Fuel Poverty vs Fuel Obesity - what smart meters tell us

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Outline

- **Problem framing and Work features**

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Problem Framing

Fuel poverty occurs when households are unable to afford adequate energy services in the home at reasonable cost, while spending more than 10% of its disposable income on energy services. It includes all uses of energy and considers the thermal comfort levels needed and not what is effectively being consumed.

It is increasingly becoming a problem in European countries (European Council Directive 2009/72/EC).

Between 50 and 125 million people are currently unable to afford proper indoor thermal comfort.

The combination of low incomes; low performance dwellings with defective insulation (i.e. windows, walls, roofs), older household members and high costs of energy are enablers of fuel poverty.

Work Features I

WHY? Fuel Poverty is well studied in several EU countries. However, it is a particular problem for southern European member states and single evaluation of such countries have recurrently dismissed Portugal.

Despite being a warm country with mild winters, several facts point Portugal as severely endangered by fuel poverty issues:

Within the group of EU countries with the **poorest housing status** with consequences in the **levels of excess winter deaths.**

Electricity and natural gas prices for families with all taxes included were, in 2014, 12% and 32% higher, respectively, compared to EU28 average.

27.5% of people at **risk of poverty**

28.3% of people **enabled to keep home adequately warm**

35.7% living in a **dwelling not comfortably cool during summer time**

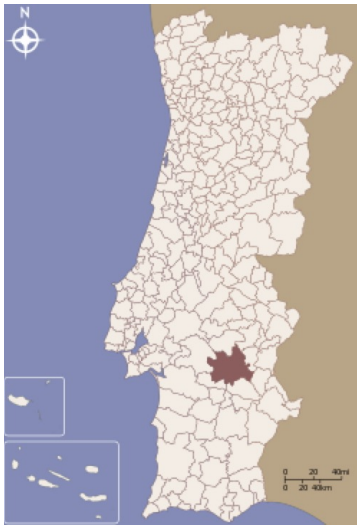
20.9% of people with **arrears on utility bills**

Work features II

HOW? Exploratory data analysis through segmentation of consumers based on clustering electricity consumption profiles and its socio economic details to identify consumers under fuel poverty and fuel obesity.

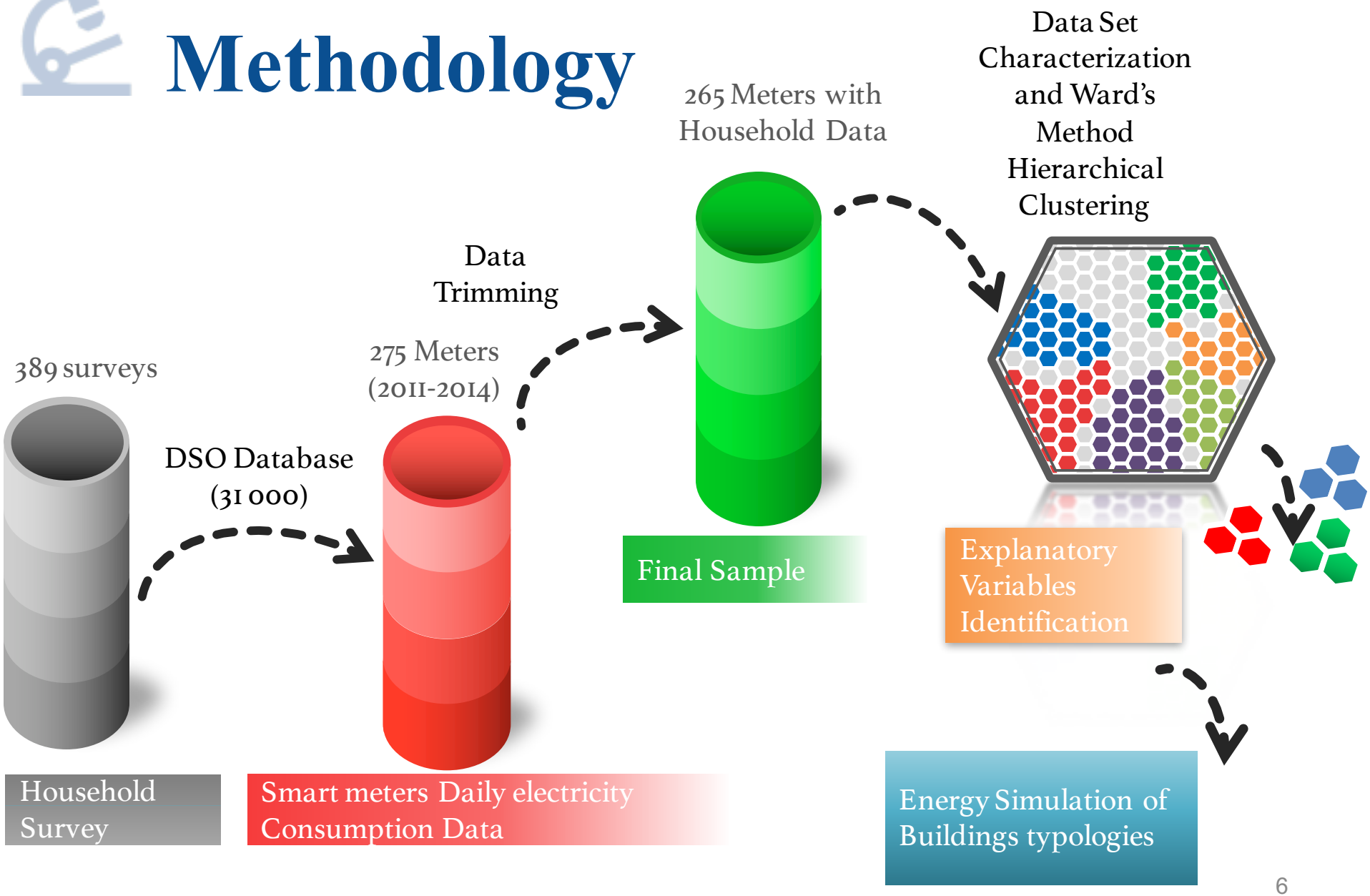
We derive this identification from electricity consumption assessing thermal comfort levels with energy simulation of buildings.

WHERE? Évora was selected has a case study since it has the first massive smart metering system (31 000 smart meters in households) in Portugal - InovCity project



Combining these two sets of information provides an extensive and coherent dataset on household electricity consumption.

Methodology

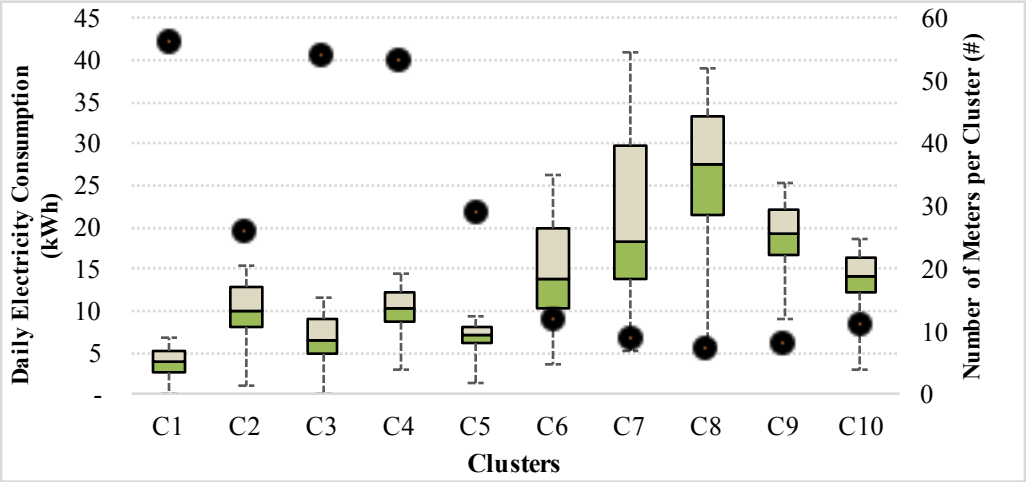


Consumers Segmentation I

Hierarchical clustering using the Ward's Method (Ward, 1963)

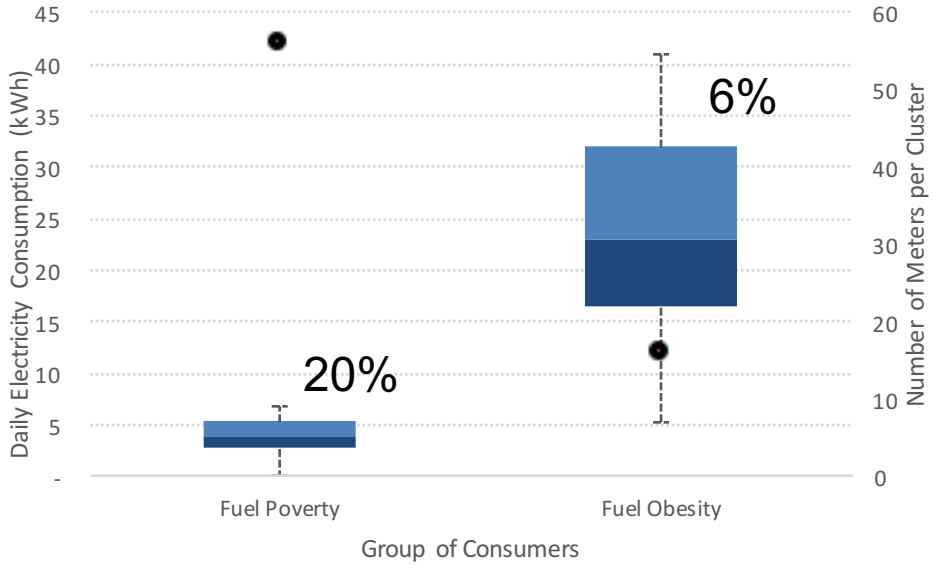
For maintaining robustness and statistical significance of the clustering, only increasing the number of clusters allows to capture distinct yearly consumption patterns and to create types of consumer for which different policy and energy reduction measures could be targeted.

10 clusters - similar distribution of meters within clusters with mean daily electricity consumptions below 15kWh (cluster 1 to 6), totaling 200 meters (more than 86%).



Box and whisker plot with clusters distribution

Consumers Segmentation II

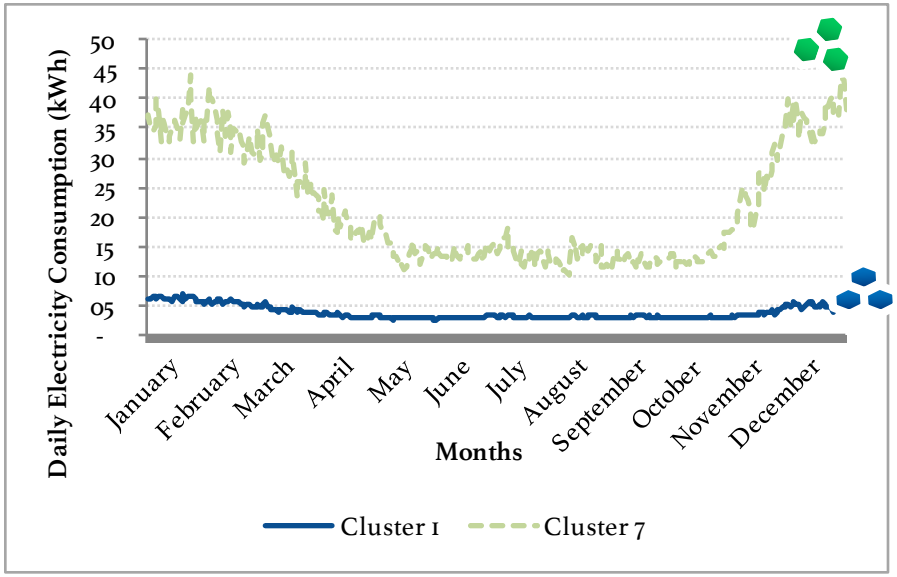


Screening of the surveys allocated to each cluster to identify the parameters that explain the electricity consumption patterns and similarities, while identifying important consumers groups.

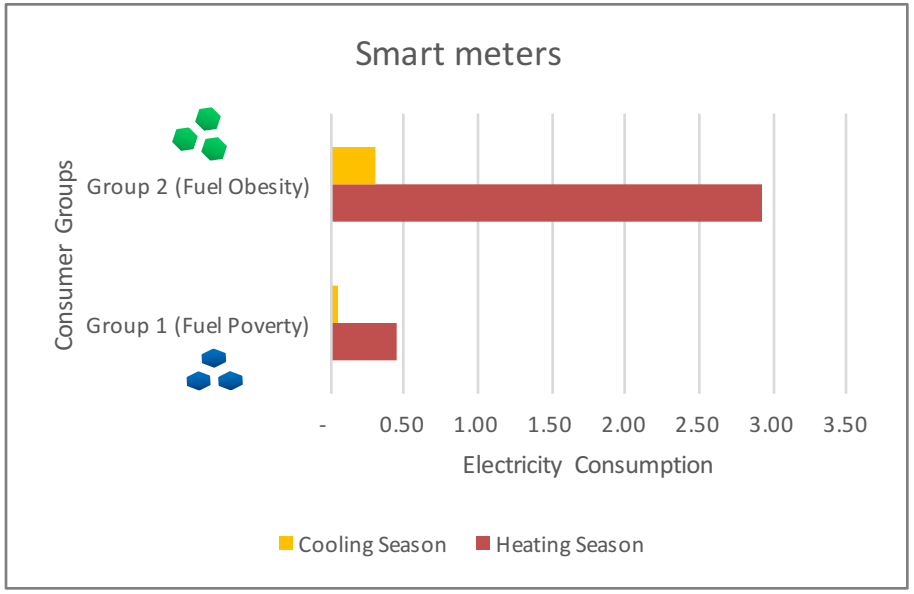
- ✧ dwelling characteristics,
- ✧ occupants profiles,
- ✧ electrical appliances ownership and use.

Results – Electricity data clusters I

Under similar climate conditions, the households have different profiles of electricity consumption, meaning a diversity of consumers.

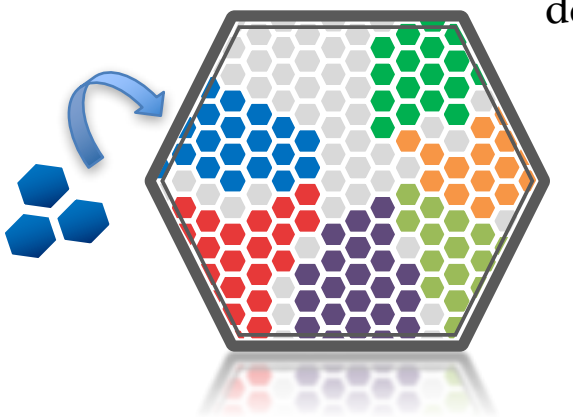


Annual electricity consumption profiles of the two groups (2011-2014 average)



Daily electricity consumption profiles of the two groups in the cooling and heating season

Results - Fuel Poverty Group: Explanatory variables



Lowest average electricity consumption (3.86 kWh) and standard deviation (1.76) of all the clusters.

- **Age of buildings** - 67% with a period of construction between 1946 and 1990
- **House size** - average of 90m².
- **Occupants' characteristics** - 70% of the households with just 1 or 2 residents; 60% of the occupants aged above 50 years old, retired and with low levels of education, monthly average incomes below 750€.

- **Windows framing and type of glazing**, 83% of the households having single glazing and the majority (60%) of wooden framing in windows.
- **Type of heating, cooling and domestic hot water appliances**. 88% have electric heaters for space heating.
- High share of houses with just fan coils for space cooling.
- **Low penetration** of dish washing machines (i.e. 29%) and freezers (61%).
- 78% of the houses **have installed power lower** than 3.45 kVA.
- 71% of the houses still have **single tariff.**

Results - Fuel Obesity Group: Explanatory variables

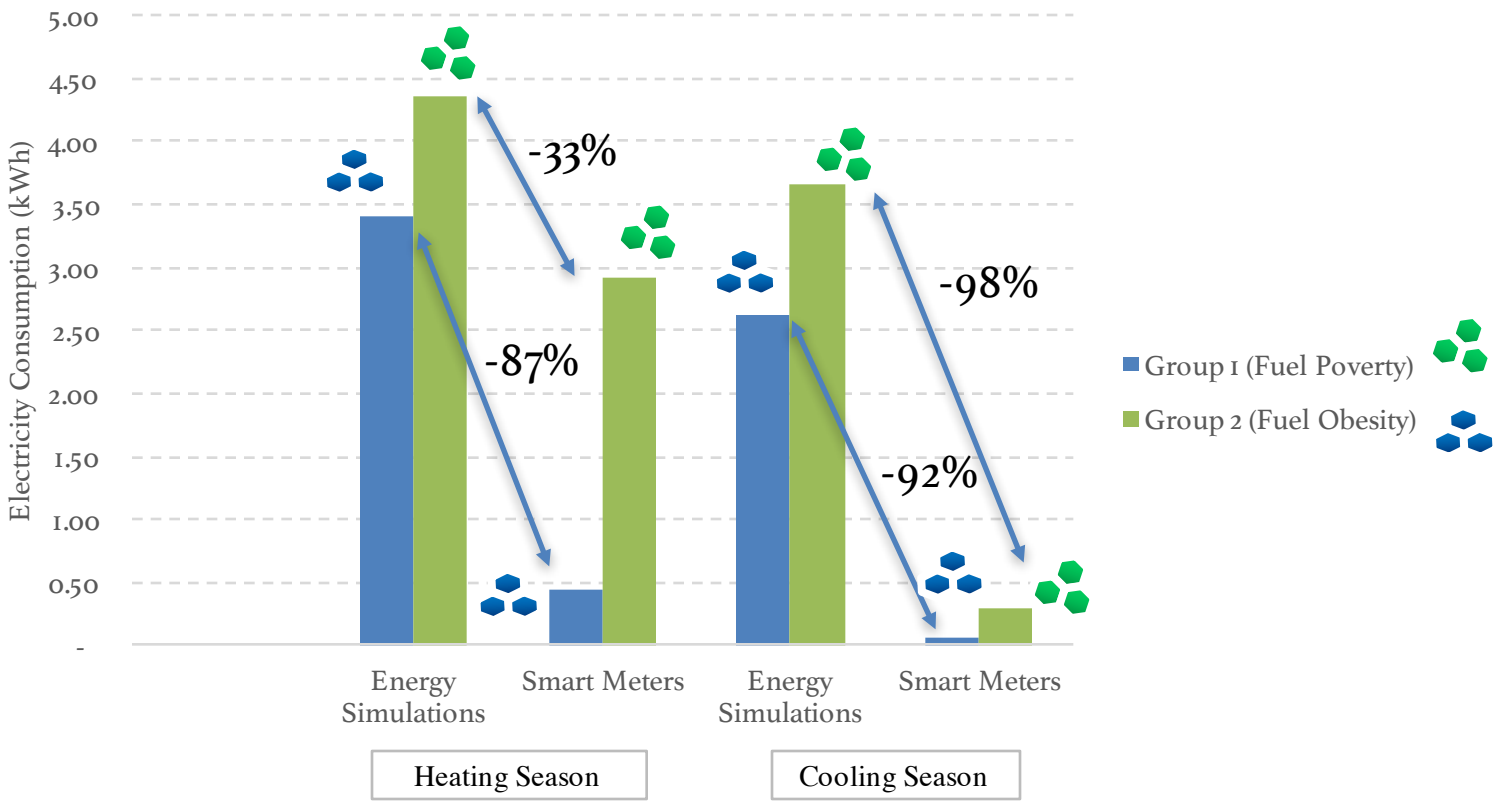
High levels of daily electricity consumption (23 kWh).

- **Age of buildings** - 75% with a period of construction after 1946
- **House size** - average of 168m².
- **Occupants' characteristics** - 70% of the households with just 1 or 2 residents; 73% of the occupants aged above 50 years old, no small children. 62% graduated, 50% working full time., 33% with monthly incomes above 2500€.

- **Windows framing and type of glazing**, 75% of the households having single glazing and the majority (71%) of aluminum framing in windows.
- **Type of heating, cooling and domestic hot water appliances**. 88% have electric heaters or A/C for space heating.
- 75% of the households with cooling equipment.
- **High penetration** of almost all white appliances.

- 94% of the houses **have installed power higher** than 6.9kVA.
- 50% of the houses with dual tariff.

Comparison of Consumers



- Lack of thermal comfort levels inside households (less consumption then what is needed)
- Mainly in the cooling season for both group of consumers
- Worse in fuel poverty group stressing the importance of the problem.
- Having the equipment does not mean is used.

Consumers under Fuel Poverty

- Lowest electricity consumption levels and annual consumption profile portraying the lack of fulfillment of thermal comfort levels inside households both in summer and winter, suggesting a case of fuel poverty.

- Socio economic details, building characteristics and equipment ownership and use behind the households in this group are consistent with the literature review characterizing enablers of fuel poverty.

- Fuel poverty issues related to cooling demand are also of paramount importance that should be further investigated, mainly on countries expected to suffer from average temperature increase due to climate change, as southwestern European countries.

Consumers under Fuel Obesity

- **Fuel Obesity - Is there such a thing?**

- Despite very high daily electricity consumption, annual consumption profile portray the lack of fulfillment of thermal comfort levels inside households mainly in summer

- Real consumption is still far from fully satisfaction of theoretical thermal comfort levels in cooling season – only electricity equipment.

- Different energy reduction measures should be applied for different consumer groups

Tackling Fuel Poverty and Fuel Obesity

- Fuel poverty can be tackled by income increase, fuel prices regulation and energy efficiency improvements in buildings.

- In Portugal, energy subsidies (named as social tariff) have been provided for the poorest households.

- These subsidies do not provide a sustainable long-term solution to the fuel poverty problem. On the opposite, energy renovation measures of households in fuel poverty risk can give a long-term sustainable answer.

- Fuel obesity should be dealt with increase of energy efficiency of equipment, information campaigns, PV production.

Conclusions

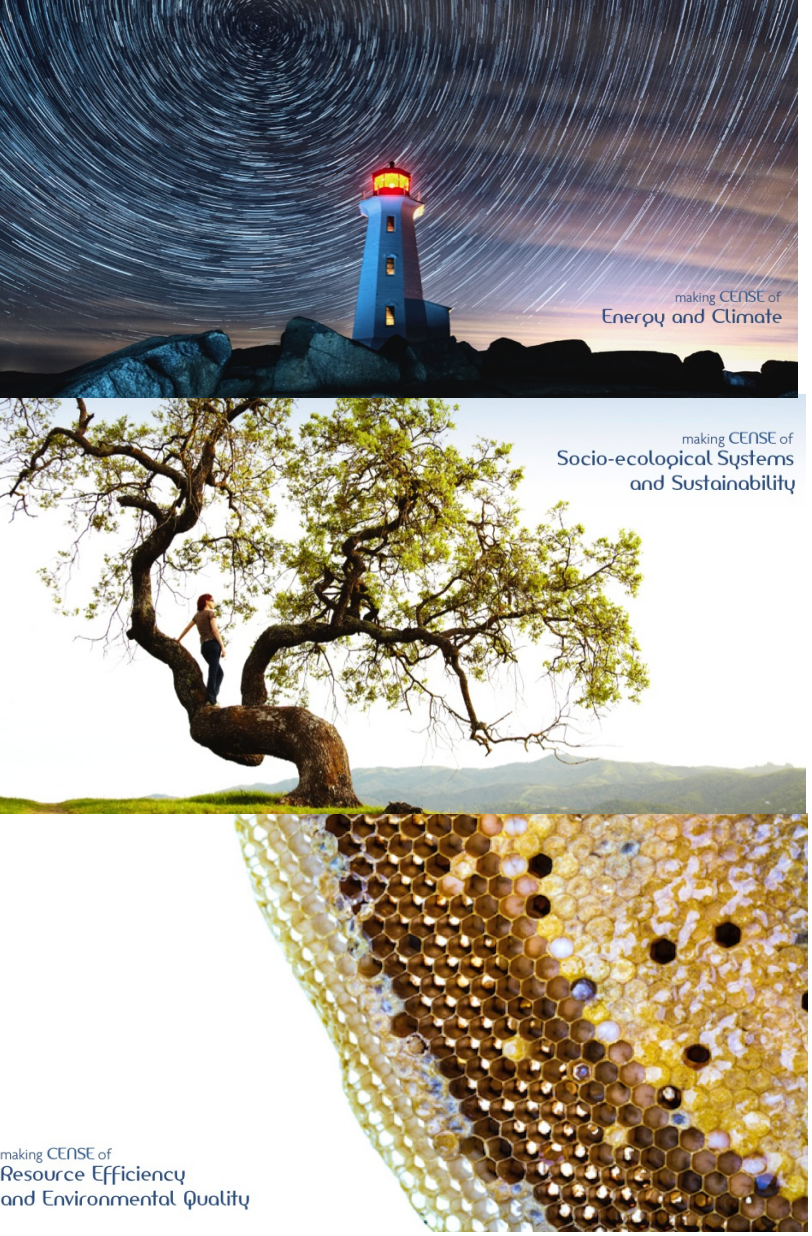
Combining detailed smart meters data with an extensive survey on household data provides a **coherent dataset for household electricity consumption analysis.**

Relevance of **consumer segmentation** to derive **important or fragile consumer groups** for policies and measures design and implementation.

If the gap between theoretical needs and real consumption for thermal comfort level inside households is bridged **strong increase in energy consumption is to be expected.**

Results provides policy makers and relevant stakeholders such as ESCOS, energy utilities and the general population to:

- recognize the problem,
- include it in current policies whilst also providing a comprehensive picture of its evolution over time.



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center for environmental
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Integrative Smart City Planning

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