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Cost optimum calculation of energy efficiency measures in the Czech Republic

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ABSTRACT

The EU Member States have adopted the Energy Performance of Buildings Directive (EPBD II) in their legislation. This directive introduces new procedures for evaluating the setting of energy performance requirements for buildings, including the so-called cost optimum requirements.

The cost optimum is calculated using a comparative methodology framework developed in accordance with the Directive and shall be submitted every four years (EPBD II, 2010). The paper introduces the national cost optimum calculation completed in June 2017 in the Czech Republic.

The main goal of this paper is to present selected results of the unique national cost optimum calculation model, including the methodology applied. The main method consists of primary data collection used to determine the cost for a full range of energy efficiency measures and the calculation of primary energy consumption in the selected types of buildings.

Due to decreasing energy prices in recent years and the lower price for EE measures and renewables, no significant movement of the cost-optimal measures was observed.

This article primarily creates the basis for calculating the cost optimum at the national level. The data can also be used to compare cost-related measures between particular EU Member States.

1. Introduction

It may seem that more substantial energy efficiency measures lead to more energy saved, but this viewpoint takes into account only final energy consumption (FEC). Therefore, it is far more important to choose measures that result in a building whose comfort has been improved and which is independent of fuel consumption, as well as to provide measures ensuring low primary energy consumption from non-renewable sources.

The price of such energy efficiency measures remains the key factor. Other important factors are fuel costs and non-energy benefits. A decision related to a single building is made based on tenders submitted. In the case of projects at the national or EU level, decisions are made based on insufficient and incomplete databases. In order to make the right decision, it is necessary to create a new tool to visualise data regarding the cost amount and payback period, adding data into statistical tools (Eurostat, 2017), or broadening the range of tools focusing on energy efficiency measures as well as on mapping of a building's data (ENTRANZE, 2012), (Tabula, 2016; Knápek et al., 2015).

The Member States have undertaken to meet the requirements for the calculation of the cost-optimal level of minimum energy performance requirements by using a comparative methodology framework elaborated in accordance with Article 1 of Directive 2010/31/EU of the European Parliament and of the Council on energy performance of buildings, including relevant parameters, such as climatic conditions and practical accessibility of energy infrastructure. The results of this calculation shall be compared to the minimum energy performance requirements in force (Directive, 2010/31/EU, 2010; BPIE, 2013).

The Member States have reported all input data and assumptions used for these calculations as well as all calculation results. The report may be included in the Energy Efficiency Action Plans referred to in Article 14 (2) of Directive 2006/32/EC. The Member States will submit the reports to the Commission at regular intervals, which shall not be longer than four years. Following the requirements, the first report was submitted on 30 June 2012 and the second one in 2016 (ECOFYS, 2015; European Commission Report, 2016).

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2. Goals

The main goal of this paper is to present selected results of the unique national cost optimum calculation model, including the methodology applied. The paper covers both the EU methodological level and specific implementation at the national level. To introduce the study results, family houses and apartment buildings were selected in order to cover the highest share of the national building stock.

The second goal of this work is to document the cost development of energy efficiency measures. Costs calculation of energy efficiency measures is based on the methodology for calculating energy performance referred to in Decree 78/2013 Coll., on energy performance of buildings. The Decree also sets the cost-optimal level of requirements for energy performance of buildings derived from the calculation of their technical and economic parameters.

In order to meet the requirements of the Decree, it is necessary to achieve lower values of energy performance indicators than presented by the values for so-called reference building. This can also be understood as the low level of the necessary investments and as determination of the minimum price of energy efficiency measures.

The prices of building materials used during a renovation as a measure for improving the energy performance of a building were obtained by means of demand and analysis of the market for each locality in the country.

The total costs of energy efficiency measures for individual buildings may differ, as costs calculation is determined by myriad factors which can substantially affect the result. The resulting costs depend on how the calculation is carried out and on the documents used. The calculation is thus affected by the building location, because the availability of building materials and the capacity of construction companies may vary.

Another factor which can influence the costs of energy efficiency measures is higher energy prices, which puts pressure on users. At the same time, the Czech Republic is trying to achieve predetermined energy savings. The market demand keeps on increasing, which creates pressure to increase the price of energy efficiency measures. For the sake of documentation, heating demands with reference buildings have been established and resulting costs for individual localities have been summarised.

3. Literature review

Buildings as results of construction projects are characterised by long lifespan and high costs. This is why all decisions connected with construction projects have long-term and significant impact (Ryghaug and Sørensen, 2009). Construction project investors often focused simply on the acquisition costs when deciding on the building design, equipment and energy systems, frequently neglecting future operation or maintenance costs (Jakob, 2006). Due to the lack of a holistic view of the true costs of a building, a cost-inefficient solution might be selected. Lifecycle costs (LCC) in general consist of an initial investment (usually construction costs) and the follow-on costs (ordinary payments, i.e. energy, utilities, cleaning and maintenance, irregular costs for renewal or replacement), while some lifecycle costing methods also include the costs of demolition (Kovacic and Veronika, 2015). Lifecycle costing is often recommended for determining cost-optimal solutions for product design and is becoming more frequently used in the design phase of buildings generally.

Lifecycle costing is a method that helps estimate the total cost of ownership. The technique can help make decisions within building investment projects (Flanagan, 1988). Lifecycle costing is particularly useful for estimating total costs in the early stage of a project (Bogenstätter, 2000). The lifecycle costing process usually includes the following steps:

- Planning of the lifecycle costing analysis (e.g. definition of objectives);
- Selection and development of the lifecycle costing model (e.g. cost breakdown structure, identifying data sources and contingencies);
- Application of the lifecycle costing model;
- Documentation and review of lifecycle costing results.

Extensive research has been performed and a report has been published focusing on lifecycle costing (Davis Langdon, 2007). One well-described LCC method is so-called cost-optimal calculations.

3.1. Approaches to cost-optimal calculations

New methods are being developed to help decision-makers in the planning process. A supporting method for selecting cost-optimal energy retrofit policies for residential buildings at the urban scale created by Chiara Delmastro et al. allows the development of building stock to be simulated and analysed from the perspectives of energy, economy and society over the long term. One of the goals of the paper is to identify a cost-optimal combination of successful renovation packages. The method is verified by urban calibration coefficients depending on the urban energy balance (Delmastro et al., 2016).

The emphasis on the correctness of the input data in creating cost-optimal construction design and its impact on the results is also shown in the text of cost-optimal nZEBs in future climate scenarios. Due to ongoing global changes, it is necessary to study and guarantee the resilience of the design of the nZEB to changes in the boundary conditions in which the cost-optimal calculation is carried out (Ferrara and Fabrizio, 2017). A similar effect of weather and climate change on the economic viability of energy-saving measures also has an influence on the costs.

Several studies on cost-optimum calculation have been introduced. The cost-optimal urban energy systems planning in the context of national energy policies: A case study for the city of Basel (Yazdanie et al., 2017), Energy retrofit alternatives and cost-optimal analysis for large public housing stocks (Guardigli et al., 2018). Another study to which it refers is a study that focuses on research into cost-optimal options and efficiency measures in new buildings depending on the climate. The data presented in this article relates to the modelling of building energy consumption, renewable energy, potential energy savings, and costs (D'Agostino et al., 2018).

Most studies focus on the cost optimum in terms of energy savings, but do not emphasise cost input data and their impact on the return on investment. Although the various costs of purchasing energy-saving measures do not have a direct impact on the amount of energy savings achieved, they are crucial when determining the project's feasibility. As national cost optimum calculations have not been introduced as a scientific paper yet, an EU comparison of the approaches applied is not possible.

EU Regulation No. 244/2012 issued in 2012 complements EU Directive 2010/31/EU of the European Parliament and of the Council on energy performance of buildings. The regulation establishes a comparative and methodology framework enabling the calculation of cost-optimal levels of minimum energy performance requirements for buildings and their elements. EU Regulation No. 244/2012 is accompanied by general guidelines which are not legally binding. However, the guidelines provide EU Member States with relevant additional information and reflect principles adopted for the calculation of costs arising from the Regulation. As such, these general guidelines should facilitate the application of the Regulation and it is the amended version of the Regulation which is legally binding and which is directly applicable in the Member States. It is important to select the right evaluation method.

The related legislation has not been changed since 2013, when the last national report on the calculation of cost-optimal levels was submitted (Trianni, 2014). The described changes refer to the year 2012.

Between 2013 and 2015, the European Commission tasked Ecofys