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Economic viability in thermal retrofit policies: Learning from ten years of experience in Germany

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HIGHLIGHTS

- ▸ The actual average German domestic space and water consumption is 150–180 kWh/m^{2}a (not 225 kWh/m^{2}a).
- ▸ This would have to be reduced to 30–35 kWh/m^{2}a to meet the 80% reduction target.
- ▸ Theoretical saving potential of retrofitting homes to EnEV standard is 33%.
- ▸ The economically viable potential of thermal retrofits in Germany is around 25% (instead of 80%).
- ▸ Policymakers should de-couple the criterion of economic viability from the 80% policy target.

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ABSTRACT

Germany aims to reduce CO_2 emissions by 80% by 2050 compared to 1990 levels and has merged this target with mandatory Energy Saving Regulations for thermal renovation of existing homes: the policy uses the criterion of 'economic viability', whereby renovations must pay back through the space and water heating fuel savings they produce. This paper explores the extent to which economically viable thermal renovations can contribute to the 80% goal, based on an analysis of Germany's experience. It finds that the theoretical savings being achieved, based on calculated pre- and post-renovation consumption, are around 33%, while actual savings, based on measured consumption, are likely to be around 25%. The difference appears to be due to the effects of household behaviour. Further, average measured consumption is estimated to be around 150–180 kWh/m^{2}a nationally, and this would have to be reduced to 30–35 kWh/m^{2}a to meet the 80% policy goal. This is beyond the limits of economically viable renovation technology, which currently achieves around 100 kWh/m^{2}a. The paper suggests that policymakers should de-couple the criterion of economic viability from the 80% goal, emphasise other reasons for renovating to economically viable levels, and consider a more systematic approach to facilitate household behaviour change.

1. Introduction

There is increasing interest in EU countries in thermally renovating housing stock so as to save heating energy and reduce greenhouse gas (GHG) emissions (Tuominen et al., 2012). Phrases such as 'easy gain', 'low-hanging fruits' and 'win-win situation' (Hoppe et al., 2011) are often used to portray thermal renovation as a cheap, economically efficient way to achieve climate and energy goals. In discussion of energy saving potential through thermal renovation it is common to refer to a graph published by McKinsey and Company (2009), which claims that 'insulation retrofit' of buildings, if 'pursued aggressively', will bring a positive gain of €60 for every tonne of CO_2 emissions saved.

Other studies, however, suggest there are severe limits to the level of energy savings that can be achieved, per euro invested, through thermal renovation measures. In a comprehensive study of thermal renovation in the Swiss residential sector, Jakob (2006) found marginal costs of such measures increasing steeply as thermal standards increased, and Galvin (2010) found a similar phenomenon in Germany. A study by the Institut Wohnen und Umwelt (IWU), which compared costs and energy savings of a range of thermal upgrade measures that had been carried out on 850 near-identical apartments in Ludwigshafen-am-Rhein, found the cost/benefit ratio much higher for more stringent thermal standards, than for lower standards (Enseling and Hinz, 2006).

The question arises, then, as to what level of thermal renovation is, in general, *economically viable*. What are the limits of

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thermal renovation that pays for itself? What is the maximum level of thermal performance that can be achieved where the monetary savings gained through the expected reduction in fuel consumption over the technical lifetime of the thermal renovation measures will be at least as great as the money spent on carrying out these measures?

Germany is an important test case for the economic viability issue, as the above definition of economic viability has been legally incorporated in its thermal renovation measures since these became compulsory in September 2002. How Germany has fared with this rule may have implications for other countries that wish to improve the energy efficiency of their housing stock. As the pressure towards more mandatory regulations for the existing building stock increases and the EU Energy Performance of Buildings Directive (EPBD) is recast in a more stringent form (Council Directive of 2002/91/EC and 2010/31/EU), it is important to evaluate the effectiveness and appropriateness of Germany's thermal retrofit regulations. In particular, the UK is currently planning its own version of the 'economic viability' criterion for its proposed 'Green Deal' (Smith, 2011). As one of the cornerstones of the UK Energy Bill 2010–2012, the Green Deal will provide rules and structure to facilitate mass thermal renovation through financing renovation projects in rental and owner-occupied homes. Unlike the German regulatory system, the Green Deal will be a voluntary financial incentive, supported by private sector annual investments of £7 billion. A property-attached loan will be offered for energy-efficiency measures that will be gradually paid back through savings in energy bills. In the form in which it is likely to be implemented in late 2012, a Green Deal customer will approach a certified Green Deal advisor, who will make an assessment and organise installations from certified suppliers, who will receive money upfront to make economically viable and certified energy efficiency improvements to their property. The customer will gradually pay the loan back through their energy bills. A key pillar of this policy is its so-called 'golden rule', in which the monthly savings in fuel consumption must be at least as high as the monthly repayments on the loan. This is precisely the 'economic viability' criterion stated above, as the monthly repayments will reflect the real costs of the thermal renovation measures, including the interest payable on the loan. The Green Deal is intended to further the UK's climate goal of reducing GHG emissions by 80% by 2050 (DECC (Department of Energy and Climate Change), 2012a). How effectively it will do this will depend crucially on what level of thermal renovation is economically viable. This also applies to other countries where policy favours instruments based on economic viability to move thermal renovation forward (for an overview see de T'Serclaes, 2007).

This paper offers an analysis of the effects of Germany's use of the criterion of economic viability as a policy initiative in promoting thermal renovation of existing homes, and comments on the policy implications for Germany, taking the Green Deal in the UK as an example. We note that in the German situation, where only 3% of domestic heating comes from electricity, each 1% reduction in heating energy consumption achieves very close to a 1% reduction in CO_2 emissions. Hence in this paper we will ask whether it is feasible to renovate existing buildings so as to achieve reductions in heating energy of 80%, asking three questions: is it technically possible; is it economically viable; and what is likely to be the *actual* energy consumption before and after the renovation?

German government ministries and agencies consistently claim the answer to the first question is yes (e.g., BMVBS (Bundesministerium für Verkehr, Bau und Stadtentwicklung), 2012b, DENA (Deutsche Eanergi-Agentur), 2012, KfW (Kreditanstalt für Wiederaufbau), 2012, and the German Energy Agency (DENA—*Deutsche Energie-Agentur)* keeps a database of exemplar renovation cases, some of which do show an 80% or better reduction based on theoretical, calculated energy ratings before and after renovation (see www.dena.de). While this blanket claim has been criticised on technical grounds (e.g., Galvin, 2010, 2012), the questions this paper seeks to address are the second and third. What does it cost to renovate to such high thermal standards? Is it economically viable, i.e., will it pay back, through fuel savings, over the technical lifetime of the renovation measures? Further, if the calculated energy ratings before and after renovation show a certain reduction, how is it reflected in the *actual* energy use?

Section 2 outlines the methodology and Germany's economic viability policy. Section 3 reviews officially commissioned studies of the 'theoretical' fuel savings that are being achieved through the economic viability policy and associated policies, and Section 4 critiques these in the light of independent and peer-reviewed studies that look at actual fuel savings. Section 5 offers an estimate of the actual level of heating energy consumption in German homes, so as to see to what potential there is in thermal renovation to contribute to the achievement of Germany's climate goals. Section 6 offers discussion and conclusions.

2. Methodology

Germany has a policy of reducing GHG emissions by 80% by 2050 compared with 1990 levels (BMU (Bundesministerium für Umwelt, Naturschutz und Reaktorsicherheit), 2007). In its Meseberg declaration of August 2007 the German government confirmed that this goal also applies to energy consumed by Germany's housing stock, including its heating consumption (BR, 2009). Since GHG emissions in this sector are nearly proportional to energy consumption, it is widely recognised that this requires an 80% reduction in domestic heating energy consumption compared to 1990 levels by 2050. The average heating energy consumption *per household* in Germany has in fact fallen by some 20% since 1990, partly due to replacement of old dwellings with new; partly due to thermal renovation of old stock (BMVBS (Bundesministerium für Verkehr, Bau und Stadtentwicklung), 2011) and most likely also due to household behaviour change (Destatis, 2010a). However, the *number of households* has increased during this period by 16%, so that the net reduction in heating energy consumption has amounted to 4% (BMVBS (Bundesministerium für Verkehr, Bau und Stadtentwicklung), 2011). Therefore, Germany still needs a 76% reduction in the heating consumption of its entire housing stock between 2012 and 2050 to meet the policy target.

12.5% of German homes standing today have been built since 1990 (Dol and Haffner, 2010) and a similar percentage substantially thermally renovated (Friedrich et al., 2007; Tschimpke, 2011). At least half these dwellings offer relatively little scope for further thermal improvement, since the legal thermal standards for new builds were substantially tightened in 1995 and again in 2002 and 2009, while thermal standards for renovations became compulsory in 2002 and were tightened in 2009 (Galvin, 2012). This suggests that all or most of the future reduction will have to come from replacement or renovation of the existing housing stock.

German thermal renovation standards are given in the *Energieinsparverordnung* (energy saving regulations—'EnEV'; see EnEV (Eniergieeinsparverordnung, 2009). A significant feature of 'EnEV 2002', as it came to be called, was that for the first time compulsory thermal standards for retrofits were introduced. Whenever 20% or more of any feature of a building (such as a wall or roof) was being repaired or renewed, that entire feature had to be thermally renovated to the same standard as a new