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FORECASTING OF RESIDENTIAL ENERGY SERVICES DEMAND: THE PORTUGUESE CASE FOR 2030

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OVERVIEW

The need of medium and long term energy services projections has been an issue of research and practice in order to fulfill a secure supply of energy, at affordable prices, and accomplishing environmental targets. Projections of energy consumption usually rely on quantitative methods, such as econometric or technological models [1]. In the case of technological bottom-up models (*e.g.* TIMES, MARKAL), energy services demand are exogenous and should be provided as a model input. Forecasting energy services demand is a very challenging topic, either as a long-term or a short-term exercise, since it depends on several (in)dependent factors from economic to climate drivers.

In Portugal, since 1990 the final energy consumption has been steadily growing (about 3.7%/year) explained by changes in mobility demand and comfort levels. In the residential sector, the energy consumption has grown 29% since 1990. This can be explained by demand factors variations *i.e.* entrance of new technologies in the market, low efficiency standards, more single person houses, houses with higher area and increase of comfort levels. These trends have been challenging especially in what concern to the task of energy services demand forecasting, which motivated the research presented here. This work proposes a bottom-up approach to develop energy services demand scenarios of the residential sector up to 2030 for Portugal. The results have been used as inputs of the technological economic model TIMES_PT [2], to obtain final energy consumption.

METHODS

The residential energy services demand forecast was driven by two socio-economic scenarios, base on different life styles and population growth assumptions: i) Trend Scenario (TS), characterized by the continuation of past recent trends, and ii) Change Scenario (CS), supported by a sharper economic growth with changes to a more efficient behavior.

The energy services demand was split into different end-uses namely, space heating and cooling; water heating, lightning, cooking, refrigeration and electric appliances, such as dishwashing and cloth washing. Moreover, due to climatic differences in the Portuguese territory, three household types were considered: single house North, multi-apartment North and single house/multi-apartment South. Although different methodologies were applied to forecast specific energy services demand, the main projection driver is the evolution of the number of households and their occupancy rate, which depends on population growth and the family size. Other drivers, such as comfort levels and electric appliances ownership, which influence the energy services demand, were also considered.

The analysis for each end use was carried out at various disaggregation levels to highlight the specifics of each end use and/or the available information. As an example, to estimate the energy service needs for heating and cooling of the Portuguese households, was used the information presented in the Portuguese Regulation of Building Thermal Behavior [3] assuming different archetypes of households, regarding their location, typology and year of

construction. The total annual energy service demand for residential space heating/cooling is described as a product between household areas (m^2), energy needs per household typology ($kWh/m^2 \cdot year$) and number of households.
The energy services demand forecasts were introduced as TIMES_PT inputs, which is used to map the Portuguese energy system from 2005 to 2030. The main goal of TIMES is the optimization of the energy system, satisfying energy services demand at the minimum global cost. The model is generally consistent with the Portuguese Government energy policies goals [4], namely, on renewable energy targets for 2020.

RESULTS

Through the analysis of the results of the energy services demand methodologies, it is expected that the need of energy in the residential increase (*e.g.* 60 and 79% in TS and CS respectively) (see Table 1). This can be explained by the introduction of new electric equipments, more hours of use of computers and televisions, and the increase of electric appliances ownership and comfort levels.

Table 1 – Energy Services Demand Growth Index (2005=100)

	2005	**2010**		**2020**		**2030**	
End Use /Scenario	TS/CS	TS	CS	TS	CS	TS	CS
Space Heating	100.0	121.9	123.1	164.7	172.8	208.6	217.1
Space Cooling	100.0	154.4	161.7	278.5	308.1	418.1	461.1
Water Heating	100.0	102.7	103.1	101.3	102.5	98.5	100.3
Cooking	100.0	104.7	109.4	111.9	124.0	118.8	134.5
Other Electric	100.0	112.5	118.8	138.2	156.2	168.7	199.6

Results also show that, in the long term, the increase of energy efficiency offsets the energy demand growth. The modeling exercise suggests changes in the energy consumption profile, switching from biomass, heat, and LPG to natural gas, electricity and solar thermal. In the residential sector it is projected a stagnation of final energy consumption in TS, with 1% growth from 2005 to 2030. In CS there is a 13% growth in energy consumption due to different installed equipments and fuel choices made by the model.

CONCLUSIONS

The proposed bottom-up methodology for each end use is focused on breaking down as possible the global energy demand. This forecasts and model results depend on a vast number of uncertain parameters. Some scenario parameters are uncertain since their future evolution is not known. Others are difficult to assess due to a lack of data available for Portugal. The results presented above show that final energy consumption in Residential sector will grow very modestly, especially in the TS. However, this masks significant growth in the demand for energy services, explained by more energy efficient equipments.

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The study was partly funded by REN - Portuguese Electricity Transmission Grid and Natural Gas Transportation Company, S.A. Lisbon, Portugal.