated to certain heating forms (e.g. gas or district heating zones in Denmark since the 80’s), in some other countries there is no such requirement in the city plans (e.g. in Finland). East European countries, which are among the major users of district heating, also follow the regulatory approach by which district heating can be favoured in certain areas. Regarding tariffs, while district heat tariffs in most East European countries are regulated, there is competition between heating forms in most other Member States.

Energy conscious spatial planning can contribute to considerable savings in public budgets. For example in Finland, it has been estimated that municipalities could save 2 billion euros in infrastructure investments by 2020 if all city planning would be carried out in line with the best examples on energy conscious spatial planning. Savings in transport fuel cost, in turn, are a direct benefit to the citizens.

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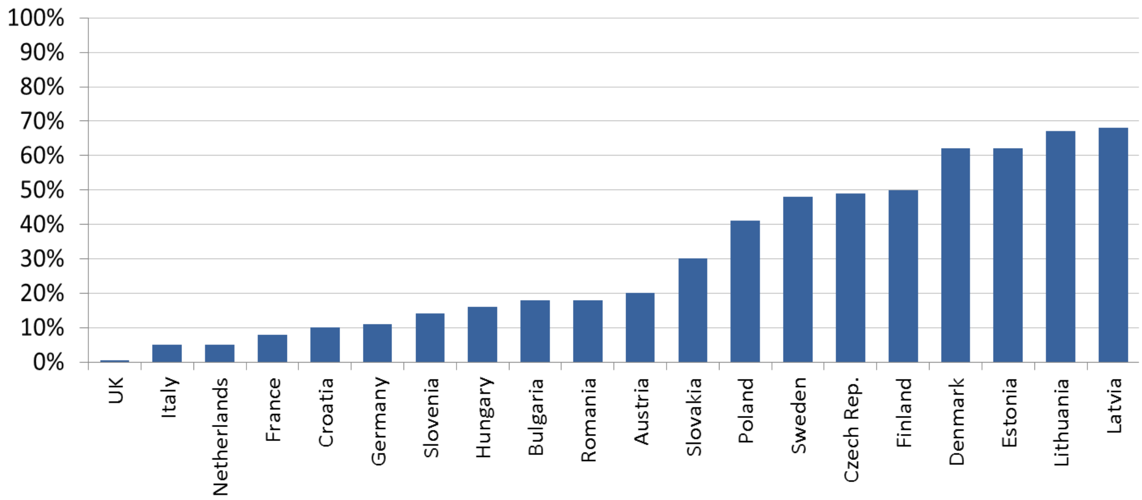
[53] The European measures (the EED, EPBD, RES, eco-design and energy labelling directives) were discussed in Chapter 3.

Figure 39: Share of citizens served by district heating by country, 2012



Source: Euroheat&Power

Urban, rural and even peripheral municipalities face quite different challenges. 80% of European population is estimated to live in urban and peri-urban areas in 2020. This needs to be recognised in all planning. For example, integrating energy issues and energy efficiency in transport into city planning is of utmost importance. District heating, which is used mainly in urban areas, will face new challenges as new buildings are quickly becoming more energy efficient requiring lighter district heating or hybrid applications. In less populated areas, spatial planning – both at local and regional level - can make a significant contribution to promoting the use of renewable energy, e.g., wind energy and biomass.

There is a degree of convergence between city planning and building regulation. For example, the location of a building on the building lot, which has an impact e.g. on solar exposure and lighting needs, can be governed by the city plan, building regulation or both.

Two key barriers for more energy conscious spatial planning are lack of motivation and skills. Integration of energy in urban planning education is still very rare in Europe and skills need to be developed. Practical work also needs to be supported by energy calculation tools.

A smart city is a place where the traditional networks and services are made more efficient with the use of digital and telecommunication technologies, for the benefit of its inhabitants and businesses. In its Digital Agenda for Europe (2010) the European Commission defines smart cities in the following way: "In Smart Cities, digital technologies translate into better public services for citizens, better use of resources and less impact on the environment. However, the smart city concept does not just stop at better use of information technologies but it means also smarter urban transport networks, upgraded water supply and waste disposal facilities, more efficient ways to light and heat buildings and more interactive and responsive city administration."

There are only a few cases on development of energy conscious spatial planning in the MURE database. A couple of examples can be found from Finland, France and Sweden (**Box 6.1**). Box 6.1 also provides a practical example from the city of Växjö in Sweden. In addition, Greece is implementing a project called “Bioclimatic upgrading of open public spaces” in which municipalities carry out bioclimatic upgrading of streets, squares and parks (**Box 6.2**).

BOX 6.1: SUSTAINABLE MUNICIPALITY/SWEDEN

Sustainable municipality is a programme administered by the Swedish Energy Agency targeting municipalities which have expressed particular interest in being in the vanguard of energy and climate related issues. The programme started in 2003 and its third phase ran between 2011 and 2014. The programme is not a funding scheme, but a way to promote cooperation and knowledge-sharing and dissemination of information, e.g. toolboxes.

The third phase focused, inter alia, on “energy smart planning”, which covered issues such as energy efficient spatial planning in small municipalities and renovation of apartment blocks built in the 1960s and 1970s. Topics covered include energy efficient city planning in small municipalities (including reducing traffic by private cars) and small-scale renewable energy generation in city planning.

Växsjö Municipality

In 1996, Växsjö (pop. 100 000) made a strategic decision to stop using fossil fuels being the first municipality in the world to go that far. It also committed itself to CO_2 *reductions, which have fallen by 40% in 20 years. Examples of the practical activities are:*

- *A large part of the heating and electricity delivered in Växjö is generated from forest residues*
- *Växjö started using biomass for district heating in 1980, and from combined heat and power production in 1983. Increasing the use of district cooling when cooling is needed.*
- *Subsidies for conversion of oil burners to pellets*
- *Food residues are collected in households for biogas production*
- *Free local energy advice*
- *Improving cycling infrastructure (lanes, parking, pump spots). Cycling has high priority in city planning.*
- *Biogas busses. Improved public transport.*
- *Free parking for environmentally friendly cars*
- *Promoting new business based on environmental technologies and solutions*
- *The target set for organic and/or locally produced foods is 80% in schools and care homes by 2020. In 2013 the figure was 40 per cent.*

Source: MURE database and www.vaxjo.se.

BOX 6.2: BIOCLIMATIC UPGRADING OF OPEN PUBLIC SPACES/GREECE

The “Bioclimatic upgrading for open public spaces” program is funded by the National Strategic Reference Framework and guided by the Centre for Renewable Energy and Save (CRES). Its main purpose is to fight against the urban heat island phenomenon. An amount of 60 to 100 billion Euros will be spent on the projects that will meet the high standards that CRES has set. There are strict criteria for eligibility including the decrease of temperature by 2 °C during the hottest days of summer leading to savings in energy used for cooling.

During the preliminary design phase, the proposals of urban planners, architects and engineers included:

•Photovoltaic installations aiming at the energy efficiency of parks, squares, streets, university campuses

•Replacement of the existing materials with the new generation of cooling materials, which are of greater reflectance and ability to decrease superficial temperature up to 10 °C

•Planting of trees and extensive use of green walls with climbing plants

•Creation or extension of bike lanes.

Source: MURE database.

5.2. RENEWABLE ENERGY IN BUILDINGS

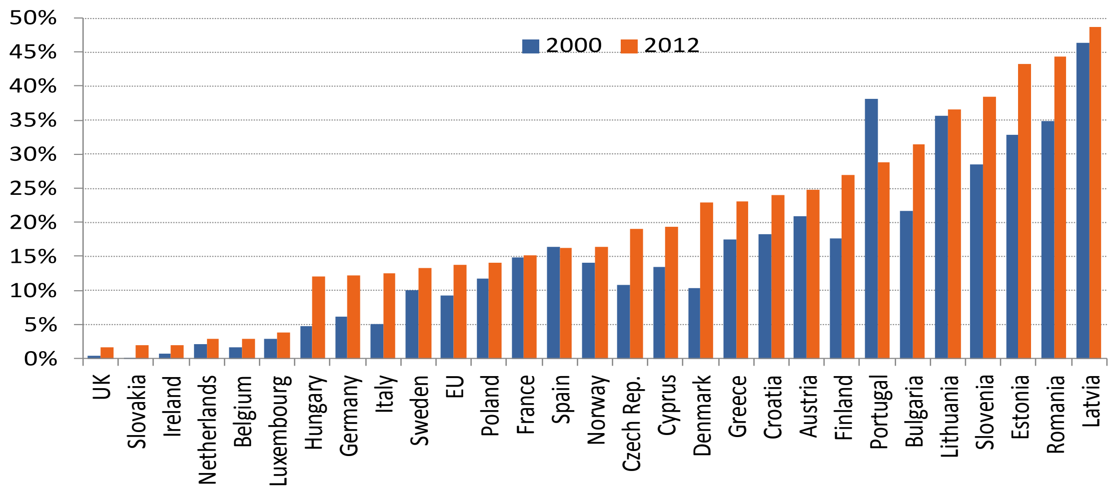
5.2.1. RENEWABLE ENERGY TRENDS IN HOUSEHOLDS

Rapid progress in the share of renewables in half of the EU countries

Renewables, mainly biomass represents 14% of total final consumption of households at the EU level and it is progressing rapidly (+5 percentage points since 2000). The largest shares of renewables are found in countries with low income and/or large wood resources: it is around 45% in Latvia, Romania and Estonia, and above 30% in Slovenia, Lithuania and Bulgaria.

The highest progress is observed in Denmark (+13 points since 2000), followed by Estonia, Slovenia, Bulgaria, Romania and Finland (+9-10 points). In half of countries the market share increased by more than 5 points. Biomass represents most of the renewables used in the household sector, among which pellet is significant in Denmark and Austria (25% and 11% of biomass use respectively).

Figure 40: Share of renewables in household consumption (direct use)



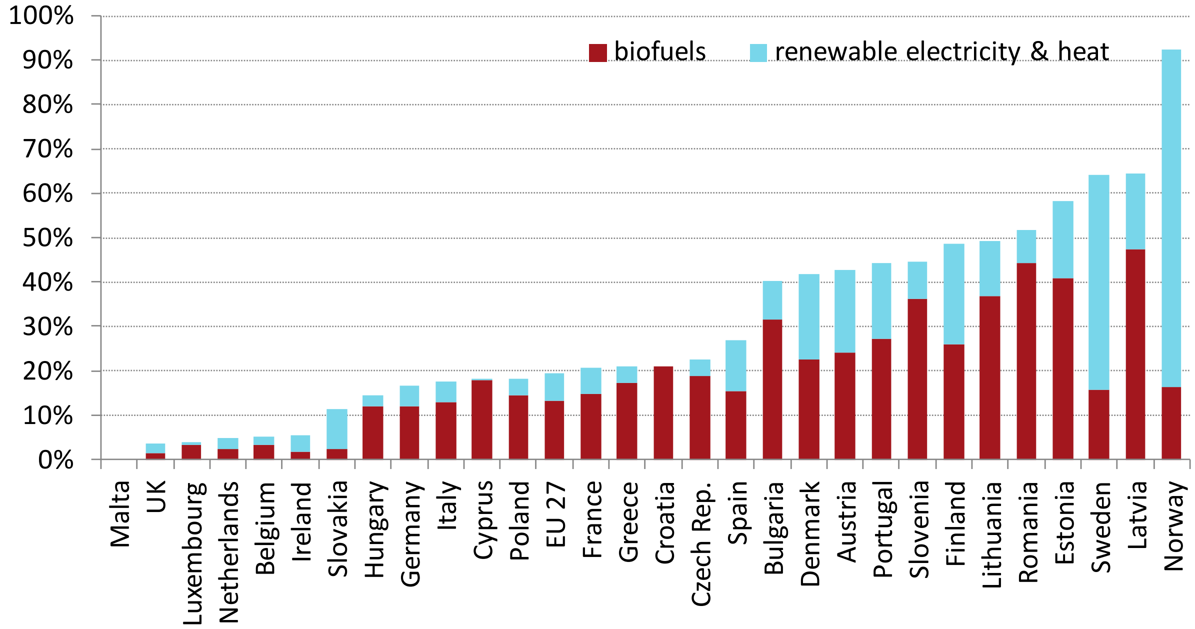
Source: ODYSSEE

Renewables are increasing their market share, both directly and indirectly

At the EU level, the share of renewables in household consumption stands at 19%, of which 13% is for biomass and 6% for renewable electricity and heat.

Taking into account the share renewables in the production of electricity and heat, the highest share is observed in Norway (over 90%) driven by hydropower, followed by Latvia and Sweden (> 60%) (**Figure 40**).

Figure 41: Direct and indirect shares of renewable in household consumption (2011)



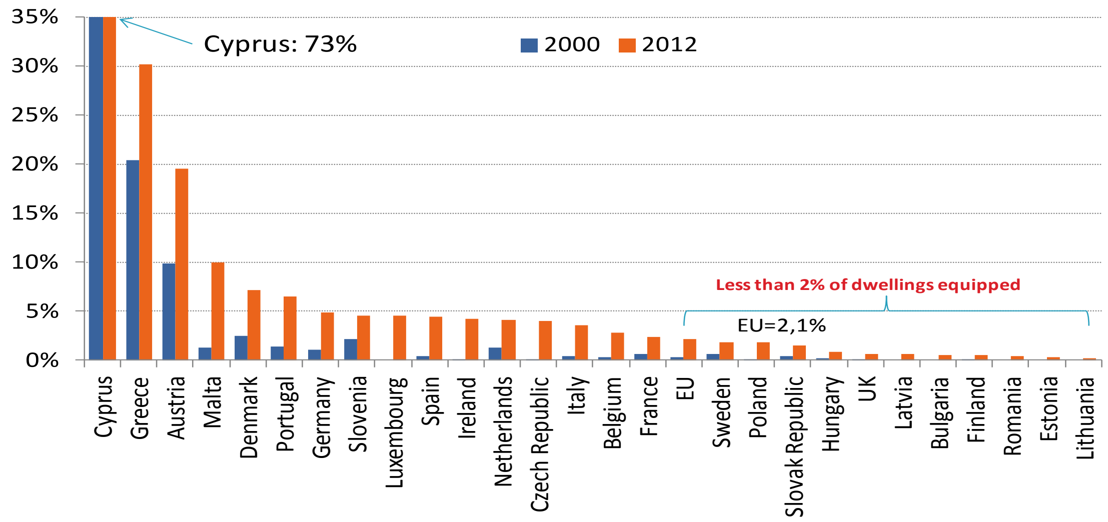
Source: ODYSSEE

Note: Indirect energy use does not take into account green electricity procured from other countries.

Cyprus and Greece forerunners in the installation of solar water heaters

Solar water heaters are promoted in many countries through financial and fiscal incentives (subsidies, soft loans or tax credits) and regulations making the installation of solar heaters in new construction or major renovations mandatory (e.g. Spain, Greece and Portugal). Around 3/4 of dwellings have solar water heaters in Cyprus and 30% in Greece. Austria is the benchmark among countries with medium solar radiation (20% of dwellings equipped in 2012). Good progress is observed in Greece, Austria and Cyprus (+10 percentage points), followed by Malta (+9 points) from 2000 to 2012.

Figure 42: Diffusion of solar water heaters (% of dwellings with solar heaters)



Source: ODYSSEE

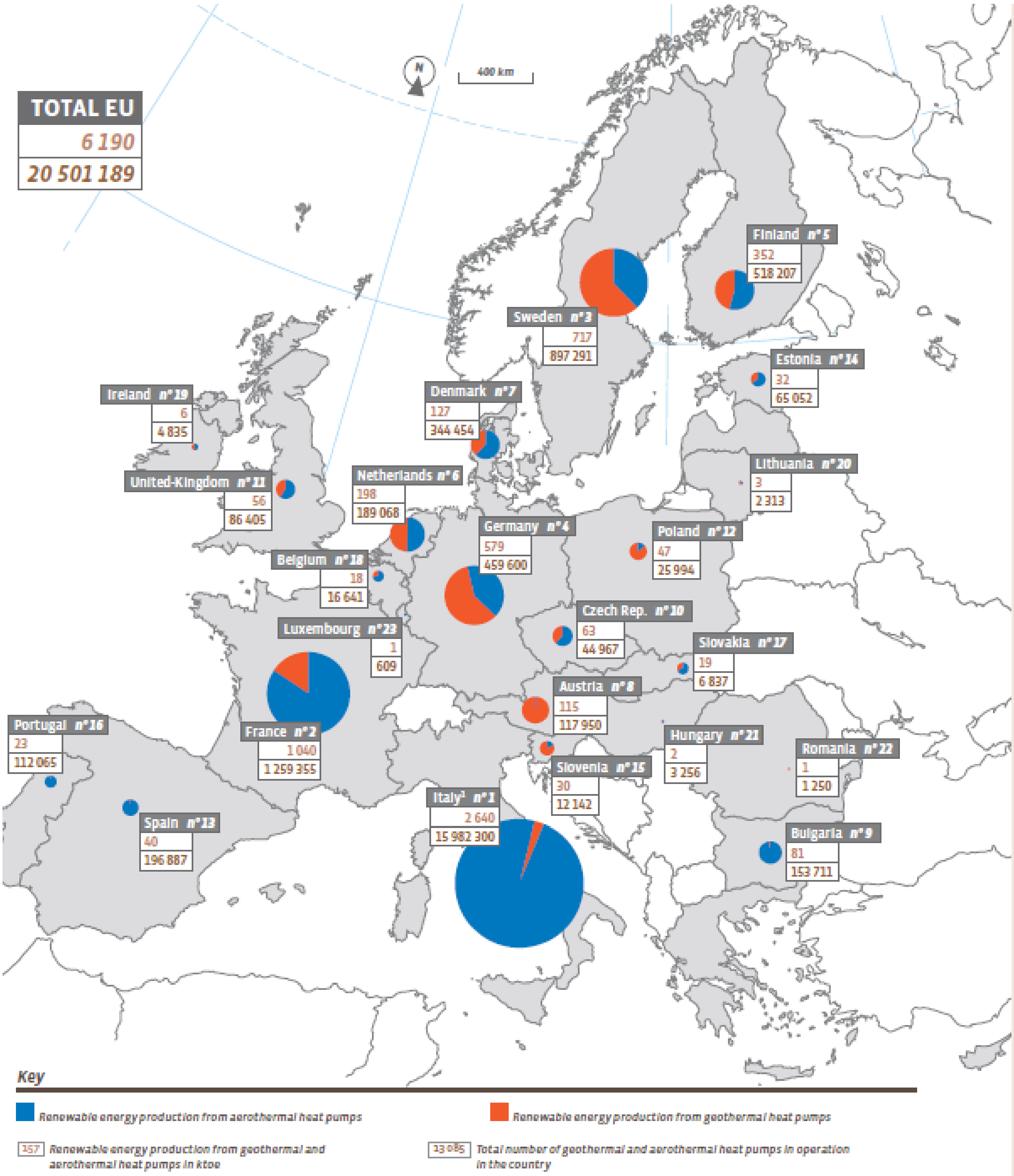
Heat pumps already make a considerable contribution

The total number of installed aero-thermal heat pumps was 19.5 million and geothermal heat pumps 1.0 million in Europe in 2012. Renewable heat production from heat pumps totalled 6.2 Mtoe in 2012, which is already comparable to the total energy supply of some smaller countries like Lithuania or Slovenia.

Italy is the clear leader in the air-to-air heat pump segment with 16 million installed units but the statistics include those with cooling as the main function (low capacity split and multi-split systems) which are not usually considered as heat pumps but which are partly acceptable by the RES Directive definitions. Sweden and Germany lead in the geothermal segment each with roughly 250 000 units, however given the market size, Sweden is a clear forerunner. (EurObserv'ER2013a)

According to the EurObserv'ER (2013a), heat pump sales in Europe surged between 2005 and 2008, have fluctuated thereafter and in 2012 there was an 8% drop in sales. The market is sensitive to construction volumes, electricity prices and policy actions.

Figure 43: Number of heat pumps and renewable energy production (ktoe) (2012)



Source: EurObserv'ER 2013b

5.2.2. POLICIES AND MEASURES FOR RENEWABLES

5.2.2.1. RES MEASURES FOR BUILDINGS IN THE MURE DATABASE

The MURE database cover energy efficiency measures and end-use of renewables, i.e., 'renewables-behind-the-meter" of the end-users, distributed renewables (e.g. subsidies for building related PV and solar thermal) as well as general measures which set general frames for renewables such as feed-in laws, quota schemes and green tariffs. Therefore, the database does not fully cover all the measures for promoting renewables. Consequently the focus in the following discussion is in the use of renewables in buildings.

Investment subsidies for RES investment are frequently used to address financial barriers. Nineteen countries have reported ongoing subsidy schemes in the household sector and just as many in the tertiary sector. Subsidy levels vary but tend to be highest for solar energy. Tax rebates can be used as well; e.g. in Finland hardly any air-to-air heat pumps are installed in existing buildings without applying for a tax rebate on labour cost. In France, the widely used Sustainable Development Income Tax Credit applies mainly to equipment (**Box 6.3**) while a separate measure, reduced VAT rate, reduces the labour cost.

In addition to measures addressing primarily RES, many reported measures promote both energy efficiency and renewable energy. In Greece, the Bioclimatic School Demonstration project improves the energy efficiency of school buildings by better energy management while making use of passive and active solar systems, hybrid systems, natural lighting, natural ventilation e.g. solar chimneys[54], solar control shading systems and green roofs.

BOX 6.3: SUSTAINABLE DEVELOPMENT INCOME TAX CREDIT/FRANCE

The Sustainable Development Tax Credit (CIDD) is a tax credit for the purchase of the most efficient materials and equipment in terms of energy consumption and greenhouse gas emissions. Cost of labour is only covered in the special case of the installation of opaque external wall insulation and ground source heat pumps.

This scheme was launched in 2005 and about 8 million households have used the facility. CIDD is available for homeowners and tenants (also occupants who do not pay rent).

Only works in existing buildings are eligible, except in the case of renewable energies, which may be financed for both new and existing buildings. A wide range of improvements are accepted: insulation of floor, roof, window and front door; insulation of heat or water distribution systems; installation of heating regulation equipment; domestic hot water equipment; energy producing equipment using renewable energy; and connection to a district heating fed by renewable energies or a cogeneration system etc. Source: MURE database.

[54] A solar chimney (or a thermal chimney) is a way of improving the natural ventilation of buildings by using convection of air heated by passive solar energy. It is a vertical shaft utilizing solar energy to enhance the natural stack ventilation through a building.

5.2.2.2. EPBD VS. RES DIRECTIVE

As discussed in Chapters 3.3 and 3.7 the EPBD and RES Directives have provisions aiming at increased use of renewables in buildings. Quite many regulatory measures in the MURE database concern the implementation of the EPBD directive which is not as explicit in its RES requirements as the RES Directive[55].

The Concerted Action RES Project has recognised that while the two directives have a common goal to reduce CO_2 emissions from buildings, there is some potential for tension between the two in achieving this. As buildings become more energy efficient, each additional energy efficiency measure will have diminishing (energy and carbon saving) returns, and renewable energy becomes relatively more cost effective.

There are three different possible approaches to integrating RES in the building regulations:

1) The approach can be very flexible involving capping the CO_2 or total energy consumption of a building and leaving it up to the developer whether they include renewables. The requirements on the energy performance are so tight that it is necessary to use some form of renewable energy to reach the requirements or to build to near passive house level. It is up to the building sector to decide which technology they want to use. The Netherlands is one of the forerunners in this holistic approach.
2) Alternatively a RES target can be specified for a building but it can be met with a manner of choice. In Norway, oil-fired boilers are banned as main heat source and all new buildings should have 40% (sizes below 500 m^2) or 60% (sizes over 500 m^2) net heat from RES (exceptions apply).
3) The third approach involves setting a target for a certain technology in a given circumstance. An example can be found from Greece, where 27% of residential buildings have solar thermal systems. By law, all new buildings and totally renovated existing buildings must have solar thermal systems which supply at least 60% of the energy needed for domestic hot water. Similar legislation is in place, e.g., in Portugal and Spain.

5.2.2.3. ON-SITE ELECTRICITY GENERATION

Prerequisites for increased electricity generation in buildings are easy network access and a possibility to sell surplus electricity. A two-way electricity meter is necessary and connection charges and building permit requirements may apply. The regulations regarding onsite electricity generation can be the same as for large plants. Technical issues such as choice of equipment need to be solved and qualified installers need to be found. Pricing of electricity sold is an important consideration in cost-effectiveness of becoming a supplier.

In the majority of countries there are measures in place to address these issues faced by local small-scale production by giving priority network access and providing feed-in tariffs. Feed-in tariffs are

[55] However, no measures can be directly connected to the implementation of the RES directive in the database because it is missing as an identifier for EU directives.

indirect subsidies which improve the cost-effectiveness for the supplier. The German Renewable Energy Act stipulates the level of the feed-in tariff and grants priority to the feeding in of, e.g., solar power. So does the Bulgarian Energy Act and RES legislation (2013 amendments taking force at the beginning of 2014). Croatia applies feed-in tariffs for solar electricity (PV and thermal) if equipment is integrated in a building.UK introduced a feed-in tariff scheme for small scale renewables and CHP in 2010 (**Box 6.4**). It is actually quite common to address smaller scale CHP production together with renewables, as biomass and biogas are viable fuel options also for small scale CHP.

Bureaucracy may be an overpowering barrier for small producers. A good practice can be found in Germany where the standard contract for feed-in tariffs that you sign with your utility is two pages long.

BOX 6.4: FEED-IN TARIFFS FOR SMALL-SCALE RES AND CHP/UK

The Feed-in Tariffs (FITs) scheme was introduced on 1 April 2010. Through the use of FITs, the government hopes to encourage deployment of additional small-scale (less than 5 MW) low-carbon electricity generation, particularly by organisations, businesses, communities and individuals that have not traditionally engaged in the electricity market. This will allow people to invest in small-scale low-carbon electricity, in return for a guaranteed payment from an electricity supplier of their choice for the electricity they generate and use as well as a guaranteed payment for unused surplus electricity they export back to the grid.

Small-scale low-carbon electricity technologies eligible for FITs are:

- wind
- solar photovoltaics (PV)
- hydro
- anaerobic digestion
- domestic scale micro-CHP (with a capacity of 2 kW or less) – a domestic scale micro-CHP pilot will support up to 30 000 installations, with a review to start when the 12 000th installation is completed.

The tariff levels have been amended multiple times since the inception of the scheme. On 9 June 2011, reductions in FIT rates were announced for PV systems with total installed capacity greater than 50 kW by 38-72% depending on the size of the installation. In its second year, the government announced further tariff reductions. The review of the FIT brought an additional decrease of around 50% for smaller installations and 14-30% for larger installations. This was mainly a result of unexpected high uptake according to government analysis.

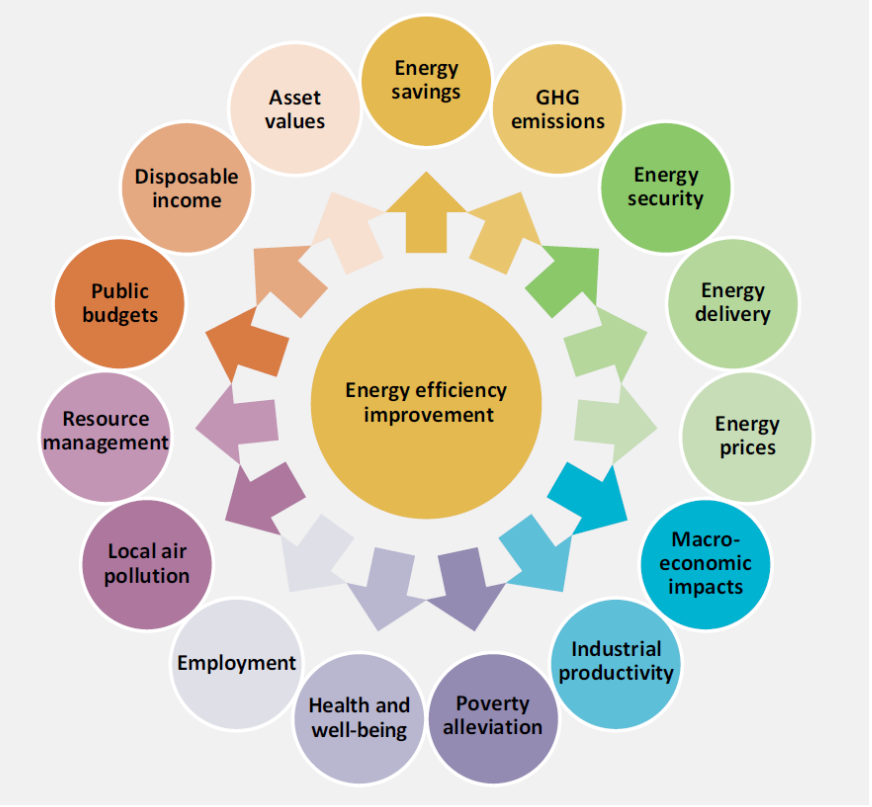
Source: MURE database.

6.3 CO-BENEFITS OF ENERGY EFFICIENCY AND RENEWABLES

Energy efficiency brings about a multitude of co-benefits, i.e., benefits that go beyond the mere energy savings. Recently, they have also been called 'multiple benefits'. Figure 44 summarises some of the most typical co-benefits, e.g. those related to security of supply, environment, health, financial gains and competitiveness. The use of renewable energy is most commonly associated with reduced CO_2 emissions and improved energy security but also job creation.

According to the IEA (2014) early investigations of these multiple benefits suggest that they are significant, however they are left out of most policy and programme evaluations for various reasons, including lack of relevant data and evaluation methods, estimation challenges and perceived credibility risk.

Figure 44: Co-benefits of energy efficiency



Source: IEA 2014.

A few examples of measures clearly recognising these benefits can be found in the MURE database. In Romania "The Green House Programme" (2010-2011, reactivated in 2014) aims at improving air quality and reducing water and soil pollution from fossil fuels and traditional fire wood heating in households and some public facilities. Solar energy, biomass and heat pumps are promoted by subsidies.

The Romanian programme recognises that also renewable energy can sometimes have adverse environmental impacts. Using fire wood (in fireplaces or wood boilers) can cause health impacts by fine particles and carbon monoxide depending on combustion technology, ventilation, quality of wood and user behaviour. In Oslo, households can receive subsidies from the local energy utility for replacement of old polluting fireplaces. Another adverse effect often associated with RES is indoor and outdoor noise from heat pumps. In the area of energy efficiency, heavily insulated low-energy buildings have been reported to block mobile phone signals.

The Greek programme “Bioclimatic Urban Reformation” reduces need for cooling energy while improving comfort by making the urban environment cooler and greener.

The Spanish Law 15/2012 on tax measures aimed at energy sustainability reforms energy taxes with a view to internalizing the environmental costs (externalities) stemmed from, e.g., electric power production. Such a tax inherently recognises the existence of co-benefits.

Other co-benefits exist in addition to those shown in Figure 44. For example, light pollution from buildings is alleviated in France by regulation (**Box 5.7**). Lithuanian museum and library programmes improve their energy efficiency and indoor conditions thus preserving cultural heritage.

The Finnish household tax deduction measure used for labour cost associated with energy efficiency and RES investments also reduces grey economy, i.e. in this case work done without a receipt.

BIBLIOGRAPHY

Borchardt K-D. 2014. Benchmarking smart metering deployment in EU. European Conference on Smart Metering Deployment in the EU Brussels, 26 June 2014.

BPIE 2014. Renovation Strategies of Selected EU Countries, A Status Report on Compliance with Article 4 of the Energy Efficiency Directive. Buildings Performance Institute Europe. http://bpie.eu/uploads/lib/document/attachment/86/Renovation_Strategies_EU_BPIE_2014.pdf

Concerted Action EED 2014. http://www.esd-ca.eu/

Concerted Action EED 2012. Public Private Partnership for Energy Efficiency.Executive Summary. Report 23 April 2012.

Concerted Action EED 2011. New and existing business models for energy services. Executive Summary. Report 6 December 2011.

Concerted Action EPBD 2013. Implementing the Energy Performance of Buildings Directive (EPBD) – Featuring Country Reports 2012. Intelligent Energy Europe Programme. June 2013.

Concerted Action RES 2014.http://www.ca-res.eu/index.php?id=2&no_cache=1

Defra. An Assessment of the Potential Effectiveness and Strategic Fit of Personal Carbon Trading. http://www.teqs.net/EffectivenessAndStrategicFit.pdf

EEA 2013. Achieving energy efficiency through behaviour change: what does it take? European Environmental Agency. EEA Technical report No 5/2013.

Ehrhardt-Martinez et. al. 2011.Changing Habits, Lifestyles and Choices: The Behaviors that Drive Feedback-Induced Energy Savings. eceee Summer Study 2011.

EurObserve'ER 2013a. The State of Renewable Energies in Europe, edition 2013.http://www.energies-renouvelables.org/observ-er/stat_baro/barobilan/barobilan13-gb.pdf

EurObserve'ER 2013b. Heat Pumps Barometer. October 2013. http://www.energies-renouvelables.org/observ-er/stat_baro/observ/baro218_en.pdf

European Commission 2011. Energy Efficiency Plan 2011. COM(2011) 109 final. Brussels 8.3.2011.

European Commission 2012. Directive 2012/27/EU of the European Parliament and of the Council of 25 October 2012 on energy efficiency, amending Directives 2009/125/EC and 2010/30/EU and repealing Directives 2004/8/EC and 2006/32/EC.

European Commission 2012. Implementing the Energy Performance of Buildings Directive – Featuring country reports 2012. Concerted Action EPBD.

European Commission 2013. Energy performance certificates in buildings and their impact on transaction prices and rents in selected EU countries. Report by Bio Intelligence Service, European Commission 2014a. Energy Efficiency and its contribution to energy security and the 2030 Framework for climate and energy policy. COM(2014) 520. http://ec.europa.eu/smart-regulation/impact/ia_carried_out/docs/ia_2014/com_2014_0520_en.pdf

European Commission 2014b. Progress report on the application of Directive 2006/32/EC on energy end-use efficiency and energy services and on the application of Directive 2004/8/EC on the promotion of cogeneration based on a useful heat demand in the internal energy market. COM(2013) 938 final. Brussels, 8.1.2014.

Eurostat 2011. Taxation trends in the European Union - Data for the EU Member States, Iceland and Norway. 2011 edition. Publications of the European Union. ISBN 978-92-79-19644-7.

Eurostat 2013. Taxation trends in the European Union - Data for the EU Member States, Iceland and Norway. 2013 edition. Publications of the European Union. ISBN 978-92-79-28852-4. http://piketty.pse.ens.fr/files/Eurostat2013.pdf

IEA 2014. Capturing the multiple benefits of energy efficiency.

JRC 2014. ESCO Market Report 2013. Joint Research Centre, Science and Policy Reports, EUR-26691-EN.http://iet.jrc.ec.europa.eu/energyefficiency/sites/energyefficiency/files/jrc_89550_the_european_esco_market_report_2013_online.pdf

Lyons R. and IEEP. Final report 19 April 2013.

http://ec.europa.eu/energy/efficiency/buildings/doc/20130619-energy_performance_certificates_in_buildings.pdf

McKinsey 2013. Sizing the potential of behavioural energy-efficiency initiatives in the US residential market. November 2013.

MURE Database: http://www.odyssee-mure.eu/

ODYSSEE Database: http://www.odyssee-mure.eu/

ODYSSEE-MURE 2012. Financing the Energy Efficient Transformation of the Building Sector in the EU. Report by the Fraunhofer Institute for Systems and Innovation Research ISI. September 2012.

Pedroli B. & Langeveld H. (Eds.) 2011. Impacts of Renewable Energy on European Farmers – Creating Benefits for Farmers and Society. Final Report for the European Commission Directorate-General Agriculture and Rural Development. 5 December 2011.

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