MODELLING HEATING ENERGY DEMAND AND RELATED EFFICIENCY POTENTIAL OF APARTMENT BUILDINGS IN THE CZECH REPUBLIC, ROMANIA AND BULGARIA

Agne TOLEIKYTE[12*], Lukas KRANZL[1], Andreas MÜLLER[1]

Motivation

At the European level, the building sector has a high potential to contribute to the 20/20/20 EU targets. According to World Energy Outlook (WEO) the European residential sector is responsible for more than 23% of the gross final energy consumption and for about 9.9% of CO2 Emissions in 2007 (IEA 2009). In central and eastern European countries (CEE) the share of building energy consumption on the total energy consumption is even higher. One reason is the high number of multi-family buildings built between 1950 and 1990. Lack of basic energy efficiency requirements at the time of construction, typical construction of cemented blocks and concrete panels are the main reasons that the buildings use twice as much energy per square meter per degree-day as Western European ones (Chandler 2000 cited in D. Ürge-Vorsatz 2006). Nowadays these apartment buildings make up a significant part of the current residential building stock in the CEE, e.g. in Czech Republic about 1.2 million flats are panel-buildings constructed after 1950. Almost 70% of them were built between 1960 and 1970 (ENTRANZE 2013).

These buildings provide a high technical potential for efficiency improvement by introducing energy efficiency measures such as building façade renovation or replacement of the windows. These activities, however, are related to relative high investments, which is a relevant barrier. Another barrier is the age of the buildings and the life time which for a large-panel dwelling house is theoretically calculated 125 year and practical investigated 10-30% lower (Ignatavicius et al 2008) as well as relatively low price of energy (traditionally district heating).

To promote refurbishment of existing buildings, there is a strong necessity for establishing financial support in the form of e.g. subsidies, tax credits and advantageous bank loans for investors. The EU member states are also obligated to put into place financial instruments to stimulate energy-efficiency related measures (EPBD recast, 2010/31/EU).

Research questions

The research questions of this paper are:

What level of energy savings can be achieved in Czech Republic, Bulgaria and Romania apartment building stock by 2030 if renovation activities were based on cost-effectiveness and without any financial support?

What level of financial support, in the form of investment subsidies for building refurbishment, is needed to achieve a higher number of renovated buildings and resulting energy reduction in the investigated countries apartment buildings by 2030?

Overall approach

To model energy demand in the three analyzed countries' apartment building stock, the dynamic bottom-up simulation tool Invert-EE/Lab is used. Invert-EE/Lab models energy demand for space heating based on highly-disaggregated data of the building stock (e.g. Müller 2012, Kranzl et al 2006). Thus, the following data on the apartment building stock were collected: geometry, envelope quality, heating systems and their characteristics and etc. Moreover, data on climate (monthly outdoor temperature, solar radiation), on occupation behavior and comfort requirements were gathered. To calculate the number of renovation and demolished buildings until 2030, a Weibull-Distribution is used.

[1]Vienna University of Technology, Institute of Energy Systems and Electrical Drives, Energy Economics Group, Gusshausstrasse 25/370-3, 1040 Vienna
[2] Phone:0043 1 58801 370337, fax: 0043 1 58801 370397, e-mail address: toleikyte@eeg.tuwien.ac.at

For this reason, we categorized buildings into building periods and defined life time of the buildings and building components. In order to decide whether a building is refurbished or not, the Net Present Value method is applied. Therefore, we define refurbishment investment costs, energy carrier costs, life-time and interest rates. Based on this data, the cost-effectiveness is analysed that compares investments of different refurbishment levels, transferred into yearly costs with yearly energy savings times energy prices. Data for building characteristics and for renovation measures are mostly based on the project ENTRANZE (www.entranze.eu).

Results

In the full paper, we will show two different types of results: The first part shows the economic viability of different renovation options in the apartment buildings in the three investigated countries and derives conclusions regarding the required amount of subsidies and economic incentives. The second part shows scenario results on number of renovated buildings and final energy demand for space heating of the model Invert/EE-Lab until 2030. As an exemplary result, the following figure shows a "no-policy" scenario (without any financial policy instruments) for the Romanian apartment building stock. The results show that the number of renovated apartment buildings is 15 tsd. in 2030. The non-renovated buildings make up 80% on the total building stock in 2030. The final energy demand for space heating in the apartment buildings in this scenario reduces from 16 TWh in 2008 to 14 TWh in 2030. However, with the implementation of investment subsidies in the range of 10%-40%, the uptake of renovation activities could increase and the energy consumption could reduce (it will be shown in the full paper).

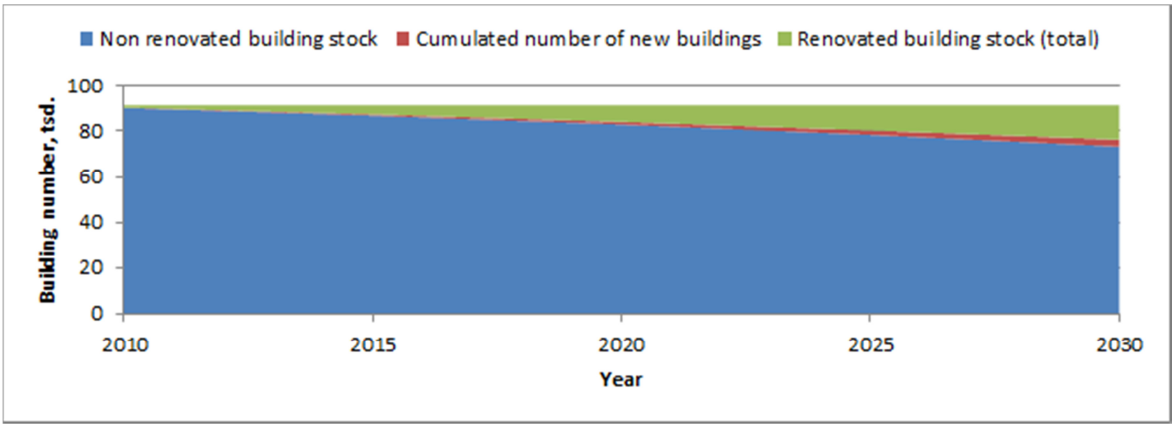

Figure 1 Number of new, renovated and not renovated Romanian apartment buildings until 2030 in a "no-policy" scenario without any financial support

The full paper will also provide estimation of total investments up to 2030. Moreover, the full paper will compare results from the three countries and derive conclusions regarding policy instruments.

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