Agência para a Energia

Energy Efficiency trends and policies in Portugal

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EXECUTIVE SUMMARY

This report presents an analysis of the main energy efficiency trends in Portugal, covering the national macroeconomic context as well as each activity sector. It refers the changes occurred in the country within the period between 2006 and 2016, based on the national collected data, international sources and energy efficiency indicators, taken from ODYSSEE database.

This report contains contributions from the previous country report of the ODYSSEE-MURE (from October 2015), due to its relevant, still updated and continued data application. Updated data are indicated, when available.

During the period 2006 - 2016, Portugal showed significant improvements in relation to energy efficiency. The main impacts observed in the referrer period were:

- Reduction of primary energy by about 13.8% in 2016 compared to 2006;
- Lower energy dependence: from 88.8% in 2005 to 74.9% in 2016;
- In 2016, 43.5% of total primary energy consumption came from renewable sources;
- The primary and final energy intensities (at M€2011) in 2016, compared to 2006, decreased by 15.4% and 18.9%, respectively;
- In the period 2006-2016 the GHG emissions averaged a decline of -1.9%.
- In terms of final energy consumption, the oil products in 2016 accounted for 48,7% (compared to 59,1% in 2006. On the other hand, the consumption of electricity increased from 21.2% in 2006 to 25,8% in 2016;
- The transport sector in 2016 was the largest consumer of energy (43%), followed by industry (27%);
- The energy intensity of the transport sector, based on the 2010 year price, decreased by about 3%, between 2006 and 2016;
- The tendency for energy consumption in the services sector is to grow since 2006, representing 13% of total energy consumption in 2016;
- The energy consumption of the household sector in 2016 represents 17% of total final energy consumption. This sector was the one with the biggest gains in terms of energy efficiency (37%);
- Concerning the NEEAP the accumulated final energy savings till 2015 are equivalent to 1102342 toe, representing an accomplishment of 55% of the 2016 target.

Considering the same comparative years (2006-2016) both, primary energy consumption and final energy consumption reduce, respectively by 16.5% and 20.0%. Similarly, the four main activity sectors decrease their energy consumption:

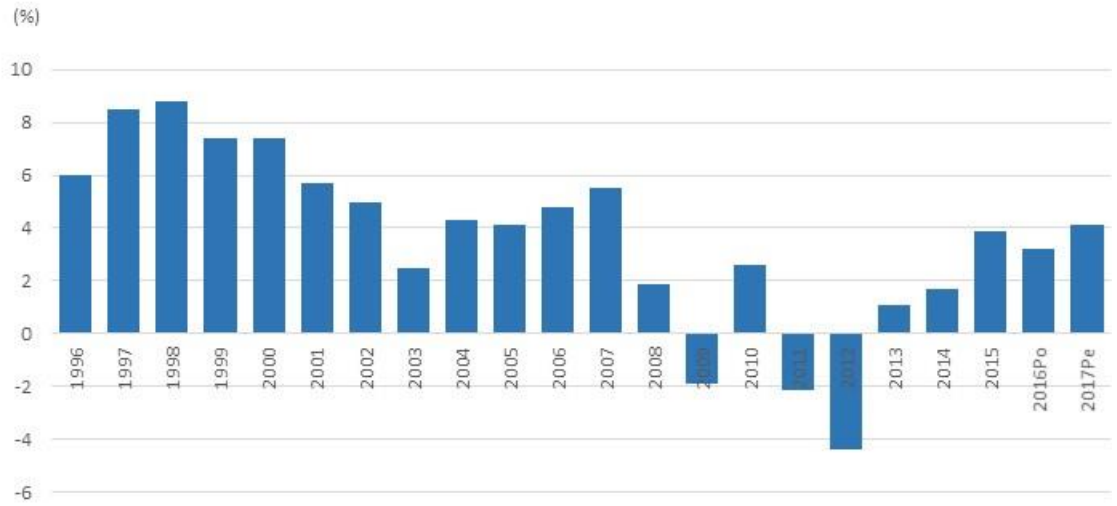
- Transports registered a decrease of 5%;
- Industry performed the highest drop with 21%;
- Household presented a diminish by 20.0% and services, with a lower impact, decreased by 10.2%;
- Overall, electricity consumption reduced by 2.4% mainly due to residential sector (-2.4%), yet followed by industry (-7.6%). In 2016 year, the macroeconomic indicators presented a slight positive trend than in 2015, according to the foreseen data.

1. ECONOMIC AND ENERGY EFFICIENCY CONTEXT

1.1. ECONOMIC CONTEXT

The Portuguese Gross Domestic Product (GDP) at market prices evaluation shows 2017 with 0.9 percentage points higher than was achieved in 2016. Its evolution throughout last 11 years is shown in Figure 1.

Figure 1: Gross domestic product at market prices (nominal change rate; annual) [Source: INE - Statistics Portugal, National Accounts]

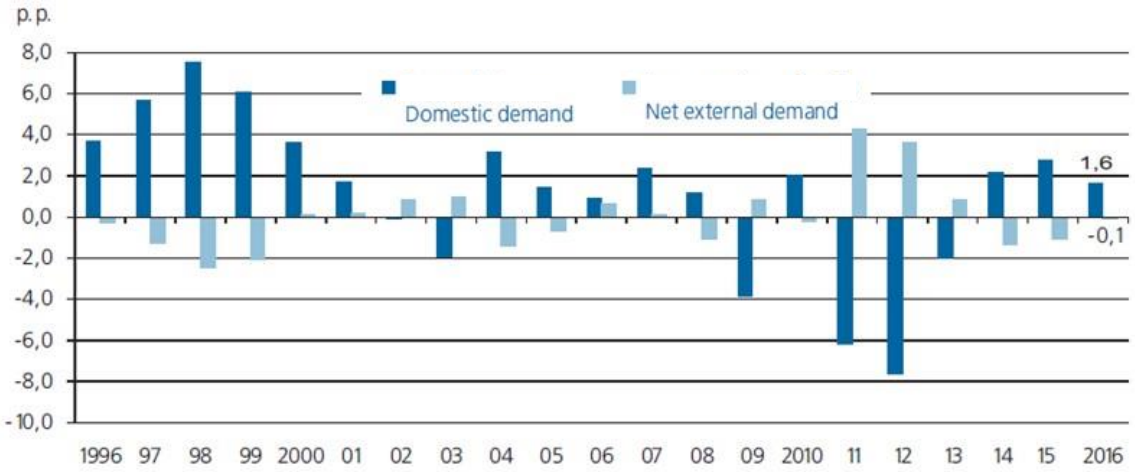


Likewise, the GDP in real terms increased in 2017 by 2.7%, 1.1 percentage points higher than the rate of change registered in 2016.

In 2016, GDP recorded a rate of change of 1.6% in real terms (1.8% in 2015). The contribution of domestic demand to annual GDP growth diminished from 2.7 p.p. in 2015 to 1.6 p.p. in 2016, mostly reflecting a steep deceleration of investment. 2017 year saw a reversal trend of domestic demand for values occurring in 2015 reflecting an investment recovery.

In 2016 net external demand contribution to annual GDP was -0.1 p.p. (-1.1 p.p. in 2015), as shown in Figure 2.

Figure 2: Contribution to GDP growth in volume [Source: INE - Statistics Portugal, National Accounts]



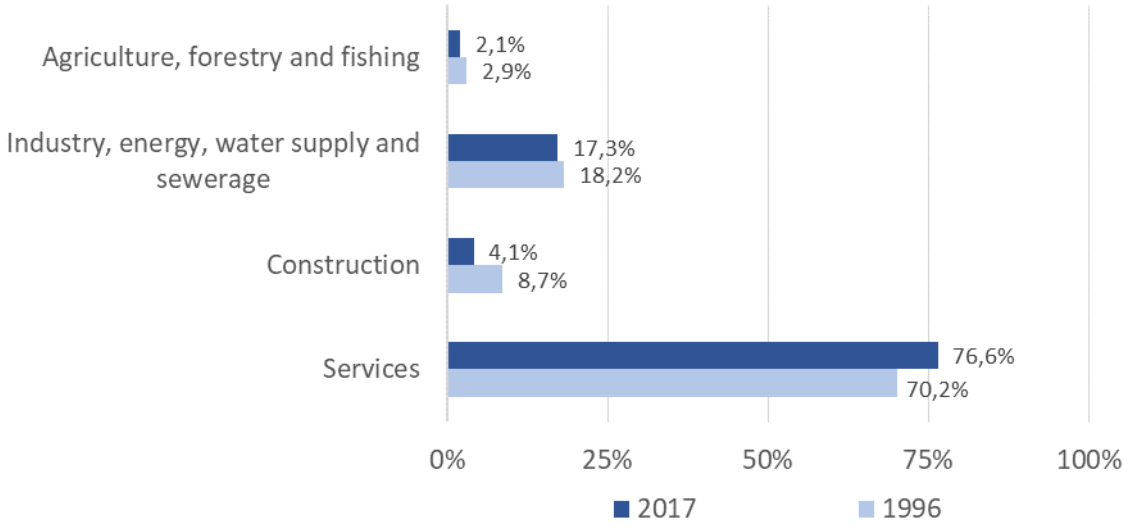
Private consumption, real growth, changed through 2.1% in 2016 to 2.3% in 2017. It is worth highlighting the evolution in expenditure on durable goods, registering an increase of 5.9% in 2017, following a 11.7% increase in the previous year.

Final consumption expenditure increases in 2017 by 1.7%, which was slightly lower than the increase in the previous year (+1.8% change).

Imports of goods and goods and services increased by 7.9% in 2017, compared to 4.2% increase in the previous year. This mainly reflects the growth of goods import by 8.0%, after a 4.5% increase in 2016. On the external demand side, there was also a strong export growth in volume, increasing by 7.9% in 2017, compared to 4.4% increase in the previous year. This mainly reflects the growth of services export by 10.9%, after a 4.3% increase in 2016.

Throughout the series started in 1996, service activities have changed in volume, on average, more than the rest of the economy. This, jointly with a change in relative prices also generally favourable to service activities – which are by nature less subject to foreign competition – has contributed to relatively higher nominal changes in the respective gross value added (GVA). Between 1996 and 2017 the structure of the economy's total GVA changed significantly (see Figure 3), stress being laid on a considerable increase in the relative weight of services, in contrast to a significant decline in the relative importance of construction.

Figure 3: Percentage composition of (nominal) GVA [Source: INE - Statistics Portugal, National Accounts]



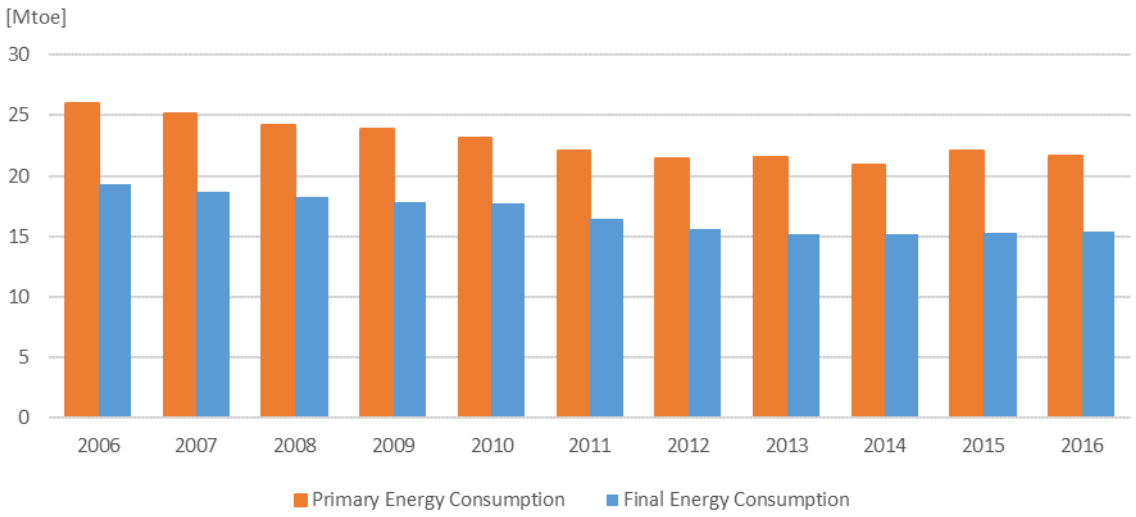
1.2. TOTAL ENERGY CONSUMPTION AND INTENSITIES

In 2016 primary energy consumption (21.7 Mtoe) decreased 1.7% compared to 2015, while final energy consumption (15.4 Mtoe) increased 0.5% compared to the previous year.

In the last years, 2006-2016, both final energy and primary energy consumption, observed an annual average decline of 1.8% and 2.2%, respectively. This scenario is observed in the figure 4, where is also noticed that the gap between both (final and primary energy) has remained relatively stables.

From 2012 to 2016 a stabilization has been observed in the final energy consumption.

Figure 4: Primary and final energy consumption [Source: Directorate-General for Energy and Geology (DGEG)]

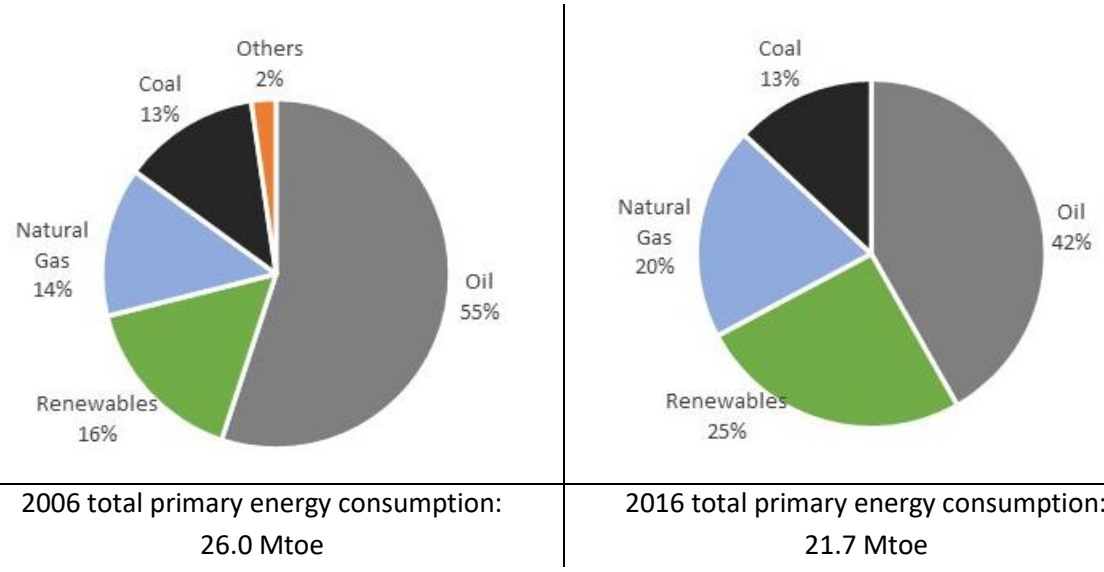


The decrease in primary energy consumption was due to several factors, as:

i) improvement of the energy efficiency of electricity production;
ii) lower losses in the transmission and distribution of electricity;
iii) greater uptake of renewable energy (renewable component accounted for 25.7% of the total primary energy consumption, which is one of the higher values ever in Portugal);
iv) reduction of the import balance; iv) increase of mini and micro production;
v) CHP more efficient according to legislative requirements for new projects, and
vi) greater efficiency in end-use.

It is also important to note the changes that had occurred over the past decade concerning the composition of primary energy sources. Oil continue to be the main source of primary energy with a share of 41% in 2016 (-13 p.p. than in 2006). However, natural gas and renewable energy increased from 2006 to 2016, mainly replacing oil and coal consumption.

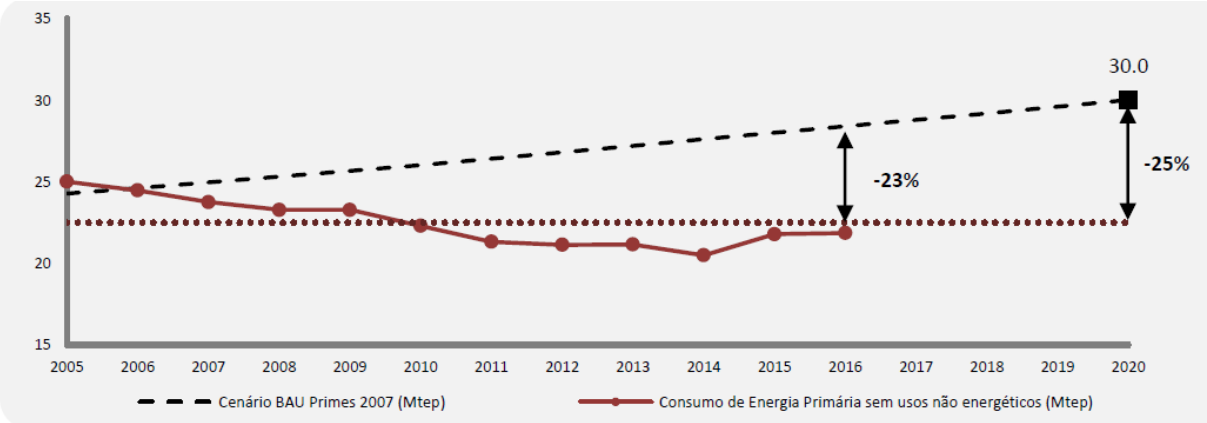
Figure 5: Share of primary energy consumption source [Source: Directorate-General for Energy and Geology (DGEG)]



2006 total primary energy consumption: 26.0 Mtoe	2016 total primary energy consumption: 21.7 Mtoe

Looking at the primary energy consumption evolution that serves as reference for the accomplishment of Energy Efficiency 2020 goals (non-energy uses excluded and international air transport consumption included), it's possible to observe that the 2016 indicator is still lower than the reference stablished for Portugal (22.5 Mtoe to ensure the goals achievement of 25% of primary energy reduction). This scenario shows that Portugal is in a good way to achieve the planned goals to 2020.

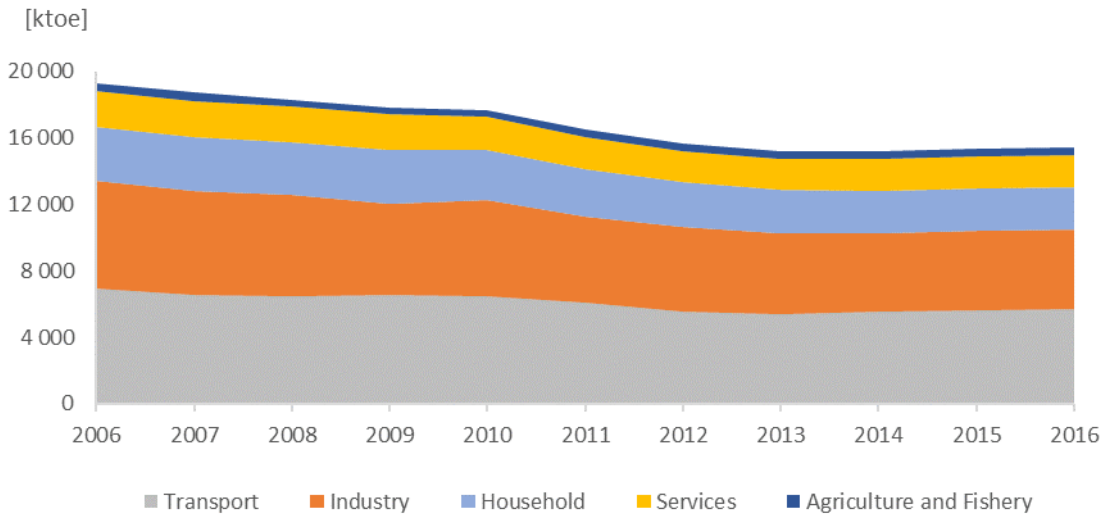
Figure 6: Evolution of Portuguese Goals on Energy Efficiency for 2020 [Mtoe] [Source: Directorate-General for Energy and Geology (DGEG) – Energy in Portugal 2016, published in July 2018]



Looking at the final energy consumption by sector in 2016 it's possible to conclude that the transport and industry sectors have the highest shares, with 37.0% and 30.7% of total final energy consumption, respectively. Compared to the previous year, energy consumption in the transport sector increase 1.9%, residential sector increased 2.1%, agriculture and fishery increase 2.3%, industry and service sectors decrease their energy consumption by 1.2% and 1.4%, respectively.

Overall, all the sectors reflected the downward trend in the final energy consumption in the 2006-2016 period, from industry, with a reduction of 26.5%, to agriculture and fishery which had a final energy consumption decreased by 9.3%.

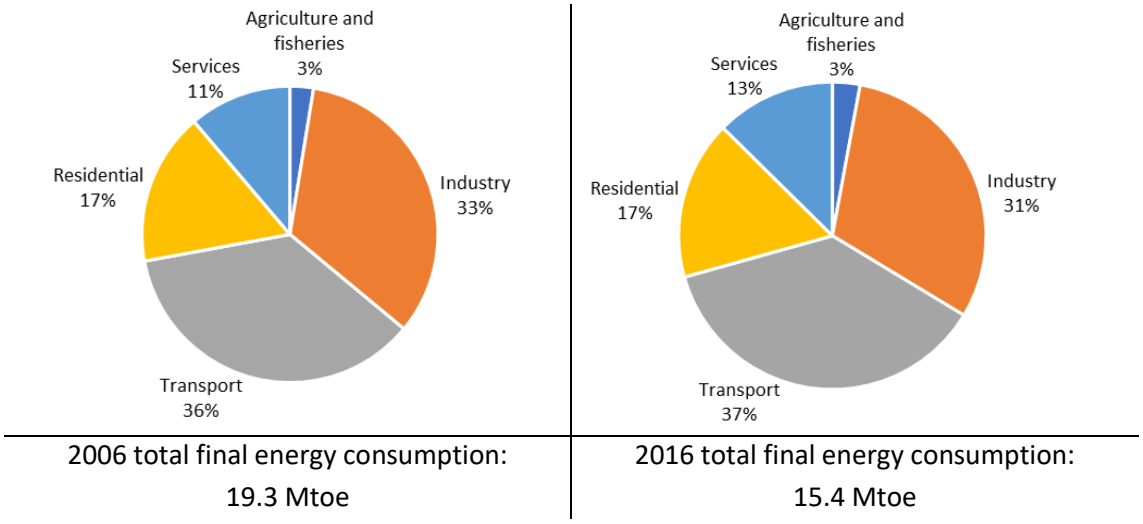
Figure 7: Final energy consumption trends (ktoe) [Source: Directorate-General for Energy and Geology (DGEG)]



Regarding the sectoral share distribution is observed that when comparing the 2016 to 2006 the services, transport and agriculture sectors noted an increase of 1.4 p.p., 0.9 p.p. and 0.3 p.p.,

respectively while, in opposite, the industry fell out by 2.7 p.p and the household sector remained unchanged.

Figure 8: Shares of final energy consumption by activity sector (%) [Source: Directorate-General for Energy and Geology (DGEG)

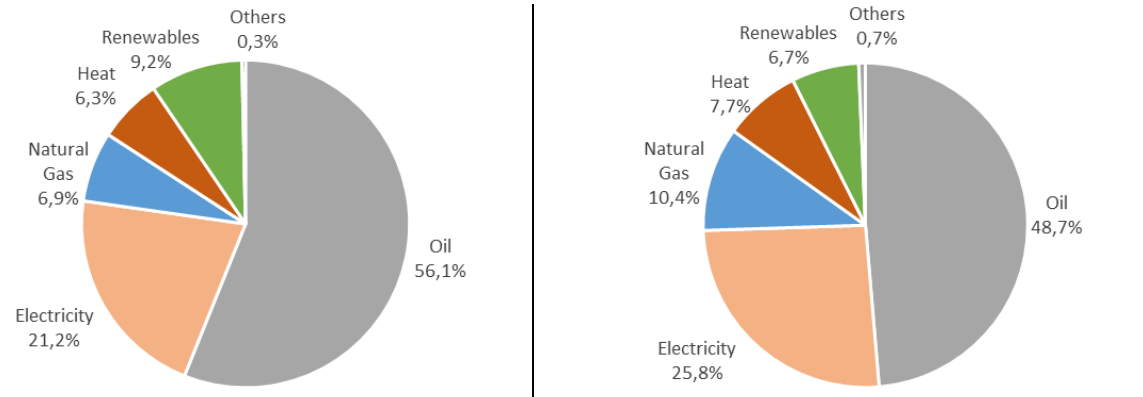


2006 total final energy consumption: 19.3 Mtoe	2016 total final energy consumption: 15.4 Mtoe

In regard to the final energy consumption by fuel type, the changes are significant:

- Oil products (mainly diesel, gasoline and LPG) decreased from 56% of total final energy consumption in 2006 to 49% in 2016.
- In contrast, together the electricity, natural gas, renewables and heat increased its share between 2006 and 2016.

Figure 9: Shares of final energy consumption by type of fuel (%) [Source: Directorate-General for Energy and Geology (DGEG)]



2006 total final energy consumption: 19.3 Mtoe	2016 total final energy consumption: 15.4 Mtoe

The final consumption of oil products decreased in almost activity sectors (excluding the agriculture sector) with the industry sector being responsible for most of this decrease, remaining relatively constant in the transport sector.

Looking at the electricity consumption in 2016, the industrial sector accounted for considerable share (37.2%). The services sector came in second (32.6%) followed by the residential (27.7%) and made up

an important part of total electricity consumption in 2016 (60.3%) which correspond to the consumption in the buildings sector.

Table 1 – Electricity consumption by consumer type [Source: ADENE based on Directorate-General for Energy and Geology (DGEG) data]

	Electricity consumption by consumer type [GWh]				
	2014	2015	% 2014/_15	2016	%2016/_15
Agriculture	825	856	+3.8%	812	-5.1%
Residential	11 908	11 975	+0.6%	13 087	+9.3%
Industry	17 294	17 427	+0.8%	17 607	+1.0%
Services	15 828	16 296	+3.0%	15 443	-5.2%
Transport	295	300	+1.7%	378	+26.0%

Electricity, the second major source marked in the national energy balance, noticed a decrease in its energy consumption from 2006 to 2016, of approximately 0.1 Mtoe (-2.4%).

Buildings sector, in 2016, led the electricity consumption with around 60.3% share, desegregated by tertiary sector with 32.6% and 27.7% in residential sector, followed by industry sector with 37.2% of share. It is noteworthy that the electricity energy consumption in the tertiary sector represents 74.3% of the consumption in this sector, while in the residential sector this type of energy represents 43.6% followed by renewable energy consumption with 31.2%.

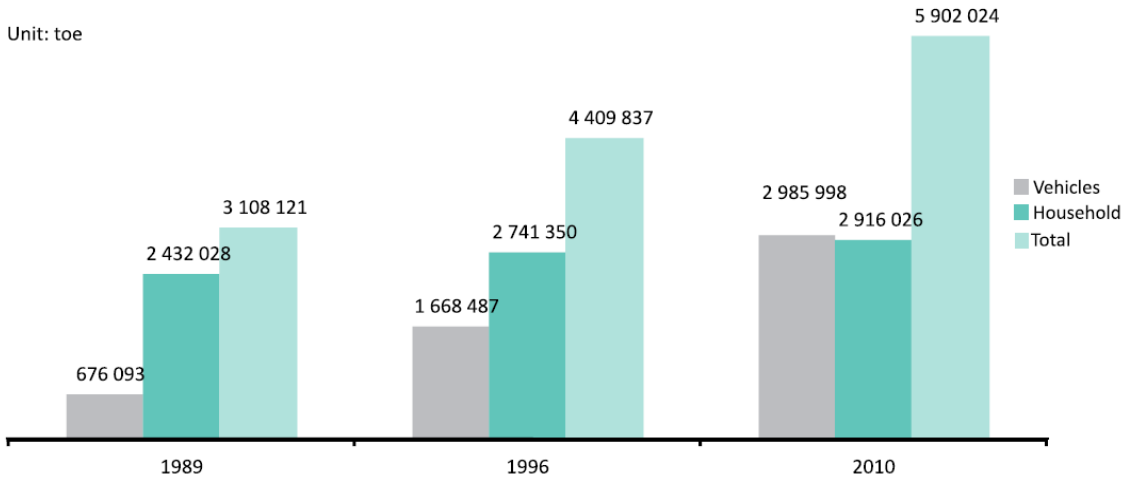
Moreover, in 2016 car fuel consumption per inhabitant was 0.53 toe (+2.1% compared to 2015). Overall, 5.2 million tonnes of car fuel (as measured through sales by distribution companies) were consumed, accounting for a 1.9% increase compared to 2015. Diesel accounted for the highest share of consumption, with 79.1% of the total. LPG consumption (auto gas) increased further (+4.1% compared to 2015), reaching 37 thousand tonnes, while gasoline consumption decreased 2.6% compared to 2015, reaching around 1.1 million tonnes of car fuel.

According to the results of the Survey on Energy Consumption in Households held in 2010 (Portuguese acronym: ICESD 2010), Portugal has witnessed a change in energy consumption habits of households over the past 15 years.

Figures taken from the ICESD 2010 showed that total energy consumption was estimated at 5.902.024 toe in the reference period. Energy consumption in vehicles used in the individual transport of household residents accounted for 50.6% of the total, and for the first time this figure was higher than energy consumption in households (49.4%). Vehicle consumption accounted for 21.8% of the total in 1989 and 37.8% in 1996.

Overall energy consumption per household was 1.5 toe on average, including vehicles consumption. Total energy expenditure was estimated at €7,245,256,634 for the same reference period, with 54.4% corresponding to expenditure on fuel used in the vehicles of household residents. Overall energy expenditure per household was, on average, €1,843 including expenditure on vehicles.

Figure 10 - Energy consumption in households – Portugal, 1989, 1996 and 2010 [Source: INE/DGEG - Survey on Energy Consumption in Households]

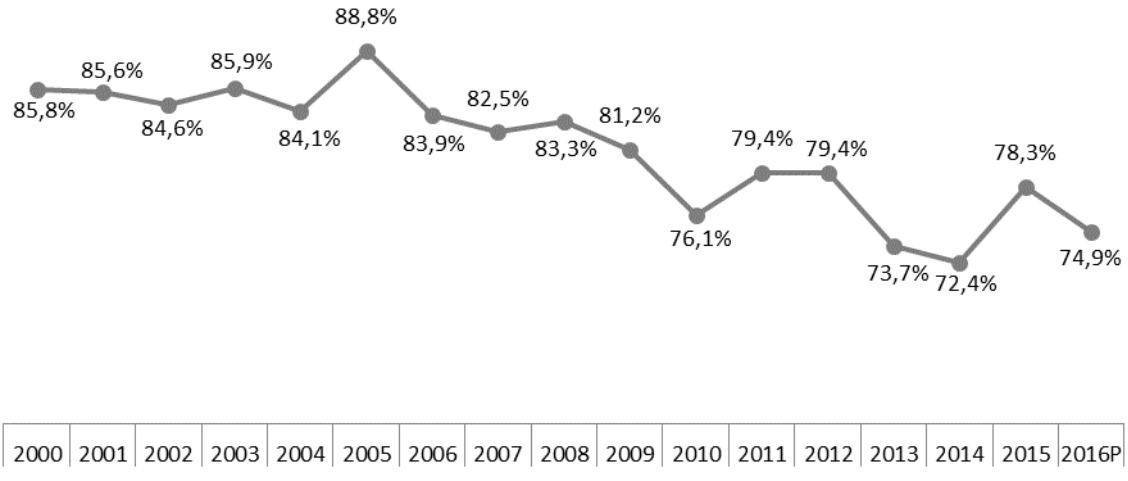


Main Energy Indicators

Over the last decades Portugal had a high energy dependence which varied between 80 and 90%. The recent focus on renewable (hydro and wind particularly) and energy efficiency and also the economic context, allowed Portugal to reduce its dependence to levels below 80%. Besides the mentioned factors, another factor also contributed to this reduction, namely the the slight decrease in imports of oil and oil products and an increase in exports of oil products.

In 2016 the energy dependence stood at 74.9%, representing a decrease of 3.4 p.p. compared to 2015 and a decrease of 13.9 p.p. compared to 2005, the year which saw the highest energy dependence in recent years.

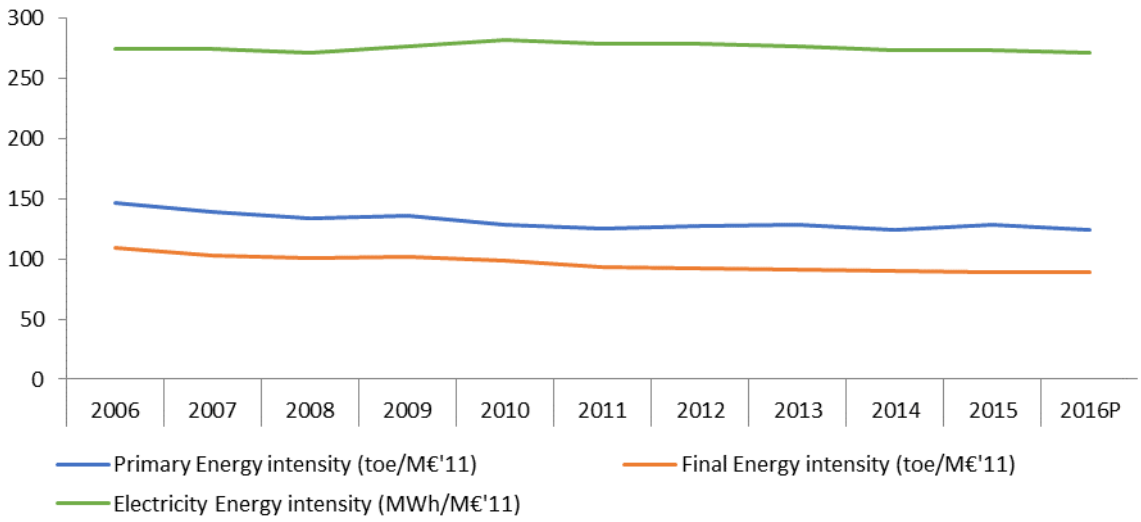
Figure 11: Energy dependency evolution in Portugal (%) [Source: Directorate-General for Energy and Geology (DGEG)]



Concerning to overall energy intensity, defined as the ratio between energy consumption and GDP, is observed that in 2016 the energy intensity of the economy in primary energy stood at 124 toe/M€'2011 (- 3.3% compared to 2015) while the energy intensity of the economy in final energy was

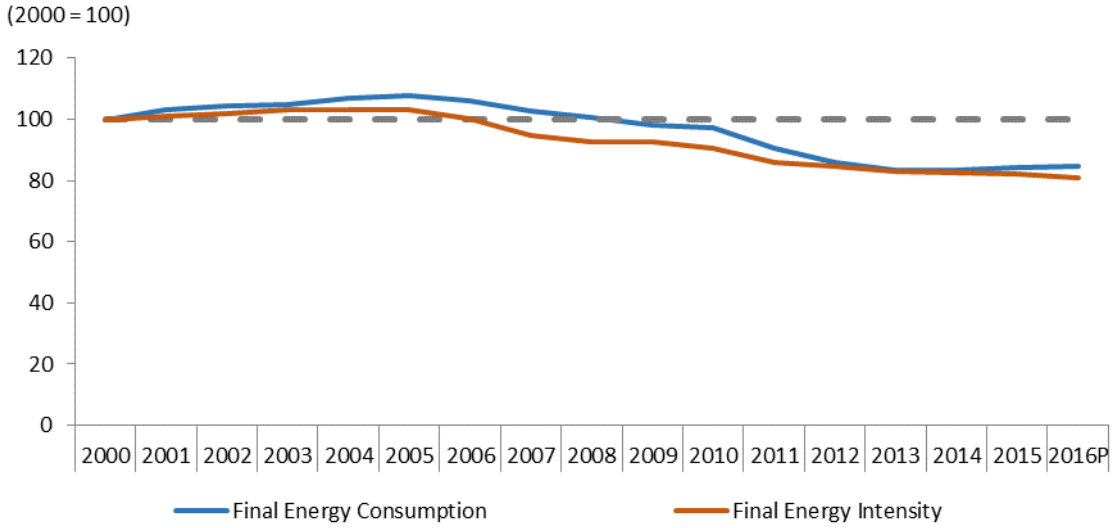
88 toe/M€'2011 (-1.1% compared to 2015). On the other hand, the energy intensity of the economy in electricity stood at 271 MWh/M€'2011 (-0.6% compared to 2015).

Figure 12: Evolution of the energy intensity evolution, MWh/M€2011 [Source: Directorate-General for Energy and Geology (DGEG)]



The final energy consumption trend and its efficiency index can be observed in figure 13. This takes into consideration the economic environment at GDP prices of 2011 according with national accounts. Between 2000 and 2016 the index of final energy improved by 16.6% (1.3%/year), mainly due to the lower final energy consumption observed through this series. Index of final energy intensity got down from 108 toe/M€2011 in 2000 to 90 toe/M€2011.

Figure 13: Final Energy trend (%) [Source: Directorate-General for Energy and Geology (DGEG)]

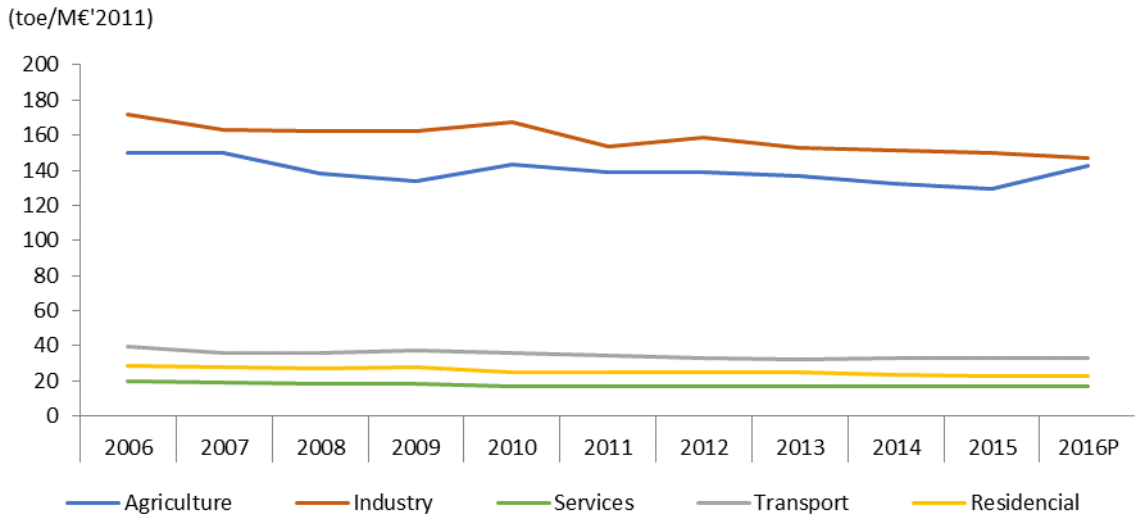


Relatively to final energy intensity by sector, in 2016 the Industry sector recorded an energy intensity of 147 toe/M€ (-3.2% compared to 2015) and the sector of Services 17 toe/M€ (-3.1% compared to 2015), while the agriculture sector had an opposite trend reaching in 2016 nearly 143 toe/M€ (+ 12.2% compared to 2015). Residential sector remains without changes between 2015 and 2016 with 23.1

toe/M€ and the transport sector showed a slight inefficient trend for the same comparison years (0.3%, 32.8 toe/M€).

Throughout the last 10 years overall sectors saw a positive trend in their energy intensity evolution from 2.7%/year in the residential sector to a more contained value in the agriculture sector with 0.5%/year.

Figure 14: Energetic intensity evolution by activity sector [Source: ADENE supported in Directorate-General for Energy and Geology (DGEG) data]

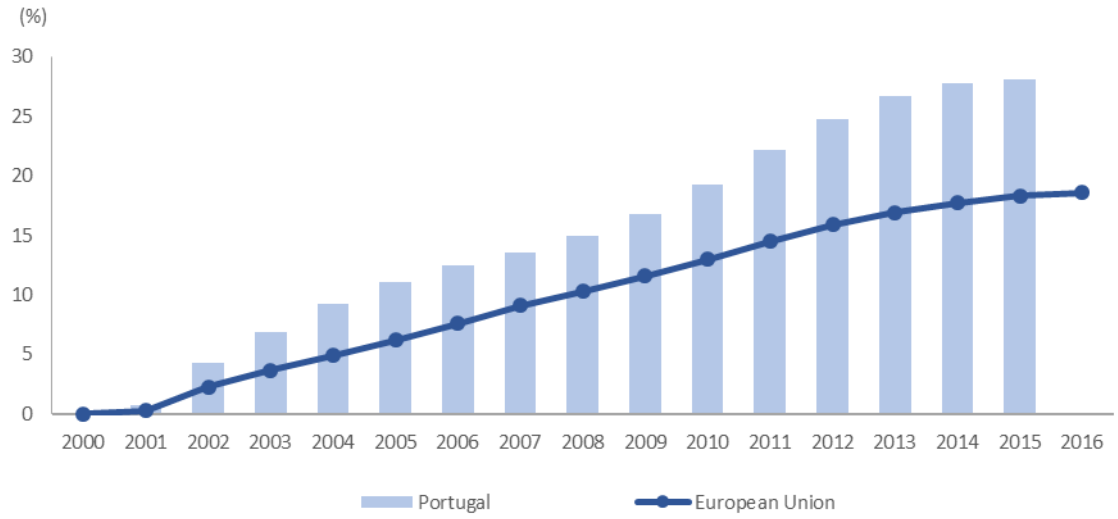


Throughout the last 15 years (2000-2015) an annual average gain of about 1.9%/year in the overall energy efficiency was observed in Portugal, like presented in the energy efficiency ratio (ODEX), Fig. 15. The reason for this improvement comes simultaneously from the three sectors with major energy consumption share, around 85% of total national final energy consumption. These sectors, residential, manufacturing and transport, had a significant improvement in energy efficiency the ODEX of about 2.5%/year for residential, around 1.7%/year in the manufacturing industry and by 2.0%/year in transport.

ODEX by sector (industry, transport, household, tertiary) is calculated from unit consumption trends by sub-sector (or end-use or mode of transport) by aggregation of unit consumption indices by sub-sector in one index for the sector on the basis of the current weight of each sub-sector in the sector's energy consumption.

Comparing Portuguese and Union European (28) energy efficiency progress in the analysed period, both have grown with a similar trend at around 1.9%/year and 1.2%/year, respectively.

Figure 15: Overall energy efficiency gains: industry, transport, households and tertiary, since 2000 [Source: ODYSSEE]



Renewables

The contribution of endogenous renewable sources corresponds on average (2006-2016) to 21.2% and 43.5% of total primary energy consumption and total electricity production, which makes Portugal a reference to the level of the European context.

Portugal, in 2016, had the seventh largest share of renewable energy in the EU-28. The percentage of renewable energy represented in 2016, 17.0% of gross final energy consumption in the EU-28 (9.5% in 2006) and 28.5% in Portugal (20.8% in 2006).

In the electricity production from renewable energy sources (RES-E), Portugal had in 2016 a 54.1% incorporation rate, the third largest of the EU-28, after Austria (72.6%) and Sweden (64,9%), and far above the European average (29.6%). [Source: EUROSTAT]

In 2016 total gross electricity production, including import balance, was 60 TWh, resulting in a 15% increase compared to 2015. From total production 60% came from renewable sources, mainly hydro and wind, with an increase of 13.9 p.p. compared to 2015. The high production of electricity from renewable endogenous sources had a positive impact on reducing the import balance of energy products.

Regarding the contribution from renewable energy to the electricity production, figure 15 shows that hydropower and wind power are the most relevant source being responsible for around 90% of the renewable production in 2016, and for around 50% of total electricity production. Electricity production form biomass remains steady in the last years (around 7% of total renewable electricity production). The contribution from photovoltaic and geothermal remained residual (around 3% of total renewable electricity production).

There's a direct relationship between rainfall and hydropower which is one of the major contributor's and greatly impacts renewable production, and 2016 was a wet year and therefore hydropower reached 16.9 TWh of production.

Wind power has been increasing its contribution due to an increase of wind farms installation mainly after 2006, reaching in 2016 a production of 12.5 TWh (+7.5% compared to 2015). At the end of 2016 the installed power in set of around 257 wind farms with a total of 5 313 MW.

Figure 16: Renewable electricity production [Source: Directorate-General for Energy and Geology (DGEG)]]

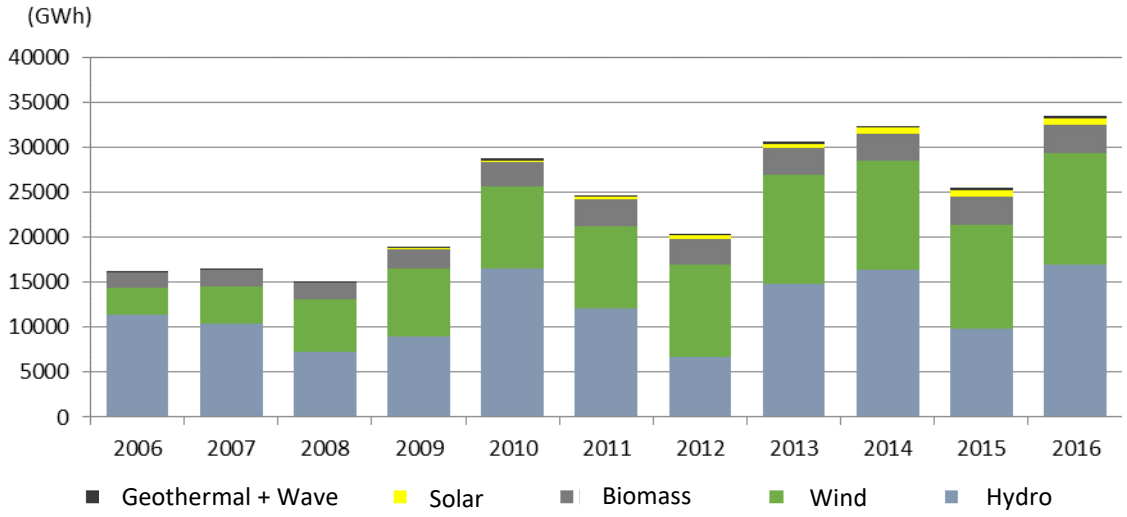
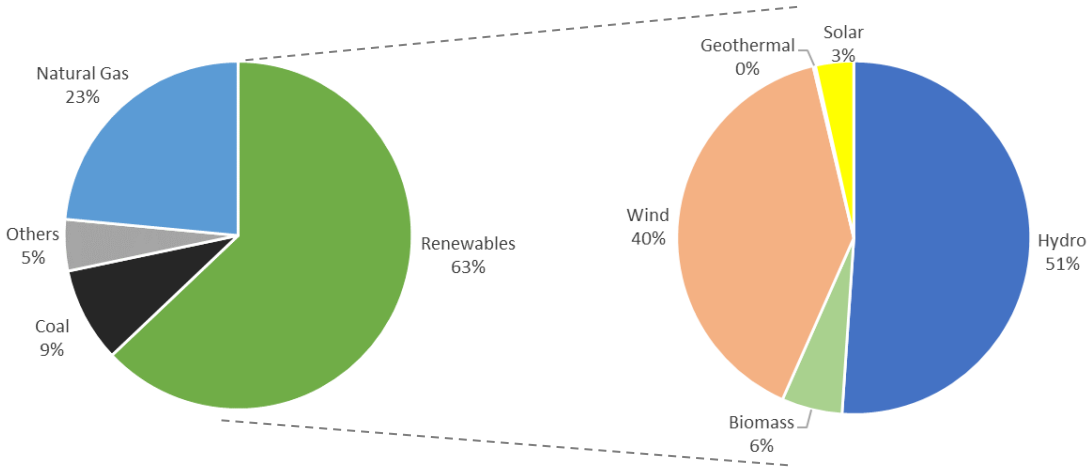
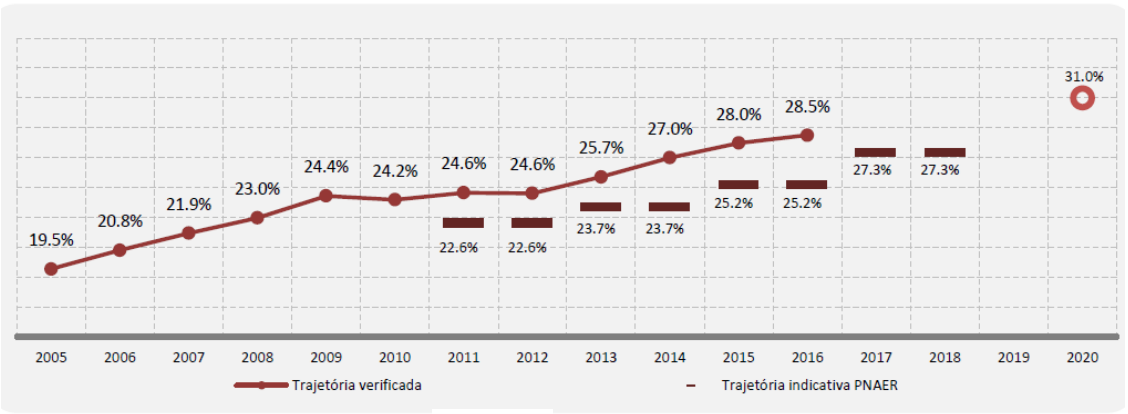


Figure 17: Mix of installed capacity for electricity production in 2016 (%) [Source: Directorate-General for Energy and Geology (DGEG)]



In 2016, the renewable energy added in the gross final energy consumption stood at 28.5%, +0,5 p.p. above the value of 2015 and 3.3 p.p. above the trajectory indicated in NREAP, making Portugal achieve around 92% of 2020 goals.

Figure 18:Evolution of the renewable incorporation in gross final energy consumption in accordance with Directive 28/2009/CE [Source: Directorate-General for Energy and Geology (DGEG) – Energy in Portugal 2016, published in July 2018]



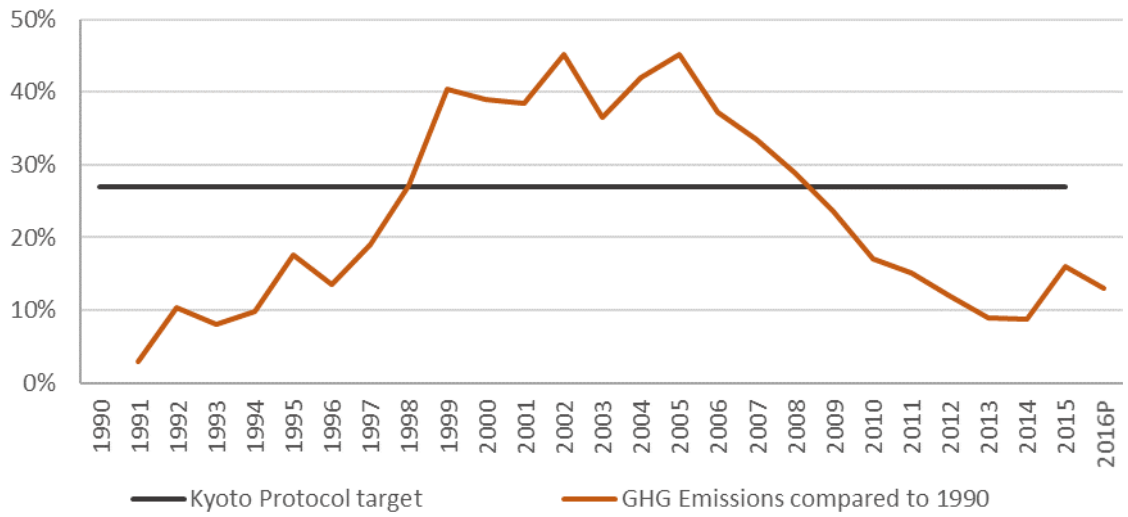
Source: DGEG, Eurostat

Greenhouse Gas Emissions

Furthermore, Portugal under the Kyoto Protocol and the agreement sharing responsibilities, should limit the increase by 27% Greenhouse Gas Emissions (GHG emissions in the period 2008-2012, compared to the adjusted reference value from the 1990 record.

Taking account this threshold, it is found that between 1999 and 2008 GHG emissions surpassed the set target. However, since 2009 the level of emissions is below target. In 2016, the GHG emissions were 13% above 1990 level. This evolution trend is in the figure bellow.

Figure 19: GHG emission change rate [Source: APA, I.P. – Portuguese Environmental Agency]



GHG emissions in Portugal are decreasing significantly since 2005, thanks to the adoption of measures related to this issue, especially in the energy sector that is responsible for 70% of total emissions. In

2016 total GHG emissions where 67.8 Mton CO_2eq, of which 47.1 Mton CO_2eq came from the energy sector, representing a decrease of 2.6% compared to the previous year.

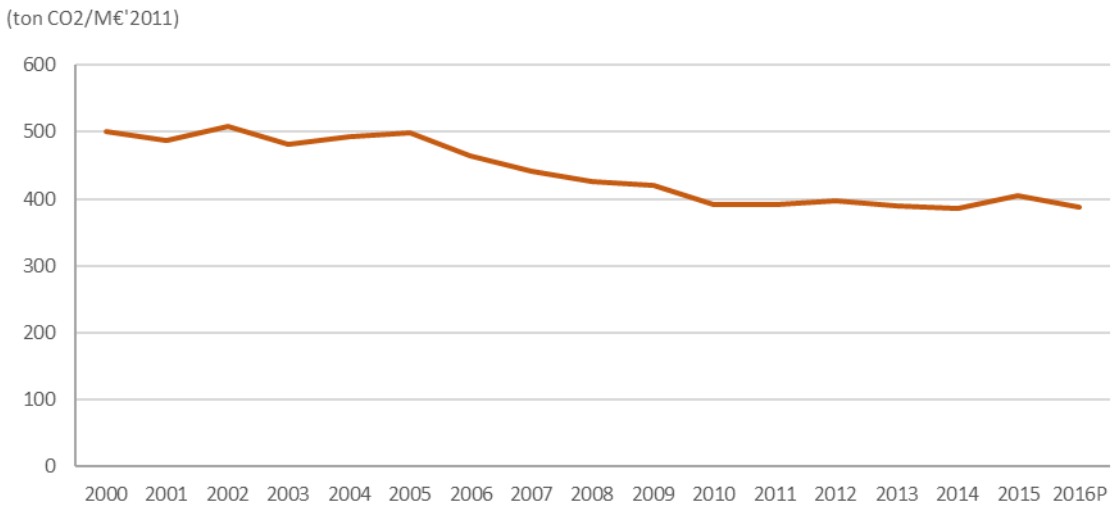
The trend of the most recent years has however been strongly influenced by the slow-down in industrial activity and consequent reduction in fuel consumption, and the cessation of some activities in the country such as the production of ammonia in 2009 with the relocation of the production facilities to India. Another fact to note is the introduction of the use of high performance catalysts and optimization of the ratio ammonia / air in the production of nitric acid which had an influence in the decrease of emissions.

Like previous stated, the principal source of GHG in Portugal in 2016 is the energy sector, followed by industry sector. The largest gas emitted is CO_2 representing approximately 75% of total GHGs emissions expressed as global warming potential (GWP) weighted emissions. The majority of these emissions are generated in energy-related activities, which are responsible for almost 92% of total CO_2 emissions.

The greenhouse effect potential increased significantly from 1997 to 1999, presenting after that an uneven development in the period 2000-2005 (with emphasis on the 2002 and 2005 peaks, justified by the low level of water in reservoirs, with the consequent change in the electricity production by using alternative energy sources to water, more polluting). After this period, the indicator of GHG has recorded successive decreases, explained largely by three main factors: i) the introduction of natural gas (decreasing coal and fuel oil consumption needs), ii) the efficiency improvements in industrial production processes and iii) the increase of the installed capacity for electricity production from wind power. In the period 2006-2016 the GHG emissions averaged a decline of -1.9%. This was due, largely, to the higher level of rainfall recorded in these period, thereby increasing the production of electricity by hydroelectric power plants.

Taking into account the last years, the indicator carbon intensity of the economy presented two different trends, a slight fluctuation among 2000 and 2005 following the GHG trend, and a sharp decline from 2006 onwards showing the positive gain in GHG. In 2016 the carbon intensity of the economy was 388 ton CO_2/M€'2011, -4.1% compared to the previous year.

Figure 20: Total CO2 intensity (kCO2/€2005) [Source: Directorate-General for Energy and Geology (DGEG)]



1.3. ENERGY EFFICIENCY POLICY BACKGROUND

Historically, the National Action Plan for Energy Efficiency (NEEAP), approved by the Council of Ministers Resolution 104/2006, of 23 August, and the National Energy Strategy, approved by the Council of Ministers Resolution n.º 169/2005, of 24 October, already included a vast set of energy efficiency measures.

Yet, in 2008 the main tool towards to energy efficiency was the National Action Plan for Energy Efficiency – Portugal Efficiency 2008. This Plan was first implemented after its approval in 2008 by the Council of Ministers Resolution n.º 80/2008, 16th of May, comprises a vast series of energy efficiency programs and measures, with a 2015 timeline, fundamental for Portugal to achieve and surpass the objectives set within the scope of the European Directive n.º 2006/32/CE of the European Parliament and Council, of 5 April 2006.

Continuing the first NEEAP work plan implementation it was carried out its revision aiming new actions and targets for 2020 integrating the concerns related to the decrease of primary energy consumption for 2020 horizon according to the directive 2012/27/EU. Thus, in 2013, the NEEAP for 2013-2016 was approved, known as the second NEEAP, by the Council of Ministries Resolution 20/2013 and published on 10th April. This document continues to include a wide range of programs and measures across all sectors, and it is considered essential for Portugal to achieve the goals set towards 2020.

In this strategic direction is intended to continue to: ensure the development of an energy model with economic rationality; ensure substantial improvement in energy efficiency of the country through the implementation of National Action Plan for Energy Efficiency (NEEAP) and the National Action Plan for Renewable Energy (NREAP) and completion of implementation of the Energy Efficiency Program in Public Administration - ECO.AP; and maintain the enhanced diversification of primary energy sources.

In turn the PNAEE review for the period 2013 -2016 is conducted in accordance with the principles of that Directive 2006/32/EC, but having already prospective the 2020, according to well that Directive

2012/27/EU. NREAP revision is made with respect for commitments made by Portugal for renewable energy laid down in Directive 2009/28/EC of the European Parliament and of the Council of 23 April 2009, but in conjunction with the new energy demand scenarios in the period 2013 -2020. (Source: PNAEE – Portugal Energy Efficiency Plan 2016)

Thus, NEEAP 2016 encloses both revised diplomas, NEEAP 2008 and NREAP with attention to energy efficiency measure and the promotion of renewables already existed in the National Program for Climatic Changes (PNAC), approved by Council of Ministers Resolution n.º 104/2006 of August 23rd and after reviewed through the publication of Council of Ministers Resolution n.º 1/2008 of January 4th.

The main lines of the revision of NEEAP and NREAP were the following:

- Alignment of the objectives of Plans according to primary energy consumption
- Elimination of measures not implemented in the 1st NEEAP and measures with a difficult quantifying implementation or with a low impact, being substituted for new measures or by the increase of existing measures of lower cost and with an easier implementation.
- Structured assessment of the impacts of the recommended measures for each Plan
- Establishment of a system structure to follow and monitored the Plans,

Taking into account the areas, programmes and measures that were included in NEEAP 2008, the NEEAP 2016 encompasses six specific areas, for which guidelines of an essentially technological nature will be issued: Transport, Residential, Tertiary, Industry, State, Behaviours and Agriculture, in a total of 10 programmes, taxes and Incentives and Financing, which were object of complementary analysis and guidelines.

Table 2 - Portugal Efficiency Programmes [Source: NEAAP – Portugal Energy Efficiency Plan 2016]

<table>
<tr><td></td><td colspan="6">Areas</td></tr>
<tr><td></td><td>Transport</td><td>Residential and Tertiary</td><td>Industry</td><td>State</td><td>Behaviour</td><td>Agriculture</td></tr>
<tr><td rowspan="3">Programmes</td><td>Eco car (vehicle renewable)</td><td>Home renewal & offices renewal</td><td rowspan="3">Intensive Energy Consumption Management System</td><td rowspan="3">Energy Certification of Buildings</td><td rowspan="3">Communicate Energy Efficiency</td><td rowspan="3">Efficiency in agrarian sector</td></tr>
<tr><td>Urban Mobility</td><td>Energy Certification of Buildings</td></tr>
<tr><td>Energy efficiency system in transport</td><td>Solar Thermal</td></tr>
</table>

Each of the aforementioned areas includes a series of programmes, which integrate a vast range of energy efficiency measures, aimed at reducing energy demands.

The Transports area includes three programmes aimed at improving energy efficiency:

i) Vehicle Renewal Programme, including three measures aimed at improving energy efficiency in vehicles, namely equipment renewal and use of more efficient products, namely:

   i.1. Eliminating vehicles at the end of their useful life
   i.2. Green Taxation: review of the private vehicle tax regime
   i.3. Green Tire
   i.4. Right pressure
   i.5. More efficiency vehicles for fuel savings

ii) Urban mobility which identifies measures related with public transport modal and commuting needs in large urban and corporate centres

   ii.1. Sustainable mobility promotion and good practices adoption
   ii.2. Use of more energy efficient transport and mobility solutions

iii) Regulation for Energy Management in the Transport Sector, which aims to quantify the impact of the concepts of logistics platforms and motorways of the sea on efficient use

   iii.1. Restructuring the passenger railway transportation offer
   iii.2. Regulation for Energy Management in the Transport Sector
   iii.3. Support to the installation of equipment to inflate tires with nitrogen
   iii.4. Promotion of fleet management systems and eco-driving

The Residential and Tertiary area includes three large energy efficiency programmes:

i) Home Renewal Programme, which defines various energy efficiency measures involving lighting, electrical appliances, consumer electronics and area rehabilitation.

   i.1. Promotion of more efficient equipment's
   i.2. Efficient Lighting
   i.3. Efficient window
   i.4. Efficient insulation

ii) Energy Certification of Buildings, aiming the improvement of buildings need

   i.1. Effect of energy certificate system in energy needs of new residential buildings
   i.2. Effect of energy certificate system in energy needs in new tertiary buildings

iii) Renewable at the Time Programme, oriented towards increased penetration of own-production energies in the residential and service sectors.

The Industry area is covered by a programme designated Energy Efficiency System in the Industry, which includes replacement of the Energy Consumption Management Regulations (Decree Law n.º 58/82) with new regulations, the Intensive Energy Consumption Management System (SGCIE) was published on 15 April 2008, trough Decree-Law 71/2008. Some transversal measures aimed at the

industrial sector should be highlighted, aimed at four technological groups: electric motors, heat and cold generation, lighting and other industrial process efficiency measures.

The State area is grouped in a programme designated Energy Efficiency in the State, which includes a series of measures aimed at State buildings and transport fleets, Street Lighting and centralized energy negotiation by the central and local administration. Also, Energy Efficiency Action Plans Public Administration (ECO.AP) is measured in this programme through active and passive measures and the Barometer of Energy Efficiency.

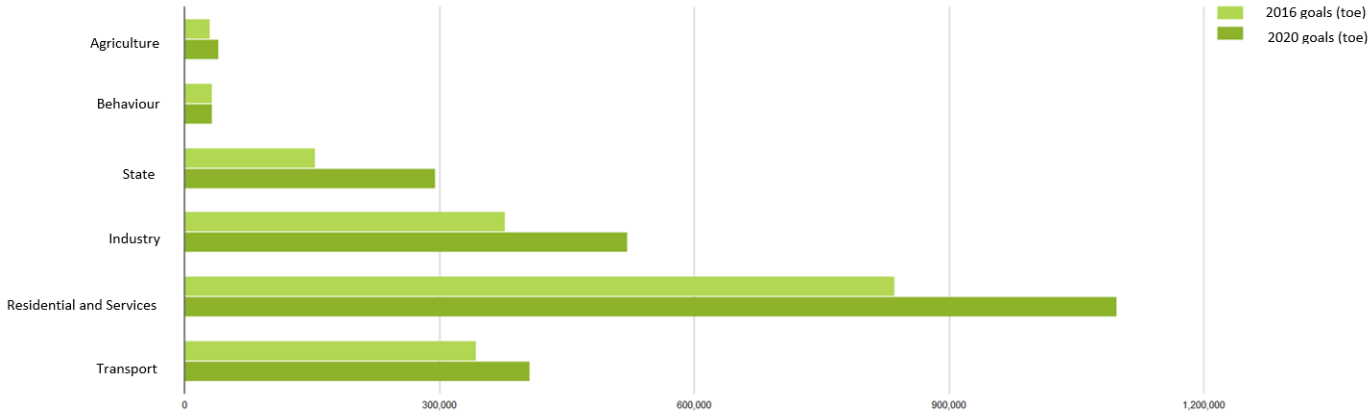
The Behaviours area includes programmes aimed at promoting energy-efficient consumer habits and attitudes, such as efficient product recommendation, through awareness and communication campaigns.

The Taxes area includes a series of measures aimed at promoting energy efficiency through tax benefits, such as creation of fast depreciation regimes for efficient equipment and establishment of links.

The Incentives and Financing area includes a series of innovative programmes, such as creation of the Energy Efficiency Fund, incentives for creation of Energy Service Companies (ESCO) and incentives for urban rehabilitation and electrical appliance acquisition and renewal. This Fund, published the Decree-law n.º 59/2010 of May 20th, implements the National Action Plan for Energy Efficiency in the green heat, solar thermal, efficient windows, or thermal insulation. In addition, it could support projects of energy efficiency in the sectors of agriculture or manufacturing industry that aim to reduce the final energy consumption.

Under the six specific areas covered by NEAAP, next figure synthesizes the goals established for 2016 and 2020, respectively.

Figure 16: Overall Synthesis of NEEAP 2016 impacts, primary energy savings (toe) [Source: Resolution of the Council of Ministries no. 20/2013, of april 2013]



The 3rd NEEAP has not yet been published in the national legislation, however this Plan has already been elaborated as part of the obligation to present a report to the European Commission. The report summary describes the measures to be adopted till 2020 to promote the energy efficiency in national territory as well as

the achieved and planned savings for the period 2008-2015. (https://ec.europa.eu/energy/sites/ener/files/documents/pt_neeap_2017_pt.pdf)

Significant policy developments:

1- Management Structure of the National Energy Efficiency Action Plan (NEEAP)

Decree-Law n.º 50/2010 of 20 May creates the Energy Efficiency Fund (EEF) aimed to fund programs and activities to finance the implementation of measures included in the NEEAP. This Decree-Law establishes the creation of a management structure, already foreseen in the NEEAP, to support and promote the implementation of its programs and measures, including the technical management of the Fund.

Following the previously mentioned legislation, Ordinance n.º 1316/2010 of 28 December was published to regulate and set NEEAP's management structure, and later Ordinance n. 26/2011, of January 10th, whose aim was to establish the financial support scheme for eligible FEE's project aiming at implementation of programs and measures under PNAEE purpose.

This Ordinance identifies the bodies and competencies of the management structure, the organizations involved and the allocation of responsibilities for the management and implementation of measures, as well as the procedures for monitoring and evaluation of results and the procedures for inclusion of new programs and measures. Also specifies, that the NEEAP is structured in four specific areas predominantly technological (transport, residential and services, industry and State), and three cross-cutting areas (behaviours, taxation, incentives and financing) which in turn are divided into programs and measures, as described in the Resolution of the Council of Ministers n.º 80/2008 of May 20.

On the other hand, the Renewable Energy Strategy is part of a new vision for 2020 of the energy sector, which focuses on the synergies resulting from the articulation of strategies for energy demand and supply, which are the subject of the NREAP and the NEEAP, respectively, guaranteeing price sustainability.

The NREAP thus adapts the evolution of future capacity and technological choices to a logic of economic rationality and free initiative of the promoters, whose investment decisions are no longer dependent on subsidy or guaranteed compensation mechanisms and on the mitigation of risk.

The NREAP 2020 provides a reduction of 18% in installed capacity in technologies based on renewable energy compared to 2010, with a base of renewable electricity share in the new NREAP to be higher (60% vs. 55%) as the global target to be achieved, which is expected to stand at around 35% (compared to the 31% target). These new lines general are based on the premise that Portugal should be an energy efficient and independent country, or a competitive country. The NREAP down for this, the trajectories of introduction of RES in three major sectors: heating and cooling, electricity and transport.

2. Implementation of the CHP Directive (First amendment)

In August 23, 2010, Decree-Law n.º 19/2010 was published as amendment, by parliamentary consideration, to Decree-Law n.º 23/2010, in particular regarding the articles related to the legal regime applicable to the remuneration of electrical and mechanical energy and useful heat produced in cogeneration.

3. Electric Mobility in Portugal

Through the Resolution of the Council of Ministers nº 20/2009, of February 20, a Program for Electric Mobility in Portugal was created, with the objective of introducing and subsequently increasing the use of the electric vehicle. Resolution of the Council of Ministers nº 81/2009, of September 7, established the strategic objectives and fundamental principles of the Program for Electric Mobility, as well as approving the respective model and phases of development, anticipating the phase pilot, an integrated network of electric vehicle charging points.

Subsequently, Decree-Law nº 90/2014, of July 11, established the legal regime of electric mobility, applicable to the organization, access and exercise of activities related to electric mobility, as well as the rules for creating a network electric mobility pilot

Resolution of the Council of Ministers nº 49/2016, of September 1, determines, among others, the completion of the first phase of the pilot network, which includes updating the current network, and launches the second phase to expand the network to municipalities not yet served in the first phase.

Regulation nº 879/2015 has established the rules for the exercise of electric mobility activities covered by the regulator's area of activity.

Regarding technical requirements, a series of legislative acts were published, such as Ordinance nº 241/2015, which establishes the technical requirements to which the assignment of a license is required to carry out the activity of operation of loading points in the transmission network. electric mobility, Ordinance nº. 221/2016, which establishes the rules applicable to the installation and operation of the charging points of electric vehicle batteries, and Ordinance nº 222/2016, which establishes the terms applicable to licenses for private use in the public domain , for the installation of charging points of electric vehicle batteries in a public place of public access in the public domain.

4. Energy Efficiency Fund (EEF)

Decree-Law n.º 50/2010 of 20 May creates the EEF, aiming to fund programs and activities that support the measures included in the NEEAP. Under this legislative act, Ordinance n.º 26/2011 was published on January 10, defining the financial support system for measures and programs eligible for the Fund.

This regulation is intended to coordinate the funding and support process for projects aiming the implementation of programs and measures that lead to reduce the final energy demand contributing to the compliance of national targets on energy efficiency.

This year under the NEEAP seven notices of EEF were launched with submission of applications from May 4th, 2015, covering the sectors of residential, services, industry, transport and State.

In recent years eight notices of EEF were launched, covering the sectors of residential, services, industry, transport and state, namely:

i) Call 13 – Support companies in the industry and agriculture sector in the following categories: (a) investments made in transversal measures of technological performance in electric motors, production of heat and cold and efficiency of the industrial process; (b) investments in equipment and systems for the management and monitoring of energy consumption; (c) costs of mandatory energy audits for operators with annual consumptions of less than 1000 toe/year.
ii) Call 15 – Support initiatives aimed at energy management of energy-intensive consumer fleets.
iii) Call 18 – Reduce reactive energy in buildings and facilities owned by public entities
iv) Call 19 – Promote and modernize the industrial and agricultural sector, which, among others, provides support for projects that lead to increased energy efficiency through energy optimization of manufacturing processes and the introduction of new technologies.
v) Call 20 – Finance energy efficiency measures that lead to the improvement of the energy performance of existing buildings, the residential sector and services in terms of solar thermal heating, installation of efficient windows, requalification of thermal insulation and efficient lighting.
vi) Call 21 - Reduce energy consumption of public administration buildings by financing investments aimed at the implementation of existing buildings occupied by public entities, of solutions that promote the improvement of energy performance, by replacing existing equipment with more efficient ones, or through the implementation of control devices that allow to optimize the conditions of use and consumption of energy.
vii) Call 22 - Promote Energy Efficiency in Industry, Agriculture, Forestry and Fisheries through the modernization and increase of competitiveness of these sectors, financing investments to improve the energy performance of the facilities, replacing existing equipment with more efficient ones, implementing control devices and optimize the conditions of use and consumption of energy, and / or the reformulation and integration of processes.
viii) Call 23 - Finance investments in tangible measures aimed at promoting the improvement of the energy performance of transport infrastructures, by replacing existing equipment with more efficient ones, by implementing control and performance devices to optimize the conditions of use and energy consumption.
ix) Call 25 - Finance energy efficiency measures that lead to the improvement of the energy performance of existing buildings, the residential sector and private law services, which can contribute to the goals defined in the NEEAP or the targets energy efficiency in the framework of the implementation of the Energy Efficiency Directive.

5. Energy Efficiency Programs in Public Administration (ECO.AP)

The Energy Efficiency Program in Public Administration "ECO.AP", launched through Resolution of the Council of Ministers no. 2/2011, of January 12, aims to achieve a 30% energy efficiency level in the

agencies and services of the Public Administration until 2020, this efficiency being achieved without increasing public expenditure while allowing the economy to stimulate the energy services sector.

The objective of this program is to enable the State to reduce energy consumption in services and bodies, the emission of greenhouse gases and contribute to a greater stimulus of the economy thus contributing to the achievement of the objectives of the NEEP and the NREAP.

In order to achieve the objectives proposed by ECO.AP, the Energy Efficiency Barometer was launched with the objective of characterizing, comparing and disseminating the energy performance of the different entities of the Public Administration. The Energy Efficiency Barometer plays a central role in the strategy to promote energy efficiency in the public sector, allowing a detailed knowledge of the energy consumption structure of the public sector, and thus support the definition of policies and measures aimed at promoting the efficient use of energy. resources in the public sector.

6. Public Contract Regime with the Energy Service Companies (ESE)

Under the National Energy Strategy 2020, Decree-Law n.º 29/2011, of 28 February, was published aiming to establish a role for the public sector in the promotion and development of an energy services market, as well as the adoption of measures to improve end-use energy efficiency.

This legislation regulates the use of ESE (ESCOs), through a competitive tender process, allowing these companies to identify potential energy savings in buildings and public facilities and to implement procedures for enhancing energy efficiency, reflected in the final energy bill. Decree-Law n.º 29/2011 also establishes the procedures for the formation and conclusion of contracts between public administration bodies and energy service companies, with a clear commitment on simplified and objective models for the evaluation of proposals.

7. Plan for Promoting Efficiency in Electricity Consumption, (PPEC)

Under the National Programme for Climate Change (PNAC) that evolved to NEEAP, was assigns to the Energy Services Regulatory Authority (ERSE) specific responsibilities in the definition of mechanisms to promote energy efficiency on the demand, aiming the electric consumption reduction till 2010 compared to a reference scenario.

In 2013, Ordinance 26/2013 of January 24th was published, laying down rules on the criteria and evaluation procedures to be followed in the selection and ranking of applications submitted to the competitions held as part of the Plan for Promoting Efficiency in Electricity Consumption (PPEC) 2013-2014 provided for in the Tariff Regulation of the Energy Services Regulatory Authority (ERSE).

The 6th edition of PPEC (PPEC 2017-2018) is now in force, whose main objective is to finance support initiatives that promote the efficiency and reduction of electricity consumption in the different consumer segments. This edition approved 75 measures that will be implemented by 33 promotors.

Both, ERSE and the DGEG, evaluated the candidate measures, and the final decision of the PPEC 2017-2018 measures was published in Order no. 15355/2016, of 21 December 2016.

The social benefits to be achieved with the implementation of the approved measures (around EUR 111 million) are much higher than the costs (EUR 23 million). The beneficial effects of the measures

will remain until 2037, representing about 1470 GWh of cumulative avoided consumption.

8. Financial Incentives

PO SEUR - Operational Programme for Sustainability and Efficient Use of Resources, established through an Execution Decision from the European Commission on December 16, 2014 and amended by the European Commission Execution Decisions of 22 August 2016 and 17 October 2017 is one of the 16 programmes created for the operationalization of Portugal 2020 Strategy (a partnership agreement established between Portugal and the European Commission that gathers the action of 5 European Structural and Investment Funds - ESIF, Cohesion Fund, ESF, EAFRD and EMFF - in which the programming principles are laid down and mark the economic, social and territorial development policy to be promoted in Portugal between 2014 and 2020). Within this scope, Portugal shall be awarded 25 thousand million euros until 2020 and for this Thematic Goals were defined to stimulate growth and the creation of Employment, the necessary interventions to execute them and the undertakings and outputs expected as a result of these funding. PO SEUR - Operational Programme for Sustainability and Efficient Use of Resources wishes to specifically contribute to the sustainable growth priority, addressing the transitional challenges to a low carbon economy based on a more efficient use of resources and on the promotion of greater resilience to climate risks and catastrophe.

The strategy foreseen for PO SEUR refers a multidimensional perspective of sustainability based on three strategic pillars which are the root of the 3 Programme Investment Axes: Axis I - Support the transition to a low carbon economy in all sectors; Axis II - Promote climate change adaptation and risk prevention and management; Axis III - Protect the environment and promote resource use efficiency.

Under Axis I of PO SEUR energy efficiency actions to be implemented shall cover all sectors of economy but priority shall be given to the most important energy consumption sectors with special emphasis on companies and transports. On the other hand, investment on the implementation of smart systems since they allow obtaining a more adequate balance between supply and demand of energy to the grid, with consequent efficiency gains and the resulting economic and environmental advantages for the national electric system

Another funding program called "Efficient House 2020" aims to provide concessional lending for operations that promote the improvement of the environmental performance of private housing, with a focus on energy and water efficiency as well as urban waste management. Interventions may cover the envelope of the building and its systems. For the period 2018-2021, the total amount of funding for the Program is € 200 million

9. Publication of Decree-law n. 68-A/2015

This diploma lays down provisions on energy efficiency and cogeneration issue, transposing into national law Directive 2012/27/EU of the European Parliament and of the Council of 25 October 2012 on the Energy Efficiency, also doing the first amendment to Decree-Law N. 118/2013 of 20 August which approve the Building Energy Certification System, the Energy Performance Regulation of Residential Buildings and Energy Performance Regulations for trade and services buildings, and

transposes Directive n. 2010/31/EU of the European Parliament and of the Council of 19 May 2010 on the energy performance of buildings.

10. Portugal 2020

Portugal 2020 is the 2014-2020 Partnership Agreement adopted between Portugal and the European Commission, formally submitted to the European Commission on 31 January 2014, that brings together the ESIF and in which are defined the principles of programming that consecrate the policy of economic development, social and territorial to promote, in Portugal, between 2014 and 2020. These programming principles are aligned with the Intelligent Growth, Sustainable and Inclusive, pursuing the Europe 2020 Strategy.

Until year 2020 Portugal will receive € 25 thousand million, and for that it was defined the Thematic Purposes to stimulate the growth and job creation, the interventions needed to achieve them and the achievements and expected results of these funding.

The programming and implementation of Portugal 2020 are organized into four thematic areas: (i) Competitiveness and Internationalization; (ii) Social inclusion and employment; (iii) Human capital and (iv) Sustainability and Efficiency in the use of resources. It also considers the cross-cutting areas related to the public administration reform and the territorialisation of interventions.

11. Financial Instrument for Urban Rehabilitation and Revitalization (IFRUU 2020)

The Financial Instrument for Urban Rehabilitation and Revitalization (IFRUU 2020) was created through the publication of the Resolution of Ministers Council (RCM) no. 84-O/2016, of December 30th, aiming to bring together, in single a financial instrument, different sources of funding to support urban rehabilitation and revitalization. IFRRU 2020 is therefore a financial instrument aimed to support investments in urban renewal, that covers the entire Portuguese territory.

IFRRU 2020 has a financing capacity of 1,400 million euros, generating an investment of around 2,000 million euros. It aims to promote the improvement of cities sustainability and improving people's life quality, creating new opportunities for economic and social development in urban centres.

ADENE, in articulation with the Directorate-General of Energy and Geology (DGEG), are supporting the technical implementation process of the IFRRU 2020 applications regarding the buildings energy efficiency. This process is based on the existing database created in 2006, when implementing the current Buildings Energy Certification System, which is leveraged by a well-established technical staff such as Qualified Experts (PQ).

Concluding/additional remarks

In general, Portugal has been evolving positively in the energy sector not only in terms of targets but also in the policy framework. The program of the government has established guidelines for the national energy policy, taking in account the measures included on the memorandum of understanding signed by Portuguese authorities with the IMF, the ECB and the EU. The energy policy will be developed around the following priorities:

- improve the energy efficiency of the country (25% reduction in consumption by 2020), with the Public Administration leading by giving the example (30% reduction by 2020);
- enhance the diversification of primary energy sources, reduce dependence on oil in the country and achieve the target of Renewable Energy fixed on the European Directive;
- create an economically sustainable energy mix that set affordable energy prices for all segments in the economy;
- liberalize energy markets, making them highly competitive, with transparent mechanisms for setting prices and stable regulation.
- promote the rehabilitation of the Portuguese buildings stock to higher energy performance levels.

1.3.1. ENERGY EFFICIENCY TARGETS

The implementation of NEEAP, in the areas of transport, residential, services, agriculture, industry, state and behaviours, allowed to achieve cumulatively final energy savings of 1.102.342 toe until 2015 reaching 55% of the 2020 target.

Notice that the analysis of the impact (current and potential) estimated the measures in the 2008 NEEAP was conducted in accordance with European standards on monitoring plans and energy efficiency measures (Recommendations on Measurement and verification methods in the Framework of Directive 2006/32/EC), and its accounting done according to the calculation methods used in the respective preparation and according to the redefinition of the methodologies for calculating bottom-up indicators in order properly individualize the direct impact of each measure.

The following table shows the resume of the energy savings by NEEAP performance areas, as well the targets foreseen until 2020, where is possible to find that the 3 most relevant areas of performance in terms of energy saving are Transport, Residential and Services, Industry and Agriculture, responsible for more than 90% of total energy savings till 2015.

Table 3 – NEEAP results energy savings and target, [Source: NEEAP Monitoring report, 2008-2015]

Areas	Energy saving [toe]		2020 Target [toe]	Compliance related to 2016 target [%]
	Final Energy	Primary Energy		
Transport	361765	348883	**2003954 (Final Energy)**	**55% (Final Energy)**
Residential and Services	436206	558680		
Industry and Agriculture	261393	273209		
State	27321	38904	**2394065 (Primary Energy)**	**52% (Primary Energy)**
Behaviour	15657	24058		
Total	**1102342**	**1243734**		

2. ENERGY EFFICIENCY IN BUILDINGS

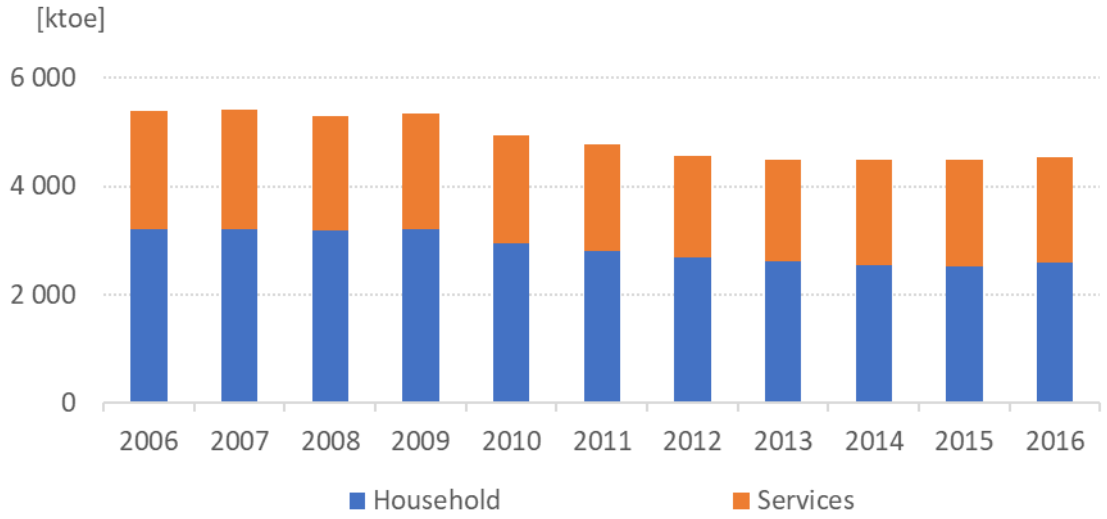
2.1. ENERGY EFFICIENCY TRENDS

Buildings represent the third major energy consumption sector with a share of 29% in 2016 (+1.4% than 2006). Despite the increase of the final energy share in national energy consumption balance, the energy consumption trend of this sector has decreased about 15.9% in last 11 years, with a relevant contribution of the residential sector (-19.7% compared to 2006).

Between 2006-2016 the residential sector presented a continuous final energy consumption reduction, although after 2014 its consumption has remained almost constant possibly reflecting a mix of measures in terms of policy implementation and energy efficiency improvement.

Regarding the services sector the final energy consumption decrease half on what was registered in the household sector (-10.2% in 2016 compared to 2006). The consumption reduction in this sector was mainly felt after 2010 (- 7.9% compared to 2006) reaching the lowest energy consumption in 2013 (1869 ktoe). After 2013 the energy consumption of this sector inverted its trend and attained 1945 ktoe in 2016 possibly reflecting the economic recovery of this sector, balanced with the policy implementation measures and energy efficiency improvement.

Figure 21: Total energy consumption in buildings, between 2006 and 2016, [ktoe] [Source: National Energy balance published by Directorate-General for Energy and Geology]

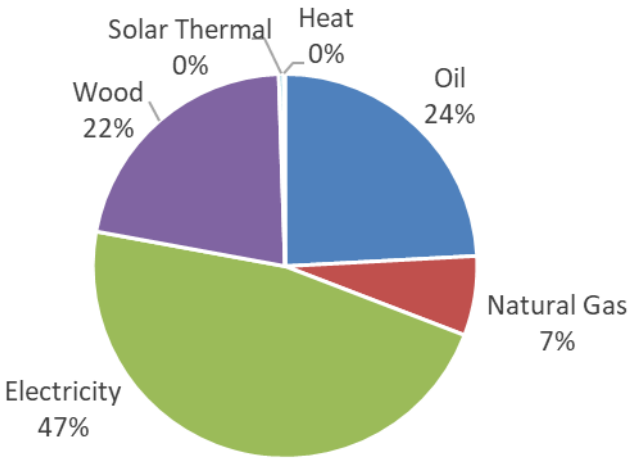


The declined trend showed in previous figure reflects the decreased of both, oil products energy consumptions (-57.9% between 2006 and 2016) and wood energy consumption (-34.1% among 2006-2016).

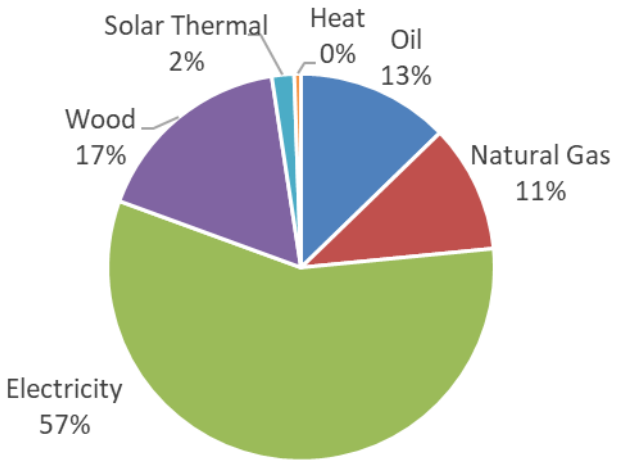
Between 2006 and 2016 electricity consumption presented a yearly slight variation (+/- 3%) reaching 2.57 Mtoe in 2016 (+1.5% compared to 2006) which may reflect an acquisition/replacement of more efficient equipment's as well as more aware behaviours on the importance of energy efficiency.

Electricity energy consumption detain a share of around 57% of the total energy consumption in buildings sector in 2016 (+ 10% than in 2006), see figure 22.

Figure 22: Total energy consumption in buildings by type of source, in 2006 and 2016, [%] [Source: National Energy balance published by Directorate-General for Energy and Geology]



2006 total final buildings energy consumption: 5.4 Mtoe



2016 total final buildings energy consumption: 4.5 Mtoe

In addition to electricity other energy sources gained expression, like natural gas reaching 481 ktoe in 2016 (+ 33.5% than 2006). Regarding wood energy consumption a disruption was recorded in 2010 onward, mostly in the residential sector, as the results of the "Household Energy Consumption Survey" (ICESD 2010), published in 2011, which allowed the review of the national energy balance.

Regarding renewable energy sources, buildings are responsible for 65.4% share in the total national renewable energy consumption (without electricity), with the transport sector responsible for 22.8% (incl. biodiesel) and 11.8% for industry.

Besides the contribution of biomass and the renewable share of electricity, solar thermal panels are also evolving reaching, in 2016, a total of (cumulatively) 1 176 105 m^2, mostly in the residential sector, which represents a verifying a 4.9% rise relatively to 2015 that corresponds to the installation of 55001 m^2 of new panels.

Table 4 – Solar thermal panels installed in Portugal (m^2) [Source: Directorate-General for Energy and Geology (DGEG), "Energy in Portugal" 2016]

	Unid.	2014	2015	% 2015/_14	2016	% 2016/_15
Total	m^2	1 074 970	1 121 104	+4.3	1 176 105	+4.9

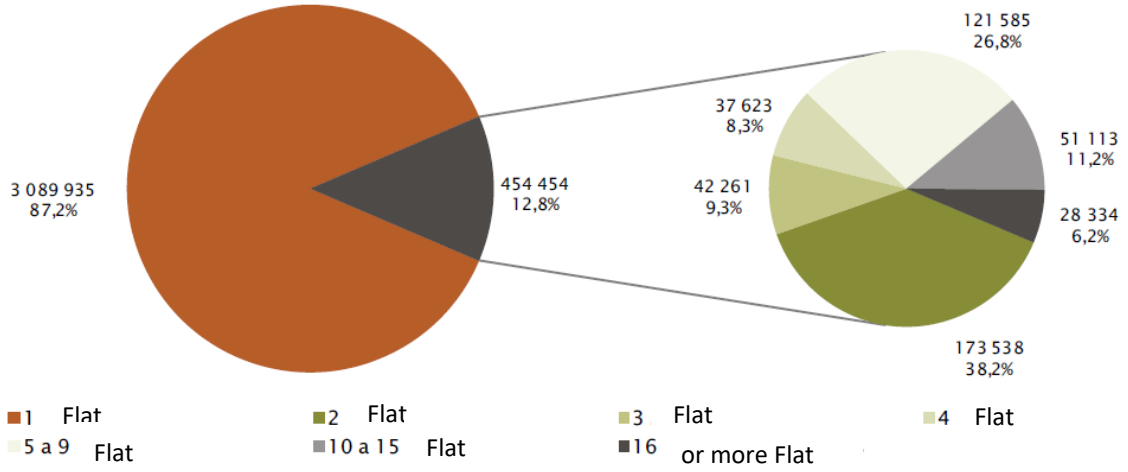
2.1.1. HOUSEHOLD SECTOR

In 2016 the Portuguese stock estimates that there were around 3.6 million classic residential buildings and 5.9 million dwellings. Both indicators stabilized (+0.1%), vis-à-vis the previous year.

The national Portuguese stock grew at an annual average rate above 1% till 2008. Since then, the variations rates slowed, registering a minimum growth of 0.1% in 2014, 2015 and 2016.

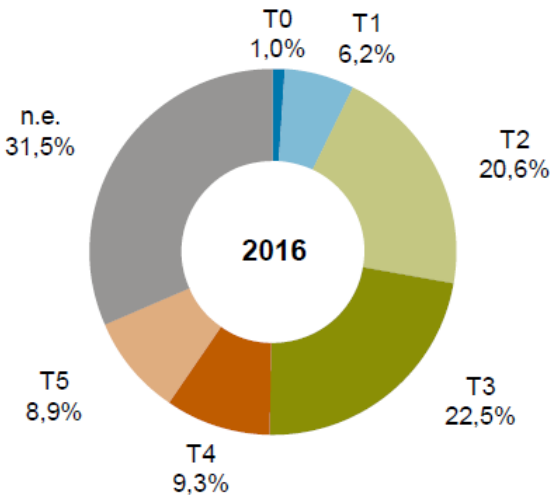
In general, most of the buildings are single family houses, leaving a percentage of 13% to multi-family buildings, as shown in next figure.

Figure 23: Building stock in Portugal [Source: INE - The Housing Stock and its Rehabilitation, Analysis and Evolution, 2001-2011, 2013 edition].



The dwelling stock estimative for 2016 pointed to a predominance of the typology T3 (22.5%), showed in figure 24. Still remains the impossibility of determining the typology of about 31.5% of the Portuguese dwellings, since they were not occupied at the time of the last Census in 2011.

Figure 24: Percental distribution of Portuguese dwellings stock according to typology - Portugal (2016) [Source: INE - Construction and housing statistics 2016].



The indices of completed buildings (residential and non-residential) have been following a downward trend since 2000 (base year), which became noticeable in the 2008-2014 period, and accounted in 2016 for around 10661 buildings (-3.2% than 2015), mostly residential buildings (63.5%) of which 69.9% is related to new ones.

In 2016, exception made to the completed buildings index, all other indices registered an increase over the previous year. The indices of complete dwellings in new residential buildings grew 9.8% compared to previous year.

The annual variation of the number of classic buildings and dwellings, between 2001 and 2016, continuous to stand out in the year 2002, with the most significant increase in both variables. This year corresponded to the last year with special conditions on household loans (the subsidized household loan scheme, namely the so-called subsidized young loan, which was in force until September 30 of 2002), with a very significant increase of completed buildings/dwellings that year.

Figure 25: Number of completed buildings and dwellings [Source: INE - Statistics Portugal, Statistical Yearbook Portugal 2016].

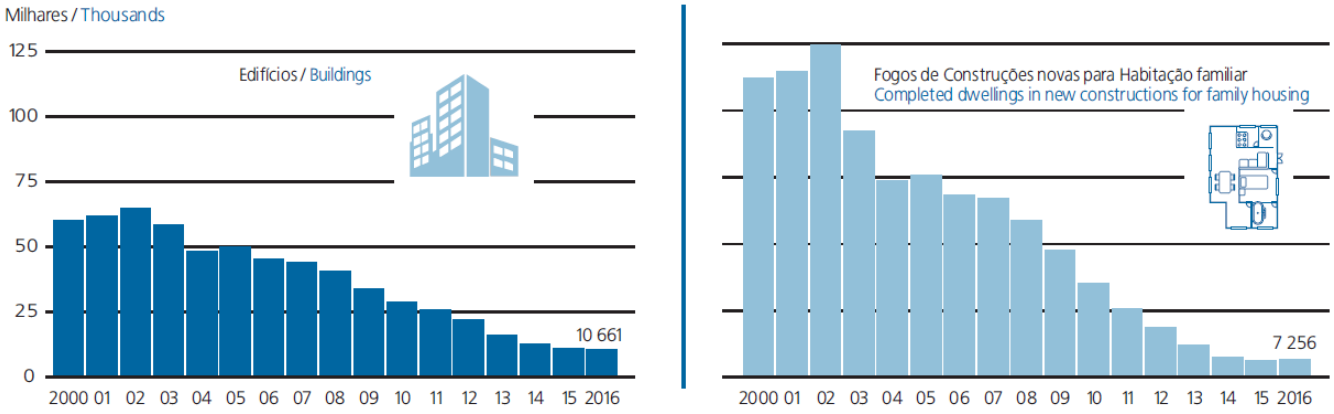
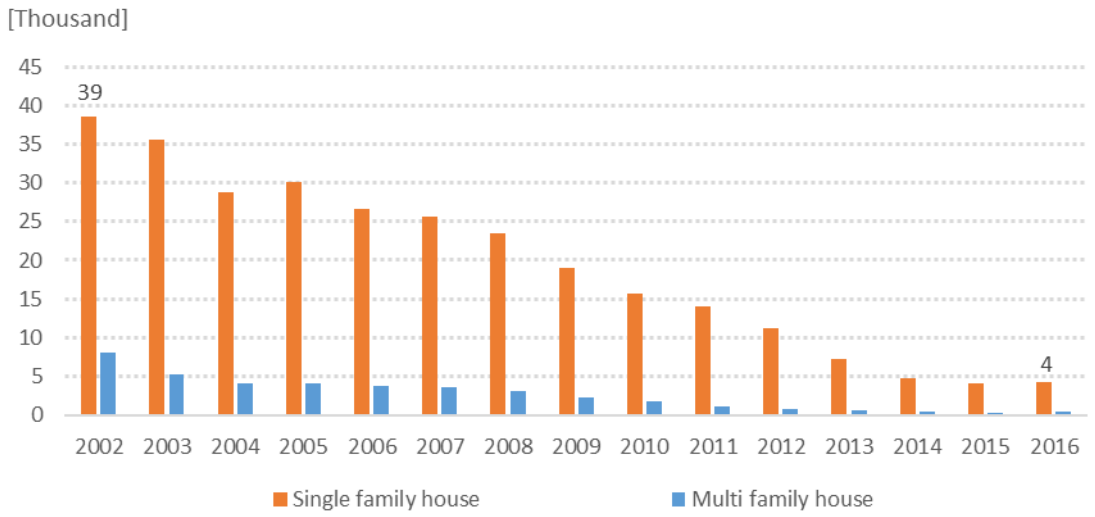
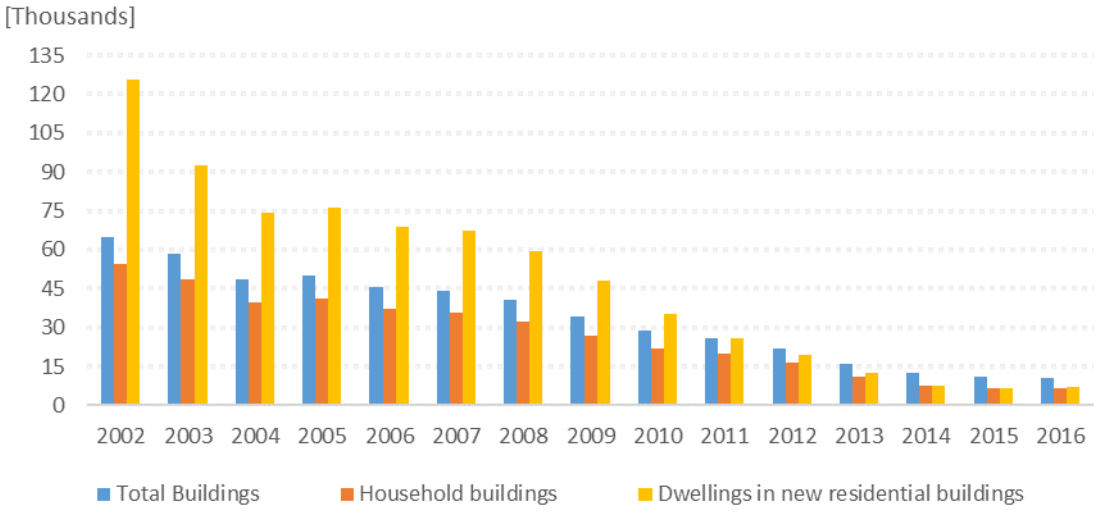


Figure 26: Number of completed buildings by type [Source: INE - Statistics Portugal, Construction works completed according to type of project].



In 2016, 10661 buildings were completed in Portugal, of which 3348 corresponded to renovation, alteration, enlargement and reconstruction works, which means that 31.4% of completed works concerned building rehabilitation. Compared to 2015, there was a 9.5% decline in the number of rehabilitated buildings. Most buildings rehabilitated in 2016 corresponded to enlargement works (70.7%), while reconstruction works corresponded to the lowest share, with a weight of 13,6%.

Figure 27: Number of completed buildings and dwellings, 2002-2016 [Source: ADENE based on INE - Statistics Portugal, Construction works completed according to type of project].



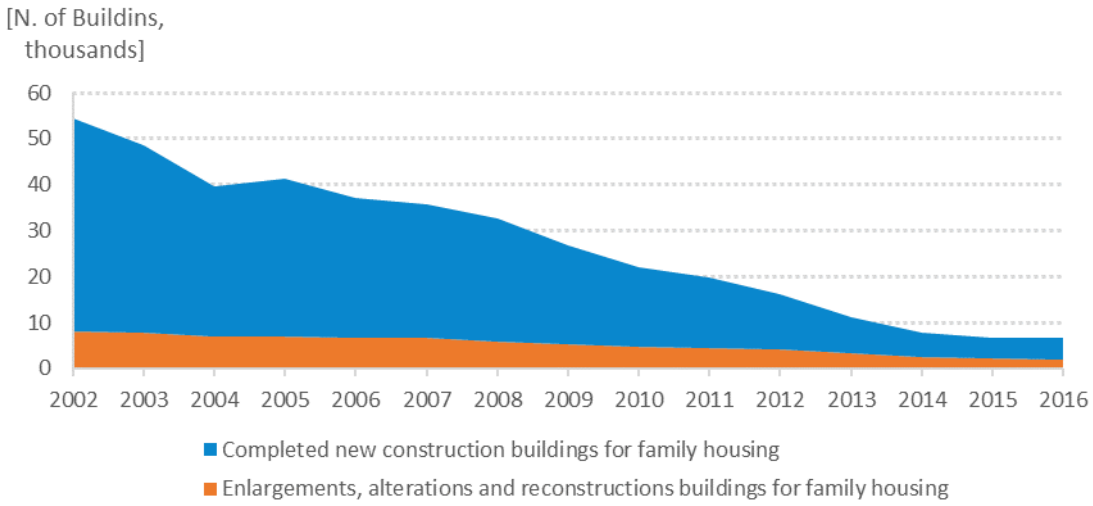
Note: Data is definite till 2010 and preliminary data as of 2011. Data for 2015 and 2016 is based on Completed Works Estimations and do not include demolitions. The total for new constructions of buildings for family housing includes apartment buildings, common buildings, mainly non-residential buildings and row houses.

From 2002 onwards, rehabilitation works declined slightly, associated with a sharp downward trend of new constructions. Hence, mainly as a result of a decrease in new constructions, rehabilitation has

been increasing in relative importance in comparison to total completed works. After 2015 new constructions increased in relative importance again.

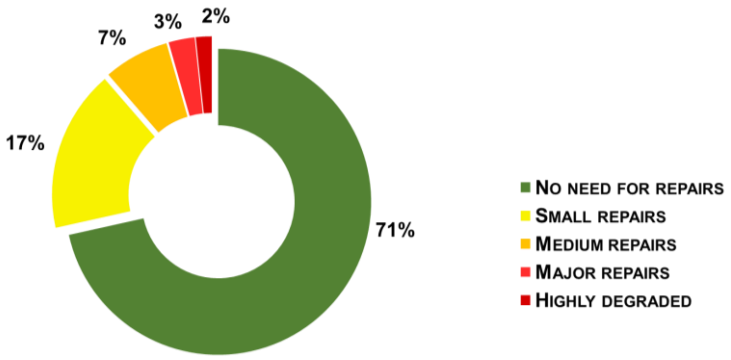
Over last 10 years (2006-2016) the renovation work in family household families decreased around 70% while completed dwellings in new constructions for family housing fell by 89%.

Figure 28: Building rehabilitation and new constructions, Portugal, 2002-2016 [Source: ADENE based on INE - Statistics Portugal, Statistics on Construction Works Completed].



National residential stock buildings mostly doesn´t need for repairs (71%) and only 5% are highly degraded or in need of major repairs, which probably will lead to a deep renovation. Yet there are around a share of 24% that are showing needs for small or medium repairs.

Figure 29: Building stock state of conservation [Source: ADENE based on INE - Statistics Portugal, Census 2011]

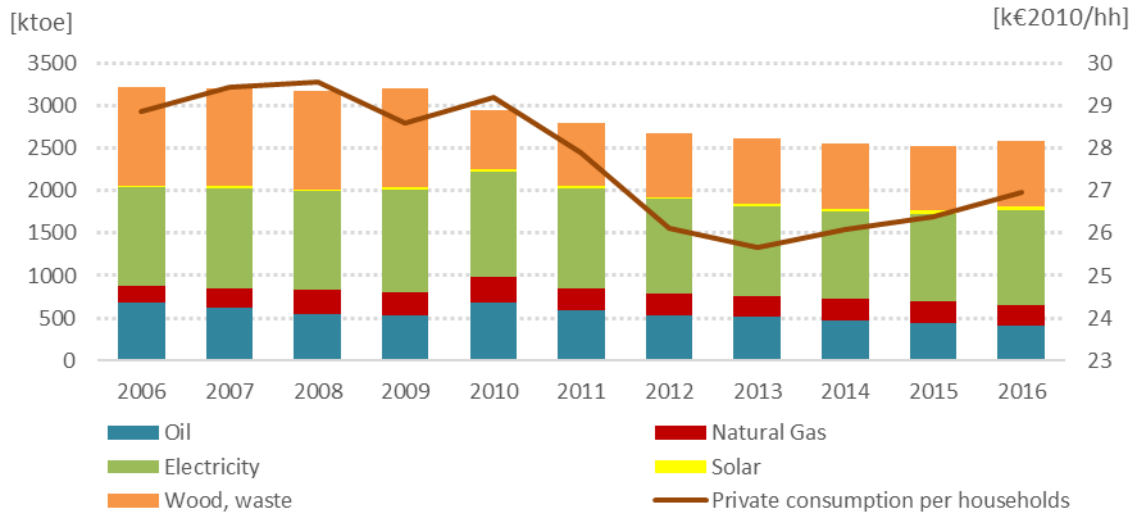


2.1.1.1. Energy consumption in household

Household final energy consumption evolution, by type of energy source characterization, as well as the private consumption per household is presented in the figure below. In 2010, the beginning of recession period, the energy consumption fell -7,8% compared to previous year and reached the lowest value in 2015 (2.5 Mtoe). Last years (2006-2016) the energy consumption decreased by -20,0%.

Also, private consumption follows the GDP trend, remarking the recession periods, 2009 and 2011 onward, with a pronounced decreased in the last period between 2011-2013. After 2013 to now a recovery begins to be felt (by +1,7%/year) reflecting the economy recovery of private consumption that increased +6,6% between 2013-2016.

Figure 30: Final energy consumption in residential and Private consumption per households [Source: Directorate-General for Energy and Geology, National Energy balance and ODYSSEE database]



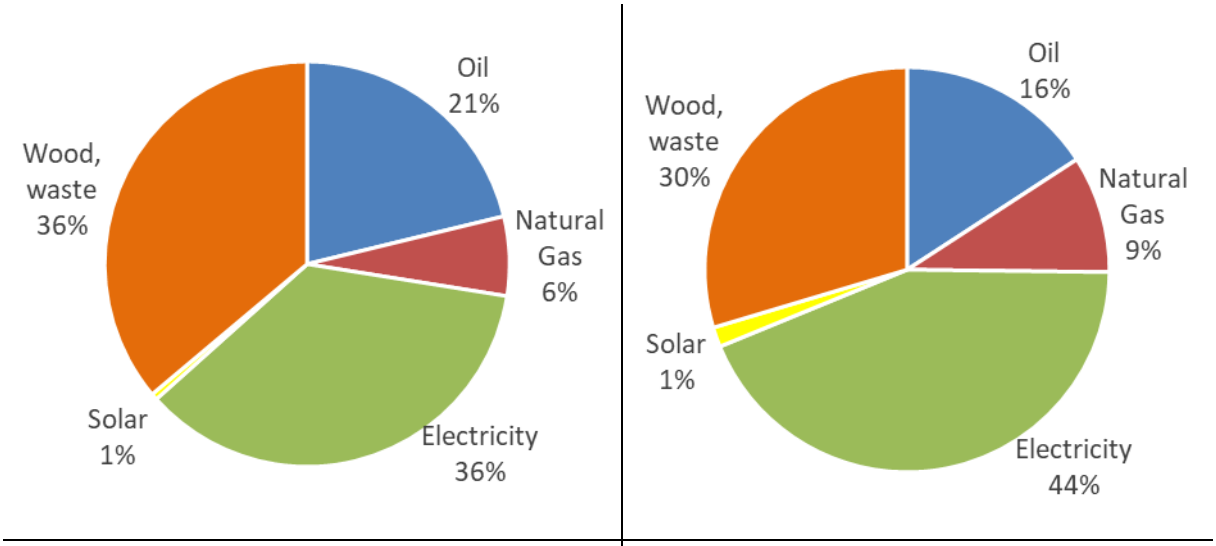
The diminished families purchase power reflected on the decrease of private consumption (private consumption means spending the economic operator households on goods and services used for the direct satisfaction of needs), have also contributed to a more moderate and controlled use of energy. This factor could be also be complemented, in what concerns to energy issues, with inhabitant's behaviour on energy consumption aiming to reduce their energy bills

From energetic point of view the positive development resulted in the continuous natural gas consumption, introduced in the country in 1996, +18.9% in 2016 compared to 2006, reaching a share in 2016 about 9%

The electricity source suffered from the effect of consumer demand habits, showing a slight decrease over the last 11 years, by -2.4%. Even so, in this period, the share of electricity is 8% higher in 2016 than was in 2006. This trend does not result of its energy increase but rather the reflection of consumption decrease of both, GPL and Biomass. The solar energy source, although with residual effect, already reflects the residential legislation revised that supported EPBD implementation in Portugal and natural gas has gained expression in the residential energy balance, (+3% from 2006 to 2016).

Nevertheless, firewood is the second main consumed energy source in Portuguese households, with a weight of 30% in total energy consumption in homes (2016). Wood and oil have been declining falling, in total, around 11% in the total energy residential consumption in the analysed period.

Figure 31: Total final energy consumption in residential by type of source, in 2006 and 2016, [%] [Source: Directorate-General for Energy and Geology, National Energy balance]



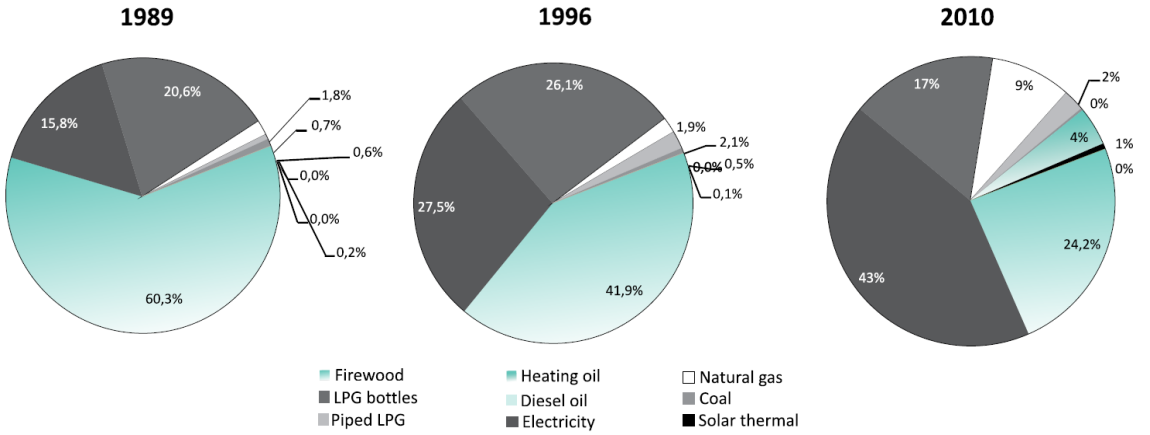
2006 total final buildings energy consumption: 3.2 Mtoe	2016 total final buildings energy consumption: 2.6 Mtoe

Regarding the prices for final consumer of the two sources that have seen a higher share increment in this sector, natural gas and electricity, the first has seen a decrease while electricity continues its growing trend. The prices practiced of natural gas was, in 2016, of 23.99 €/GJ (-11.8% compared to 2015) while for electricity was 0.232€/kWh (+5.5% faced to 2015). The average price for natural gas increased significantly from 2011 till 2014 (less than 20 EUR/GJ in 2011 to 27.415 EUR/GJ in 2014), however, after 2014 the price has been decreasing. The price of natural gas increased by 3.0%/year between 2007 and 2016. Comparing the natural gas price in Portugal to the average price in European Union in 2016, the price in Portugal is 37.4% higher (in EU-28 the average price was 17.465 €/GJ).

Concerning the electricity price, a considerable increase was noted from 2007 (a few more than 0.15 €/kWh) to 2016 (0.232 €/kWh), recording a yearly increase rate of 4.7%. Regarding the average price practiced in European Union in 2016, Portugal price is 13.0% higher (in EU-28 the average price was 0.205 €/kWh).

Following the ICESD 2010, in regard to the energy consumption in households, electricity was the main consumed energy source in the reference period, accounting for 42.6% of total energy consumption in households. This energy source underwent the greatest changes vis-à-vis the latest surveys (15.8% in 1989 and 27.5% in 1996). Firewood was the second main consumed energy source in Portuguese households, with a weight of 24.2% in total energy consumption in homes, stress being laid on its loss of importance in the past few years (60.3% in 1989 and 41.9% in 1996).

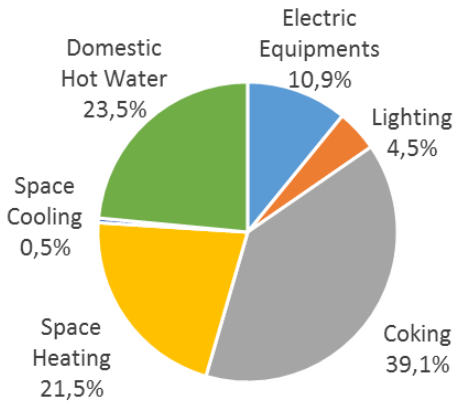
Figure 32: Distribution of energy consumption in households by source type - Portugal, 1989, 1996 and 2010 [Source: INE INE/DGEG - Survey on Energy Consumption in Households]



Taking into account the different energy uses in households, the use of energy in the kitchens recorded the highest weight, i.e. around 39%, compared with other types of use. It was followed by energy use for heating water, with 23%. However, depending on the type of use, the predominant energy source was different, given that the use of electricity was predominant in kitchens, whereas for water heating preference was given to LPG bottles.

Thus, the energy consumption weight by end-uses focus the following 4 areas: kitchen appliances, domestic hot water, space heating and electric equipment's. Lighting share is not so relevant, only with a 4.5% weight and the space cooling hardly has any expression.

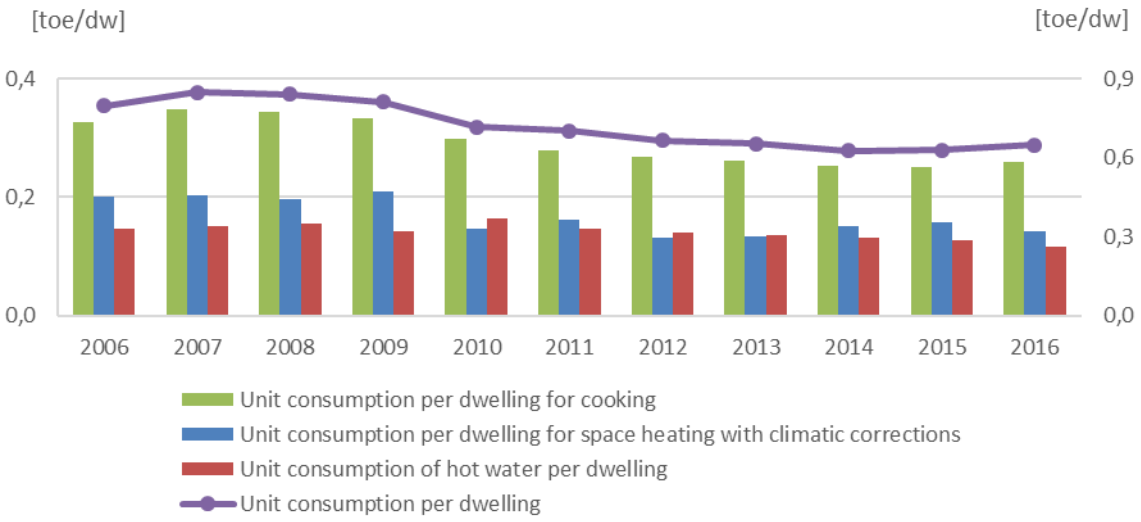
Figure 33: Distribution of energy consumption in housing by type of energy and type of end-uses- Portugal, 2010 [Source: INE INE/DGEG - Survey on Energy Consumption in Households]



Energy consumption per dwelling remained stable until 2009 showing after that a continuously decrease by 2.9%/year. The decline trend is associated to energy efficiency improvements such policy measures, national scenario through value-added tax increment associated also to income tax rise and higher energy prices.

Regarding the three major end-uses of energy consumption, their improvement in last 10 years, mostly notice after 2009, was around 28.6% for space heating and by 21.1% and 20.5% for DHW and cooking, respectively.

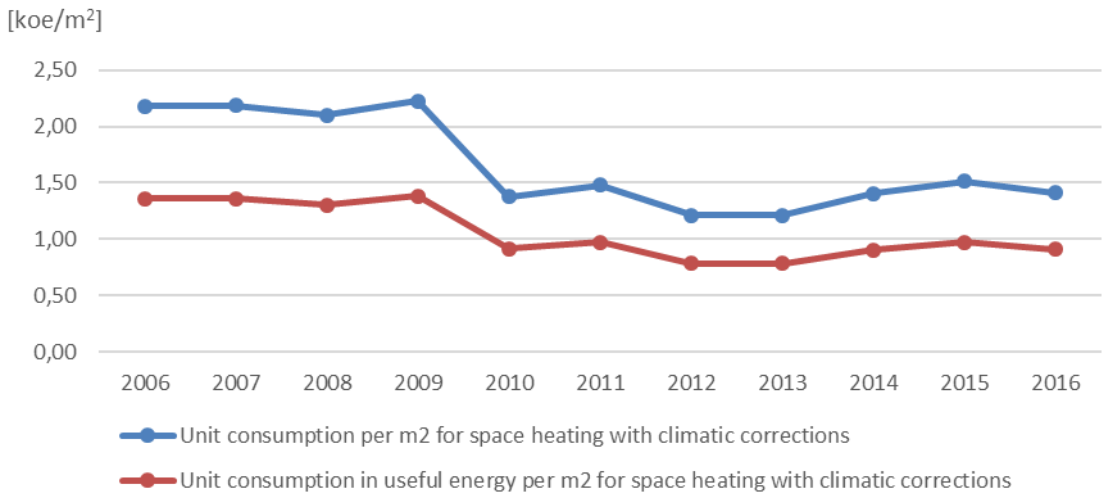
Figure 34: Unit consumption by end-use, (toe/dw) [Source: ODYSSEE]



Focusing on the energy consumption of space heating per square meter in last 10 years (2006-2016) it had two differentiated trends leading, one among 2003 and 2009 showing no relevant changes and another one from 2010 onward with a significantly energy improvement to values around 1.5 koe/m^2 and 1.2 koe/m^2 of unit energy consumption, resulting also from the impact of economic downturn and the significant increase in energy costs.

The unit consumption reproduces the energy consumption for space heating to the number of permanently occupied dwellings.

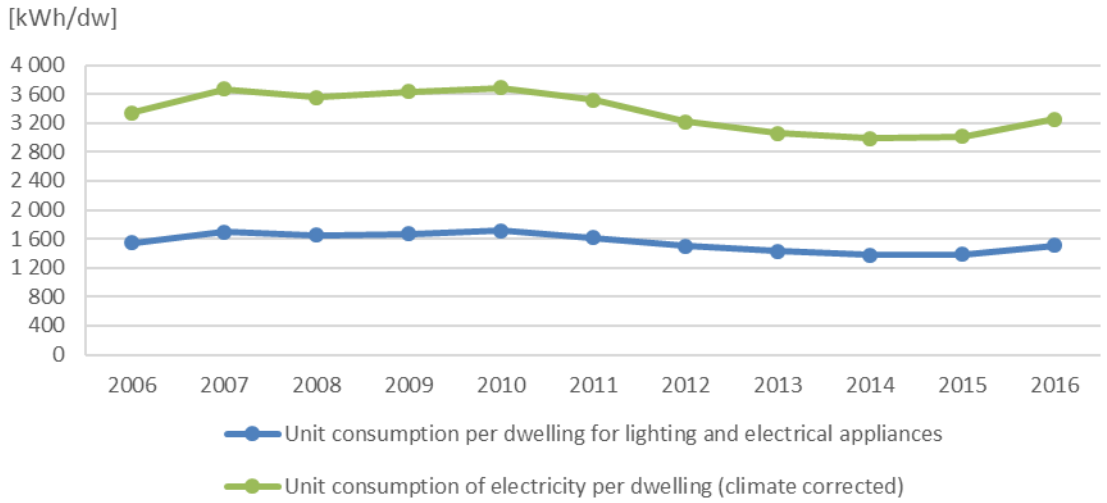
Figure 35: Unit consumption of space heating per m^2 and unit consumption in useful energy per m^2, both with climatic corrections (ktoe/m^2) [Source: ODYSSEE]



In the analysed period unit consumption of electricity per dwelling decreased at a ratio of 0.3%/year in which the energy consumption in dwellings for lighting and electrical appliances accounts by 46% of it. It was noticed a deep increase of washing machine stock followed by other appliances such as TV, dishwasher and refrigerator. Yet, these appliances are to be increasingly efficient whereby the electricity consumption did not grow, the unit consumption for lighting and electrical appliances decreased by 2.3% from 2006 to 2016.

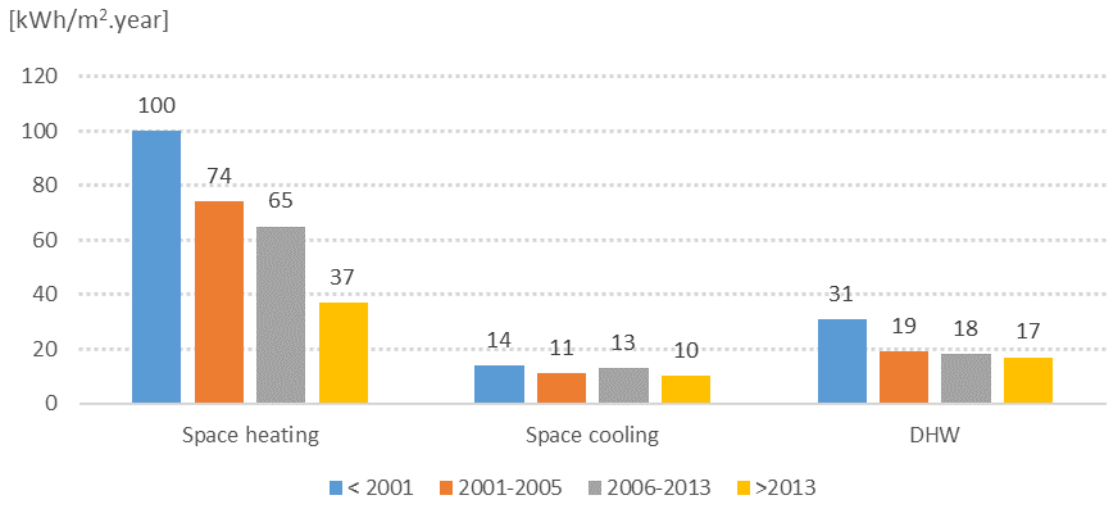
Lighting share is responsible for almost one third on the unit consumption for lighting and electrical appliances. The substitution of incandescent lamp by CFL lamp permitted a constant electricity consumption throughout the years.

Figure 36: Unit consumption per dwelling concerning to electricity (kWh/dw) [Source: ODYSSEE]



Following the transposition of the EPBD in Portugal, several changes were introduced in the legislation. One of the main impacts was the change in the construction sector (with more efficient building components) and the introduction of solar thermal panels for domestic hot water production. In that way the figure below represents the energy evolution demands in recently constructed buildings for heating, cooling and domestic hot water. It's possible to notice an energy demands improvement by 63% in space heating followed by domestic hot water with 46% and last by space cooling with 27%.

Figure 37: Energy demands by end-use by construction year (kwh/m². year) [Source: ADENE, Energy Certificate System database]



2.1.1.2. Energy efficiency in household

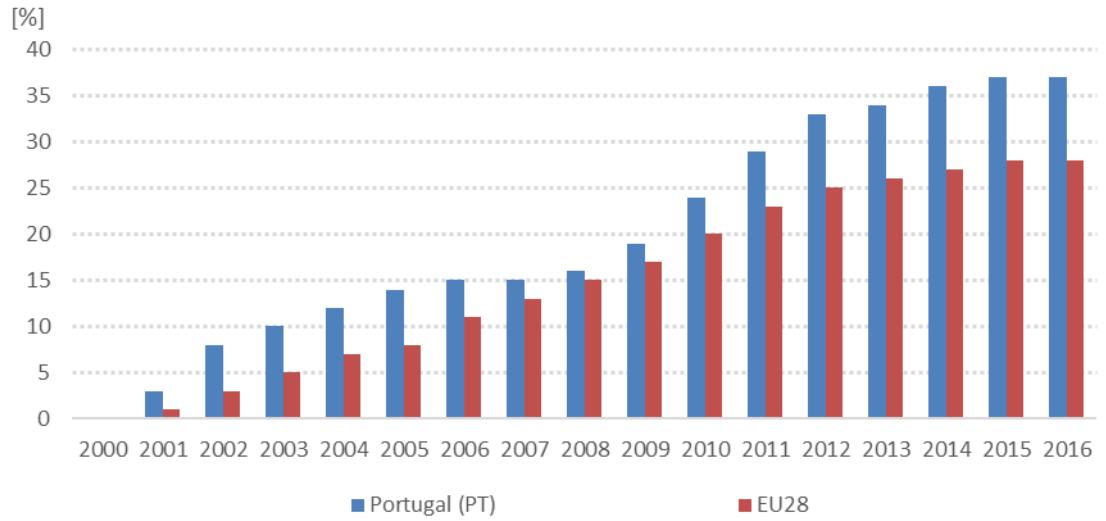
Household sector, which represents about 17% of energy consumption in the country, noted one of the largest developments in energy efficiency gains, according to the ODYSSEE methodology, of around 37 % (ODEX indicator) among 2000-2016.

The energy efficiency gains on residential sector are calculated from ODEX and reflect efficiency gains since 2000. ODEX in households is evaluated carrying out at the level of 3 end-uses (heating, water heating, cooking) and from unit consumption trends by end-uses/equipment's (5 large appliances of which: refrigerators, freezers, washing machines, dishwashers and TVs) by aggregation of unit consumption indices by end-uses in one index for the sector on the basis of the current weight of each mode in the sector's energy consumption. For each end-use, the following indicators are considered to measure efficiency progress:

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

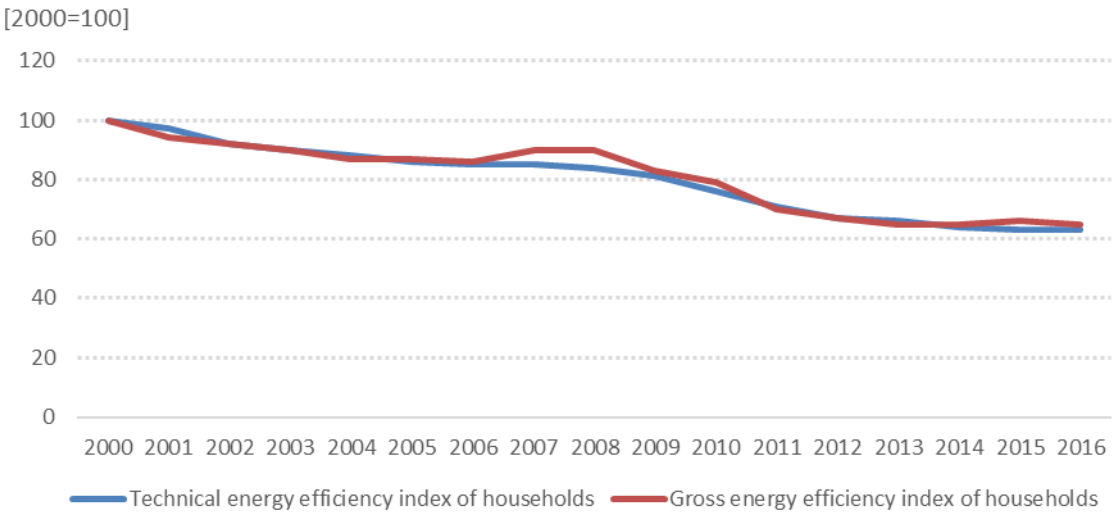
The next figure shows the gain of household sector in terms of energy efficiency, expressed in [%], related to year 2000, comparatively also to EU. The gain trend in Portugal has followed the tendency of EU, however a higher rhythm after 2008.

Figure 38: Energy efficiency gains in residential, since 2000 (%) [Source: ODYSSEE]



Regarding the influence of behaviours factors that could even be further improved by estimating the technical gains associated to the diffusion of efficient technologies (eg CFL, condensing boilers, etc), in Portuguese case no main difference between the Technical ODEX and Gross ODEX (next figure), exception made between 2007 and 2010 which also correspond to the higher energy consumption registered in this sector when is observed the timeline evolution from 2006 to 2016. Implementation of NEEAP as well as other programs as FEE or PPEC, that have included not only actions focused in efficient technologies but also in other levels of action namely behaviour campaigns, allowed that after 2011 the gap verified among both ODEX is almost nil.

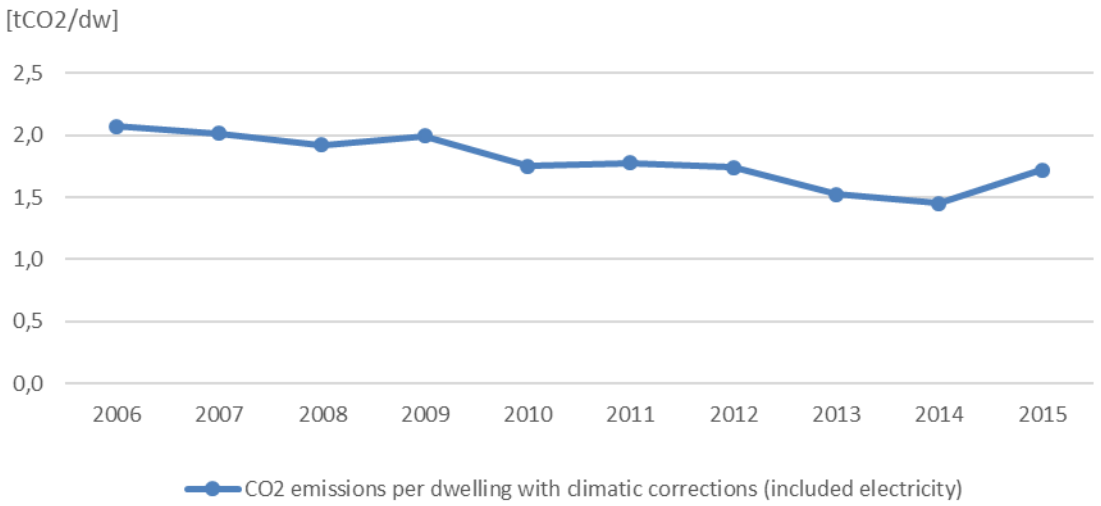
Figure 39: Energy efficiency (ODEX) in residential, (200=100) [Source: ODYSSEE]



2.1.1.3. CO_2 emission in household

In 2015 each occupied dwelling is responsible for about 1.7 tCO_2 emissions. Following the energy trend in this sector, that conducted consequently to CO_2 emissions reduction, and despite not having registered a significant decrease in the first 4 years of this series (2006-2009), a positive trend from 2010 onward is registered, with -1.7% of tCO_2 by dwelling in 2015, compared to 2010 (-13.6% of tCO_2 by dwelling when compared to 2009).

Figure 40: CO2 emission per dwelling, (tCO^2/dw) [Source: ODYSSEE]



In household sector the main factors that had contributed to the decrease of energy consumption are: More efficient household buildings design; more efficient equipment's for acclimatization and domestic hot water and income tax rise in private consumption that lead to a higher attention on population behaviour. All this context permitted to decrease the final energy consumption in the residential sector by -19.7% in last ten years (Fig. 31), or -11.7% when compare the years 2000-2016.

Following the same tendency, energy savings, resulting from energy efficiency improvements in the various end-uses, has got around 37% gains between 2000 and 2016.

2.1.2. SERVICES

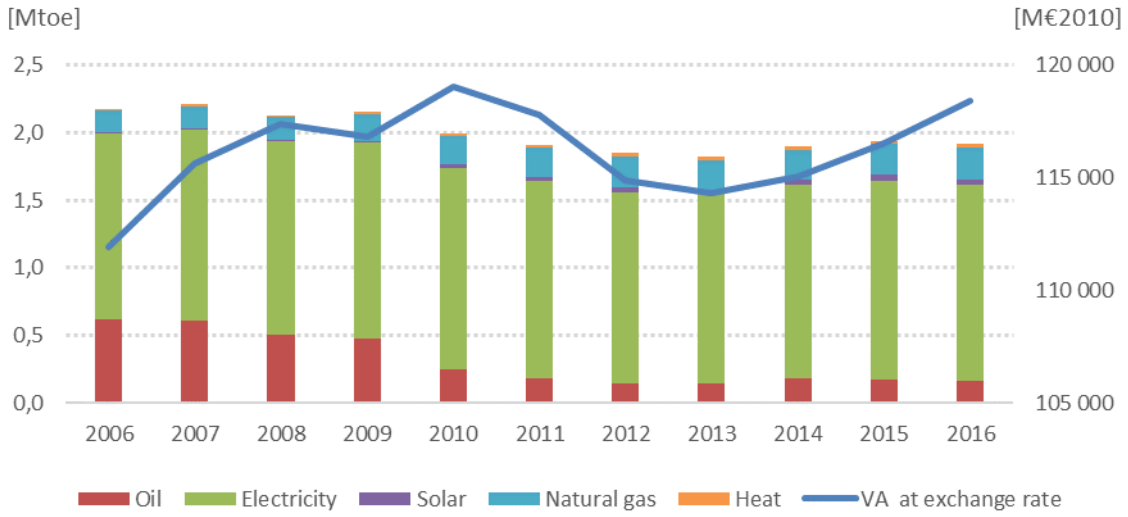
Services sector recorded an annual growth of about 0.6% in the value added (VA) between 2006 and 2016. However, this trend was featured by a fluctuation that can be distinguished in three different periods: i) the first one (2006-2010) exhibited an annual growth of 1.6% , ii) the second one falling steeply between 2010 and 2013 by -4% (marked by the recession period) an iii) the third one following the economy revitalization with a noted growth of about 1.2%/year. The VA registered in 2016 is even slightly lower than the value presented for 2010 (-0.5%).

VA is the difference between the production obtained and the value of consumption of intermediate goods necessary for its production, such as sum of salary, rent, interest and profit.

This sector portrays the data related to public and private buildings (e.g. public and private offices, commercial surfaces, shops, schools, hospitals) as well as public lighting energy consumption.

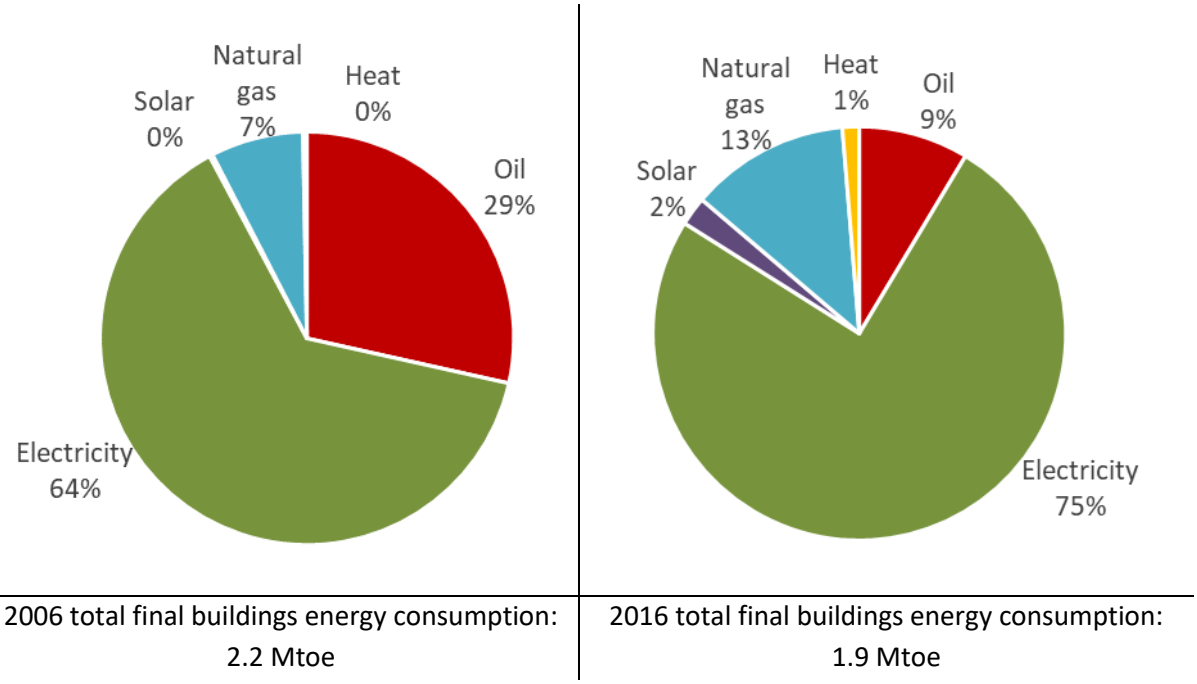
Regarding the energy consumption it had a development without significant variation among the years 2006-2009, decreasing after that reaching in 2016 the value of 1.95 Mtoe (-10.2% compared to 2006). This trend was mainly due to less use of oil energy consumption (-35.1% in 2016 compared to 2009). On the other hand, natural gas has increased by 5.2%/year (from 2006 to 2016) reaching, after 2011, a higher share than the one performed by oil products in the energy consumption of this sector.

Figure 41: Final energy consumption in service (Mtoe) and Value Added (VA) [Source: Directorate-General for Energy and Geology, National Energy balance and ODYSSEE database]



In the energy consumption desegregation by type of energy source, nowadays electricity represents about 75% of the share in the pictured sector of activity (+11% than in 2006). Natural gas was also reflected in a greater demand with 6% of the share in total consumption, being now the second major energy source consumed in the sector. On the other hand, oil have fallen in last 11 years around 20%.

Figure 42: Total final energy consumption in services by type of source, in 2000 and 2013, [%] [Source: Directorate-General for Energy and Geology, National energy balance]



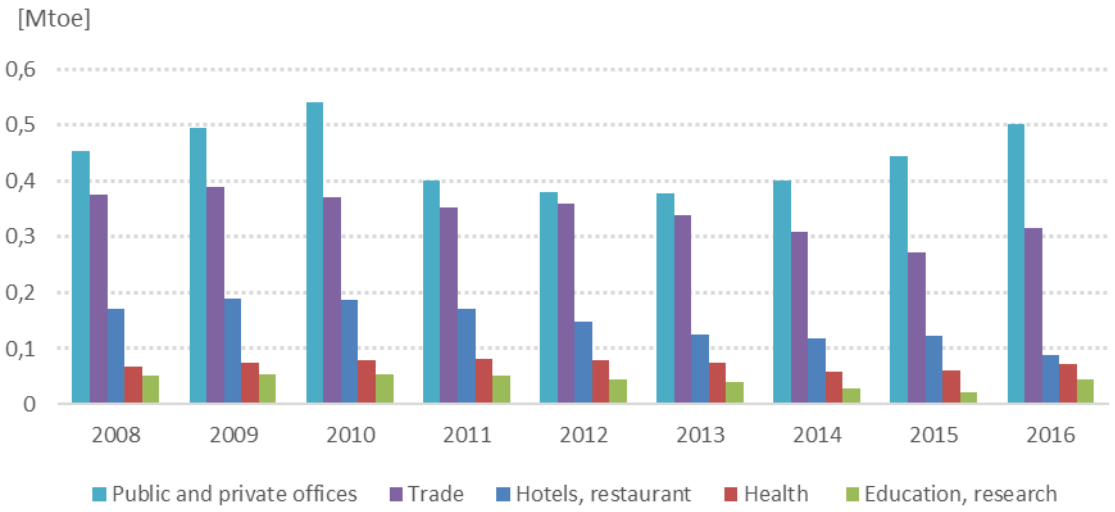
2006 total final buildings energy consumption: 2.2 Mtoe	2016 total final buildings energy consumption: 1.9 Mtoe

Taking into account the high electricity share in national energy balance it is interesting to observe its desegregation by service building typology (Fig. 43), leaded by public and private buildings and trade services. Nevertheless, the administration sector contributes with a slightly share for this figure (around 24.7% of the public and private buildings electricity consumption, in 2016).

Three typologies shows an electric reduction energy consumption over last eight years, Hotels & restaurants, Education & research and Trade by 48.6%, 13.7% and 15.5%, respectively. All other typologies saw an opposite trend, namely Health with +5%, Administration by +40.3% and Offices with +3.7%.

The transposition of the directive n.º 2012/27/EU of the European Parliament and of the Council of 25 October 2012, that establishes a new framework to promotes energy efficiency in the European Union might have a positive impact in the future. In regard to this new context all non-small medium enterprises must undergo periodic audits and register its energy consumption in a central database.

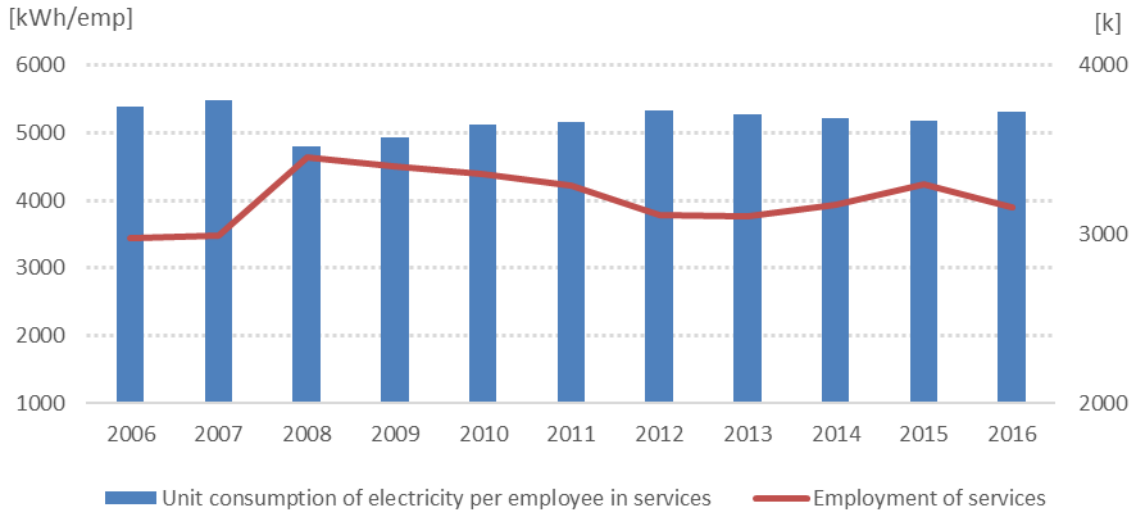
Figure 43: Consumption of electricity by service building typology [Source: ODYSSEE]



Looking at the electricity consumption evolution by the number of employees it's also interesting to see some changes. During the reporting period (2006-2016), the number of employees had two different evolution growing between 2006 and 2008 with +8.1%/year, reducing after that by -1.1%/year until 2016. The recovery felt in this sector mainly after 2013 brought a slight increase but it was not enough to attain the value obtained in the first analysed years.

Next figure shows the unit energy consumption of electricity per employee that assumes, since 2012, a stabilized evolution. This indicator not reflects the decrease felt in the number of employees since 2008.

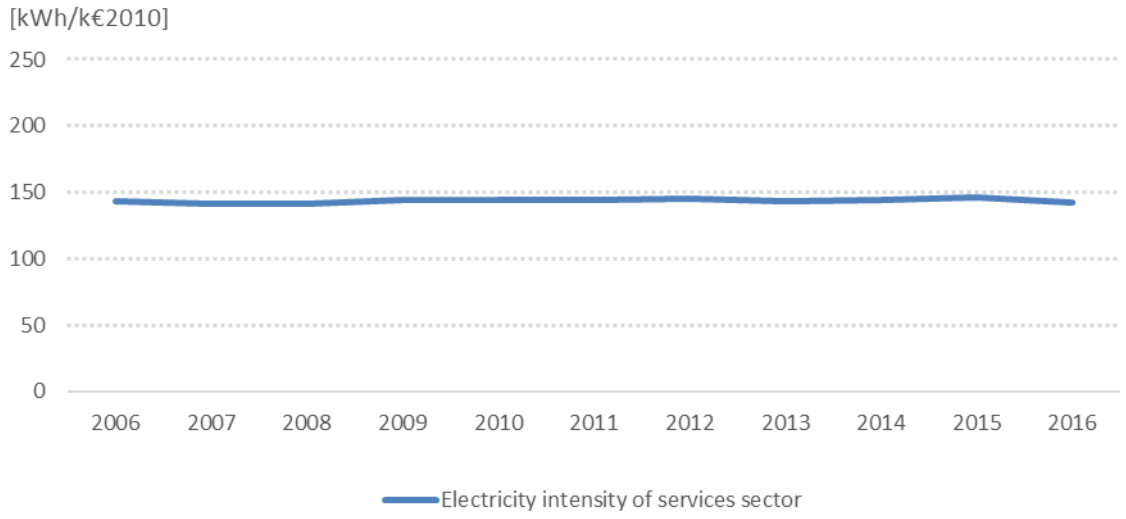
Figure 44: Unit consumption of electricity per employee and employment in tertiary [Source: ODYSSEE]



2.1.2.1. Electricity intensity in services

The final electricity energy consumption of the services sector and the value added measured in constant monetary units (2010, in the present case), also observed a positive trend by 1% during last 11 years, nevertheless it had an inverse peak among the period 2009-2015 that is directly linked to the increase of electricity consumption recorded in the same year when compared to the evolution observed in the value added, as shown in figure 45.

Figure 45: Electricity intensity of services sector [Source: ODYSSEE]



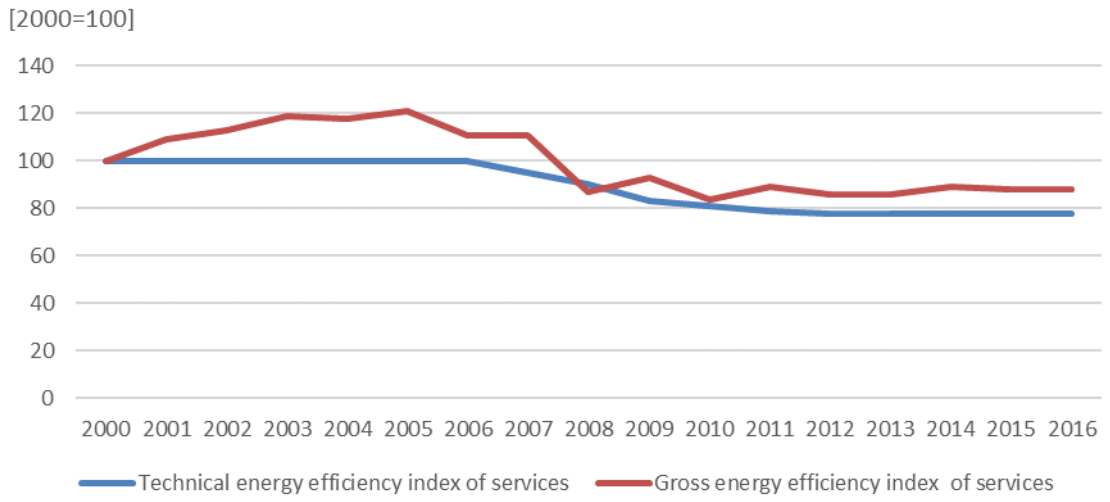
2.1.2.2. Energy efficiency in services

Services sector represents nowadays about 13% of the total final energy consumption in Portugal and according to indicators shown above have had a marked fluctuation during the analysed period, as for energy consumption, value added or number of employees, influencing the energy efficiency of this sector.

Regarding the influence of behaviours factors that could even be further improved by estimating the technical gains associated to the diffusion of efficient technologies, it was observed a gap between both, Technical ODEX and Gross ODEX (next figure). This trend, showing an inefficient trend of this sector between 2000-2006, as it concerns to efficient technologies and behaviours factor, began to walk in a opposite way since then, which could reflect the effect of EPBD implementation as well as all the other programs (NEAAP, ECO.AP, FEE and PPEC).

Still worth to observe that the efficient technologies effects have a higher impact in the energy efficiency of this sector (22% lesser in 2016) than the behaviours factors, which only succeeded for about 12% improvement showing a potential for future measures implementations.

Figure 46: Energy efficiency (ODEX) in residential, (200=100) [Source: ODYSSEE]

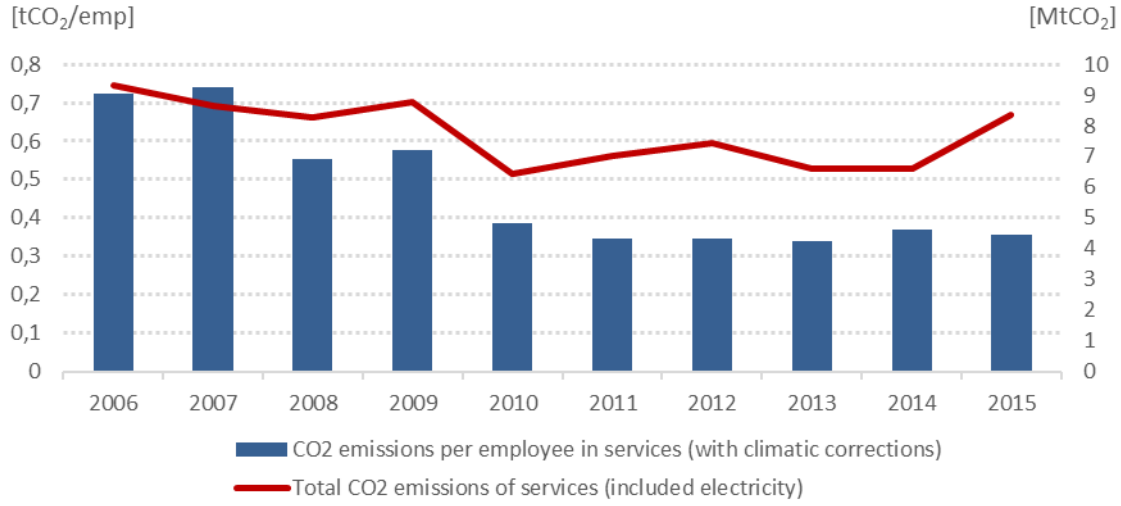


2.1.2.3. CO_2 emission in services

Concerning the CO_2 emissions under the services sector an improvement was noticed (-10.2% of $MtCO_2$ in 2015 comparatively to 2006, including electricity) reaching 8.37 $MtCO_2$ in 2015.

From other approach, shown in figure 47, it can be seen that the CO_2 emissions in both approach, per number of employment and per the economic scenario sector measured by value added, have a positive trend and improvements has been achieved from 2006 to 2015 by 1.1%/year and 5.7%/year, related to $MtCO_2$ and tCO_2/emp, respectively.

Figure 47: CO_2 emissions per employee and CO_2 intensity [Source: ODYSSEE]



2.2. ENERGY EFFICIENCY POLICIES

Main recent energy efficiency policies in buildings sector focus on the publication of Energy Certification of Buildings, Decree-Law 118/2013, August 20th that transposes to the Portuguese Legislation, the European Directive n 2010/31/UE, regarding the recast of the energy performance of buildings directive and thus promoting the continuation of the energy certification of buildings, the improvement of requirements, among other issues. This Decree-law is supported through the publication of 6 ordinances and 14 orders that includes the specific calculation methodology, renewable energy account, energy performance certificates (EPC) lay-out, climate data, primary energy conversion factors and others.

The Decree-law 118/2013 was published in a different configuration when compared to the previous legislation dated from 2006, which was built on three decree-laws. This new regulation revised and updated the three previous decree-laws (Decree-law 78/2006, Decree-law 79/2006 and Decree-law 80/2006, all from 4th April) and aggregated it one unique decree-law.

The overall decrees-law, law, ordinances and orders which define specific issues that support this new building regulation are listed as follows:

- Decree-law 118/2013, of August 20th (SCE – Buildings Energy Certification System);
- Law n.º 58/2013, of August 20th (Professional qualifications of SCE technicians);
- Ordinance n.º 349-A/2013 of, November 29th (Establishes the buildings category of energy certification (CE) as well as the types of certificate model, the taxes of CE register in the SCE internet platform and the criteria for quality verification of energy certification process.
- Ordinance n. 349-B/2013 of November 29th (REH solutions requirements for residential buildings);
- Ordinance n.º 349-C/2013 of December 2nd (Establishes the required documents for the construction and use permit);
- Ordinance n. 349-D/2013 of December 2nd (RECS requirements for non-residential buildings);
- Ordinance n.º 353-A/2013 of December 4th (Indoor air quality requirements for non-residential buildings);
- Ordinance n.º 353/2013 of December 4th (Establishes the building cost per square meter)
- Order n.º 15793-C/2013 of December 3rd (Publishes the energy certificate layout for residential and non-residential buildings);
- Order n.º 15793-D/2013 of December 3rd (Publishes the final energy conversion factors to primary energy and CO2 emission system under energy certificate process);
- Order n. 15793-E/2013 of December 3rd (Establishes the rules of simplified calculations methods to be applied in existing buildings);
- Order n.º 15793-F/2013 of December 3rd (Publishes the climate data);
- Order n. º 15793-G/2013 of December 3rd (Establishes the proceedings for testing and acceptance of facilities as well as the guidance of minimum information required to be included in the Maintenance Plan)
- Order n.º 15793-H/2013 of August 20th (Establishes the rules for the accounting of renewable energy under energy certificate process);

- Order n.º 15793-I/2013 of December 3rd (Publishes the methodology of nominal energy household demands);
- Order n.º 15793-k/2013 of December 3rd (Publishes the thermal parameters of constructions solutions);
- Order n.º 15793-L/2013 of August 20th (Defines economic viability methodology to support the energetic rational plan under RECS buildings);
- Order 8892/2015, of August 11st, (Defines the classification methodology to adopt for lifts, conveyors and escalators to be installed in commercial buildings and services in order to assess compliance with the minimum energy efficiency requirements according to VDI 4707 standard)
- Order 7113/2015, of June 29st, (Responsible for publishing quality verification of the selection criteria of the processes and methods of checking the quality of the certification processes carried out by the technicians of the Building Energy Certification System (SCE), particularly the Qualified Experts)
- Order 14985/2015, of December 17th, (Defines the methodology to be used for determining the values (Qusable) and Seasonal Performance Factor used in the calculation methodology of the renewable energy contribution from heat pumps).
- Order 3156/2016, of March 1st, (Replaces the calculation program of the determination of the energy produced by the solar thermal system and solar photovoltaic system, under the Building Energy Certification System).
- Order 6470/2016, of May 17th, (Defines the requirements associated to the elaboration of energy rationalization plans).

Besides all above listed diplomas, it was also published in April 30th the Decree-law 68-A/2015 that establishes requirements on energy efficiency and CHP, transposing for national legislation the European Directive 2012/27/UE.

Like indicated above the decree-law 118/2013 establishes several requirements for new and buildings undergoing renovations or major renovations, as well as for building components and technical systems. Some of these requirements are already expected to evolve in certain dates that are already stated in the legislation. This situation allows for the market to prepare itself and adapt to future requirements. Table 7 presents a brief resume of the requirements in place for technical systems.

Table 5 – Minimum requirements for technical systems [Source: ADENE based on DL118/2013]

<table>
<tr><th rowspan="2">Building type</th><th rowspan="2" colspan="2">Technical system</th><th colspan="3">Requirement evolution</th><th rowspan="2">Standard</th></tr>
<tr><th>Before 2013</th><th>2013-2015</th><th>After 2016</th></tr>
<tr><td rowspan="8">Residential and non residential buildings</td><td rowspan="3">Heat pumps</td><td>cooling</td><td rowspan="8">None</td><td>Eurovent Label C

(Example: Chiller COP ≥ 2.8; EER ≥ 2,7)</td><td>Eurovent Label B

(Example: Chiller COP ≥ 3.0; EER ≥ 2,9)</td><td>EN 14511</td></tr>
<tr><td>heating</td><td>EN 14825</td></tr>
<tr><td>DHW</td><td colspan="2">COP ≥ 2.3</td><td>EN 16147</td></tr>
<tr><td colspan="2">Boilers</td><td>Minimum nominal efficiency 86%</td><td>Minimum nominal efficiency 92%</td><td rowspan="3">-</td></tr>
<tr><td rowspan="2">DHW Gas heater</td><td>Power ≤ 10kW</td><td colspan="2">Efficiency ≥ 82 %</td></tr>
<tr><td>Power > 10kW</td><td colspan="2">Efficiency ≥ 84 %</td></tr>
<tr><td>Residential</td><td colspan="2">Domestic Electric Storage Water Heaters</td><td colspan="2">Maximum stand-by heat loss</td><td>EN 60379</td></tr>
<tr><td rowspan="5">Non residential</td><td colspan="2">Air handling unit</td><td>Eurovent Label D

Efficiency ≥ 47%
Velocity ≤ 2.5 m/s
Δp ≥ 125 Pa</td><td>Eurovent Label C

Efficiency ≥ 57%
Velocity ≤ 2.2 m/s
Δp ≥ 170 Pa</td><td>EN 13053</td></tr>
<tr><td colspan="2">Pumps</td><td rowspan="2">Minimum EFF2 label</td><td colspan="2">Minimum IE2 or IE3 class</td><td>IEC60034-30</td></tr>
<tr><td colspan="2">FANs</td><td colspan="2">Minimum IE2 or IE3 class
Minimum SFP 4 or 5 (W/m^3/s)</td><td>IEC60034-30
EN 13779</td></tr>
<tr><td colspan="2">Lighting</td><td rowspan="2">None</td><td colspan="2">Maximum power (W/m^2)/100lux

Example: Offices 2.5 (W/m^2)/100lux for 500lux</td><td>EN 12464-1
EN 15193</td></tr>
<tr><td colspan="2">Lifts</td><td>Minimum C</td><td>Minimum B</td><td>VDI 4707</td></tr>
<tr><td colspan="2">Central building management system</td><td colspan="3">Mandatory if HVAC thermal power > 250 kW</td><td>EN15232</td></tr>
</table>

Taking account all the information collected from past years of SCE implementation and also the development in the requirements for buildings, it is interesting to perceive how the energy demands and primary energy consumption have evolved. Table 6 contains a summary of this indicators by building typology. In general the total primary energy average in residential buildings (for the end-uses of heating, cooling and DHW) improved about 52%. In the case of service buildings the primary energy improvements varies according to typology from 1% (educational buildings) to 45% (Retail trade). Nevertheless the comparison between periods in order to evaluate the evolution and impact of requirements is not recommended due to the difference between methodologies, requirements, cost optimal studies, etc.

Table 6 – Energy performance indicators and corresponding requirements [Source: ADENE based on DL118/2013]

			Existing				New	
			Before EPBD		EPBD		EPBD recast	
			(before 2006)		2006-2013		after 2013	
			Average	Minimum	Average	Minimum	Average	Minimum
Residential	Heating [kWh/m^2.year]	Useful energy	94	a)	45	b)	45	c)
	Cooling [kWh/m^2.year]	Useful energy	15	14	12	13	10	10
	DHW [kWh.year]	Useful energy	0	-	0	d)	0	d)
	Total [kWh/m^2.year]	Primary Energy	259	e)	87	f)	103	g)
Hospitals	Total [kWh/m^2.year]	Primary Energy	217	222	209	281	200	226
Sports facilities	Total [kWh/m^2.year]	Primary Energy	218	211	144	182	148	191
Hotels	Total [kWh/m^2.year]	Primary Energy	226	227	237	255	215	250
Educational buildings	Total [kWh/m^2.year]	Primary Energy	118	109	76	112	117	198
Offices	Total [kWh/m^2.year]	Primary Energy	157	144	120	161	159	211
Restaurants	Total [kWh/m^2.year]	Primary Energy	265	256	125	191	183	245
Retail trade	Total [kWh/m^2.year]	Primary Energy	146	144	123	174	81	136

a) Varies between 33 - 56 kWh/m2.year (1st and 3rd quartile)
b) Varies between 38 - 66 kWh/m2.year (1st and 3rd quartile)
c) Varies between 46 - 75 kWh/m2.year (1st and 3rd quartile)
d) Minimum solar energy contribution for DHW
e) Varies between 105 - 182 kWh/m2.year (1st and 3rd quartile)

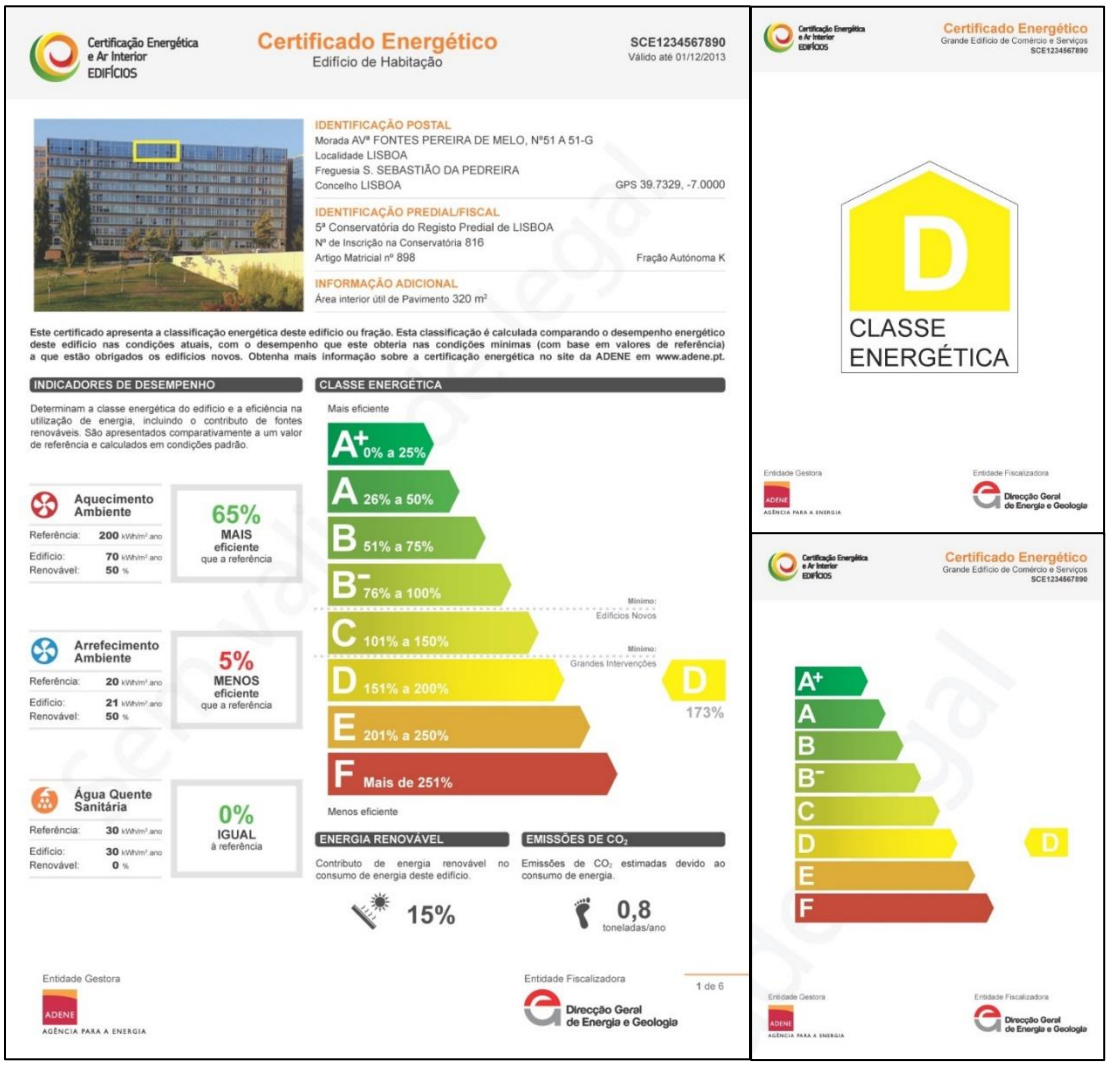
f) Varies between 88 - 177 kWh/m2.year (1st and 3rd quartile)
g) Varies between 113 - 220 kWh/m2.year (1st and 3rd quartile)

The Energy Performance Certificate (EPC) is the most visible aspect of the SCE and one of the requirements implemented after the transposition of the EPBD in 2007. This document will assign an energy performance label to residential and non-residential buildings and it may list measures for improving their energy performance, besides other relevant information.

The energy label classifies the buildings on an efficiency scale ranging from A+ (high energy efficiency) to F (poor efficiency). This is similar to the scale currently used for some domestic appliances and other equipment (although classes A and B are evenly subdivided in to classes A+, A, B, B-, to improve the distinction among new buildings – all new buildings must be in the A+ to B- classes) and it allows for easy reading and interpretation by the consumer.

Figure 48 shows the 1st page of the residential Energy Certificate as well as two smaller variants (A6 size) for the non-residential sector that can also be used as an alternative to the 1st page (useful when there's some difficulty displaying an A4 size version).

Figure 48: National Energy Certificate [Source: ADENE]



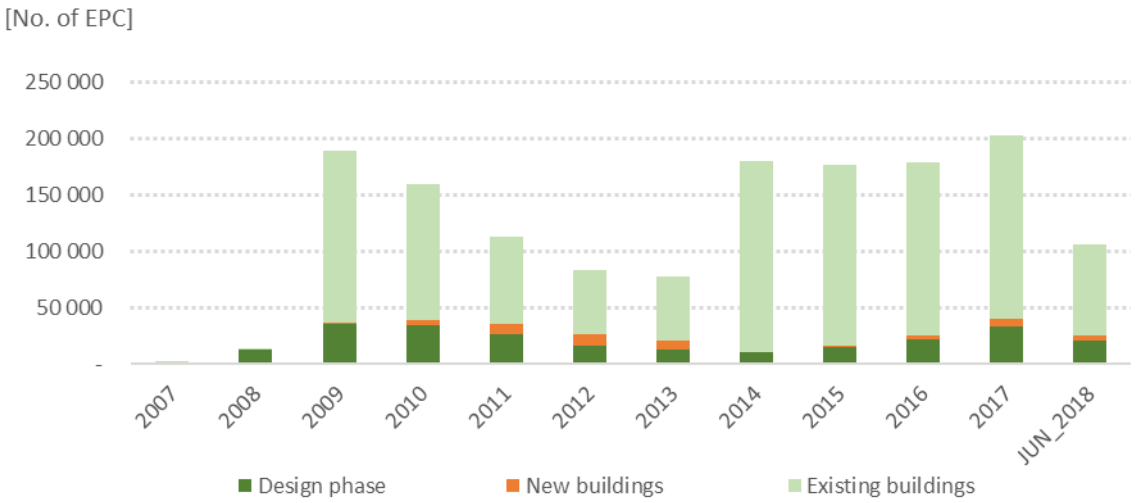
According to the legislation the EPC is required in the following occasions:

- New buildings, in the design phase and before the use permit concession;
- Buildings that undergo a major renovation, in the design phase and before the use permit concession and;
- Existing buildings before they're rented or sold, including the moment they're advertised for that purpose where the energy label has to be shown.

In addition, all large buildings, above 1000 m^2 of floor area (museums, hospitals, schools, office, etc), or above 500 m^2 for specific type of buildings, (namely large supermarkets, shopping centres and covered swimming pools), will be required to display this certificate. This requirement is also extended to public buildings with a floor area above 500 m^2. Except for large buildings subjected to periodic energy evaluations where the EPC is valid for 8 years in the remaining situations the EPC is valid for 10 years.

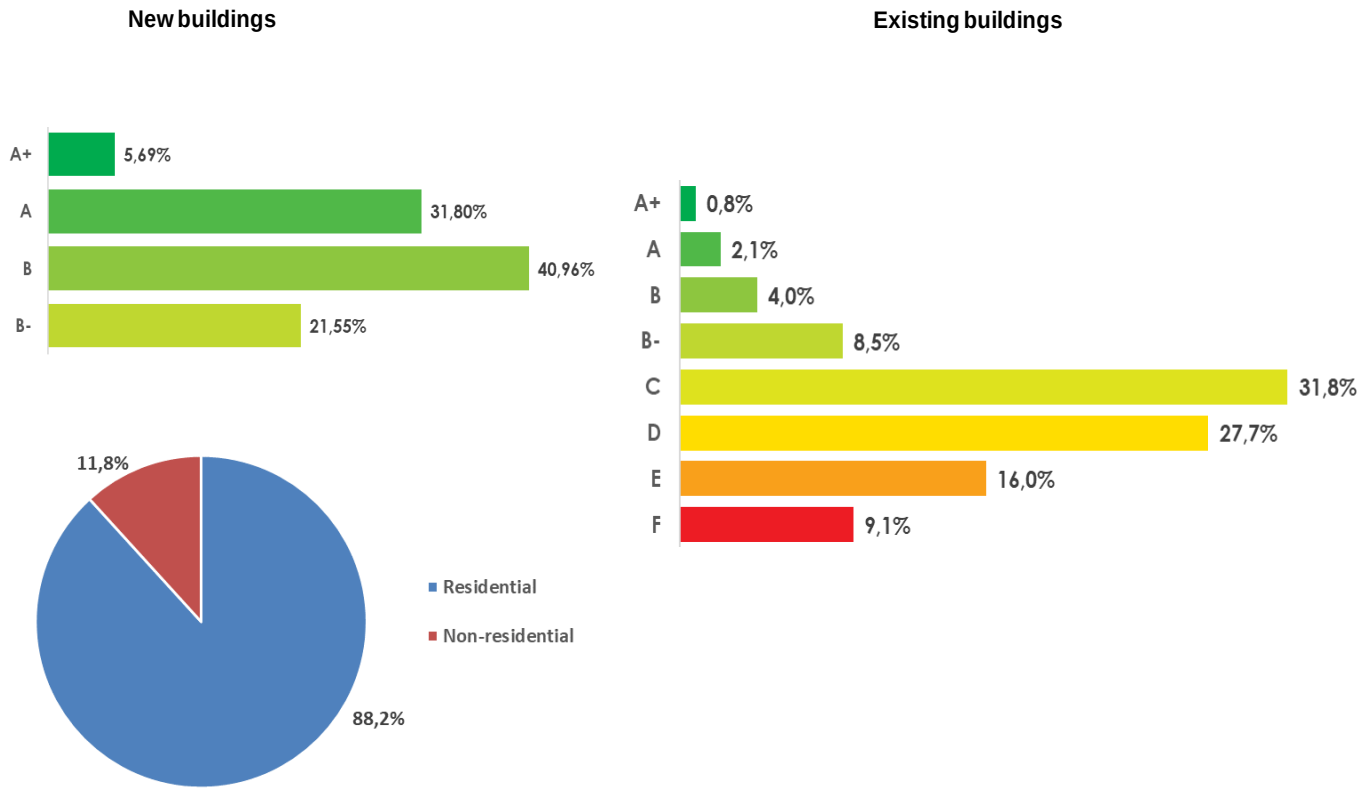
Since the beginning of the SCE implementation to June 2018 there are almost 1483 thousand EPC issued.

Figure 49: Evolution on the number of EPC issued [Source: ADENE]



Next figure shows the desegregation of building certificate type as well as the energy classes for new and existing EPC. New buildings ranging from A+ to B- and the existing buildings from A+ to F.

Figure 50: Evolution on the number of EPC issued [Source: ADENE]



Buildings sector is also included in the NEEAP 2 with three programs that have more than one measure associated:

- Renew Home & Office;
- Energy Certification of Buildings;
- Solar Thermal

1. Program Renew Home & Office

The objective of this program is to encourage the replacement of equipment in the residential sector and in the services sector, in order to make electric appliances electrical equipment and lighting more efficient, incorporating technological advances and a growing market requirements to reduce the energy consumption.

This instruments can act primarily at two levels: i) through measures to encourage the use of more efficient products from the energy point of view, or ii) through penalty measures or restrictions on the purchase of certain products or even the prohibition on marketing and placing on the market of equipment with energy performance below certain levels.

The measures are based on the application of national legislation transposing Directives on energy labelling (Directive N.º 2010/30/EU of 19 May 2010) and ecological (Directive Ecodesign) of appliances and other products, Community regulations, voluntary certification systems for energy-efficient equipment or disincentive mechanisms for the purchase of inefficient products.

This program has 5 measures, namely:

1.1. RSp1m1 program – Promotion of more efficient equipment

The main objective of the measure is to promote the replacement of appliances and other electrical equipment for domestic use primarily by reducing the specific consumption of household appliances park. Energy labelling, introduced by Directive No 92/75/EEC of 22 September 1992, allowed consumers started to be informed clearly about the characteristics and performance of the products they intend to purchase. This Directive covered a wide range of equipment with high energy consumption, considering the total consumption of the residential sector, in particular the electric consumption. Products initially classified from A (most efficient) and G (least efficient) seen, however, in 2003, expanded its performance class scale energy, with the introduction of classes A and A ++ +.

1.2. RSp1m2 program – Efficient lighting

Efficient lighting aimed at the adoption of national programs leading to promotion of efficient lighting through the renovation of the park by the replacement of energy inefficient lamps and respective phase-out. Decree-Law n.º 18/2000 of 29 February, establishes the rules on energy labelling of electrical lamps for home use, transposing into national law Directive 98/11/EC of 17 January. Just like the appliances, lamps are classified according to their energy efficiency, enabling customers to get a sense of consumption associated depending on the intended use. In addition to this information, there is also a mechanism that promotes the use of more efficient lamps and which results in the application of a tax on low-energy-efficient lamps (Decree-Law n.º 108/2007 of 12 April), which has contributed significantly to the acceleration of the phasing-out of incandescent bulbs.

1.3. RSp1m3 program – Efficient Window

This measure, set in the residential sector retrofitting, includes interventions related to the building envelope and is intended to rehabilitation glass surfaces, either through the use of double glazing or using frames with thermal cut, or the use of efficient glass (low emissivity). The purpose of this measure in promoting the replacement glass surfaces associated with the operation of the product labelling system, with the planned deployment by 2016, between 750 and 800 thousand m2 of efficient windows.

1.4. RSp1m4 program – Efficient Insulation

Just like the previous measure, this one is also considered in the retrofitting of the residential sector, contemplating renovations related to the building envelope with respect to thermal insulation, aiming its application to roofs, floor and walls. The objective of this measure, associated with the rehabilitation of buildings, involves the application of efficient insulation.

1.5. RSp1m5 program – Green Heat

This measure aims to encourage the application of heat recovery in dwelling units as a complement and alternative to traditional means of space heating (open fire). In addition, the heat exchangers combine the advantages of using biomass with a forced air system allowing them uniformly distributing the hot air produced by the heating areas.

2. Program Energy Certification of Buildings

The Energy Certification program aims to improve the energy performance of buildings. This program has 2 measures, namely:

2.1. RSp2m1 - SCE Residential Buildings

SCE requires that new buildings or major rehabilitations of buildings achieve minimum shares for efficient classes (B – to A +). Additionally, in the context of specific regulations mechanisms that encourage improved energy class buildings are to be established.

The provided objective for this indicator is to certificate with energy class B - or higher, until year 2020, and in the context of new buildings or major renovations about 268 000 residential homes.

2.2. RSp2m2 - SCE Service Buildings

This measure is similar to the one dedicated to new buildings but focuses on non-residential buildings. The aim is certificate, by 2020, about half of the services buildings with an energy class of B - or higher.

3. Solar Thermal

The program aims to promote the integration of solar thermal systems into the building stock. This program has 2 measures, namely:

3.1. RSp3m1 - Solar Thermal in Residential buildings

The measure aims to create a sustainable market for the residential sector of 100.000 m^2 of solar collectors installed per year, leading to a number about 800.000 m^2 of collectors installed and operational by 2016 and about 1,2 million m^2 by 2020.

This measure aims also revitalize the existing equipment park, creating favourable conditions for the replacement and/or specialized repair/maintenance of this systems.

3.2. RSp3m2 - Solar Thermal is Services buildings

The measure aims to create a sustainable market, translated into an installation of 40.000 m^2 of solar collectors per year, leading to a number of about 330.000 m^2 of installed and operational collectors by 2016, and about 500.000 m^2 2020 .

All together the programmes on buildings sector, under NEEAP 2, led to an accumulate energy saving of 267008 toe and 371147 toe, respectively to final and primary energy. Next table shows the energy saving by implemented measure.

Regarding all programmes under NEEAP 2, the accumulative energy saving is of 287,842 toe. The PNAEE 2013-2016 targets and results expected for each measure are the following:

Table7 – Energy saving from NEEAP Programmes and measures for buildings area [Source: Monitoring Report of National Action Plan for Energy Efficiency (NEEAP 2016)]

Measure Code	Energy saved (toe)		Target 2016 (toe)		Execution 2016 (1)	Target 2020 (toe)		Execution 2020 (2)
	Final	Primary	Final	Primary		Final	Primary	
RSp1m1	99,931	156,869	189,363	297,257	53%	235,535	361,886	43%
RSp1m2	48,530	76,181	98,236	154,207	26%	98,236	154,207	49%
RSp1m3	311	339	997	1,088	31%	1,500	1,636	21%
RSp1m4	435	475	1,068	1,165	41%	1,716	1,872	25%
RSp1m5	15,796	15,796	110,249	110,249	14%	157,354	157,354	10%
RSp2m1	57,473	71,554	77,473	96,453	74%	94,580	117,751	61%
RSp2m2	23,697	29,098	83,272	102,251	28%	152,671	187,465	16%
RSp3m1	16,303	16,303	52,236	52,236	31%	81,238	81,238	20%
RSp3m2	4,532	4,532	21,371	21,371	21%	34,663	34,663	13%
Total	**267,008**	**371,147**	**634,265**	**836,277**	**42%**	**857,493**	**109,807**	**34%**

(1) Comparing with final energy

(2) Comparing with primary energy

The high energy-saving recording in 2010 resulted from the redefinition of the methodologies for bottom-up indicators calculating ("calculation method in detail") that was made in order to properly individualize the direct impact of each measure, exclude indirect impacts and align the measurement and verification mechanisms with current European guidelines.

Besides legislative/normative measures described above and applied to NEEAP 2 for the energy efficiency improvement Implementation, other financial mechanism is also available to promote efficiency measures on the buildings sector. Thus, under the Energy Efficiency Fund several calls were launched till 2018 reached a primary energy saving of 925.03 toe/year. A target summary of FEE calls on buildings sector is shown in the table below.

Table8 – Summary of call under EEF directed to buildings sector [Source: Energy Efficiency Fund public reports]

Call	Sector	Call name	Total Eligible Investment	Total EEF funding	Primary energy savings (toe / year)	Notice Status
Call 03	Residential	Efficiency Building 2012	3,841,536.47 €	1,704,366.43 €	296	Implemented
Call 05	State	Energy Certification Buildings, State 2012	239,076.20 €	239,076.20 €	-	Implemented
Call 09	Services	Energy Audit Elevators Services Buildings in 2015	114,742.40 €	52.770,00 € [(b)]	-	Implemented
Call 10	Residential	Efficient Building 2015	1,013,337.30 €	384,009.20 €	-	In implementation
Call 11	Hotels	Hospitality - incentive to the promotion of Energy Efficiency 2015	280,500.00 €	76,925.00 €	317	Implemented
Call 12	Services	Requalification of Solar Thermal Systems 2015	15,837.00 €	7,918.50 €	9.4	Implemented
Call 18	State	Reduction of Reactive Energy Consumption in the State sector in 2015	596,718.69 €	594,322.03 €	-	In implementation
Call 20	Buildings	Efficient Buildings	3,158,108.39 €	1,300,000.00 €	302.63*	Formalization contracts phase
Call 21	State	Efficient Public Administration	3,741,740.55 €	3,244,922.27 €	-	In implementation
Call 25	Buildings	Energy Efficiency in Buildings	-	-	-	Open Call

Also, under the Plan for Promoting Efficiency in Electricity Consumption 2013-2014, described in chapter 1.3. Energy Efficiency Policy Background, some measures were approved on the household and services sector. The approved measures are:

a) For the household sector

a.1. Heat pumps for domestic hot water and heat reducers. The measure promotes the installation of 1.000 heat pumps for domestic hot water (DHW), through the replacement of Electric Heaters and application of flow reducers for showers and faucets, to reduce electricity consumption in water heating.

a.2. LED's for halogen spots replacement

The measure promotes the use in the residential sector of lighting equipment LEDs (light-emitting diode or light emitting diode, in Portuguese). In order to enhance the transition of lighting focuses on the residential sector to a more efficient technology, the measure will distribute 200.000 LED GU 10.

a.3. Measure me

The measure promote the energy efficient rationalization and management in the residential sector. It'll be using detailed information about electricity consumption and respective charges, provided by a measurement plug device, and savings optimization platform, trying to contribute to greater consumer awareness about the impact of their actions and the adoption of more efficient behaviour.

a.4. Light Makeover Residential

This measure promotes the LEDs in the residential market, via the replacement bushing dichroic halogen lamps GU5.3 and GU10 with LEDs of the same type of bushing with 100.000 LED lamps available.

a.5. Intelligent plug

This measure promotes the use of a multi smart plug (auto power off, the master-slave type) to eliminate the use of secondary devices in standby mode when the main power is turned off.

a.6. Efficiency check for combined refrigerator

The measure provides the replacement of combined refrigerators with class C and B, for combined refrigerators class A +++, and it will includes the exchange of 8000 equipment. The measure is based on the offer of an efficiency check worth 100€ and it is intended to residential customers who own a refrigerator/combined class B or C.

Altogether the measures applied for household sector expected to avoid 293806 MWh in electric consumption and 108708 of CO_2 emissions.

b) For service sector

b.1. Installation of astronomical clocks in public lighting

The measure aims to promote the installation of astronomical clocks in public lighting. The target device of this measure is the astronomical clock used for street lighting control. The target consumers of this measure are the municipalities of Metropolitan Areas, Urban Communities, Intermunicipal Communities.

b.2. Installation of regulation systems in public lighting flow

The measure aims to promote the installation of flow regulators, in public lighting of roads access or urban environment. The targets of this measure are the flow regulators for public lighting of 36 kVA and 45 kVA of. The target consumers of this measure are the entities responsible for the public lighting management of roads access or urban environment.

b.3. LED traffic lights

The measure aims to promote traffic signal lighting installation of LED technology, in order to disseminate this technology to transform the traffic signal lighting market in a more efficient market. For this measurement will proceed to the replacement of traffic signal lamp of 100 W (optical 200mm) and power of 60W (optical 100mm) for technology LED lamps of 3,6W and 7,83W, respectively.

b.4. Variable speed drives on systems for capturing and water treatment

This measure aims to co-finance the installation of 40 electronic variable speed drives (VSV) in electric motors of average power rating of 55 kW (15 to 75 kW), pumping systems associated with the capture, adduction, purification and distribution of water and waste water in 5 companies in the services sector dispersed throughout the mainland, to afford an average reduction of 25% of electricity consumption in the motors associated with these equipment's.

b.5. Energy optimization of public lighting in monuments

The measure aims to promote the light conversion of 5 monuments of the city of Lisbon to the LED technology. It is expected to replace incandescent lighting and discharge by LED technology.

b.6. Luminous flux dimmable systems and LED lighting in public roads LED and monuments in the Autonomous Region of Madeira (RAM)

The measure aims to promote the installation of luminous flux dimmable systems, replacement of high-pressure sodium vapor lamps with LED lamps and implementation of LED technology to replace metal halide lamps for lighting facades of two high visibility in Madeira. The measure provides the acquisitions and installation of 60 luminous flux regulators, preferably three-phase type, with about 20 to 30 kW nominal power, replacing 100 high-pressure sodium vapor lamps (250 W) or lower efficiency with ferromagnetic ballasts for LED fixtures with high efficiency, with luminous flux regulator incorporated on public roads (road and pedestrian) and the replacement of conventional façade lighting (400 W) of two monuments for LED fixtures with high efficiency with regulator embedded luminous flux and the direction of incidence of light source devices.

b.7. Combined efficiency lighting solutions for public buildings

The measure aims to promote the installation in public buildings (administrative centres, schools, cultural facilities, sports facilities, social service and health facilities, etc.) of energy efficient lighting solutions. Provides actions such the replacement of bulbs and

fixtures, elimination of ferromagnetic ballasts, installing occupancy sensors and lighting, control systems, among other combined solutions in the lighting area.

b.8 Ballast electronic multi.level for public lighting flow control

The measure aims to promote the installation of multi-level electronic ballasts in public lighting of the urban environment in order to transform the market towards the choice of equipment that provide significant energy savings. The targets equipment of this measure are the electronic ballasts multi-level dimming in public lighting to apply lamps with an output of 150 and 250 W. The target consumers of this measure are the Municipalities and other public entities managing the national public lighting network.

In sum, it is expected that all measure applied to service sector will promote an avoided electric consumption of 832 838 MWh and as well an avoided CO2 emissions of around 229223 tonCO2.

Giving continuity to PPEC, in December 2016 was published the final homologation decision of the measures inserted in the 6º edition of PPEC (PPEC 2017-2018), aiming to financially support initiatives that promote the efficiency and reduction of electricity consumption in the different consumer segments.

Considering that the full implementation of the PPEC 2017-2018 measures, ERSE has decided to extend the period of the measures implementation from 31 December 2018 to 31 December 2019.

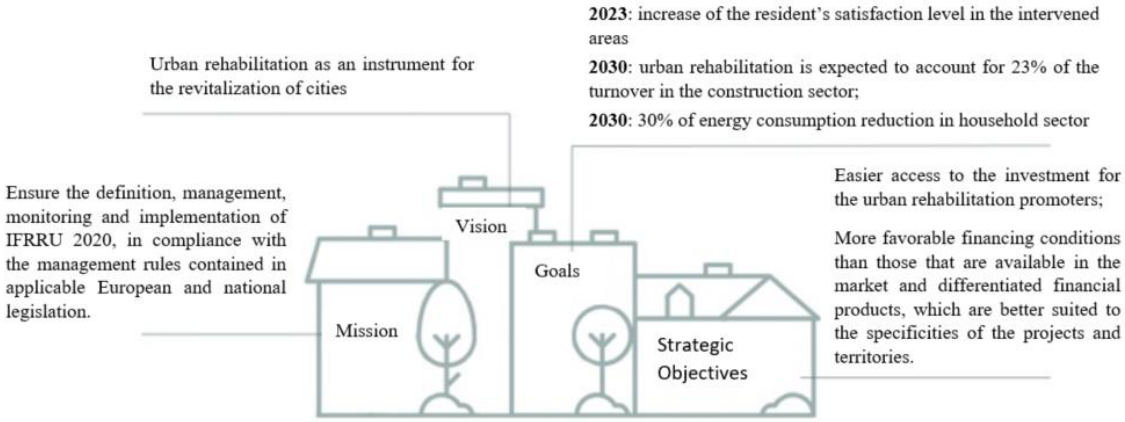
The next table it is summarize the expected indicators as a result of the implementation of PPEC 2017-2018 measures.

Table9 – Summary of expected indicators as a result of the implementation of PPEC 2017-2018 measures [Source: ERSE]

	Consumption			
	Total 2017 [MWh] (1)	Saved 2019 (*) [MWh] (2)	Avoided (2/1)	Total avoided [MWh]
Services	13 233 174	44 063	0.3%	458 555
Residential	11 632 565	14 687	0.1%	251 915

(*) Year that the maximum savings are verified, since it includes the equipment installed in 2017 and 2018

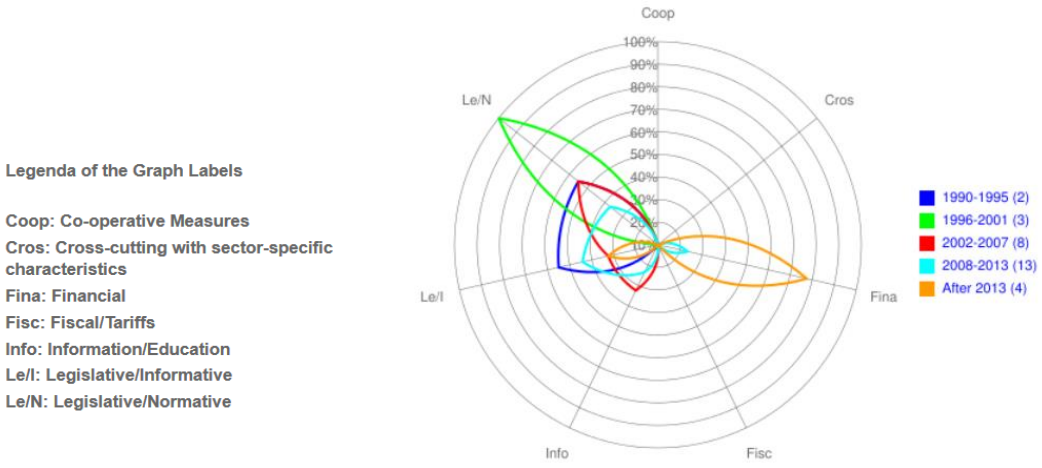
Furthermore, in the end of 2017 the Financial Instrument for Urban Rehabilitation and Revitalization (IFRUU 2020) was launched, aiming to bring together in a financial instrument different sources of funding to support urban rehabilitation and revitalization. The image below, adapted from Portal da Habitação website, provides information about Mission, Vision Goals and Strategic Objectives.



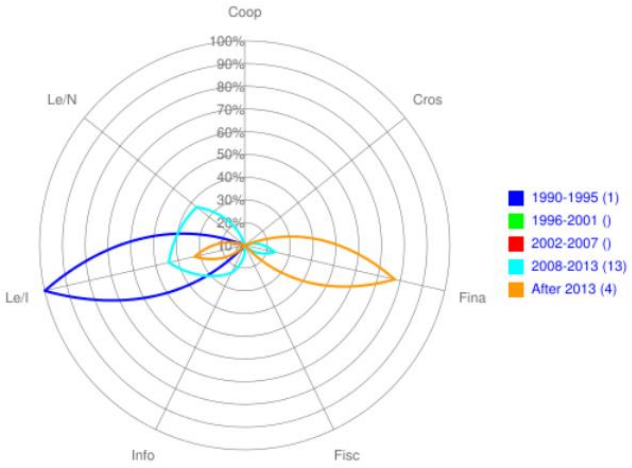
Moreover, next figures shows graphically the type of measures that have been described in MURE database since 1990 for both sectors, residential and services, by type (Financial, Fiscal/Tariffs, Legislative/normative, information/Education) and by impact on energy efficiency (categorized by low/medium/high).

Most of the measures of buildings sector are Legislative/Normative and Financial with a medium/high impact in the energy efficiency of the sectors of activity. These measures could be consulted in http://www.measures-odyssee-mure.eu/query-energy-efficiency-policy-household.asp

Figure 51: Number of Energy Efficiency Measures in residential sector: development of measures by type over time [Source: MURE]



Total measures described in Mure database (all status)



Total measures described in Mure database (ongoing status)

Figure 52: Impact of ongoing Energy Efficiency Measures in residential sector: development of measures by type over time [Source: MURE]

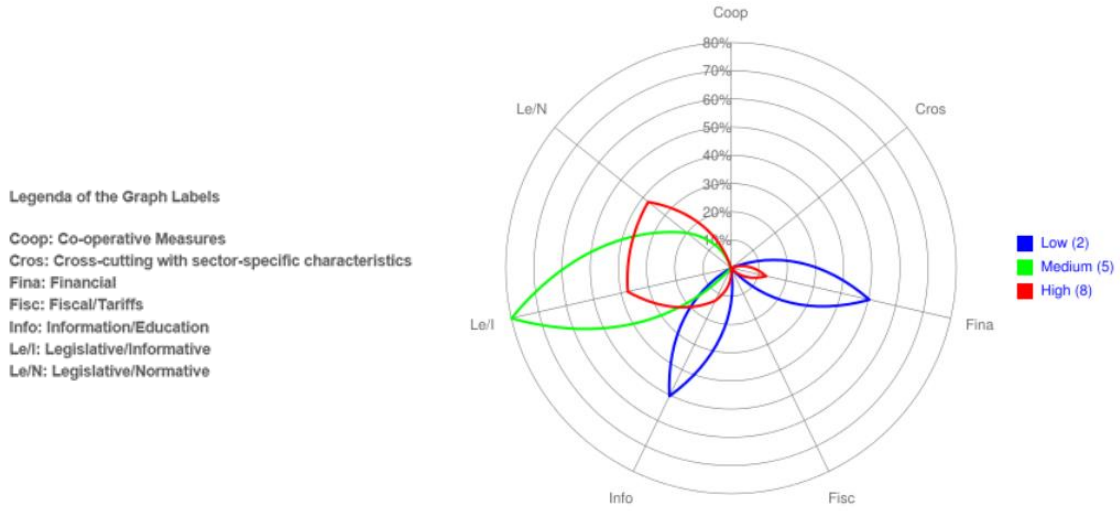
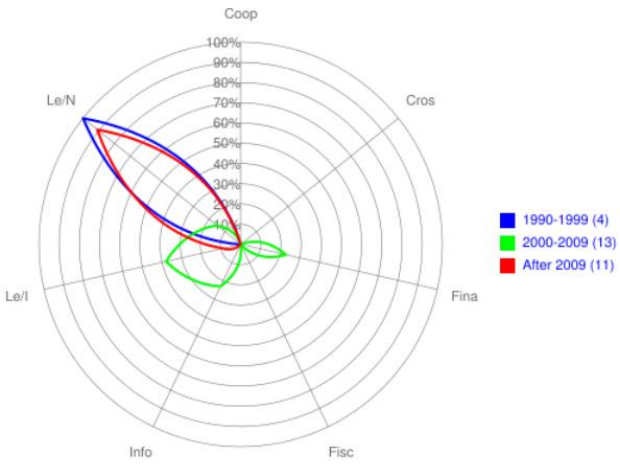


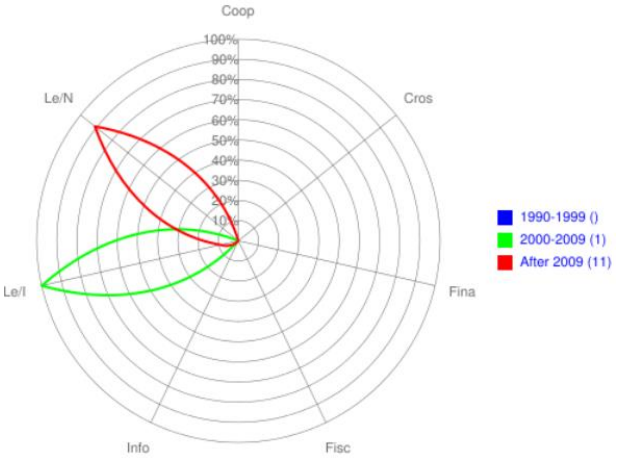
Figure 53: Number of Energy Measures in service sector: development of measures by type over time [Source: MURE]



Legenda of the Graph Labels

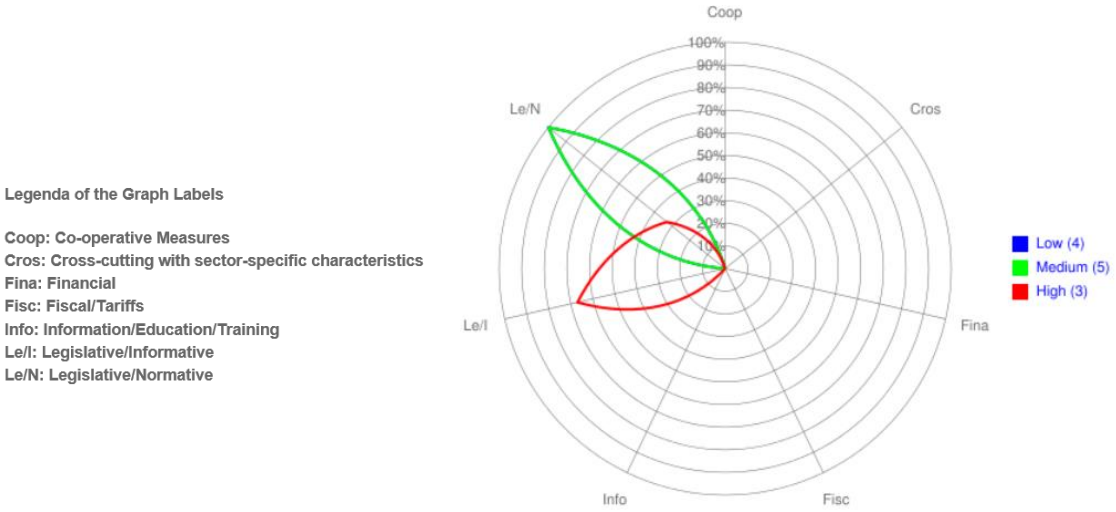
Coop: Co-operative Measures
Cros: Cross-cutting with sector-specific characteristics
Fina: Financial
Fisc: Fiscal/Tariffs
Info: Information/Education
Le/I: Legislative/Informative
Le/N: Legislative/Normative

Total measures described in Mure database (all status)



Total measures described in Mure database (ongoing status)

Figure 54: Impact of ongoing Energy Efficiency Measures in service sector: development of measures by type over time [Source: MURE]



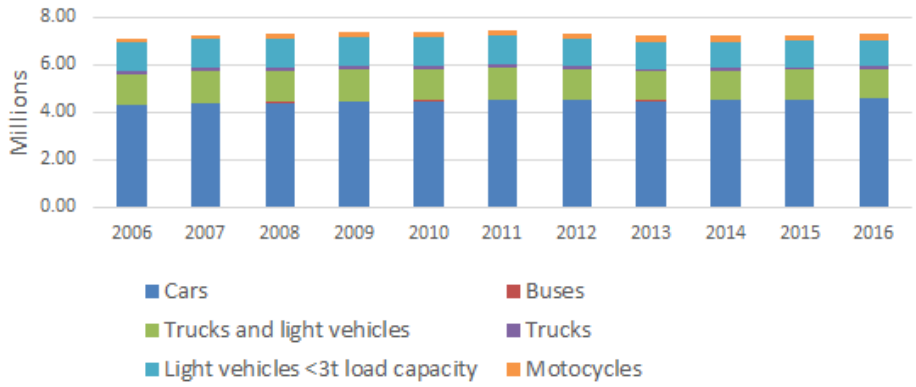
3. ENERGY EFFIENCY IN TRANSPORT

3.1. ENERGY EFFICIENCY TRENDS

The transport sector is the larger energy consumption in the country with 43% share in the total final energy consumption. Between 2006 and 2016 this sector has seen a growth in the cars stock by 7.2%, mainly due to the intensely grew of the GPL (+147.9%) and diesel (+69.6%) cars stock, with regard to an increase of 0.03 and 1.08 Million cars, respectively. Even though gasoline stock cars kept more than 50% of the stock cars share until 2012, it has decreased 7% in until 2016.

As motorcycles saw their stock demand increases by 60.2% since 2006, every other road transport presented a stock fallen of 1.0% for buses, 8.9% for trucks and light vehicles, 17.0% for trucks and 7.9% for light vehicles <3t load capacity.

Figure 55: Transport stock (M) [Source: Automobile Association of Portugal (ACAP) and ODYSSEE]

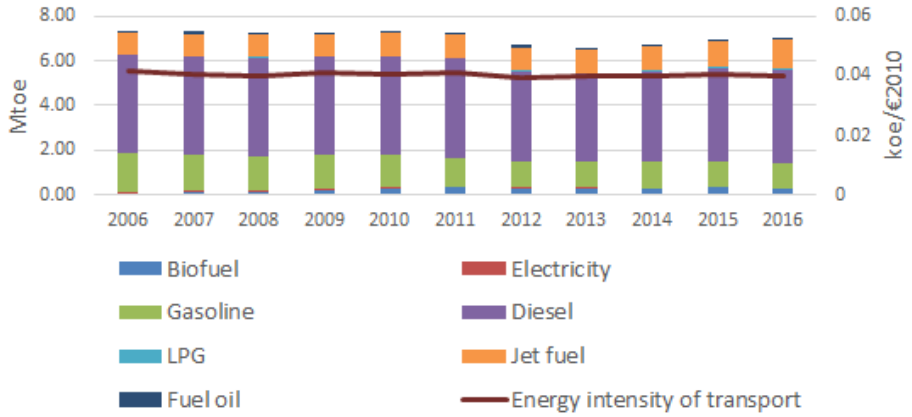


3.1.1.1. Energy consumption in transport

The transport sector represents the major final energy consumption sector towards the national energy balance, reaching in 2016 to a share of 43%. The **Figure 56** shows the final energy consumption, by source, as well as the energy intensity of the sector that is calculated as the ratio of the transport energy consumption by the GDP.

Energy intensity has remained stable along the years, with minor changes to register and that accompany the final energy consumption.

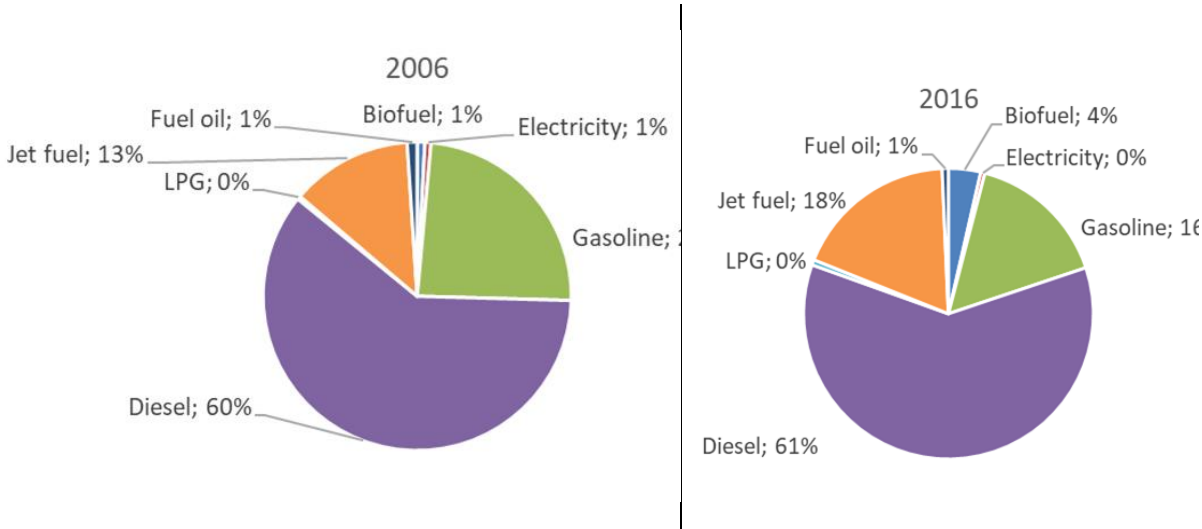
Figure 56: Final energy consumption in transport (Mtoe) and Energy intensity [Source: Directorate-General for Energy and Geology, National Energy balance and ODYSSEE database]



Oil products consumption of transport represented 96% in 2016 of the total final energy consumption, led by diesel with a share of 61% followed by jet fuel and gasoline, respectively with 18% and 16%. To note that jet fuel consumption includes both, national and international air transport. The big change to notice since 2006 was the increase of biofuel (+325%) and LPG (65%). Gasoline and fuel oil were the two main oil products that registered the big decreases (37% and 36%, respectively).

Nevertheless, the final energy consumption of this sector has been relatively constant, with minor fluctuations. Compared to 2006, in year 2016 the final energy consumption fell 5%.

Figure 57: Total final energy consumption share in transport by type of source, in 2006 and 2016, [%] [Source: Directorate-General for Energy and Geology, National Energy balance]



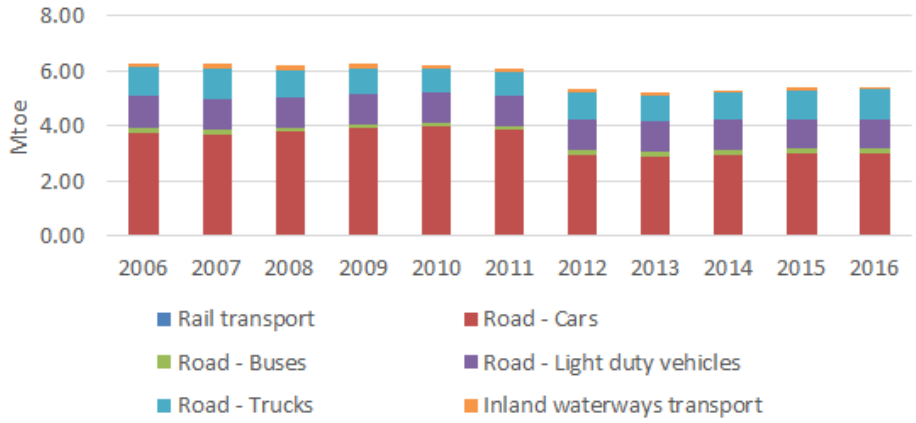
Final energy consumption: 7.32 Mtoe	Final energy consumption: 6.98 Mtoe

Regarding mode transportation from 2006 to 2016 the energy consumption remained with a light fluctuation in terms of road transportation. The year 2012 was the one to register an important decline, with -24% of energy consumption in cars.

Concerning the year 2016, all the transportation modes has registered a decrease in energy consumption. In percentage terms, the rail transport led the decline (-41%), followed by the inland waterways transport (-26%) and then the road transport (-13%).

In global terms and in the balance of the three types of transport, the road transport continues to have the highest percentage weight, with 97% in 2006 and 98% in 2016.

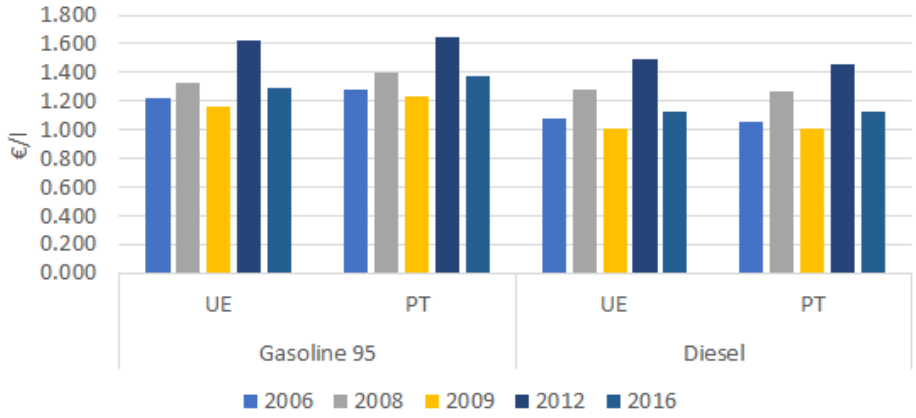
Figure 58: Total final energy consumption by type of source and mode, [Mtoe] [Source: Odyssee]



In 2016 the average sales price to the public of liquid fuels in Portugal suffered, without exception, a decrease compared to 2015. In the case of gasoline 95, whose average price was 1.376€/l in 2016, the reduction was 4% compared to 2015. The average price of diesel was 1.127€/l in 2016, with a reduction of 5% compared to 2015.

Looking at the development of average prices of sale to the public of the two main liquid fuels consumed in Portugal, road diesel and gasoline 95, there is a substantial increase until 2012 and a decrease from then. In the case of diesel, there's a decrease of 22% over the price in 2012 and in the case of gasoline95 a decrease of 16% over the price in 2012.
Comparing the average prices in Portugal to average prices in UE and in 2016, we can observe that gasoline 95 was 7% higher (1.291 €/l in EU) and in the diesel case it was practically the same (1.124 €/l in EU).

Figure 59: Fuels price evolution in transports, [€/l] [Source: Directorate-General for Energy and Geology]

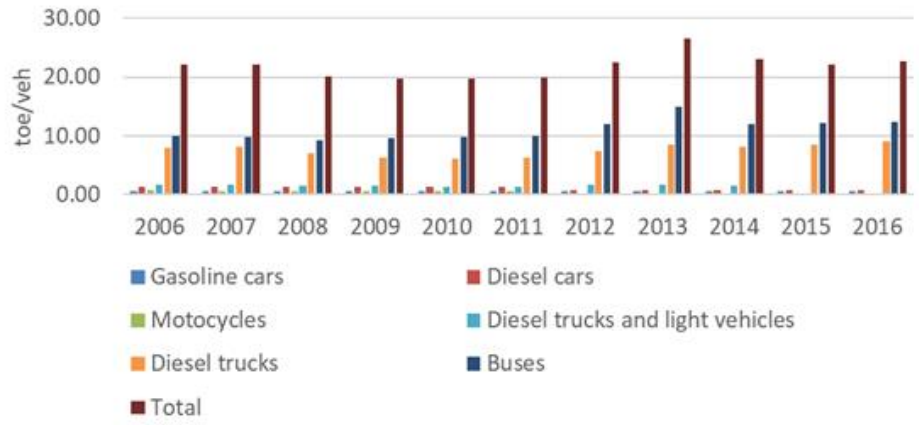


In terms of new cars, the highest penetration recorded over the last 10 years was the case of LPG cars, with an increase of 9 173% (18 in 2008 to 1 020 in 2016), followed by the electric cars, with an increase of 4 417% (in 2006 to 813 in 2016). New diesel cars are the predominance in Portugal, with 133 705 cases in 2016, even though it represents a 13% decrease since 2006.

In Portugal new diesel cars presented a consumption of 4,0 l/100km, demonstrating their good performance in energy consumption. The new gasoline cars had also a good performance, but are not so good as diesel cars, showing 5,2 l/100km.

The next figure contains the unit consumption development, expressed by energy consumption by the stock of vehicles, reaching into the highest unit consumptions in 2013, 26.66 toe/veh. High improvements were achieved 2016, comparing to 2006, in motorcycles (-75%), followed by diesel cars (-46%) and gasoline cars (-19%). Diesel trucks and buses increased their unit consumption, with 41% and 24%, respectively.

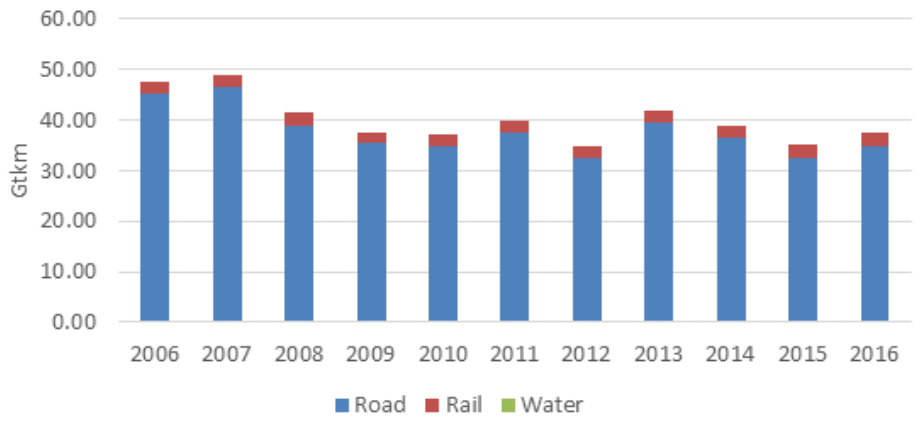
Figure 60: Unit consumption by mode in road transport, [toe/veh] [Source: Odyssee]



The freight transport has experienced a decrease every year from 2008 until 2015. Nevertheless, it was registered a decrease of -21% when comparing the total in 2016 with 2006.

Freight transport (for hire or reward) was carried out mainly by road (93%), with 34.68 Gtkm, followed by railway (7%), with 2.77 Gtkm.

Figure 61: Goods traffic, [Gtkm] [Source: Odyssee]



According to the results of the survey on road transport of passengers (ITRP in Portuguese) for 2016, 546.383 thousand passengers were transported (-6,9% than in 2012). Urban, suburban and long-distance traffic accounted for 95,3% of passengers transported by road in the Portuguese territory (mainland). The utilization rate reached 24,8%, corresponding to an actual utilization of only a quarter of the 24.468 million available seat kilometres, with a slight improvement from 2012 (24,4%). [Source: INE]

3.1.1.2. Energy efficiency gains in transport

The energy efficiency gains on transport sector are calculated from ODEX and reflects efficiency gains since 2006. ODEX in transport is calculated from energy efficiency trend at level of 8 vehicles types (cars, trucks, light vehicles, motorcycles, bus, total air transport, rail and water transport) by aggregating in a single indicator the energy efficiency for the whole sector.

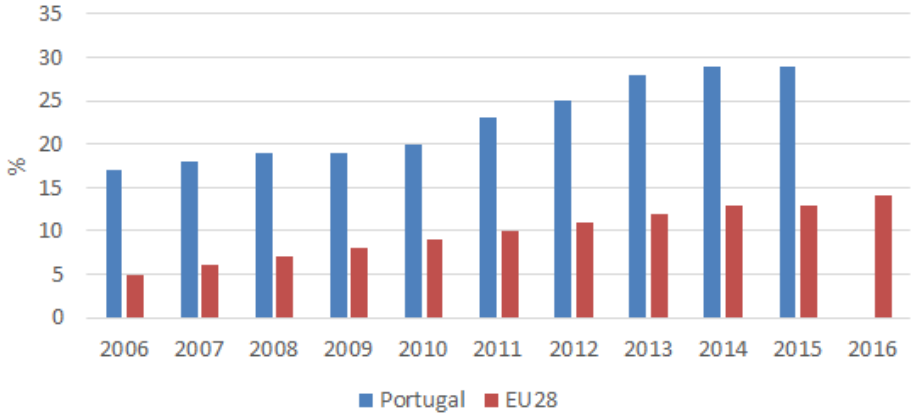
For each mode or transport vehicle, the following indicators are considered to measure efficiency progress:

- Cars: litre/100 km
- Trucks and light vehicles: goe/tkm
- Air: transport toe/passenger
- Rail: goe/pass-km for passenger
- Rail and water: goe/tkm for transport of goods
- Motorcycles and buses: toe/vehicle
- Transport sector incremented energy efficiency gains

Gains in energy efficiency in the transport sector has followed the positive trend observed in the European Union. This positive efficiency achievement reflects either the social context in a crisis living scenario, the implementing of legislation such as vehicle taxation the IUC (Circulation tax), which promote the acquisition of smaller cars or other measures implemented from the NEEAP II,

complemented with factors as a good performance in energy consumption of new cars and the decrease of freight transport since 2008.

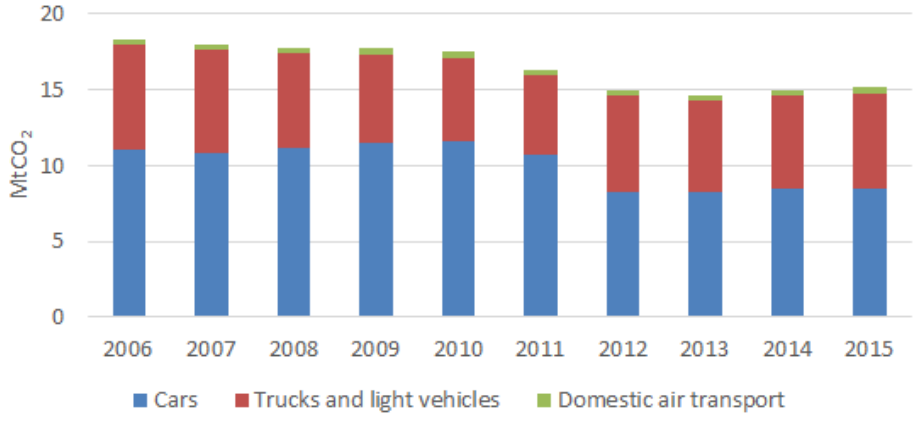
Figure 62: Energy efficiency gains in transport, [%] [Source: Odyssee]



3.1.1.3. CO_2 emissions in transport

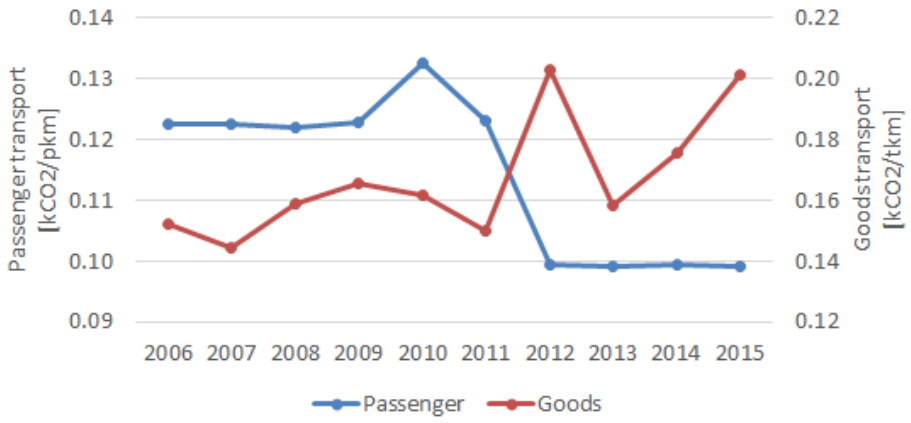
In terms of cars, the CO_2 emissions per vehicle had been decreasing through the years, with a big oscillation in the year 2012 (-69%). Since 2006 until 2015, the decrease had registered 78% (2.58 tCO_2/veh to 1.88 tCO_2/veh). In terms of motorcycles, the tendency has been the same, with a major decrease of 22% in the year 2012 and a total decrease of 28% in the year 2015 compared to 2006 (1.92 tCO_2/veh to 0.42 tCO_2/veh). These tendencies are mainly due to new and efficient technologies in vehicles making which is also a reflection of specific legislation with establishment of CO_2 minimum requirements. In the year 2015 Portugal presented CO_2 emissions for new cars lower than the mandatory limit, 130g for cars manufacturers established in Regulation (EU) No 510/2011.

Figure 63: CO_2 emissions per vehicle by mode [Source: Odyssee]



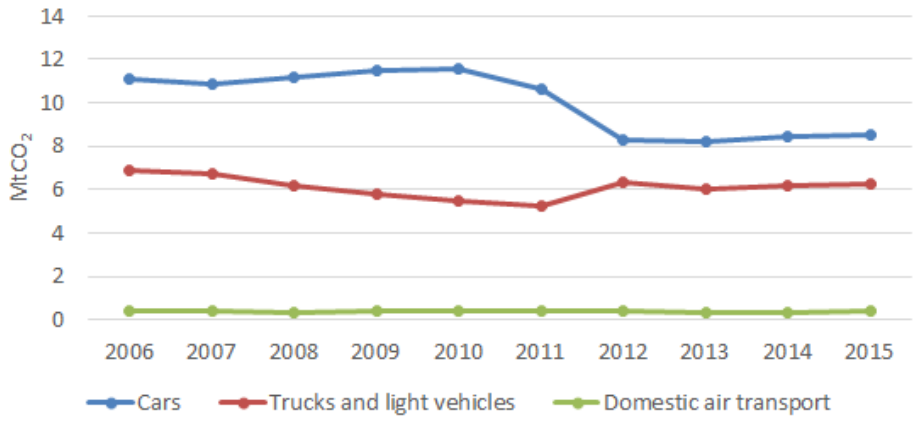
While the emissions of the transport of goods per tonne transported has been increasing since 2011, mainly due to the recovery of the economy (+32% in year 2015 compared to 2006), the emissions of the transport of passengers per people transported has registered a slightly decrease (-19%).

Figure 64: CO_2 emissions per type of transport [Source: Odyssee]



The CO_2 emissions from transport have been decreasing since 2006, but in 2014 we can observe a slightly increase (2% in 2014 and 1% in 2015). Cars are responsible for 56% of these emissions, followed by Trucks and light vehicles with a share contribution by 41%. Less important face to the representative share of the total (2,2%) domestic air transport decreased 5% of its CO_2 emissions in 2015 compared to 2006.

Figure 65: CO_2 emissions for transport by mode [Source: Odyssee]



3.2. ENERGY EFFICIENCY POLICIES

Main recent measures aiming energy efficiency in transport sector under NEEAP 2, are still ongoing until NEEAP 3 is approved. Those are the ones existing in the National Action Plan for Energy Efficiency (NEEAP 2013-2016), approved by Ministries Council Resolution nº 20/2013.

The National Action Plan sets several guidelines for energy efficiency in the transport sector, which are organized into three programmes:

- T1: Eco Car – aiming to promote private transport energy efficiency;
- T2: Urban Mobility – to promote the use of public transport; and

- T3: Transport's Energy Efficiency System – to promote energy efficiency within passengers and freight transport operators. These programmes are subsequently divided into more specific measures that are going to be briefly described.

1. Eco Car – Tp1 (Eco Carro)

1.1. Tp1m1 – Green Taxation: review of the private vehicle tax regime

This measure intends to maintain and improve current conditions to promote the introduction of vehicles with low CO_2 emission, through mechanisms that can disseminate them in the road transport sector. Some of these mechanisms relate to the vehicle tax regime review, as well as the availability of fuel consumption guides and energy information publication about new vehicles. This measure is in line with the European Community strategy, essentially set on 3 pillars: (i) voluntary commitment of the automotive industry to reduce the emission of greenhouse gases, (ii) better information to the consumer and (iii) promotion of more efficient vehicles regarding energy consumption, through the implementation of fiscal measures. The measure intends to encourage the acquisition of new light duty passenger vehicles, for private or commercial use, with lower pollutants emissions. The mechanisms that enforce it are from fiscal nature, associated with the differentiation of the Tax over Vehicles – *Imposto sobre Veículos* (ISV) – and the Tax over Vehicles' Circulation – *Imposto Único de Circulação* (IUC) – based on the level of gCO_2/vkm. The ISV computation considers CO_2 emissions according with the progressive tables that are annually set in the State Annual Budget, to boost the lower emission vehicles market.

1.2. Tp1m2 – Green Tire

This measure intends to increase the market introduction of energy efficient tires, with low rolling resistance (RR), and the reduction of passenger vehicles that are circulating with the wrong tire pressure. This measure is divided into two: Efficient Tires (Tp1m2-1) and Right Pressure Tires (Tp1m2-2).

Tp1m2-1: It is estimated that the sub-measure Efficient Tires will produce a fuel consumption average reduction between 1 and 2%. The EC Regulation nº 1222/2009, of November 25th, regarding tire labelling, introduced the obligation to label tires from November 2012 onwards. This Regulation intends to increase the sale of energy efficient tires, through the quality improvement of the information that's available about these products, namely the ones concerning fuel consumption reduction and vehicle security increase. Furthermore, the Government is committed to promote, with the collaboration of sector associations and tires' manufacturers, campaigns on the advantages of the use of more efficient, safer and with lower noise emissions levels tires. Currently, some features regarding the supervision of the Regulation implementation (namely the information that has to be on the label and the communication duties) are still not fully regulated in Portugal.

Tp1m2-2: The Right Pressure Tires sub-measure intends to reduce the number of passenger vehicles that are circulating with the wrong tire pressure. The number of vehicles that can be covered by this measure is projected to be high. The fuel consumption increase due to the vehicle circulation with the wrong tire pressure is estimated to go from 1 to 2.5%. The mechanisms implemented along with this measure should essentially be campaigns to promote the use of the correct tire pressure and its calibration, as well as incentives to the periodic tire pressure check. It should be also promoted its enforcement as mandatory, namely in the Periodic Mandatory Inspection Centers - *Inspeção Periódica Obrigatória* (IPO).

1.3. Tp1m3 – Promotion of electrical vehicles acquisition

This measure intends to encourage the purchase and introduction of electric vehicles in the light duty and passenger vehicles' market, as well as electric scooters, taking advantage of the investments already made for the development of a smart and integrated management platform during the Mobi.E programme. In order to implement this measure, one of the suggested solutions is the adaptation of the already existent charging infrastructures, altering them to fit covered parking spots (public and private), namely through the development of domestic charging solutions. Other solution is the demonstration of electric vehicles and scooters use advantages, highlighting the technologies' benefits namely when comparing with the growing costs of conventional fuels and associated environmental impacts. Electric vehicles have a fiscal differentiation translated into the total exemption of the environmental component of the Tax over Vehicles' Circulation IUC and the exemption of the ISV, approved by Law nº 22-A/2007, of June 29th.

2. T2: Urban Mobility

2.1. Tp2m1 – Sustainable mobility promotion and good practices adoption

This measure intends to encourage public transportation use in detriment of individual transportation, particularly in urban areas. The development of public transportation infrastructures, associated with better offer and services, has been a catalyser for the users increasing number. This should be articulated with an effort to improve planning and mobility management, which combined with restrictive measures to private vehicles circulation and parking, will contribute to increase public transportation and soft modes use.

2.2. Tp2m2 – Use of more energy efficient transport and mobility solutions

This measure intends to increase energy efficiency through the introduction of more efficient vehicles in the public transport sector. It is divided into three sub-measures: Minibus and flexible transport services (Tp2m2-1); Fleet management centrals and automatic attribution of taxis' services (Tp2m2-2); Bikes and soft transport modes use (Tp2m2-3).

Tp2m2-1: The minibus and flexible transport services sub-measure intends to promote the use of minibus fleets that can contribute, in an autonomous way or integrated in a conventional

bus fleet, to better adequacy of passengers' demand during off-peak hours in urban public transport fleets or rural space with low demographic density. The measure also plans the implementation of innovative solutions that can answer to the population mobility needs through flexible public transports (TPF), which offer services with variable itineraries, stops and schedules. This will better adequate public transport services to the existing demand, improving the performance levels (reduction of consumptions, paths and distances) and reducing the use of individual transport.

Tp2m2-2: Regarding the introduction of fleet management centrals and automatic attribution of taxis' services, new organization solutions for taxi services are thought, namely its integration with TPF. The taxi use is an intermediate solution between collective transport and private vehicle, allowing to better reply to specific transportation needs. It is also recommended the development of fleet management centrals and automatic designation of taxis' services, which will allow to locate all taxi vehicles and evaluate their availability, encouraging taxis to wait for the service assignment in their parking lots and therefore reducing the services attained when circulating. The decreasing of the routes made with no passengers has the immediate result of reducing fuel consumption, traffic jams, vehicles' maintenance costs, pollutants' emissions, etc.

Tp2m2-3: After the elaboration of the "Plan to Promote Bikes and Other Soft Modes Transports – 2013-2020" it was created an action program that proposes the development of a strategic, coherent and articulated set of measures to promote the daily use of bikes, as well as the adoption of sustainable mobility solutions. This was also associated with the creation of better and safer conditions to soft modes use, and behaviour changes to favour the reduction of motorized individual transportation use. The reinforcement of daily bike utilization, besides the leisure and sports component, is linked with the growing number of municipalities that have been implementing bike sharing solutions and constructing bike lanes. The recent conclusion of the action plan and the Government's initiative to gather a team to elaborate the "Light Mobility Chart" should likewise promote the increase of soft transport modes use and its input in the modal share.

3. T3: Transport's Energy Efficiency System

3.1. Tp3m1 – Restructuring the passenger railway transportation offer

This measure was already considered in the previous National Plan for Climate Changes, approved by the Ministries Council Resolution nº 104/2006, of August 23rd, and intended to promote the change of the travel offer of CP (national railways company) through the reduction of travelling times between Lisbon-Porto, Lisbon-Castelo Branco and Lisbon-Algarve trips. The activities developed within this measure's scope are connected with exploration efficiency, improvement of service quality, reduction of travelling time and demand increase.

3.2. Tp3m2 – Regulation for Energy Management in the Transport Sector

This measure intends to perform the evaluation of the current Regulation for Energy Management in the Transport Sector (RGCEST) approved by the Ordinance nº 228/90, of March 27th, and altered by the Law nº 7/2013, of January 22nd, and the corresponding impacts of energy consumption reduction on the transport sector. The measure is directed to fleets managers' and vehicle fleets that have an annual fuel consumption above a predetermined referential (the current Regulation sets the referential at 500 toe). These fleets must conduct an audit procedure (that should be performed at least once every 3 years) and elaborate rationalization plans (PREn) in order to reduce the specific energy consumptions or improve the energy intensity of the fleet. The rationalization plan should describe all the actions to be developed, place them in a time frame and name the subsequent costs. The audit should account for the conditions and use of the vehicles, namely: (a) fleets' composition (technically, usage and age), (b) fleets' management procedure, in particular, maintenance, (c) production, i.e. tonne-kilometres (tK), (d) control of fuel supply (liters, l), (e) energy balance, (f) assessment of the usage conditions, and (g) assessment of the specific energy consumptions of the last 3 years. The energy audit reports and the energy consumption rationalization plans must be submitted to the General Directorate of Energy and Geology (DGEG) for its approval.

3.3. Tp3m3 – Support to the installation of equipment to inflate tires with nitrogen

This measure intends to promote nitrogen generator systems placement in passengers and freight operators' workshops, as well as private fleets' workshops (private companies and municipalities), assuring priority to heavy duty vehicles fleets. The use of tires with wrong pressure values, apart from other consequences (as decreasing security, comfort and tire life expectancy), result in vehicles' fuel consumption increase, with the associated air pollutant emissions. One way to efficiently assure the reduction of the vehicles' number that are circulating with wrong pressure tires is to evaluate the possibility to support transporters and business fleets with the acquisition of nitrogen generator systems to inflate tires. In a second stage, public inflating stations and repair and assistance workshops could be also contemplated in this measure. The fact that tires are inflated with nitrogen will allow, besides other advantages, to reduce pressure loss. No matter the drivers' pressure checking habits, the use of nitrogen assures for a longer period of time that the pressure used is adequate.

3.4. Tp3m4 – Promotion of fleet management systems and eco-driving

This measure intends to promote the adoption, by passenger and freight transporters, of professional drivers' performance monitoring systems that can enforce the correction of inadequate driving behaviours, good practices adoption, introduction of drivers coaching tools, as well as technical solutions compatible with open operative systems, which can help drivers and allow information gathering on driving and vehicles' performance. This measure will be completed with training in eco-driving based on the attained results.

Transports represent 36% of total final energy consumption of the country, making them a high priority area for the successful implementation of PNAEE 2016. Regarding all programmes under NEEAP 2, the accumulative energy saving is of 287,842 toe. The PNAEE 2013-2016 targets and results expected for each measure are the following:

Table 10 – Energy saving from NEEAP Programmes and measures for transport area [Source: Monitoring Report of National Action Plan for Energy Efficiency (NEEAP 2016)]

Measure Code	Energy saved (toe)		Target 2016 (toe)		Execution 2016 (1)	Target 2020 (toe)		Execution 2020 (2)
	Final	Primary	Final	Primary		Final	Primary	
Tp1m1	40,017	40,017	47,326	47,326	85%	54,055	54,055	74%
Tp1m2-1	2,061	2,061	8,024	8,024	26%	16,082	16,082	13%
Tp1m2-2	1,565	1,565	3,678	3,678	43%	5,158	5,158	30%
Tp1m3	0	0	1,861	1,506	0%	8,077	6,478	0%
Tp2m1	98,817	98,817	98,817	98,817	100%	98,817	98,817	100%
Tp2m2-1	785	785	1,745	1,745	45%	2,617	2,617	30%
Tp2m2-2	5.329	5,329	25,635	25,635	21%	53,208	53,208	10%
Tp2m2-3	0	0	1,806	1,806	0%	2,779	2,779	0%
Tp3m1	45,659	45,659	60,000	60,000	65%	60,000	60,000	65%
Tp3m2	2,885	2,885	25,343	25,343	11%	25,343	25,343	11%
Tp3m3	0	0	3,866	3,866	0%	6,282	6,282	0%
Tp3m4	0	0	10,096	10,096	0%	20,155	20,155	0%

(1) Comparing with final energy

(2) Comparing with primary energy

The two figures below shows, in a graphic way, the type of measures that have been described in MURE database since 1990 for the transport sector by type (Financial, Fiscal/Tariffs, Legislative/Normative, Information/Education, Infrastructure) and by impact on energy efficiency (categorized by low/medium/high).

Most of the measures of transport sector lie in Legislative/Normative, Infrastructure and Fiscal, with a high impact in the transport energy efficiency. These measures could be seen in the figures below.

Figure 66: Number of Energy Measures in transport sector: development of measures by type over time (NEEAP 2) [Source: MURE]

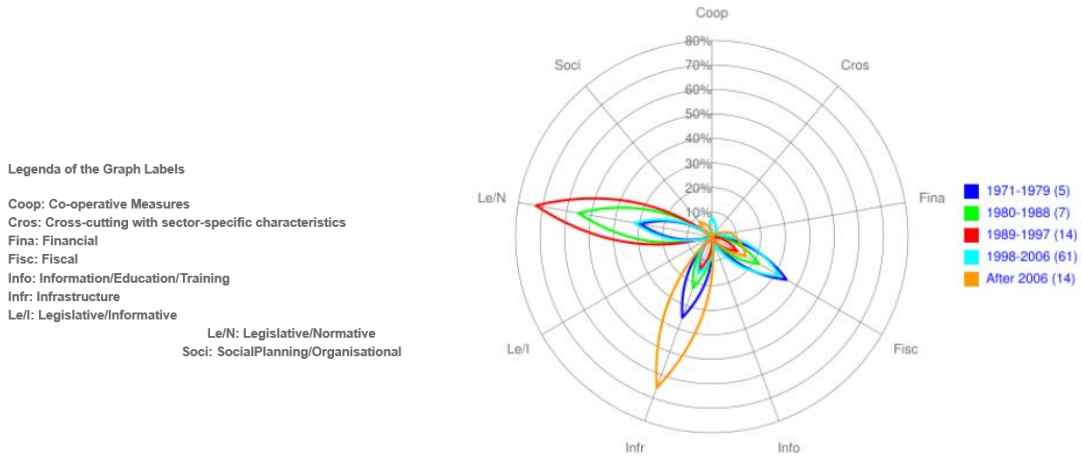
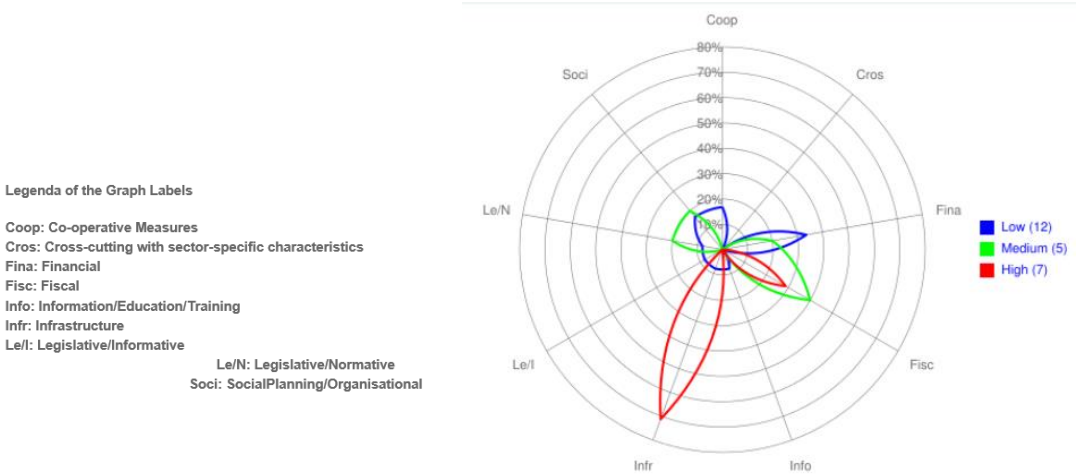


Figure 67: Impact of Energy Efficiency Measures in transport sector: development of measures by type over time (NEEAP 2) [Source: MURE]



4. ENERGY EFFICIENCY IN INDUSTRY

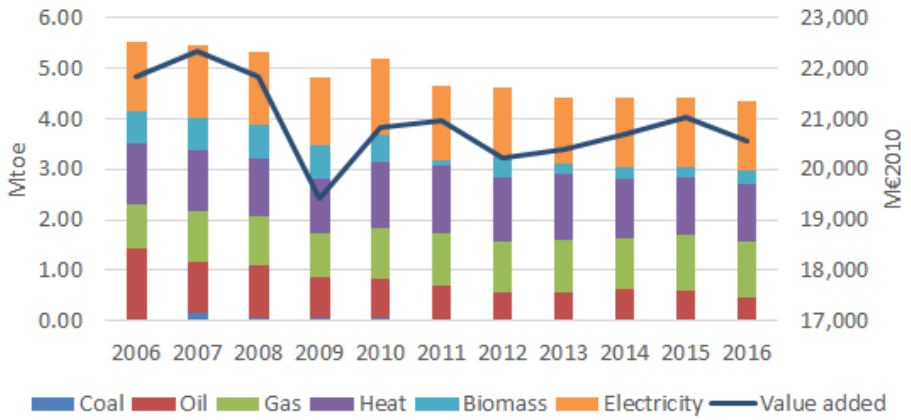
4.1. ENERGY EFFICIENCY TRENDS

The industry sector is the second larger energy consumption in the country with 27% share in the total final energy consumption, including the subsectors of manufacturing industries, mining and construction. From national energy balance of 2016, manufacturing is responsible for 98% of the energy consumption in the industry sector, followed by construction with 3% and mining with a residual share contribution of 1%.

From 2006 to 2016 the energy consumption decreased by 21%, reaching 4.42 Mtoe in 2016. Yet, this decrease was felt in a more emphatic way from 2007, mainly due to oil consumption reduction.

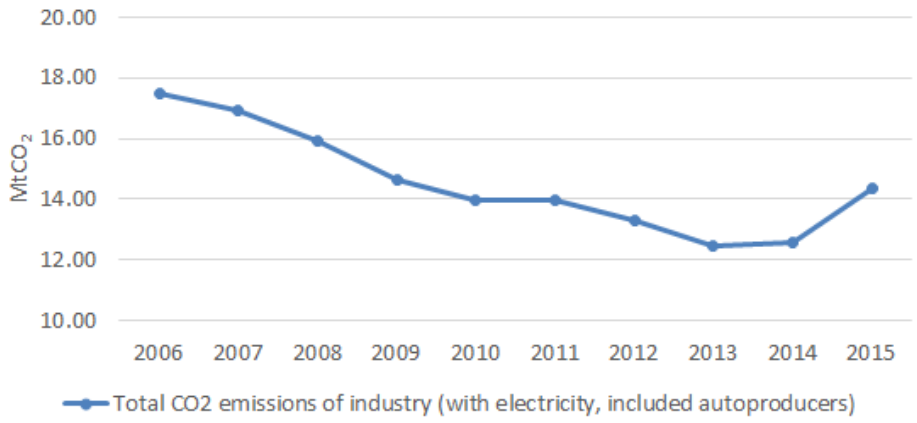
Similarly, analysing the energy intensity at constant structure, which translates the ratio of energy consumption and value added of the sector, we can observe an improvement of the energy consumption per unit of production from 2006 (-11% in 2016 compared to 2006).

Figure 68: Final energy consumption in industry (Mtoe) and Energy intensity [Source: Directorate-General for Energy and Geology]



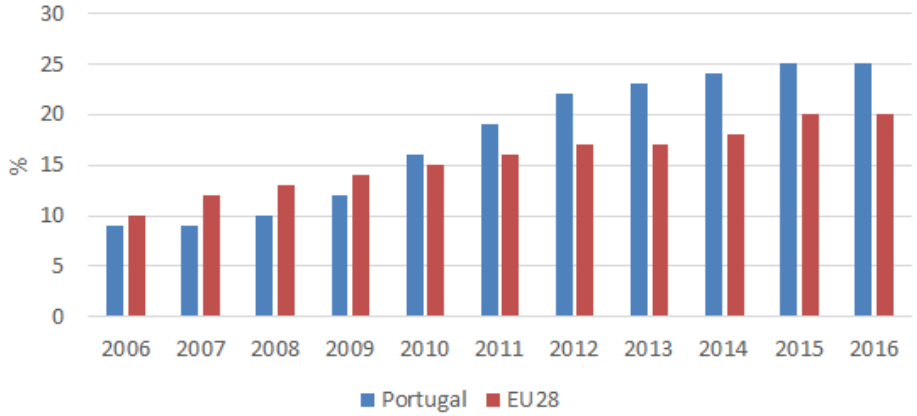
Regarding the CO_2 emissions evaluation, we can observe a decrease of 3.13 $MtCO_2$ from 2006 to 2015 (-18%), which resulted from the energy consumption decrease and the European Emission Trading System (ETS).

Figure 69: Total CO2 emissions of industry (with electricity, included autoproducers ($MtCO_2$) [Source: Odyssee]



The industry shows an important energy efficiency gains trend. We can observe a significant impulse from 2010 onward, and in 2016 the gains were recorded by an increase of 178% related to 2006 in Portugal. Alongside with EU-28, Portugal kept a stable evolution until 2009, but after that, a significant increase was observed overtaking EU-28 in 2010.

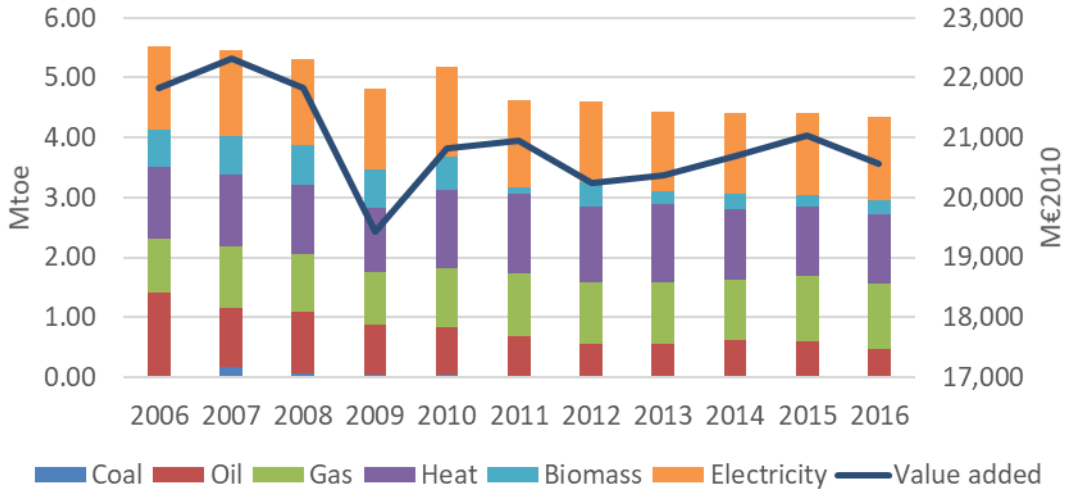
Figure 70: Energy efficiency gains in Portugal and in EU-28 (%) [Source: Odyssee]



4.1.1. MANUFACTURING INDUSTRY

Featuring in detail the sub-sector with the highest weight in the industry sector, manufacturing industry, Figure 71 shows the energy consumption from 2006 to 2016 revealing in the first four years a decreased of the final energy consumption and after 2010 small fluctuations. Following a similar energy consumption trend, the manufacturing industry gross value added at 2010 prices indicates also an accentuate smash from 2007 to 2009 and after that a small recover until 2016 (+6% comparing 2009-2016).

Figure 71: Final energy consumption in manufacturing industry (Mtoe) and gross value added (M€2005) [Source: Odyssee]



All over the last 11 years the energy consumption of this subsector fell 21%, due to the almost extinct coal consumption in this subsector, as well as oil products consumption which had fell out 67%. Although electricity share has risen 7% in total final energy consumption in 2016, this form of energy showed a small decrease (-1%) in 20016 compared to 2006.

Oppositely gas share got up 9% in its share contribution on total energy consumption in 2016, increasing his consumption between 2006 and 2016 by 25%.

Natural gas average prices in 2016 practiced for industry sector was about 10.53 €/GJ (-15% compared to 2008 and -23% compared to 2012) and for electricity it was of 0.14 €/kWh (-1% compared to 2008 and to 2012). Comparatively to UE-28 and in 2016, the price of natural gas was 3% higher and the price of electricity was 3% lower.

Figure 72: Fuels price evolution in industry, [€/l] [Source: Directorate-General for Energy and Geology]

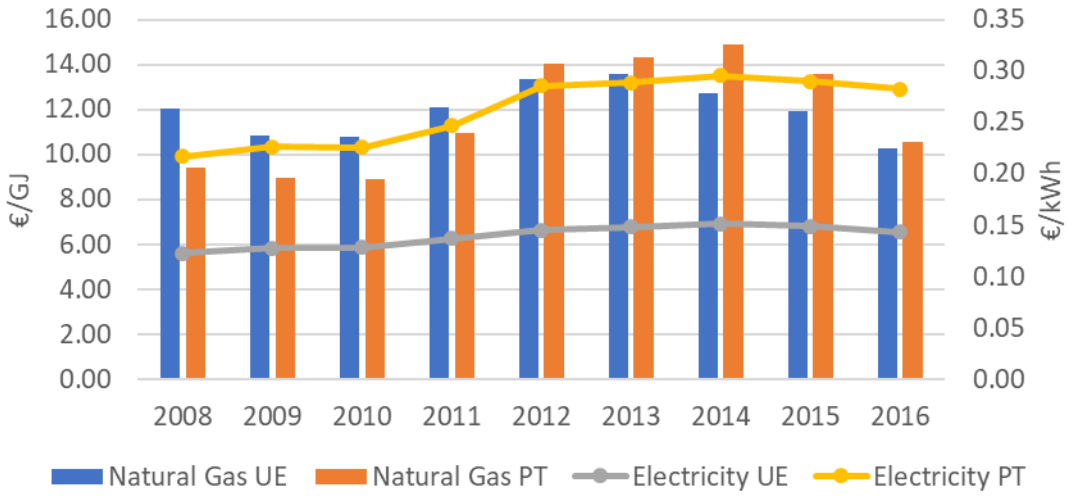
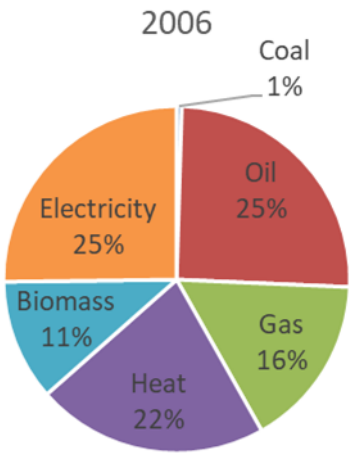
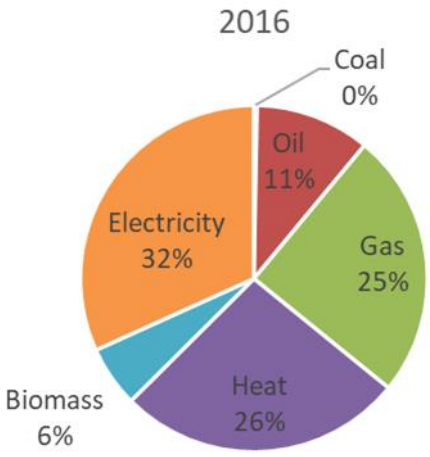


Figure 73: Final energy consumption in manufacturing industry (Mtoe), 2006 and 2016 [Source: Odyssee]



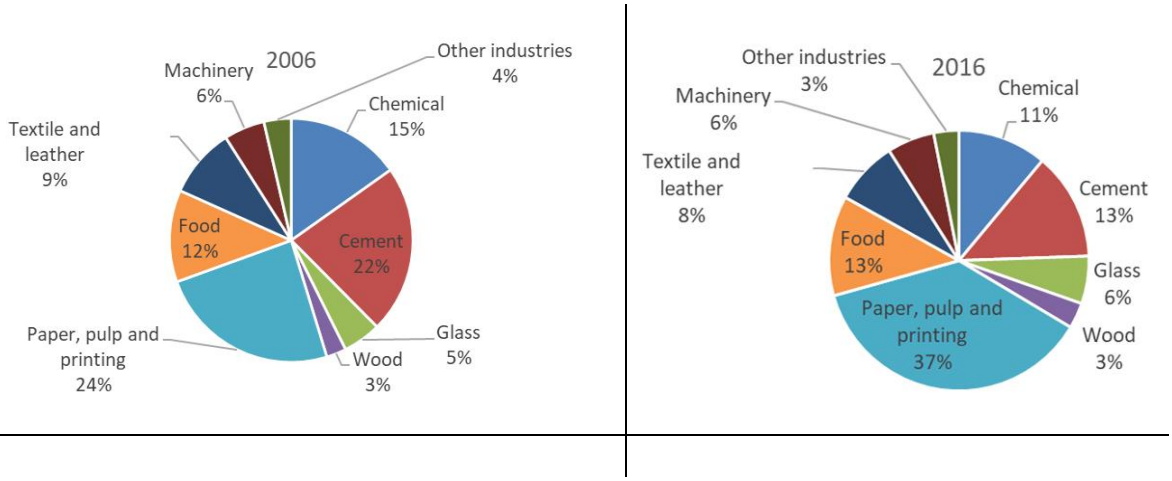
Final energy consumption: 5.52 Mtoe



Final energy consumption: 4.34 Mtoe

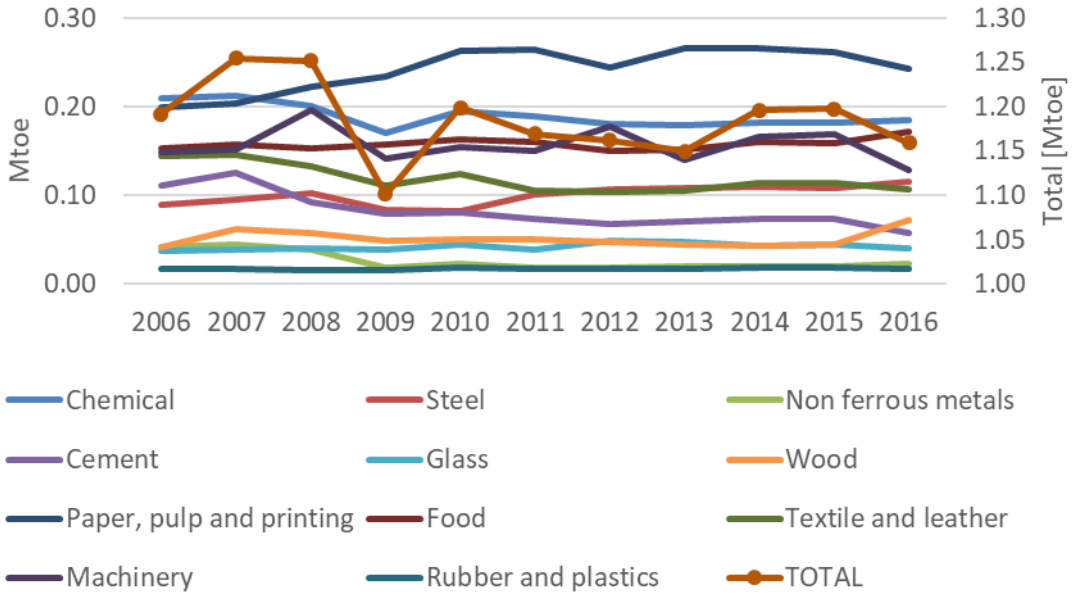
The paper sector has already lead back in 2006 (24% of the total) and in 2016 its leadership in terms of consumption is further enhanced (37% of the total). The cement sector is in second place with (22% in 2006 and 13% in 2016), followed by chemical and food sectors. The final consumption of the other sectors is residual.

Figure 74: Final energy consumption in manufacturing industry branch (%), 2006 and 2016 [Source: Odyssee]



Regarding the electricity consumption, we can observe approximately the same trend in almost all branches, with a decrease of 12% of the total in the year 2009. The behaviour after 2010 was similar and constant.

Figure 75: Final energy consumption in manufacturing branches (Mtoe) [Source: Odyssee]

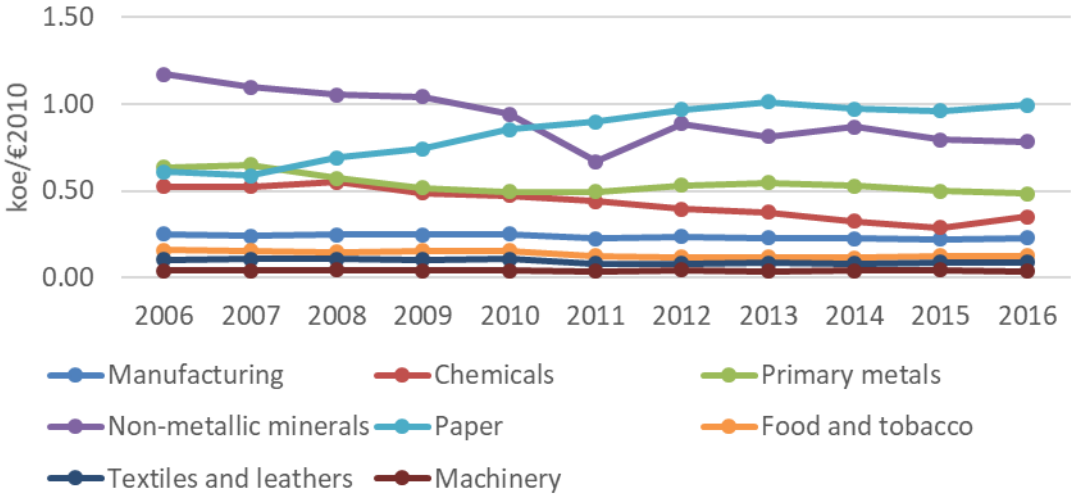


4.1.1.1. Energy intensity in industry

Analysing the energy intensity at constant structure, which translates the ratio of energy consumption and value added of the sector, we can observe an improvement of the energy consumption per unit of production from 2006 (-12% in 2016 compared to 2006).

It is possible to observe a downward trend in most sectors, with the paper sector being the exception, with an increase of 5% annually. The biggest differences were registered in the chemicals and in the non-metallic minerals sectors, with a decrease of 33% each in 2016 compared to 2006.

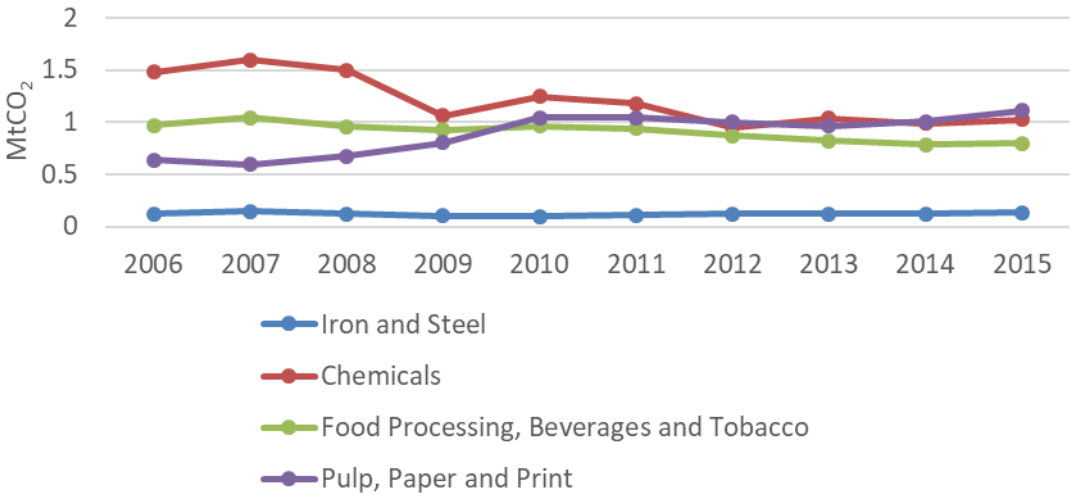
Figure 76: Energy intensity by manufacturing branch [Source: Odyssee]



4.1.1.2. CO_2 emissions in industry

Regarding the CO_2 emissions it's notorious the decline registered in chemicals sector (-31%) and in food Processing, Beverages and Tobacco sector (-18%) in 2016 compared to 2006. A sharp increase was registered in the Pulp, Paper and Print sector, with +76% in 2016 compared to 2006.

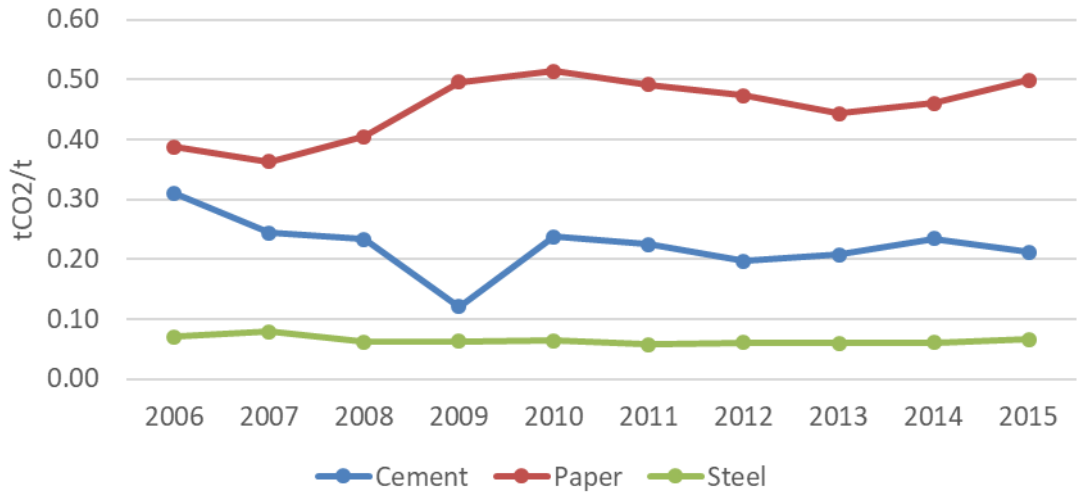
Figure 77: CO_2 emissions by manufacturing branch [Source: Odyssee]



As a result of the above, CO_2 emissions from the paper sector have increased and their specific emissions (per tonne) have also increased considerably (+29% in 2016 compared to 2006).

The steel industry has maintained its specific emissions approximately constant, while the cement sector has been decreasing its CO_2 emissions per product since 2006 (-32% in 2015 compared to 2006.

Figure 78: CO_2 emissions per tonne by manufacturing branch [Source: Odyssee]



4.1.1.3. Energy efficiency gains in industry

The energy efficiency gains on industry are calculated from ODEX and reflect efficiency gains since 2006. ODEX in manufacturing industry is calculated from unit consumption trends by branches considering the current weight of each branch in the sector's energy consumption. For industry, the evaluation is carried out at the level of 11 branches:

- 5 main branches: chemicals, food, textile & leather and equipment goods
- 3 energy intensive branches: steel, cement and pulp & paper
- 3 residual branches: other primary metals (i.e. primary metals minus steel), other non-metallic minerals (i.e. non-metallic mineral minus cement) and other pulp, paper and printing (i.e. mainly printing).

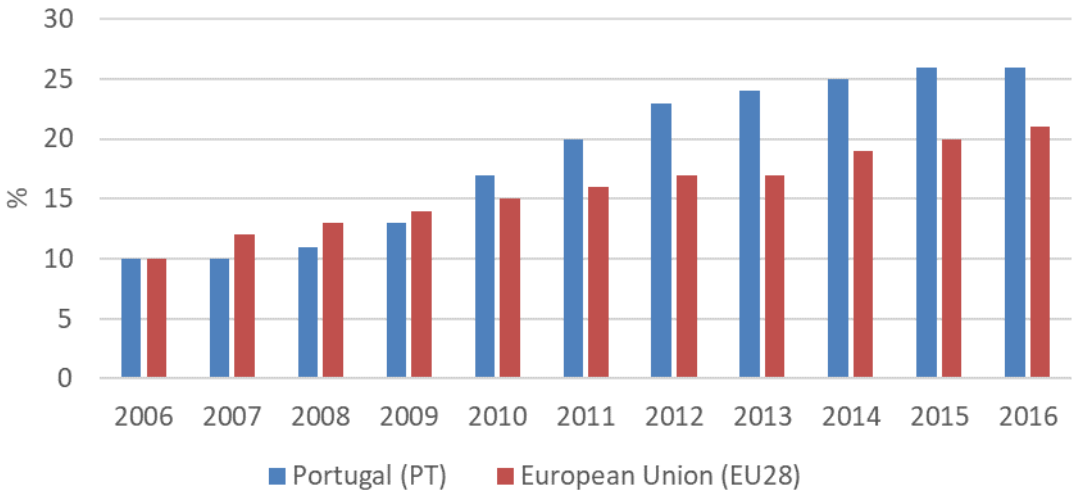
The unit consumption is expressed in terms of energy used per tonne produced for energy intensive products (steel, cement and paper) and in terms of energy used related to the production index for the other branches.

Taking up the review period (2006-2016) one of the sectors where energy efficiency was emphasized most was the paper which reached an annual energy efficiency of -1%/year, passing from a unit consumption of 0.66 toe/t in 2006 to 0.60 toe/t in 2016.

The crude and the cement branches also developed a negative efficiency trend, but in a very smooth way.

Portuguese manufacturing industry observed a slowly improvement from 2006 to 2009, growing faster after that, reaching in that 2016 a gain of 160% related to 2006 and overtaking EU-28 gains with a gain of almost 24% in 2016.

Figure 79: Energy efficiency gains in manufacturing industry for Portugal and EU-28 [Source: Odyssee]



4.2. ENERGY EFFICIENCY POLICIES

The Intensive Energy Consumption Management System (SGCIE) was published on 15 April 2008, through Decree-Law 71/2008, being one of the measures of the NEEAP - National Energy Efficiency Action Plan that results of an extension up to 2016 of the measure of the PNAC 2006 (National Climate Change Plan), relative to the revision of the RGCE- Regulation of Energy Consumptions Management. It was changed by the Law nº7/2013.

The objective of this measure is to promote the increase of energy efficiency through the modification of production processes, the introduction of new technologies and the behaviours changes.

The SGCIE applies for all companies and facilities (also named "Operators") that have an annual consumption over 500 toe/year, imposing binding energy audits, with an 8-year periodicity.

Facilities under European Emissions Trading System (ETS) are not covered by SGCIE, but they may participate on a voluntarily basis, as can facilities with annual energy consumptions lower than 500 toe.

Intensive energy users are obliged to elaborate and execute Energy Consumption Rationalization Plans (PREn), establishing targets for Energy and Carbon intensity and Specific energy consumption, which also outlines energy rationalization measures. The Plan must be submitted through an online system (http://sgcie.publico.adene.pt) to the Directorate General for Energy and Geology (DGEG), as well to submit biennial execution and progress reports. Upon DGEG´s approval, as the competent authority that supervises and inspects the SGCIE's operation, PREn becomes a Rationalization Agreement for Energy Consumption (ARCE).

By the end of each PREn period, operators must reduce their target indicators – Energy intensity and Specific energy consumption – in 4% or 6% depending if they have reference energy consumptions over 500 toe/year or under 1000 toe/year respectively. They also must, at least, maintain Carbon intensity.

The ARCE provides facility operators with excise duty exemptions on oil (*Imposto sobre Produtos Petrolíferos* – ISP), electrical power and energy products (coal, oil coke, fuel oil, oil gases, and natural gas), as well as possibility to apply for incentives on energy audit costs and on investments in energy management and monitoring equipment.

Exemptions in excise duties are foreseen in the national budget for fuels used either by consumers committed to the reduction of CO_2 emissions in the framework of the ETS or by consumers that have an ARCE.

Figure 80: Synthesis of SGCIE application [Source: ADENE]

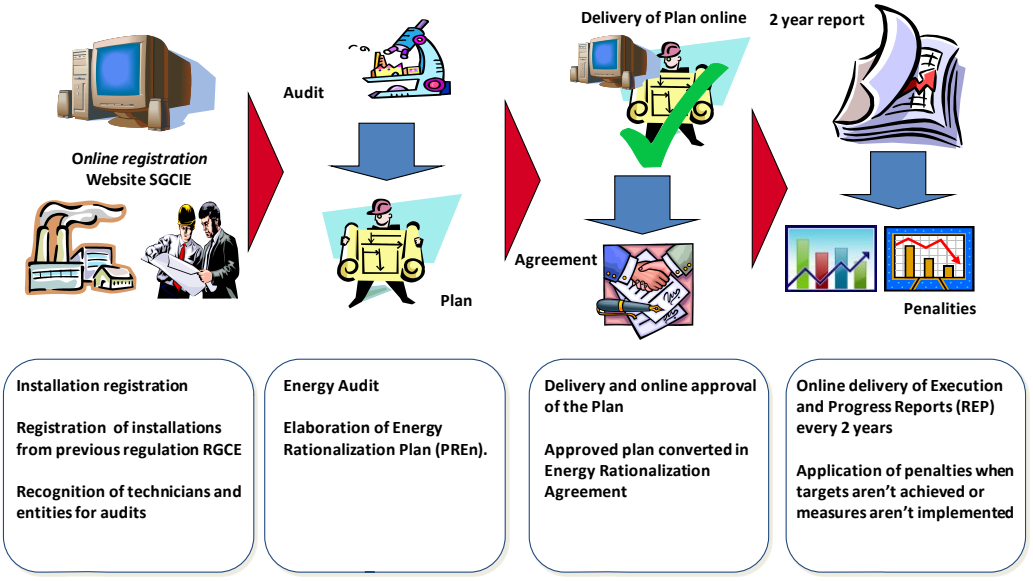
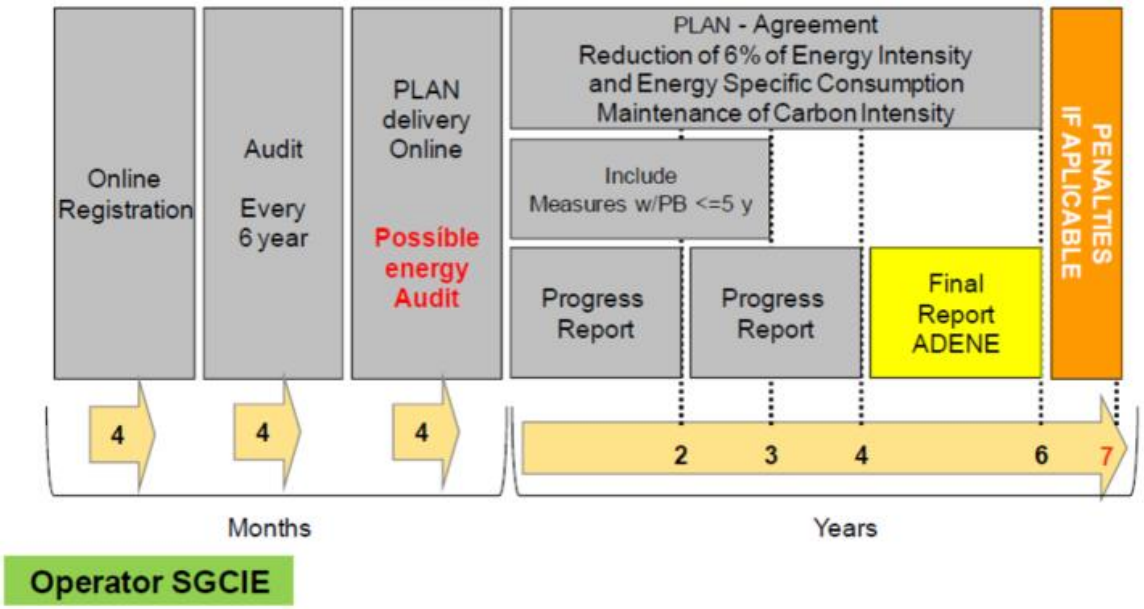


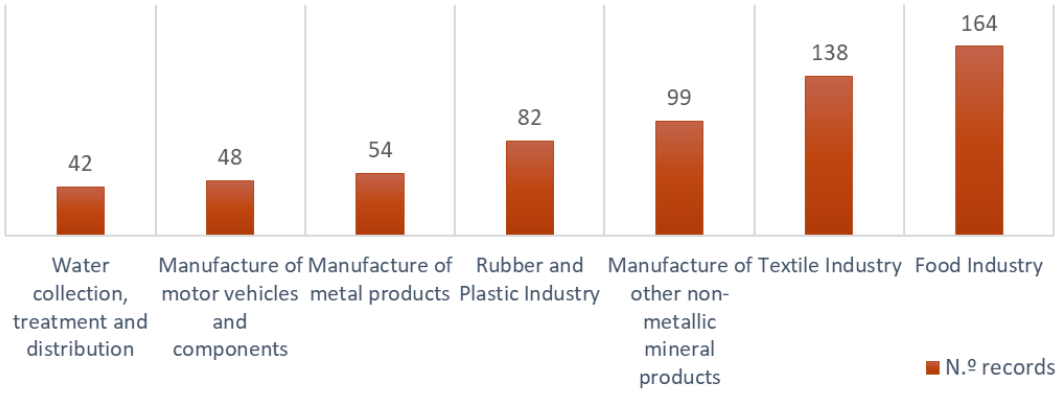
Figure 81: SGCIE schedule [Source: ADENE]



Until July 2017, 1124 intensive energy consuming companies were registered online. In the universe of registered operators dominates the number of companies with annual energy consumption higher than 1 000 toe/year.

The following graphs show the distribution of records concerning its top 7 geographical distribution and the classification of economic activity.

Figure 82: Number of operators per economic activity until July 2017 [Source: ADENE]



Based on 108 REPs for the last biennium of ARCE, there is a 7.7% reduction in energy consumption, a reduction of 5.1% in GHG emissions and a 6.5% reduction in the GVA generated by the installations, compared to the base year of each plan approved. These developments focus on the macro variables and do not take into account the fulfilment of the indicators.

Also, the Decree-law 68-A/2015 published in April 30th establishes issues on energy efficiency and CHP, transposing for national legislation the European Directive 2012/27/UE, is being applied in the industry sector, as well as the transport and building sectors.

As the NEEAP 3 is not published yet, this chapter will be focused on the measures under National Plan for Energetic Efficiency, NEEAP 2, that are ongoing.

Industry sector includes one program designated by Intensive Energy Consumption Management System. Measures in the industrial sector will continue to focus on the implementation of SGCIE, through the potential of constant energy savings of PREn and arising from the implementation of mandatory energy audits. The measures will be broken down as follows:

1. Measure Ip1m1 – SCGIE, Transversal measures
   Four technological groups were identified within the transversal measures, namely: electric motors, heat and cold generation, lighting and other industrial process efficiency measures.

2. Measure Ip1m2 – SGCIE, Specific measures
   Cross-cutting measures for a significant number of industry branches were identified, including a set of specific or sectoral measures that translate possible performances. It is only applicable in the respective production processes.

3. Measure Ip1m3 – SGCIE, Other sectors

   In these measures the existing saving potential in SGCIE to other sectors of activity is identified, besides those referred to in measure Ip1m2, as well as the potential resulting for new cogeneration projects or other actions not directly related to the implementation of SGCIE but leading to an increase of energy efficiency in industry.

Thus, the measures in industry sector referred to NEAAP 2, led to an accumulate energy saving, from 2008 to 2015 of 261,394 toe. Next table shows the energy saving by measure.

Table 11 – Energy saving from NEEAP Programmes and measures for industry area [Source: Monitoring Report of National Action Plan for Energy Efficiency (NEEAP 2016)]

National Action Plan for Energy Efficiency (NEEAP 2016)

Programmes and Measures			Impacts (toe)								
Program	**Measure**	**Measure code**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015[1]**	**Accumulated**
Intensive Energy Consumption Management System	SGCIE – Tranversal measures	Ip1m1	154	3,581	12,358	20,172	14,030	12,544	20,481	11,327	**94,647**
	SGCIE – Specific measures	Ip1m2	151	421	3,121	1,652	781	1,342	912	331	**8,711**
	SGCIE – Others sectors	Ip1m3	0	18,278	2,929	110	520	283	497	110	**22,727**
	Retroactive measures	I7M4	69,338	45,201	20,770	n.a.	n.a.	n.a.	n.a.	n.a.	**135,309**
Total			**69,643**	**67,481**	**39,178**	**21,934**	**15,331**	**14,169**	**21,890**	**11,768**	**261,394**

Moreover, under the Plan for Promoting Efficiency in Electricity Consumption 2013-2014 (PPEC 2013-2014), described in chapter 1.3. Energy Efficiency Policy Background, several measures were approved including some at the industry sector, namely: Promoting of Energy Efficiency in compressed air systems in industry; Ecube in food industry; Electronic variable speed drives in Agriculture and industry; Driving force control system; Frequency converters; Global lighting in industry; Capacitor banks; High-efficiency motors; Electronic variable-speed in industry; Control system of UV equipment; Right lighting in the company; Solutions of Energy Efficiency in compressed air systems and Industrial demand management. With the exception of measure "Promoting of Energy Efficiency in compressed air systems in industry", these measures promote altogether an electric consumption savings of 659,381,839 kWh and an avoided CO_2 emissions of 243,971 tCO_2.

A brief description of PEEC 2013-2014 measures is as follow:

a.1 Promoting of Energy Efficiency in compressed air systems in industry aims the production of one energy efficiency manual in industry compressed air systems to be distributed at

[1] Provisional data

companies and an execution of three courses with practical component (with training in audit work).

a.2. Electronic variable speed drives in Agriculture and industry aims to co-finance the installation of 110 variable speed drives in electric motors with an average nominal power of 75 kW (22 to 110 kW), attached at centrifugal pumps, ventilators and air compressors.

a.3. Electronic variable-speed (VEVs) promote the installation of 330 VEVs in the industry sector to reduce of the electricity consumption in driving force as well as to promote the penetration of this speed control engine technology in this sector. The consumers target are all consumers of the industry and agriculture segment with pumping systems, ventilation, compression and exhaust, processes or industrial cold and at all driving force applications where there is flow variation (liquid or gaseous) operating at least two rounds.

a.4. High-efficiency motors promotes the installation of 450 high-efficiency motors in the manufacturing industry, replacing the reduced efficiency motors (EFF3 efficiency class motors), to reduce the electricity consumption in driving force, and the transformation of market in an effort to increase significantly the use of this technology.

The target device of this measure will be the high-efficiency motors (IE2 efficiency class) belonging to one of the following power ranges [0,75 to 11] kW, [15-75] kW and [90-250] kW for application in manufacturing industry to replace Eff3 efficiency class motors.

a.5. Solutions of Energy Efficiency in compressed air systems promotes the improvement of the compressed air systems supply in industrial facilities through specific interventions such as the installation of new compressors, elimination of leaks in networks, installation of control systems, correction of air intake systems or heat recovery, among others. The target device of this measure will be the components of the industrial compressed air systems, existing in most installations. The main susceptible components of intervention include: compressors, control systems and distribution networks. The target consumers are all consumers of the industrial sector and agriculture, provided that they have compressed air systems on their premises.

a.6. Right lighting in the company consists in supporting the installation of energy optimizers technologies, innovative technological system consisting of a technical cabinet that accommodates specifically a set of special transformers, equipped with outlets to regulate voltage levels, scaled to different powers according to the needs of the electrical system dedicated to lighting.

a.7. Industrial demand management promotes the installation of 200 freight management mechanisms and consumption adjustments in the industry, in order to reduce electricity consumption and to study the asset of implementing a dynamic price scheme for Small and Medium Business - Industrial SMEs. Thus, it is intended to implement two types of demand management mechanisms: (i) active: remote cuts and interruptible programs; and (ii) passive: indirect reduction via optimized management achieved at the expense of information available from monitoring systems.

The target audience are all Portuguese industries using electricity energy source and that have potential for savings through demand management systems and monitoring and control.

a.8. Capacitor banks proposes the installation of capacitor banks in all participants that, due to the absence or failure of reactive power compensation equipment, are consuming reactive power during periods outside of emptiness.

Potential participant's consumers are all units of the Industry sector & Agriculture located in mainland Portugal and the Autonomous Regions, with plans to install 200 capacitor banks with outputs adjusted to each installation.

a.9. Ecube in food industry promotes the installation in companies of Food Industry of 3000 food temperature simulation devices (eCube), to reduce energy consumption in refrigerated spaces (corridors, industrial areas of food processing, refrigeration and freezing chambers).

a.10. Control system of UV equipment intends to intervene at the level of drying systems, disinfection and surface treatment by UV (ultraviolet), promoting the use of intelligent control systems that, by regulating the electrical parameters, raise efficiency levels of these equipment, only providing required energy to perform the task.

The measure provides for 80 UV equipment controllers, with average power estimated at 18kW, in 40 industrial companies, providing average reduction levels more than 40% of the active energy consumption and 50% of and reactivea.11. Frequency converters proposes the installation of 100 frequency converters for AC induction motors that turn the power frequency (50 Hz) of electrical energy into variable frequency, achieving thereby vary the speed of the motors and increase their level of efficiency.

The measure intended to all consumer units of the Industry sector and agriculture sector that have engines with needs to operate at variable load.

a.12. Driving force control system intends to intervene in terms of driving force drives by promoting the use of intelligent control systems that, by regulating the electrical parameters of input motors, raise the level of efficiency of these machines only providing the energy required to perform the task. It provides the application for 150 driving force controllers in electric motors of average power estimated at 55kW in 50 companies in the industrial sector.

a.13. Global lighting in industry provides the installation of 11.000 high-efficiency lighting equipment to replace less efficient equipment in the industry and agriculture sector companies. They include several conventional and efficiency technologies: (i) replacement of fluorescent fixtures T8 for T5 of 49W; (ii) replacement of steam high-pressure lamps with fluorescent lamps T5 160W; (iii) replacement of fluorescent tube lamps T8 of 24W LED tubes

Besides legislative/normative measures described above and applied to NEEAP 2 for the energy efficiency improvement implementation, other financial mechanisms are also available to promote efficiency measure on the industry sector. Thus, under Energy Efficiency Fund, Call 13 – "SGCIE – Incentive to promote of Energy Efficiency II in 2015" which were already described in the present report chapter - 1.3. Energy Efficiency Policy Background, was launched in 2015.

Additionally, it is already in implementation the 6º edition of the Plan for Promoting Efficiency in Electricity Consumption 2017-2018 (PPEC 2017-2018), which aims to financially support initiatives that promote the efficiency and the reduction of electricity consumption in all the different consumer segments. The implementation of all the approved measures will allow social benefits are (around EUR 111 million) are much higher than the costs (EUR 23 million). The beneficial effects of the measures will remain until 2037, representing about 1 470 GWh of cumulative avoided consumption.

The following figures shows the dynamics of the national energy efficiency measures from 1990 to 2016 (national measures and those triggered by EU measures) in the different demand sectors. This examination is based on the MURE Database on energy efficiency. This database covers a number of rational energy related policy measures, a coverage that has been updated over the years by type (Financial, Fiscal/Tariffs, Legislative/normative, information/Education) and by impact on energy efficiency (categorized by low/medium/high).

Most of the measures of this sector are Cross-cutting with sector-specific characteristics, Financial and Legislative/normative with a medium in the energy efficiency

Figure 83: Number of Energy Measures in industry sector: development of measures by type over time (NEEAP 2) [Source: MURE]

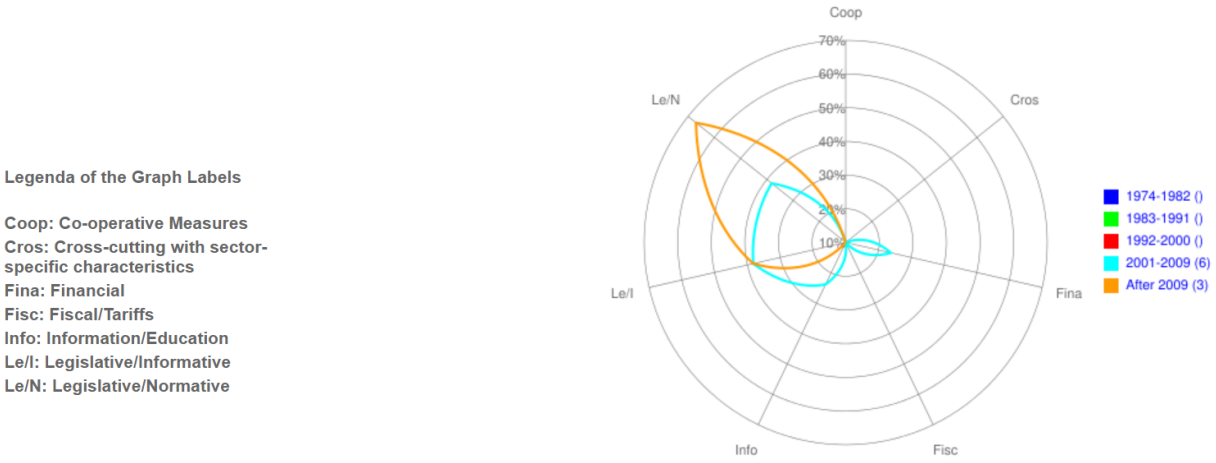
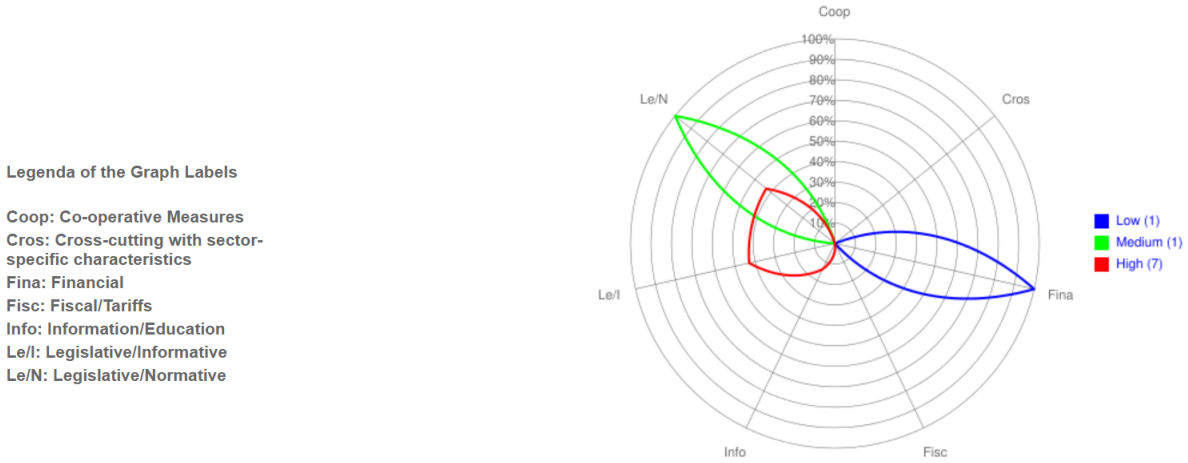


Figure 84: Number of Energy Measures in industry sector: development of measures by impact over time [Source: MURE]



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