Energy Economics Group

IEWT 2017

10. Internationale Energiewirtschaftstagung "Klimaziele 2050: Chance für einen Paradigmenwechsel?"

Die Kurfassungen, Langfassungen, Präsentationen und Poster der IEWT 2017 sind unter dem Menüpunkt Programm herunterladbar.

Das weltweite Klimaschutzabkommen von Paris wurde von allen beteiligten Staaten einstimmig beschlossen und darf als Erfolg gewertet werden. Die zentralen Fragen sind jetzt: Was müssen einzelne Akteure zur Erreichung dieser Ziele beitragen? Und stellt dieses Klimaschutzabkommen eine Chance für einen Paradigmenwechsel dar, oder wird weiterhin versucht, „traditionelle“ Geschäftsmodelle und die Nutzung fossiler Energie aufrechtzuerhalten?

Cost curves of energy efficiency investments in buildings– methodologies and a case study

8 - Energiepolitik

Agne TOLEIKYTE[1(1)], Lukas KRANZL[(1)]
[(1)] Energy Economics Group, Technische Universität Wien

Motivation und research question

Energy Efficiency is one of the priorities in the European Union Energy Strategy [1]. Renovation of the European building sector is considered a priority sector to apply energy efficiency measures and to achieve a high potential of energy savings and to reduce the emissions of greenhouse gases in a cost-effective way. However, the building sector is very complex and cost effective investments and especially effective public investments require a detailed analysis of the building sector, looking at the building thermal characteristics, climate conditions and supplied energy fuel prices.

Cost curves are a well-established instrument to show the economic assessment of investments and energy-related benefits widely used in the academic journals and scientific reports [2], [3], [4]. There are different approaches on how to deliver a cost curve and apply for the building sector used in the abovementioned papers. Two different approaches might be distinguished:

- Cost curves showing the building investors‘ perspective
- Marginal cost approach showing a societal, overall economic perspective

Both approaches provide information on the energy saving potential in the total building stock. However the first approach selects the most cost-effective solutions from the investor point of view while the second one delivers information on the additional costs which would be required from a societal, overall economic perspective in order to achieve national energy saving goals or reduction of the emissions of greenhouse gases.
The main aim of this paper is to show the methodology and application of these two approaches. As a case study, the Lithuanian residential building stock is analysed. The paper shows the energy saving potential for space heating and hot water and related investment cost in the energy efficiency solutions in the Lithuanian building stock until 2030. Moreover, the paper shows a new concept on how to connect the private and societal perspective.

Method

To derive energy savings cost curves, the Lithuanian residential building stock was described on a bottom-up basis:

- The building stock was categorized into 30 building typologies taking into account building type, construction period and heating supply system. Additionally, data on the total building floor area were collected. The main data sources are project ENTRANZE, ZEBRA and national statistics.
- 15 following energy efficiency solutions were defined: energy efficiency improvements of the building envelope and heating system as well as domestic hot water supply system (energy efficiency improvements of the building envelope are related to 5 building class standards from D to A++); installation of decentralized heating system (heat pump, ground source) (in combination to these 5 building class standards); and finally installation of solar system (in combination to the 5 building class standards and heat pump system). Energy efficiency solutions and their techno-economic data come from the Lithuanian cost-optimality report.

For each building typology, the final energy demand for space heating and hot water was calculated before renovation and by applying all 15 energy efficiency solutions. The calculation was carried out using the monthly energy balance approach based on EN13790 methodology. The calculation of the useful energy demand was made with the building simulation tool Invert-EE/Lab. For each energy efficiency solution and building typology the levelized costs of heating energy service was calculated.
By having all these data, the cost curves were derived. The first cost curve showing the building investors ‘perspective is defined as additional cost and energy-related benefits compared to a reference case which is a maintenance renovation (meaning renovation without thermal energy reduction). For each building typology, additional specific costs are calculated and least cost option is chosen. The total energy savings for space heating and hot water is calculated for the total building stock by applying the least cost energy efficiency solution. The assessment of energy savings is

[1] Gusshausstrasse 25-29/370-3, 1040 Wien; Tel. +43-1-58801-370337; toleikyte@eeg.tuwien.ac.at

assessed until 2030 taking into account the cumulated renovation rate calculated using the Weibull-distribution. This cost curve shows the cost of the most cost-effective investment of each building class on the y-axis and corresponding total energy savings from 2012 to 2030 on the x-axis.
By using this type of the cost curve, information on the energy saving potential by using energy efficiency solutions with higher energy savings and costs is lost. That is why the marginal cost curve is derived which shows additional costs and benefits compared to the previously defined efficiency solution. This type of cost curve might deliver information on the additional costs which might be covered by the public economy in order to achieve national energy saving goals or reduction of the emissions of greenhouse gases. In particular, most cost-effective solutions in the whole building stock can be derived.

Results and Discussion

Figure 1 shows energy savings from 2012 to 2030 by applying energy efficiency solutions in the Lithuanian residential building sector. The energy efficiency solutions were selected for each building type by using the least cost approach from the investor's perspective point of view. Final energy demand for space heating and hot water in the residential building stock was 7.7 TWh in 2012. Final energy demand can be reduced by 56% until 2030 by selecting the energy efficiency solutions for each building type which are the most cost effective. The highest saving potential can be achieved by renovating apartment buildings built between 1961 and 1990 followed by the single family houses built in the same period. The least cost option for these buildings is selected as the improvement of the building envelope achieving C standard. When it comes to the cost effectiveness of the investments, two main parameters have an obvious influence, price of the energy supply and size of the building which correlates to the specific initial investment in an efficiency solution.
This cost curve approach neglects many energy efficiency solutions which would result in higher energy savings however are not cost effective for the investor without public support. In the full paper, the second approach will be shown, too. The marginal cost approach will show the marginal cost and energy savings compared to the previously defined efficiency solution. Moreover, the total public investments will be calculated which are needed to achieve national energy savings goals.

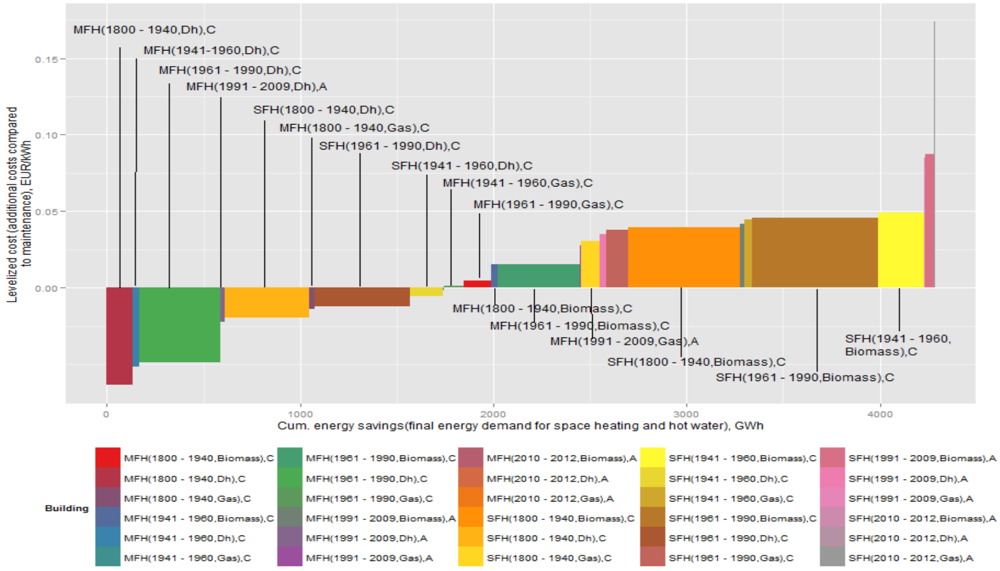

Figure 1 Cost curve of the energy savings by applying energy efficiency solutions in the Lithuanian residential building sector. X-axis shows cumulated energy savings from 2012 to 2030, y-axis - additional cost of the investments in the energy efficiency solution for each building type (least cost option).

Literature

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