

# Energy efficiency trends in buildings

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## Key questions

- **What are the main drivers of the energy demand in EU buildings?**
- **How has improved energy efficiency in residential and service buildings over the last 16 years in the EU?**

**In 2016, buildings represent almost 40% of the EU final energy consumption. There are large disparities in building performances across countries.**

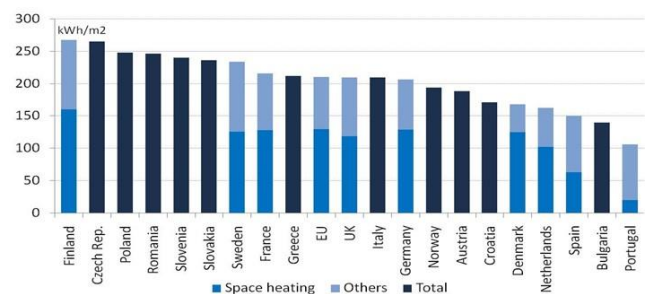
With a consumption of 458 Mtoe in 2016, buildings account for 41% of the final energy consumption and 60% of the electricity consumption in the EU-28. Two thirds of this consumption are for residential buildings.

After an increase of 0.7%/year from 2000-2008, energy consumption of buildings has steadily decreased until 2016 (-0.6%/year). After the economic crisis, energy consumption has decreased by 0.3%/year (since 2010) while GDP has risen by 1.3%/year.

In the EU, the average annual consumption per m<sup>2</sup> for all types of buildings reaches around ~200 kWh/m<sup>2</sup>. Service buildings are on average 60% more energy intensive than residential buildings (300 kWh/m<sup>2</sup> compared to 170 kWh/m<sup>2</sup>). This specific consumption varies significantly among EU countries: for instance, values for Spain and Sweden are respectively 25% lower and 5% larger than the EU average. Such

differences can be explained by climatic conditions, high share of space heating or air cooling, technical characteristics of dwellings etc.

Figure 1: Energy consumption in building (kWh/m<sup>2</sup>)

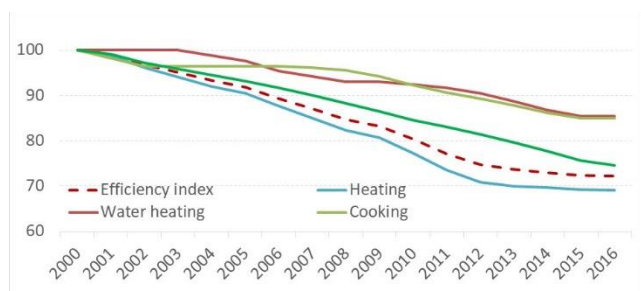


Source: ODYSSEE

**Household energy efficiency has improved by 28% at EU level since 2000 thanks to more efficient heating systems and buildings.**

Energy efficiency of European households, as measured by an energy efficiency index called ODEX, has improved by 28% since 2000 (-2% /year). Most improvements are registered for space heating (-2.3%/year), which is the most important end-use (66% of total household consumption) (**Figure 2**).

Figure 2: Energy efficiency trends for households at EU level based on ODEX



Source: ODYSSEE

There is an increasing diffusion of efficient heating systems throughout Europe. Italy is for instance the leading country for heat pumps (75% of dwellings equipped in 2015), followed by Sweden and Finland (above 25% in 2015). The Netherlands has the largest share of dwellings equipped with condensing boilers, with more than 80% dwellings equipped<sup>1</sup>. UK has experienced very large penetration rates from 1,5% in 2000 to 40% of dwellings equipped with condensing boilers. The diffusion of pellet boilers and stoves instead of traditional wood heating systems also contributes to improve efficiency: Italy is the country with highest share of pellet boilers and stoves in Europe (115 equipment per 1000 dwellings in 2016), following by Austria (51 per 1000 dwellings), France and Germany.

To a lesser extent, energy efficiency improvement for households is also due to the construction of low-energy buildings. According to EU regulations, the average theoretical consumption for new dwellings is 40% less than for dwellings built before 1990. However, new dwellings represent each year on average only 1.1% of the existing stock (2000- 2016). The impact of new dwellings on the global energy performance of the stock is thus limited. Also part of the improvement is due to the

<sup>1</sup><https://ec.europa.eu/energy/sites/ener/files/documents/Report%20WP2.pdf>

<sup>2</sup> Large appliances include cold appliances (i.e. refrigerators and freezers), washing appliances (washing machines, dish washers

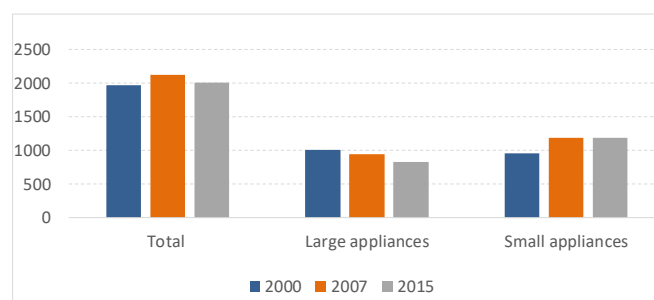
and dryers) and TVs. Refrigerators, dish washers and freezers represent almost 60% of the electricity consumption of large appliances.

**Energy efficiency of large electrical appliances has largely improved and counterbalances the rapid growth of small appliances in the household consumption.**

The average consumption of electrical appliances per dwelling has increased until 2007. It has subsequently slightly decreased, reaching ~2 000 kWh/dwelling in 2015. This trend results from two opposite effects:

- a regular decrease of the specific consumption of large appliances <sup>2</sup> (- 1.2%/year since 2000)
- a rapid increase of the specific consumption of small appliances until 2007 (by 3%/year), followed by a stabilization (**Figure 3**).

Figure 3: Specific consumption trend of electrical appliances

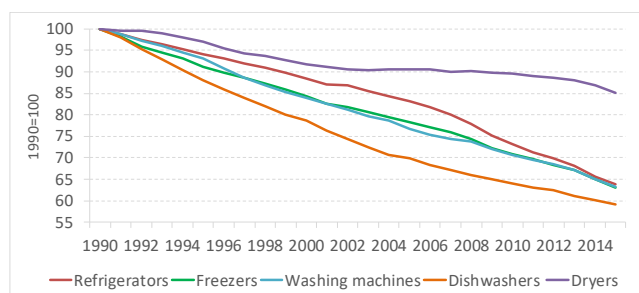


Source: ODYSSEE

As a result, in 2015, small appliances show the largest share of the appliances energy consumption (60% in 2015 compared to around 50% in 2000) (**Figure 3**).

and dryers) and TVs. Refrigerators, dish washers and freezers represent almost 60% of the electricity consumption of large appliances.

Figure 4: Change in specific consumption of large appliances



Source: ODYSSEE

Specific consumption of large appliances (measured in kWh per appliance) has decreased steadily since 1990 with the diffusion of new efficient technologies driven by labelling and eco-design regulations. Efficiency gains are above 35% for cold appliances (refrigerators and freezers), washing machines and dish washers; for dryers, gains are lower, around 15% (Figure 4).

**Energy consumption of residential buildings slightly decreased over the last 15 years, with energy savings counteracting other drivers**

Energy consumption of residential buildings showed an increase of 0.5%/year between 2000-2008 and a decrease of 0.7%/year between 2008-20016. As a result, in 2016, the energy consumption is slightly below its 2000 level.

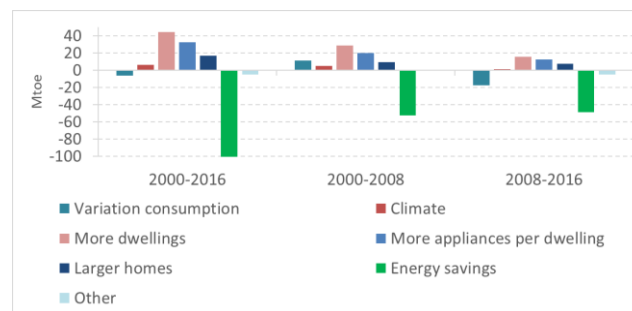
Two main factors are responsible for an increase in household energy consumption:

- A growing number of dwellings, explained by population growth and, in some countries, an increasing number of one-person households;
- An increasing demand for comfort (“lifestyle effect”) characterized by an increasing number of domestic appliances and larger homes.

The final energy consumption of residential buildings was 6 Mtoe lower in 2016 than in 2000. On the one hand, two main factors contributed to increase energy consumption over the period – more dwellings (by 44 Mtoe), and lifestyles (32 Mtoe

because of “more appliances per dwelling” and 17 Mtoe due to “larger homes”). Energy savings (101 Mtoe) more than offset the effect of the drivers of consumption growth and explain the observed decrease in energy consumption (Figure 5).

Figure 5: Drivers of the energy consumption variations for households (EU)



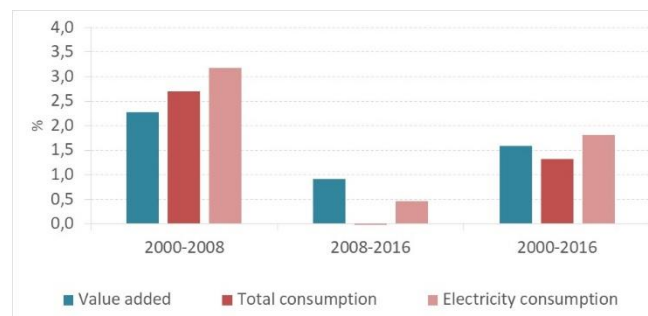
Source: ODYSSEE decomposition tool; actual consumption

**Energy consumption in services has increased by 20% since 2000 despite a slowdown after the economic crisis**

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

Energy consumption of services in EU reached 150 Mtoe in 2016 (23% more than in 2000). It increased rather rapidly by 2.7%/year until 2008 and remained almost stable afterwards. (Figure 6).

Figure 6: Trends in energy consumption and value added in services (%/year)



Source: Eurostat

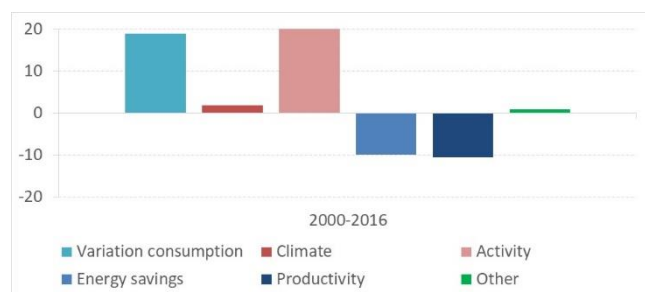
In the EU, the energy consumption per employee (at normal climate) increased by 0.7%/year between 2000-2008 and subsequently decreased by -0.6%/year.

### Increasing energy consumption of services because of a growing activity which outweighs energy savings and productivity reduction

Changes in energy consumption in the service sector can be decomposed into various explanatory factors:

- Change in economic activity, measured with the value added ("activity effect")
- Energy savings, measured from changes in energy use per employee
- Changes in labor productivity, i.e. changes in the ratio value added per employee
- Climate effect
- Other effects, i.e behavioral effects and "negative savings".

Figure 7: Decomposition of energy use for services



Source: ODYSSEE

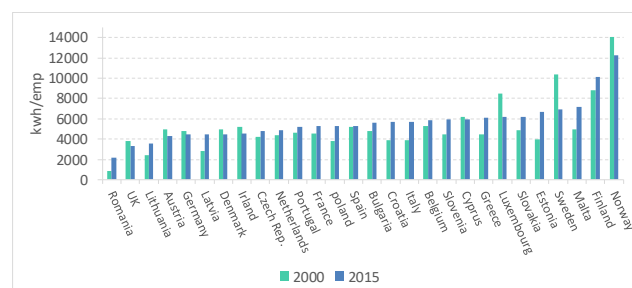
At the EU level, the increase of energy consumption of the service sector between 2000-2016 (19 Mtoe) is mainly due to an increase in activity (37 Mtoe). This effect is partially counterbalanced by energy savings and labor productivity (representing 10 Mtoe each) (Figure 7).

### Net slowdown in the electricity consumption of services since 2008

Electricity consumption has increased by more than 3%/year from 2000 to 2008 and by only 0.5%/year from 2008 to 2016 (Figure 6).

At EU level, the electricity consumption per employee shows a growing trend of 1.4%/year between 2000- 2008 and remains quite stable afterwards. A similar trend can be observed in most countries except in 10 countries of which Germany, UK, Austria, Ireland, Slovakia, Denmark, Luxembourg, Sweden and Norway. It exists in Europe a large discrepancy among countries: lowest level for Romania and UK, highest level in Nordic countries and Malta, partly due to a large use of electricity for heating (Nordic countries) or air conditioning (Malta) (Figure 8).

Figure 8: Electricity consumption per employee (EU)



Source: ODYSSEE

For further reading or information, please visit <http://www.odyssee-mure.eu/>