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10 Questions

Ten questions concerning sustainable domestic thermal retrofit policy research

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ABSTRACT

The ten questions posed in this paper stand out among others after six years of joint and collaborative research, by the authors, on sustainable domestic thermal retrofit policy. This is a very wide field, touching on many disciplines, and we approach it from an interdisciplinary perspective informed by our experience in architecture, engineering, social science, policy studies and economics. Our basic concerns are: what makes a *sustainable* thermal retrofit; and what kinds of policies can support such retrofitting. 'Sustainable' retrofitting, in our view, not only reduces energy consumption and climate-damaging emissions but is also affordable for all, enhances occupant health, and preserves architectural heritage. Often achieving all these is a delicate balancing act. Our questions cover issues such as the appropriate depth of retrofits; the roles and interplays of social theory and physical science in this research; the place of qualitative research; specific social issues such as gender and wealth inequalities; consumer behavior issues such as the rebound effect; and the interesting concept of social desire paths. We conclude by summarizing key issues that policymakers and researchers could consider in order to lift home heating energy savings from their current torpor while also addressing related aspects of sustainability.

1. Introduction

Governments first mandated thermal standards in homes in the mid-1970s after politically induced oil crises [1]. In more recent decades policies on climate change mitigation became entwined with those on energy saving, giving extra momentum to the tightening of these standards. In Germany, for example, the Thermal Retention Regulation (*Wärmeschutzverordnung* - WSVO) was introduced in 1977 and set maximum space heating energy consumption for new homes at an average of 230 kWh/(m^{2}a) depending on the size and geometry of the building. This was progressively reduced to the current 50 kWh/(m^{2}a), now under the Energy Savings Regulations (*Energieeinsparverordnung* - EnEV) which replaced the WSVO in 2002 [2,3]. Similar steps have been taken in other OECD countries, with EU regulations supporting and attempting to drive this process forward in EU and EEA countries [4]. Thermal regulations for building refurbishments are generally less stringent than those for new builds but are often mandatory if significant refurbishment is undertaken [3].

Two factors – reducing reliance on fossil fuels and mitigating climate change – are the main policy drivers behind thermal retrofitting of existing homes, though other factors also play a role. One is the mitigation of 'fuel poverty', which came to prominence in the early 1990s through Milne and Boardman's pioneering work [5]. Another is changes in 'heat comfort practices' [6] in which households are seen to be increasingly demanding warmer homes. Thermal retrofitting has stimulated large commercial infrastructures providing materials, expertise and labour for thermal retrofits, together with increased research and its funding on relevant issues including building engineering, heating technology, development of standards and evaluation, and a burgeoning of social science approaches to better understand interactions between households and their buildings.

While this paper takes these developments into account, its main focus is research related to policy: the policies that aim to foster thermal retrofitting in homes. The EU faces the challenge of large-scale retrofits but the retrofit rate even in forerunner countries like Germany remains very low [7,8]. It is clear that energy and

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CO2 emission reduction targets will not be achieved with current policies [4,8]. In Germany an average annual comprehensive thermal retrofit rate of 2% of the existing building stock would be needed to meet targets [9]. Until recently the German Housing Ministry estimated the rate over the past decade at around 0.8% per year [10]. After the Green Party challenged this figure in Parliament on 21 August 2014 a new, highly detailed survey commissioned by the Federal Institute for Building and Urban Research (BBSR) estimated it at around 0.2% and steadily falling [8]. Ironically, energy consumption over the past 12 years has been reducing steadily, but this appears to be mostly due to factors other than thermal retrofitting [7]. In the UK the Association for the Conservation of Energy and the Regulatory Assistance Project estimate that with current policies the UK is likely to reduce CO2 emissions from buildings by just 12% below the business as usual case by 2030 rather than the targeted 30%.

Current dominant policy instruments are regulation-based, incentive-based and/or market-based, and tend to aim at large sub-sectors of the building stock. Policy has been slow to develop ways of including homeowners' nuanced preferences and socio-economic factors, such as gender or ethnic origin, in thermal retrofit policies (cf [11,12]. For example, in Germany there is no provision in retrofit policy for the possibility that the 3-million-strong Turkish-origin population might have specific needs and aspirations in thermal issues in housing. Despite increasing numbers of single person households there is no policy differentiation between male and female clientele.

This paper aims to challenge simplistic elements in thermal retrofit policies and suggest a research approach to move from blanket policies towards a more nuanced understanding of occupant needs and thermal retrofit practices.

The current authors have worked jointly (ten joint papers and a book) in the field of thermal retrofits of homes over the past 6 years, as well as making independent contributions to the topic previously and concurrently. We form an interdisciplinary team, drawing from our experience in architecture, policy studies, engineering, social psychology, micro-economics, statistics and social work. This has given us an understanding of thermal retrofits and relevant policies from a number of different and interlinked perspectives. We have found there is considerable strength in consistently interdisciplinary work on a common theme over a long period of time. We both also follow other academic interests but as our research has been motivated by carbon reduction, thermal retrofitting is the theme around which all our joint work has focused.

Most of our empirical work has been conducted in the UK and Germany, with lesser amounts in other European countries (e.g. Finland and the Netherlands) and in New Zealand, also China, Japan and the BBNP program in the US. For this reason, most of the examples in this paper come from these countries. Although the paper makes a number of generalizations, which apply especially to north western European countries, it must also be emphasized that thermal retrofitting is very diverse throughout the world. It is influenced by the material features of local building construction; cultural norms regarding thermal comfort and household practices; local climate conditions; levels and distribution of economic wealth; regulatory frameworks and other factors. Hence the somewhat Eurocentric viewpoint in this paper should not be taken as true for the entire world.

There are of course hundreds of possible questions that can be asked regarding this topic. The 10 presented here are those which have formed up, to us, as a result of our years of joint interdisciplinary research in the area. Some have presented themselves as questions which we have then sought to find answers for; others have presented themselves more as answers along with their questions simultaneously. We have identified these questions as under-researched areas and have deliberately excluded more technical questions, such as development of new products or improving thermal retrofit processes and management (including contractual arrangements). These questions are relevant but beyond the scope of our expertise and, in our view, already covered by research in the field.

The paper is structured as follows. It addresses 10 questions for sustainable retrofit policy research, starting with more from a more holistic question on definition (Q1) towards more specific, quantitative research gaps such as the rebound (and prebound) effect (Q10). Our tentative answer is presented after each question and the final section presents the conclusions.

Our ten questions and our responses to them are:

Question 1. What elements define a sustainable thermal retrofit?

Answer: By 'sustainable' we mean good for both people and the environment in the long run (cf [13]. This implies balancing competing factors and avoiding ideological emphasis on just one or two chosen elements. The factors we find essential are: reducing non-renewable energy consumption; mitigating environmental damage (especially climate change); increasing thermal comfort and health; keeping homes affordable; and retaining architectural heritage [14,15].

With regard to *energy saving*, as noted above, policy on thermal retrofitting became attached to regulations for new builds in response to the 1970s oil crises. Increasing concern over *climate change* in the late 20th century became grafted onto thermal retrofit policies in the early 2000s [16].

During this period the notion of *increased indoor comfort* became attached to policy discourse promoting thermal retrofits. Our work in the early 2010s showed that in temperate Western European countries, average actual heating energy consumption was consistently lower than the engineering estimates for adequate thermal comfort in homes with poor thermal quality [17]. We dubbed this the 'prebound effect': the ratio between the shortfall in consumption required for adequate comfort and the engineering estimates. Our subsequent research has confirmed this phenomenon more generally [18].

This has a number of important implications. Firstly, it challenges the optimism of theoretical calculations of the economic gains to be won through energy saving after thermal retrofits: 'You can't save energy you are not already consuming' [17]. Secondly, it adds to discussion of how accurate or useful current methodologies are for calculating older buildings' space heating energy ratings – the amount theoretically required to heat the building to a comfortable level. To some extent the large gaps between actual and theoretical consumption in older buildings may be due to changing patterns of usage [19]; others to over-pessimistic estimates of U-values in the solid wall fabric of older buildings [20]. Fuel price elasticity also appears to play a big roll [4: 58ff]: most people cannot afford to fully heat homes that demand more than 150 kWh/m^{2}a for full thermal comfort.

Thirdly, this resonates with Boardman's [21] and others' findings on fuel poverty. While in the past, cold damp homes were considered normal in countries like Britain and New Zealand [22], studies increasingly showed the deleterious health effects of living in such homes [23]. This has led to further motivation for thermal retrofits, in this case often sponsored by public funds, such as in Kirckaldy [24] and the 'Warm Up New Zealand' project [25].

Fourthly, the prebound effect goes into reverse for low energy homes and passive houses: they often consume significantly more heating energy, on average, than estimated at design stage [26]. This exacerbates rebound effects (see Question 9), frustrating policy

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