Towards an energy efficient European housing stock
Monitoring, mapping and modelling retrofitting processes

Visscher, Henk; Sartori, I.; Dascalaki, E.

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Editorial

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Content

The European Union has formulated ambitious CO_2 reductions and energy efficiency goals for the next decades. Residential buildings are at the center stage of these efforts. Energy consumption in buildings accounts for 38% of Europe's total final energy consumption in 2014, the share of households being 25% of the total. The residential sector has registered a decrease in the final energy consumption by almost 10% in the period from 2000 to 2014 [1]. The energy mix is mainly formed by natural gas (35%) and electricity (26%) consumption, followed by renewables (15%).

In 2050 the built environment should be nearly carbon neutral, with greenhouse gas emissions 88–91% lower than in 1990 [2]. Consequently, the housing stock by 2050 should almost halve its energy demand compared to current values [3]. About 70% of the building stock of 2050 already exists today. This means that most of the energy reductions will have to be achieved by deep retrofitting of existing buildings. But what are the characteristics of the European housing stock? What is the current energy performance? What are the common renovation actions that are currently undertaken? What is the current renovation rate? What kind of energy conservation measures are most effective to meet the national or regional targets? These are some of the questions addressed during the EPISCOPE project (April 2013–March 2016).

EPISCOPE (www.episcope.eu) was co-funded by the Intelligent Energy Europe Programme of the European Union with the objective to make energy saving processes in the European housing sector more transparent and effective. The aim was to ensure that climate protection targets could actually be attained and that corrective or enhancement actions can be taken in due time, if necessary. A predecessor project (TABULA) developed a harmonised approach to classify building stocks according to their energy related properties by a commonly used building typology scheme and were implemented in 13 European countries. EPISCOPE

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extended the outreach of the TABLE approach to include a total of 20 European counties.

In the framework of EPISCOPE, official statistical data were collected regarding the status and quality of the building envelope and systems for space and domestic hot water heating as well as refurbishment trends in the residential building stocks of 20 European countries (http://www.buildingsdata.eu/data-sources/episcope-data).

Case studies for residential building stocks on local, regional or national level have been conducted in 17 countries. Based on the national TABULA typologies, individual building stock models were elaborated and/or applied to map the current state and energy performance for each of the building stocks considered. Scenario analysis was performed to assess the effectiveness of different envelope and system modernization trends towards reaching the national/regional targets for the years 2020, 2030 and 2050.

This special issue presents a collection of papers based on representative work performed during EPISCOPE. Some papers report on national or regional studies while others are based on data from more EU Member States to highlight the trends and developments in energy upgrading of the European housing stock.

Loga et al. present the background information on the building typologies in 20 European countries developed in the TABULA and EPISCOPE projects and highlight their usability for cross country comparison. Each national typology consists of a set of types resulting from classification of the buildings according to their size, age and further parameters. Exemplary buildings are assigned to each one of these building types. U-values of different age bands and energy expenditure factors of heat generators of the buildings are compared. In the context of inhomogeneous building stocks in the various European countries, the results allow an understanding of the average and variation of parameters like U-values, supply system performances or final energy consumption. The concept of 'synthetical average' buildings is discussed and their applicability in setting up simplified housing stock models is also elaborated.

Sartori et al. developed a dynamic building stock model and worked this out in a paper with the general algorithm and an exemplification for Norway. The driving force in the model is a population's need for housing and the necessary input are retrievable from national statistics on population, often dating back to around 1800, and its prognoses up to 2050 or beyond. The model outputs include the construction, demolition and renovation rates; analysis of the renovation activity is given particular attention. The model shows how the renovation rates are a result of the need for maintenance of an ageing stock, and provides quantitative estimates of the present and future natural renovation rates, *i.e.* without specific incentives. The paper shows how to use the model's future projections on construction, demolition and renovation activities in scenario based analyses of dwelling stocks' energy demand and greenhouse gases emissions.

Sandberg et al. applied the same dynamic building stock model to 11 European countries. In this way the evolution of the building stock is simulated of over half of all European dwellings, between 1900 and 2050. The authors trace only minor future increases in the renovation rates across the 11 countries to be between 0.6–1.6%, falling short of the 2.5–3.0% renovation rates that are commonly assumed in many decarbonisation scenarios. They conclude that, as no more than one deep renovation cycle is likely to occur during this timeframe, it is crucial to implement the most energy efficient measures available at these opportunities.

Csoknyai et al. look at the building stock characteristics and energy performance of residential buildings in Bulgaria, Serbia, Hungary and the Czech Republic. The work makes analysis of heterogeneous data sources and how to collect and compare relevant information on the housing stock under a common comparison framework based on building typology data between countries. The contribution supports the harmonization of the building typology approach.

Diefenbach et al. explore how and how fast the climate protection targets – a reduction of CO_2 emissions by 80%–95% until 2050—for the heat supply of the German residential building stock can be reached. Various scenarios are investigated in order to assess the energy consumption for space heating and domestic hot water (DHW) in the German residential building stock, considering available technologies combined with renewable energy supply. Results show that within the next 10 years (until 2025) continuous progress should be made in order to double the annual rates of thermal building modernization and move to a completely different structure of newly installed heating systems (*i.e.* moving away from boilers to heat pumps, cogeneration and solar systems). In addition, a long-term change of the district heating and electric power generation (used for heat supply) towards a high share of renewable energy by 2050 will play an important role for meeting the national targets.

Dascalaki et al. investigate different energy refurbishment scenarios towards the 2020 and 2030 targets for the residential building stock of Greece. This work exploits census and statistical data for defining the Hellenic building stock and empirical adaptation factors to make more realistic estimates from normative calculations. The analysis of the housing stock is supported by a detailed data disaggregation in terms of the number of dwellings and floor areas, based on envelope thermal characteristics, heat production units, energy carriers, use of renewables etc. Numerous combined scenarios for different modernization rates are assessed for identifying the most promising refurbishment strategies in space heating and DHW for reaching the national CO_2 emission targets.

Corrado et al. analyze a regional pilot case in Italy and the refurbishment trend. Three realistic scenarios are investigated. The first one considers the annual current refurbishment trend and the most common energy efficiency measures. The second scenario considers the measures resulting from a cost-optimal analysis. The third scenario explores the mean annual refurbished floor area necessary to meet the climate protection targets. The scenario results emphasize the need of implementing major refurbishments, rather than setting stricter requirements.

Filippidou et al. explore the possibilities of the Dutch non-profit housing associations to reach the national energy efficiency goals of 2020. The non-profit housing sector in the Netherlands is relatively large since it represents 31% of the total housing stock. The analyses are based on a monitoring system that contains data about the physical state and the energy performance of more than 1.5 million dwellings. The research documents that most of the changes in the stock are in the space heating and DHW systems and the glazing. The rest of the building envelope elements are not improved at the same frequency. The results show that the goals for this sector will be hard to achieve if the same renovation strategies are followed in the future.

Serrano-Lanzarote et al. consider a strategy for the energy renovation of the housing stock in the Comunitat Valenciana, Spain. The work quantifies the energy savings potential and the related reduction in CO_2 emissions by improving the buildings' thermal envelope. Several scenarios are assessed with intervention periods of 10, 20 and 30 years. With the current rate of annual building renovations, it will be nearly impossible to reach the national goals. A deep refurbishment of the building fabric within this sector could help in achieving them.

Serghides et al. elaborate a case study of retrofitting existing buildings towards nearly zero energy buildings in Cyprus. With the current trends the national climate protection energy targets are unattainable. This is mainly due to the inadequate rate and depth of energy refurbishment of the existing housing stock and the ineptness of the Directives to effectively address the reduction of the cooling energy needs, in the new constructions.

Finally, Sandberg et al. explain the historical energy use in the Norwegian dwellings in the period 1960–2015 based on a dynamic model. They find that significant energy savings are due to a large-scale improvement of the thermal envelope of the Norwegian dwelling stock that has taken place through renovation and construction of new dwellings. Even larger energy savings in the system are due to a historical shift to more efficient energy carriers and heating systems (*i.e.* electricity and heat pumps). However, the total energy savings are nearly offset by changes in user heating habits. A significant decrease in average delivered energy intensity is only observed after the introduction of heat pumps.

In conclusion, all the case studies underline a clear message: the energy saving targets based on renovation of the housing stock cannot be reached with the current renovation practices. It is evident that there is a need to find ways to significantly increase the renovation rate and depths tremendously or we should reduce our expectations of what can realistically be reached by reducing the energy demand in the existing dwelling stock.

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Guest Editor
Henk Visscher *
Guest Editor
Igor Sartori
Guest Editor
Elena Dascalaki

* Corresponding author.
E-mail address: h.j.visscher@tudelft.nl (H. Visscher)

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