

# Energy consumption and energy efficiency in the residential sector: A joint analysis by administrative and survey data

The article analyzes the investments in energy efficiency by Italian families through a joint reading of sample data on energy consumption of households and administrative data on various incentive mechanisms in the residential sector

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Over the past few years, the energy issue has become increasingly important in the political agenda and in the scientific debate, given its close interrelation with the economic and social systems and its impact on the environment. In particular, national policies pay great attention to energy sustainability through a number of measures, aimed at containing consumption and related emissions and at promoting innovation in renewable energy sources.

Investments in energy efficiency allow to deliver more services for the same amount of energy input, or the same services for even less energy input. In recent years, energy efficiency has increasingly been recognized as the “first fuel”: a source of energy in its own right, it provides a key contribution to decarbonization objectives and is associated to a wide range of economic and social benefits. As is the case for renewable energy sources, energy efficiency strongly innovates the energy system, in a

holistic way and on both the demand and the supply side.

The 20% reduction of primary energy demand<sup>1</sup> is a very important target of Europe’s 20-20-20 targets of the “Climate and Energy Package”, to be achieved through the increase in energy efficiency (Directive 2012/27/EU). The contribution of the residential sector for the achievement of this target is significant, given the importance of household consumption on total energy consumption (in 2015, more than 28% of consumption

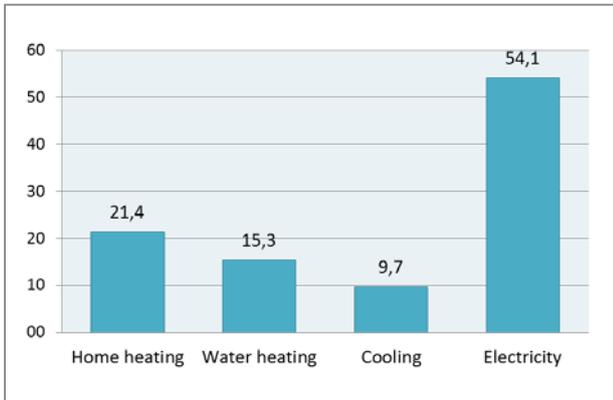


Fig. 1 Households who made investments to reduce energy consumption costs for purpose (for 100 households)

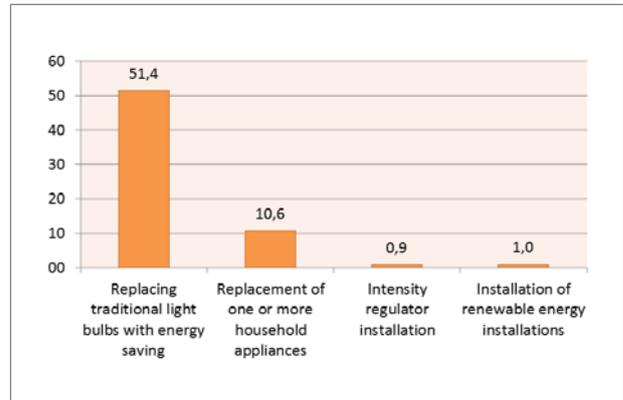


Fig. 2 Households who made investments to reduce electricity costs for purpose (for 100 households)

in the EU-28, vedi pagina web: <http://www.eea.europa.eu>.

The availability of information on household energy habits is essential for the promotion of solutions that contribute to reduce energy demand and to increase the efficiency of consumption, encouraging conscious behaviors by end users.

Aim of this paper is to analyze the investments in energy efficiency by Italian families through a joint reading of sample data (Istat survey on energy consumption of households) and administrative data (ENEA, MiSE and GSE databases on various incentive mechanisms in the residential sector).

### Sample Data - Istat

Istat survey on energy consumption of households responds to information needs at international level, and in particular to the European Regulation on “Renewable energy statistics and final energy consumption” (no. 1099/2008). In order to expand the level of detail of information on energy consumption (art. 9), Energy Regulation has been recently amended to include the statistics on energy consumption in the resi-

dential sector in mandatory data requests (Commission Regulation (EU) no. 431/2014).

Istat data on energy consumption of households has also been widely used to feed the flow of information for monitoring two EU 20-20-20 targets: the target of 20% share of renewable sources in energy consumption (HP and biomasses consumption of the residential sector) and the target of emission reduction by 20% (biomasses consumption of residential sector).

The survey was conducted by Istat for the first time in 2013 with reference

to the entire national territory – in cooperation with the Italian National Agency for New Technologies, Energy and Sustainable Economic Development (ENEA) and the Ministry of Economic Development (MiSE) – to estimate energy consumption of households by energy source and final destination, in accordance with EU Regulation N. 1099/2008. The main topics are: Dwelling characteristics and census of energy facilities and equipment; Space heating; Space cooling; Water heating; Lighting and electrical appliances; Energy consumption and expenditures; Invest-

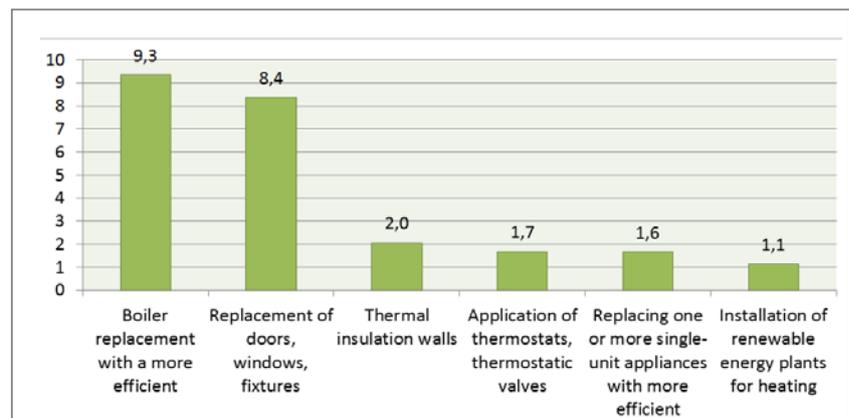


Fig. 3 Households who made investments to reduce heating costs for purpose (for 100 households)



Fig. 4 Households who made investments to reduce energy costs for geographic area (synthetic indicator)

ment to increase efficiency and energy savings. The sample consists of 20,000 households, representative, at regional level, of 25,872,613 resident families.

### Energy Saving Investment

Energy saving is a virtuous practice aimed at respecting and protecting

the environment by the adoption of new daily behaviors which reduce at the same time fuel consumption, expenses, and related pollution. Households were asked if they had invested in money over the past five years to reduce their energy costs. In 54.1% of households, investments were made to reduce expenses for electricity (mainly due to the replacement of bulbs); in 21.4% for home heating costs; in 15% for heating water and in about 10% for conditioning.

The replacement of traditional light bulbs with energy-saving ones (51%) is the most common electricity saving investment in households, while only 10.6% replace appliances.

The costs for space heating are mainly reduced by replacing boilers with more modern and efficient devices (9.3%), but also by changing doors, windows or fixtures in order to reduce the loss of heat (8.4%). More structural (and therefore more expensive) interventions, such as thermal insulation, are still negligible.

Renewable energy systems, both for electricity and heat production (about 1%), are still uncommon.

Among the many possible investments to reduce energy costs, the most complex and costly interventions were selected and combined for the construction of a synthetic indicator for a more immediate and representative reading of the phenomenon. The selected investments are: replacement of heating devices or appliances with more efficient equipment and/or installation of renewable electricity and heat production systems and/or installation of equipment for monitoring consumption.

According to the synthetic indicator, 22% of households made investments in energy efficiency.

Compared with households resident in South, families living in central and northern Italy show a greater propensity to make investments for energy saving. The most “virtuous” regions are: Lombardy and Autonomous Province of Trento (26%), Veneto (25.3%), Emilia Romagna and Liguria (24.5%), Umbria (24.3%) and Piemonte (23.2 %). A stronger inclination to energy saving is still to be developed in Sicily (14.2%), Autonomous Province

	2007	2008	2009	2010	2011	2012	2013	2014	2015	Total
<b>Tax deductions for energy renovation</b>										
Overall renovation	0.006	0.014	0.010	0.004	0.003	0.003	0.003	0.003	0.006	0.052
Thermal insulation of the envelope	0.016	0.043	0.043	0.066	0.052	0.047	0.064	0.065	0.061	0.457
Efficient heating system installation	0.023	0.053	0.054	0.083	0.055	0.047	0.056	0.046	0.012	0.429
Solar shading	-	-	-	-	-	-	-	-	0.001	0.001
Multiple action	0.015	0.034	-	-	-	-	-	-	-	0.049
<b>Total</b>	<b>0.060</b>	<b>0.144</b>	<b>0.107</b>	<b>0.153</b>	<b>0.110</b>	<b>0.097</b>	<b>0.123</b>	<b>0.113</b>	<b>0.080</b>	<b>0.988</b>
<b>Tax deductions for building renovation</b>										
Efficient heating system installation and windows replacement	0.204	0.197	0.185	0.173	0.213	0.191	0.132	0.162	0.18	1.637

Table 1 Savings from tax deductions (primary energy, Mtoe/year) 2007-2015 period  
Source: ENEA



Sector	White Certificates	Tax deductions*	Thermal account	Legislative Decree 192/05*	Measures in transport sector*	Other measures**	Energy saving		Achieved target (%)
							Achieved in 2016 <sup>b</sup>	Expected by 2020	
Residential	0.59	1.56	-	0.91	-	0.02	3.09	3.67	84.2%
Services	0.13	0.02	0.003	0,05	-	-	0.19	1.23	15.4%
Industry	1.84	0.03	-	0.09	-	-	1.95	5.10	38.3%
Trasport	-	-	-	-	1.13	0.04	1.18	5.50	21.4%
<b>Total</b>	<b>2.56</b>	<b>1.60</b>	<b>0.003</b>	<b>1.05</b>	<b>1.13</b>	<b>0.07</b>	<b>6.41</b>	<b>15.50</b>	<b>41.4%</b>

**Table 2** Achieved and expected savings according to Italian National Energy Strategy measures (primary energy, Mtoe/year) 2011-2016 period  
Source: ENEA elaboration on data from Ministry of Economic Development, ISTAT, Gestore dei Servizi Energetici SpA, ENEA, FIAIP, GFK

\* Estimates for 2016

\*\* Saving deriving from major appliances replacement are considered in residential sector total. Savings associated to high speed railways are included in transport sector figures

of Bolzano (17.6%), Basilicata and Abruzzo (18.7%).

### Administrative Data - ENEA

Tax deductions for energy renovation have been a key driver of energy efficiency improvements in the housing sector, representing the main incentive mechanism for favouring interventions in the existing building stock. Initially introduced by Law no. 296/06 (2007 Budget Law), tax deductions for energy renovation – also called Ecobonus – were extended several times by different laws. In particular, the 2017 Budget Law (Law n° 232/2016) confirmed the tax rebate scheme until the end of December 2017, and until the end of December 2021 for the renovations carried out on the common parts of residential buildings. Relative to the initial version of the scheme, the main changes are that the incentive has been extended to new interventions and the rebate rate increased from 55% to 65% (and in 2017 the Ecobonus could reach 75% for specific interventions).

In tax terms, the incentive works as a direct deduction for IRPEF (person-

al income tax) or IRES (corporate income tax), to be repaid in 10 years, and aimed at realising interventions to improve energy efficiency in existing buildings. According to the law, a wide range of beneficiaries can apply for the incentive: natural persons; professionals; companies and firms; and, since 2016, also social housing institutions.

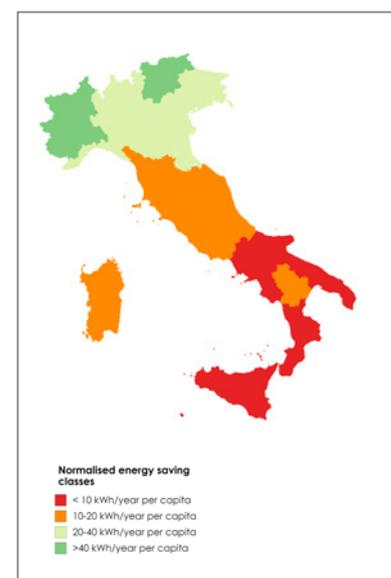
In particular, possible interventions can be summarised as follows:

- Renovation of existing buildings;
- Improvement of thermal performance of building envelope (insulation, windows replacement);
- Solar shading;
- Installation of solar thermal systems for hot water;
- Replacement of heating systems (condensation boilers, heat pumps, geothermal systems, biomass boilers);
- Building automation systems.

### Tax deductions for energy renovation

Total saving from energy renovation interventions in the 2007-

2015 has been almost 1 Mtoe/year<sup>2</sup> (Table 1). In this period, around 3 million interventions were incentivised by tax deductions for energy renovation, with more than 31 billion € invested by households. A large amount of interventions concerned efficient heating system installations, including condensation



**Fig. 5** Per capita energy savings (primary energy) associated to tax deductions for energy renovation in 2015 (preliminary values)  
Source: ENEA

boilers, incentivised also by tax deductions for building renovation (incentive equal to 50% of the expense). In particular, a significant share of condensation boilers sold on the market, and used to replace old systems, are incentivised by this other tax rebate scheme. Using for calculation the energy saving per unit available from deductions for energy renovation, the overall value of saving achieved in 2015 associated to condensation boilers has been estimated equal to 0.88 Mtoe/year (Table 1)<sup>3</sup>.

Compared to the energy saving objectives set in the 2014 National Energy Efficiency Action Plan, the overall cumulated saving in the period 2011-2016 represents 41% of the 2020 target, as shown in Table 2. Almost half of this value is achieved thanks to the White Certificate mechanism. At sectoral level, the residential sector has already achieved 84% of the 2020 objective.

Figure 5 shows energy savings associated to tax deductions for energy renovation in 2015, classified by geographic regions and expressed in primary energy. As other market-indicators (investment or type of intervention), energy savings clearly show great heterogeneity among regions. Differences are very significant between maximum and minimum values (with a ratio up to 1:10). In northern Italy, the best results are observed in Piemonte, Val d'Aosta and Autonomous Provinces of Trento and Bolzano: these regions have always been very sensitive to the energy efficiency issue. Central Italy shows quite homogeneity in results expressed in absolute value, even though these results are associated with different categories of interventions. Lower unitary savings are registered in southern regions, except for Basilicata, due both to climatic reasons and limited spending capacity.

## Conclusions

The incomplete correspondence of information on energy efficiency from administrative and sample sources encourages a joint data analysis, in order to implement a wider and more detailed description and interpretation of Italian population's behaviors in the energy field. This analysis has shown that, overall, the contribution of households to energy efficiency is significant, also thanks to a greater participation of residents in the North, only partly due to more pressing climate-related needs. Further developments in view of a more in-depth analysis of available data will provide more insights into the causes and determinants of this phenomenon.

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<sup>1</sup> The target was increased to 27% for 2030 ([http://ec.europa.eu/clima/policies/strategies/2030/index\\_it.htm](http://ec.europa.eu/clima/policies/strategies/2030/index_it.htm))

<sup>2</sup> Preliminary data for 2016

<sup>3</sup> This value has been computed by applying the share of condensation boilers to the overall number shown in Table 1 for tax deductions for building renovation (efficient heating system installation and windows replacement)