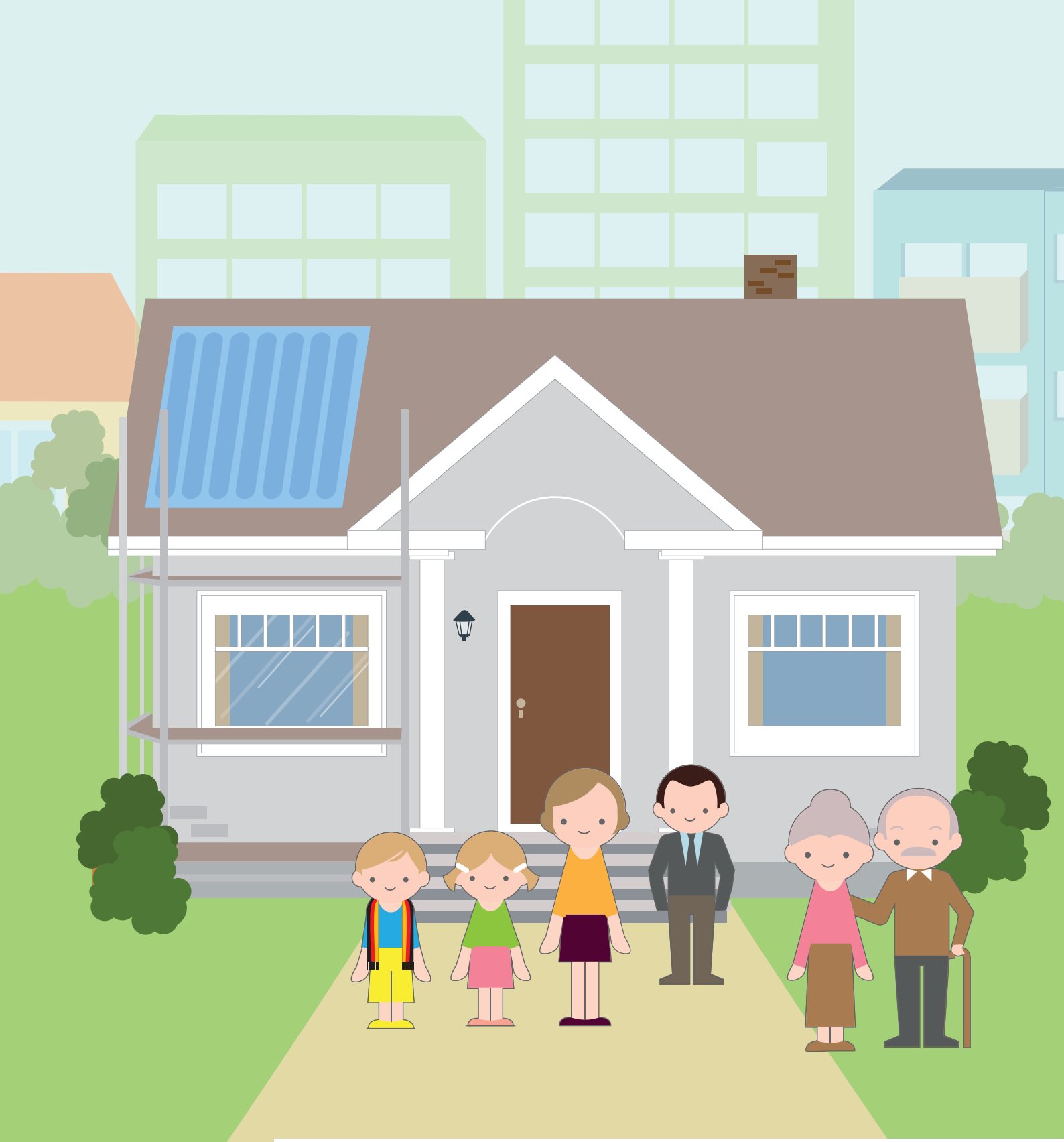

Results of the study “Energy-Focused Building Refurbishment in Germany”

Fraunhofer IBP

Forschungscenter Betriebliche Immobilienwirtschaft FBI

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Bases:

Study Part 1:
Hoier, A. und Erhorn, H.:
Energy-Focused Building Refurbishment in Germany
Development and energetic assessment of alternative refurbishment roadmaps.
Report WB 170/2013 of the Fraunhofer Institute for Building Physics, Stuttgart (2013)

Study Part 2:
Prof. Dr. Andreas Pfnür and
Dipl.-Ing. Architekt Nikolas Müller:
Energy-Focused Building Refurbishment in Germany
Forecast of costs of alternative refurbishment roadmaps and analysis of the financial burden on owners and tenants to 2050
Report of the Research Centre for Real Estate Business Administration (FBI), Darmstadt (2013)

Results of the study

Energy-Focused Building Refurbishment in Germany

1. Background and objectives of the study

The Federal government has set ambitious targets in its energy plan. By 2050, there is planned to be an 80 per cent drop in primary energy use in the housing sector, compared to 1990.

However, the proposed "refurbishment roadmap" announced in the 2010 plan has not yet seen the light of day.

As past years have shown, the main drawback for energy-focused building refurbishment is financial. On behalf of the Institut für Wärme und Oeltechnik e. V. (IWO), the Fraunhofer Institute for Building Physics (IBP) and the Research Centre for Real Estate Business Administration (FBI) of TU Darmstadt IWO investigated the best way to achieve the desired primary energy saving while at the same time keeping the financial burden on owners and tenants to a minimum.

Two different approaches to this research were used:

- A technology-independent approach, in which property owners are free to choose the energy-saving measures, as long as the targets are ultimately achieved, as was implemented in the Energy-Saving Ordinance.
- A technology-based approach, in which the legislator imposes the type of measures and the timeframe for their implementation on owners, as is pursued with the "Renewable Energy Laws".

The study consists of two parts: in the first, the Fraunhofer Institute for Building Physics (IBP) designed and investigated alternative refurbishment road maps. The second part was handled by the Research Centre for Real Estate Business Administration (FBI) of TU Darmstadt. In this part, the costs of implementation are forecast and the financial burden on owners and users are analysed.

The study is based on the Federal government's energy plan. An assessment of these requirements in not the subject of this investigation.

2. The main results at a glance

If we simply continue the current refurbishment trend in accordance with the guidelines of the Federal government we will miss the 2050 80 per cent saving target. The two roadmaps developed in the study (technology-independent and technology-based), on the other hand, are designed to achieve the specified target.

Technology-independent refurbishment clearly has the advantage: it produces a cost to society as a whole totalling at least 1.7 trillion euros. This is around 22 per cent less than in the technology-based refurbishment roadmap, which requires investments of around 2.1 trillion euros. Individual refurbishment investments could be up to 33 per cent more favourable with technology independence, depending on the type of building.

Overall, energy-focused building refurbishment pushes up the cost of housing significantly. Households with a below-average income are disproportionately affected and will not be able to afford the necessary funds for the refurbishment. However, technology-independent refurbishment again performs better than technology-based refurbishment. In addition, the scenarios show that independence of technology does not impede technological progress, and is likely to respond more flexibly to future developments and allows appropriate individual solutions.

3. Results of the study

3.1. Study Part 1:
Development and energetic assessment of alternative refurbishment roadmaps

In the first part of the study, three different scenarios were examined: the basic scenario describes the development that stands out based on previous trends and announced tightening of requirements. Technology-independent and technology-based refurbishment roadmaps also were developed and compared. By definition, these should achieve the target of the Federal government's energy plan of saving 80 per cent of primary energy for the supply of heat in the housing sector by 2050.

For the analysis and comparison, the housing stock was depicted in a simplified manner using two representative building types, taking into account current energy requirements of the housing concerned. Uniform refurbishment cycles are assumed and innovations that are likely to take place are taken into account for the refurbishment roadmaps. To achieve the desired 80 per cent saving target, significantly higher refurbishment efforts are required in both alternatives than in the basic scenario.

For the forecast of energy demand by 2050, rebuild and newbuild developments were estimated and taken into account by means of statistical data, as well as energy efficiency improvements in new builds. Further technical developments and increases in efficiency were also incorporated, together with the resultant changes in the market and the assumptions / framework conditions of the Federal government's energy plan. The various refurbishment roadmaps are also presented and evaluated by way of examples using representative buildings.

Results of the projections and the comparison of the refurbishment roadmaps:

- The basic scenario leads to a reduction in the primary energy demand in the housing stock from 2008 to 2050 by around 64 per cent. The desired 80 percent saving target would only be achieved around 2075. Significantly more effort is required within energy-focused refurbishment to reach the target by 2050.
- In the technology-independent and technology-based refurbishment roadmaps the 80 per cent saving target of the energy plan is achieved.This is conditional on all previously uninsulated components of the buildings' shells that are more than 50 years old being insulated to a high standard, high-quality energy-saving windows being installed, and increasing renewable technologies to generate heat being used.
- A clear difference emerges in the continuity of the refurbishment rate. The maximum rate, visible in all scenarios, is between 2020 and 2030. In the technology-based scenario, it remains very high there until 2040, but then rapidly declines to 2050. Against this background, we must consider practical building and economic constraints.
- The technology-based refurbishment roadmap can impede the progress of development, as it requires the sudden introduction of a high quality refurbishment level and specifies specific technologies and timings.
- Since the technology-independent roadmap only sets targets, it allows a flexible reaction to changes and developments.
- The technology-independent refurbishment roadmap allows individual solutions, which is beneficial since residential buildings vary in design, leading to specific framework conditions for refurbishment in each case.

3.2. Study Part 2:
Forecast of the cost of alternative refurbishment roadmaps and analysis of the financial burden for owners and tenants to 2050

In the second part of the study, the investment requirement of the two approaches is estimated as well as the financial burden for owners and tenants.
This is done on the basis of the quantity structure developed in the first part, in which the most efficient technical measures of energy-focused building refurbishment and their energy-saving potential were determined. The comparison examines which approach is more suitable in terms of the financial burden on the public and the economy.

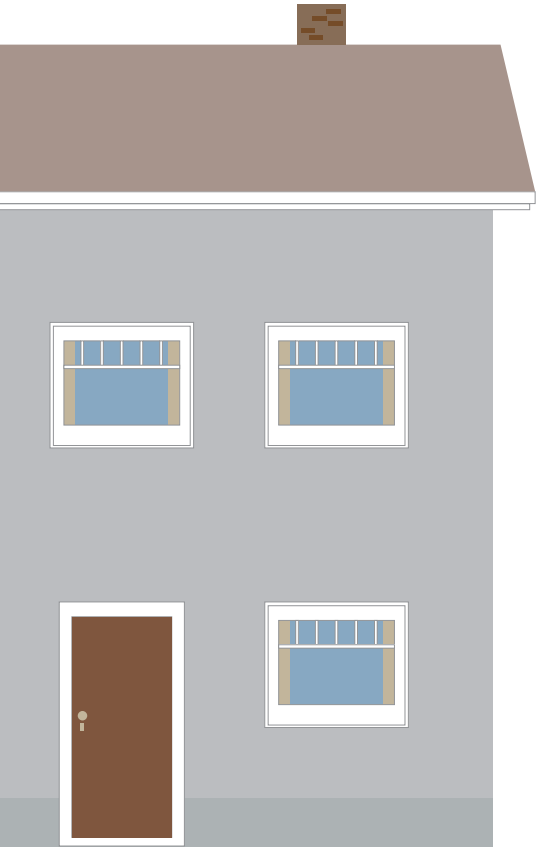
The key results for refurbishments that follow the 80 per cent saving target of the Federal government for 2050:

- Adjusted for inflation, the cost to society as a whole of energy-focused building refurbishment cost is at least 1.7 trillion euro, if a technology-independent refurbishment roadmap is implemented. With the technology-based plan, investments of around 2.1 trillion euro are needed. It is therefore on average 22 per cent more expensive.
- Technology-based refurbishment roadmaps make refurbishment much more costly. The technology-based refurbishment of an average single-family house costs 140,000 to 148,000 euros. For an average multi-family house, this cost is 303,000 euro. Conversely, depending on the building type, a technology-independent roadmap allows 16 to 33 per cent of cost reduction compared to the technology-based option.
- The cost of housing will rise considerably if a technology-based refurbishment roadmap is implemented. The cost of housing in a single-family house rises from the first refurbishment measure to 2050 on average by around 260 euros a month, and in a multi-family house by around 140 euros per housing unit.
  With technology independence, the increase is more moderate: in a single-family house, the extra cost from the first refurbishment measure to 2050 is around 140 euros a month, and in a multi-family house around 100 euros per housing unit.
- Energy-focused building refurbishment reinforces social inequalities. Households with a below-average income are disproportionately burdened.
- In the entire housing stock (single- and multi-family houses), the technology-based refurbishment roadmap means that the cost of housing for households in rented properties with a household income of less than 2,000 euros a month will on average rise by around 26.4 per cent. The technology-independent plan, on the other hand, leads to an increase of around 19.6 per cent for this group. For socio-political reasons, preference should therefore be given to a technology-independent refurbishment roadmap.
- The capital requirement of house owners is high: for the technology-based refurbishment roadmap. It amounts to a total expenditure of around 14.6 billion euros per annum. The technology independent variant requires less investment by the home-owner totaling some 12 billion euros per annum – although this still is a significant sum.

4. Recommendations of the study creators

As this study shows, it is possible to achieve the Federal government's demanding target of saving 80 per cent of primary energy by 2050 in the housing sector. However to do this much effort is needed during building refurbishment. The resulting high costs must be reviewed critically to give refurbishment roadmaps a chance of success. The following recommendations can be derived from the study:

- From a technical and economic perspective, a technology-independent refurbishment roadmap is the best option, with concrete targets but without specifying a particular method of implementation.
- To mitigate the significant social upheaval involved due to the increased cost of housing, a higher budget must be provided in social policy to cover these costs.
- Refurbishment measures should always take account of individual and situation-based factors and leave room for adaptation, to minimise costs.
- Refurbishment roadmaps must master the balancing act between on-site conditions and the mass appeal of the necessary technologies.
- Technology-independent refurbishment roadmaps create feasible target horizons and planning security. On a subsidiary level, an approach in stages with intermediate targets would also be useful.



	2050 Refurbishment roadmap	
	technology based	**technology independent**
Costs of refurbishment **House owner**	€ 2.1 trillion Investment costs	€ 1.7 trillion Investment costs
Rise in cost of housing **Multi-family house**	**+ € 140.00** per housing unit and month	**+ € 100.00** per housing unit and month
Single-family house	**+ € 260.00** per month	**+ € 140.00** per month

5. Background information on the study creators

Fraunhofer Institute for Building Physics (IBP)

The Fraunhofer Institute for Building Physics (IBP) is concerned with research, development, testing and consulting in the areas of building physics. These include protection against noise, measures to increase energy efficiency, issues of indoor climate, building material emissions and heat, humidity and weather protection, the preservation of buildings and monuments. Using the "Life-Cycle Assessment", the Fraunhofer IBP also analyses products, processes and services from ecological, economical, social and technical perspectives.

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Research Centre for Real Estate Business Administration (FBI), TU Darmstadt

The Research Centre for Real Estate Business Administration (FBI) at the Technical University of Darmstadt deals with the central commercial issues of the real estate business. These include, for example, the use of real estate as resources, the management of real estate investments as capital investments and the planning, construction and operation of real estate. Current working priorities of the Research Centre are real estate investment management, corporate real estate management, public-private partnerships and residential real estate management.

www.real-estate.bwl.tu-darmstadt.de/praxistransfer/konzeptdesforschungscenters/index.de.jsp

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Institut für Wärme und Oeltechnik e.V. (IWO)

The Institut für Wärme und Oeltechnik e. V. (IWO) is an institution of the German petroleum industry. Renowned heater and component manufacturers support IWO's activities as promoting members. IWO initiates research and development projects in the areas of oil firing technology and fuel oil as well as the integration of renewable energies. IWO advises and trains experts from the heating market and offers end-consumers independent information on all aspects of heating with oil. The Institut also makes its expertise available for shaping the political framework conditions of the heating market.

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