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Does demolition or refurbishment of old and inefficient homes help to increase our environmental, social and economic viability? ☆

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ABSTRACT

The issue of whether to demolish or refurbish older housing has been debated for over a century. It has been an active policy area since the late 1880s, when the Government first authorised the statutory demolition of insanitary slums. In the 1960s, revulsion at the scale of 'demolition blight' and new building caused a rethink, leading to a major reinvestment in inner city neighbourhoods of older housing. In the past 5 years, debate on demolition and new building has been intensified by the Government's Sustainable Communities Plan of 2003, with its proposals for large-scale clearance and building. Environmental arguments about renovating the existing stock have gained increasing prominence as people have sought to defend their communities from demolition.

The evidence on whether demolition would reduce the amount of greenhouse gases we emit into the atmosphere is unclear and disputed. This paper summarises the evidence and arguments, and attempts to clarify the most realistic, achievable route to major reductions in energy use in homes. The arguments that apply to housing also apply to most other buildings and therefore to the overall built environment, which accounts for half of all carbon emissions.

Three main sources of evidence have helped in the development of this paper, but there are many other studies we draw on in the discussion.

Firstly, the Environmental Change Institute at Oxford University has argued that around three million demolitions are necessary by 2050 if we are to reach the stringent energy reduction targets that will be required in our housing stock [Boardman et al., 2005. 40% House. Environmental Change Institute, Oxford]. Its demolition figure is based on complex modelling that with small modifications can produce very different numbers. Its assessment does not take account of the embodied carbon costs such as volume of new materials, energy use in producing concrete, steel and other structural and infrastructural elements, and other factors affecting the environment such as land use, infrastructure and area blighting. We discuss these issues in order to clarify the scale of the challenge and the relative value of demolition or renovation.

Secondly, the Sustainable Development Commission [SDC, 2006. 'Stock Take': Delivering improvements in existing housing. Sustainable Development Commission, London] argues the urgent need to upgrade the existing stock on the grounds that 70% of all homes that will exist in 2050, even with the ambitious new building programme now announced, are already built. The maximum feasible demolition of two million existing homes by 2050, based on experience to date, suggests that under 10% of the current stock will have been demolished by then. We argue that upgrading this stock to high environmental standards can actually be achieved more cheaply than demolishing it, and with as significant a carbon reduction.

Thirdly, the German Federal Housing, Urban and Transport Ministry has announced an ambitious energy reduction programme that will upgrade all pre-1984 homes in Germany by 2020, an estimated 30 million units.[1] This is based on evidence from several CO_2 reduction programmes since 1996, showing the feasibility of upgrading. An 80% cut in energy use has been achieved, making the performance of the renovated homes at least as good as Germany's current exacting new build standards. The evidence from Germany is more grounded than any that has so far been produced in the UK, as it is based on several thousand examples.

☆ While the Government Office for Science commissioned this review, the views are those of the author(s), are independent of Government, and do not constitute Government policy.

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[1] Zukunft Haus http://www.bmvbs.de/en/Building/Climate-change-and-energy-effi,-2826/Programme-to-reduce-CO2-emissi.htm.

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The paper also discusses the social and political problems of demolition. There is widespread opposition to large-scale demolition of older stock, mainly pre-1919 terraced homes, which is currently the most 'leaky'. This older property is a prime target for demolition in the Environmental Change Institute's proposals and the Government's plans.

The environmental benefits of refurbishment are shown, based on work by the Empty Homes Agency, evidence from English Heritage, the Building Research Establishment and the Prince's Foundation. Work on refurbishment shows that existing homes, often in brick-built terraces, are relatively easy to upgrade and, with careful reinvestment in the existing buildings, can achieve as high environmental efficiency standards as current new build.

We consider major social, economic and environmental benefits of refurbishment compared with demolition, including: a reduction in the transport costs, reduced landfill disposal, greater reuse of materials, reuse of infill sites and existing infrastructure, reduced new building on flood plains, local economic development, retention of community infrastructure, neighbourhood renewal and management. We weigh these benefits against the full costs of demolition and rebuilding, involving much higher capital costs, higher material wastage, greater embodied carbon inputs, the polluting impact of particulates, greater use of lorry transport for materials and waste, greater use of aggregates, more noise and disruption. On the social issues of housing need and fuel poverty, we argue that refurbishment and infill building are socially more acceptable, cheaper and create far lower environmental impact, while reducing fuel poverty. The incentive problems associated with renovation and the barriers to delivering it are also discussed.

The evidence we have uncovered counters the suggestion that large-scale and accelerated demolition would either help us meet our energy and climate change targets or respond to our social needs. Many arguments remain unclear, but the overall balance of evidence suggests that refurbishment most often makes sense on the basis of time, cost, community impact, prevention of sprawl, reuse of existing infrastructure and protection of existing communities. It can also lead to reduced energy use in buildings in both the short and long term.

Many factors will influence what happens in practice, but it seems unlikely under any scenario that the rate of demolition will accelerate far above current levels. Upgrading the existing stock is likely to gain in significance for environmental, social and economic reasons. Adopting policies that aid the retention and upgrading of the existing stock will help develop the necessary skills and technologies, save materials and land, and enhance the integration of existing communities in need of regeneration.

1. Introduction

Throwing away material objects is harmful to the environment, wasteful of energy and materials, and careless in the face of diminishing resources. Demolishing houses, which are bulky and valuable material objects, should be a last resort. Normally it is only advocated to remove unsound or unwanted buildings. But since 2003 it has been adopted with government support as a tool for regeneration, or for restructuring housing supply to suit modern conditions. Many have argued that this is harmful to the environment, costly and damaging to the long-term community networks that grow slowly and invisibly within housing areas.

As a policy, demolition has proved highly contentious, slow to deliver new replacement homes and generally unpopular. But, since 2004, the idea that demolishing the poorest and oldest homes will improve the environmental efficiency of the overall stock has gained ground. It is also held to reduce fuel poverty. This proposition has been used to justify the plans for large-scale area demolition of Victorian terraced housing in many Northern and Midlands cities and towns since 2003. This policy paper examines the evidence for and against such a contentious and potentially risky policy proposal.

There is considerable interest in housing and its environmental impact. The subject has risen to the very top of the political agenda because of the need for more supply, the high cost of land and building, and the shortcomings in energy performance and need for basic repair of many existing homes. There is very little agreement on how best to hit ambitious building targets of 240,000 additional homes a year while avoiding sprawl building and consequent environmental impact. Each new home, however efficiently built, adds significantly to carbon dioxide (CO_2) emissions in embodied energy. Nor is there any serious political debate about how to reduce drastically (by 60% at least) the energy used in running existing buildings, even though they contribute 50% of our current CO_2 emissions and homes constitute over half of this. How we build and run homes have major consequences for the future of our society and the environment.

1.1. Aims and sources

This paper has been commissioned to shed light on energy use in buildings and the possible role of demolition in improving the environmental performance of the existing stock. It has three basic aims:

- to assess, on the basis of available technical information, whether a structured policy of demolition to remove the worst-performing stock helps energy efficiency, and how such a policy would work in practice;
- to examine the impact of large-scale demolition and rebuilding on the social, environmental and economic performance of the existing built environment, and to explore whether a wider sustainable development perspective would help inform decisions on the scale of demolition and refurbishment needed to upgrade the physical environment and social structure of existing communities, alongside saving energy; and
- to explore alternatives for the existing stock involving renovation, neighbourhood renewal and energy-efficiency measures in order to ensure the sustainability of existing communities and the supply of more affordable housing, taking environmental and land constraints into consideration.

The discussion and conclusions will draw on actual experience of regeneration, upgrading, demolition and new building rather than on theoretical scenarios that do not sufficiently allow for the complex chains of behaviour and social structures within the existing built environment (RCEP, 2007). The sense of urgency conveyed by the Stern report leads to the assumption underpinning our work that delays of anything over a decade or so in reducing carbon emissions significantly will push up the price of tackling climate change impacts, making them more serious.

Retaining cheap housing helps to meet acute housing need and should in theory protect vulnerable communities. It should also reduce the environmental impact of demolition and new building. However, hard evidence to support this theory is to date limited to a few studies. The arguments for large-scale demolition to remove the least efficient stock, on the other hand, do not appear to take sufficient account of the wider environmental impacts of demolition and replacement building, nor of its social consequences. The case for demolition is based on the argument that this is essential to reach a 60% cut in total energy use in housing by 2050. An examination of the arguments for and against demolition or refurbishment demonstrates that a more sustainable approach would be to refurbish whenever possible and could reach the same target more quickly and more easily.

LSE Housing and the Sustainable Development Commission (SDC) have worked over the last 4 years on the upgrading potential of the existing stock, using the Sustainable Communities Plan as a baseline for developing a more sustainable approach to the built environment (Power, 2004a, b; SDC, 2006, 2007). The plan proposes new build homes (the Growth Area and Growth Point agenda), demolition and refurbishment (within the Housing Market Renewal areas), and regeneration and renewal (ongoing in most cities, towns and existing communities). The SDC is directly involved in current work on the existing stock with CABE, English Heritage, the Office of Climate Change, the Building Research Establishment (BRE), the Green Building Council and the Environment Agency among others, and we draw on this work.

2. The environmental impact of buildings

We start by setting out briefly the context in which the built environment is set. There are at least nine wider issues affecting the built environment to consider in order to assess the most energy-efficient approach to the built environment.

2.1. Existing communities

Around 80 of the population live in urban areas, and 99% of all homes at any one time already existed a year before. How we care for existing neighbourhoods and maintain their condition and services shape the potential for renovation or the likelihood of demolition. The roles of gradual incremental renewal and neighbourhood management are undervalued, or even ignored, in the debates about sustainability. Yet the sheer scale of existing neighbourhoods in need of renewal and the concentration of housing, buildings and people within them make their renewal essential. Existing areas contain virtually the entire supply of cheap, affordable housing since, without large subsidies, new replacement homes are unaffordable for people with low incomes.[2]

2.2. Existing stock

While new buildings add at most 1% a year to the existing stock, the other 99% of buildings are already built and produce 27% of all carbon emissions (The Economist, 2007; Office of Climate Change, 2007a, b). There are around 24 million homes in the UK today and at least 87% of these (22 million) will still be standing in 2050, even at the highest previous demolition rate of two million over 40 years. An ambitious building rate of 200,000 per annum[3] would add nine million homes by 2050. But even then, 70% of the 2050 stock would comprise what has already been built today, and the older the stock, the less energy efficient it is likely to be (see point (1) in Appendix). Evidence to date suggests that it is feasible to raise the energy performance of existing homes to at least as high standards as current new build, cutting their energy in use by 60% or more (SDC, 2007).

2.3. Demolition

Removing the worst property may seem the easiest and quickest way of reducing energy use. Many urban areas are poorly maintained and rundown, and occupied by generally disadvantaged populations (ODPM, 2003). However, demolition is slow, costly and unpopular. It provokes community opposition among the very people who are supposed to benefit, often because the same communities have already been displaced over long periods by earlier, slow-moving clearance programmes.

The highest rate of clearance, 80,000 demolitions per annum, was reached for a few years during the late 1960s in the mass clearance era (Mumford and Power, 2002). The mass demolitions of the 1960s and 1970s were part of the government-driven slum clearance programme, which ran from 1930 to 1980 and peaked in the late 1960s. In that long period, interrupted by the Second World War, two million formally designated ‘slums’ were demolished in large concentrated areas of Britain’s inner cities, the ‘largest clearance programme in the Western world’ (Power, 1993). It was facilitated by high subsidies, political drive and strong state powers of compulsory purchase. But the revulsion against demolition as a tool for area renewal or for improving housing conditions was so strong that even today it is not considered practicable to attempt anything like the average scale of demolition of the post-war clearances, of 60,000 a year.

2.4. The feasibility of renovation

An extremely rundown area seems a lot easier to demolish than to renovate, and many of the older inner city areas in the industrial North, the Midlands and the East End of London were demolished on these grounds in the post-war period. Today, areas of poor housing may appear to have few social attractions and limited economic value. But they house many low-income communities, and rundown areas have considerable latent value to the people who depend on them for survival. They also have considerable potential value if they are upgraded (Power and Mumford, 2003). Older, pre-first world war property is the least energy efficient but is often the easiest to renovate and make more efficient. It is also potentially the most attractive. Thus, there is almost an inverse relationship between the scale of current decay and neglect and the recycling potential of an area. Social housing estates and concrete blocks of flats can also be renovated to high environmental standards, as the German programme shows. The Empty Homes Agency (EHA) has demonstrated the feasibility, cost-effectiveness and energy gains of renovation (Ireland, 2005).

2.5. Density, transport and the environment

The need for higher density is driven by households becoming smaller so that population density falls. With low population

[2] Housing Market Renewal compensation problems—Sheffield and Liverpool visits, 2006.

[3] The Government aims to achieve 240,000 per annum by 2016, but does not currently look likely to achieve it.

density there are simply not enough people to make public transport a viable alternative to cars. We need to achieve a density of 50 homes per hectare as a minimum sustainable density to support a regular bus service (Power et al., 2004). Smaller households occupy more space, use more energy and therefore have greater environmental impact (Office of Climate Change, 2007a, b). Existing areas of terraced housing and low- and medium-rise blocks of flats normally far exceed this density, reducing energy use in transport, encouraging local shopping and offering easier conditions for high-efficiency renovation. Higher density also helps social integration and reduces isolation by supporting mixed uses and better services. Existing suburbs in cities and towns have an average density of 35 homes per hectare or less. They could be made more environmentally sustainable through subdivision of property and infill building, creating enough density to support local services and public transport within walking distance.

2.6. *Meeting housing needs*

The Government projects an increase in households of around 230,000 per annum. We currently build far fewer homes than this, around 160,000–180,000 per annum. However, 70% of newly formed households are single people living alone. It is not clear that this demographic trend will continue in linear form for the next 40 or even 20 years, nor that new homes should be built unquestioningly to this socially unsustainable projection.

The environmental consequences of new building to meet household multiplication in ever smaller units are extremely serious. It pushes up the consumption per person of energy, space, water and adds to the ownership of cars and electrical gadgets (see point (2) in Appendix). Aligning more progressive social policies with environmental limits and avoiding the expansion of average space and energy per person are critical to sustainability.

Couples and low-income families with children are often the hardest-hit by the lack of suitable, affordable homes. But we have at least 18 million family-sized homes, far more than the actual number of families. The distribution of space is highly unequal but we have more, larger homes in the UK than elsewhere in Europe (Whitehead and Scanlon, 2007). Incentives could redress this inequality.

2.7. *Materials and their embodied energy*

The building process and the materials used are both highly energy intensive. New homes use four to eight times more resources than an equivalent refurbishment (Ireland, 2008; Yates, 2006). This is because most of the building mass and structural elements in an existing property are already there and only rarely need replacing. For many structural and organisational reasons, almost all the building mass of new buildings is newly produced and processed. This constant requirement for new materials, however good the long-run energy efficiency of the building in use, has major energy, carbon and wider environmental impacts.

2.8. *Wider environmental impacts of large-scale housing development*

Building on flood plains and demolition are conspicuous environmental issues today. The exhaustion of available landfill sites also has serious implications for the scale of building and demolition. Demolition and building are the biggest source of landfill by volume, around 30% of the total.

New build also raises other, wider environmental issues, such as the transport impact of large-scale demolition and building (due to the sheer volume of material to be shipped around), the use of toxic and energy intensive materials (such as UPVC, chipboard, glues, cement and aggregates) and the resulting particulate pollution. This suggests the need to minimise building activity in order to maximise housing gain with minimal environmental impact.

2.9. *Social and economic consequences of large-scale building*

Planning for housing on the basis of supply and energy calculations, without including the social and economic roles of housing, risks missing the links between housing, family, facilities, schools, transport and jobs. We have already experienced this problem with the earlier generation of new towns, which in only rare cases have become self-sufficient (DCLG, 2006b).

New estates on the edge of existing areas do not offer the proximity, familiar landmarks, neighbourhood identity and local culture of established areas. Location and proximity are increasingly important for access to employment and services and to reduce environmental impact.

2.10. *Large-scale planning*

Large-scale, cheap house building over accelerated time periods tends to produce ‘lowest common denominator estates’ outside existing communities (Power et al., 2004; Rogers and Power, 2000). Standards are frequently reduced in order not to slow down the pace of building and to avoid pushing up costs, so quality suffers. Essential infrastructure often arrives after development and sometimes not at all. Funding is usually reduced during large building programmes because of cost over-runs, and the end product is usually far from the original proposal.

The overwhelming majority of builders are small firms with invaluable experience of repair, upgrading and small-scale development. An incremental approach to renovating existing homes, adding housing units on small sites and within existing buildings, would rely on the 50,000 small local building firms that operate at a more local scale. This would fit far more easily with land constraints and environmental and social conditions.

We need to explore carefully the balance of arguments for demolition, new build or renewal before proposing large-scale demolition and large-scale building as a tool for energy reduction or community sustainability. In the next section, we present a brief summary of the arguments and evidence on these issues.

3. The evidence for demolition

3.1. *The 40% house*

The Environmental Change Institute, in its report *40% House* (Boardman et al., 2005), sets out to show how we can reduce domestic carbon emissions from homes by 60% between 1997 and 2050. It argues that demolition of the most ‘leaky’ homes is needed to achieve this. It proposes three million demolitions by 2050.[4] The demolition proposals do not include any assessment of the environmental impacts. There are many unexplained emissions and assumptions in the report, including the following:

- The political and social problems of quadrupling the rate of demolition to 80,000 per annum are not assessed. Large-scale clearance was advocated in the Sustainable Communities Plan in 2003, but it involved generous demolition subsidies and guaranteed alternative housing for those displaced.

[4] Other aspects of the report deserve greater attention than we can give here since our main focus is on the relative merits of demolition and refurbishment.

- The embodied carbon in the 250,000 additional new homes per annum to meet household growth is not counted.[5]
- The embodied carbon in the three million replacement homes that replace those demolished is not counted.
- The wider environmental and social impacts of large-scale, disruptive demolitions within existing communities are not assessed.
- The policy tools required for such extensive removal of privately owned property are not mentioned.
- Whole-area demolition would be necessary to achieve the proposed scale of demolition, but the waste of resources, social damage and blight this would cause over large areas is not discussed.
- The impact on the elderly of demolition and forced rehousing plans is extremely negative but not mentioned (Mumford and Power, 2002; Power, 1987, 1993).
- The disintegration of many building materials during demolition, particularly slates, bricks and timber, is not discussed.

These omissions weaken the arguments presented by the ECI for large-scale demolition as an environmental and energy gain (see point (3) in Appendix).

In contrast, the study assumes extremely high energy performance for new homes. Those built since 1996 are assumed to use less than a quarter of the energy in use of renovated pre-1996 property. New build homes from 1996 onwards are predicted to perform far beyond current standards. However, there is no allowance for the embodied energy inputs into new building. As we have seen, building, demolition and renovation waste make up about one-third of all landfill (SDC, 2006). The infrastructure required for new building and its significant energy costs and emissions impact are not discussed (Ireland, 2008).

The study does not allow for renovation to high energy standards. Floor insulation is not included at all and it assumes that only 15% of solid wall properties (of which there are about 8 million) will be insulated by 2050 (Boardman et al., 2005; DCLG, 2007). It also assumes continuing growth in single-person households, which is questionable on social, health, environmental and cost grounds (Power and Houghton, 2007; Rogers and Power, 2000).

The study does not reflect the length of time materials and structures actually last, given repair, maintenance and weatherproofing, especially older structural materials that have survived to date. Rather, it argues that demolition is also necessary in order to reduce the apparent average length of time properties would have to last at current rates of demolition—over 1000 years.

But this calculation of the durability of buildings ignores the incremental, small-scale nature of ongoing repair, which gradually makes good or replaces the main building elements as needed. This effectively replaces and renews the building stock in a constant reinvestment process. Over half of all current building spending is dedicated to repair (Power, 2006a). To preserve the existing stock as resources become scarcer, repair and energy-efficiency standards will need to be far higher than are currently required or than the *40% House* proposes. The SAP rating of existing English homes, a measure of their energy efficiency, averages 50, whereas it should reach 80 and higher if possible (see point (4) in Appendix).[6]

The report argues that the elderly are the most likely group to live in over-large properties that they cannot afford to heat, a major cause of fuel poverty. They usually own their own home, and occupy unmodernised properties because they do not easily adapt and often cannot afford adequate repair. They often rely on electric heating, which is expensive and is the most carbon intensive source of heat. These older, larger properties are frequently cold and expensive to heat, but they are also the easiest and most attractive to renovate and insulate (Ireland, 2005). These are often family-size homes more suitable for younger age groups anyway. The ECI argues that demolition of such properties would help reduce fuel poverty, but does not discuss possible alternatives such as subsidised upgrading.[7] Levels of fuel poverty are much lower in social rented housing than other renting as a result of higher standards of energy efficiency and insulation, in spite of the fact that social housing houses disproportionately poor households (Hills, 2007).

The aim of reducing carbon emissions from in-use energy in homes must take account of complex urban policy issues, which we discuss in later sections; it must allow for the full environmental cost, including the embodied energy of new building, and it must examine the full potential of renovation alongside demolition and new build before determining the best methods of improving the environmental performance of the buildings we have.

3.2. Royal Commission on Environmental Pollution (RCEP)

In assessing the energy impact of the built environment, the RCEP's report, *The Urban Environment* (RCEP, 2007), used the ECI's work to estimate the energy and carbon impacts of new build and refurbished properties, allowing for embodied energy.

It shows that if homes are refurbished to the basic standard suggested in the *40% House* (which is below an achievable level when known efficiency measures are adopted), refurbished older homes can perform over a 60-year period as well as new homes built to current standards (see points (5) and (6) in Appendix).

In order to achieve a 60% reduction in embodied and in-use energy by 2050 for new build, including embodied carbon, all homes between 1996 and 2050 would need to be built to the equivalent of BedZed (Lararus, 2002)[8] or the highest level of the Code for Sustainable Homes, relying on high embodied energy but very low energy in use.[9] The short-term embodied carbon cost of these thermal standards is extremely high. If renovation, with its much lower embodied carbon, is carried out to the low ECI standard, the 'BedZed zero carbon' new build will outperform a renovated home after 9 years, whereas a standard new build energy-efficient home will take 28 years to outperform a higher efficiency renovated home (see point (7) in Appendix). This underlines the importance of renovating to higher standards than the ECI proposes, including solid walls and floors. The Nottingham Eco-House demonstration, one of the renovation examples used, shows that reductions of 85% are possible if all readily available efficiency measures are adopted.[10]

The RCEP report suggests that over a short time frame of 10 years, renovation saves more carbon emissions. But over a long time frame

[5] The Government's current building target is 240,000 per annum; the *40% House* proposes 250,000. Neither target includes making up for extra homes lost through higher rates of demolition.

[6] The highest current SAP rating of 100 matches Level 5 (out of 6) of the new Code for Sustainable Homes, launched in 2007 by the Department for Communities and Local Government for new build homes. In the absence of a Code for Existing Homes to establish a desirable standard, we use the renovation case studies referred to in this paper as a reference point. They reach a SAP rating of 85 or more. This is essential if carbon emissions from existing homes are to be sufficiently reduced.

[7] ECI unpublished report following discussion of embodied and in-use energy and refurbishment and new build, May 2007 (Gavin Killip).

[8] BioRegional http://www.bioregional.com/.

[9] Issues around light weight (e.g. timber frame) and heavy weight (e.g. concrete and steel) constructions are complex, but many argue that highly insulated timber frame construction rather than heavy concrete 'zero-carbon' construction is more resilient to extreme weather, more sustainable if the timber is harvested from sustainable sources and as energy efficient (http://www.passivhaus.org.uk/). See Crichton (2005).

[10] Nottingham Eco-House. http://www.msarch.co.uk/ecohome/.

of 50 years, homes with high embodied but low in use energy ('zero-carbon homes') may eventually outperform refurbished existing property. However, behaviour change in adopting better energy practices, incremental improvements in performance through renovation, demand management, increased incentives for higher quality renovation, and better, cheaper efficiency measures would help renovation achieve similar levels of efficiency. As a result, the RCEP does not endorse large-scale demolition proposals. Rather, its report flags up the associated social and environmental problems of demolition and argues for as much renovation as possible.

3.3. The sustainable communities plan

In the late 1990s the Government proposed greatly increased house-building targets. The targets were driven by a shortage of housing in many parts of the country accompanied by apparent surplus in the late 1990s of older, poor-quality property in former industrial areas. The targets lacked clear proposals for energy efficiency, density, infrastructure support, transport links and other services to make the new communities 'sustainable' in the longer term. They have been heavily criticised for this. At the same time, the plan proposed major Housing Market Renewal areas, covering a million existing homes, within which 'large-scale clearance' of perhaps 400,000 homes would play a part (ODPM, 2004).

Currently, Housing Market Renewal plans involve around 10,000 demolitions a year, a far lower number than originally envisaged. But even this is difficult to execute, costly and in many places deeply unpopular. The demolition plans are virtually all drawn up on an area rather than a single property basis, taking out already renovated and well-maintained properties alongside inadequate or derelict ones (Neild, 2007; Power and Houghton, 2007). As a result, the concerted attempt in recent years to foster systematic demolition on a moderately large scale has proved extremely difficult to implement, damaging to communities and unjustifiably expensive. The plans have also undermined conditions in large areas earmarked for demolition, causing ever further depopulation and loss of services within blighted areas.[11] The demolition approach within the plan is now being radically modified because of increasing housing demand, rising property values and the proven viability of renovation.

3.4. Core cities reports on housing market renewal

In advance of the Sustainable Communities Plan, in 1998–2002 the Centre for Urban and Regional Studies (CURS) at the University of Birmingham produced for the Core Cities[12] a series of studies on the 'M62 Corridor'—a band of built-up areas across the north of England, including many old industrial towns and cities stretching from Liverpool in the west to Hull and Newcastle in the east, showing a 'growing crisis of abandonment' that our own work in this field has also highlighted.

The CURS reports argued for housing market interventions involving large-scale demolition and new building. There was no reference in this work to the energy implications or wider environmental costs of such large-scale interventions. Our own findings, based on similar evidence to the Core Cities reports, supported renovation, conservation and close community involvement in any limited demolition that proved necessary. After 10 years of upheaval, the approach of extremely limited demolition and extensive renovation is beginning to prevail.

[11] Community Demolition Workshop, Trafford Hall, June 2007.

[12] The Core Cities formed a network of major industrial cities experiencing steep decline as a result of economic and social change. They commissioned the first report by CURS on urban abandonment, which was published in 2001.

3.5. Chartered Institute of Environmental Health (CIEH)

There is evidence on the impact on health of poor-quality, damp, unrepaired and older properties. According to the CIEH, some demolition of such homes can be justified on health grounds (CIEH, 2006; North Islington Housing Rights Project, 1976). However, if damp is treated and properties are insulated, health problems associated with older properties can be overcome, as was shown in 1970s renovation programmes.

Overall, neither the 40% House study nor evidence from the RCEP, the Government, the Core Cities or the CIEH strengthens the technical case for demolition. In fact, they underline the urgency of developing much higher standards for renovation of virtually all existing homes.

3.6. Extreme weather, flood plains, insurance and vulnerability of newer homes

There is a totally different perspective on whether buildings are suitable to withstand the future impact of climate change. Even current conditions, and likely climate conditions in the near future, make many modern homes unsuitable and only adaptable with difficulty and significant cost. Storms including high winds, heavy prolonged rain and serious flooding have damaged several million properties to varying degrees, some very seriously, over the last 20 years. The years 1987, 1990, 1999, 2001 and 2007 have been among the most notable in England for such damage (Mootoosamy and Baker, 1998; Parry, 2000). A close examination of insurance claim records over 20 years reveals that post-1970 properties are less resilient than older ones and that the materials used are less resistant to damage (Black et al., 2006; Clark et al., 2002; Mootoosamy and Baker, 1998). 'Make good' work by insurance companies is often of low quality and even less resistant to future damage. Large-scale building since 1970 is frequently in flood-prone areas of southern England. So potential risks from future storms involve many more properties, at least four million, than are currently categorised as having a very low SAP rating (only three million) (Parry, 2000). This evidence would reinforce the argument that upgrading and insulating older properties makes sense when it is possible, as the materials have proved stronger, longer-lasting and more resilient in extreme weather conditions, which are now far more likely (Crichton, 2005; Roaf et al., 2005). It also suggests that much more work is needed to proof more modern buildings against climate damage. It underlines the complexity of the issues involved, going far beyond the scope of this paper.

4. The evidence for renovation of existing buildings

4.1. The German Zukunft Haus Pilot Programme 2003–2005

This programme involved upgrading and installing energy-efficiency measures in 915 homes in 34 mainly rented blocks of flats across Eastern and Western Germany, mostly built before 1978.[13] The blocks were generally in poor condition and relatively hard to let. The main measures adopted in the pilot were high

[13] Prior to 2005, there have been a number of housing CO_2 reduction programmes running in Germany including:

1996–2005 KfW CO_2 Reduction programme (685,000 dwellings),
2001–2005 KfW CO_2 Building Rehabilitation programme (196,000 dwellings) and
2003–2005 Existing Low-Energy Houses programme (part of the Zukunft Haus umbrella campaign) (2230 dwellings).

insulation including external and internal cladding, high-quality glazing, efficient heating and energy systems, solar collectors for hot water, heat recovery mechanisms, and where possible the addition of south-facing balconies. Through these measures, energy consumption was reduced by over 80% and the renovated homes became twice as energy efficient as the current German new build standard in spite of the much higher and more strictly enforced building standards in Germany than in the UK (see point (8) in Appendix) (Dena, 2005). The German Federal Government announced in 2007 a programme to bring all pre-1984 properties up to this standard by 2020 through a system of loans, grants and tax incentives (Bundesministerium für Verkehr, Bau und Stadtentwinklung, 2007). The new programme covers 17 million blocks of pre-1984 homes and about 30 million dwellings and includes owners, tenants and landlords of all kinds as well as schools, public offices and other buildings. The building upgrading programme will make a major contribution to Germany's ambition to reduce overall CO_2 emissions by 40% by 2020.

4.2. The Empty Homes Agency (EHA)

The EHA was set up by the UK Government to bring empty properties back into use. Its work involves the renovation of dilapidated property. A recent study by the EHA looks at six exemplars of energy use in buildings, three new build and three renovations, to assess the embodied energy and energy in use of new and existing buildings. The existing buildings are being renovated to varied energy-efficiency standards and the new ones are being developed by major builders to 2002 or higher building standards (Ireland, 2008).

The aim of the research was to compare the embodied energy and energy in use over a 50-year life for the two types of property. This study included infrastructure costs for new build, an additional input compared with refurbishment, which generally reuses existing infrastructure.

The research shows that embodied energy constitutes 35% of the total CO_2 emitted over the estimated 50-year lifetime of the new properties, whereas for renovation the embodied energy is 7% of the total energy over the lifetime (see point (9) in Appendix). The in-use CO_2 for the two renovated Victorian properties in the sample was similar to the new build, whereas the 1950s renovated property performed considerably less well. The average in-use emissions for the three renovated properties were 40% higher than for the new build property, whereas the two 19th century properties were 20% higher in in-use energy.

Taking the full energy inputs, embodied and in-use, over 50 years, the average new build lifetime emissions totalled 174 tonne of CO_2 and the refurbished average was 194 tonne per home (Ireland, 2008). The worst-performing refurbished property performed better for 28 years than the average new build before its cumulative impact became worse than the new build.[14] Allowing for equivalent space, the renovated properties performed as well as the new build over the whole 50-year period (see point (10) in Appendix). This finding does not support the ECI assumption that refurbished homes use 60% of the energy of an average unmodernised home, nor that pre-1996 properties use four times the energy of post-1996 homes (see point (11) in Appendix). The EHA demonstrates that older refurbished properties can perform significantly better than the ECI allows.

4.3. English Heritage

English Heritage works to preserve, renovate and restore older property. It has demonstrated the upgrading potential of older buildings to overcome criticism that many of its older properties are poorly insulated due to the physical character of listed buildings. At a community level it became involved in protecting traditional streets and homes as part of its wider role in preserving our built heritage, through a process called characterisation (English Heritage, 2006).

Based on a study by the BRE, English Heritage showed that terraced housing was relatively cheap to restore, and cheaper to maintain than current new build, requiring considerably less materials input and therefore less embodied energy. It argues that restoration saves large amounts of embodied energy in bricks, beams and other structural elements. The materials last far longer than those in new homes and the repair costs of renovated property are therefore lower. Older restored housing was more valued than the equivalent modern house once it had been upgraded. This work demonstrated the value of high insulation and the potential for much lower energy in-use for terraces than for standard modern homes. This gain is possible because in a terrace, most side walls are shared and frontages are narrow. Contrary to the case put forward by the ECI, the internal insulation of solid walls is achievable in this form of housing since front and back walls tend to be narrow, and end of terrace external walls can be insulated (English Heritage, 2006).

English Heritage is now mounting a much more comprehensive study of terraced housing and the potential environmental benefits of renovation and upgrading within a standard, currently occupied terraced street. This in-depth study will provide more thorough evidence of the value of renovation both to community heritage and to the environment.[15]

4.4. Building Research Establishment (BRE)

The BRE Trust carried out an energy audit for the Prince's Foundation of the impact of energy-efficient renovation on SAP ratings. It showed that a 60% reduction in energy use was achieved in tenement flats with insulation to roofs, external walls (internally applied), windows (double glazing), gas central heating and hot water replacing a mix of gas and electricity, and draft-sealing doors. The levels of insulation introduced were far below those recommended today, yet SAP ratings still rose from 23 to 57 in one case and from 50 to 86 in another (Yates, 2006). The average SAP rating for all homes is 51 (see point (12) in Appendix) (DCLG, 2006a).

The BRE Trust argues that wider neighbourhood renewal plays a significant part in overall improved performance, mainly through better management of the urban environment, which

(*footnote continued*)

These programmes have demonstrated the potential to reduce energy consumption of homes, with the highest performing (Existing Low-Energy Houses programme) reducing energy consumption by 80%, and exceeding new build standards. So clear was the evidence and so enthusiastic the uptake that in 2006 these programmes led the German government to relaunch the KfW CO_2 Building Rehabilitation programme, which now aims to bring all pre-1984 dwellings up to current German new build standard by 2020. It was further extended to all building types in 2007.

KfW (Kreditanstallt fur Wiederaufbau) is the German government-owned development bank. http://www.bmvbs.de/en/Building/Climate-change-and-energy-effi-,2832/Existing-Low-Energy-Houses.htm.

http://www.bmvbs.de/en/Building/Climate-change-and-energy-effi-2826/Programme-to-reduce-CO2-emissi.htm.

http://www.kfw-foerderbank.de/EN_Home/Housing_Construction/KfWCO2-Buil.jsp.

[14] These calculations do not allow for the risks attached to future gains in reduced emissions by comparison with the certainty of the initial carbon costs of new building.

[15] English Heritage/CABE meeting, July 2007.

leads to greater investment in repair and renovation. The report introduces the new Housing Corporation Standard for upgrading housing association properties in traditional inner areas, Eco-XB. Since many of these are older street properties, first renovated in the 1970s, they are in need of significant reinvestment. This standard underlines the wider role of property upgrading in urban renewal, neighbourhood management, and brownfield and infill building, as well as direct energy efficiency (see point (13) in Appendix).

4.5. University College London study

A study by University College London (Johnston et al., 2005) explored the technological feasibility of achieving CO_2 emission reductions in excess of 60% within the UK housing stock by the middle of this century. The study developed an energy and CO_2 emission model of the UK housing stock and was used to develop and evaluate three illustrative scenarios for the household sector. The results of the scenarios suggest that it may be technically possible, using currently available technology, to achieve CO_2 emission reductions in excess of 80% within the UK housing stock by the middle of this century. And, in contrast to the ECI study, it suggested that provided that a significant proportion of existing solid-walled dwellings can be externally insulated (which is dependent on some developments in the solid wall insulation technologies and supply chain), very large reductions in CO_2 emissions can be achieved without recourse to large-scale demolition of the housing stock by 2050.

4.6. Stock take

The SDC was funded by the Department of Communities and Local Government (CLG, formerly ODPM) to carry out a year's study of how the existing stock of homes could be upgraded with the aim of applying the proposed Code for Sustainable Homes to existing as well as new homes. The work followed on from the Sustainable Buildings Task Group and fed into the review of existing homes being conducted within the Building Regulations Division of CLG, and the Office of Climate Change (OCC) based in Defra.

By examining the use of energy, water, construction materials and waste, and detailing how performance can be improved, the study demonstrates the feasibility of upgrading the existing stock to a high-energy performance standard. It outlines policy tools that could deliver radical improvements relatively easily. Given the reality that the vast majority of homes that will exist in 2050 and beyond are already built, it presents a powerful case for upgrading in the most cost-effective ways to the highest possible level.

Its findings coincide with the German experience, showing that roofs, outer walls, under floors, windows, doors and heating systems are the most important and basic elements for saving energy to achieve maximum efficiency. The carbon emissions reductions are greatest from tried and tested measures applied to these parts of the house (see points (14) and (15) in Appendix). The SDC is now collecting case studies of individual house renovation projects to demonstrate the gains that can be made from basic insulation measures. In all the case studies so far of existing pre-first world war homes, energy reductions of more than 60% have been achieved.

4.7. Office of Climate Change (OCC)

Drawing on Stock Take, the OCC based in Defra has analysed household carbon emissions from existing homes and highlighted the potential for reducing emissions as well as the urgency of doing so (see point (16) in Appendix).

4.8. Decent Homes Programme

A major government investment programme, aiming to bring all social housing up to a decent standard by 2010, has invested an average of £10,000 per home in basic repair, weatherproofing, improved thermal comfort, modern kitchens and bathrooms. According to CLG estimates, about 70% of social landlords have upgraded the thermal insulation of properties in the course of this programme (DCLG, 2006a). Fewer social housing tenants now fall into fuel poverty even though this stock has the highest concentrations of poverty, particularly non-working families and lone parents, and it includes many poorly built and insulated concrete blocks. Spending on basic modernisation can improve energy performance considerably. Repair and upgrading go hand in hand with additional work on thermal efficiency gains such as condensing boilers, double glazing and better insulation. One encourages the other. This in turn raises the popularity and value of existing homes, helping to overcome some of the barriers individual householders face to upgrading. It argues for a whole-programme approach to upgrading, which is economically and environmentally beneficial (Power, 2006b).

4.9. Vattenfall Utility Study

A Swedish study, carried out by a major international, Stockholm-based, utilities company, has shown that the overall economic cost of insulation measures in buildings to reduce their carbon emissions is in fact negative. The energy savings resulting from insulation measures have demonstrable payback times within the lifetime of the products and without economic subsidy. The biggest energy-efficiency gains come from added insulation, better heating efficiency and better transport (see points (17) and (18) in Appendix). This evidence has been used by the OCC to push for more household advice and incentives on cost-effective measures.

All the studies we looked at confirm that it is both possible and important to upgrade the existing stock at the same time as reducing carbon emissions and the environmental impacts of new building. Six basic energy-efficiency improvement measures can significantly cut energy use in existing homes: insulation to roofs, walls, floors, double glazing, damp-proofing and condensing boilers for heating and hot water (see point (19) in Appendix). If these known efficiency measures are applied to all the main structural elements, and to space and water heating, then renovation can outperform current new build.

4.10. The wider problems of demolition

It is questionable whether large-scale demolition is justified for energy-efficiency reasons, given that the energy performance of renovated homes can improve significantly over time. Even solid wall insulation shows a positive return after 14 years (see point (20) in Appendix). Wider issues affecting demolition must also be taken into account before opting for demolition as a solution to energy and regeneration problems.

Demolition is a particularly difficult tool in regeneration and housing renewal for a number of reasons:

- Demolition involves the loss of a home and the cost of a new replacement one. Compensation to the owner rarely covers the use value or replacement value of an existing home. This has proved a big barrier to demolition in most Housing Market

Renewal areas and is a major cause of the intense unpopularity of demolition in occupied areas, even in areas that face many problems.
- Demolition causes damage to neighbouring properties through disrepair and decline, since homes proposed for demolition do not attract any investment, often even essential maintenance. This can lead to water penetration, increased vandalism and arson, break-ins and other blight for neighbouring homes. Adjacent properties lose value and there can be a domino effect on local conditions.
- It is difficult to carry out area renewal by means of demolition on a restricted house-by-house basis. The physical layout of most property proposed for demolition, either in streets or estates, tends not to permit this approach. Whole blocks, streets or areas are usually involved, and as a result viable properties are destroyed. Our own work in areas with significant housing abandonment leads us to suggest a 'scalpel' approach to demolition, where only the few most derelict and unusable properties were removed (Mumford and Power, 1999, 2002).
- Even in the most unpopular older areas proposed for demolition, 70% of homes are occupied on average, making area-based approaches to demolition organisationally complex, extremely slow and costly in rehousing terms (Elevate East Lancashire, 2004; NAO, 2007; Nevin, 2001). This is a major factor in generating opposition to demolition. It is also socially disruptive.
- Demolition plans have knock-on effects on schools, shops, health provision, banks and other local services, most of which leave an area before it is demolished and do not return till long after rebuilding, if at all (Mumford and Power, 1999). This causes hardship to the residents and, if they are elderly, can have very negative health impacts (Kontinnen, 1985).
- Ugly gaps often remain for decades due to the withdrawal of investment and the loss of viability of an area following demolition. Such sites become refuse-strewn and unsightly, affecting local businesses over a far wider area.
- The problems of demolition blight can be made worse by the loss of essential social infrastructure and social capital, which take decades to build up again. Facilities and meeting places are costly to reinstate once they have been lost, and young people can become very disorientated as demolition is planned and carried out.
- Housing capacity is reduced by the process of demolition and rebuilding because of the time it takes, including the slow legal processes involved in expropriating properties for demolition. Normally it takes several years to agree precise demolition plans and acquire properties. Rehousing existing residents delays demolition and creates extra housing demand.
- Rebuilding timescales are slowed by the need to renew infrastructure after demolition. The whole process can take up to 20 years. All in all, it is rare for a demolition plan to deliver replacement housing in less than 10 years, even with strong government backing and funding, as the Housing Market Renewal area demolitions are showing. It often takes far longer (Turcu, 2005–2007).
- Because demolition blights poorer neighbourhoods, it drives sprawl building and demand for housing outside existing areas. The bigger the demolition plans, the wider the blighting effects spread and the greater the urban exodus (Rogers and Power, 2000).
- The average full cost of demolition per home is £17,000–£35,000 (ODPM, 2003). If we add the cost of delays in reusing the land, the loss of housing capacity and the infrastructure cost of new housing, then demolition would rarely be justified in cost terms, since repair and upgrading would normally cost far less than the total cost of demolition and replacement housing.

All these factors make demolition costly, disruptive, damaging to wider areas and therefore unpopular. The local environmental impacts of demolition are obvious: unsightly boarding up, accumulated rubbish, increased dumping, overgrown gardens, decayed streets and reduced maintenance. The wider environmental impacts of demolition are even more serious: loss of valuable and increasingly scarce materials; impact on landfill sites; transport of materials to and from demolition sites; particulate pollution in the process of demolition and transportation of rubble; and loss of housing, creating the need for new housing with its high embodied energy. Only the most extreme physical conditions justify such high social, economic and environmental costs.

5. The wider benefits of renewal

In contrast with the negative wider problems generated by demolition, refurbishment in all but the most extreme cases is both cheaper and less damaging to the local environment than demolition and new build. Refurbishment offers many clear benefits:

- Renovation preserves the basic structure of the property, and retains existing infrastructure in an existing built environment.
- The renewal of a single house has an immediate beneficial effect on neighbouring properties because it gives a clear signal that the neighbourhood is worth investing in.
- Upgrading is far quicker than demolition and replacement building, because in most cases it involves adaptation of the existing structure and layout of a house rather than starting from scratch.
- It is far less disruptive to residents, because even where major work is undertaken, unless a dangerous structure is involved, residents can usually stay and the area services continue to operate. If residents have to move out temporarily, it is normally for months rather than years.
- It involves a shorter and more continuous building process since most of the work can happen under cover in weatherproof conditions. New build involves many months of exposure to all weathers while building the foundations and main structure.
- It has a positive impact on the wider neighbourhood, sending a signal that renewal and reinvestment will ensure the long-term value and stability of an area. This in turn generates other investments and a broader upgrading.
- Older existing neighbourhoods and homes require constant upgrading. Renovation has a positive effect on street conditions, social mixing, service quality, local transport and schools, since it adds value and attractiveness.

5.1. Renovation attracts investment

Successful and prosperous towns and cities have their low-income neighbourhoods and estates. But there, continuous renewal happens and demolition is rarely proposed for old terraced streets or social housing estates. This shows that renovation is a feasible and viable option, even for previously rundown, old and inefficient property. Very often poorer, existing residents are gradually displaced by richer gentrifiers. Durham, York, Chester, Lancaster and Oxford are a few examples of this process of constant renewal. In poorer towns, lack of investment and repair can lead to demolition.

5.2. Land values can drive demolition

London's extremely high land values and shortage of space make low-income social housing estates particularly vulnerable to proposals for demolition and rebuilding. This has little to do with energy efficiency. Rather, it is driven by a combination of developer ambitions, the Government's interest in more mixed housing and a lack of local authority resources, reinvestment and management over long periods of time. This leads to declining social conditions on estates and provides impetus for large-scale regeneration, normally involving demolition. Such schemes are extremely costly and have even longer timescales than street demolition. The areas involved are fully occupied and have complex site layouts. Rehousing the inhabitants also involves unavoidable social problems.[16] Many estate demolition plans are now opposed by residents with low incomes, who fear losing out from the process of rehousing and rebuilding. Upgrading low-income neighbourhoods, which comprise about one-third of our urban areas, will make a major contribution to social cohesion and integration, as well as revaluing our built environment and reducing development impact on the wider environment (Lupton, 2003, Paskell and Power, 2005).

5.3. Renovation helps renew poorer neighbourhoods

There are four benefits to renovation. Firstly, upgrading existing property sets in train a virtuous circle of reinvestment, revaluing unused buildings and land while encouraging upgrading of all property to much higher quality and energy-efficiency standards (ODPM, 2006). If an area's homes are renewed, many other existing, under-used buildings become potential sources of the additional homes we need. This applies to unwanted office buildings, disused shops, storeys over shops in central locations, old schools, warehouses, workshops, pubs, churches and other buildings. Most under-used buildings can be brought back into use for some purpose, whether as housing or for community or commercial use. This significantly reduces the need for large new building sites. Renovation of larger existing homes encourages families to stay within existing communities. Conversion into smaller, more manageable units allows elderly people to remain in a community alongside young single households providing much greater support and access to more sustainable accommodation.

Secondly, renewal gives added value to infill spaces. These are small gaps in the area, caused by change of use, earlier demolition or bad land use planning. They are awkward because of their small size (usually under a hectare, often far under). They are not officially counted in planning documents or in brownfield land registers. They could provide virtually all the extra land we need for additional building for at least 30 years. Many are in rundown areas, vacant because of the perceived investment risk, the low value of the land in these areas, the complexities of planning for new building within existing areas and the priority given to wider-scale renewal (Power et al., 2004).

This infill capacity requires an intensive neighbourhood management system if it is to become revalued. Highly cost-effective in preserving property and involving existing communities, such management would revalue under-used capacity in existing communities.[17] Areas previously written off as requiring demolition are recovering through neighbourhood management and reinvestment approaches.[18]

Thirdly, density has become a critical issue in urban renewal because plummeting household size has led to increased demand for homes, accompanied by the loss of a critical mass of people to support local services. It leads directly to neighbourhood decline (RCEP, 2007). Infill building raises density in the face of falling household size, which can otherwise lead to a shrinking population per hectare of built land (see point (21) in Appendix). The low average urban densities we currently have and still often build at do not support regular, high-quality services, including buses, shops and local schools. Higher density would have a beneficial effect on the cost and sustainability of public services and infrastructure. Low density encourages amalgamation and scaling up of provision, which in turns leads to the withdrawal of front-line services, reducing supervision, creating more need for cars and generating more traffic.[19]

A fourth benefit of renovation, as opposed to demolition and new build, is local economic development, since it involves reinvestment in declining neighbourhoods. Renovation is well suited to small, locally based building firms, often hiring local workers. With high rates of economic inactivity in urban areas, in spite of low official unemployment, renovation can generate new jobs, skills and motivation within demoralised communities (Bundesministerium für Verkehr, Bau und Stadtentwinklung, 2007; Winkler, 2007).

6. Barriers to renewal and proposals to help upgrade existing homes

Renovation, repair and upgrading will remain by far the most significant contributors to progress in energy efficiency and environmental protection for the foreseeable future. Therefore, incentives for energy efficiency alongside renewal are essential.

Current incentives favour demolition and new building. The most obvious example of this is VAT. At the moment new build is VAT-free, whereas almost all repair and reinvestment are subject to 17.5% VAT, falling to 5% for property that has been empty for more than 3 years. Even in government-targeted regeneration areas, the VAT rule applies, offering a perverse incentive for demolition.

Meanwhile, demolition costs in area renewal programmes are paid by the Government, as is the cost of infrastructure for new build homes. These add £17,000–35,000 per home for demolition and an estimated £55,000 for infrastructure for new development.[20] This adds an estimated £72,000 to £90,000 to the cost of building a home, falling to £50,000 per property without prior demolition. If this amount was redeployed on refurbishment, then most existing homes could be upgraded if VAT was equalised between new build and repair, demolition costs were carried in full by the developer of the replacement new homes and there was an infrastructure charge on new build.[21]

There are some obvious measures that could be adopted immediately. Solid wall insulation needs stronger government support and better techniques. Other established refurbishment measures need to be turned into a standard upgrading package to

[16] Woodberry Down regeneration feasibility report http://www.hackneyhomes.org.uk/hhs-woodberry-down.htm.

[17] Evidence from Newcastle and Manchester.

[18] LSE CASE Weak Market Cities City Reformers Group Meeting, 19–21 September 2007.

[19] Presentation by Pedro Luis Emparanza of Instituto de Estudios Territoriales de Bizkaia on 20 September 2007 at the LSE CASE Weak Market Cities City Reformers Group Meeting. Available on http://sticerd.lse.ac.uk/case/_new/research/weakmarketcities/default.asp.

[20] These estimates are based on feasibility studies by Roger Tym and Partners for ODPM (2006) on the Growth Areas and on follow on work. Office of the Deputy Prime Minister (ODPM) Housing, Planning, Local Government and the Regions Committee: Affordability and the Supply of Housing: Third Report of Session 2005–06, ODPM, London, 2006.

[21] Milton Keynes has introduced a 'roof tax' of £20,000 on all new build homes as a contribution to the infrastructure costs.

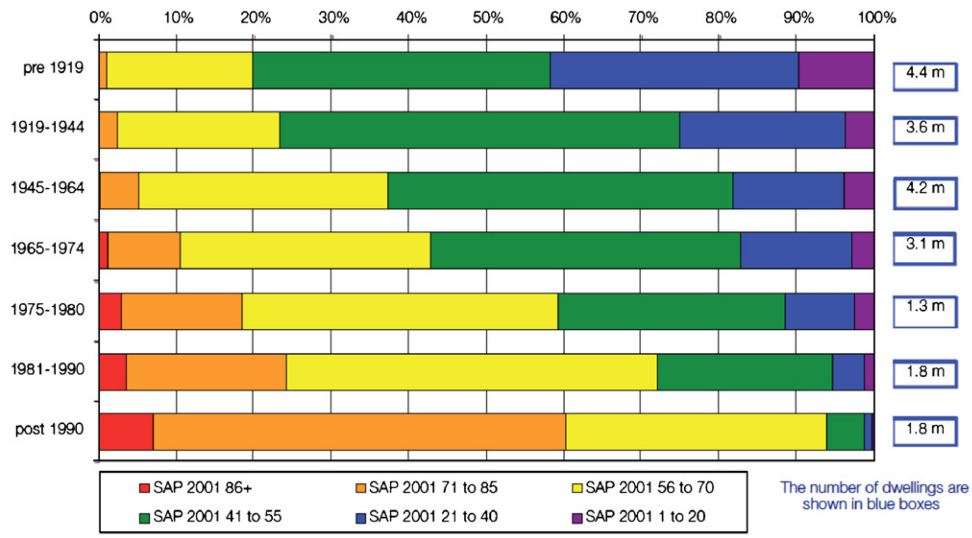

Chart 1. Profile of Energy Performance in Existing Dwelling Stock, 2004. *Source*: Department for Communities and Local Government (DCLG) Review of the Sustainability of Existing Buildings: The Energy Efficiency of Dwellings—Initial Analysis, DCLG, London, 2006.

five main building components: walls, roofs, doors, outer doors and windows.

To work in practice, an upgrading programme that included energy efficiency would require an enforceable code for existing homes, equivalent to the recent Code for Sustainable Homes, which applies only to new build. Enforcement of building regulations on existing homes would encourage investment in energy efficiency. Energy improvements complying with a tough enforceable building code for existing homes could attract a sliding scale of subsidy for improvements, depending on how much they reduce carbon emissions. The energy information packs now being introduced will show the energy performance of a home.

Incentives for the reuse of infill sites and empty buildings, as proposed by Barker (2006), would encourage new supply alongside neighbourhood renewal and upgrading. To support such reinvestment in dense built-up, mixed-use and low-income areas, we need to ensure the long-term maintenance of communal areas to retain the attractiveness of the existing built environment (Power, 2004d).

As urban densities rise to a more sustainable level through these measures, there would be beneficial knock-on effects, particularly on transport and car use but also on local services, further reducing energy use (Satterthwaite, 1999).

7. Conclusions

The case for planned large-scale demolition for energy reasons is greatly weakened when we consider embodied energy as well as energy in-use. There are many unclear areas of information such as exact embodied energy values, the costs and applicability of refurbishment, the direct energy impact of demolition and its wider environmental impact. Renovation is possible in most circumstances as the German experience and SDC case studies show. It sets in train a virtuous circle of renewal with wide benefits for social, economic and local environmental conditions, thereby reducing pressures to sprawl as people try to escape 'bad neighbourhoods'.

Highly selective demolition, a 'scalpel' approach to existing areas, can remove dangerous and un-saveable properties, whereas planned government-supported demolition invariably targets whole streets, blocks, estates or areas (Power and Mumford, 2003). Both the wider arguments and concrete evidence support a focus on renovation rather than large-scale demolition.

Even with the highest feasible level of demolition, the existing stock would remain the dominant energy challenge in the built environment far into the future. Higher incentives through policy reform could reduce energy use within a short time frame, and could achieve a significant reduction of carbon emissions from buildings by 2020. Upgrading of the existing stock to reduce CO_2 emissions cheaply, quickly and easily would be invaluable in shaping future housing policy.

There are gaps in the scientific evidence base around the issues we have discussed.[22] Further work is needed on the wider environmental impacts of demolition, new build, renovation, density, materials and other issues to clarify the arguments put forward in this paper.

The timescales for reducing energy in buildings are short and the task is huge and urgent. While the very best new build will deliver energy gains on a significant scale in the long term, from about 2045 onwards, each new and unrenovated existing home will incur large energy debts in the short term. Since the case for demolition on energy grounds is not clear cut, higher refurbishment standards for existing homes, including under-floor and solid wall insulation, using known methods, offer better value and potentially greater gains.

There are many technical unknowns in the energy world and the science of climate change and energy is fast moving. The next decade is likely to see major transformations. Decentralised energy supply for whole areas and micro-CHP in existing homes could transform energy calculations in existing homes within a few years, for refurbishment as well as new build, and for existing communities as well as newly planned ones. We will have to respond to new scenarios in a flexible and evolving way. It is unclear how energy use will work out in practice. So, an approach grounded in the realities of our complex built environment seems

[22] Issues needing further evidence include: the full carbon impact and wider environmental impact of demolition; the relationship between density and energy use; the balance of energy impacts between thermal mass and light weight construction; the problems of overheating and the need for cooling in buildings; the wider environmental impacts of development on biodiversity, water use, water treatment, waste, tree cover, flooding and agriculture; the relationship of transport to building infrastructure costs; decentralised energy potential in existing areas; and new energy-saving technologies.

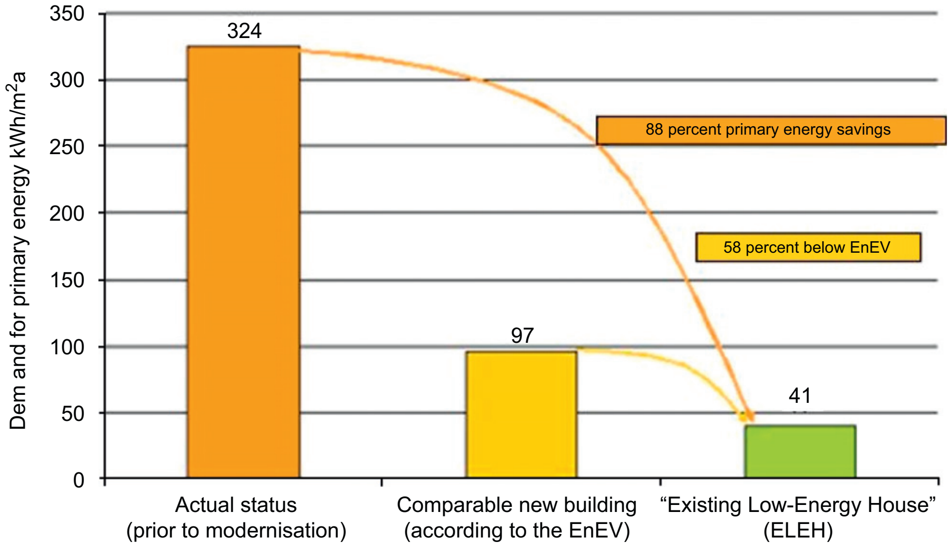

Chart 2. Evidence of energy reductions in German Zukunft Haus Programme. *Source:* DENA, http://www.bmvbs.de/Bild/original_989637/bild.jpg.

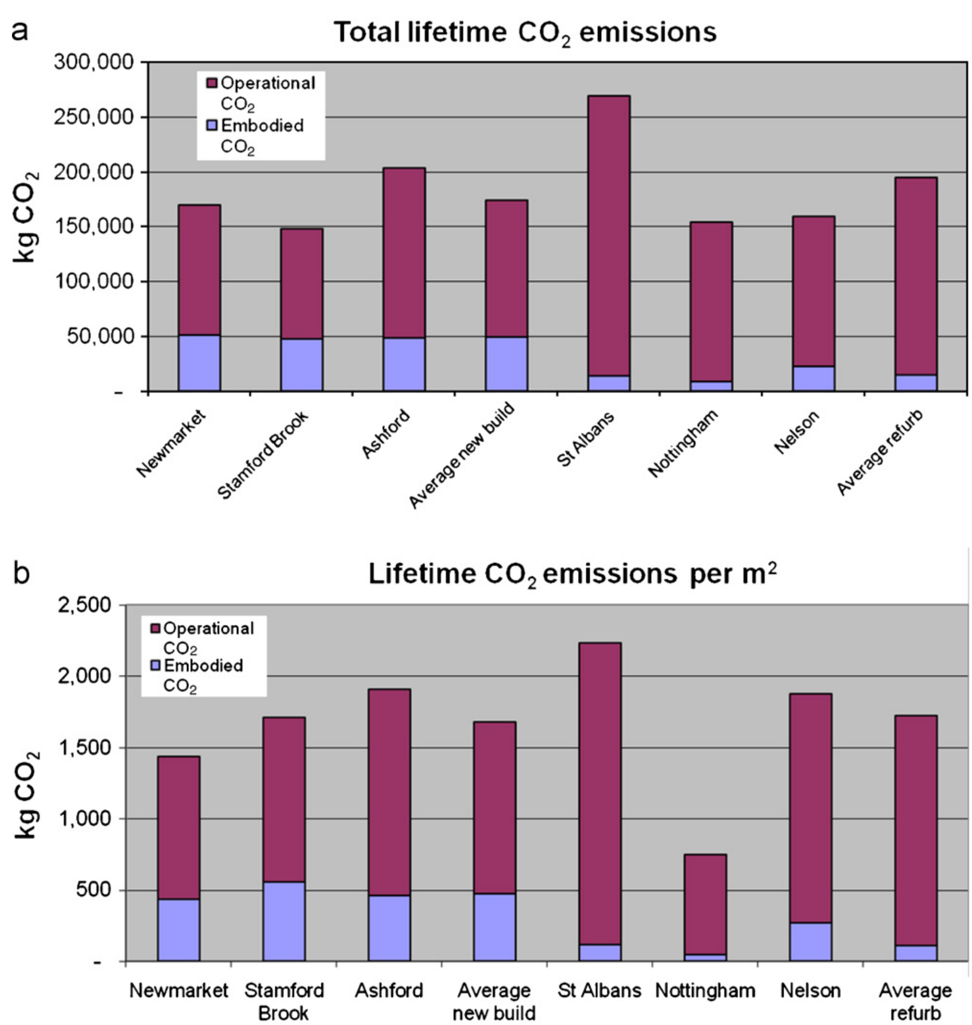

Chart 3. (a) CO_2 emissions from new build and refurbished homes. *Note:* Nelson and Nottingham are both 19th Century properties and compare favourably with average new build in total CO2 emissions. *Source:* Ireland D. New tricks with old bricks: how reusing old buildings can cut carbon emissions, The Empty Homes Agency, London, 2008. (b) CO_2 emissions from new build and refurbished homes per m^2. *Source:* Ireland D. 2008.

more hopeful than a theoretical, long-term and largely uncosted plan to build and demolish on unprecedented scales within our seriously constrained environment.

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Lizzie Chatterjee made many helpful suggestions with invaluable technical advice. Through her work on existing homes, she uncovered case study evidence and evidence from many organisations working in this field. John Hills provided advice on analysing the full economic costs of new build, demolition and refurbishment. Laura Lane traced source documents, references and appendixes, corrected the text many times and liaised with original sources for the work. David Ireland of the Empty Homes Agency, Gavin Killip and Brenda Boardman of the Environmental Change Institute, Deborah Lamb of English Heritage, Tim Yates of the BRE Trust contributed extensively to the thinking behind this paper through their own work and in many lively discussions. Thanks are due to them all. The author bears full responsibility for any mistakes or misinterpretations. As this is a discussion paper, the author would welcome suggestions, comments and alternative views.

Appendix

(1) Profile of energy performance in existing dwelling stock, 2004 (Chart 1).
(2) Demand for energy services is increasing, with more smaller households demanding more power.
(3) Housing stock demolition rate, lifetime and energy consumption, UK.
(4) Average SAP rating by tenure.

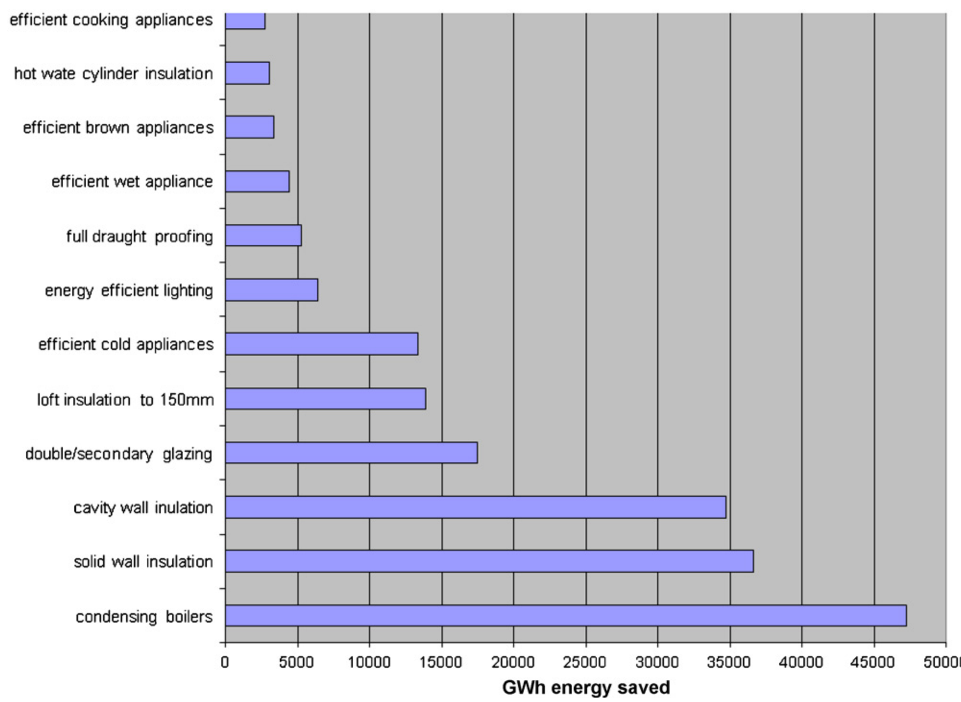

Chart 4. Average carbon savings from different energy efficiency measures. *Source:* Sustainable Development Commission (SDC), 'Stock Take': delivering improvements in existing housing. SDC, London 2006, p33.

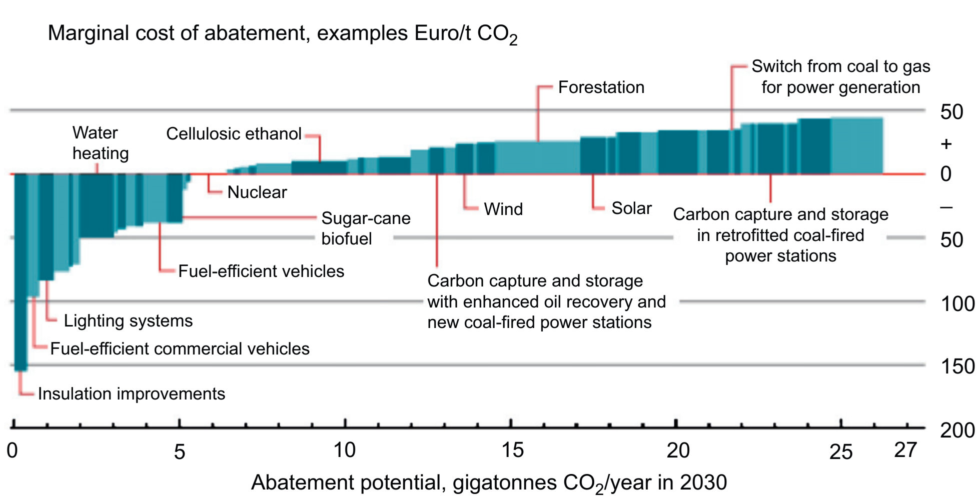

Chart 5. Negative cost of energy efficiency measures. *Source:* The economist, a special report on business and climate change, June 2, 2007.

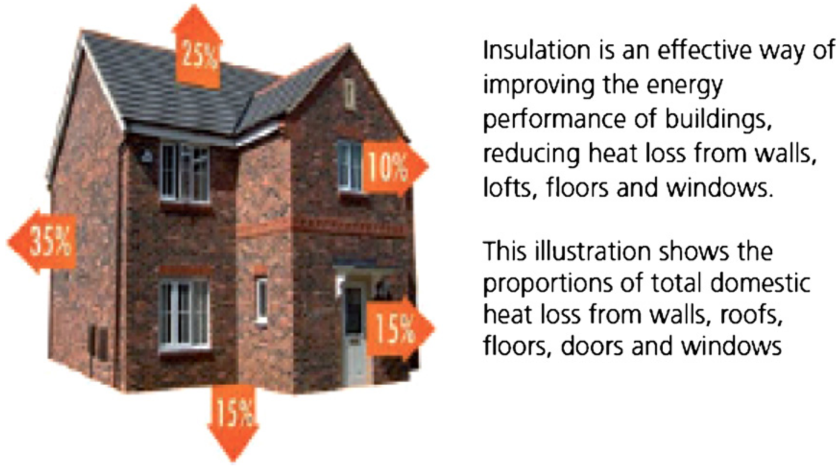

Chart 6. Main building elements showing the percentage of energy they lose without high insulation. *Source:* DCLG, 2006.

	1 person	2 people	3 people	4 people	5+ people	All
Owner-occupied	77	48	33	27	21	46
RSL	54	31	24	19	15	36
Couple + dependent child(ren)	-	-	31	26	20	26
Couple aged 60+	-	48	34	27	20	46
1 person under 60	65	-	-	-	-	65
1 person aged 60+	71	-	-	-	-	71
All	69	44	31	25	20	44

Chart 7. Average floor space by household size and category, England, 2001 (m^2/person). *Source:* adapted from Department for Communities and Local Government (DCLG), English House Condition Survey 2001, DCLG, London, 2003.

(5) Performance of pre-1996 housing when refurbished.
(6) Performance of new homes to 2050.
(7) Comparison of embodied and operational energy for refurbishment and new build, Scenario B.
(8) Evidence of energy reductions in German Zukunft Haus Programme (Chart 2).
(9) CO_2 emissions from new build and refurbished homes (Charts 3a, b).
(10) Cumulative CO_2 from sample of new build and refurbished properties.
(11) Net space heating energy demand, existing stock and new build to 2050.
(12) Estimated SAP ratings, energy costs and CO_2 emissions before and after refurbishment.
(13) Housing Corporation Standard for EcoHomes.
(14) Average carbon savings from different energy-efficiency measures (Chart 4).
(15) Cost per carbon unit saved for range of measures (Chart 5).
(16) There are many cost-effective energy-efficiency measures available to households.
(17) Negative cost of energy-efficiency measures.
(18) Heating and travel provide the largest contribution to the average individual's annual CO_2 emissions.
(19) Main building elements showing the percentage of energy they lose without high insulation (Chart 6).
(20) Microgen and solid wall insulation is more expensive than other measures and will take a longer time to repay.
(21) Average floor space by household size and category, England, 2001 (m^2/person) (Chart 7).

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