Why German homeowners are reluctant to retrofit

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Germany is frequently seen as a leader in thermal retrofit policy, with stringent mandatory standards for insulation, windows and boilers. However, the annual rate and average depth of thermal retrofits are considerably lower than expected. One of the main policy planks for promoting thermal upgrades is the claim that thermal retrofitting, to federal standards, is always ‘economically viable’, i.e. it always pays back, through fuel savings, over the technical lifetime of the upgrade measures. Policy discourse therefore tends to blame homeowners for complacency or ignorance in failing to see the financial opportunity offered by retrofitting. However, a five-year in-depth study of the policy, buildings and occupants finds this policy is out of step with both the buildings and the majority of their owners. The policy’s claimed ‘economic viability’ of retrofits fails to account for the real nature of the buildings and overstates the savings. The negative effect of misplaced claims of economic viability is considerable. Many thoughtful homeowners are deterred. It is argued that policy needs to change: more nuanced upgrade measures are needed that suit specific buildings and occupants; top-end retrofits can be promoted where appropriate and affordable, but for reasons other than economic gain.

Keywords: energy savings, homeowners, housing, low-carbon, pay back, public policy, refurbishment, residential buildings, retrofit, Germany

Introduction

This paper explores some of the key reasons why homeowners in Germany are thermally retrofitting their properties at a much slower rate, and by a shallower average depth of thermal improvement, than has been planned and expected in federal policy. It builds on peer-reviewed technical, social science and policy studies research results from a detailed and long-running investigation of German thermal retrofit policy and practice (Galvin, 2010, 2011, 2012, 2013a, 2013b; Galvin & Sunikka-Blank, 2012, 2013a, 2013b; Rosenow & Galvin, 2013; Sunikka-Blank & Galvin, 2012). This research has included technical analyses of thermal properties and performance of over 100 dwellings throughout Germany and targeted observations of many more; interviews with federal, state and municipal policy-makers and civil servants; interviews with expert federal policy advisors, key players in the building retrofit industry and private and corporate homeowners; extensive document research; and a long-term ethnographic study of how German people talk about and practise domestic heating consumption and thermal upgrades of their homes.

The hypothesis explored in this paper is that much (though not all) of Germany’s failure to deliver its retrofit goals can be explained in terms of the peculiarities of federal policy rather than shortcomings on the part of homeowners. In particular, it identifies crucial points where regulations do not fit well with the physical characteristics of the majority of German residential buildings, and where the arithmetic used to work out the costs of retrofits fails to take account of the financial realities of homeowner investment. The paper also steps back from the details and offers an overview of some of the wider issues that seem to be driving the policy approach that has led to the less-than-expected results for thermal retrofits in Germany.

The second section outlines the technical background to thermal retrofit policy and practice in Germany. The third section explores how the economic assumptions in the retrofit regulations tend to deter rational
investors. The fourth section suggests how these factors act to inhibit the rate and depth of thermal retrofits. The fifth section reflects on wider issues lying behind the current policy impasse. The sixth section makes recommendations for policy. The seventh section provides conclusions.

**Brief technical background**

Germany is often seen as a leader in improving the thermal efficiency of its housing stock (de t’Serclaes, 2007). Mandatory thermal standards were first introduced in the Thermal Retention Regulations (Wärmeschutzverordnung – WSVO) for new builds in 1977 (WSVO, 1977). Standards were tightened in 1984, 1995, 2002 and 2009 (EnEV, 2002, 2009; WSVO 1982, 1995). The methods and criteria for calculating thermal standards varied among these sets of regulations, but the maximum permissible heating energy consumption was reduced over this period from an average of 270 kilowatt-hours per square metre of useable floor area per year (kWh/m²a) in 1977 to 70 kWh/m²a in 2009.

In 2002 the WSVO was replaced by the Energy Saving Regulations (Energieeinsparverordnung – EnEV). For the first time this set mandatory thermal standards for renovation of existing homes. Whenever 20% or more of any feature of a residential building – such as a wall or roof – was being repaired, then the entire feature had to be retrofitted to meet the new build thermal standard. This was tightened to 10% in 2009. An exception was permitted for comprehensive retrofits: when an entire building is being retrofitted, the comprehensive retrofit standard is laxer than the new build standard. In this case, the retrofit standard allows 40% more energy to be consumed when compared with the new build standard.

These standards provided a regulatory background to underpin a major policy drive to reduce energy consumption in home heating, which comprises approximately 17% of Germany’s CO₂ emissions (Statistisches Bundesamt Deutschland, 2010; European Commission, 2010). In concert with European Union goals, Germany aims to reduce the heating energy demand from buildings by 80% by 2050, from a base level of 2008 (Tiefensee, 2006). Calculations by Galvin and Sunikka-Blank (2013b) indicate that current rates of reduction are unlikely to enable Germany to come close to this goal. This is partly because the number of new builds has outstripped the number of demolished or abandoned dwellings by approximately two to one in the last 10 years, partly due to a relatively low uptake and shallow depth of thermal retrofitting, and partly because of peculiarities in the way federal regulations estimate potential reductions per dwelling – what Sunikka-Blank & Galvin (2012) call the ‘prebound effect’.

Policy-makers speak of four main instruments they employ to persuade homeowners to undertake thermal retrofitting: regulation, incentivizing, informing and demonstrating (Galvin 2011, 2012). ‘Regulation’ covers the mandatory thermal standards in the EnEV, plus rules on boiler replacement and the use of renewable energy sources such as solar collectors. ‘Incentivizing’ mostly concerns a subsidized loan and grant scheme run by the Housing Ministry (Bundesministerium für Verkehr, Bau und Stadtentwicklung – BMVBS) via the German Development Bank (Kreditanstalt für Wiederaufbau – KfW), discussed in Rosenow & Galvin (2013). ‘Demonstrating’ concerns an increasing number of exemplary thermal retrofit cases in which performance is measured and widely publicized in a promotional way by the German Energy Agency (Deutsche Energie-Agentur – DENA). ‘Informing’ is more complex, but the government’s core message over the last decade has been that thermal retrofitting to EnEV standards or better brings financial advantages to homeowners because it is ‘economically viable’ (wirtschaftlich) – i.e. it is claimed that the cost of the energy-efficiency measures always pays back, through fuel savings, within the technical lifetime of those measures.

Actual progress in reducing energy consumption and CO₂ emissions through thermal retrofitting, boiler replacement and replacement of old with new dwellings is far slower than planned for in government policy. The equivalent of about 0.8–1.0% of dwellings are thermally retrofitted each year (Diefenbach, Cischinsky, Rodenfels, & Clausnitzer, 2010; Friedrich et al., 2007; Weiss, Dunkelberg, & Vogelpohl, 2012) and heating fuel consumption is reduced in these, on average, by about 25% (DENA, 2012a). Windows are replaced in a further 0.6% of homes, bringing savings in these homes of about 5–6%, while approximately 3.2% of the residential stock has boilers replaced each year, bringing savings of about 18% per replacement (cf. CO2online, 2013; Diefenbach et al., 2010). This adds up to reductions in final energy consumption of around 0.83% per year (as a back-of-the-envelope calculation: (0.9% × 25%) + (5.5% × 0.6%) + (3.2% × 18%) = 0.83% reductions per year). While theoretically this would be enough to bring a saving of some 31% by 2050 (0.83%/year × 37 years = 31.4%) in fact it cannot because most boilers have already been replaced (Simons, 2012). Without these the rate of reductions in consumption through thermal efficiency improvements slumps to about 0.23% per year. New builds contribute almost zero to fuel reductions (see above) so unless something radically changes Germany could be heading for savings of less than 25% by 2050.
Economic peculiarities in the thermal retrofit regulations

A key plank of the EnEV is its claim that the thermal measures it demands are ‘economically viable’, both for new builds and retrofits. It can only demand measures that fit this criteria, as the EnEV (a set of regulations) is subject to the Energy Saving Law (Energieeinsparungsgesetz – EnEG), which states that regulations may only demand thermal measures that are ‘economically realizable’ (wirtschaftlich vertretbar) and defines this as paying back, through fuel savings, within these measures’ technical lifetime (EnEG, 2009, para. 5). Although the intention of this law was to protect homeowners from financial loss, the federal government has used this clause primarily as a promotional tool: a rational homeowner will willingly retrofit because s/he will thereby either gain financially or at least break even. This theme is ubiquitous in government websites, pamphlets and advice bulletins. A typical example is a newspaper promotional pullout section, sponsored by the BMVBS, headlined by the word play: thermal retrofitting ‘lohnt sich’ (pays back/is worth doing) (Bundesregierung, 2012). Similarly DENA (2012c) declares that thermal retrofitting of detached houses ‘rechnet sich’ – it pays; it will not result in losses (DENA, 2012c). In a more polemical article aiming to refute critics, DENA (2012d) restates the case that thermal retrofitting in general is ‘wirtschaftlich’.

However, German homeowners frequently see the arithmetic of the EnEV’s claimed economic viability as a bookkeeping trick for six reasons which are described below.

‘Prebound effect’

Firstly, the EnEV’s calculation method compares the pre- and post-retrofit theoretical, calculated consumption levels (called the Bedarf in German), rather than actual, measured consumption levels (Verbrauch). Sunikka-Blank & Galvin (2012) showed that on average in Germany the (measured) Verbrauch is 30% lower than the (calculated) Bedarf, and this gap rises to over 50% for older, thermally leakier buildings – a phenomenon these authors dubbed the ‘prebound effect’. They defined this as the difference between the calculated and actual consumption, divided by the calculated consumption, normally expressed as a percentage. DENA also now recognizes this (DENA, 2012b), while studies by Simons (2012) find the gap to be even larger. It is now a common theme in German peer-reviewed studies (e.g. Schröder, Engler, Boegelein, & Ohlwärter, 2010, 2011) and research institute reports (Walberg, Holz, Gniechwitz, & Schulze, 2011).

There may be a number of different possible reasons for this gap: occupant reluctance to pay the huge fuel bills that would be incurred with heating large, thermally leaky homes to a level of full comfort; inaccuracies and faulty assumptions in the calculation methods; and the peculiarities of the ‘rebound effect’ as an energy-efficiency elasticity (Sorrell & Dimitropoulos, 2008). For the UK Green Deal various ‘in use’ factors are taken into account to mitigate the arithmetic effect of pre-retrofit energy performance gaps. The point here, however, is not why the gap occurs or how some countries are seeking to deal with it in calculations, but that it occurs in the German housing stock, in a regulatory context which does not take it into account. It serves to make the arithmetic of economic viability calculations wrong.

Since pre-retrofit consumption is much lower than the EnEV calculation method recognizes, the actual fuel and monetary savings will be considerably less than those in the EnEV bookkeeping. Savings are usually around 40–50% less than calculated, without even considering the further problems outlined below. This has nothing to do with the retrofit suffering technical failure; it is simply an arithmetic glitch.

Thermal improvement costs and ‘anyway’ costs

Secondly, EnEV bookkeeping takes into account only the ‘thermal improvement’ costs, not the full costs of a retrofit. This makes sense if a building has to be renovated anyway, for cyclical maintenance. If, for example, a wall needs to be repaired because it has become porous, and in doing so a thick layer of external wall insulation is added at the same time, then the cost of the scaffolding, render and paint would not be counted as part of the insulation costs.

Ethnographic research indicates that German homeowners do not generally regard their buildings as candidates for serious comprehensive maintenance (Galvin, 2011, 2012). Simons’ (2012) technical study finds little material evidence of the need for this kind of maintenance in German housing.

This constitutes a second blow to economic viability. While the ‘thermal improvement’ portion of the costs of a retrofit typically amount to around €200–€300/m² of useful living area, the full costs are typically in the range €500–€900/m². Depending on the state of a building before a retrofit, the costs accounted for in the EnEV reckoning may be as low as 40% of the actual costs incurred by the homeowner.

Assumptions about fuel price rises

Thirdly, the EnEV has its own way of accounting for future increases in the price of fuel. The higher the future fuel price, the greater the value of fuel savings through retrofitting, and therefore the greater the financial return. The EnEV’s economic viability
Calculations are based on the expected average price of heating fuel over the lifetime of the retrofit measures (usually taken to be 25 years). The fuel price rises assumed in the EnEV’s calculation methodologies (Feist, 1998; Hauser et al., 2012; Kah et al., 2008) are modest, but a problem arises due to the fact that they are oriented toward the long-term future. If heating fuel rises in price at, say, 4.8% per year (the average annual increase for 2000–10), then its average price over a 25-year lifetime of retrofit measures will be 1.7 times today's price. The economic viability calculations use this value rather than today’s value in order to take the annual increases into account. The problem, however, is that this average fuel price will not actually be reached until 14 years after the retrofit due to the nature of the mathematical function governing annual percentage increases. For the first 14 years the homeowner will be out of pocket. Returns in the first year will be only 60% of the average value, causing accumulated losses for 14 years, which will then be gradually won back until the breakeven point in the last month of the 25th year.

For an investor with a 25-year horizon this is not a problem. However, investment horizons for private homeowners are much shorter (Friedrich et al., 2007). Homeowners find they have to cope with a much lower than average payback than expected for the first 14 years immediately after retrofitting.

**Investor’s discount rate**

A fourth issue concerns what economists call the ‘discount rate’. Savings that are expected to be made in future years are worth fewer euros today than the book value they will have at that future time. This is partly due to inflation and cost of living increases, and partly due to risk factors and lost opportunity costs. Whenever money is invested in a project with a long time horizon there is a risk of losing it if something goes wrong in the intervening years. A relationship breakup, the loss of one’s job or an unexpectedly premature move into a retirement home can bring the forced sale of a recently retrofitted property. These and similar situations were found among homeowner interviewees by Galvin (2011). For a business a typical discount rate is 8–9%, but implicit discount rates for private homeowners can be considerably higher. A Canadian study found an average discount rate of 20.1% for homeowners (Sadler, 2003). A German study found a range of implicit discount rates among homeowners from 8% to over 20%, with the majority in the range 13–20% (Friedrich et al., 2007). But German policy documents regularly use discount rates of 5% or less when translating future fuel savings into today’s equivalent value for thermal retrofits, setting the framework by which the EnEV is interpreted. The mathematics of this gap show that from the homeowner’s perspective (using, for example, a discount rate of 12% rather than 5%), the expected savings in the 10th year after the retrofit are worth only 50% of what the EnEV bookkeeping calculates, and those made in the 25th year are worth only 18%. The average value of the savings over the 25 years is then 48% of the EnEV calculation.

Before noting the fifth and sixth problems, it is worth offering a back-of-the-envelope calculation of the combined effect of the above four problems. The first reduces the savings potential by around 35%, as evidenced in studies of prebound effects. The second reduces savings in relation to investment by around 60%, though only in cases where major, comprehensive maintenance of the building was not due to be undertaken anyway. The third makes no actual difference if the homeowner has a 25-year time horizon for the return on their investment, while the fourth reduces effective returns by about 48% over this time span. The result is that for a home that was due for major maintenance anyway, the total return through fuel saving is, on average, about 32% of what the EnEV bookkeeping calculates (48% of 65%). If major maintenance is not due, and a homeowner simply wants to undertake thermal retrofitting to make the home warmer or reduce CO₂ emissions, the return can be as low as 15% of the EnEV calculation (65% of 48% of 48%).

**Shape and structure of the building**

A fifth problem arises when buildings do not have the physical form that easily takes thick insulation. If, for example, the eaves are too narrow to provide cover for the 16 cm or more of external wall insulation required by the EnEV, the eaves will have to be widened, which can result in roof extension work or in some cases even a new roof having to be built. A similar problem arises with roof insulation if there is not enough space between the tiles and the ceiling lining to fit the required 22 cm or more of insulation (there is provision for less ambitious roof insulation in such cases, but this is not encouraged by the government – see below). Attaching 10 cm of insulation to basement ceilings can also be a problem if the basement is only just high enough to stand up in. External wall insulation can be further problematic if it intrudes into driveways, pathways or neighbours’ properties.

These problems are very common, since old houses were not designed to take a thick outer layer of insulation. They can add to the costs of a thermal retrofit in ways that are not accounted for in the EnEV bookkeeping. There is a proviso in the EnEV (Section 25) for applications to local councils where it is not possible to make a retrofit economically viable, but the onus is on the homeowner to prove this, and this increases the difficulty of getting a retrofit underway.
Further problems can arise due to a building’s structural peculiarities. For example, some houses have window frames of solid concrete that protrudes both outward and inward, forming a thermal bridge. This can cause the need for non-standard forms of insulation on the external wall. Some older buildings have relatively small windows, which tend to disappear down long thin tunnels when thick external wall insulation is added – what the Germans call the ‘arrow-slit effect’. Again, these problems can be expensive to overcome, so that the actual costs of thermal retrofitting exceed those assumed in the EnEV bookkeeping.

The energy performance gap
The sixth problem concerns an assumption in the EnEV about the level of heating energy consumption in a home after a retrofit. The EnEV methodology does not take account of the so-called post-retrofit ‘energy performance gap’ – the difference between post-retrofit actual and calculated consumption. It assumes these will be about equal. But in a large majority of cases actual consumption is significantly higher than calculated consumption – the reverse of the case in pre-retrofitted homes (see the third section on the prebound effect).

This issue compounds the problem of the prebound effect. Whereas prior to a retrofit the actual consumption is generally considerably lower than the calculated consumption, after a retrofit this often goes into reverse. In some ways the two phenomena are closely related. The high cost of heating a thermally leaky home constrains consumption, whereas the low cost of heating a thermally efficient home can lead to lax heating habits, or even a conscious decision to heat more liberally because it is cheaper. Most homeowners expect to be warmer after a retrofit than before, so they often increase their indoor temperature, ventilation rate, number of rooms heated, duration of heating, etc. (Maxwell & McAndrew, 2011). The term ‘comfort taking’ is often used to describe the combination of these factors. Seen positively, this can lead to the mitigation of fuel poverty (Milne & Boardman, 2000).

It should be noted here that the term ‘rebound effect’ (Berkhout, Musken, & Velthuijsen, 2000; Madlener & Hauertmann, 2011; Sorrell & Dimitropoulos, 2008) incorporates both of these phenomena into its mathematics. There is now concern in Germany that the rebound effect is not taken into account in calculating savings through retrofitting.

In other ways, however, the two phenomena of prebound effect and energy performance gap seem unrelated. There are concerns that retrofit technology does not always produce the high efficiency that has been designed and calculated. Heat pumps, for example, may often run at a much lower coefficient of performance than expected (EST, 2010), and optimization can be difficult where heat pumps are used in combination with under-floor heating (Verhelst, Logist, Van Impe, & Helsen, 2012). There can also be problems of user control of new heating technology – such as under-floor heating, which takes a long time to heat up or cool down; forced ventilation which can cause a continual breeze which leads some users to turn the heating up; or erratic heating behaviour when occupants do not feel they have control of their heating system (Karjalainen, 2013).

While the prebound effect seems to be around 30% on average (and closer to 40% on average for older, non-retrofitted dwellings), there do not appear to be systematic studies on the magnitude of the energy performance gap in Germany for energy-efficient or post-retrofit dwellings (though this study is more advanced in the UK). A brief review of relevant literature in Sunikka-Blank & Galvin (2012) indicates it could be around 25% on average for energy-efficient German dwellings, though possibly much less, or non-existent, in passive houses. When the two effects are combined, the actual energy savings after a retrofit seem to be reduced, typically, to around 50–60% of the theoretical savings as calculated using the EnEV methodology.

How this leads to fewer and shallower retrofits
Many retrofits turn out to save less energy than expected for purely arithmetic reasons arising from the prebound effect, discussed above. This is simply an arithmetic peculiarity in the way fuel savings are calculated in the EnEV regulations. It grossly overestimates pre-retrofit consumption and therefore the quantity saved through consumption. The post-retrofit energy performance gap, discussed in the third section, gives a further reason for lower energy savings than expected – either because occupants want to utilize some of their retrofit gain in the form of increased comfort, or because of shortcomings in the retrofit technology.

The other issues discussed above affect the rate or number of retrofits rather than their depth. The distinction between ‘anyway’ and ‘thermal improvement’ costs (see the third section) deters homeowners who do not consider that their properties are due for comprehensive maintenance. Despite the theoretical distinction between the two kinds of costs, in practice many homeowners face both kinds of costs together. Interestingly, one of the original architects of the EnEV costing system strongly agrees that this makes many thermal retrofits non-economically viable. The author of the expert report that set the levels of
economic viability for the first EnEV in 2002 (Feist, 1998) argues more recently that the EnEV was designed only for buildings that were due for major maintenance overhauls (Feist, 2009) and that in other cases thermal retrofitting is unlikely to be economically viable. Hence, ironically, German Federal policy created, in the EnEV, an energy saving ordinance that does not work well for homeowners who want to retrofit their homes simply to save energy. Instead it is a roundabout way to induce those who are planning comprehensive maintenance to include thermal upgrading in their renovation designs.

To some extent it has been very successful in this. Some large housing providers, such as Volkswohnung in Baden-Württemberg and Erbbauverein in North-Rhine Westphalia undertake comprehensive cyclical maintenance on their property portfolios and adhere strictly to EnEV thermal standards. The retrofit rate of around 0.8% of residential properties per year indicates steady progress, even if it is well below federal expectations.

Retrofits still have to cope with the peculiarities of the buildings’ shape and structure (see above). This has led to some housing providers finding it increasingly difficult to fulfil the EnEV standards economically viably. The maintenance manager of Erbbauverein noted:

We’ve reached a boundary. For me the new EnEV 2009 is absolutely fine for new builds. But with regard to existing buildings I have a big question mark. We’re coming up against boundaries. Partly technical: we have retrofit candidates where problems are arising to do the required insulation. Windows that can’t be opened; difficulties with balconies and window ledges. Overall critical […] We’re hitting the boundaries technically. And the other is the economics. We’re also coming up against economic boundaries.

(quoted in Galvin, 2011)

One of these economic boundaries is due to the required thickness of insulation. In the mid-1990s the average thickness of insulation demanded by the regulations was 8 cm. At the time this was regarded as being in the forefront of technology. The required average thickness was increased to 12 cm in 2002 and 16 cm in 2009. Each time the thickness is increased, the proportion of buildings with geometric difficulties, such as narrow eaves, increases.

Finally, the economic issues discussed above tend to deter homeowners whose understanding of microeconomics is above a rudimentary level, and also those who simply do not like investing a large sum of money in advance for a return that will come in the distant future.

Reflections on the context of thermal retrofits

Thermal retrofitting of existing homes in Germany takes place against a background that is dominated by concerns and discourse on the urgent need to reduce energy consumption and CO₂ emission levels. With respect to buildings, much of this discourse is in turn dominated by aspirations to make the built environment carbon neutral, exemplified by calls for ‘zero-energy homes’ or ‘nearly zero-energy homes’ (e.g. Flasbarth, 2009), and the European Union directive that all new buildings must be carbon neutral by 2020 (EC, 2003/2012).

This often goes hand in hand with the notion that reducing heating energy consumption in existing buildings is a ‘low-hanging fruit’ just waiting to be plucked. This view is promoted, for example, via the McKinsey Company’s popular graph of the (supposed) costs of CO₂ abatement (McKinsey & Company, 2007).

It is important to highlight the contrasts between this prevailing discourse and the actual nature of existing homes in Germany. Firstly, these buildings are already standing and are just the way they are: often not only thermally poor, but also very hard to make energy-efficient. They are also very varied in their shape, geometry, design, material composition and orientation to the sun. The thermal retrofitting of existing homes does not mean starting with a blank slate and planning thermally idealized dwellings. If a new building is designed and there is a wide choice of sites, then a thermally efficient home can be planned and built for a reasonable price. However, it is a mistake to impose this thinking into what can be done with the vast majority of already-existing homes. The nature of these existing buildings forces owners (and by extension, civil society) to be pragmatists rather than idealists, to be flexible rather than have fixed views on what can and must be achieved. Of course, some types of old buildings lend themselves to thermal retrofitting to EnEV standards, particularly multi-storied apartment blocks from the 1950s and 1960s that are clearly due for major comprehensive maintenance. But this is the exception rather than the rule.

Secondly, most people in Germany and other European countries have to live in such buildings, and usually in the specific one in which they find themselves: they have no choice. There are simply not enough zero-energy buildings to go round, and if there were, we would have emitted unacceptably high levels of CO₂ by building them and demolishing the old ones.
Therefore the policy framework for thermal retrofits of existing homes has deep implications for social justice, not merely for environmental concern. Whenever policy-makers set mandatory thermal standards for upgrades, this often entails people (i.e. homeowners and tenants) paying large sums of money, and often those who can least afford it. Policy-makers therefore need to be very sure they are doing these residents a good turn and not forcing them to pay for high-minded aims and goals these residents might not even share. There is also the additional concern that raising the costs for maintenance and refurbishment will result in some buildings falling into disrepair.

Thirdly, and closely related to this, is the unquestioned assumption that the CO\textsubscript{2} emissions from the existing building stock have to be reduced by the same percentage as the emissions from other sectors such as transport, industry and commerce – generally taken as 80% by 2050 compared with 1990 levels. The unspoken assumption is that the current proportional distribution of emissions in each of these sectors is about what it should be; while all are to be reduced by 80%, the distribution of emissions among them should remain as it is now.

This implies, for example, that the emissions from private motorized transport are proportionally as socially acceptable as those from buildings. It does not allow discussion as to whether the right to drive anywhere at any time is as much a social good as allowing people to keep themselves warm in homes that are thermally ‘leaky’ yet very hard economically to improve. Due to the \textit{de facto} legitimization of current distributions of CO\textsubscript{2} emissions across sectors, there is little, if any, discussion of alternative approaches in which reductions might be shared between sectors. Hence there is relentless pressure for existing homes to meet the reduction goals promulgated in the 80% reduction discourse. While not wanting to open up a very large area of possible debate and discussion in this paper, it is also noted that such discussion would be likely to include questions concerning which reductions in which sectors are more economically efficient than others. Further detailed thought and discussion are also needed on whether the 80% reduction target should apply to all buildings or represent an average across the building stock, a neighbourhood or a combined cohort of existing and new buildings.

Fourthly, the people who own the vast majority of these buildings are often treated by policy-makers and their expert advisors as non-experts in their own domains as homeowners. A homeowner would have to lack basic computational skills to miss all the points of economic mismatch outlined in the third section – and in this author’s experience of interviewing homeowners they usually see at least half these points without effort. Yet at the same time, the regulations treat homeowners as professional investors, who are willing to lay out large sums which will not pay back for 25 years. Further, the indoor lifestyle needs of homeowners are rarely taken into account: it is assumed they live according to the assumptions embedded in the calculation methodology of the EnEV – that they heat all the rooms in their homes continuously to at least a temperature of 19°C, and that they have not developed any tricks, skills or strategies to save energy while keeping warm in their pre-retrofit homes. Their financial situation is also irrelevant to the regulations: it is assumed that, if they need to do minor repairs on a wall or roof, they will be able to invest comfortably in the upgrade measures demanded in the EnEV regulations.

Further, their marginal heating needs are not taken into account. Many households would be happy to be a little warmer than at present, or to heat one more room than they do at present, or to have the heating come on an hour earlier in the morning. But the regulations do not generally allow for small, stepwise thermal upgrade measures: it is all or nothing. Even where such a measure is legally permitted, the prevailing policy discourse discourages it. The maxim is ‘Wenn schon, den schon’ – if a job is worth doing, do it properly (Galvin, 2011).

Policy-makers often argue (Galvin, 2011) that modest, stepwise thermal upgrades will prevent homeowners upgrading more fully in later years. An example is where a maximum of 6 cm of external wall insulation can be applied during routine wall maintenance without having to extend the roof overhang. It has been suggested if a homeowner undertakes such a modest retrofit, then it may prevent or de-motivate the homeowner from future retrofitting to a deeper level if fuel prices rise significantly before the lifetime of the retrofit measures has been reached. This assertion may be true in some cases, but its promulgation by the government is exactly what discourages many homeowners from doing any retrofitting at all (see, for example, Hanf, 2013).

It should also be noted that Germany does not have an active building inspection regime, so that it is easy for homeowners to retrofit below the EnEV standards without being officially detected. It could therefore be argued that the EnEV does not act as a brake on retrofitting, as no one really has to obey its rules. But this would be too simplistic. The EnEV is embedded in a culture made up of bureaucracy, building works, thermal upgrade products with properties attuned to the EnEV, services and popular discussion, including media reports and the government’s own promotional material. Many people do retrofit their homes below the EnEV standards, but the lack of enforcement of regulations does not imply that these regulations have no real bite or impact.
When the EnEV was updated in 2009 the federal government’s plan was to introduce a further update in 2012 which would tighten the thermal standards for both new builds and retrofits by a further 30%, with the long-term goal of a further tightening of 30% in 2016. However, by early 2012 plans for tightening the standards for retrofits had been dropped, as more and more reports from housing providers and the building industry were indicating that the current standards were already too difficult to meet economically. The final blow came when an expert report commissioned by the housing ministry argued that further tightening of thermal standards, for both new builds and retrofits, would not be economically viable in 2012, nor in 2014 (Hauser et al., 2012). In July 2012 Federal Minister Ramsauer announced that plans for tightening thermal standards for both retrofits and new builds had been abandoned (BMVBS, 2012). The political pressure of a backlash against the regulations, together with the more scientifically oriented calculations of Germany’s top experts in the field, led to the policy stalling.

Meanwhile the discourse on retrofitting and the EnEV among policy actors seems also to be changing. Although economic viability is still proclaimed, there appears to be a softening of some of the more insistent and overt claims of the centrality of economic viability.

**Recommendations for policy**

The issues outlined in this paper point to the need for certain modifications to German policy on thermal retrofitting, in order to increase the rate of thermal retrofits, draw nearer to the government’s energy and climate goals, and provide residents with warmer, healthier and more comfortable homes. One of the central claims of this paper is that the strictness of the policy as embodied in the EnEV is at least partly to blame for the reluctance of many homeowners to undertake energy retrofits. However, this is not to imply that most homeowners are closely familiar with the text and details of the EnEV. It affects them because the process of retrofitting involves dealing with a range of firms and service agencies, through whom the rules and regulations are mediated. Whether the EnEV itself has a high impact on retrofit rates, or this impact comes through the works, bureaucracy and culture attached to the EnEV is a moot point. The seat of the regulations is the EnEV, and this would have to change – along with a number of policies – for this particular brake on the retrofit rate to be slackened. Appropriate policy changes are suggested below.

**Modifying the CO₂ reduction target**

As noted above, the question as to whether the current proportional distribution of CO₂ emissions among the various sectors of the economy is just and fair has not been discussed in policy forums. It needs to be asked whether the goal of 80% reductions is appropriate for housing, or whether housing is a more fundamental human need than private motorized transport, air travel, export industries, etc.

**Stepwise reductions: a new ‘appropriate technology’**

There are many significant thermal upgrade measures that could be executed in existing homes, which would increase thermal comfort and reduce energy consumption *to a degree*, and which would clearly be affordable and economically viable. An example for Germany is modest roof insulation – which, ironically, is already legal, but discouraged by the government. Millions of German homes have no insulation in their roofs. In a four-floor apartment block in Aachen (Galvin & Sunikka-Blank, 2013b), a layer of 12 cm of glass wool insulation was applied between the rafters for the cost of €400 for materials plus two days’ labour. This reduced the heat loss through the roof by approximately 90%, as previously there were only tiles and a thin layer of building paper. This was calculated from the temperature in the rooms underneath the attic compared with previous winter days prior to insulation, and also modelled, based on the old and new U-values. The German government discourages such measures (and the Aachen city council engineers erroneously claimed they would be illegal⁴), as they do not meet the new build standard, which requires a thickness of around 22 cm. This would have reduced the heat loss by 95%, but would have required the roof to be rebuilt, for the cost of approximately €20 000.

This is a case where a simple, cheap solution does not meet the most advanced standards but can bring significant benefits. Other examples are thinner wall insulation than the legal minimum so as to avoid the problem of short roof overhangs; internal wall insulation where room space permits; draft stripping to seal air leaks around window frames as a stopgap measure; and basement ceiling insulation that is not so thick as to adversely reduce the floor to ceiling height (i.e. compromise the ‘standing room’) in the basement. Solutions such as these could mobilize actions in low to medium income households, or in buildings where the geometry, construction, materials or positioning make EnEV-standard retrofits ludicrously expensive.

**Top-end retrofits where appropriate and affordable – but not for economic gain**

Many homeowners in Germany could comfortably afford a comprehensive thermal retrofit of their home though their calculations might indicate it would never pay back through fuel savings – it would not be
‘economically viable’. But for many people, this need not be seen as a barrier to retrofitting. People who can afford it can be challenged to thermally retrofit their homes, just as they retrofit their bathrooms or kitchens – not because it pays back, but for other reasons: environmental concern; prestige; giving an old home a new lease of life; increased thermal comfort; and a degree of protection from swings in the price of heating fuel.

Interviews with homeowners throughout Germany reported in Galvin (2011) indicate that many who have retrofitted claim not to have expected to gain or break even on fuel savings, but say they were motivated by various combinations of the above advantages.

Since it is specious to claim that retrofitting to EnEV standards is always economically viable, the claim should be dropped. The regulations need to be redesigned so as to set standards to aspire to, but also to allow flexibility for situations where a complete building envelope of super-insulation is neither affordable nor sensible.

Conclusions

Mandatory standards for thermal retrofits of existing homes in Germany have led to a slower rate and depth of retrofitting than will be required to meet energy and climate goals for this sector. This shortfall can be explained, at least in part, in terms of mismatches between policy, the nature of existing residential buildings, and the normal financial aspirations of homeowners. The mandatory standards in the EnEV are too stringent and inflexible for the material realities of a major proportion of the existing buildings. Further, the EnEV overestimates consumption in these buildings by 30% or more, thereby overestimating potential energy savings and compromising the economic viability of retrofits. This is exacerbated by its underestimate of typical post-retrofit consumption. Further economic assumptions in the EnEV are misaligned with financial reality: there is a disregard of the (other) retrofit costs that do not directly contribute to thermal improvement; (inappropriately) low discount rates are assumed on investment return; and the delayed growth of the curve for future fuel price rises is often ignored.

The combined effect of these problems is to deter homeowners from retrofitting to EnEV standards. In addition, the lack of any other retrofit standard (other standards are generally illegal) discourages stepwise retrofit measures that might be more appropriate to the nature of the building, the actual thermal needs of the occupants and their financial situation.

To escape from this impasse, the economic difficulties within the EnEV need to be revised; standards need to be more flexible to suit actual buildings and owners; and policy-makers need to shift their promotional rhetoric away from the claim that retrofitting to EnEV standards is always economically viable. Instead, retrofit measures appropriate to the buildings, occupants and owners need to be encouraged, while a great many homeowners can be challenged to undertake comprehensive, high-standard thermal retrofits for reasons other than economic payback. There also needs to be discussion as to whether the uncritical setting of an across-the-board CO2 reduction target, implicitly for all sectors of the economy, is appropriate, considering the different levels of human welfare achieved in each of the sectors.

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**Endnotes**

1These are ‘average’ figures because the calculation methods take into account the buildings’ geometry: the higher the ratio of surface area to volume, the harder a building is to heat, and therefore the higher the permissible heating energy consumption. Figures are also given as primary energy rather than energy end use to take account of the losses in transmission or transport of energy source to the building.

2The sum of the geometric series $1.048^1 + 1.048^2 + \ldots + 1.048^{25}$ divided by 25.

3The lead author of the expert report, Professor Gerd Hauser, is Director of the Fraunhofer Institute for Building Physics and Professor of Engineering at the Technical University of Munich. He is widely regarded as one of the leading building physicists in Germany and an enthusiastic supporter of thermal retrofitting of existing homes.

4This is one of the few cases where a lower standard of insulation is legally permissible, though this is not well known or publicized.