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# Cost-effective investments in building renovation from Vilnius to Sofia: The impact of climate conditions and energy prices

## 5. Energieeffizienz in Gebäuden (Wirtschaftlichkeit von Energieeffizienzmaßnahmen) Agne TOLEIKYTE<sup>1(1)</sup> <sup>(1)</sup>Energy Economics Group, Technische Universität Wien

### Motivation und zentrale Fragestellung

The building sector has a high potential to contribute to the EU targets 20/20/20 by improving energy efficiency in the building sector. In order to promote energy efficiency, the EU building directive (EPBD, 2010/31/EU) was established. Following the directive, the member states have to define minimum requirements for the buildings which must not be less ambitious than cost-optimal levels. Moreover, EU member states have to set the nearly zero-energy building (nZEB) levels which also should be cost effective but should be more ambitious than cost-optimal levels of current building codes.

In this paper, the cost-effectiveness of different renovation measures among the renovation to nZEB is discussed. The following questions will be answered: (1) What is the cost-effective renovation level in three different cities under different climatic conditions? (2) Which parameters play an important role on the economic-effectiveness of the building renovation? To answer these questions, three European cities located in different climate zones are investigated and compared.

#### Methodische Vorgangsweise

In order to calculate cost-effectiveness of renovation measures and to find the most cost-effective level and target level (nZEB level) in the investigated countries, the cost-optimal methodology framework is used (in accordance with Article 5 and Annex III of Directive 2010/31/EU). The flowchart of the methodology is given in Figure 1. The core of the methodology is the techno-economic assessment of the renovation packages. First, energy demand for space heating is calculated by using a monthly energy balance approach according to the quasi-steady-methodology. Second, the net present value of investments and energy costs over the depreciation period is calculated. Finally, the most cost effective zone and target renovation zone (nZEB) are defined.



Figure 1 Flowchart of methodology to calculate cost-effectiveness of renovation packages and to evaluate and compare level of cost optimality and nZEB. Own illustration based on EPBD and BPIE 2010

Three typical apartment buildings from the 1960's in Vilnius, Prague and Sofia are investigated. This type of apartment buildings makes up a big share of the residential building stock in the considered

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cities. The investigated apartment buildings have the same technical and geometrical characteristics. However they are located in different climatic zones. The economic parameters such as energy price for space heating and the investment costs for refurbishment measures are as well country specific.

Sixteen retrofitting measures starting from window replacement to a deep building renovation are defined and applied for three investigated buildings<sup>2</sup>. The renovation levels differ in the U-values and investment costs.

#### Ergebnisse und Schlussfolgerungen

Final energy demand of the investigated apartment buildings is 148 kWh/m<sup>2</sup> in Sofia, 191 kWh/m<sup>2</sup> in Vilnius and 181 kWh/m<sup>2</sup> in Prague before renovation. Figure 2 shows the net present value (NPV) of the renovation measures in Sofia, Vilnius and Prague. The most cost-effective zone indicates the renovation measures with the highest NPV while the nZEB zone presents the renovation measures which achieve the lowest final energy demand. Despite the fact that the applied renovation packages have the same technical parameters; the NPV of packages varies strongly from one country to another. The cost optimal zone presenting roof replacement in all cities, provide energy savings of 60 kWh/m<sup>2</sup>, 81 kWh/m<sup>2</sup> and 75 kWh/m<sup>2</sup> in Sofia, Vilnius and Prague respectively. The highest energy saving which in my assessment is considered as renovation to nZEB can be achieved by using a deep renovation activity in Sofia is related to high investment costs and corresponding negative NPV. However in Vilnius and Prague, the deep renovation can be considered as cost-effective. This is due to the cold climate in Vilnius and high energy prices in Prague.





In the full paper, other parameters which can have an influence on the cost-effective renovation will be discussed. Moreover, policy instruments which can support cost-effectiveness of the renovation measures will be considered and suggested.

#### Literatur (selected)

**EPBD recast**, 2010/31/EU, Directive 2010/31/EU of 19 May 2010 of the European Parliament and Council on the energy performance of buildings.

**Entranze 2013**, The challenges, dynamics and activities in the building sector and its energy demand in the Czech Republic. D2 .1 of WP 2 from Entranze Project, 2013.

BPIE 2010, Cost optimality in building renovations (2010)

**TABULA 2012**, "Typology Approach for Building Stock Energy Assessment. CZ Czech Republic - Residential Building Typology", 2012

<sup>&</sup>lt;sup>2</sup> Investigated buildings are supplied by district heating systems. This is a reason that only building envelope renovation is taken into the consideration