ENERGY SAVING COST CURVES FOR THE CASE OF THE GERMAN BUILDING STOCK

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Motivation

Germany's buildings account for 40% of final energy use and are the source of 30% of the country's greenhouse gas (GHG) emissions. Improving their energy performance can substantially cut energy use, while delivering multiple benefits – cost savings, job creation, improved energy security, increased comfort, better productivity, as well as environmental benefits in the form of improved air quality and lower GHG emissions.

However, net costs of renovating buildings are not evenly distributed among the building stock. The question is which share of the building stock is economically attractive to renovate until 2030 and how policies could support further renovations.

Research questions

Thus, the key research questions of this paper are:

- What are the costs and energy saving potentials up to 2030 for renovating the building stock, for the case of Germany in various building categories from an investor's point of view?
- What is the impact of various framework conditions like energy prices, subsidies, technological learning, transaction costs and interest rate on the results?
- Which methodological aspects and presumptions drive the results and what has to be taken into account when deriving energy saving costs curves?

Method

The starting point for the analysis in this report is the categorisation of the German building stock according to a number of about 4450 representative building segments. The energetic refurbishment potential for each of these reference buildings is then assessed, for three renovation levels: *standard*, *moderate*, and *ambitious*. The methodology adopted in this study has been to focus on comprehensive renovation of the building envelope combined with the replacement of the heating system. Partial renovations or single measures are not considered. The associated costs and energy savings for each of the three renovation levels for each reference building is calculated compared to a reference case of renovation without any thermal improvement of the building envelope. Least cost renovation options for each reference building for a given set of economic conditions are identified for every building segment.

The results (costs and energy savings) for these building segments are summarized into building clusters in order to draw them in a transparent way in energy saving cost curves. It is important to note that the resulting energy saving cost curves represent the perspective of an investor, i.e. taking into account different economic side conditions, policies, energy taxes, expected payback periods, rate of return etc.

Results

The following figure shows the main results for a number of main scenarios and related sensitivity analyses within the limits of parameters shown in the table below the graph. Each band of the curves represents a building cluster, which will be described more detailed in the full paper. The coloured lines show the main scenarios which are discussed more intensively in the full paper.

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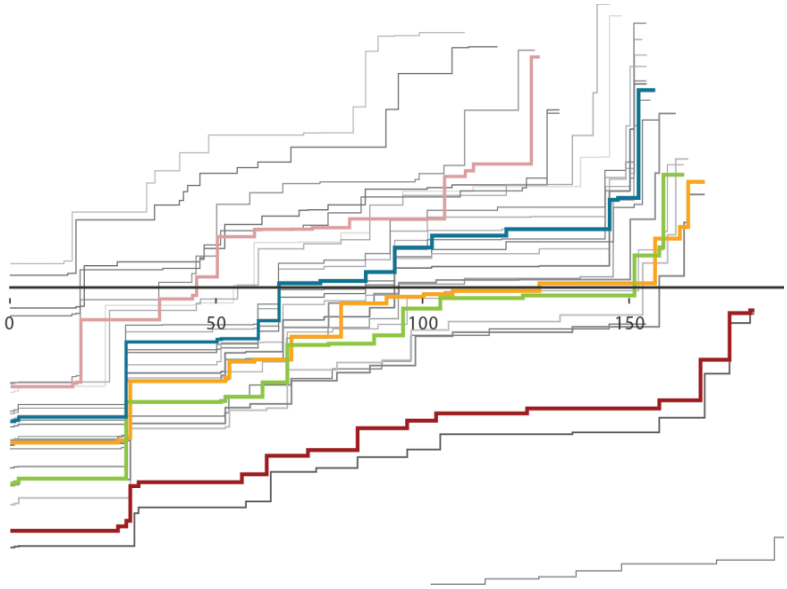
The blue line reflects the status quo conditions: current level of subsidies, medium transaction costs, medium discount rate, medium expected cost decrease of renovation activities, medium energy price increase. All these data are based on literature and previous studies.



Limits	Subsidies	Transaction costs	Discount rate	Learning effects (cost reduction 2015-2030)	Annual gas price increase (2015-2030)
Lower	0%	2.5%	2%	3-13%	0.27% per year
Upper	20% -40%	10%	10%	9-38%	2.28% per year

Figure 1: Energy Saving Cost Curves for the case of the German building stock. The table indicates the ranges of parameter variations.

Discussion

The results show that in the status-quo scenario (blue line) more than one third of the energy saving potential is economic from an investor's point of view. Another 20% of the potential is achievable at very low cost, which are nearly to zero. However, changing policies and economic conditions do not only lead to a shift of the costs (i.e. shift the curve up or down). They also have an impact on the achievable energy saving potentials, since more ambitious renovation packages become cost effective, which extends the curve to the right. The full paper includes a discussion on the impact of different policy packages and economic side conditions and assumptions (e.g. interest rate) on the results. Furthermore, the full paper includes a discussion of methodological aspects: several implicit assumptions are inevitable for deriving energy saving cost curves which have an impact on the results, e.g. how to aggregate building segments, how to take into account the impact of various renovation levels etc.

References

[1] Dengler, J., Kost, C., Henning, H.-M., Schnabel, L., Jochem, E., Torro, F., Reitze, F., Steinbach, J., 2011. Erarbeitung einer Integrierten Wärme- und Kältestrategie Arbeitspaket 1 - Bestandsaufnahme und Strukturierung des Wärme- und Kältebereichs. Fraunhofer ISE, Fraunhofer ISI, IREES, Öko-Insitut, Bremer-Energie-Institut, TU-Wien. Forschungsbericht im Auftrag des Bundesministeriums für Umwelt, Naturschutz und Reaktorsicherheit (BMU), Freiburg, Kalrsruhe.

[2] Diefenbach, N., Cischinsky, H., Rodenfels, M., Clausnitzer, K.-D., 2010. Datenbasis Gebäudebestand - Datenerhebung zur energetischen Qualität und zu den Modernisierungstrends im deutschen Wohngebäudebestand. Institut Wohnen und Umwelt (IWU), Darmstadt.

[3] Steinbach, J., 2015. Modellbasierte Untersuchung von Politikinstrumenten zur Förderung erneuerbarer Energien und Energieeffizienz im Gebäudebereich. PhD Thesis at the Department of Economics and Managment, Karlsruhe Institute of Technology (KIT).