It's the Size of the Reduction Target, Stupid! The Need for a Wholesale Re-Think of Energy Efficiency Policy in UK Housing

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ABSTRACT

Energy efficiency programmes in the UK have traditionally sought to promote individual measures (eg loft insulation, central heating upgrades) which meet 'cost effectiveness' criteria but, even if they were to achieve 100% uptake, these measures do not have the potential to deliver sufficient savings to reach a 60% reduction in CO_2 emissions by 2050, even less an 80% reduction target. However, the technical potential is substantial if the cost-effectiveness criterion is ignored and a more integrated, holistic approach is taken to achieving low-carbon retrofits.

Lessons can be learned from the successful transformation of stocks of appliances in Europe but buildings present significant challenges: compliance with codes is poor for new-build; codes for existing buildings are at a very early stage of development; quality of installation is key but hard to monitor or enforce; products need to work together as part of an integrated design, while piecemeal interventions can undermine performance overall.

Tackling these problems will require policy interventions in several domains simultaneously: training and skills; financial incentives; more research on the robustness of low-carbon building technologies and systems; development of suitable standards (including the choice of suitable metrics). An ambitious and relatively costly investment in the housing stock can achieve several policy goals – not just climate change mitigation, but also adaptation to unavoidable climate impacts, improvements in health, increased energy security, and the creation of new jobs and business opportunities.

The Origins and Limits of Current Policy

The UK is unusual in having deep, long-term CO_2 emissions reduction targets. Following the report 'Energy – the changing climate' by the Royal Commission on Environmental Pollution in 2000 (Royal Commission on Environmental Pollution 2000), an ambition to achieve a 60% reduction in the nation's CO_2 emissions over a 1990 baseline has been a consistent element in UK government policy documents. The energy white paper of 2003 set out 4 objectives for UK energy policy (Department of Trade and Industry 2003):

- a 60% reduction in CO_2 emissions over 1990 by 2050
- eradication of fuel poverty
- security of supply
- competitiveness of UK economy

Thus, for the first time, the government set the environmental goal of tackling climate change on an equal footing with key social and economic dimensions of energy policy.

The 60% reduction target is consistent with stabilisation of atmospheric CO_2 concentrations at 550 parts per million by volume (ppmv) (Royal Commission on Environmental Pollution 2000): more recent climate science suggests that stabilisation needs to be at a significantly lower level, say 450 ppmv, which implies a more radical cut of perhaps 80% (Tirpak, Ashton et al. 2005). In debates on the Climate Change Bill, currently before parliament, these figures have been much in evidence. The Bill, if passed into law, will place a legal duty on the UK government to achieve and report on greenhouse gas reduction targets. The report on the draft Bill by the Environment, Food and Rural Affairs Committee commented in July 2007:

> Whilst we agree with the substantial amount of evidence calling for the 2050 target to be higher than 60%, we recognise that this target itself is still extremely ambitious. We are not in a position to suggest whether the 2050 target should be higher than 60%. However, we recommend that the first task of the Committee on Climate Change should be to assess the current state of knowledge regarding climate science in order to determine what the 2050 target should be and the trajectory for achieving it.
>
> (House of Commons Environment Food and Rural Affairs Committee 2007)

Analysing an entire nation's climate change impacts is, by definition, a cross-sector exercise. Even so, sectoral analysis is still needed to get to grips with the detail of policy going forward. Energy use in housing accounts for 27% of UK CO_2 emissions and deep reductions across the economy will require action in this significant fraction of the total emissions profile. Indeed, some have argued that emissions reductions in the housing sector will have to be higher than average in order to allow for less ambitious targets in other sectors, such as transport, where the scope for savings is thought to be smaller.

While climate policy has a history of less than 20 years (taking the 1992 Rio Earth Summit as a rather arbitrary starting point), energy and housing policy have much longer pedigrees. The focus within the area of energy in housing has been on social welfare and benefit to the poorest, most vulnerable households. In much of the twentieth century, policy was directed at improving slum conditions, reducing over-crowding and providing a level of sanitation and health in housing which the majority of UK citizens nowadays take for granted (Power 1987). Even so, there remains a persistent problem of fuel poverty affecting millions among vulnerable householders, which has become greater as a direct consequence of steep fossil fuel price increases since 2002 (Boardman 2007, Department for Communities and Local Government 2005) There were some 26,650 excess winter deaths in Great Britain[1] in 2006-2007 (General Register Office for Scotland 2007, National Statistics).

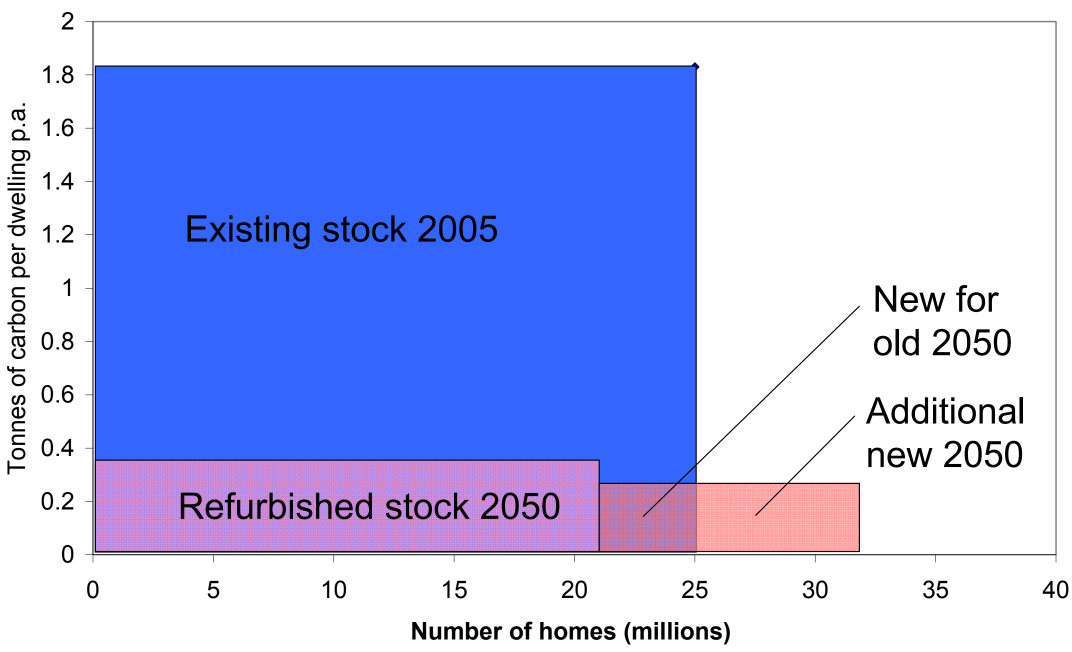
Without dismissing the important improvements in welfare that have been achieved over the last century or so, nor the need for continued work in the area of fuel poverty, the fact remains that the newer climate change policies sit uncomfortably alongside the better established policies on energy in housing. Approaches from the earlier policy framework continue to be adopted in the belief that they can meet multiple objectives: provision of improved welfare and deep cuts in sectoral CO_2 emissions. With an outlook to 2020, the government's Energy

[1] Official statistics often vary as to the precise boundaries covered. The British Isles comprise Great Britain, Ireland and many smaller islands. The largest island, Great Britain, comprises England, Scotland and Wales. The island of Ireland comprises the Republic of Ireland, an independent state, and the province of Northern Ireland. The United Kingdom comprises England, Scotland, Wales and Northern Ireland. The population of the UK in 2006 was 60.6 million:50.8m in England (84%); Scotland 5.1m (8%); Wales 3m (5%); Northern Ireland 1.7m (3%).(National Statistics 2007))

Efficiency Action Plan 2007 estimates that current policies across the whole economy can achieve an 18 % reduction in primary energy consumption by 2016 and that a 20% reduction will be possible by 2020 (Department for the Environment, Food and Rural Affairs 2007).

In fact, there are several reasons why government projections can be shown to be optimistic at best. Firstly, several of the policies relate to new-build housing and the savings claimed for these are compared with previous (less stringent) editions of the energy-related parts of the regulations. These policies are shown shaded in table 1, and represent 37% of the total expected savings by 2020. However, each new home constructed represents an additional burden, not a saving: the homes built between now and 2020 are additional to the building stock that existed in the base year over which savings are calculated. If every new home built achieved zero net emissions in practice, then the total savings in absolute terms would be zero. In order to make a real contribution to savings, new homes would have to be better than zero-carbon, ie they would have to be net exporters of renewable energy. In fact, the UK house-building industry is currently struggling to get to grips with the policy announcement that all new homes in England should be zero-carbon by 2016 (the target date is 2011 in Wales; a slightly different approach is being adopted in Scotland). Homes currently being built are certainly not at this standard.

Figure 1. Co_2 Emissions from Refurbished and New-Build Housing in a Scenario Achieving 75% Co_2 Reductions by 2050 (Source: Royal Commission on Environmental Pollution 2007)



Demolitions and replacements will make relatively little impact in the UK because of the size of the existing stock and the rates of new-build and stock losses (mainly demolitions). A scenario achieving 75% CO_2 reductions by 2050 was developed by the Environmental Change Institute for the Royal Commission on Environmental Pollution's report The Urban Environment. This scenario included a five-fold increase in current demolition rates, as well as zero-carbon new homes from 2020. The bulk of energy and carbon savings will come from upgrading the existing stock (fig 1).

Table 1. Policies and Expected Cumulative Savings in the Household Sector in 2010, 2016 & 2020 (Department for the Environment, Food and Rural Affairs 2007)

	Expected cumulative energy and carbon savings:					
	in 2010		in 2016		in 2020	
Policy	**TWh**	**MtC**	**TWh**	**MtC**	**TWh**	**MtC**
Energy Efficiency Commitment Phase 1 (EEC1)	3.1	0.3	3.1	0.3	3.1	0.3
Energy Efficiency Commitment Phase 2 (EEC2)	7.8	0.5	7.8	0.5	7.8	0.5
Carbon Emission Reduction Commitment (CERT)	14.2	1.0	15.5	1.1	15.5	1.1
Supplier Obligation	0.0	0.0	31.2	2.2	50.2	3.5
Northern Ireland Energy Efficiency Levy	0.4	0.0	0.4	0.0	0.4	0.0
Fuel Poverty Schemes	2.7	0.4	2.8	0.4	2.8	0.4
Energy Performance of Buildings Directive (EPBD)	3.5	0.2	7.6	0.4	10.1	0.6
Building Regulations England & Wales 2002	11.4	0.6	12.5	0.7	12.5	0.7
Building Regulations England & Wales 2005/6	13.2	0.7	33.8	1.8	49.4	2.6
Building Regulations Scotland 2007	1.8	0.1	4.7	0.2	6.8	0.4
Building a Greener Future – Towards zero-carbon homes	0.0	0.0	4.2	0.2	22.6	1.2
Billing and Metering	2.6	0.2	5.8	0.4	5.8	0.4
Product Policy	6.6	0.6	11.2	1.0	14.2	1.3
Package of Measures	1.4	0.1	1.5	0.1	1.5	0.1
TOTAL HOUSEHOLD SECTOR	**68.7**	**4.7**	**142.1**	**9.3**	**202.7**	**13.1**

UK government Department for the Environment, Food and Rural Affairs 2007

A second reason why savings projections are optimistic is the question of compliance: expected savings due to revisions to building regulations are based on an assumption that design codes are complied with in practice. Two studies of new-build housing in the UK have shown that this is not the case: new homes commonly failed to meet the airtightness standards in the 2002 regulations (Grigg 2004) and the energy-related section of the building regulations is systematically not enforced by Building Control inspectors, who only take seriously those defects which affect structural safety and fire safety (ie where failure is a matter of personal safety). To threaten a constructor with legal action because of non-compliance on an energy-related issue is seen as an inappropriate course of action, out of proportion with the seriousness of the infraction (Energy Efficiency Partnership for Homes 2006).

Savings from policies targeted at the existing housing stock also present problems, especially if the timescale for CO_2 reduction targets is extended beyond 2020. Much of UK energy efficiency policy for housing is financed by an obligation on energy suppliers to invest in their customers' homes. This programme was called the Energy Efficiency Commitment (EEC), which ran in two rounds, EEC1 and EEC2, between 2002 and 2008. From April 2008 – 2011, the new programme name is Carbon Emissions Reduction Target (CERT). Energy suppliers understandably seek to obtain maximum CO_2 reductions at minimum cost, and the effect of policy over several decades has been to create a delivery infrastructure that is geared to installing individual measures with a simple payback of 7 years (table 2).

Table 2. Energy efficiency refurbishment measures, showing which are supported by policy and which are not.

Measures supported by government programmes (<7 years simple payback)	**Other technically feasible refurbishment measures (>7 years simple payback)**
Cavity wall insulation	Solid wall insulation
Loft insulation	Ground floor insulation
Draught-proofing	High-performance glazing
Hot water tank insulation	Reducing air infiltration (eg blocking up redundant chimneys, flues)
Efficient heating boiler[2]	Passive solar design features (where site conditions allow)
Heating controls	

The cost-effective measures have been supported through such policies for decades and the potential for further uptake, though still considerable, is nonetheless limited by the available number of suitable properties for each measure.

Low- and zero-carbon technologies (LZCs)[3] are supported under a separate grants programme, the Lower Carbon Building Programme, which offers a percentage contribution towards capital costs on condition that the cost-effective energy efficiency measures have already been incorporated into the building (ie no funding for a solar panel if the quick and cheap demand reduction measures are not in place). It is estimated that there were some 107,000 homes served by LZCs in the UK in 2005, with 228,000 projected for 2011 – still less than one per cent (Boardman 2007).

Three separate studies using computer modelling of the energy use and CO_2 emissions from UK housing each conclude that 100% saturation rates for the cost-effective energy efficiency measures are insufficient to achieve a 60% reduction in CO_2 emissions from housing by 2050. However, these same studies each describe scenarios in which reductions of 60 - 80% or more are technically achievable by some combination of ambitious demand reduction through refurbishment and supply-side solutions, be they LZCs or remote low-carbon electricity generation (Boardman, Darby et al. 2005, Johnston 2003, Shorrock, Henderson et al. 2005).

A Possible Way Forward: A Market Transformation Approach

A Market Transformation approach for UK buildings is being studied by a consortium of UK universities[4], developing a policy approach that has proved successful in the successful transformation of stocks of electrical appliances across Europe since the mid 1990s, based on three inter-linked policies: provision of information on performance; incentives for innovation; regulation of a minimum energy performance standard (Boardman 2007, Boardman, Darby et al.

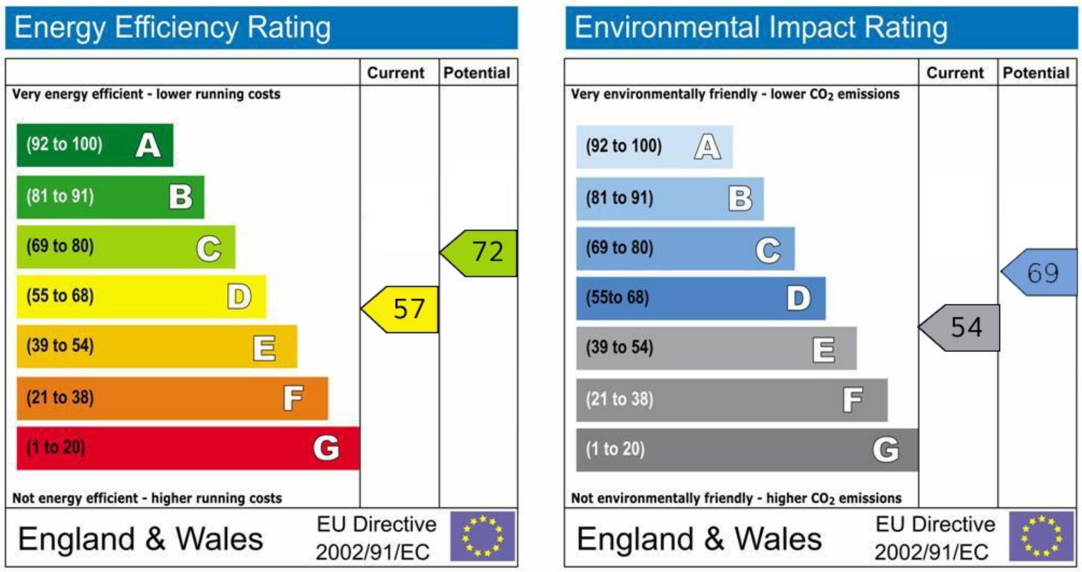
[2] Condensing boilers were supported under early years of EEC, but have been ineligible for support since they were mandated by minimum standards introduced in 2005.

[3] Low-carbon technologies are those which use fossil fuel more efficiently than conventional alternatives (eg heat pumps, combined heat and power); zero-carbon technologies use renewable energy sources.

[4] Universities of Bath, Cardiff, Oxford, Strathclyde. See http://www.eci.ox.ac.uk/research/energy/bmt.php

2005). Implementation of the EU Energy Performance of Buildings Directive now means that homes offered for sale are required to have an energy performance certificate (EPC), which gives a current and potential rating for the property, both in terms of energy consumption and CO_2 emissions (fig 2). Rented properties are to be included from October 2008. Thus, despite some remaining concerns about the detailed workings of the EPC, there is information on the energy performance in the market for UK homes for the first time. However, incentives for innovation are absent, while the whole question of a minimum energy performance standard for refurbished property is not being addressed at all.

Figure 2. Energy Performance Certificate Ratings for Homes at Point of Sale in England & Wales



The processes of innovation in housing refurbishment are quite different from those involved in product design. A product design process can be typified as being fairly linear (albeit with feedback loops between the different steps of the process) and under the control of one decision-making body, the product manufacturer. Once a prototype reaches the required technical standard, the shift to full-scale production is relatively straight-forward. In contrast, the refurbishment of an entire nation's housing stock involves a web of inter-dependent actors and decisions, each one having a potentially significant effect on others and on the final outcome. In the UK, 70% of the 25.7 million dwellings are privately owner-occupied, meaning that the impact of the stock of buildings is related to a very large number of very small-scale decisions, both by the householder and by the installers called in to do any refurbishment work. For example, the performance of a heating system requires the heat source to be sized to match the building's thermal characteristics. If the boiler is selected without consideration of major insulation works being carried out, it may be over-sized and wasteful as a result. Similarly, if a heat source is selected on the assumption that the home will be well insulated, then it will be insufficient if the insulation falls short of expectations, for whatever reason. A secondary (and possibly inefficient) heat source may well be needed to maintain comfort. The integration of micro-generation technologies into a building requires skills and knowledge about the performance of the whole building and its various energy systems, not just one element. For example, solar hot water systems typically need a hot water storage tank, and their installation involves skills from at least four traditional building trades (roofing, plumbing, electrics, general building) in addition to specialist solar skills.

These issues raise a series of questions about training, skills and the challenge of successfully integrating the work of a number of specialist building trades, which have traditionally been seen as separate (eg plumbers, electricians, general builders). It also suggests that some of the interventions that will be required are going to be most effective (or, perhaps, only effective) when applied through a holistic package of measures, rather than as one-off installations of separate products. The scale of interventions needed, and the need for a holistic approach to optimise the various elements of a package both point to the need for activity on a large scale. A process of audit and major refurbishment is indicated, and the need for innovation is at least as much about new processes and ways of working as about new technologies. The ordering of works is key to the successful integration of appropriate insulation materials, for example, and the need to carry out repairs and improvements that are completely unrelated to energy conservation often represent significant opportunities for such works (eg re-wiring or re-plastering offer opportunities to insulate walls internally). Seizing opportunities to reduce cost and disruption to marginal levels will be key to this new process of whole-home audit and refurbishment. Similarly, the prescriptive schedules of major works for public-sector housing need to integrate packages of measures beyond what is currently cost-effective in order to bring those buildings up to standard (eg when roof repairs are needed on an apartment building, the need to pay for scaffolding represents an opportunity to upgrade insulation and windows as well as being a good time to consider roof-mounted renewable energy technologies).

> Incentives could be used to stimulate refurbishment activity generally (ie not specifically targeted at carbon reduction targets), which would be administratively easier than linking incentives to measures, and would liberate the scope of works from the narrow definition of 'cost-effective' which underpins so much of current energy policy in housing. A reduced rate of value added tax (VAT) from 17.5% to 5% has the potential to meet all or most of the marginal costs of refurbishment to meet or exceed a 60% reduction target - admittedly based on an analysis of only a handful of prototype 'demonstration' projects (Killip, Eyre forthcoming).

Other tax-based incentives could be linked to reduction targets (although no refurbishment standard currently exists) or, more likely in the short-term, to approved measures. Candidates include exemptions to Stamp Duty, the UK's property transaction tax, and Council Tax, which partly funds local government services. A precedent exists for Stamp Duty rebates used to incentivise construction of zero-carbon new homes (NB not refurbishments), and Council Tax rebates have been used as a vehicle for incentives on a handful of one-off, locally limited (and often short-lived) schemes.

When it comes to minimum standards, the UK government's focus has been on new-build housing, where a zero-carbon target by 2016 has been announced and the adoption of the 6-star rating scheme under the Code for Sustainable Homes provides a means of measuring progress towards that target. What would a realistic target for energy/carbon performance be for refurbishment? Should there be one target or several, in recognition of the different practical barriers, costs and technical details to be worked out for homes of different types? Is energy consumption per square metre the appropriate metric, or does that give undue freedom to pollute to larger homes, typically occupied by more affluent households? If the metric were to be emissions per household, would that make refurbishment of certain (larger) properties all but impossible, with negative consequences in terms of economic hardship and, at the extreme, possibly abandonment of otherwise sound homes on the grounds that they cannot be brought up to standard at an acceptable cost? Clearly, more research on appropriate standards would be needed before such a scheme could be introduced.

The development of a standard (or set of standards) presents an opportunity to engage with the construction industry as part of the process of making low-carbon refurbishment mainstream. Here, the appropriate incentives might be competitions and prizes for ground-breaking projects, following the example of the European Energy+ programme to reward appliance manufacturers producing refrigerators and freezers which went beyond the top A rating on the label, and which led to the introduction of A+ and A++ categories to keep up with the rapid advances in product performance (Energy+ 2004).

Compliance could begin to be tackled by mandating a monitoring and reporting programme as part of an awards scheme for innovation, and feeding the lessons learned back into construction training programmes. Quality of insulation installation, thermal bridging and heat loss through uncontrolled ventilation have been identified as major contributors to under-performance (Olivier 2001) and yet awareness of these issues is still very low. Education of construction workers has the potential to reduce that part of the compliance problem which is due to ignorance. Improving the compliance regime through inspections is no doubt desirable, but the scale of the refurbishment works under discussion here would represent a huge increase in the workload of an inspection regime, which is already under-resourced to meet the workload of new construction. A first step towards better compliance might have to be found elsewhere. It may be possible to use consumer power, coupled with one or more measures to increase the visibility of energy consumption, and thereby create consumer demand. Better display devices or meters have the potential to raise the energy-literacy of the population, as does the EPC. It remains a moot point whether and how this awareness can translate into householders being more effective in achieving good quality results from building contractors.

From Voluntary to Mandatory Standards

Germany has had a voluntary programme of advanced refurbishment since 1996, aiming to bring the entire stock of pre-1984 homes up to modern standards in twenty years. A number of impressive case studies of individual buildings from this programme show that an integrated approach to refurbishment, not limited by narrow definitions of cost-effectiveness, can achieve deep cuts in CO_2 emissions – at least in theory. However, the rate at which the work is being carried out falls a long way short of the ambitious target: if work were to progress at the rate of the average over the first nine years of the programme, it would take over 175 years to refurbish the entire stock of 17.3 million German homes (Killip forthcoming). Similarly, the voluntary Swiss Minergie standards (which include a standard for residential refurbishment of 60 kWh/m^2/year for heating, hot water and mechanical ventilation) have been adopted for a few hundred residential buildings across Switzerland and France (Minergie website), an insignificant fraction of national building stocks.

If the lessons from market transformation of electrical appliances are valid for building refurbishment, the missing element in the German refurbishment programme is regulation of the minimum standard. While participation in the scheme remains voluntary, and there is no penalty (or threat of a future penalty) for non-participation, it appears that advanced low-carbon refurbishment remains a minority activity.

Property transactions may be the best intervention point for regulation of a standard, using the EPC rating as the publicly visible scale against which the standard applies (even if the technical definition of the standard 'under the label' may well have to change over time, particularly if monitoring data can be collected to provide a reality check for the computer algorithms currently in use). The Home Truths report proposed that such a standard would not apply on the first transaction after the introduction of the standard, but would apply on every sale or rental thereafter, with the standard getting progressively tighter over time (Boardman 2007). It would be illegal to sell or rent a property which did not meet the standard. This would provide an incentive to maximise low-carbon opportunities at every refurbishment as a means of safe-guarding property against future unsaleability. Such a scheme is some time away from being realisable in purely technical terms (not least because there is no standard) but by far the greater barrier is political. It would surely take enormous political courage and strong leadership for an elected politician to propose such a scheme, and the social climate in which it might be politically acceptable seems a long way off at present.

A strategy begins to emerge from this discussion. While the market transformation approach and the experience of voluntary standards both suggest that mandatory minimum standards will be needed, there are clearly other elements of policy and programmes that need to be in place first. A standard needs to be developed, as does the capacity of the construction industry to deliver a measured result, which is currently very unfamiliar. Involvement of the construction workers in helping to develop or test the standard could be a good way of improving learning, while an engagement with the public through promoting labels and display devices may help stimulate demand for low-carbon refurbishment services. Key to both processes is the need to build upon and maximise the potential of the EPC. There are also enormous socio-economic benefits of an ambitious refurbishment programme: eradicating fuel poverty; improving health and comfort more generally; helping to protect consumers against future fossil energy price shocks; incorporation of adaptation measures (eg to protect against flooding) will help protect assets and insurability; creating extra activity and potentially large numbers of new jobs in construction.

Conclusion

The UK's approach to policy for energy efficiency in housing has been based on one-off installations of measures defined as currently cost-effective. With the historical focus on housing and social welfare over at least a century, this approach has achieved significant amounts of improvement to the stock and the lives of householders, even though the scourge of fuel poverty persists. However, the potential of this policy approach is insufficient when coupled with a climate change policy requiring 60% or 80% reductions in CO_2 emissions by 2050.

The measures-based approach is set to continue for the foreseeable future, and will be valuable in achieving more of the 'easy wins'. However, a method is needed to innovate and start a market for low-carbon refurbishment against a standard which is consistent with the national policy target for CO_2 reduction.

An equivalent of the Energy+ programme for buildings could be used to foster innovation among the construction industry, especially among the small and medium-sized firms, who are primarily involved in refurbishment. This could help inform the development of suitable standards for refurbishment, as well as providing monitoring information to feed back into national vocational training programmes. In the absence of an effective compliance regime, another route to ensuring greater quality could be to educate property owners to be more effective clients for refurbishment work, building on any means to make energy more visible, and therefore comprehensible, to the general public.

Even so, a voluntary standard and a greater level of energy-awareness among builders and householders is unlikely to be enough, given the experience to date in other European countries. At some stage, if the lessons from market transformation of appliances are valid for buildings, there will need to be a mandatory minimum standard. Rather than shrinking from this conclusion as too politically unrealistic, a start can be made towards a climate in which it becomes not only realistic but welcomed – by emphasising the considerable benefits to the environment, economy and society.

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