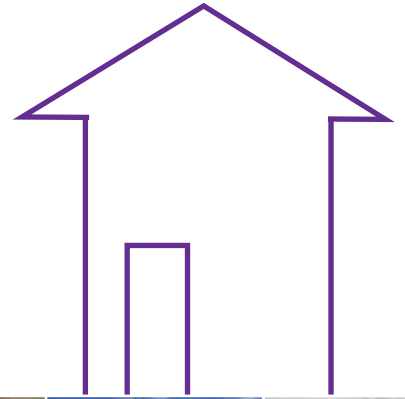


# achieving zero

delivering future-friendly buildings



Brenda Boardman



Environmental *Change* Institute



## Cover images

The buildings on the front cover are all super energy-efficient retrofits that have achieved passivhaus standard or reached a A/B-band on the energy performance certificate. They include (from left to right):

- o A 1930's semi-detached property in Falmouth, Cornwall
- o 17 St Augustine's Road, Camden
- o A renovated property by the *Target 2050* project run by Stroud District Council and Severn Wye Energy Agency
- o Totnes B & B, a retrofit that achieved the more demanding Passive House standard
- o The inside of a Victorian property on Stapelton Rd, Oxford
- o A second renovated property by the *Target 2050* project
- o Mayville Community Centre, Bere architects

## Acknowledgements

The wisdom of numerous people has helped me develop and ground these ideas – their knowledge, freely given, has been inspirational and salutary. I hope I have used it wisely. Several colleagues have read drafts at various stages and the comments and firm guidance from Stephen Berry, Joanne Wade and Tina Fawcett have been particularly important. I thank them all. Most importantly, I am grateful to Doug Parr for liaising with the Greenpeace Environmental Trust to make this commission come about and to Nick Eyre, as head of the Lower Carbon Futures team at the ECI, for his support and encouragement. Let the debate begin!

## About the author

Dr Brenda Boardman, MBE, FEI is an Emeritus Fellow with the Lower Carbon Futures team at the Environmental Change Institute, University of Oxford and Honorary Visiting Professor at the University of Exeter. Since 1981, her main research focus has been on domestic energy efficiency, with a strong concern for the fuel poor and policy generally. Her recent publications include: *Home Truths* (2007), *Fixing Fuel Poverty* (2010) and, with other LCF team members, *40% house* (2005).



This work was supported by a grant from Greenpeace Environmental Trust.

Greenpeace Environmental Trust is a registered charity founded in 1982 with the objective of furthering public understanding in world ecology and the natural environment. The Trust achieves its aims by grant-funding a variety of investigations, scientific research and educational projects, such as work associated with the protection of Amazon and Indonesian rain forests, and, education, research into and solutions on climate change.

ISBN: 1 874370 48 6  
© Brenda Boardman, 2012  
January 2012

Environmental Change Institute  
Oxford University Centre for the Environment  
South Parks Road, Oxford OX13QY

Download report at: [www.eci.ox.ac.uk/research/energy/achievingzero/](http://www.eci.ox.ac.uk/research/energy/achievingzero/)  
Contact: [enquiries@eci.ox.ac.uk](mailto:enquiries@eci.ox.ac.uk)



# Achieving zero

## Delivering future-friendly buildings

Brenda Boardman

University of Oxford's Environmental Change Institute

# CONTENTS

<b>Foreword</b>	<b>iv</b>		
<b>Executive summary</b>	<b>v</b>		
<b>1 The challenge</b>	<b>1</b>		
<b>Energy and emissions</b>	<b>2</b>		
Greenhouse gases and carbon dioxide	2		
Energy use and buildings	3		
Fuel mix and energy supply choices	6		
Energy services	8		
<b>People and buildings</b>	<b>9</b>		
Size of the building stock	9		
Landlord and tenant	10		
<b>The report</b>	<b>11</b>		
Boundaries and data	11		
The market transformation approach	12		
Structure of the report	17		
<b>Summary</b>	<b>18</b>		
<b>2 Upgrading the stock</b>	<b>19</b>		
<b>Labels</b>	<b>20</b>		
EPCs	23		
DECs	25		
Compliance	26		
Databases	27		
<b>More of the best</b>	<b>29</b>		
Future-friendly buildings	29		
Exemplars	32		
Construction standards	33		
<b>Removing the worst</b>	<b>33</b>		
Minimum standards	34		
<b>Improving the average</b>	<b>36</b>		
Individual measures vs outputs	37		
Exemplars	39		
Getting each building right	39		
<b>Heating systems choices</b>	<b>40</b>		
Green gas	41		
Combined heat and power	42		
Heat pumps	44		
The renewable heat incentive (RHI)	45		
<b>Summary</b>	<b>46</b>		
		<b>3 Constraining electricity demand</b>	<b>49</b>
		<b>Linking supply and demand</b>	<b>50</b>
		Peak electricity demand	50
		Electricity market reform	51
		<b>European product policies</b>	<b>52</b>
		<b>Market transformation in action</b>	<b>54</b>
		Cold appliances (fridges, freezers, etc)	54
		Lighting	56
		Televisions	58
		<b>Labels</b>	<b>58</b>
		Absolute vs relative	58
		measurements	11
		<b>Removing the worst</b>	<b>59</b>
		<b>More of the best</b>	<b>61</b>
		<b>Improving the average</b>	<b>62</b>
		The role of education	62
		Business awareness	63
		Smart meters and tariffs	64
		Supplying your own electricity	65
		<b>Summary</b>	<b>65</b>
		<b>4 Money and value</b>	<b>67</b>
		<b>Present situation</b>	<b>29</b>
		Funding energy efficiency	29
		Private expenditure on building	32
		improvements	33
		Property value	33
		Investment in demand reductions vs	34
		new supply	36
		Sums required	37
		<b>Financial incentives</b>	<b>39</b>
		Council tax	39
		Lifetime mortgages	40
		Green deal	41
		<b>Summary</b>	<b>42</b>



**5 Who delivers? 83**

**Participants 83**

Eradicating fuel poverty 83  
 Low carbon zones 86  
 People, attitudes and behaviour 88  
 Personal carbon allowances 91  
 DECs and businesses 92  
 Green leases and MOU 94  
 Business sub-sectors 95

**Delivery agents 96**

The UK government 96  
 Working with Ofgem and the utilities 96  
 Local authorities 97  
 Property owners 99

**Summary 100**

**6 Template for action 101**

**The core strategy 102**

Adding value to the property 103  
 Equity and fuel poverty 104  
 Demand reduction before new supply 105

**Market transformation 107**

Labelling properties and databases 107  
 - identifying the choices

**Removing the worst 108**

Minimum standards and existing buildings 108  
 Minimum standards and products 110

**Making the best better 111**

Pulling the market 111  
 Procurement and exemplars 112

**Improving the middle 113**

Financial incentives - a useful inducement 113  
 Existing buildings, Building Regulations and consequential improvements 117

**Education and awareness 117**

**Timescales and milestones 118**

What to do first 121  
 2016 and 2018 commitments 122  
 Résumé 124

**References 125**

**Abbreviations 136**

**LIST OF FIGURES**

1.1 Residential energy demand, by use, UK, 1990 - 2010 (TWh)  
 1.2 Business energy demand, UK, 1990-2010 (TWh)  
 1.3 Market transformation curves, now and in 2050, residential stock, UK  
 2.1 Part of a residential energy performance certificate  
 2.2 Display energy certificate for public buildings  
 2.3 Relationship between the EPC, total energy, carbon and costs, per sector, UK 2009/10  
 2.4 Distribution of DEC certificates, UK, 2009 and 2050  
 3.1 Half-hourly electricity demand in a new science building, Oxford University, 18-25 October 2010

**LIST OF TABLES**

1.1 Energy use in buildings, UK, 2009  
 2.1 Regulated vs unregulated total energy use, UK, 2009/10 (% of stock average)  
 2.2 EPC distribution, residential, England (%)  
 3.1 Components of peak electricity demand, GB, 2006 (GW)  
 3.2 Index of electricity consumption in UK refrigerators, 1990-2011  
 4.1 Investment implications of different technologies  
 6.1 Proposed over-arching policy instruments  
 6.2 Target ratings on EPCs, UK, 2009-2050  
 6.3 Electricity use in lights, appliances and equipment, UK, 2009-2050 (kWh pa, per property)

---

# F

## oreword

---

The UK is one of the few countries in the world that has transformed concerns about climate change into legal targets for greenhouse gas reductions. Almost half of all UK CO<sub>2</sub> emissions come from energy use in buildings: as a nation, we want to be able to heat, light, and enjoy our lives in comfort. So to meet any emissions targets for greenhouse gases such as the 80% cuts we are committed to under the Climate Change Act we require a stunning transformation in energy use in buildings. And with some areas like agriculture and aviation it is difficult to make radical reductions in emissions, so the built environment will need to make even more substantial cuts. Even though the UK has some of the worst building stock in EU.

The challenges are significant but the benefits are enormous. Beyond meeting emissions targets, improving the energy performance of buildings increases our energy security, reduces our exposure to rising and volatile fuel prices, reduces energy bills which helps to tackle fuel poverty, creates jobs, reduces the squeeze on living standards and will make our buildings better places to live and work. That's why Greenpeace Environmental Trust wanted to explore a strategy for radical cuts in energy and emissions: we simply cannot deliver our climate change ambitions without it. This is not just a technical prescription of what is needed, but charts a policy pathway to get us on the right track, being aware of the challenges and obstacles – political, economic and behavioural – that lie in the way.

This report identifies the essential components of a strategy to shift our buildings up to a standard of thermal performance compatible with the dramatic cuts in energy use and greenhouse gases over the next few decades. It looks beyond the timeline of government's flagship 'Green Deal' policy and sets out a clear path: the transformation of the building stock is something that will happen over decades not years.

Yet there are inevitably some uncomfortable truths to acknowledge here. Regulatory standards for energy performance – already accepted for the private rental sector – will need to be extended to the owner-occupiers. It will need significant investment and much of the money to pay for decades-old poor construction will have to come from the public purse. But since there's no honest way of hiding from this, there needs to be a political track accompanying any technical roadmap because bold political leadership will be required to deliver these benefits for Britain. The political track needs to start with essential information tools – audits and building labels – to increase public awareness and show the importance and opportunities to those outside the building sector.

Given the growth in per capita power consumption over many decades, policy challenges inevitably remain including how to cap carbon consumption in both business and domestic sectors. Proposals like personal carbon allowances may be unattractive, but if not this policy, what is the alternative? But mostly the direction of travel is clear and the majority of the changes we need to see in building stock are matters of political will; coupled with the determination to set goals and follow-through. The longer we wait, the harder it will be and the more our population will experience high bills and poor housing. All we need now is a Government with the courage to take it on.

**Dr Douglas Parr**  
**Policy Director, Greenpeace UK**



*Achieving zero* provides the policy framework to ensure that all energy use in all buildings in the whole UK results in zero carbon emissions by 2050. This covers 26 million homes and 2 million business (ie non-domestic) properties. The study views the challenges from a people’s perspective – the roles of the property owner and the occupant – with the implications for energy supply one of the results. The emphasis on energy services, rather than energy purchases, shifts the debate on to demand reduction rather than energy supply and on to lower, not higher, bills. Investing in greater energy efficiency provides users with a better standard of living: a future-friendly property is one that it is warmer, more comfortable, healthier.

Zero carbon emissions do not mean zero energy use. The energy services that people want can be obtained with reduced energy demand combined with fuels of a low carbon intensity and building-integrated renewables. In this strategy, the 477TWh of gas and oil and 200TWh of electricity are reduced to a demand for 100TWh of renewable electricity supplied by the grid. The emissions in 2050 would be zero carbon.

The policy framework is developed though a market transformation strategy, whereby a series of policies are designed to interact to lower energy use in buildings. Several of the individual policies exist in embryonic form as isolated actions, but have not previously been welded together. A strong, clear market transformation strategy enables each policy to achieve its full potential as a result of becoming part of a powerful, coherent whole that moves towards low energy use in buildings.

The strategy builds on two sets of natural divisions at the level of an individual property:

- o the different roles of the building owner and the building occupant;

- o the energy use that results from the characteristics of the building (mainly gas for space and water heating, but including electricity in fixed lighting) and the energy use that results from the behaviour of the occupant, including the use of the contents of the building (mainly electricity for appliances and equipment).

Together these form the core policy matrix (Table 1). Responsibility for reducing building-related energy use is given to the building owner, through minimum standards based on the energy performance certificates (EPCs). The occupant has responsibility for the energy used in appliances and equipment and for the standard of energy services generally. In businesses, this is linked to the display energy certificates (DECs) and in households through some other policy that covers all energy use, such as personal carbon allowances (PCA).

	<b>Property owner</b> Theoretical energy use: mainly gas	<b>Occupant</b> Actual energy use: includes all electricity
<b>Residential</b>	<b>Minimum standards based on EPC</b>  82% of all energy in 2009	<b>Personal carbon allowances</b>  100% of all energy
<b>Business</b>	<b>Minimum standards based on EPC</b>  69% of all energy in 2009	<b>Display energy certificates</b>  100% of all energy

*Table 1: Proposed over-arching policy instruments*

It is an essential component of the strategy that more energy-efficient buildings become worth more than energy-inefficient ones. Several policies are designed specifically to ensure this happens and are combined with making

the property owner clearly responsible for the standard of energy efficiency of the property. This provides the property owner with a return on investments in energy efficiency, through higher property values. And conversely, that the property diminishes in value (relatively, if not absolutely) as a result of inaction.

The link between greater energy efficiency and higher market values is created by the introduction of mandatory minimum standards for buildings that are progressively increased. These standards are based on the bands in the energy performance certificates, with the first phase being to take action on F- and G-rated properties, in all tenures, whether residential or business.



## EXECUTIVE SUMMARY

---

The steady ratchetting up of the minimum standards, together with other policies, is designed to ensure that the average existing property is at the top of band A on the energy performance certificate by 2050. At this level, it uses zero net energy – any energy required is provided by on-site renewables.

At least until 2025, the expectation is that gas will remain the main heating fuel, rather than electricity, while the carbon intensity of electricity remains high. The natural gas system will be decarbonised through the addition of green gas from anaerobic digestion thus prolonging the period of its carbon acceptability. Beyond 2025, the need for any space heating will disappear as properties are made low-energy or brought up to passivhaus standard.

Beyond the EPC, the remaining 18% (in homes) and 31% (in businesses) of energy is mainly electricity used in (non-fixed) lights, appliances and equipment. The European Commission is introducing a suite of policies to improve the energy efficiency of these products, which increasingly means that all purchases have to be of energy-efficient models. If made sufficiently ambitious, together with some gentle constraint by building users, the demand for electricity use in lights and appliances, per property, could be halved by 2050. The 2050 targets cannot be obtained without some positive involvement by people, as building occupants.

For larger businesses, gentle pressure already comes from the need to pay the carbon reduction commitment and, in public buildings, to show a DEC. Policies are proposed that will reinforce this pressure, for instance requiring a DEC on all business buildings, clear statements on energy use and carbon emissions in company annual reports and publicity ranking companies on their DECs. This remains an uncertain, but essential policy area. These soft-measures, involving naming and shaming, will be most successful when businesses realize the financial benefits that come from lower energy bills, better conditions for the workforce and the enhanced value of their properties.

For householders, the proposal is to develop a similar policy for all energy use in the home, for instance through the introduction of personal carbon allowances. This free allocation identifies the level of carbon emissions from energy use that is their current free entitlement. By lowering that entitlement over time, the choices of the household contribute to achieving

the nation's targets and are not made in ignorance of them. PCAs provide a method of increasing awareness and responsibility, at the same time and fit well with minimum standards for buildings and products as these latter policies are helping to deliver the reduced demand required by PCAs.

A range of fiscal incentives and policies are suggested to ensure that the costs of this transformation can be met. Because all property owners, by definition, have a capital asset, the policies are designed to utilise that asset. The role of grants is minimised and replaced with government subsidies on loans to make them affordable for low-income property owners. Other financial inducements come in the form of reduced tax liability (stamp duty, council tax, VAT), but are at a scale required to ensure popular support in conjunction with the regulatory framework. The size of financial incentives is inversely proportional to the certainty of the regulatory environment, particularly on minimum standards. The emphasis on demand reduction results in the most cost-effective cuts in carbon emissions, with lower bills and greater comfort for consumers. The alternative of new electricity-generating capacity implies considerably higher bills for users, thus pushing more households into fuel poverty, without providing any improvement in the level of energy services.

There are strong and important roles for every group in society if *Achieving zero* is to be accomplished. The most urgent one is for clear government announcements on the strategy and firm statements about the timescales for action, particularly minimum standards. The role of government is to formulate and announce the plan. The first step has been taken by the government with the declaration that it will be illegal for a privately-rented F- or G-rated property, whether residential or business, to be let after 2018.

Local authorities have a primary role in the delivery of that plan, at a geographical level. It is their responsibility to ensure that important components are enacted, for instance that:

- o minimum standards are delivered,
- o there is a local database of the energy efficiency of all properties;
- o there are low carbon zones, primarily to upgrade the homes of the fuel poor.

Through this geographical coverage, every household and every business will be involved, monitored and encouraged to take action.





These two tiers of government, central and local, also have an important role in the delivery of exemplars. Both government offices and social housing can implement the high standards being required for low-energy buildings and, through these exemplars, help to train the construction industry in the necessary new and innovative practices.

The construction industry will be required to deliver large numbers of low-energy properties from now onwards and ensuring that the skills are there to do this is a major challenge. In order to deliver the targets required on fuel poverty, 1.2m homes have to be improved up to a minimum of a B-grade (SAP 81+) each year between 2012-16, and for climate change, the target is 720,000 properties each year brought up to a standard of the top of the A-grade (a SAP or SBEM of 100) from now until the end of 2050. Policies are required that will deliver these targets and shift the

present distribution of the housing stock (the purple line in figure 1) to the 2050 distribution (the black line).

The proposed components of a market transformation strategy for energy use in buildings, as encompassed in the figure, would also include:

- o complete coverage of the building stock with energy performance certificates and address-specific databases at a basic level by 2013, for fuel poverty eradication. This is the pre-requisite for all other policies;
- o extension of display energy certificates to every business property and the publication of league tables to encourage action and improvements;
- o high minimum standards in the Building Regulations for new buildings, covering all energy use as soon as possible;
- o Building Regulations for existing properties to require consequential improvements, so that major changes to the building do not increase its overall energy consumption;
- o Building Control Officers to have a role as mentor for individual properties, to ensure they are on a low-energy trajectory that is understood by the owner;
- o financial and fiscal incentives to encourage both take-up of the most energy efficient products and buildings and improvement of the least efficient;
- o education to alert consumers to the importance of energy efficiency and the extent to which it varies between products, properties and lifestyles;
- o computer-based networks and directories to facilitate information exchange on innovative products and services between producers, purchasers and communities;
- o the immediate development of a Low Carbon Zone in each local authority to take action on the worst housing, occupied by the poorest people.

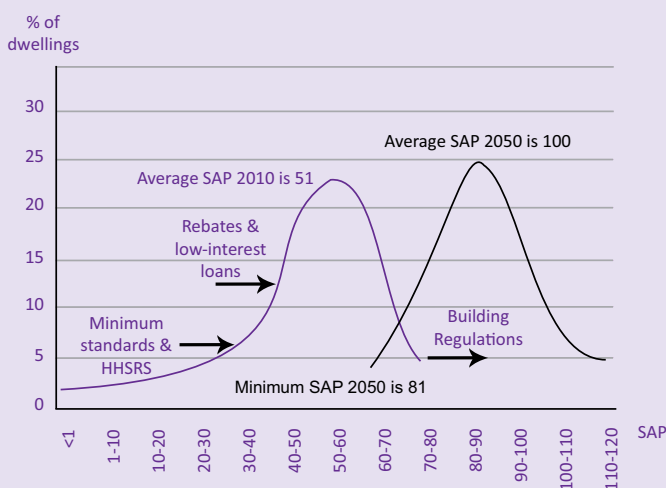


Figure 1  
Market transformation strategy for housing, UK, 2010-2050

Note: SAP stands for standard assessment procedure, the government's preferred method of indicating the energy efficiency of a home. High numbers are best

The UK cannot meet its legal obligations on eradicating fuel poverty by 2016 and 80% reduction in greenhouse gases by 2050 without most, if not all, of the proposed initiatives.





# 1 The challenge

Achieving zero carbon emissions is the reality facing the whole of the UK's building stock by 2050 and, therefore, for each owner of a home or business premises to deliver. The UK's legal obligation to reduce greenhouse gas emissions by at least 80% by 2050 (under the Climate Change Act 2008) will require achieving zero carbon dioxide emissions (or very close to this) from all buildings (CCC 2010a, p237). With the likelihood that some sectors like aviation, shipping and agriculture either cannot reduce their emissions by as much as 80%, or only at prohibitive cost, other sectors have to compensate by doing more. Buildings are seen as providing the potential for quick, substantial and cost-effective cuts. Major reductions are cost-effective against both other sectors and, particularly, the cost of additional supply (DECC 2009, p25). Not needing energy is the best option. And the European Commission has added:

Energy efficiency is the most cost-effective and fastest way to increase security of supply (COM (2011) 370, p1).

Compliance with the Climate Change Act 2008 is a legal and political imperative and this has been reinforced by the Government's new commitment to the fourth target period of 2023-2027, which requires a 50% reduction in greenhouse gases (GHG) over 1990. According to the Secretary of State this target is ambitious but achievable (Hansard, 2011a).

*Achieving zero* examines the tasks involved for both domestic (called residential from now on) and non-domestic properties (called business premises from now on) – the whole building stock. It takes as a starting point the evidence and recommendations made in previous work in order to progress the debate. This study identifies the policy imperatives and the structure of a route-map to 2050 and, while it can only sketch the decisions that have to be made and the direction of travel, this overview is badly needed. Demand reduction is rarely given serious attention by energy modellers: recent analysis by the UK Energy Research Centre showed



---

that, in different scenarios, expectations for residential electricity use up to 2050 varied from an increase of 90% to a drop of 32% (Eyre et al 2010, p277) – far too wide a range to be helpful. The discrepancies result from the difference between econometric modelling and a perspective that starts with people, their priorities and behaviour. The latter is the approach taken here. An analysis that takes people’s priorities as the starting point involves a very different perspective. In particular, a focus on energy services, for instance warmth, rather than the acquisition of energy.

In 2010, the buildings sector was important because:

- o it contained the 28m UK buildings, of which 26m were homes and 2m business premises (VOA 2010, grossed up) and collectively there were worth a total of £5.3tn;
- o they were responsible for at least 36% of all greenhouse gas emissions and 41% of all carbon dioxide emission with residential responsible for about twice as much as business buildings in 2009 (CCC 2010a, p197)<sup>1</sup>;
- o 40% of energy (DECC 2011a, p29);
- o two-thirds of all electricity (DECC 2011a, p136);
- o £20.6bn of fuel costs for residential + £10bn for business (DECC 2011a, p32)
- o £35bn on building repairs, maintenance and improvement (ONS 2011), thought this is less than 1% of the £5.3tn value of the properties.

## ENERGY AND EMISSIONS

The only coverage of greenhouse gases and carbon dioxide is in this chapter – most of *Achieving zero* is focused on all energy use by the final users. Much of the debate is about energy efficiency, though, in reality, demand reduction requires energy conservation. A more energy-efficient, but bigger product (building, fridge, TV) can easily use more energy, so policy has to go beyond greater energy efficiency to make sure demand actually drops.

### Greenhouse gases and carbon dioxide

Zero carbon is the contribution from buildings to the UK’s legal obligation, but this is very different from zero energy. If the energy provided is zero carbon (eg from renewable sources), then any quantity can be used. It is the carbon intensity of the fuels used that links energy and

---

<sup>1</sup> Appears to omit industrial buildings. Business statistics are tricky as they vary in the coverage of public buildings and industrial buildings and processes.



carbon emissions and, as a result, the mix of fuels used in buildings and at the power station is important. It is helpful if the debate can distinguish between the quantities required and the quality of what is used. *Achieving zero* focuses on the quantity required, to identify what policies are needed on this part of the equation.

Across the whole economy, all greenhouse gases (CO<sub>2</sub>e) and the major one of these, carbon dioxide, have reduced between 1990 and 2009, by 28% and 20% respectively. In both cases, the residential sector has reduced less (14% of GHG and 11% with carbon dioxide). Because of structural changes causing the industrial sector to shrink its impact even faster, the residential sector has increased in importance from 21% of the total emissions in 1990 to 26% in 2009. Business buildings have increased as a proportion of the total: buildings are becoming more important as they represent a bigger share of emissions.

Figures for 2010 for the total economy for carbon dioxide emissions show a growth of 7% in comparison with 2009: partly because of cold weather, unplanned shutdowns with nuclear plants and more coal-fired electricity generation (CCC 2011b, p131). Our climate change targets are absolute, not weather-corrected. This increase demonstrates that there is no room for complacency - there is much more to be done.

Previously, much of the recent success at reducing total UK emissions had been credited to the recession (CCC 2010a, p13). This creates a misplaced sense of achievement, whereas in reality it is a trap: an economic bounce-back would return the country to the high levels of emissions recorded at the turn of the century, as too little new policy is in place to maintain the savings.

The relatively poor performance of the buildings sector indicates that future policy will need to focus greater attention on delivering faster rates of change. With fixed targets for 2050, each year of under-performance increases the annual rate of reduction required in the remaining years (CCC 2010a, p85).

## Energy use in buildings

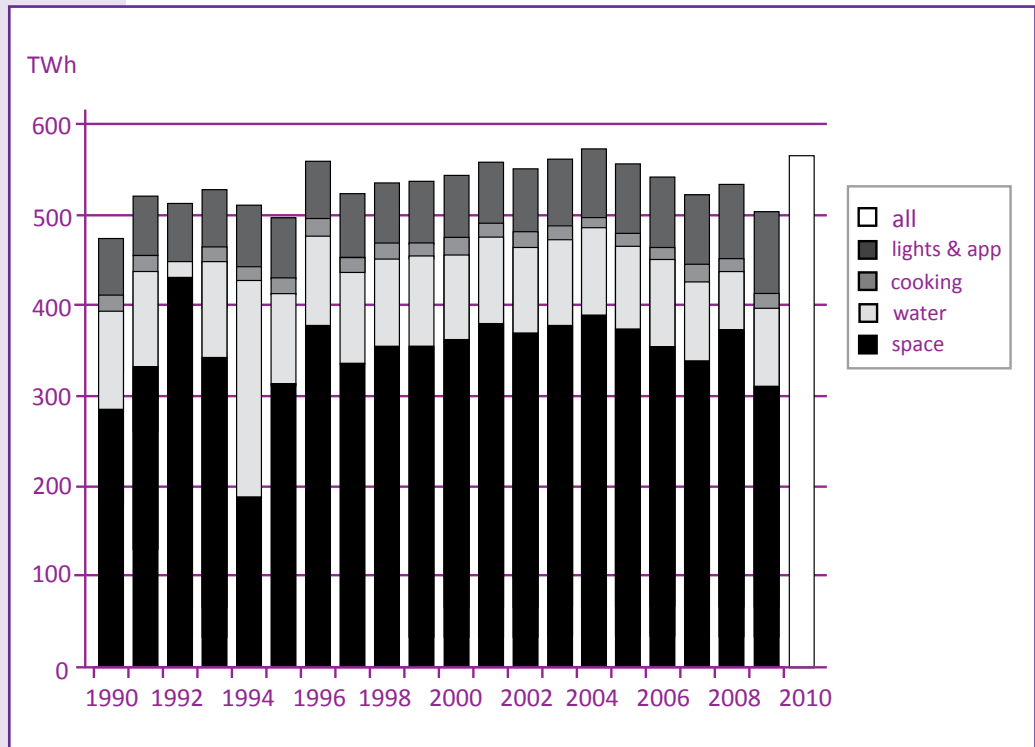
Energy use in the residential sector since 1990 has increased (figure 1.1), but each end-use tells a different story, with a strong decline in the amount of energy used for hot water and for cooking, a slight increase in space heating and the largest growth has been in electricity for lights and appliances. Between 2004 (the peak year) and 2009, total energy use was dropping at around 2.5% pa. This started before the recession and coincides with heavy energy price rises for the residential sector (Boardman 2010, p74). There was a sharp reversal in 2010,

possibly because the cold weather (at either end of the year) affected homes more than businesses, as homes need heating for more hours a day.

**Figure 1.1**  
Residential energy demand, by use, UK, 1990-2010 (TWh)

Note: 2010 figure is provisional and has not yet been broken down

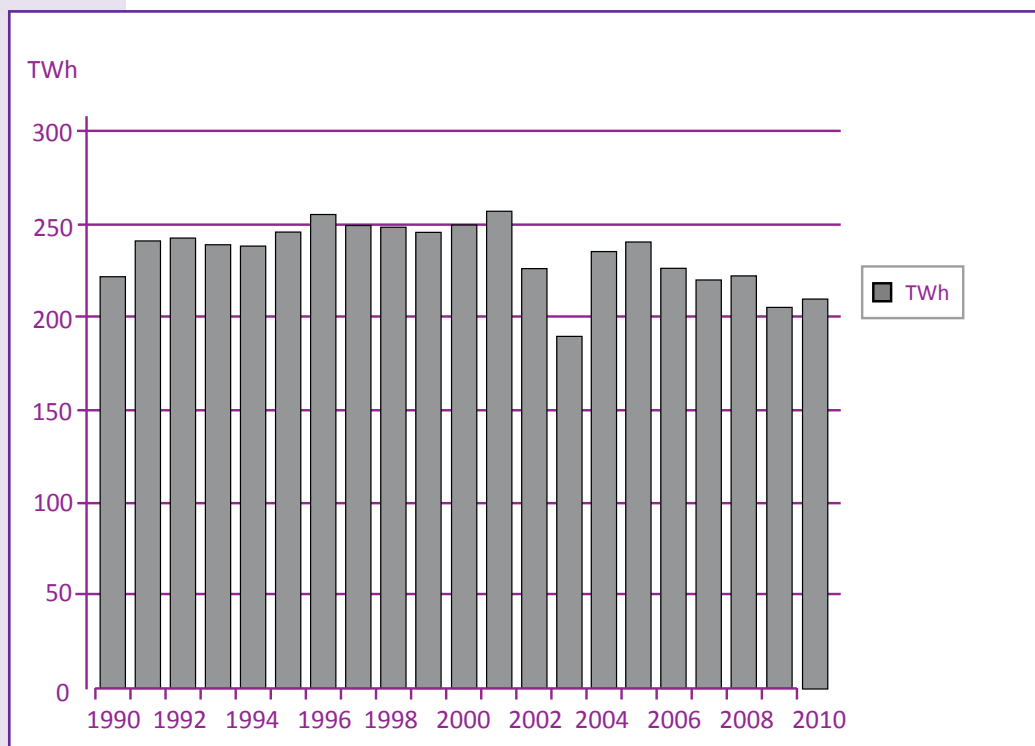
Source: DECC 2011b, tables 3.1, 3.6



**Figure 1.2**  
Business energy demand, UK, 1990-2010 (TWh)

Note: Excludes industrial buildings; no time-series breakdown by use is available

Source: DECC 2011b, table 5.1 (service sector)





The growth in total demand largely reflects the increased number of households: at the level of the individual home, there has been a decline of 1% in the energy used. This modest drop in energy used resulted from a growth in electricity demand of 7% and a slightly greater decline in gas use (based on DECC 2011a, various tables).

There is a similar see-saw with business figures (figure 1.2), but 2010 was slightly lower than 1990 and there has been a general decline since 2001 (the peak year), again predating the recession. There is no time series giving a breakdown by energy end-use for the business sector, so it is not possible to identify which individual uses are growing or shrinking. Overall, the business sector (as defined here) uses just under half of the energy of the residential sector.

The type, quantities and way energy is used in individual residential and business premises is very different (table 1.1):

- o Nearly four times as much gas is used in the home than in businesses;
- o In each sector, over three-quarters of the gas is used for space heating;
- o Hot water is the only other substantial use of gas
- o The two sectors use similar amounts of electricity, spread amongst a wide range of activities;
- o lighting is the biggest user of electricity in businesses;
- o appliances are an important electricity use in the residential sector (eg washing machines, TVs, refrigeration), but negligible in businesses;
- o computers use relatively more electricity in the home than in businesses;
- o cooling and ventilation use more electricity than computers in businesses;
- o less than 20% of electricity is used for space and water heating in both sectors;
- o the remaining 80% of electricity is used where there are no alternatives: for lighting, appliances, computers and so forth.

The total amount of energy used in buildings in the UK in 2009 is 677TWh, of which two-thirds is gas or oil and one-third electricity. Around three-quarters of this energy is used by the residential sector and the remainder by businesses, not including industrial processes.



Table 1.1: Energy use in buildings, UK, 2009

	Electricity		Gas and oil	
	Residential (%)	Business* (%)	Residential (%)	Business* (%)
Appliances	50			
Lights	17	41		
Computing	8	6		
Cooking / catering	5	13	2	8
Space heating	14	14	76	77
Hot water	6	4	22	14
Cooling and ventilation		9		
Other		13		2
TWh	119	95.6	368	93.6
kWh per property	4577	47,800	14,154	46,800

Note: although gas and oil have been combined, oil represents only about 10% of these figures: \*excludes industrial buildings

Source: DECC 2011b tables 1.14, 3.10, 5.5

## Fuel mix and energy supply choices

It is possible to reduce carbon dioxide emissions by switching to cleaner fuels, either in the property or at the electricity-generating power station, but the first and most cost-effective route is to reduce the amount of energy needed. The latter has the added advantages of making any supply-side targets (such as the proportion of energy from renewable sources) easier to achieve with cheaper solutions; reducing the need for imported fossil fuels, which aids security of supply and the balance of payments, as well as contributing to our carbon targets.

The reductions in carbon dioxide emissions that have occurred since 1990 are largely because of fuel switching by consumers (solid fuel use in homes has been reduced by 76% since 1990) or by the electricity utilities (increased generation from gas), with achievements from energy efficiency a second-order effect.



Fuel switching choices in buildings depends on the relationship between the carbon intensity of gas and of electricity, as these are the two main fuels used in buildings. In 2011, electricity in Great Britain is more than double the carbon intensity of gas (500 vs 200 gCO<sub>2</sub>/kWh). The carbon content fluctuates only for electricity, because of variations in the mix of fuels in generation. The carbon intensities of the other fuels (gas, oil, solid fuel) are effectively constant. While electricity has as high a carbon content, as now, then the task is to reduce its use as much as possible. This approach also results in lower investment in future generation.

Fuel switching in electricity generation occurs as the industry chooses to operate the economically optimal mix of plant to meet demand. In the last few years the carbon intensity of electricity has largely been determined by the price of gas: when gas is expensive, more coal is burnt in power stations, so the carbon intensity of electricity increases, and vice versa. Over time, the carbon intensity of electricity will be reduced as fossil fuel generation is phased out and more renewable sources of power are developed. With the phase out of nuclear power happening more rapidly than new nuclear generation can contribute, the carbon intensity of electricity depends upon the combination of more renewables and less demand, as influenced by policies on carbon pricing.

The expectation of the Committee on Climate Change (CCC 2010a, p129) is that the carbon intensity of electricity will have been reduced from the 2008 level of 544gCO<sub>2</sub>/kWh to:

- o 320gCO<sub>2</sub>/kWh by 2020
- o 50gCO<sub>2</sub>/kWh by 2030, a tenth of the present level.

Both of these are immensely challenging targets and the rapid rate of decarbonising may now be affected by decisions on the level and speed of nuclear investment, post Fukushima (more regulations and cost) and over the delay in funding a carbon capture and storage pilot. There is a delicate interaction between the level of electricity decarbonisation and the extent to which policy first focuses on reducing use of electricity and then switches to using more of it. Certainly until 2020 and probably 2025, the high carbon content of electricity means that it should be the primary focus for demand reduction. This is particularly true if the UK is to achieve its fourth budget of a 50% cut in greenhouse gases by 2025 (the mid-point of 2023-27) over 1990.

*Achieving zero* is focusing primarily on the opportunities to reduce demand, so the level of decarbonisation of electricity is largely ignored. That is not to diminish its importance, but merely to see it as a second-order issue that only comes into play when the amount of demand is confirmed. This approach is substantially different from that apparently taken by the Committee on Climate Change where the decarbonisation of electricity has tended to lead the debate on which fuels should be used in buildings, rather than the other way round.

---

Hence, after this chapter, the rest of the debate will be in energy terms, to avoid the confusion created by possible levels of carbon intensity in electricity.

## Energy services

The analysis in this report is taking people's behaviour and priorities as the starting point and this includes:

- o a focus on energy services, for instance warmth, rather than the acquisition of energy;
- o obtaining tangible benefits from expenditure, with the improvements delivering a more comfortable, affordable lifestyle;
- o certainty over the effects of any expenditure, for instance smaller fuel bills, calibre of workmanship, improved value of the property, so that any expenditure is clearly an investment;
- o for many, but not all, reducing the impact on the environment of the use of energy to provide these energy services;
- o acceptable levels of disruption as a result of any changes, such as added insulation (this may mean doing a lot, or a little, depending on the household's circumstances);
- o any disruption results in a property that is then easier to run and maintain (less kit, simple controls);
- o a clear strategy from Government, to provide guidance over the timing and scale of improvements required, so the property owner can plan with confidence;
- o for business, a link between reduced environmental impact and enhanced reputation (as with CRC league tables);
- o importantly, that people have a sense of involvement in and control over the decisions in their lives, that they have a sense of agency: 'if people feel empowered that they can make a difference if they make certain decisions, then they are more likely to do so' (SWEA 2011, p20).

The most influential of these points, for this report, is the emphasis on energy services. People buy energy because of the energy services they want – the warmth, cooked or cold food, hot showers, well-lit stairs. People are not interested in purchasing energy *per se*. Improved energy services are strongly linked with improved energy efficiency – there are no cold walls and draughty windows in a warm, comfortable home; condensation and mould are a thing of the past.

The provision of additional generating capacity cannot deliver greater energy services as the electricity coming down the wires is still just electricity and cannot be differentiated from any other source of electricity supply.



The non-energy benefits that result from greater energy services as a result of improved energy efficiency may be worth three times as much as the direct energy savings (Heffner and Campbell 2011, p12). These are rarely part of a cost-benefit analysis, but include reduced ill health and the associated costs to the NHS, less stress and mental problems, less accidents from poorly lit spaces. They are worth a great deal to people, especially the fuel poor.



## PEOPLE AND BUILDINGS

### Size of the building stock

The UK population grows each year and increases the demand for more homes and businesses. If the trend towards fewer people per household continues, this will exacerbate the demand for homes. There is considerable variation in the projections of how many homes there will need to be, for instance the Committee on Climate Change considers there will be 30% more homes by 2030 over 2008 (CCC 2010a, p202), where previously the Environmental Change Institute thought this would be about the number needed in 2050 (Boardman et al 2005, p28). Either way, the more the number of properties grows, the greater is the reduction per building

*By 2050, there has to be zero carbon emissions from the use of all energy in all buildings in the UK*

---

needed. In the residential sector, this could see the average required impact drop from 5.8tCO<sub>2</sub> per household in 2008 to around 2tCO<sub>2</sub> per household in 2030 ie to about a third.

The distinction between business and residential premises is not always made nor relevant, because nearly half of business premises are less than 100m<sup>2</sup>, with an average floor area of 50m<sup>2</sup> (the size of a small flat) and a further quarter are 100-250m<sup>2</sup>, with an average floor area of 175m<sup>2</sup> (the size of a large house) (CLG 2007). For these three-quarters of business premises, it would be perfectly appropriate to have many of the same policies as if they were residential – they often are converted homes. Thus, the differences between residential and business premises mainly occur in the 25% of the largest buildings.

While there is clear recognition of the need to move all new buildings to a net zero carbon standard and the need to create sustainable communities, there is less policy clarity on many other aspects of the existing building stock. For example, the optimal rate of new build, the rate of demolition, the problem of under-occupancy and the effect on space standards of households with less people. None of these major issues appears to be being debated with any clarity or planning. They – like many other issues – will have to be the subject of other reports.

## **Landlord and tenant**

A strategic overview is becoming necessary of the relative roles of landlords and tenants to provide clarity on their respective responsibilities. With housing:

- o the Government's minimum energy-efficiency standard for existing buildings will be imposed on private landlords (Energy Act 2011);
- o grants are available for landlords through the landlord energy saving allowance (LESA) which permits energy efficiency expenditure to be offset against rental income;
- o both landlords and tenants have to agree if the green deal finance is to be taken up, but the repayments are incurred by the tenant as an offset to lower fuel bills. This could soon result in the tenant paying for the landlord's obligation to improve the building, which would be patently unfair;
- o the present CERT (carbon emission reduction target) and its proposed replacement, ECO (Energy Company Obligation), provide free measures to vulnerable tenants, irrespective of the wealth of the landlord - a subsidy for the landlord.
- o For business, the CRC refers to the organisation named on the energy bill, whether landlord or tenant.

This strategy starts the debate by building on the Government's proposals that it has to



become the landlord's responsibility to provide a minimum energy-efficiency standard and limits the role of financial incentives to low-income tenants.

## THE REPORT

### Boundaries and data

Where possible, the data and policies refer to the UK, but other sub-divisions are occasionally necessary, for instance because the figures are only available for England and Wales. There are considerable variations between the circumstances of the four devolved administrations (England, Scotland, Wales and Northern Ireland) in terms of the characteristics of the building stock, sources of energy and legal systems (Boardman 2010, pp194-7). These are clearly important, but the debate in *Achieving zero* is about the overarching framework, within which detailed policies can reflect these regional variations.

There is woefully little accurate data on energy consumption in businesses and what is available is often partial, for instance excluding industrial buildings, or based on old surveys. The embarrassing lack of precision on policy and trends in the business sector in this report is a direct result. Often the numbers that are given here have a low level of confidence attached to them.

Most of the focus is on activity within the four walls of the building, with limited references to the wider neighbourhood (eg for community combined heat and power). For the business sector, the aim is to exclude the energy used in industrial processes and only reflect on the energy used in space and water heating, lights and appliances. It is assumed that:

- o Fuel prices will continue to rise in real terms;
- o Eradicating fuel poverty by 2016 (as far as is reasonably practicable) remains a legal obligation, ie the present Warm Homes and Energy Conservation Act 2000 remains in force, despite the independent study on fuel poverty that has been commissioned from Professor John Hills;
- o Some measures will be required that are not (at the moment) deemed to be cost effective. Either they will be by when they are to be implemented (eg post 2037, CT 2010, p6) or the importance of climate change mitigation will be over-riding.



---

## The market transformation approach

The erratic, but recently mainly downward, trends in energy demand in buildings have occurred partly in conjunction with substantial, fuel price increases. For instance, by mid 2011, the real price of fuels for the home had increased by nearly 70% since 2000. While this has substantially increased fuel poverty, the fuel price rises have not induced a parallel, significant improvement in household energy efficiency, despite the fact that higher prices make efficiency measure more cost effective. The trends that have occurred are as a result, at the level of the individual property, of the:

- o upward effect of higher standards of energy services (particularly more IT equipment and warmer homes);
- o upward effect of cold weather, for instance in 2010;
- o downward effect of greater energy efficiency, biased towards better-off occupants and owners, who can afford the investment;
- o downward effect of higher fuel prices in poorer homes, where the tight weekly budget does not allow consumption to keep pace with price rises. As a result of lower consumption, there is greater deprivation and an increase in fuel poverty.

The existing mixture of policies on energy efficiency and higher prices is not sufficiently effective, so a new approach is required.

For policy purposes, market transformation is a useful perspective. It concerns the integration of a series of policies into a strategy to ensure that the average of the products sold moves towards greater energy efficiency (figure 1.3). The product could be a light bulb, fridge or a property. The market transformation approach originated with energy-related products, such as windows and fridges and has been shown to provide a powerful framework within which to conceptualise policy. It is now at the core of much European policy on energy in products to facilitate trade between Member States with common standards for transportable products, such as fridges, now extended to buildings, through the Energy Performance of Buildings Directive (EPBD).



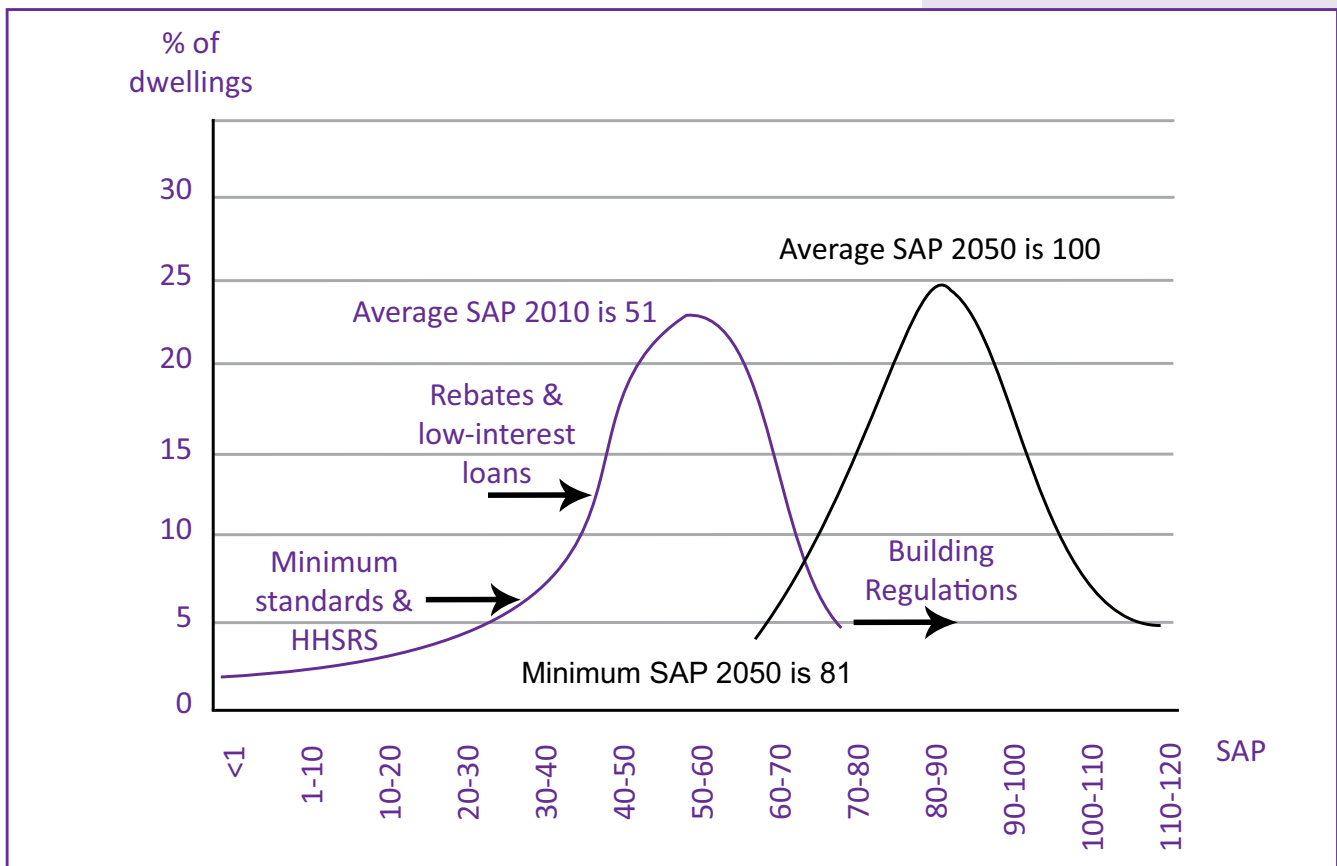


Figure 1.3: Market transformation curves, now and in 2050, residential stock, UK

Notes: SAP is the standard assessment procedure, the government's preferred measure of the energy efficiency of a home. The present scale is from 1-100, but has been extended beyond this to cope with energyplus properties, that have net exports of energy. SBEM is the similar system for business premises

The need for a market transformation approach, or even for any policy, may not be recognized at the beginning. This is the lesson that has come from minimum standards on appliances, for instance with cold appliances (fridges, freezers, etc):

- o initially, neither customers nor manufacturers considered that the energy-efficiency of the product was of any relevance or importance. The variation in energy efficiency between different products was not known, the options for reductions were not understood, energy efficiency was not seen as an issue;
- o since the introduction of labels (1995) and then minimum standards (1999), energy-efficiency has become one of the major drivers of the market (together with price). As shown in chapter 3, the cold appliances will have more than doubled in energy efficiency between 1995 and 2015 and the manufacturers are still finding opportunities for technological improvements to lower energy use.



*Few new homes are being built, so most of the energy saving has to be in existing buildings*

The situation with the property markets seems similar: energy efficiency is not deemed to be salient, the variations between properties are not recognised as significant and the opportunities for improvement barely understood. The time has come to transform the market for properties, with an emphasis on low-energy consumption.

One of the over-riding benefits of a market transformation strategy is that it sets a standard (of energy efficiency), but does not dictate the method of achieving that standard – it does not identify the specific technologies. The property owner is free to choose the route to achieving the target performance. This is the opposite of much UK policy, where grants are attached to specific measures, such as loft and cavity wall insulation.

The large number of components in a building – windows, appliances etc – means that there is simultaneously a market transformation required for the total building stock and the individual components. There can be a whole family of market transformations acting in concert, stimulating innovation at various scales.



Many of the constituents of such a market transformation strategy have been identified as important in earlier studies. For business premises, the two main sources are the Carbon Trust (CT 2010) and the Low Carbon Construction Group (LCC 2010). For the residential sector, there are four background papers (Boardman et al, 2005b; Boardman 2007; Boardman 2010, Eyre et al 2010). The latter is an excellent exposition of the changes that can occur when a modelling exercise is anchored on people and their lifestyles, rather than economics or technology. In all of these reports, explicitly or not, there is an assumption that society is accepting of the need to act to mitigate climate change and will therefore be supportive of regulations such as minimum standards. This requires the government and the people to work together in developing this acceptance. The strong similarities in the recommendations in these reports demonstrate that much policy can be generic to both residential and business premises.

*Achieving zero* takes all these recommendations and demonstrates how they can be brought together into a coherent whole through the unifying perspective of market transformation. This combines sensible, useful, individual policies into a powerful strategy. Another important attribute of market transformation is that it involves actions by a wide variety of players, from the European Commission to the individual property owner. For instance, both energy labelling and mandatory minimum standards have to be introduced by Brussels, whereas the building regulations, financial incentives, education and voluntary agreements are the responsibility of the UK Government or devolved administrations. Individual households are responsible for acting on information and incentives. Exemplars can be provided by any individual or company.

Another important attribute is the way that costs can be minimised through clear, firm policies. If government (in the EU or UK) announces a strong policy on mandatory minimum standards for products or buildings, then this minimises the cost of expensive advertising programmes or costly financial incentives to persuade people to take action. If the UK Government introduces a coherent approach to improving the energy efficiency of an existing property through Building Regulations, then this minimises the need for extensive financial incentives.

It is important for policy-makers to realize the essential differences between a market transformation approach and much traditional policy, particularly those involved with trading. With market transformation, there is no attempt to identify the effect of any one single policy, for instance labelling. It is the hugely powerful, synergistic effect of a combination of policies, over time, and the use of different delivery agents, that causes the substantial shift in ownership of energy-efficient products. The multiplicity of policies affecting a single

---

product is the essential ethos of a market transformation approach. This is the opposite of the government's concerns about double-counting, which requires each policy to be evaluated separately. The potential conflicts between these two different policy perspectives cannot easily be overcome and may require some radical adjustments.

The benefits of a market transformation approach becomes clear when considering the present, patchy state of policy. There are various initiatives affecting all energy use in the business sector:

- o labels, in the form of both energy performance certificates (EPC) and display energy certificates (DECs) – existing policy is being extended through the recast Energy Performance of Buildings Directive;
- o minimum standards – in Energy Act 2011 for privately-rented sector only, by 2018;
- o ranking of organisations through league tables under the Carbon Reduction Commitment - Energy Efficiency Scheme (usually just known as CRC) – existing policy;
- o finance for small and medium-sized enterprises (SMEs) through the green deal – proposed policy from October 2012;
- o financial penalties for high levels of energy use and carbon emissions, under the CRC, existing policy;
- o Building Regulations to cover all energy use from 2019 – proposed policy;
- o minimum standards of energy efficiency for various lights and appliances – ongoing EC policy;
- o awareness-raising through corporate reporting of carbon emissions – legislation required under the Climate Change Act 2008.

There is a similar patchwork of policies for the residential sector:

- o the EPC label – existing policy, poorly enforced;
- o minimum standards – in Energy Act 2011 for privately-rented sector only, by 2018;
- o housing, health and safety rating scheme (HHSRS) – duty on local authorities to take action on the least energy-efficient properties as they provide unhealthy living conditions – existing policy, not enforced.
- o Building Regulations – gradually requiring higher standards of energy efficiency in new buildings, but the 2016 code for sustainable homes level 6 standard does not now apply to all energy use;
- o grants for energy-efficiency improvements to the homes of the vulnerable (warm front) to cease in 2012;
- o the green deal – providing loans to improve the insulation of the fabric, repayable through electricity bills – policy to start in October 2012;



- o utility-funded CERT to become the ECO from 2012, with only 25% for disadvantaged households;
- o feed-in-tariff (FIT) for small-scale renewable electricity-generating installations – rewards the building owner/installer for each kWh generated and additionally if exported. Started April 2011;
- o renewable heat incentive (RHI) – similar scheme for heat, although the heat cannot be exported. Main start for residential buildings is in 2012;
- o LESA – tax offsets for landlords investing in energy efficiency improvements with an allowance for each property, each year – existing, poorly advertised policy;
- o smart meters and their associated displays, are to be introduced from Summer 2012.

Much of existing policy focuses on individual measures rather than reaching an overall energy or carbon emission performance standard. This is true for both the main uses of electricity and for insulation. In the former, there is a piecemeal, product-by-product approach and with the latter individual measures (loft or cavity wall insulation) are installed, with no focus on the overall performance of the building. The totality of energy use per property is not a major concern for users or for policy.

## Structure of report

Much of the evidence and detail refers to the residential sector, whereas the policies are for all buildings, including business premises. This is all that could be achieved given the paucity of data on energy use by businesses. The content of the chapters is:

- o the opportunities to reduce demand for space and water heating (mainly gas) and a brief debate about which fuels and heating technologies should provide this demand – chapter 2;
- o the opportunities to reduce demand for electricity, mainly in lights and appliances – chapter 3;
- o the issues around money and property value, including present expenditure and options for financial incentives – chapter 4;
- o the role of different players in delivering these policy initiatives, including personal responsibility and protecting the fuel poor – chapter 5;
- o the full market transformation strategy, with some indications of timescales and targets for a draft routemap – chapter 6.

---

## SUMMARY

It is certain that radical action is needed to improve the energy efficiency of the UK's building stock - if it is to become zero carbon by 2050. This involves a combination of energy demand reduction and the supply of zero-carbon fuels. The Committee on Climate Change has identified the targets and possible trajectories and several reports have outlined some of the policy components of this programme. There is, as yet, no coherent policy framework that will deliver this transformation. Much of the recent success at reducing emissions has been as a result of the recession. This creates a misplaced sense of achievement, whereas in reality it is a trap: an economic bounce-back would return the country to the high levels of emissions recorded at the turn of the century, as too little new policy is in place to maintain the trajectory of reducing emissions.

The importance of this debate has been reinforced by the UK's commitment to a 50% reduction in greenhouse gases by 2025, over 1990 levels, confirmed by the Government in May 2011. This represents a further 25% reduction from 2010 levels, in 15 years – a substantial challenge, independently of the health of the economy.

*Achieving zero* examines some of the essential components of a policy framework for low-carbon buildings that could deliver the scale and speed of reductions required. It covers all energy use in the whole UK building stock for the period until 2050, all buildings, whether residential or business, and all energy use. It is not an exercise involving precise numbers, but a policy framework for action with people at the heart of the debate.





# 2 Upgrading the stock

In the UK, most building energy is used for space heating and hot water and most of this is gas. The way to reduce this demand is to improve the thermal efficiency of the building through insulation (walls, ceiling, windows and doors) and supply that reduced quantity of heat through more efficient systems. The potential for saving gas and other heating fuels is the

focus of this chapter, starting from the assumption that retaining gas as the main heating fuel is the preferred option, at least in the near future, and investigating what could be achieved with a positive policy on demand reduction. Four times as much gas is used for heating and hot water in the home than in businesses, demonstrating that the greatest gas savings are likely to occur in homes.



Although we construct new buildings each year, most of these are to accommodate the needs of our expanding population and economy. A few, mainly business premises, are to replace buildings that have been demolished. As a result, the vast majority of buildings (over 80% in each sector) that have already been built will still be in use in 2050: the refurbishment of the present stock is the major task. Because of the cost-effectiveness of many building energy-efficiency improvements, the cheapest way to get to zero carbon by 2050 is undoubtedly for this refurbishment to be to an extremely high standard – ideally resulting in properties using less energy than a new building in 2011. It is important to remember that a low-energy building is comfortable to live or work in and the most affordable in a scenario of rapidly increasing energy prices.

The market transformation framework is reflected in the structure of the chapter starting with labels, before progressing to regulations, exemplars and incentives. The choice of heating system – and therefore fuel - is dealt with at the end as it involves other decisions before entering the market transformation arena.



---

## LABELS

Any policy to reduce energy use and carbon emissions from the building stock should start with evidence of the present levels of energy efficiency, in order to identify the best and worst properties. This enables action to be targeted while identifying the degree of intervention needed. Fortunately, the European Energy Performance of Buildings Directives (EPBD – Directives 2002/91/EC, 2010/31/EU) requires labels that do this:

- o all residential and business properties to have an energy performance certificates (EPC) when there is a new occupant (whether through construction, sale or rental). The formats of these are similar (figure 2.1), even though the methods of calculation are different. They are both based on modelled (ie theoretical, warm and well-lit) consumption at standard occupancy levels, for most but not all energy end-use. Businesses are assumed to be occupied 37.5 hours a week. The EPC is based on primary energy <sup>1</sup>, as required in the Directive and is valid for 10 years;
- o all larger properties (extended to >250m<sup>2</sup> from 9 July 2015, 2010/31/EU, article 13) that are frequently visited by the public or occupied by a public authority to display an energy certificate in a prominent place, visible to the public. This is assumed to be a DEC (figure 2.2) in the UK as a continuation of present policy. The DEC identifies total actual energy use (ie delivered energy), rather than modelled. DEC's have to be updated every year.

The recommendations that form part of the EPC do provide the property owner with useful information on the most cost-effective measures and the extent to which they would push the property into a higher band, but only for the energy services covered by the certificate. Implementing the recommendations on the EPCs for residential, would result in 22% reduction in carbon emissions (NES 2009b, p16). If the recommendations in 'further measures' were included, this would double the savings. The new occupant or owner does have the information to choose the next, most appropriate investments.

---

<sup>1</sup> primary energy is what goes into the power station to produce the electricity that is 'delivered' to the meter. Every kWh of delivered electricity requires three units of primary energy to be put into the power station. With natural gas there is little difference between primary and delivered energy, as it does not need to be transformed at a power station – it just flows from the gas field to the home.



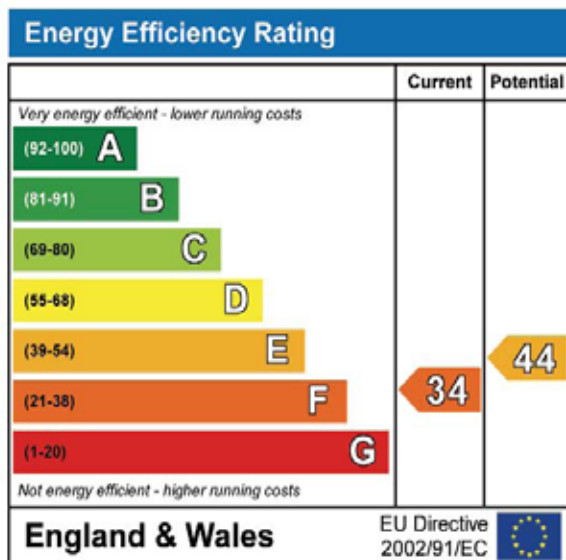
## Energy Performance Certificate



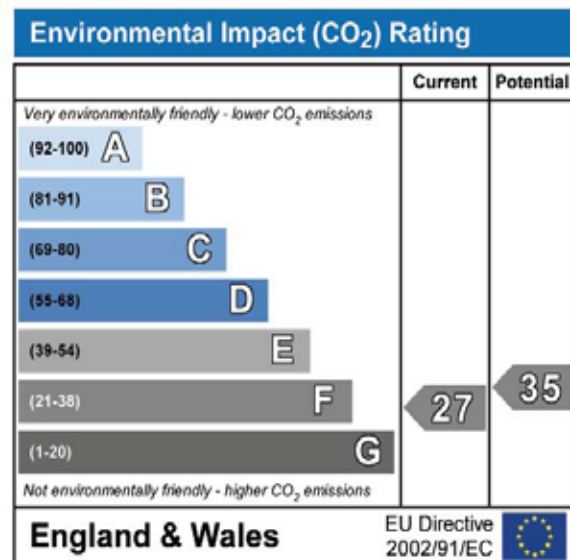
[address]

Dwelling type: Semi-detached house  
 Date of assessment: 15 May 2008  
 Date of certificate: 16 May 2008  
 Reference number: 0000-0000-0000-0000-0000  
 Total floor area: 69 m<sup>2</sup>

This home's performance is rated in terms of the energy use per square metre of floor area, energy efficiency based on fuel costs and environmental impact based on carbon dioxide (CO<sub>2</sub>) emissions.



The energy efficiency rating is a measure of the overall efficiency of a home. The higher the rating the more energy efficient the home is and the lower the fuel bills will be.



The environmental impact rating is a measure of a home's impact on the environment in terms of carbon dioxide (CO<sub>2</sub>) emissions. The higher the rating the less impact it has on the environment.

All three types of certificate base the rating on impact per square metre of floor area, rather than total energy use, which facilitates comparisons between properties of different sizes.

All the certificates rate the property on a seven-band scale of A-G, similar to the familiar energy labels on fridges, cars and light bulbs, etc, with A being the best. This provides a helpful, instant familiarity, though it can cause confusion and imply there is little difference between EPCs and DECs.

Figure 2.1:

Part of a residential energy performance certificate

Note: the numbers on each band refer to the standard assessment procedure (SAP) rating. The certificate includes other sheets giving recommendations

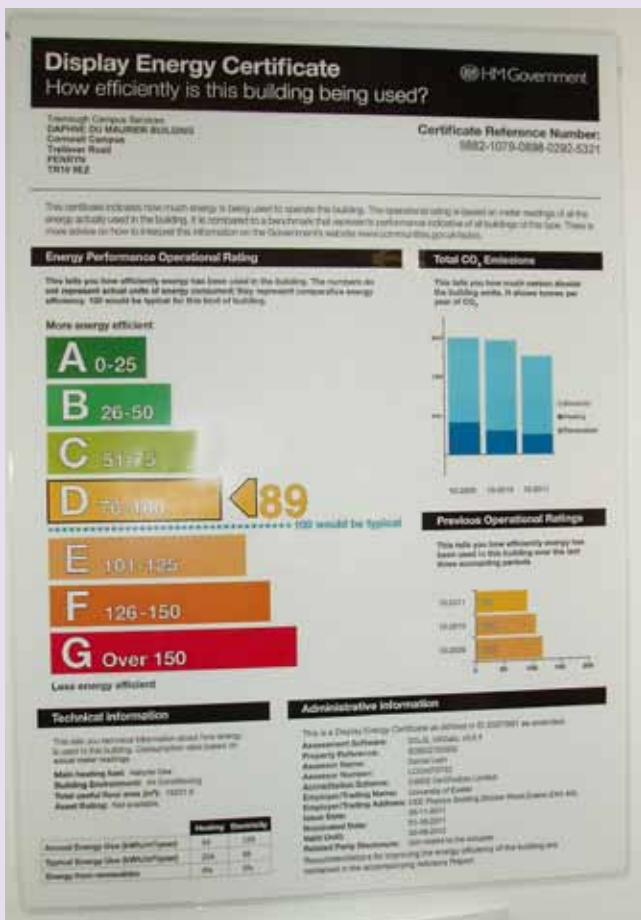


Figure 2.2:  
Display energy certificate for public buildings

Note: the scale is an index based on the 'typical' property being 100. The top of the scale is 0 and the G category starts at 150. This scale is the opposite of the EPC. DEC's are accompanied by an advisory report on cost-effective action that could be taken.

The roles of EPCs and DEC's vary because their coverage varies: EPCs are theoretical standards of service and partial energy use, whereas DEC's communicate all actual energy use. The consumption covered by EPCs is limited to space and water heating, cooling, ventilation and fixed lighting, which are called the 'regulated' uses. These are the uses that are most clearly tied to the construction of the building. They include nearly all gas use and the electricity used in fixed lighting. The EPC does not include the energy used for appliances, whether refrigerating, cooking or computers – the 'unregulated' uses – these are only covered by the DEC label for public buildings (table 2.1). There is no comparable coverage to DEC's for residential buildings. For both sectors, the EPC does cover the bulk of the energy use. Within the business sector, the proportion of energy that is regulated is largest with buildings that use relatively high levels of lighting, but with little other electrical equipment, such as retail, and lowest for buildings like hospitals, which have a considerable amount of ancillary equipment.



Table 2.1: Regulated vs unregulated total energy use, UK, 2009/10 (% of stock average)

	Residential	Business
Regulated (in EPC)	82	69
Unregulated	18 (not covered by a label)	31 (in DEC)

Source: Table 1.1 and DECC (2011b, table 1.7)

The unregulated uses are predominantly powered by electricity. As electricity is both more carbon intensive and more expensive than gas the proportion of costs and carbon covered by the EPC is lower than the coverage of energy use (figure 2.3). While to date, the tendency has been for policy to concentrate on the regulated energy uses, increasingly policy will have to focus on reducing demand for electricity for both carbon and cost reasons. This means that the uses excluded from the EPC are of considerable and growing importance.

## EPCs

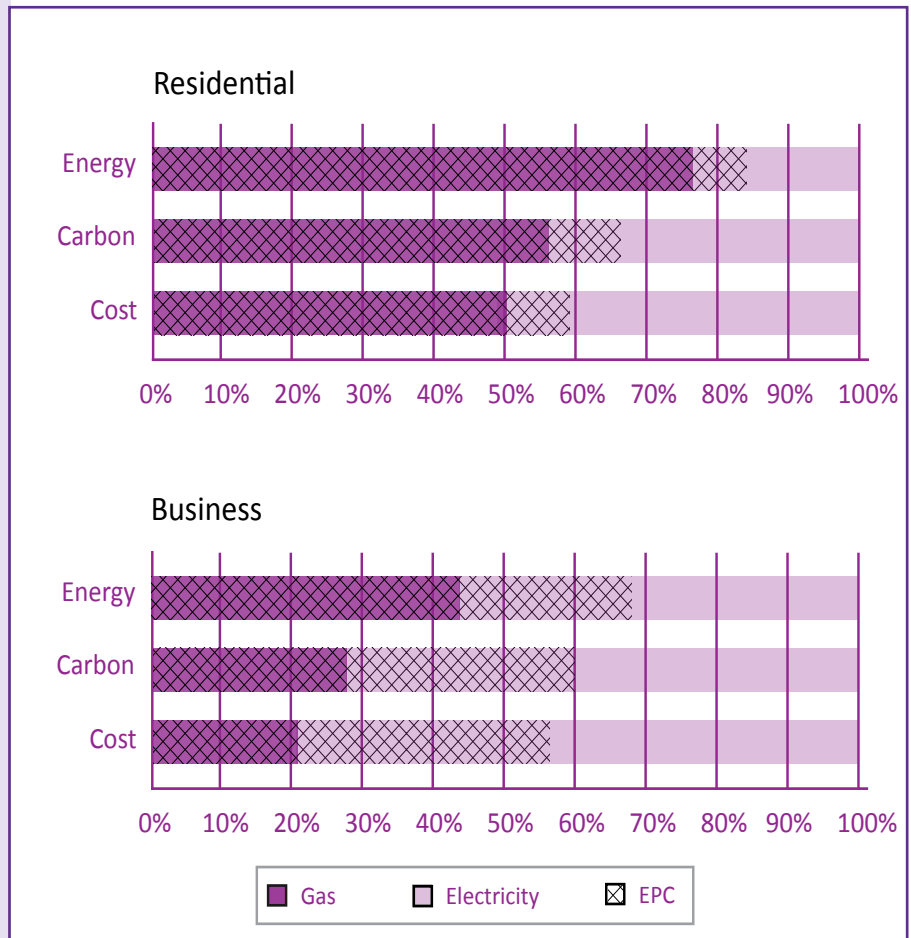
For the UK residential EPC, the scale is the standard assessment procedure (SAP), which ranges from 1 (dreadful) to 100 (net zero energy use). For the fuel poor, the method in the residential EPC is helpful, as it is based on costs and it is costs that matter most. The scale behind the business EPC is the simplified building energy model (SBEM), which does not include fuel costs. Both SAP and SBEM consider the efficiency of the building fabric and of the heating system. While there are criticisms of the methodology and implementation behind EPCs (Banks 2008), the rating provides valuable information and probably ranks buildings according to their performance: a C is more energy-efficient than a D.

The distribution of residential properties in England is skewed (table 2.2): there are more energy-inefficient properties than there are efficient ones. Between 2001 and 2009, the proportion of F- and G-rated properties nearly halved, which is excellent, but there are still virtually no A- or B-rated properties. The penalties of living in the worst homes are still with us, whereas a small, but growing proportion of residents have a reasonably energy-efficient home. The situation is similar with business properties (CT 2010, p100): there are virtually no A-rated properties and too many Fs and Gs. For 2050, the target is for every building to be at least A-rated, with a score of about 100 – for comparison, a brand new residential property in 2011 has a rating of 80 SAP points.

Figure 2.3:  
Relationship between  
the EPC and total energy,  
carbon and costs, per  
sector, UK, 2009/10

Note: The numbers are  
indicative – precision is  
not possible from existing  
data

Sources: Table 1.1 and  
DECC (2011b table 1.7)



Energy performance  
certificates will be more  
important in all property  
sales and rentals in future

www.chancellors.co.uk

**Chancellors**

**Linkside Avenue, North Oxford**

Charming pre-war semi detached family home. In need of modernisation. Lovely views to rear, potential for loft conversion or extension (subject to consents).

• Entrance Hall • Sitting Room • Dining Room • Kitchen • Three Bedrooms • Bathroom • Garden • Garage • Off-Street Parking • No Chain •

**£475,000 Freehold**

We guarantee your property matters



Table 2.2: EPC distribution, residential, England, 2001-9 (%)

Energy Efficiency Rating Band (SAP points)	2001	2008	2009
Band A/B (81-100)	0.1	0.3	0.6
Band C (69-80)	4.3	10.0	13.2
Band D (55-68)	23.0	35.4	37.5
Band E (39-54)	44.4	37.4	33.8
Band F (21-38)	20.8	13.4	11.4
Band G (1-20)	6.0	3.5	3.4
Average SAP	45.7	51.4	53.1

*Note: SAP = Standard Assessment Procedure, the government's preferred method of assessing residential building energy efficiency. The more SAP points, the more energy-efficient the property, so A is the best. There is no similar time-series for business properties*

*Source: CLG 2011a, p33, 54*

It appears as if the housing stock is on the right trajectory: an improvement of slightly less than 1SAP point pa has occurred since 2001. Using a slightly different scale, from 1970 to 2007, the GB housing stock improved at a slightly lower rate of 0.89 SAP points pa (DECC 2011i, p85). From now to 2050, an increase of slightly more than 1 SAP point pa is required, which appears feasible. This rate of improvement hides a problem of economics. The low cost of upgrading some very poor-performing houses with simple measures has delivered the cheapest point gains, often with the use of a grant. From now on, the cost of achieving an extra SAP point will become increasingly more expensive and, therefore, the rate of annual improvement will drop without significant policy intervention.

The rate of change has not been the same in all tenures. The greatest improvements have occurred with social housing and the slowest rate of upgrade is in the owner occupied sector: in 2009, 35% of housing association and 9% of owner occupied properties were rated A-C (CLG 2011a, p55). Privately rented and local authority housing were in-between. As two-thirds of all homes are owner occupied, this demonstrates the challenge for policy.

## DECs

The DEC, used in large, public business premises, is based on all energy use, so it includes the energy efficiency of the building, its heating and cooling systems and fixed lights, as well as the use of energy in all other equipment (other lights, catering, vending machines, computers



---

etc). The DEC, therefore, includes all the energy uses covered by the EPC, plus the remaining energy uses. The final figure is a reflection of the way the building is used and managed, so it is a behavioural indicator. For instance, a building can have a good EPC (because of energy-efficient fabric and heating system and low-energy lights), but be poorly managed, leading to a poor DEC rating. The response to a poor EPC requires capital investment, whereas the implications of a poor DEC include managerial and behavioural factors. Improvements to the DEC, therefore, require better use of controls and a firm understanding of how the building and its occupants actually use energy. It is a powerful comparator of management styles, as well as levels of investment in the fabric.

There is growing interest in the potential impact of DECs and there is nothing to prevent the UK Government unilaterally proceeding more quickly than required by Brussels. Both the UK Green Building Council and Low Carbon Construction have proposed that all non-domestic buildings should be required to have a DEC from 2012 onwards (UKGBC, p7; LCC 2010, p167) and a voluntary approach is being considered by the Government (Treasury and BIS 2011, p211; DECC 2011c, p31).

An attractive feature of DECs is that they are cheap to acquire, once the floor area has been established, as they are based on actual fuel bills, in delivered energy. The receipt of the annual bills, provided they are based on actual consumption, allows the automatic updating of the DEC, as required by legislation.

## **Compliance**

Once EPCs are more accurate, there is still the problem of compliance: making sure the certificates are provided to the potential purchaser or tenant. In December 2009, 68% of agents could not provide an EPC for the commercial building that they were selling or letting (NES 2009a, p2): only 32% of transactions were compliant. With the residential sector, of those who remembered receiving an EPC and who had read it, some 34% did not do anything because they did not agree with the recommendations (NES 2009b, p28). Two years later the situation had not improved, with less than half the households seeing an EPC before renting or buying and only one in five of those who did see it acted on its recommendations after moving in (Consumer Focus 2011). For a label to work well it has to be trusted, visible and to cover all buildings, so that the user can compare them.

The recast EPBD will go some way to improving the situation, as estate agents will have to show the EPC to the prospective purchaser or renter, not just have it 'available'. At the moment, there are definite contraventions of the spirit, if not the wording, of the directive, so





people are being deprived of useful information about the property they are about to occupy. A small but useful step will come from the requirement in the recast Energy Performance of Buildings Directive (2010/31/EU, Article 12) to display the EPC rating on all advertisements for the sale or rent of the property. EPC information should be more readily available for people at each stage of decision-making.

For a market transformation strategy – the labels are there, but as yet, the EPCs and the DECs do not have the accuracy, coverage and policy framework to make them influential in affecting the market.

Labels and databases, together with local authority involvement, will be required to enforce a minimum standard in the privately-rented sector as there will have to be a register of private landlords (residential and business), together with details of the energy efficiency of the property they own. This additional legislation is the opposite of what the government has recently done in removing ‘the secondary legislation that provided for the creation of a national landlords register for homes in multiple occupation’ (Hansard 2011d). Government is not yet joined-up on this issue and there are considerable problems, still in providing EPCs for homes in multiple occupation (several households, probably not in self-contained accommodation).

## Databases

There are two aspects to databases: first those that are relevant when someone is changing property and, secondly, those required for monitoring policy.

A label is only influential if it can be seen at the right stage of the decision-making process. With products, such as fridges, this is easy – every model in the shop has to be labelled and this is clearly visible to shoppers and enforcers alike. With buildings the process is fragmented and the problems are compounded by poor compliance on the part of those in the selling or renting chain. The process would be immeasurably more effective if there were a publicly-accessible database, so that anyone could search the energy-efficiency of the properties that are on the market, anywhere in the country. Advertising will help, but some people are geographically flexible and might want to give energy-efficiency considerable importance.

The Department for Communities and Local Government, the custodians of the data from certificates, have resisted making the information from EPCs publicly available. There is no justifiable reason for this – there is no personal information about the past householder or tenant on it and, of course, nothing about the future one. The only named person is the

---

individual or company that did the audit. The Government are prepared to make the details of the 5.5m EPCs currently in existence freely available to the commercial providers of green deal, to help with their marketing (DECC 2010, p9). Further access should result from the Energy Act 2011, which ‘enables the removal of unnecessary restrictions on access to data’, but no details have been given as to what this might mean. This lack of public information is inhibiting the power of the labels and needs to be reversed quickly, so that the labels can be used in the choice of property.

For effective monitoring and policy implementation, there is a need for publicly-searchable, address-specific databases showing the energy efficiency of each building in the stock. This would enable the best and the worst properties to be identified and enable progress on the whole stock to be monitored. The foundations for this already exist, as every building has a unique property reference number (UPRN) that is part of the local authority’s Local Land and Property Gazetteer (LLPG), which in turn contributes to a national database. Each local authority could extend their LLPG to include energy-efficiency data for the buildings in their jurisdiction.

The EPC is only required of some buildings, at certain points in time: when the property is offered for sale or for rent. This means that there will not be full coverage of the whole stock for several decades, because of the long residency of some occupants. A reasonable picture of performance can be derived, in conjunction with housing surveys, as shown in table 2.2. To accelerate the population of the LLPG with energy-efficiency information would require the production of EPCs in conjunction with other transactions, for instance, whenever there is:

- o an application for planning permission;
- o building regulation approval;
- o a new mortgage;
- o receipt of a grant or green deal finance.

Even these new interventions are unlikely to be sufficient to populate a database quickly for all building types. For business premises, the Carbon Trust has recommended that all business have an EPC by 2015 (CT 2010, p97). A similar requirement for residential properties could be implemented, at a basic but sufficient level, by the local authority, using data it already possesses or is readily available (Durham 2011).

For *Achieving zero*, it is seen as a necessary requirement for each local authority to be given the task of creating an address-specific energy-efficiency database for all the properties in its area. For the purposes of fuel poverty eradication, this should be completed as soon as practicable, so the homes with continuing problems can be identified and helped before 2016, the legal commitment for ending fuel poverty.



## MORE OF THE BEST

### Future-friendly buildings

A building that is designed to be low-energy provides a high standard of energy services, particularly warmth. It is more comfortable to work or live in, as there are no cold surfaces, no draughts, no condensation and is generally healthier. It is to be desired and sought after. It is not a frugal standard of living. These concepts have not yet been understood, but when they are should constitute a strong pull towards super-energy-efficient properties. They represent future-friendly buildings because they also:

- o insulate the occupant from future price rises;
- o reduce fuel poverty;
- o limit the UK's use of fossil fuels and, therefore, imports;
- o minimise the carbon emissions that cause climate change.

But it is the higher level of energy services that make these buildings particularly desirable.

*Solid wall insulation and double-glazing improves the appearance of a 1920 building and makes it more comfortable inside*

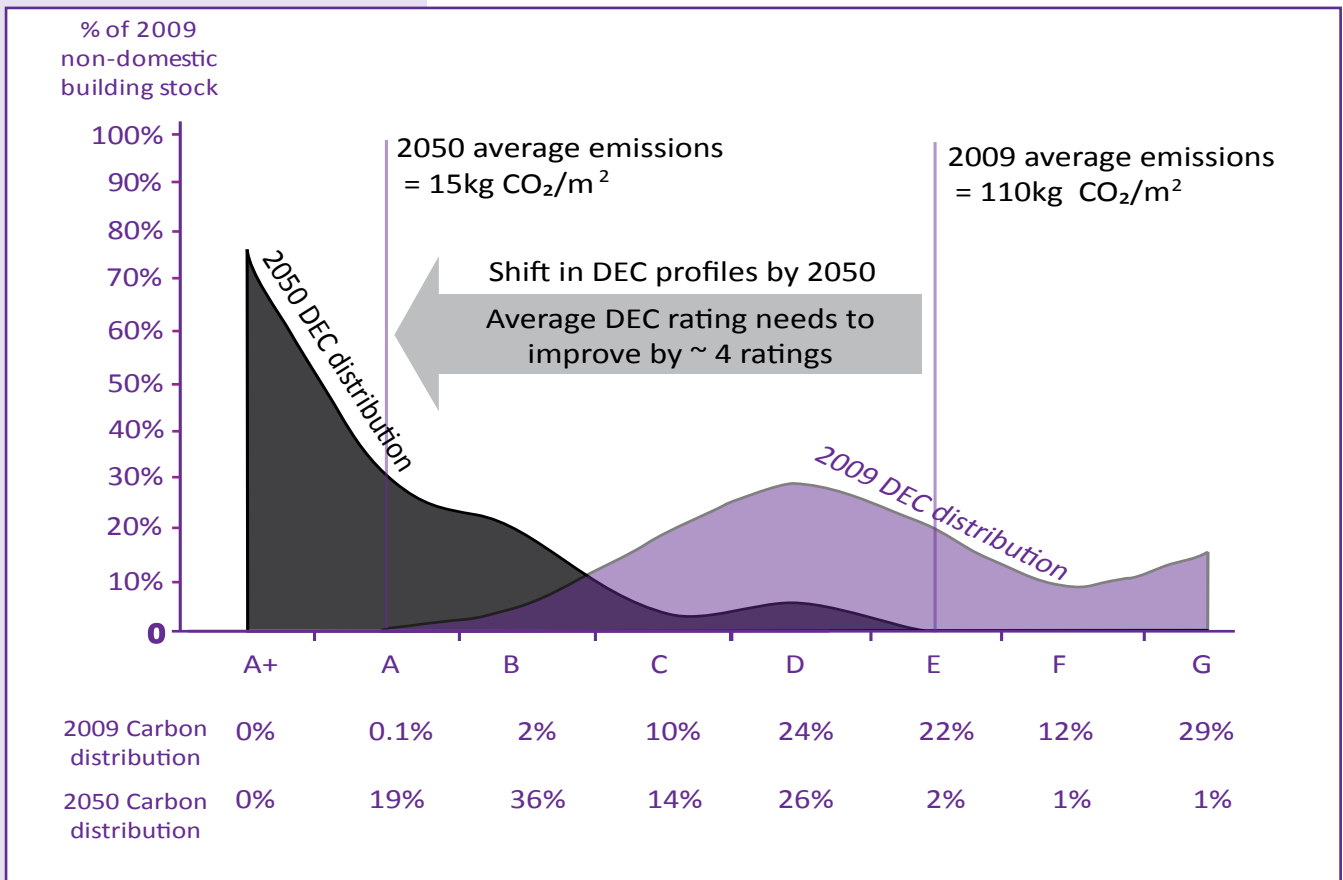


Figure 2.4:  
Distribution of DEC certificates, UK, 2009 and 2050

Note: an A+ rated property is a net energy exporter. The present scale on the EPC and the DEC only goes to A, but there are bands above A on electrical appliances

Source: CT 2010, p71

Once properties are labelled and the distribution identified, in a market transformation approach, there should be specific policies to improve the proportion and standard of buildings that are super energy-efficient, in order to pull the distribution curve towards lower energy use. The required shift in the distribution of the stock is well illustrated for the business sector (figure 2.4), with archetypal market transformation curves. Although the graph is for DEC, not EPC bands, the principle and the shift required are similar: the average business property has to improve by four bands from 2009 to 2050. In that scenario, by 2050, there are minute numbers of E-, F- and G-rated business properties in the UK, and the vast majority are A or A+.

There is an equivalent challenge for residential properties, with the average building in the UK improved by at least three bands on the energy performance certificate by 2050 (from today's average of a D, to an A) and the worst ones improved by as much as eight bands (from a G to an A).



Currently, the most energy-efficient buildings are either new build (because of the Building Regulations) or exemplars that demonstrate what can be achieved (whether new or converted). The standard of new buildings is important, for the message that it gives to the construction industry and landlords, and for the transformational effect of the improved skills, knowledge and tools experienced by the building sector generally. It is less important in terms of the effect on total emissions, because of relatively low level of new construction compared to the size of the existing stock. Progress is often not as fast as many would like, nor as climate change policy dictates, but nevertheless a major industrial sector is being gradually transformed. Building regulations are a devolved responsibility, so are somewhat different in England, Wales, Scotland and Northern Ireland. For instance, new homes are to be zero carbon in Wales by 2013.

The main tension exists between which energy end-uses should be affected by Building Regulations and which energy end-uses should be driven solely by appliance minimum energy performance standards and labelling. Currently, Building Regulations are concerned just with those uses of energy that are fixed by the design and fabric of the building: space and water heating and integrated lighting (the regulated uses of the EPC). Their presence (not their use) is more independent of the occupant than other forms of energy-using equipment, such as TVs and refrigeration. The key points in this debate include:

- o fabric-related impacts are only easy to determine at the point of construction (eg the width of the cavity in the wall, insulation under the floor or the orientation of the building), so should be given priority in the initial design and permission;
- o as the Building Regulations are getting tighter, more of the energy use is non-regulated, but some of which can also be influenced at construction stage (for instance, many new homes have a fitted kitchen, so the efficiency of the appliances has been determined by the builder; a gas connection provided to the kitchen makes it possible to use gas for cooking).

The debate continues, but is diverging between residential and business properties. By 2019, all new business properties have to achieve a zero carbon standard for all energy uses. The Carbon Trust believes that the zero carbon standard for business premises could be introduced earlier (CT 2010, pp20-21). Zero carbon new residential buildings were to be required from 2016, but the Government has recently reduced the standard to regulated uses only. From the perspective of meeting Government carbon abatement commitments, this is a backward step. Further pressure is in the pipeline as the recast Energy Performance of Buildings Directive (EPBD) requires that 'by 31 December 2020, all new buildings are nearly zero-energy buildings' (Article 9). This will cover at least all the regulated energy uses, and perhaps the unregulated ones, depending on how the UK government interprets the legislation. However, a move to incorporate a more comprehensive set of energy end-uses into the standards for new buildings has to happen soon, for both sectors, merely because they are now predominant.

---

The government is announcing the regulatory requirements for zero carbon homes, to apply from 2016. To ensure that it remains viable to build new houses, the government will hold housebuilders accountable only for those carbon dioxide emissions that are covered by Building Regulations, and will provide cost-effective means through which they can do this (Treasury and BIS 1011, p117).

The stamp duty relief for new zero carbon homes, limited to a maximum £15,000, is the only fiscal incentives to encourage the provision of super-energy efficient buildings in the UK. This has been a dismal failure, as only 25 properties were covered by the scheme in the first two years. To facilitate market transformation, significant incentives will be needed to encourage super-energy-efficient exemplars for both new and existing homes.

## **Exemplars**

Exemplars are the link between the current and future paradigms. Every building that is made more energy-efficient proves to others what can be done and demonstrates to the users the quality of the internal environment that is produced. Exemplars play an important role in market transformation by communicating target performance levels in the most tangible way to all stakeholders: from policy makers to building professionals to end-users. Policy mechanisms are necessary to create and showcase local exemplars for both business and residential sectors.

With the present low rate of new construction, most of the progress to A- and B-rated properties has to come from the conversion of existing properties. A tough standard for both refurbishment and new build is known, after its German origins, as the passivhaus standard: where the aim is to provide a property that can be heated by passive sources of heat only (sunlight, human bodies, waste heat from appliances). It does not require an active space heating or cooling system: the house maintains a good level of thermal comfort in all seasons. The components of the standard cover all uses of energy in the building. The passivhaus standard has no formal regulatory backing in the UK at this stage, but as a voluntary standard it rigorously defines what is required in both new and refurbished properties (known as EnerPHit), mainly residential (as in haus), but also, gradually, businesses. There is potential for future links between the passivhaus standard and the requirements under the recast EPBD. By April 2011, there were 8 passivhaus properties in the UK: 6 new build and 2 converted. Elsewhere in the world there are 30,000 passivhaus buildings (Passivhaus 2011).



The list of existing homes that have been converted to high standards of energy efficiency and low carbon emissions is growing and many are members of Old Homes, Superhomes, or other networks such as Good Homes Alliance. For businesses, the European Commission runs a site dedicated to green buildings (EC, JRC, 2011) and had 549 case studies at the end of October 2011.

## Construction standards

Quality of build and refurbishment work is an important issue. Whether renovating an existing property or building something new, there is a high likelihood that the work will not deliver the expected energy-efficiency savings. This is not an exclusively British problem – though we may have an extreme case of it. In a survey of 16 newly-completed homes, the actual rate of heat loss was found to be from 10-125% greater than was predicted at the design stage (Bell et al 2010, p79-81). This demonstrates that consumers are being let down by inadequate construction procedures, or even a lack of design detailing. The solution is for enforcement bodies and regulatory compliance to be strengthened, particularly through additional resources for building control and greater monitoring. Otherwise, progress on carbon abatement will require even tougher Building Regulations in future (CT 2010, pp20-21).

One encouraging move is the proposal, accepted by the government, that the regulated energy uses in new residential buildings should be assessed on actual usage, not at the design stage (ZCH 2010). If enforced, this will require the construction industry to deliver air-tight buildings, without thermal bridging and should be a powerful lever for better standards.

## REMOVING THE WORST

To transform the distribution of EPC performance levels towards A-rated homes, there has to be a push towards lower energy use from policy on the worst existing properties, as well as the pull of new Building Regulation standards and exemplar projects. There is legislation on minimum standards, linked to the provision of healthy buildings - the housing, health and safety rating scheme (HHSRS) in England and Wales and the tolerable standard in Scotland. These give the local authority a duty to take action on the least energy-efficient homes, but there is little actual activity (Impetus 2008, p20).



---

## Minimum standards

The most obvious way to ensure that the worst properties are upgraded to a good level of energy-efficiency appears to be through the introduction of effective minimum standards – to use regulation to start the process. Many of the recent major reports on UK buildings have emphasised the need for mandatory minimum standards of energy efficiency across the existing building stock (e.g. UKGBC 2008; LCC 2010, p149) or just for businesses (CT 2010, pp20-21). There is growing recognition that this policy will be required to focus the minds of owners and occupants on taking action. At present, the process of improving the building stock is left to motivated individuals: it can be done if you feel like it. There is no requirement to achieve a certain standard, let alone by a specific date. The rates of improvement being required, both in individual years and within each decade, require a completely different sense of purpose and trajectory for carbon reductions, particularly for owner occupied properties.

There is a precedent for this approach: the Clean Air Act 1956. For each declared smokeless zone, all households had five years to stop using coal and replace their heating system, often with a grant from the local authority. The justification was similar – the improved health of the occupant and the greater good to society of cleaner air.

To bring about the transformation in the UK buildings market the proposal is that there should be a policy on minimum standards in all buildings, business and residential. The Government has announced the first stage of this process in the Energy Act 2011 and linked the standard to the bands on the EPC:

from April 2018, it will be unlawful to rent out a residential or business premise that does not reach a minimum energy efficiency standard (the intention is for this to be set at EPC rating “E”).

This will affect the 680,000 homes in the privately rented sector that are F- or G-rated (Hansard, 2011b) – a maximum of 14% of the fuel poor. With businesses, the 6% of buildings that are G-rated are responsible for 15% of carbon emissions (LCC 2010, p149). The impact could be rapid as over a third of privately-rented homes are vacated each year and for businesses, the average lease has dropped to about 5 years with 63% of all leases being for less than 5 years (BPF/IPD 2011).

The concept of minimum standards for business premises has been advocated for a while; LCC 2010, p149; CCC 2011b, p123). With business buildings there is more of an expectation that the savings will be achieved in full, as there is nothing comparable to the rebound effect in low-income homes, where part of the savings are taken as extra warmth and higher energy services.



By linking the required minimum standard to the EPC, the Government is dealing with the regulated uses only. The proposal appears to be that the minimum standard would come into effect when the property is let or sold, whereas it should sometimes be on resale (Boardman 2010 pp92-3), depending on when the first EPC is obtained. If the minimum standard is only triggered at the point of sale or when a new rental occurs, the rate of change will be relatively slow. However, this is the least intrusive approach and, therefore, most politically acceptable. The financial incentives (chapter 4) help to speed up the rate of change and make substantive action less dependent upon someone moving. This type of interaction between policies is typical of a market transformation approach: there is a choice between strong regulatory action and generous financial incentives, but both may not be needed.

A more rapid introduction of minimum standards would be achieved through a revitalised housing, health and safety rating scheme (HHSRS): F- and G-rated properties are deemed to be providing a health hazard for the occupants so there should be action on them. This exists, provides the perfect legal framework, but is ineffective, as local authorities do not give it sufficient resources. This would be an important contributor to early action (before the 2018 standard becomes operative) and achieving the 2025 carbon budget target.

The energy efficiency of social housing (owned by the local authority or housing association) has been improving, partly because of the accepted moral obligations and partly because of the impact of policies such as the decent homes standard (DHS). A second round of the DHS is required, for instance bringing all properties up to a minimum of a C on the EPC (SAP 69 or better). This approach has been recommended by the Local Government Association and endorsed by a House of Commons Select Committee (Boardman 2010, p146). It would contribute usefully to reducing fuel poverty, but ought to be to a higher standard (A or B rating on the EPC) as fuel prices have continued to rise.

The single most important task for the British Government is to introduce a policy of requiring minimum energy performance standards for all existing buildings, whatever the tenure and to make sure that every property owner knows that it will apply to their property at some stage. The date is less important than the communication of certainty: the market must recognize that the occupation and use of energy-inefficient properties is becoming unacceptable to the British public.



*Building-integrated renewables, such as solar thermal and combined heat and power, together with green gas could provide all the energy required for hot water by 2050*

## **IMPROVING THE AVERAGE**

The energy efficiency of the stock is improving, gradually: at about 1 SAP point pa for residential (table 2.2) and has to proceed at a somewhat faster rate of 1.2 SAP points pa. The scale of the challenge can be expressed in terms of the numbers of properties to be upgraded each year:

- o there were 5.5 million households suffering from fuel poverty in the UK in 2009 (DECC 2011g, p9). Because of subsequent fuel price rises, this is estimated to be over 6m in 2011. To eliminate fuel poverty by 2016, as required by the Warm Homes and Energy Conservation Act 2000, means that 1.2m fuel poor homes have to be upgraded each year to at least SAP 81 (B-rated or better);
- o for compliance with the zero carbon emissions from the residential sector by 2050, it is necessary to undertake substantial upgrades to 600,000 existing residential properties a year from 2017 until 2050, ideally to A or A+



rated. If a lower standard is achieved, this will require each property to be visited more than once, and hence require a greater level of activity, perhaps double;

- o with the 2m business premises, over 50,000 properties have to be improved by at least four bands each year.

While the scale of the task seems daunting, the first three years of CERT has provided some individual insulation measures to over 2.6m homes. The provision of a couple of insulation measures is significantly less than the quantum of changes needed to retrofit a home to an A standard, but upgrading 600,000 properties a year has been achieved. The large number of actions required per home combined with the number of properties to be treated each year from now on makes this is an unprecedented task.

### **Individual measures vs outputs**

‘It is frustratingly hard to make a really big dent in the leakiness of an already-built house’ (MacKay 2009, p296). But this is what has to be done. Few details of the technologies or measures are given here, as the focus is on the policy framework.

The types of measures that will be required to bring a property up to a high standard of energy efficiency (and low rate of heat loss) include all of the following:

- o insulation to the external surfaces: walls, windows, roof, underfloor (if possible);
- o reduction in ventilation losses and re-use of warmth in stale air with mechanical ventilation and a heat exchanger;
- o the installation of an efficient boiler and renewable sources of energy;
- o the replacement of all lights with light emitting diode (LED) technology.

The majority of interventions in the UK have been piecemeal: the installation of individual insulation measures, for instance through CERT, Warm Front, and their predecessors for the residential sector. This incremental approach has been driven by Government policies which encourage specific actions, rather than whole house retrofits, and will continue through green deal and ECO (chapter 4). There is nothing at present requiring or encouraging people to undertake major improvements or achieve a specified whole-house performance standard.

---

While it is possible to believe that demand for space heating will be reduced as minimum standards take effect, there will be a residual demand for water heating. Present household consumption of just over 3,000kWh pa (table 1.1) will be reduced through the:

- o installation of more efficient boilers and equipment (eg washing machines);
- o installation of solar thermal panels and combined heat and power, partly as a result of the renewable heat incentive;
- o general behavioural shift to the more careful use of energy (for instance, shorter showers).

In addition, a certain proportion of the remaining gas use will be supplied by green gas, with no carbon emissions. This proportion will increase as the demand for gas, both in space and water heating, declines and as anaerobic production increases. The assumption is that the net effect will be nil demand for energy for water heating from fossil-fuelled sources by 2050 and thus no resultant carbon emissions.

With the refurbishment of an existing building, particularly one where the focus is on extra space rather than energy efficiency, there is a role for a 'consequential improvements' clause in the Building Regulations. These relate the effect of the new extension to the energy performance of the whole building. The objective is to make sure that the new addition to the building will not, overall, increase the buildings' energy consumption or carbon emissions. Consequential improvements have twice been in draft Building Regulations for the residential sector and twice removed.

The recast Energy Performance of Buildings Directive is requiring action on consequential improvements, for both residential and businesses premises, with 'major renovations' defined as costing more than 25% of the value of the building (less the value of the land) or affecting more than 25% of the building envelope (2010/31/EU, article 2.10). In both cases, this is a high threshold, so the majority of renovations will not be affected. The UK Government unilaterally could introduce a more rigorous standard and this is recommended.

Both the Carbon Trust and the Low Carbon Construction reports consider that consequential improvements for the business sector could easily be introduced and should be framed in terms of kgCO<sub>2</sub>/m<sup>2</sup>, under part L2B of the Building Regulations. At the moment Part L2B only covers the refurbishment of about 1.5% of the building stock each year as, again, the definition of major refurbishment is too generous and precludes a large volume of building activity (CT 2010, p96).

Consequential improvements become less important if there is a policy of minimum standards in place, though they help to prepare a building, at a time when work is being done. Conversely, the failure to define consequential improvements provides a further imperative for introducing minimum standards: the alternatives have not worked.



## Exemplars

Improved standards and activity is being proposed for public buildings (including social housing) through the EU Energy Efficiency Directive, currently in draft. It is proposed that 3% of the floor area of public buildings should be improved to a high standard each year. This may become a Directive (Com(2011) 370, article 4). Considerable pressure is already being exerted by the government on its own departments over the energy efficiency of their buildings. This is having some minimal effect: in 2010, one in five of the premises occupied by UK government departments was G-rated and none A-rated; over a third did not have a valid EPC (DECC 2011b, table 5.11). The role of public buildings as exemplars is important as it demonstrates that the government is concerned about and committed to energy efficiency. The successes and failures should be widely publicised.

Public sector leadership should be shown in existing, occupied buildings by implementing cost-effective measures as defined by the DEC advisory reports, as if the voluntary measures had been mandatory (CT 2010, pp20-21).

All exemplars, whatever tenure, provide a learning and training opportunity for both the construction industry and the public. For this reason, they are vitally important and local examples should be highlighted by each local authority or by community groups.

## Getting each building right

The diffuse nature of the works required to convert an existing building to a zero carbon or low-energy one means that many different trades could be involved, but none of them has a strong over-view of the relationships between the diverse interventions.

There are various options that would improve this situation, for instance by having an experienced person in the building firm – an integrator - oversee the work, liaise with the property owner and make sure that the intervention both aids sustainability and is carried out to a high standard (Killip 2011; WBCSD 2009, p11). This is particularly important if cold bridging is to be avoided and air-tightness achieved. The risk is that the additional cost of this service is likely to make such firms less competitive and to result in the property owner going to an individual trades-person and never receiving the advice.

A more formal approach would be to give local authority Building Control Officers the role of ‘mentor’ for each building in the stock – they would have responsibility for making sure that, wherever possible, improvements to a building would result in it moving along the trajectory



---

to zero carbon. They probably would not have the power to prevent work being commissioned by the owner, but they would have made sure that the detrimental aspects of the proposal were understood and that could result in expensive work to counteract in order to meet future minimum standards. Building Control Officers are already the most technically trained, but the result would be to require all work to be notified to Building Control, not less as the Government is proposing.

Both the integrator and the Building Control Officer would have an important educational role as they can meet the property owner face-to-face and explain the options. As with most educational activities, this is not a cheap process and would undoubtedly involve additional funds for local authorities.

An interim approach is provided by the advice included with the EPC. The recommended measures identify the most cost-effective improvements to undertake. This list helps as long as energy-efficiency has become a primary objective for investments.

## HEATING SYSTEM CHOICES

It is relatively easy to set standards of thermal efficiency for a building and to select the insulation measures required to achieve it. When it comes to the fuel used for heating and hot water, there are several choices and the reasons for selection are not always obvious, particularly when nationally some of the choices are based on carbon rather than energy reductions. Saving carbon may have some value for businesses, because of policies such as the carbon reduction commitment. However, carbon has little relevance to householders, whereas they receive economic benefits from saving energy.

As shown in table 1.1, gas provides the majority of space heating and hot water in both sectors. Continuing the use of gas is, therefore, likely to be the preferred option for many users: the substantial capital investment embodied in a central heating system together with its durability means that the system is only likely to be replaced slowly. In 1970, 30% of homes had central heating; this had increased to 60% by 1982 and only reached 90% in 2002 (DECC 2011i, p88). It took over 32 years for central heating to become the dominant system. There are 39 years between now and 2050. A rapid conversion away from the gas boiler and wet central heating system looks improbable.





Three of the important technologies that influence which heating system will be used – green gas, combined heat and power (CHP) and heat pumps – are detailed next. These provide examples of where the demand side and supply side debates overlap and the importance of individual circumstances. The reasons for choosing between them vary according to the priority given, for instance, to:

- o low capital expenditure by the property-owner – favours green gas or community CHP (Table 4.1);
- o low carbon emissions – favours green gas or all types of CHP until electricity is substantially decarbonised (2025+);
- o generating income through the receipt of a feed-in-tariff for electricity – favours electricity from green gas and micro CHP pilots;
- o generating income through the receipt of the renewable heat incentive – favours green gas (as gas) and heat pumps.

These are not all directly competing as green gas can be used in CHP and heat pumps may be the choice for a post-2025 world. If there is to be a clear priority to encourage a move away from gas central heating, then there will certainly be a need for a strong strategy to achieve it, probably with considerable financial incentives. With both CHP and heat pumps, the considerable expenditure required will not be appropriate for buildings that have become really energy-efficient and require little heating.

## Green gas

The carbon-intensity of gas is about a third of that of electricity (MTP 2010a). If it could be lowered further, by producing renewable gas from home-grown sources, then gas could remain a major heating fuel while contributing to greater security of supply.

Green gas is a renewable form of gas as it is created through the anaerobic digestion (AD) of waste (from dustbins, sewage and farms). AD replicates the process that occurs naturally in a landfill site, but speeds it up in controlled conditions. It is an established technology that does not result in unpleasant odours or toxic gases and is particularly efficient at large-scale. Because it uses waste, it achieves a helpful policy bonus: the reduction of biodegradable material going to landfill, which has to be reduced to 35% of 1995 levels by 2020 (as required by European legislation) (DECC and Defra 2011, p21).

Once produced, green gas requires treatment to clean it up and the resultant bio-methane can be added to the fossil (natural) gas network, partly decarbonising it. No new distribution system is needed. This will delay the shift to electricity on the grounds of lowering carbon

---

emissions. The Government has stated that it is 'committed to facilitating bio-methane injection into the gas grid' (DECC and Defra 2011, para 61).

There is uncertainty about the amount of green gas that could be produced in the UK. The National Grid (NG 2009) considered that by 2020 it could be equivalent to about half of all the gas currently used in the home. This is the maximum level and would be reduced to 46% if there is no use of miscanthus or any other crop. Other sources consider there is less of a resource (CCC 2010a p214; CCC 2011a, p126). The extent to which there could be large-scale production of green gas will depend partly upon policies on waste disposal, for instance by building less incineration plants. AD construction should be relatively easy to implement as 'the construction of AD facilities can be comparatively swift, and compared to some other waste management technologies can be relatively inexpensive' (DECC and Defra 2011, para 24).

Bio-methane is one of the technologies supported by the new renewable heat incentive (RHI) (DECC 2011d, pp35, 38), so there will be a financial incentive to increase production from November 2011 onwards, particularly at the small scale. The extra cost of RHI will be borne by the Treasury, not the utility rate payer, which makes it a progressive policy: few low-income households pay income tax, whereas they all pay energy bills.

The Government increased the rate of the feed-in-tariff for anaerobic digestion from August 2011, in order to encourage more developments that produce electricity (WEP 2011). Adding green gas to the natural gas system is a better use of the resource than burning it to produce electricity: half the gas used to generate electricity is wasted (maximum efficiency of a combined cycle gas turbine is around 50%) whereas a gas condensing boiler is 90% efficient – only 10% is wasted.

The opportunities to increase the amount of bio-methane added to the gas grid should be implemented as fully as possible, to decarbonise the gas used in most buildings (90% of homes and at least half of all businesses).

## **Combined heat and power**

Combined heat and power (CHP) is the equivalent of a mini-power station, as it provides electricity and useful heat (in the form of hot water) at the same time. It is the same process that occurs at a large electricity generating station, where the hot water is usually vented as steam, or in the household's gas boiler, where the heat is used, but the opportunity to create



electricity is not. CHP can be implemented at any scale, in both sectors. Even if the boiler is changed, the wet central heating system (pipes and radiators) stays. The CHP can be provided at three different scales:

- o for a local community with the heat distributed via a district heating scheme and the electricity generated at the central plant. Most suited to dense urban areas;
- o per individual property: an enlarged gas boiler, called micro-CHP, replaces the old gas boiler and is now commercially available. For suburban areas, which are on the gas network. The feed-in-tariff for electricity has been available for micro-CHP pilots since April 2010 to provide evidence on the way they work;
- o using waste heat from low-carbon thermal power stations, piped to users.

With community CHP in particular, it is relatively easy to convert the process to a different fuel in future, say from gas to hydrogen. At all three scales, the use of green gas is sensible and potentially applicable to all properties on the gas network, ie at least 90% and more if bottled gas is included.

All CHP systems have the substantial advantage of supplying electricity during the period of peak demand when electricity is at its highest marginal value: the maximum demand across the UK for electricity occurs late afternoon in the middle of winter, when people return home from school and work. This coincides with the main demand for heating. In a CHP scheme, because the heating was going to be required anyway, the electricity is effectively free (it is the automatic result of burning the gas). The provision of electricity at peak times is an important attribute and the low cost of this electricity would benefit the fuel poor, through community schemes, and the individual property owner at the micro level.

Using the waste heat from a thermal power station has been a sensible suggestion for many years, but does not occur in the UK. Many existing power stations are some distance from urban areas, so extensive heat networks would be required. A future requirement of all new installed thermal capacity (eg gas or coal with carbon capture and storage, even nuclear) could be that it provides heat to the local community. With well-insulated distribution, waste heat can be piped to local communities several kilometres away from the power station.

There is an important interplay between the role of CHP and the scale of electricity use for heating in the future. To avoid the substantial heat losses from thermal power stations being wasted, they would have to be used in some form of community heating, thus reducing the need for electric heating.

---

## Heat pumps

Heat pumps are the third of the competing technologies. They take low temperature heat from the ground, air or water and concentrate it for use in the home at a higher temperature. The source of the heat is renewable, so the whole process is considered to be renewable despite the pump being driven by electricity. This is a somewhat curious situation while electricity is so carbon-intensive. A well-functioning system will deliver three units of heat (or more) for one unit of electricity, to give a coefficient of performance (COP) of 3. In primary energy terms, where the electricity is taken from the grid, this is about 1:1, as three units of energy have gone into the power station to make the unit of electricity in the first place. A heat pump will save carbon emissions if replacing oil, but not gas, at present levels of efficiency and carbon-intensity of electricity, though if powered by renewable electricity a heat pump has a zero carbon impact.

Air-source heat pumps are usually placed outside in the open air, but the coefficient of performance lowers with air temperature. There are few opportunities to use a heat pump to extract heat from water (eg a river). Most of the discussion is about ground-source heat pumps (GSHP), which take the heat from the ground. A GSHP requires long lengths of pipe to be installed in the ground, either vertically or horizontally, but in both cases a garden is implied with an existing property. The cost of installing a ground source heat pump is directly proportional to its maximum power rating (a 10kW system is twice as expensive as a 5kW system), whereas the cost of a gas boiler increases marginally with size. Evidence on the performance of heat pumps in practice is still being collected (EST 2010).

Heat pumps should only be installed in a well-insulated building, otherwise they may not be able to supply sufficient heat at reasonable cost – they are no cheaper to run than a conventional gas-fired system. When the building has been properly insulated, however, there may be no need for a central heating system at all, merely for a couple of panel radiators or wood stove (LCC 2010, p112), or less with a passivhaus.

There is another practical reason why the market for heat pumps may be difficult to stimulate. Most new boilers in existing buildings are distress purchases – the boiler breaks down, often in winter, and has to be replaced promptly. Householders value comfort and convenience and conduct minimal research before purchasing a new boiler, perhaps leaving the decision of what type of boiler up to the installer and requiring that it is installed as quickly as possible (Banks 2001). It does not appear realistic to expect the householder to wait until the home has been insulated, the garden dug up and the GSHP installed.



The Committee on Climate Change is expecting large numbers of heat pumps to be installed, particularly after 2025, when the electricity system is meant to have been decarbonised. Heat pumps are the main reason for the expected growth in electricity demand from buildings: ‘electric heat could add 14% to demand from existing sectors in 2030’ (CCC 2010a, p275). Between 2025 and 2030, heat pumps are expected to be installed in over 1m homes a year, to give a penetration rate of 25% in the residential sector (6.8m homes) and 59% in the business sector by 2030 (p129). This may be a misreading of people’s likely response to the technology.

### **The renewable heat incentive (RHI)**

The RHI started in summer 2011 to provide cash bonuses for 20 years when solar thermal, bio-methane, heat pumps or other renewable heating technologies are installed in a property. During 2011, the RHI is available to business, and from the end of 2012 for residential, to coincide with the Green Deal (DECC 2011d).

Bio-methane and heat pumps have been described. Solar thermal panels on the roof can provide the vast majority of hot water needs during the summer and some top-up capacity during the rest of the year (in total about 40-50% of the annual hot water demand). During the summer, the gas boiler can be switched off, as there is no need for either space or water heating. About 50% of roofs are suitably orientated to take solar thermal panels, potentially providing a quarter of all residential hot water by 2050 (Eyre et al 2010, p270). The acquisition of solar technologies (solar thermal, and photovoltaics producing electricity, covered in chapter 3) should be encouraged as they utilise a truly renewable source of energy. The development of dual systems, that provide both electricity and hot water (the sun shines through the photovoltaic front panel onto the solar thermal behind) would mean there will be less competition for roof space.

*Heating systems are redundant in really well-insulated buildings*



---

## SUMMARY

Improving the thermal efficiency of the building fabric and heating system and, by implication, reducing energy demand, is universally agreed as one of the substantial contributors to a low-energy future. It involves everyone in the country, as owner or occupier, the technology is known, many of the options are already cost-effective and exemplars are appearing.

There are substantial opportunities to reduce demand for heating (space and water) in the building stock. These are well-known, though the scale and speed of reduction required is barely recognized by the public. The problems are not with the technology, as many solutions are readily available; the problem is with the creation of demand for higher performance.

For market transformation, the first policy is to label each property, to create an informed market, facilitate better decision-making, and establish the performance distribution. The labels are there in the form of EPCs and DEC, but their full potential is not utilised. The existence of two, very different types of labels is helpful for policy and both EPCs and DEC have central roles in this strategy.

With buildings, the labels have to be supported by user-friendly, comprehensive, national databases – to provide the ‘shop window’ on a screen for people wanting performance information on a new property to purchase or rent. The label is the pre-requisite of all other policies, but with buildings will always be less effective without such a database. There is no such publicly-available, address-specific energy performance information at the moment and this is a crucial omission.

Policies to bring more super energy-efficient properties onto the market – the pull-factor at the top end of the distribution – are reliant on future standards for new construction and the stamp duty incentive for zero carbon homes. There are no other incentives for new or existing buildings to achieve the best standards (eg A-rated or passivhaus), beyond Building Regulations. It will be important to pull the market strongly, particularly for existing buildings and exemplars should be developed (and widely publicised) to demonstrate the best levels of retrofit and new construction. For new construction, the Building Regulations may have to cover all uses of energy, to comply with European regulation.

The construction industry often delivers poor standards of workmanship, resulting in buildings that do not perform as designed or modelled. Skills levels should improve if the standard



for new build housing is based on actual consumption, rather than a theoretical design, or through a more rigorous inspection process. The Zero Carbon Hub proposal recommending the standard of new residential buildings be based on performance is important for this reason and provides a useful precedent.

There is legislation focusing on the least energy-efficient homes, for health reasons, but this duty on local authorities is not enforced, though it could be ramped up to transform rapidly the worst performing section of the market. The minimum standard for privately-rented homes and businesses, announced in the Energy Act 2011, will not be operative until 2018, creating an unnecessary hiatus. The push-factor on the tail end of the distribution is still too weak.

The most powerful driver towards greater energy efficiency, across the whole stock, would come from the introduction of minimum standards for existing buildings. This would require action on the worst properties, in all tenures, and provide a clear decision-making framework for the moderate middle. Many other things would follow: labels would have to be on all buildings, databases would have to be complete and accessible and there would be more of a focus on standards of workmanship – a demonstration of how market transformation creates interactions between policies.

The bulk of residential properties are owner occupied and this is the tenure group where there is least energy-retrofit activity. Where a property is altered there is no role for the impact on the rest of the building to be considered in the Building Regulations, through consequential improvements. Changes to Building Regulations, invoking consequential improvements for any reasonable investment in building upgrade, would accelerate energy-specific investments.

The three tasks for government are, first, to introduce quite tough requirements for consequential improvements – so that enlarging or improving a property has to be accompanied by reducing its total energy use. Secondly, to get consistency across the Building Regulations for all buildings, and make the standards for residential properties cover all energy uses (regulated and unregulated) match those for businesses, to be introduced in 2019. Thirdly, extend the proposal by the Zero Carbon Hub that actual performance should be required as proof of meeting a standard (not just a theoretical calculation and design) to all compliance standards for energy efficiency in the Building Regulations for new construction.

If electric heating is the future – and it still is an ‘if’ – this should only be after 2025 or when electricity supply has been decarbonised in relation to gas. For now, a greater emphasis on the



---

use of anaerobic digestion to provide green gas and decarbonise the existing gas system would enable householders and businesses to continue with their present space and water heating systems. It would also allow expenditure to be concentrated on reducing demand through greater energy efficiency within the property, which should always be the first priority. The more that demand for gas in the home can be reduced, the greater the proportion that could be green gas and zero carbon.

There is continuing uncertainty about the role of combined heat and power: both community and individual systems have their advantages and disadvantages and either could use green gas. In both cases, one of the major attributes of CHP is that it produces electricity during the peak demand period of late afternoon in December and January. This reduces the need for new electricity generating capacity as the old nuclear and coal power stations are phased out - a major economic saving for the country.

The present picture indicates that current policy on improving the energy efficiency of the built environment is weak and incoherent. The whole system relies on motivated individuals - and most individuals are not being motivated. A strong market-transformation approach is deemed essential, to unite policy into a coherent framework so that the whole building stock moves, rapidly, towards greater energy efficiency.

The message about a low-energy future for buildings is both radical and normal: every property has to be made super low-energy and to be improved to an A standard by 2050, which sounds, and is, a major challenge. But the rate of progress, at an increase of 1.2 SAP points pa in residential and a similar amount on the business index, is only slightly greater than the rate of 1 SAP point achieved in homes between 2001 to 2009. We have been progressing towards the transformation required, now all we have to do is deliver it more effectively across the full range of building ownership arrangements.



# 3

## Constraining electricity demand



Reducing demand for electricity is both more problematic and more urgent than the issues surrounding gas use. It is more urgent, because the present carbon intensity of electricity is high. It is more problematic because of the sheer number and diverse types of electrical appliances and equipment used in our buildings and the lack of a coherent national policy to reduce electricity demand. Even the government's major new energy efficiency policy, the Green Deal, is likely to focus largely on insulation opportunities and, therefore, on gas usage and will, probably, hardly affect electricity consumption. This is a huge omission from mainstream UK policy, though the government is proposing to look at the issues (HMG 2011, p82).

This chapter focuses on the unregulated uses of energy (figure 2.3) – including all electricity use in lighting – that, for businesses, are within the DECs. For households, there is no comparable label and no incentives to own fewer appliances or to use them more carefully – there is only the rising cost of the fuel itself. For the majority of users, the benefits of the myriad of electrical appliances far outweigh the cost of operating them, even with rapidly increasing electricity prices. Many of the most important and precious energy services – cold and hot food, lighting, watching the television, using the computer, charging the mobile phone – are not going to be relinquished, nor should they be. They can only be powered by electricity, so fuel switching is not an option, merely the more careful use of electricity combined with a responsible attitude to appliance ownership.

The more careful use of electricity is the rationale behind European product policy – a discrete market transformation approach to an individual appliance or product. These products – whether light bulbs, fridges or large screen TVs – are all components of and useful contributors to the larger transformation of all energy in the whole building.

---

Reducing electricity demand will remain a priority particularly while the carbon intensity of electricity remains high relative to gas, probably until at least 2025. When new generating capacity enables the carbon intensity to drop, policy towards fuel switching to electricity, for instance from gas for heating, can become germane. In the immediate future, electricity for space and water heating should remain a minority activity, for both building sectors.

There are two components to electricity demand: the total annual consumption (kWh or GWh) and the short period (about half an hour) of maximum demand in the year, known as peak demand (GW). These have completely different, but vital impacts on policy.

## LINKING SUPPLY AND DEMAND

### Peak electricity demand

Much of energy policy is driven by debates about electricity supply (renewables, nuclear, carbon capture and storage) and of the expected 'gap' in supply if there is growth in electricity demand, while old generating plant is phased out. The gap is measured by the relationship between the few moments in the year of peak demand and total generating capacity. As two-thirds of all electricity is used in buildings, these scenarios are driven by how we use our lights and appliances, in the home and at work, but the links are rarely made explicit. So, reducing electricity demand in lights and appliances is important because of the extent to which this minimises peak demand and the consequent need for new generating capacity.

Seasonal, and therefore climate-related, differences in demand are large (BRE 2008). The highest demand for electricity, across the whole economy, comes close to Christmas, when short days (and a lot of lighting) coincide with cold weather (and top-up heating). The peak is around 4.30-5.30pm in the afternoon and is predominantly the result of residential electricity use, as children come home from school and people return from work.

At peak time, the two biggest users of electricity in the home are cooking (ovens, kettles, microwaves) and lighting (Boardman and Houghton, 1991, p29). It is difficult to do much about cooking – other than encouraging more cooking with gas and less with electricity - but facilitating the switch to low-energy lighting contributes to lowering the peak. Lighting in buildings was over a third of peak demand in Great Britain in 2006: 21GW out of 60GW (table 3.1), mostly in business premises. Peak demand has been dropping since 2002, partly because of the phase-out of incandescent bulbs and their replacement with compact fluorescent lights (CFLs). The options for reducing electricity use in lighting are discussed below.



Table 3.1: Components of peak electricity demand, GB, 2006 (GW)

	Lighting	Other	Total peak
<b>Residential</b>	7	21	28
<b>Businesses</b>	14	6	20
<b>Industrial process</b>		11	11
<b>Rest (including street lighting)</b>		1	1
	21	39	60

Source: Based on BRE 2008, pp24, 26

Conversely, proposals that increase peak demand are to be avoided, and heat pumps are expected to significantly increase peak electricity demand (Scottish government, 2010, table 4.2.1). This is another reason to be concerned about high levels of take-up of heat pumps, without parallel increases in micro-generation technologies that can supply electricity during peak demand (ie CHP).

There are no policies to identify their peak demand to users. In Italy the electricity meter sets the tariff according to the peak demanded: the higher the peak, the higher the tariff per unit. A similar impact in the UK will come from the displays attached to smart meters, though they may only show the instantaneous demand for power, not the peak on the day, month or year.

## Electricity market reform (ERM)

The Government and Ofgem are undertaking a major review of the electricity market, but this is almost solely focused on the supply-side. When demand reduction measures are discussed, they are linked to limited options such as those that result from smart meters and time-of-day pricing. While useful, these are hardly of the same magnitude of impact on demand reduction as other policy options. Certainly, scenarios that include substantial demand reduction result in a lower overall cost to society than those that supply unrestricted demand (Eyre et al 2010). There is a real risk that this partial review will result in misplaced expenditure and considerable unnecessary costs to electricity users, including the fuel poor.

Meanwhile, the EU is investigating one form of guaranteed demand reduction – white certificates (Ends 434, March 2011, p62). These would provide a tradable commodity that values increases in energy efficiency and the resultant demand reduction. An alternative to this, that links to the reform of the electricity market, would be for a new type of macro feed-in-tariff that rewards demand reduction, whether through technology or behaviour (Eyre 2011; Bertoldi et al, 2009).

---

## EUROPEAN PRODUCT POLICIES

Most of the policy that affects electricity use in products originates in Brussels, with the EU setting minimum energy efficiency standards for manufacturers and requiring performance disclosure with energy labels (EC 2011). In combination these policies act to change the distribution of models on sale by eliminating the worst performers and by encouraging the selection of the best-performing products. It is only the EC that can introduce labels and minimum standards on products (things that can be traded) – because it is a common market. These policies have previously delivered substantial savings at very little or nil extra cost to the UK Government or consumers.

The UK Government confirmed reliance on European product policy, as the only related policy action cited is to continue ‘working with the EU to agree energy efficiency and labelling standards for the remaining energy using products in residential and tertiary sectors and some industrial products by December 2012’ (DECC 2011c).

Under the eco-design programme and the Energy using Products (EuP) Directive (2005/32/EC) there is a raft of policy being formulated in Brussels: over 40 product groups are being considered and legislation is complete on 12 of these (ECEEE 2011). This invariably means minimum standards as described for cold appliances and televisions below. These new standards will:

- o be introduced over the next several years, as the reports result in agreed legislation;
- o cover a substantial, but unknown, proportion of total energy use. The percentage is likely to be highest with electricity;
- o be irreversible and the effect of the legislation will peak at some time after it is introduced, the speed depending upon the natural replacement cycle of the product (14 years for a fridge, less with a TV);
- o the savings are cumulative as each annual cohort of new appliances is improved – with minimum standards there are (virtually) no non-compliant, wasteful products on sale, the policy is effective;
- o have difficulty in constraining demand in some areas of high growth, such as IT, because they are new products or not easy to define in test procedure.

The extent to which a minimum standard represents a dramatic improvement is effectively a political decision: with cold appliances, the 1999 minimum standard was framed to improve energy efficiency by 15% (Boardman 2004). This was a lot less than the cost-effective potential as a result of political caution.



The UK's market transformation programme estimates the likely reduction based on the policies known at that time: for both sectors, the likely drop in electricity use by 2020, over 2009, would be about 15% (MTP 2010). This is a moving target, though, as new proposals are constantly being adopted by the Commission. The 2020 target for a 20% reduction in primary energy, compared to projections, is seen as of considerable importance by Brussels and the focus will switch to the achievements in each Member State:

If the 2013 review shows that the overall EU target is unlikely to be achieved, then as a second stage the Commission will propose legally binding national targets for 2020 (COM (2011) 109, p3).

The phrase 'legally binding' usually means that there are financial penalties for non-compliance. The Commission is getting firmer in this area, which is likely to result in faster action, tougher individual minimum standards and an overview of the policies of the UK Government. The proposed directive on energy efficiency is part of this process (COM (2011), 0370).

Pressure to speed up and strengthen EU product policy can be expected, partly because of Germany's decision to phase out nuclear power quickly will mean that they have a powerful incentive to reduce electricity consumption as much as possible. Further support will come as a result of Denmark's decision to phase out fossil fuels by 2050. The technology is available, if the political will can be found. Even so, it does not appear that EU policy on minimum standards and labels alone will deliver the potential savings.

Within European legislation, the UK Government is entitled to go further and faster, as has occurred with the phasing-out of incandescent lamps. More opportunities such as this need to be found and utilised.

More challenging standards are certainly possible: a potential 43% reduction by 2050 has been identified for residential lights and appliances. The latter may be an underestimate of the savings, because of recent technological developments in televisions and lighting. The amount of electricity used per household for lights and appliances is assumed to have risen from 3000kWh in 1998 to 3300kWh in 2009 and that it will more than halve to 1500kWh in 2050, despite more appliances per household and higher standards of energy service (based on Boardman et al, 2005b, p49).

---

## MARKET TRANSFORMATION IN ACTION

As with building fabric, the *Achieving zero* market transformation strategy would include policies to move the stock of appliances and equipment (mainly electrical) towards greater energy efficiency. Current policy tends to be specific to a particular product group: agreed test procedures have to precede the labels and only then can there be discussion about minimum standards. The evidence for the effectiveness of a market transformation approach to product policy is instructive and is examined in relation to three groups: refrigeration, lighting and televisions.

### Cold appliances (fridges, freezers, etc)

The cold appliances are the most advanced of the product groups as labels were introduced on 1 January 1995 and the first round of mandatory minimum standards became effective in September 1999. The latter succeeded in reducing UK electricity demand for residential new cold products by 15% in 15 weeks (Schiellerup 2002).

When the EU energy label was introduced, the average new cold appliance in Europe had an energy efficiency index of 100 (EEI 100) – probably slightly higher (ie worse) in the UK – based on kWh/litre volume of the appliance. Under the Energy using Products (EuP) Directive, the minimum standards for fridges will have to be (OJ 23.7.09):

by 1 July 2010	EEI < 55 (ie minimum of A)
by 1 July 2012	EEI < 44
by 1 July 2014	EEI < 42 (minimum of A+)

This means that between January 1995 and July 2014, new fridges in the whole of Europe will have improved from an average of 100 to a minimum of 42: an improvement of the EEI of over 60% in 20 years. The manufacturers are delivering remarkable savings, when pushed by Brussels. Whilst most of the evidence is for the residential sector, many businesses, such as offices, buy domestic-scale cold appliances and will have benefitted similarly. Commercial refrigeration is another story.

As a result of progress on higher standards of energy efficiency, the EU energy label for cold appliances has been revised: the seven bands now stretch from A+++ to D: there will be no bands and no appliances in the E, F and G categories from 30.11.11 (OJ 30.11.10).





The effectiveness of this policy in the UK is a complex mixture of tough EU efficiency standards and social factors, such as the number of households, ownership levels and size of appliance chosen. The EU Energy label for cold appliances is rated according to the amount of energy used, per unit volume of interior space (kWh/litre). This has had the unfortunate effect of encouraging the manufacturers to produce ever-larger cold appliances. However, since 1990, when data were first available, using an index, the best new technologies are perhaps a tenth of the energy consumption of the average 20 years ago (table 3.2).

*Table 3.2: Index of electricity consumption in UK refrigerators, 1990-2011*

	<b>Index</b>
<b>Stock 1990</b>	129
<b>Stock 2001</b>	100
<b>Average new 2001</b>	77
<b>Best new 2001</b>	41
<b>Next technology, vacuum insulated panels</b>	13

*Note: assuming all the same size*

The lessons from cold appliances are that:

- a. policy should ensure that the focus on energy efficiency does not provide an incentive for manufacturers to produce larger appliances, so that there is a real drop in energy consumption;
- b. savings can be negated by consumer behaviour and the ownership of more and bigger appliances;
- c. the growth in the number of new households means that demand reduction targets at the household level have to be stringent, if there is to be a net reduction in energy use.
- d. the consumer benefits of successful policy are substantial money savings, both through reduced consumption and, with cold appliances, lower purchase prices;
- e. more energy-efficient appliances deliver higher energy services, for instance a well-insulated fridge is less likely to warm up and spoil the food if there is a short power cut.

With durable products a minimum performance policy takes several years to be effective, about 14 years with cold appliances before the maximum effect is apparent. Electricity consumption in cold appliances was largest in 1997, with annual reductions since. Between 2009 and 2010, electricity use in residential cold appliances dropped by 3% (DECC 2011b, table 3.10), so the benefits of the policy are still feeding through. These could be enhanced

---

if there was a powerful policy to replace the worst, old appliances more rapidly with scrappage schemes: some products take too long to fall out of the stock.

There are few examples where the market transformation process has been so well monitored. Because of sensible timing to fit in with design cycles, the costs to manufacturers and Government have been negligible, whereas there have been large benefits for consumers. A well-organised market transformation programme, combining aggressive policies, can be extremely effective.

## Lighting

Lighting in buildings is one of the main uses of electricity representing 17% of household electricity use and 41% of the electricity in businesses (table 1.1). It is also responsible for about a third of peak demand. The highest levels of lighting in individual business sub-sectors are found in retail outlets – two to three times the amount used in offices and public buildings. Lighting is responsible for 37% of the carbon emissions in businesses – considerably greater than space heating and hot water combined (CLG 2008, p68).

Light bulbs have been labelled – the familiar A-G scale – since 1999 (OJ 10.3.98) and the phasing out of the traditional incandescent bulbs began in 2009. The British Government progressed with this phase out more rapidly than the rest of the EU, with the aim of completing the process by 2011 (ENDS Oct 2007, p49). The minimum standard was introduced in tranches, as befits the product. Obligations on the energy utilities to reduce demand, through the Carbon Emission Reduction Target and its predecessor, accelerated the distribution of CFLs and contributed to this phase-out.

As a result, lighting in the home has declined from 720kWh per UK household in 1997 (Palmer and Boardman 1998, p48) to 600kWh in 2009 (MTP 2010b, p64) – a drop of 17% in 12 years. Across the whole UK, total electricity use in residential lighting dropped 7% from 2008 to 2009 and a further 9% between 2009 and 2010. Reductions will continue, but will increasingly depend upon progress with the next technology - light emitting diodes (LEDs).

The market for LEDs is taking off more rapidly than expected. Phillips Electronics recently announced that LED-based products already account for more than 10% of their (global) annual lighting sales. One of the problems is the lack of test procedure for LEDs and the market transformation that this would permit:

Formalisation of product quality and a performance testing process is needed urgently (Vito 2009, p426).



When LEDs have replaced compact fluorescent lamps, electricity consumption for lighting could be just 10% of its 1997 level at 70kWh per home instead of 700kWh (Boardman 2007, p29), but only if lighting levels remain constant. Historically, there has been a tendency for levels of lighting to increase (more fittings), thus slightly offsetting the gains in efficiency.

The reduction in energy demand in business premises might not be so significant, because of the high proportion of fluorescent tubes already in use. The electricity usage could perhaps be halved by increases in technological efficiency. One suggestion is for lighting to be measured as kWh of actual use/m<sup>2</sup> as covered in EN BS 15193 (Raynham pers comm.) and this would encourage the use of controls so that lights are not left full on when the sun is shining or the building is empty. Lighting controls (ie timers, daylight sensors, movement sensors) could halve lighting electricity use in many situations and could be instigated by unilateral action by the UK Government through Building Regulations. Such an approach could be accompanied by a move towards maximum levels of lighting (for instance below the normal 900 lux – the amount of light falling on an area - in retail outlets). This might well be acceptable to the companies themselves as it would reverse the present escalating dazzle in many shops and supermarkets.

When fully complete, say by 2030, the process of transferring to LEDs and introducing more controls, will not only have reduced total electricity demand for lighting, but also its contribution to peak demand from a third to a quarter. The latter represents a 7GW cut in peak demand equivalent to about seven power stations.



*Compact fluorescent lamps reduce electricity demand for lighting to a quarter*

---

## Televisions

Televisions were for a long time seen as a problematic product for minimum standards – the technology changed more rapidly than the test procedure could keep pace with. However, televisions will now be labelled from 20.11.11 (OJ 30.11.10) and the EU has defined new energy efficiency classes (EC No 642/2009) for all televisions placed on the market until 31 December 2012. This has the effect of banning all products that are:

- o below the 2007 average level of energy efficiency from September 2010;
- o not better than 20% more energy efficient than 2007 average from April 2012.

The A-G scale will then be tightened up three times: first in early 2014, then in 2017 and in 2020. Again, the opportunities for more energy-efficient products are considerable: with a liquid crystal display (LCD) monitor about 70% of the electricity consumption is saved in comparison with old cathode ray tube (CRT) monitors; most TV sales are LCDs, with a power consumption about a quarter of plasma TVs, and power consumption in LCDs could potentially be reduced to a third (Raynes pers comm.). LED monitors will be better again and organic LEDs (OLEDs) a further improvement in energy efficiency.

In these three examples, a market transformation approach involving energy performance labels and minimum standards, sometimes in concert with other incentives to accelerate stock changeover, results in absolute energy savings: a coherent strategy works. The disadvantage of minimum standards is that they can be introduced without the customer being aware of the policy intervention: the education of consumers about reducing demand depends upon other government policies. As the policy results in major savings to the individual purchaser, at nil cost to the government, there is a very good news story to publicize and replicate.

## LABELS

### Absolute vs relative measurements

The A-G rating of the EU Energy Label is clear, eye-catching, widely recognised and used by the British public. Hence it has been replicated, sensibly, in the labels for buildings. The disadvantage, as mentioned with cold appliances, is that it portrays energy-efficiency, rather than energy use. With cold appliances this means it is framed in terms of kWh/litre of internal volume and with washing machines the scale is based on kWh/cycle. The annual consumption (kWh pa) is on the label, but is not the basis for grading the appliance. In both cases, a predictable response of manufacturers has been to increase the size of their appliances, as this makes it easier to obtain a good rating. Some size increases may have been related to



(or caused) social trends, promoted by clever marketing. It also means that total energy consumption can increase in conjunction with greater energy efficiency, thus offsetting some of the benefits of the policy. It may be a temporary aberration, as there is a limit to the size that fridges and washing machines can be, given the size of kitchens in existing buildings, so perhaps from now on the savings will be greater.

Alternatively, it would be helpful if the labels could incorporate factors that remove the advantages of larger products, for instance they could be based on absolute consumption (kWh pa). This argument is clear with appliances, but it also applies to buildings, where measurements of energy use are frequently divided by the floor area (kWh/m<sup>2</sup>). The debate has occurred with cars and the Danish Government took the decision to compare all cars on the same basis (big vs small) and not group them by size as in the UK (big vs big; small vs small). Usually the labels have to be identical across Europe so moving to absolute not relative consumption for products and buildings will require considerable debate, but it would help demand reduction and climate change policy. A rethink in Brussels would be welcome.

## REMOVING THE WORST

Old appliances have the useful attribute of breaking down – in most cases they remove themselves from the stock. There will, however, often be some long-lived pieces of equipment that are still being used even when they are 20 years old. The appropriate policy to deal with aged appliances is to pension them off through a scrappage scheme, such as the one used to help people replace their old G-rated boiler with an A-rated one. About 120,000 households in England each received a £400 voucher towards the total cost of around £2,500. The majority of installations were gas to gas, some were oil to oil and a few were oil to gas. Less than 1% was for innovative



*Neither empty offices nor laboratories should be fully-lit in the middle of the night*



technologies, such as heat pumps or biomass boilers. The majority of installers were SMEs. The scheme is now only available in Scotland.

A similar scheme for old fridges – Fridgesavers – was also extremely successful, also for a limited period of time in 2004. The programme was only available for low-income families on defined benefits and provided a subsidised new B-rated fridge or fridge-freezer to replace an old, but working one. A total of 250,000 low-income households throughout the UK benefitted from this programme (Changeworks 2011). There were major energy savings as many of the original pieces of equipment were extremely energy inefficient, partly through lack of maintenance (Boardman et al 1997, chapter 5).

*The definition of 'unnecessary' appliances will change as environmental concern grows amongst consumers*

Utility-funded schemes to reduce electricity consumption in old equipment owned by low-income households should be re-instated as part of the market transformation suite of policies. These scrappage schemes are good for the





environment and for alleviating fuel poverty, particularly if they can be funded without adding to the bills of the fuel poor.

Some of the other forms of profligate new equipment are those devised by manufacturers with no respect for the environment. There is no way to stop manufacturers producing products that waste energy with debatable benefits for society, eg the early plasma TVs, large new TVs (some are now the size of a single bed), patio heaters, fuel effect fires, hot tubs. Once a manufacturer has introduced such a piece of equipment, it takes time to control them, if it is even possible. Similarly, product policy cannot influence the trends towards more appliances – that has to be dealt with through different approaches: for instance awareness programmes. The aim is for conspicuous consumption to become socially unacceptable (Eyre et al 2010, p270). Educated, aware consumers are the best safeguard against purchasing these unnecessary or profligate appliances and, therefore, inhibiting manufacturers devising them. These are good reasons for promoting personal carbon allowances, or a similar scheme.

## MORE OF THE BEST

The combined effect of labels and minimum standards will push the distribution of many appliances towards a higher standard, sometimes quite rapidly. The assumption is that once manufacturers start competing on the basis of energy efficiency, there will be constant pressure on them to redesign their ranges and produce models in a higher band on the energy label. There are occasional financial incentives to encourage consumers to purchase the best products and increase their market share, for instance through CERT. Financial incentives are politically sensible if the manufacturers need a sweetener to offset the impact of the minimum standards: help develop the market for their best products while preventing them from selling their worst. This was particularly important at the turn of the century, when market transformation was a relatively new concept and manufacturers tried to argue for voluntary agreements.

Financial incentives can be quite expensive. Whoever funds them, the money is likely to go to better-off households who can afford to buy new products. Many low-income households are likely to purchase second-hand, less energy-efficient equipment. Where demand for energy efficient products is well established – the cold appliances – financial inducements are no longer necessary. Where the old product is not going to be available – light bulbs – they are also not needed. Elsewhere they could still have an important role.



---

Bringing innovative, new products to market can be achieved through procurement. Typically this requires a group of purchasers, such as housing associations or government departments, formulating a combined specification so that the manufacturer has a confirmed market. Co-operative procurement is a helpful, alternative process that brings together potential purchasers and manufacturers to grow an embryonic market. Energy+ did this with highly efficient cold appliances from 1999-2004 (Boardman et al 2005a). The project assembled lists of super-efficient fridge freezers and, separately, lists of people interested in purchasing them (eg housing associations, retail chains). By constantly circulating the information, networking and acting as go-between, the project facilitated the market in a low-cost way. As a result the number of models increased dramatically (from 0 to 800 models in three years) and so did sales. This is an excellent example of how low-cost, information networks can provide a considerable fillip to the sales of energy-efficient products. Either way, accelerating the demand for high performance products can drive innovation, encourage competition in the marketplace and bring better products to a wider audience.

## IMPROVING THE AVERAGE

### The role of education

Most opportunities in this area are concerned with behaviour, rather than with purchases, though behaviour includes the decision to purchase a piece of equipment or not in the first place. There are few opportunities to improve the way your existing appliances operate, other than good maintenance. Campaigns to reduce stand-by, by properly switching off equipment when it is not in use, have been reasonably successful and this is widely recognized as 'good behaviour'. The focus is somewhat misplaced as it only effects 8-10% of all electricity use in the home. The wider debate about constraining total electricity use has barely started.

The market transformation approach on individual products cannot help to constrain the number of appliances and pieces of equipment owned by the household or business. This has to be the focus of other policies. As the EPC excludes almost all electricity use (except for fixed lighting), the main information for the individual occupant is the standard electricity bill, which is just informative and does not provide any guidance or boundaries. Hence there is a need to expand the role of DEC's for business and introduce a new policy to cover all energy use in households, for instance the personal carbon allowance (chapter 5). Therefore, the policy to begin to constrain total electricity use per occupant is to have a DEC for every business property and to work towards personal carbon allowances (or something similar) for households. In this way, there will some information and feedback for individual occupants, to discourage the continual growth in appliance ownership. Because each piece of equipment is



becoming more efficient, there will be opportunities for a higher level of energy services: more use, or bigger equipment, or more appliances, but not for all three if total electricity demand is to be reduced, as required.

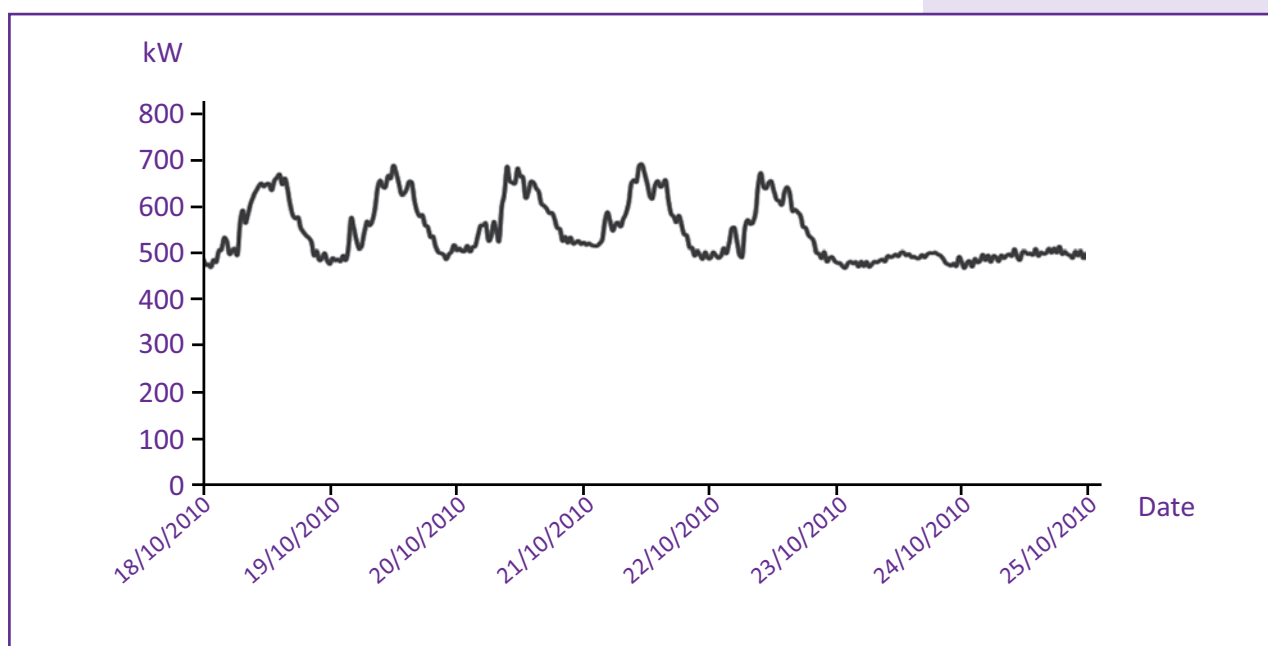
With the stock of appliances already in homes and businesses, the user can operate the equipment in a lower-energy way. However, the depth of the ignorance, the inaction and the need to confirm, at an individual level, the scale of energy consumption supports the introduction of an over-arching framework for households to decide on their priorities for energy use and carbon emissions.

### Business awareness

For businesses, the scale of electricity consumption is included, with all other energy, in the display energy certificates (DECs – figure 2.2). This is a start and does enable the company to track how its energy use is changing each year. The wider use of DECs, together with a higher standard for lighting controls and technology, will help organisations manage their energy use. Additional policies that name and shame profligate energy consumers would increase pressure on companies to control their energy-related behaviour better.

*Figure 3.1:  
Half-hourly electricity  
demand in a new  
science building,  
Oxford University,  
18-25 October 2010*

*Source: ECI 2011*



---

The failure to control energy consumption in business premises, especially when they are empty, results in high levels of electricity use and wastage, even in new buildings: the four newest buildings in Oxford University are responsible for 16% of the University's electricity use (excluding the colleges). The background consumption in lighting, fume cupboards in science laboratories, computers and monitors can be as much as 70% of peak demand (Figure 3.1), independently of any occupants. Many other new business buildings probably demonstrate similar levels of unnecessary consumption as a result of poor design.

There is strong evidence that the proper commissioning of plant and good energy management in a building can reduce consumption by at least a half for typical office and retail buildings (Bordass and Leaman, slide 67). Unfortunately, this happens too rarely.

### **Smart meters and tariffs**

The old-fashioned electricity and gas meters, in cupboards under the stairs, are to be phased out and replaced with smart meters (in the same place), but with a roving display unit that could be highly visible and provide useful feedback to households. A detailed implementation plan will lead to the full roll-out of smart meters by 2019 (DECC 2011c). The smart meters and associated displays will:

- o provide the utility with detailed information on energy use in the household;
- o allow (and encourage) the introduction of different price bands across the day, to reflect periods of high electricity demand - this can achieve 10% peak time savings (Darby 2010, para 1.37). Care will be required to limit the hardship created by these varying prices on the fuel poor;
- o increase awareness of household members and, therefore, engage them in choosing to control demand, particularly through behavioural changes, such as switching stuff off. This should lead to modest savings: about 2% is expected by government, though research has found a range of 5-15% for electricity (Darby 2006).

Smart meters are seen as one of the changes that will inform and educate people about energy use (and perhaps carbon emissions). On their own they may result in relatively small savings, but are another vital contributor to intelligent household energy use, just like labels on appliances and more informative bills.

Separately, the development and take-up of smart appliances that can communicate directly with the electricity supplier and be turned off for a few minutes, could enable load-shifting, with no noticeable effect on the level of energy service to users.

The utilities could investigate and promote tariffs that encourage lower levels of consumption,



for instance:

- o through a rising block tariff. This was suggested by the ex-regulator of Northern Ireland's electricity market as a way of supporting those who only use of electricity for basic energy services, but penalising those with large, discretionary demands (McIlldoon, 2008);
- o ensuring that the design of the smart meters they are trialling are as informative and consumer-friendly as possible;
- o giving due publicity to the fuel mix of electricity supply, as required by disclosure.
- o by eliminating the standing charge, as the first kWh purchased is the most expensive at the moment.

## Supplying your own electricity

The behaviour of the occupants may be changed by the installation of equipment that generates electricity and demonstrates its contribution on a clear display. These would include photovoltaics, wind turbines and combined heat and power. In a super-efficient building, the result can be a building using net zero electricity, or even being a net exporter (over the year, producing more electricity than is consumed). A reasonable expectation is that 15 per cent of dwellings would have solar photovoltaics installed by 2050 and 5 per cent (with rural or exposed sites) will have micro-wind turbines (Eyre et al p270). The take-up of these technologies has escalated with the introduction of the feed-in-tariff, to a rate of 16,000 in the month of September 2011 (DECC 2011e), but is likely to be curtailed by the lower tariff from December 2011.

Analysis in 2007 showed that there is the potential for every home to have at least one of the low or zero carbon technologies some of which displace gas, some electricity and some both (Boardman 2007, p64).

## SUMMARY

Two-thirds of all electricity is used in buildings and lighting reflects a third of national peak electricity demand: buildings are disproportionate users of electricity. As buildings become more thermally efficient and use more efficient boilers, these uses of electricity form a greater proportion of all energy used in buildings.

EU policy on individual products is bringing in a raft of minimum standards that will reduce energy consumption, particularly electricity. As a result, by 2020, electricity consumption is likely to be at least 15% below 2009 levels in both business and residential sectors. There is a potential

---

to reduce it further through existing or expected EU policies. There is virtually no UK-specific policy to reduce electricity use in lights and appliances. It is being allowed to float upwards and only regulated downwards by Brussels.

The Government is relying on European product policy and the diffuse effect of upstream caps on utility generation, through the EU Emissions Trading Scheme to deliver reductions in electricity consumption. The Government has a direct interest in supplementing European policy with UK-specific initiatives. These are particularly important because of the continuing high carbon-intensity of UK electricity. One possibility is to make Building Regulations for new buildings cover all uses of energy, whereas at the moment these unregulated uses of electricity are excluded from the regulations and energy performance certificates.

The main electricity reduction potential is likely to be in lighting, which is a major contributor to both total and peak electricity demand. The UK government could unilaterally bring in tougher product policies (as occurred over the phase-out of incandescent bulbs), particularly to accelerate the take-up of light emitting diodes, and require the widespread use of control systems (daylight sensors, movement sensors, timers). The switch to LEDs would be beneficial for the business sector, particularly if accompanied by policies on maximum lighting levels for the retail sectors and controls in all business buildings.

It is perfectly possible for electricity use in the unregulated energy uses – lights, appliances and equipment - to be halved, per property. This would result from tough product policies, accelerated uptake of high performance products and expected technological advances that leap performance beyond those standards already being discussed. National consumption will be less than 50% in total when the growth in numbers of households and businesses is factored in and of about the same magnitude as the reduction in electricity demand of 32% in the residential sector in the UKERC Lifestyle scenario (Eyre et al 2010). The latter was a modelled scenario with the trends determined externally to the model.

Tough product policy in conjunction with solar photovoltaics or combined heat and power systems could make net electricity use close to zero for many properties.

Product policy focuses on individual pieces of equipment, appliances or building components (eg windows, boilers), but does not prevent the accumulation of equipment in a building. Policies that would encourage more constraint in the home and at work could address the growth in ownership of electrical products. Policies with a behavioural focus, such as personal carbon allowances for households and the wider use of DEC's in the business sector, would provide the necessary educational and psychological pressure to reduce electricity use.



# 4 Money and value

The market transformation framework identifies the policy levers needed to shift towards greater energy efficiency, but does not identify the sums of money to be spent and by whom. With appliances and equipment, the extra costs of greater energy efficiency are often minimal, particularly if the changes are absorbed into the manufacturer's normal design cycle.

With existing buildings this is certainly not the case, particularly for the fuel poor.



In order to examine the cash flows inherent in this proposed routemap, it is necessary to look, briefly, at present funding and examine what is changing, what has to change and what the alternatives are. After that, the link between investing in the energy efficiency of a property and its market value is examined as a further and vital component of the decision-making framework. Then it becomes easier to examine the likely implications of these options.

## PRESENT SITUATION

### Funding energy efficiency

External funding to encourage property owners to undertake energy efficiency investments and install renewable technologies in buildings comes from two main sources:

- o Utilities – through retailer obligation schemes such as CERT;
- o Central Government – through grant programmes such as Warm Front.

Most of the grants for energy efficiency are targeted on the fuel poor. In 2008/09 this amounted to £1bn across the whole of the UK (Boardman 2010, p154), of which about half came from the utilities and the remainder from the government.

---

The government is withdrawing from funding or subsidising energy-efficiency programmes. This is the sad reality of the present deficit-reduction programme and seems unlikely to be reversed for several years. It is particularly unfortunate as Exchequer-funded schemes are progressive: many low-income households do not pay income tax. The last major programme will stop at the end of 2012, when warm front ceases, so from then on there will be no capital investment programme on the energy efficiency of homes that is funded by the Treasury, probably for the first time since 1976. The objectives of warm front, in theory, will be delivered by an extended CERT and then its replacement.

The one exception is the new renewable heat incentive, which started in summer 2011 and is funded by the Treasury. This has a budget of £860m over the spending review period (until 2014/15). The initial focus is on businesses, but £15m has been reserved for residential properties until 2012 (DECC 2011d).

The largest programme of grants for energy efficiency improvements in the home is CERT, funded and operated by the utilities, under a government mandate. The programme provides subsidies for all income groups, though about half the expenditure is required to go towards supporting disadvantaged households (DECC 2011f). CERT continues to December 2012, when it is replaced by the energy company obligation (ECO) as part of the green deal. The affordable warmth quarter of the ECO grant is for the disadvantaged – in the consultation document. This is both completely inadequate and likely to be regressive.

The problem with programmes funded by the utilities is that the costs are recouped equally from all bill payers, regardless of their ability to afford the increase in energy prices. CERT (and ECO) is only one of the policies funded by the utilities on behalf of Government. The renewables obligation and EU emissions trading scheme are also paid for by all households through their fuel bills. In total, this sum has already risen to £90 per household pa and there are numerous policies and expenditure programmes that could add to this amount substantially (eg as a result of the feed-in-tariff and smart meters). The effect of future price rises on an individual household or business depends crucially on assumptions about how they react to fuel price rises and whether they benefit from these policies. For non-beneficiaries, the penalties can be severe.

To date, because of the problems of identifying the fuel poor, they have received less in benefits than they have contributed: the poor are subsidising the better-off, so the policies are regressive. This will continue if a large part of the ECO is used to subsidise better-off households with their installation of solid wall insulation. A complementary support





programme would be to cap the cost of funding these programmes for each fuel poor household at the 2009 level of £80 (Boardman 2010, p217+). Otherwise Government policy affecting fuel prices will force more households into fuel poverty.

Thus, the two major sources of energy efficiency funding are either ceasing or are too regressive in their present form to continue or be expanded.

The implication is that the costs of improving the thermal efficiency of the property have to come out of other funds and in *Achieving zero* the proposal is that these should be linked to the value of the property and become the responsibility of the owner.

### **Private expenditure on building improvements**

Beyond the traditional estate agent's mantra of 'location, location, location', the value of a building is mostly linked to space, quality of fittings and available facilities (gardens, garage, etc). Energy efficiency, even in the new world of EPCs, is yet to rank in importance and is unlikely to become a major factor without a change in policy.

The slow rate of refurbishment of the housing stock demonstrates that home owners are not choosing to put their capital into energy efficiency improvements. In 2010, in the UK, the number of cavity wall installations dropped by 30% over 2009 and there are still 2m solid-walled homes to be insulated by 2020 (CCC 2011b, pp8, 9). Progress is declining, perhaps because of the recession, but for whatever reason investment in energy efficiency needs to be pushed back up the agenda if the carbon reduction targets are to be met.

Any internet search for advice on 'How to add value to my property' will identify that the main recommendations are



*The renewable heat incentive will increase the popularity of solar water heaters*

---

always to add space and make the place presentable (loft extension, conservatory, better kitchen, new bathroom, decorate). The words 'energy efficiency' rarely come onto the screen. This may be because features such as central heating and double glazing, which do improve the property's energy efficiency, are now accepted as adding value. However, the concept needs to be confirmed and extended.

A lot of money is spent on the repair, maintenance and improvement (RMI) of properties. In 2010 in Great Britain (ONS 2011, table 2.1):

- o £21.7 billion was spent on residential properties; and
- o £13.1 billion was spent on business premises.
- o In both cases about a third was spent on public buildings and the remaining two-thirds on private properties. This is a disproportionate amount of the expenditure as public buildings represent 5% of business premises and social housing is about 18% of the residential stock.
- o In the residential sector, more was spent on RMI than on new construction
- o None of the RMI expenditure was for infrastructure.

A considerable proportion of this currently goes on those items thought to improve the value and amenities of the property, for instance smart new kitchens and bathrooms (Killip 2011, pp332-3). If a substantial proportion of this £35bn could be diverted into making the property low-energy it would fund a reasonable rate of energy-efficiency improvement: £10,000 for each of 1m properties per year would be only a third of the amount of present RMI expenditure. So, often, it is not a shortage of money that is the problems, more that different investments result in different returns, from the householder's perspective.

For buildings in the UK, the present system is failing to deliver a strong link between the value of a property and its energy-efficiency. As a result, the only significant financial incentive to undertake an energy-efficiency investment is a saving in fuel bills. The slow rate of action (particularly by owner occupiers) demonstrates that this is insufficient and, as the cheapest measures are installed, the greater cost of future interventions will slow activity even further.

## **Property value**

The value of the building stock represents an enormous part of the country's wealth: £4,048bn is the value of the housing stock and £1,284bn the worth of all other buildings (including some civil engineering assets). These are 61% and 19% respectively (ie 80% in total) of the £6,669bn net worth of the UK's non-financial assets in 2009 (ONS 2010).



The problem of linking property value and energy-efficiency in both sectors has been recognised as a core issue by the Low Carbon Construction report, which proposes that the government should 'commission research to understand how the market values low-carbon buildings'. The judgement is that there will only be major investment in low-carbon buildings if there is a clear business case for it. In commercial properties in the US, there are some examples of higher rental values and stronger evidence of enhanced capital values for green buildings (RICS 2009). Research for the Carbon Trust found an 'expected increase in asset value over a standard, speculative building' (CT 2010, p32). This was in addition to the benefit of an ambience that results in happier, more productive staff and who are sick less often.

Recipients of an energy performance certificate do know what energy-efficiency investments would be the most cost-effective – they are provided as part of the certificate. They may not have absorbed the information, but they do have it. A survey commissioned by Consumer Focus has found that EPCs are failing to influence most house buyers and new tenants (Ends, March 2011, p18). This is partly because with the present system a more energy-efficient property is not more valuable than an energy-inefficient one. If this could be changed, it would transform the way in which property owners make decisions about 'investing' in their properties: lower carbon investments would be seen as such.

The need to make energy-efficient properties more valuable is an important justification for the proposed minimum standards. If the principle could be accepted and the market for homes transformed, it alters significantly the way that expenditure would be viewed and the types of financial support needed.

### **Investment in demand reduction vs new supply**

In a coherent energy strategy, the expectations about investment by the Government, the utilities and property owners would be synchronised: if demand reduction is given a priority, then the utilities do not need incentives to create new supply. At the moment, the debate does not appear to have brought these three perspectives together and in all cases the sums involved are in the billions of pounds.

Some scenarios, including those used by the Committee on Climate Change, have shown up to a 90 per cent increase in electricity generating capacity by 2050, whereas those prioritising demand reduction can demonstrate a reduction in the need for generating capacity of about a third (Eyre et al 2010, p277). Traditional models (eg economic optimisers, such as Markal) may not have the right answers and may be committing the UK and the electricity industry

---

to unnecessary levels of expenditure on new generating capacity. This huge range in possible levels of future electricity demand result from totally different perspectives on the potential role of demand reduction, behaviour and people as decision-makers.

Overall, the Committee on Climate Change is assuming (CCC 2010a, p129) that:

- a. the electricity supply will be decarbonised extremely rapidly, from 544gCO<sub>2</sub>/kWh in 2008 to 50gCO<sub>2</sub>/kWh by 2030 and
- b. in conjunction with this there will be a switch to electric heating, particularly heat pumps. The CCC has 25% of homes and 59% of businesses with heat pumps by 2030 in its medium abatement scenario, so that
- c. there is a drop in CO<sub>2</sub> emissions through the reduction in the use of fossil gas.

This sequence is predicated upon large capital investment by the property owners and by the utilities: the former in both high levels of insulation and completely new heating systems (ie heat pumps); the latter in new generating capacity (nuclear, renewables and carbon capture and storage) and new transmission lines. The scale of the investment in the UK is thought to be £200bn for new generating capacity (Atherton, 2011, slide 2). While substantial capital investment is needed, this set of solutions might not be the most appropriate use of capital nor the easiest to bring about. The time seems right to reconsider this proposed dependence on electricity for heating<sup>1</sup> as greater value could be gained from focussing on a more aggressive reduction in gas heating demand.

Taking the perspective of property owners, especially owner occupiers, there will be a desire to minimise their own capital expenditure (whether lump sum or via bills) and to ensure that where investment is necessary it results in lower fuel bills, as a result of reduced demand (more insulation, more efficient boilers) or additional income (feed-in-tariff or renewable heat incentive to install renewables). It is likely that householders will be reluctant to replace the whole heating system in order to reduce the country's carbon emissions, for instance by installing a heat pump after 2025. Political capital should be spent on encouraging property owners to invest in demand reduction rather than fuel switching.

This is a question about who spends which sums of money, with what effect on the utilities' customers (table 4.1). The assumption is that investment by the utilities in additional generation and transmission is passed through as higher total costs for customers, especially in our deregulated market. What people want is to have more or adequate energy services, for less cost. This can only occur through greater energy efficiency, without the need to pay for additional generation and transmission.

---

<sup>1</sup> The dependence on electric vehicles to displace petrol and diesel is a different debate.



Table 4.1: Investment implications of different technologies

Technology	Investment by property owners	Investment in distribution*	Investment by generators
Heat pumps	+	+	+
Individual chp	+		-
Community chp		+	-
Green gas			+
Building-integrated renewables (eg photovoltaics and solar thermal, through the FIT and RHI)	+		-
Insulation/energy efficiency (eg through Green Deal)	+		-

Note: most +/- could easily each represent £billions; \*for electricity this includes transmission and distribution. The individual technologies are discussed in the text in chapter 2

Heat pumps appear to be the worst choice (on capital expenditure grounds) as they require investment by all three parts of the chain. From a property-owner's perspective, green gas has a much lower investment impact, as there is only one tranche of expenditure and that is undertaken by the generator, not them. Several of these options will be required and improved insulation should always be the first choice and will be needed in every building, whatever fuel and system is used for heating.

## Sums required

The sums of money involved in making the existing stock of 28 million residential and business properties low energy are substantial, but estimates of the cost are rare and varied. Some of the discrepancy comes from figures that are based on single, problematic properties, whereas others use an average across the whole stock. This is patently a situation where the type of policy influences the cost – a street-by-street, area-based approach can deliver considerable economies of scale, particularly if a major upgrade is undertaken (eg if only one set of scaffolding is needed for both solid wall insulation and to put a solar technology on the roof there is a saving of £1000). With area-based approaches, the local authority could be responsible for the administrative costs (such as discussions with the property owner) and managing the scheme, with the private sector acting as contractor. When the work is done piecemeal, the scale opportunities are lost and costs include administration expenditure each time.

---

The Low Carbon Construction report estimated for the 26m homes:

an overall investment of around £200 billion (at current prices, at a crude mean of £7,500 per dwelling) would be required by 2050 to deal with the fabric of homes, without any implementation of local energy solutions. This should deliver around a 60% reduction in regulated CO<sub>2</sub> emissions (LCC 2010, p108).

If based on the earlier estimate by Boardman (2007, p89), this will not include any administrative overheads and is assuming the economies that come from an area-based approach.

The Technology Strategy Board is undertaking the retrofit for the future programme with social housing providers receiving an average of £142,000 per property 'to demonstrate deep cuts in carbon emissions' (TSB 2010). These costs are unusually high, because they are exemplars and will be carefully monitored. They do not represent the likely cost per property for large-scale retrofit initiatives.

The interesting 'Challenge 100' (E.On, undated) lifted 42 of the 100 families out of fuel poverty, but no costs are given in the report. A pay-as-you-save scheme in Stroud indicated that it would cost £20-30,000 per home to implement all recommended measures. However, the average loan taken out by householders was £8,820 (SWEA 2011, pp15, 26), reflecting both some of their own money and undertaking a selection of the measures.

There is little doubt that the sum will be in excess of £10,000 for each of the 26m residential properties, perhaps as high as £20,000 (not including any cost of a heat pump). There is little reliable evidence on the likely costs, across the whole housing stock, for such a high standard of retrofit. Assuming the higher figure, the total cost would be £520bn, to be spent over the next 39 years, at an annual rate of around £14bn. This is in comparison with the £21.7bn already being spent by householders on repairs, maintenance and improvements. It is a matter of refocusing much of the existing investment towards a low-carbon outcome.

It has been estimated that for every £5bn invested annually, there would be 55,000 direct jobs created and 'hundreds of thousands of jobs indirectly' (Impetus 2009). This would be most effective if it is new money, rather than householders replacing expenditure on the new kitchen with solid wall insulation.

Estimates for the business sector have not been found, but as 75% of business premises are of a similar size to a home (1.5m properties averaging around 80m<sup>2</sup>), the costs for the refurbishment of these properties could also be about £20,000 each. The remaining 0.5m will be larger business premises and much more expensive to upgrade.





While for many properties, private funds should deliver the required action, in the case of social housing much of the funding will have to come from government sources, unless local authorities and housing associations are given permission by the government to borrow money against the value of their portfolios.

## FINANCIAL INCENTIVES

Typically, UK governments have provided financial incentives via one of three routes:

- o a direct cash incentive, funded from tax revenue (eg warm front, renewable heat incentive). These require new and often expensive allocation processes and are not favoured by the Government, at the moment, as the costs show as Government expenditure;
- o a direct tax incentive, funded by foregoing tax revenue (eg the zero carbon stamp duty rebate and landlord energy saving allowance - LESA). As these work with existing tax processes and use existing administrative systems, they are cheaper and can be highly effective as they affect the behaviour of actors within normal decision-making

*The response to the feed-in tariff on photovoltaic panels was contagious and is creating a new social norm*





---

processes. They reduce the Treasury's tax take, but do not represent capital expenditure by the government (Boardman 2007, p101);

- o indirect incentives, funded by other parties (eg CERT, feed-in-tariff). When these are funded by the utilities and poorly targeted, they are regressive for low-income households. When a third-party is involved with an indirect incentive, it means that much of the design and effectiveness of the incentive is its responsibility, not the government's.

Within the private sector there will be households on a wide range of incomes. The support mechanisms offered would recognize this diversity and the funding options could involve several variants, so that the most suitable could be chosen by each household. The expectation is that all the investment costs are the responsibility of the building owner and that the income level of the occupant in rented properties is immaterial, except for the ECO. Apart from the owner's own capital, the options could include:

- o a discount on council tax for the year the work is done, like the rebate for single occupancy. This would have to be funded by the local authority;
- o lifetime mortgages for owner-occupiers with no cash (these are repaid when the property is sold, or earlier). They will need to be offered at a low or zero interest rate, possibly through the Green Investment Bank, as a result of a government subsidy;
- o green deal finance for better-off households, using private finance;
- o stamp duty rebates for the recently-moved, if upgrading by a band or more in the first 6 months of purchase;
- o for private sector landlords, the LESA could be enhanced;
- o 5% VAT on all energy-efficiency products and retrofit installations, down from the present 20%, to match the level charged on new properties and on energy use.

The first three are now discussed in detail (the rest are self explanatory and represent direct tax incentives, not direct cash incentives). Even collectively, they do not replace the effect of minimum standards for existing properties, but they do provide the means by which the measures could be funded.

One of the debates prompted by looking at this as a market transformation strategy is where the financial incentives are most effective. With many appliances the discount is provided to encourage take-up of the best, most energy-efficient models. There is no comparable incentive with housing, at the moment, except for the rarely-used zero-carbon stamp duty rebate. An incentive to encourage the conversion of existing homes to a high standard, for instance to passivhaus levels, would be appropriate. With housing, the financial incentives, such as grants, have traditionally been given to improve the worst properties, partly for fuel poverty reasons. This latter approach, however, has the effect of fossilising the housing stock – making some



of the worst properties inhabitable for a bit longer, when either a significant investment in retrofit or replacing the building may be more sustainable in the longer term.

The other major difference between these two types of incentive is that in most countries, the finance is either attached to individual measures in the worst homes or to a whole-house standard with the best ones. These can be exemplified as short-term palliative interventions versus a holistic approach that is focused on real improvements to the building stock (Klinckenberg pers comm). In reality, most countries take the measures approach, though there is a strong case for this to be complemented by a focus on outputs, optimised for the longer-term, as well. The best example of the latter is the German policy with the KfW bank that relates the size of the subsidy to the degree of improvement – the more you do, the lower the rate of interest on the loan (EuroAce 2010).

## Council tax

It is sometimes considered that council tax could be used as a lever to encourage energy efficiency improvements, but this seems unlikely. There are seven valuation bands with A the lowest value and H the highest (ie the reverse of the EU energy labels) and the council tax is levied in proportion to these values. With the present system, any home improvement (energy efficiency or otherwise) does not alter the council tax band, for the present occupant. But when the property is sold, there can be a revaluation, which could result in the property being moved into a higher band and hence a higher liability for council tax (VOA 2011). Thus, a link between the value of a property and its energy efficiency will, eventually, result in a liability for a higher council tax bill. Not a great incentive.

An appropriate incentive would be for a property to be given a temporary council tax discount as a result of an energy efficiency improvement, so that, say, all properties that are moved up into the A-C bands would be entitled to a 20% discount on their council tax for the following year. It may be possible for a council to offer the energy-efficiency discount as a local discount, but it would be more powerful if it were a national scheme. This could be £100-£400 for a lot of households. Evidence from CERT has been that people are more likely to accept and pay for insulation if it results in a council tax rebate (of about £100), than if they received a direct grant from the utility.

The Government is trialling a one-month council tax holiday for people who install loft and/or cavity wall insulation through the green deal (Cabinet Office, 2011, p11). It is not clear whether central or local government would pay this subsidy.

---

In the longer-term, a more radical approach is possible. The next revaluation of business rates (1.8m in England and Wales) is planned for April 2015. This would be an appropriate occasion to investigate whether the link between the value of a property and its energy efficiency could be framed in a positive way that would encourage, not discourage the adoption of energy efficiency improvements. There is discussion about a review of the way in which council tax is levied on residential properties – there has not been a revaluation since 1993 in England. If it were to happen, a revision of the process of valuing properties would provide opportunities for the links with low carbon and energy efficiency to be achieved, for instance to require EPCs to be issued for all properties.

The role of council tax appears to be minimal, partly because of the many other functions that it has to perform. At the moment, it is difficult to see how council tax could be used to provide an investment incentive to make properties more energy-efficient.

## **Lifetime mortgages**

Lifetime mortgages already exist and are the most popular form of equity release – the (usually elderly) homeowner takes out a mortgage on their property, to provide them with a lump sum. Those taking out a lifetime mortgage do not have to make regular repayments on the loan. Instead, the money borrowed, plus the interest accrued, is repaid when the property is sold, for instance because of death, when the owner moves from the property into a care home, or into a smaller property. The amount borrowed depends on age – older people can borrow more. For example, a 60-year old could borrow up to 28% of the value of their property, while a 65-year old could borrow up to 33% (The Telegraph, 23 April 2011, Y2). In most cases, such a large loan is unlikely to be needed for energy efficiency improvements, unless the property was generally in a poor state of repair or low value.

In April 2011, the interest rate on lifetime mortgages was about 7.15% in comparison with 5.32% for an ordinary mortgage and less than 3% on bank deposits. The final amount owing can grow into a considerable sum: £20K over 10 years at 7% compound interest amounts to a loan of £39K, ie virtually double. It is not clear why the interest rate should be a third higher, as there can be no default, as there are no payments. The cost of the lifetime mortgage is adding interest at a compound rate, so this provides a strong disincentive to holding the mortgage for long.

Lifetime mortgages would be more useful if they were more widely available (ie not just to the elderly) and if, for the fuel poor, the government or the Green Investment Bank were to subsidise the interest rate, in order to ensure that major energy efficiency improvements can



be funded by low-income owner-occupiers. To stimulate considerable uptake for this market segment, there would probably have to be a very low or zero interest rate.

## Green deal

The green deal is the government's primary energy-efficiency initiative, which is due to commence in October 2012 and is for households and small and medium-sized enterprises (SMEs) and has two components – green deal finance and the energy company obligation (ECO).

Green deal finance focuses on improved insulation and, perhaps, new boilers, ie gas and oil use, and the average loan is expected to be £10,000-£16,500 per property. It appears that the renewable technologies are not covered, as they are supported by the FIT and RHI. So the green deal will not significantly affect electricity use in most properties, even though the ECO is funded by all utilities, including the electricity providers.

Green deal finance is a financing mechanism - a range of private providers will lend the property owner the money to improve its energy-efficiency. The finance is fixed to the property, not the occupants, and is repaid over 25 years. The 'golden rule' is that the cost of the repayments must be less than the amount saved. If calculated accurately, this effectively limits the deal to better-off households, where there is no demand for extra warmth, or to minor interventions in the homes of poorer families who will save less if they were previously cold. The introduction of mandatory minimum standards for private-sector landlords means that few tenants would be expected to agree to the green deal finance, as this would result in them subsidizing the landlord's obligation. Green deal finance will, therefore, be taken up primarily by owner occupiers or SMEs. There is no guarantee that the private sector involvement will result in full geographical coverage for green deal finance (Wade and Jones, 2011).

It is difficult to predict whether green deal finance will be successful as there are mixed messages about its design and likely level of activity. First, the commercial providers (utilities, B&Q, etc) may only offer the loans at fairly high interest rates of 5-9%, perhaps as high as 11%. This would make the loan more expensive than borrowing the money through a mortgage and may not appeal to homeowners. The comparison with the present system is striking. Under CERT:

consumers can access subsidised cavity wall insulation worth £400 for around £150, or less, from energy suppliers.

---

Under green deal finance

the same measure would cost around £1,000, paid over 25 years (Lainé, 2011, p26).

Despite this, the government is talking about retrofitting 14m homes by 2020 at a rate of 1.7m homes a year. This is over ten times faster than the rate achieved in Germany with publicly-subsidised interest rates of 2.65% (Hansard, 2011c). Time will tell whether the scheme is as popular as the Government expects.

ECO – the energy company obligation will be the new name for the requirement on the energy utilities to invest in the energy-efficiency of the homes of their customers (the old CERT). The controversy here is about what proportion of the ECO provides support for the fuel poor and what is used to provide subsidies for better-off property owners undertaking expensive measures such as solid wall insulation. The proposal is for only a quarter to be spent on the fuel poor. As all households contribute equally to the ECO, through their fuel bills, it is a regressive measure unless almost all is used to fund improvements in low-income homes.

With this uncertainty about how households and SMEs will respond to the green deal finance, one of the best opportunities for the fuel poor appears to come from aligning the ECO with an area-based approach, such as low carbon zones (LCZ) – chapter 5. It is not certain whether government will have any powers to require this, nor whether the local authorities will have the inclination, powers and finance to instigate them. The Local Government Association has requested that legislation should provide a clear role for local authorities within the green deal (LGA 2011, para 5.3) and:

the New Local Government Network argues for social landlords to have a prominent role in co-ordinating green deal measures across their estates on an area-wide basis, given that pilots suggest that costs can be reduced by as much as 20% per home when whole streets are improved collectively at the same time. That could be facilitated by ensuring that the energy company obligation (ECO) fund is paid into an open pot that all green deal providers, including local authorities and registered social landlords, can bid into, in order to ensure that the green deal delivers on fuel poverty (Hansard 2011c).

The creation of a collective pot of money, funded by the utilities, but available to local authorities to spend is an interesting suggestion and could begin the process of shifting from piecemeal individual measures to coherent upgrades of whole areas, something that is probably essential for fuel poverty eradication. It would also facilitate the installation of area-based supply, such as community combined heat and power, smart grids and energy islands.



The Secretary of State has confirmed that he thinks ‘all councils should play a role in delivering the green deal’ (Hansard 2011b). There are 348 councils (district/unitary) in England and Wales, so this would provide the basis for each authority creating and implementing a LCZ. There does not seem to be any mention of local authorities accepting or being given any responsibility for fuel poverty.

## SUMMARY

There are several very large sums of money involved with energy use in buildings:

- o The building stock represents 80% of the country’s non-financial assets, worth £5.3tn 2009. Despite this huge investment, there is virtually no link between its value and the performance of the properties, in energy-efficiency terms;
- o Annual expenditure on maintaining this stock is £35bn, across both sectors: an average of £1200 per building. The investment goes into repairs, maintenance and improvements, yet the sums being spent on insulation are declining (CCC 2011b, p131). Undoubtedly this expenditure is improving and maintaining the value of the property according to people’s present understanding of the market. What is needed is for the role of lowering energy demand to achieve a higher priority;
- o If each property needs an average of £20,000 spent on it to make it low energy, this would be a total of £560bn over 39 years across both sectors, or about £14.5bn pa, with most of this required in the residential sector. This is equivalent to diverting 40% of present expenditure on RMI into low energy investments;
- o Around £255bn may need to be spent on new electricity generating capacity and associated distribution networks, much of it before 2030. The utilities may find it difficult to raise this amount of money and consumers would certainly find paying for it, through higher energy bills, a considerable burden. It would substantially increase the numbers of households in fuel poverty. Quite a large proportion would be the result of a switch to electric heating and a significant sum would be saved by demand reduction.

A much greater synergy is required between policies on demand reduction and the subsequent need for new supply. Too much of current policy takes demand as a given, even increasing demand, which could commit the country to unnecessary and inappropriate capital investment programmes that quickly become stranded assets. Investment in reducing demand is the first and most cost-effective set of actions to take on any building, in the context of the political imperative to substantially reduce emissions. All energy policy should focus on achieving demand reduction first and then consider the quantity and types of fuel required to provide the residual supply.

---

The proposal here is that the funding for the energy-efficiency investments comes from diverting present expenditure on home improvements and from releasing some of the equity in the building stock. The resultant energy savings would reduce the cost of providing energy services for these buildings. When combined with the substantially reduced expenditure by the utilities on new plant, there would be a further saving for users: a double return on their investment in energy efficiency improvements, together with the value added to the property. The value of the property and its energy efficiency would be linked through the introduction of minimum energy efficiency standards for existing properties: the worst properties become worth less as they need work done to them to bring them up to the required standard. This link with property value is one of the major reasons for advocating minimum standards.

The funding of energy-efficiency measures, particularly for low-income households, is in the process of changing as Government withdraws its own funds. Policies that are based on utility funding, such as CERT, have been regressive so far and there are similar fears for its successor, the ECO. The transfer of responsibility for funding other forms of government policy to the utilities, for instance the feed-in-tariff, means that fuel prices are increasing more rapidly than required by world fossil fuel prices. These policy-related price rises should be capped for the fuel poor at around £80pa per household to prevent numbers of sufferers increasing even faster.

A large programme of energy-efficiency investments would create greater employment than the alternative of investment in generation capacity and this brings in tax revenue for the government and reduces the need for unemployment benefit. Another double benefit. The financial incentives are more powerful in the context of minimum standards, cost less and many can be phased out after a few years.

Possible direct government incentives could include:

- o low or zero interest loans for low-income households through lifetime mortgages, perhaps funded through the Green Investment Bank;
- o social housing providers to implement a second decent homes standard;
- o funding for each Local Authority to introduce a low carbon zone;

Possible new tax incentives are:

- o VAT reductions on energy-efficient products and services,
- o an enhanced landlord's energy saving allowance,
- o emphasised enhanced capital allowances for businesses,
- o a stamp-duty rebate or a council tax holiday when there is a major renovation.





# 5 Who delivers?

The market transformation strategy for buildings, heating systems, appliances and equipment has been defined. The ways in which it could be funded have been outlined. It is now time to consider who is responsible for delivering the results. A lot of players have important roles, but there are three main actors – the government, local authorities and people - and their most important actions are identified.



Before looking at those with responsibility for delivery, there is consideration of one group who need protection – the fuel poor.

## PARTICIPANTS

### Eradicating fuel poverty

So far, there has been little discussion in *Achieving zero* about delivering a low-carbon future in an equitable way, though this is essential for a just society and a sustainable future. The main social injustice considered here is the problem of fuel poverty. There are many other aspects of inequality – poverty, unemployment, old age - and making sure the rights of future generations are fully acknowledged. All of which are partly addressed by a focus on fuel poverty, within the context of the refurbishment of the whole building stock and the resultant reductions in carbon emissions. There are strong synergies between the policies on fuel poverty and on climate change: both have to tackle the least energy-efficient properties.

All four UK governments have declared their continuing commitment to eliminate fuel poverty, as framed in the legal obligation of the Warm Homes and Energy Conservation Act 2000 and elsewhere. The requirement is to have eradicated fuel poverty 'where reasonably practicable' by 2016 (2018 in Wales). The Hills Fuel Poverty Review is contributing to the study of fuel

---

poverty and the hope is that its recommendations will help to deliver practical and permanent solutions, within this legal timescale (Hills 2011).

This discussion about the fuel poor solely concerns the residential sector; there does not seem to be an identified, equivalent business group. A household is fuel poor if it is unable to afford adequate energy services for 10% of its income (Boardman 1991, p207; DECC 2001, p30). As incomes stagnate or drop, as pensions fail to keep pace with inflation and as fuel prices rise in real terms, the numbers of fuel poor continue to increase. The permanent solution to fuel poverty, not only for those already fuel poor, but also for those at risk of falling into fuel poverty, is to make sure that all households live in extremely energy-efficient homes, that cost only a small portion of their income to maintain thermal comfort and all other energy services: the poorer the household, the more energy-efficient the home has to be. That is the reverse of the present situation for almost all households. Therefore an equitable, low-carbon future requires energy-efficiency improvements to be focused strongly on the poorest people first. This is a considerable challenge.

In 2009 there were 5.5m households in fuel poverty in the UK (DECC 2011g, p9). That was nearly 20% of all households, two years ago and the number will have risen since in spite of Warm Front and CERT action. Fuel poverty almost definitely affects a quarter of all British households in 2011. Details on the challenges posed by fuel poverty and on possible solutions can be found in *Fixing fuel poverty* (Boardman 2010), but some of the issues for policy are:

- o a fuel poor household suffers from both a low income and living in an energy-inefficient property. This combination makes a fuel poor household difficult to identify by any single criteria or combination of social and economic circumstances. As a result, the targeting of programmes on the fuel poor is only about 25% successful: the other 75% of fuel poverty policy money goes to the non-fuel poor;
- o not only is identifying the fuel poor on the doorstep difficult, but it is, possibly, counter-productive. If energy-efficiency improvements are seen as an indicator of poverty, it is feared that many people would refuse them to avoid being identified as poor to their neighbours;
- o hence, dealing with fuel poverty should be in the context of a radical new approach to the energy efficiency of the whole housing stock, while targeting the areas where fuel poverty is concentrated first;
- o investment in energy-efficiency improvements are the best solution to fuel poverty as they are one-off, not recurring, with a long-term, semi-permanent effect. However, most current fuel poverty policy expenditure goes on income support and subsidising fuel prices, ie treating the symptoms not the cause;



- o the average fuel poor home has to be taken from a SAP 38 level of energy efficiency up to at least SAP 81 as this will remove 83 per cent from fuel poverty, at February 2009 fuel prices (Boardman 2010, pp160-1, 217). Or, to give another standard, a gas-heated 70m<sup>2</sup> passivhaus would cost only £25 a year to heat (Passivhaus 2011);
- o the measures applied to the home should include installing low and zero carbon technologies, as well as improved energy efficiency, so that the fuel poor can benefit from the feed-in tariff and the renewable heat incentive (Boardman 2010, p223);
- o at least 1.2m households have to be lifted out of fuel poverty, each year, between now and 2016. The annual level of activity required to meet the 2016 deadline will rise if action is delayed;
- o ideally, each home should be upgraded in one go – it is inefficient (and time consuming) to undertake two or more energy-efficiency retrofits in each fuel poor household;
- o the initial target is to improve the least energy-efficient homes, regardless of the tenure or income of the occupant (Boardman 2010, p219);
- o the fuel poor have no capital of their own with which to fund the energy-efficiency improvements, though two-thirds of them have equity in their own home.

An emphasis on the obligations of landlords (public and private) will benefit about 30% of the fuel poor, but the remaining 70% are owner occupiers, mainly elderly. For them, the policy lifelines include:

- o access to zero or low-interest lifetime mortgages (chapter 4), that will be repaid when the property is sold. The investment is made worthwhile both by the improved standard of living of the occupant and the increased value of the property;
- o the ECO, provided it is well-targeted on the fuel poor and not used as proposed to subsidise expensive measures in the homes of the better-off;
- o grants could be available to convert part of the home into self-contained accommodation for renting out. Local authorities receive a payment from government for the creation of each new home and this could be used to help under-occupying elderly home owners shrink their own space and obtain additional income from the new rental. The need for new housing is growing each year as more households are formed than extra homes built, so the housing shortage continues to worsen;
- o a wider range of new developments specifically for elderly empty-nesters. These will not just be the standard sheltered housing, but more imaginative and attractive enclaves for the active elderly (for instance including access to a gym and a swimming pool), who can look after themselves, but no longer want the responsibility of managing a property. There may be a resident concierge, rather than a warden.

---

A combination of policies such as these should enable the fuel poor owner occupier to have a range of choices that provide for the improvement of the existing home, perhaps generating additional income, or, if that is too much hassle, a better range of alternatives to move into than exist at the moment. Other solutions may be needed for those fuel poor who live in isolated rural dwellings or villages, where the options are limited and they wish to stay in familiar surroundings. *In extremis*, the energy efficiency of such under-occupied properties should be to an even higher standard, to reflect the amount of space to be heated by just one income.

### **Low carbon zones**

One of the most useful approaches available, considering all of the above, would be to have an area-based approach in each local authority, provisionally called a low carbon zone (LCZ). This approach is particularly appropriate for dealing with concentrations of fuel poverty in urban areas and for helping those who are reluctant to identify themselves – the ‘I’m not complaining group’ (Boardman 2010, p220):

Building relationships with those who find it hard to trust – the elderly or disabled, lonely and isolated people, the mentally ill or ethnic minority households – requires patience and understanding (WZ, undated, p10).

LCZ would be based on the highly successful warm zones (EST 2005; Boardman 2010, p222). Each local authority draws a red line on a map that encircles the area of their worst fuel poverty and all the properties in this area are tackled on a house-by-house, street-by-street basis. These properties should all be brought to a high SAP rating (A- or B-rated on the EPC), which fuel-poverty-proofs them for most low-income families. There would be economies of scale at the property level (one lot of scaffolding to put a solar technology on the roof and to externally insulate the solid walls) and at the street level (minimising contractors’ travelling time). There are also opportunities for area-based solutions (such as community CHP) that are not so likely if an individual property approach is taken.

There would be a sequence of LCZ, just as there has been a succession of smokeless zones under the Clean Air Act 1956, so that the whole local authority area is dealt with, from the worst onwards. This would represent a real attempt to eradicate fuel poverty by 2016. The scale of the challenge is formidable, but present policies are woefully inadequate and ineffective in a scenario of rapidly increasing energy prices; hence fuel poverty is increasing, not decreasing, every year.



The success of a LCZ would depend largely on the prior announcement by the government of mandatory minimum standards for all homes, rising over time. Then every property owner knows that the improvements are going to have to be made, at some stage. As the offer through the LCZ is for a LA-run/approved scheme, offering considerable discounts and minimal hassle, then the likelihood would be for a high-level of take-up: the work has to be done, so why not now. There could be a useful synergy between policies on LCZ and the ECO under the green deal, with local authorities and the utilities combining to focus support on the fuel poor.

Communities have an influential role. In LCZ, the experience of neighbours and of general street gossip would be useful contributors to enrolling all households and property owners in the activity. With tenanted property, this will be particularly important, because of natural suspicions of the motivation of the landlord. This would be part of a wider social movement:

Even with the growth of web-based information systems, significant behavioural change results primarily from more trusted [than Government] role models, e.g. friends, family and community leaders. The

*Constructing the Olympic village has provided the opportunity for green buildings*



---

implication is that similar principles of technological innovation need to be applied, with Government supporting rather than undertaking social innovation, e.g. by financing social entrepreneurs, in community projects and adopting a portfolio approach to recognize the inevitability of some innovation failure (Eyre et al 2010, p281).

## **People, attitudes and behaviour**

Local authorities, central governments and industry can decide whatever they like, but the success of many policies is likely to depend upon enrolling, informing and helping people and working with their priorities. This, of course, is especially important with energy as it is individuals that adjust the thermostat or turn on the lights.

To get the maximum effectiveness out of a policy depends upon an informed response from the population, which is difficult as the level of energy literacy in the UK is still abysmally low. This is why the personal carbon allowances, performance labelling, live feedback and other awareness-raising policy instruments are perceived as essential.

The recognition of the importance of people, as individuals, is covered excellently in the UKERC publication on lifestyles and energy scenarios. The radically different energy future that could result is a much-needed antidote to the extravagant projections often published. Some of the identified factors are (Eyre et al 2010):

- o the implication for policy-makers is that policy needs to help empower consumers to change lifestyles and to help them make intelligent choices about the future (pp 259, 288);
- o the behaviour of energy users is not fixed, but rather the outcome of developments in society, and that these are uncertain with the level of uncertainty increasing over time. (p286);
- o that the interaction between public policy and lifestyle change is not straightforward or uni-directional: public policy helps create the conditions in which different lifestyles are more or less acceptable, and pressure for particular lifestyles sets the parameters for public policy (p280);
- o that it allows early action, resulting in lower cumulative emissions;
- o makes the need for costly, potentially disruptive technologies less likely (p278);
- o The lifestyle scenario envisions a society with significantly different attitudes, lifestyles and politics (p282).

The link between lifestyle changes and levels of energy service (less use of appliances, cooler homes) is uncertain. It may be that there will be a declining level of energy services (Eyre et





al 2010, p268), or it may be that when properties and equipment are super-energy-efficient, the additional energy required to provide a higher level of energy services will be negligible and acceptable (Boardman et al 2005b, p49). If there are personal carbon allowances and influential DEC's the choice will be the users, within a national framework.

One way of giving greater energy efficiency more status would come from the recognition that the properties are more comfortable, provide healthy living and working conditions and are future-friendly. The cold, mould, condensation, sick-building syndrome could all become things of the past, residing in the memories of the older generations. The pull that could come from the desire to live and work in better-quality, healthier environments does not seem to have been mobilised yet.

Part of the expectation about green deal is that it will work best if there is a strong local link. As CSE's Plan LoCal found there can be radical shifts in expectations and acceptance if the process starts with debates with local groups, around a model of the built environment and discussing the question:

“How are we going to make our contribution to tackling climate change around here?”  
The discussion teased out the relative importance of big wind turbines, individual photovoltaic installations, greater energy efficiency, whilst keeping the debate focused on local solutions. Had the question been framed in terms of “What are you going to do about climate change?” it would have resulted in comments about the role of central government, industry and China, rather than accepting any local responsibility (CSE 2011). An innovative, creative approach to involving people in their local community can be extremely effective.

Policies that foster the relationship between local people, their community and local government are poorly understood, but are an important part of delivering the social ambience within which to achieve low-energy communities in practice.

The gist of the Government's 'Big Society' and localism agenda is that we are going to function as local communities, undertaking initiatives for ourselves, deciding our own priorities, without them being led by the government or industry. This assumes that, somehow, there will be local groups, keen and eager to deliver a low-carbon society. There is some evidence that such groups are forming – there are over 60 in Oxfordshire alone (ClimateXchange 2011). What has to be remembered is that each group will have its own priorities and these may not entirely align with either local or central government expectations, for instance there may be more emphasis on renewables and less on energy efficiency than was hoped for by government.



*Community groups are springing up and have an important part to play*

The existence of strong communities, well-resourced local authorities and involved individuals will be crucial in delivering a low-energy, low-carbon future, but they are insufficiently factored into the process at the moment.

While a large car or house may be seen as status symbols, virtually no-one actively seeks to use a lot of energy, just for the sake of it. But, the British are not known as an energy-literate society, so there are situations of excessive energy demand as a result of ignorance or misguided cultural trends:

- o we could be comfortable indoors at 21oC, but would require 23-24oC if we insist on going around in T-shirts in winter;
- o fresh air is healthy, but opening windows or standing at an open front door while the heating is on is not the answer and is expensive;



- o in summer heat-waves, leaving the upstairs windows open at night and cooling down the building is a good alternative to installing an air-conditioning system;
- o similarly, a summer dress code that accepts the wearing of light-weight clothes, rather than heavy suits reduces the demand for air conditioning in businesses, as has been found in Japan;
- o a short shower is just as effective as a long one;
- o fuel-effect fires provide the illusion of warmth, but in reality 90% of the heat is going up the chimney.

There is an important role for education, but information campaigns are most effective when people see the need for it. The lack of knowledge in the UK about how energy can be conserved will only be counteracted when there is an overarching system, such as proposed in *Achieving zero*, that creates awareness of the limits of socially-acceptable energy consumption.

### **Personal carbon allowances (PCA)**

After labels and minimum standards (which cover the regulated uses) the next most important task for Government is to create widespread awareness in households of their total energy consumption and associated carbon emissions. For businesses, this is achieved through DECs (chapter 2), but there is, as yet, nothing comparable for the residential sector. DECs would not work with homes, as there is no process of public display that would 'name and shame' the householder. The only way that has been identified to bring householders face-to-face with the realities of their energy consumption and to learn how to reduce it, particularly for electricity use, is the introduction of personal carbon allowances for householders (Fawcett 2010, Fawcett and Parag 2010). These can also be called personal carbon trading. PCA are, in reality, more powerful than DECs, as they provide a performance standard that covers all actual energy use and that can be reduced over time. It is difficult to do this with DECs.

With PCAs, there would be a free, annual allowance of carbon for everyone that is exchanged when undertaking carbon-emitting purchases. The coverage would, probably, only be of energy in the home, personal transport and aviation – less than one transaction a week. When the allowance is used up, there would be a trading system, so that high carbon-emitters can purchase the allowances of low-carbon emitters. The latter are almost certainly the fuel poor and low-income households who are less likely to have a car and do not fly. There are two strong, positive attributes to PCA: they are progressive, involving money flows from the rich to the poor; and they cap the total amount of carbon that can be emitted by the residential

---

sector through the number of allowances issued. This amount decreases annually, in line with climate change policy commitments. Constraint is built into the system and thus the PCA discourages the use of profligate equipment or ever-higher numbers of appliances – it puts energy-related decision-making into a context.

The strength of the government's commitment is more important than actual dates. The actions to prepare householders will take a few years as it involves bridging the gap between energy services, energy use and carbon emissions. Some of the contributory measures are:

- o the introduction of smart meters (2012 onwards) that show energy use (kW and kWh) and the carbon emissions of that particular (electricity) supplier;
- o new billing systems that give total annual consumption and emissions;
- o and greater information about the carbon intensity of different fuels. Publicising the already obligatory process of fuel mix disclosure will inform users of the substantial variations in the carbon intensity of electricity (at least 60%) supplied between the main six utilities, more if the green energy companies are included.

The existing feedback on energy costs takes too long (quarterly or six-monthly billing), so it cannot influence behaviour and the profligate use of energy, whether through non-essential appliances, leaving equipment on (lights and standby), buying bigger than necessary, and so forth. The circle will not be completed without education, live and convenient information and, probably, a clear, personal accounting system.

Political interest in PCA has waxed and waned, partly because it cannot be introduced through a staged process: it is like the congestion charge, it is either there or not there. However, the requirements of the 2050 target will be impossible without involving everyone in changing their lifestyles. Even if all electricity could be decarbonised, a major reduction in demand (over future anticipated levels) is required. In addition, this is another way of making the markets work better: if people are positively trying to live within their carbon budgets, then they are more likely to buy energy-efficient equipment. As consumers they will be putting pressure on the manufacturers, rather than the impetus coming from Brussels only. This pressure on the manufacturers should make it more difficult to launch energy-profligate equipment, such as patio heaters and fuel-effect fires, as the public will no longer be ignorant – and uncaring.

## **DECs and businesses**

The market transformation strategy would incorporate many of the things already mentioned such as minimum standards based on EPC labels, improved product policies, tax-based



incentives and access to information. To these can be added issues that are more specific to the business community and, in particular, financial penalties, reputational risk and public shaming from:

- o the annual cost of the CRC;
- o performance league tables published under the CRC from October 2011 (Environment Agency, 2011);
- o the rating of the DEC in the building's front entrance;
- o a publicly-searchable database of DEC information, on an address-specific basis;
- o the requirement to identify energy consumption and carbon emissions separately in annual reports (part of the Climate Change Act 2008);
- o lights blazing away in the middle of the night.

It may be optimistic to have faith in publicity, but, given the range and disparate nature of the business sector, a tighter programme for all energy use is difficult to envisage. Some of these initiatives can be combined to make the pressure clearer and coherent:

We will not achieve radical reductions in carbon emissions from our private sector non-domestic buildings unless we have consistent and robust data and a clear, comparable rating system that works for all building occupancy types. With minor improvements, DECs provide the basis for this. This report also highlights how a roll-out of DECs can align with other policies, notably the CRC-EES, and ways in which the CRC-EES can be improved (UKGBC, 2011, p39).

One aspect of reputational risk will be covered under forthcoming legislation, as a result of the Climate Change Act 2008. Section 85 requires mandatory corporate carbon reporting:

- (1) The Secretary of State must, not later than 6th April 2012—
  - (a) make regulations under section 416(4) of the Companies Act 2006 (c.46) requiring the directors' report of a company to contain such information as may be specified in the regulations about emissions of greenhouse gases from activities for which the company is responsible, or
  - (b) lay before Parliament a report explaining why no such regulations have been made.

A supporting requirement could require the amount spent on energy to be identified separately in the company accounts. In combination, these could be the first step of bringing 'carbon to the attention of the board' (LCC 2010, p159) and help identify possible reduction opportunities. Companies Act 2006 makes provision for such a requirement and now the Government is consulting on how to improve company reporting on greenhouse gas emissions (DEFRA 2011).

---

The business sector, as with residential premises, contains the split responsibilities of the landlord and tenant. The aim is to turn this dichotomy into a positive, with specific responsibility for each partner. While it is proposed here that responsibility is increasingly focused on the property owner, there are opportunities for immediate progress through green leases. Landlords and tenants could co-operate to agree an energy management plan for their buildings, to accompany the DEC (LCC 2010, p138).

## **Green leases and MOU**

Green leases are a way of formalising the energy relationship between landlords and tenants, so that each party knows what consumption it is responsible for and can control it. Originally developed by the Australian Government for properties they rent, these documents ideally require the legal obligations to be anticipated in the building's design and, particularly, the metering of the building. For instance, lighting circuits should not cross responsibility boundaries: no switch should put on lights that are both in the landlord's and the tenant's domains. Similarly, the heating and cooling loads paid for by the tenant have been minimised through a commitment, by the landlord and developer, in return for an enhanced rent, to provide a building built to a high standard of energy efficiency, with a defined resultant heating demand.

Green leases are a whole new art form, but they can result in low energy bills, high rent returns and a harmonious relationship between the landlord and tenant. Sample clauses and guidelines are being developed, to speed up the process (Cardiff University, 2011). They do assume a strong level of commitment, from the design of the building onwards, to making sure that the energy costs are minimised, fairly divided and predictable. There have been proposals for the adoption of mandatory green leases in the public sector initially, followed by commercial properties to overcome the landlord-tenant divide (CT 2010, pp20-21).

The Ethical Property Company has amended and simplified the green lease approach and proposed a memorandum of understanding (MOU). The MOU is more suitable for an existing building, whereas green leases are particularly useful for new buildings which promise higher performance in return for higher rents.

As a minimum, all buildings rented by the government or other public bodies should have green leases, in order to bring energy costs under control.





## Business sub-sectors

Many groups of businesses have special responsibilities, of which some are:

- o the construction industry in developing the skills and training courses to ensure high-quality energy-efficient buildings that deliver the expected energy savings. Developing the profile and specification of an integrator, who would interface with the property owners to advise on how to get the building onto a low-energy trajectory;
- o property and estate agents to ensure that the EPC is treated with respect, shown to clients and used prominently in advertising and marketing, so that a high level of energy-efficiency becomes a selling point;
- o retail outlets to introduce lower, more focused and more efficient levels of lighting, perhaps entering into a voluntary agreement with the government to achieve a reducing amount of energy in lighting (kWh/m<sup>2</sup>) in the next few years.

*Construction will have to be to a high standard to deliver the expected energy savings*





---

## DELIVERY AGENTS

### The UK Government

The major requirement for the government is to develop the strategy for 2050 and future-friendly buildings. The second task is for this and succeeding governments to enhance, not diminish, this routemap. Policy consistency and conviction will be vital in delivering these energy and carbon reductions.

There is a major package of policies required from the government, but collectively they provide substantial benefits: they will create employment, reduce the threat of climate change, improve energy security and help to eradicate fuel poverty. This should make it easier politically, although it is still a set of initiatives that will take political courage and foresight to introduce.

The Government has a vital role in decisions about the range of appropriate financial incentives and how these are funded and where they are applied: there is a clear trade-off between additional regulation or generous financial incentives. To achieve a given environmental impact, if incentive funding is not sufficiently generous then the complementary regulatory requirements have to be stronger. Some of the financial incentives, particularly those combined with performance disclosure and/or minimum standards, can be short-lived in order to establish the new market and trend.

### Working with OFGEM (the regulator) and the utilities

A theme of *Achieving zero* has been the need for a greater integration of policy on energy demand and the resultant need for energy supply. Demand reduction is the essential first priority, but, on occasions, it can be targeted to meet a specific supply-side objective. The prime example is the role of lighting in causing peak electricity demand and hence defining the country's required electricity generating capacity. A strong focus on low-energy lighting would significantly reduce the peak demand and save several billions of pounds of expenditure on new electricity generating stations. Demand reduction, particularly peak load reduction, is more important and valuable than new low-carbon capacity.

This is an area where greater study would be beneficial, but it should always start from the perspective of realistic householder behaviour. For instance, a scenario that assumes 9m property owners will have invested both in major levels of insulation and in a brand new heating system (heat pump) by 2030 seems improbable. An unrealistic set of assumptions about human behaviour could result in ineffective policies or stranded assets.



There is an urgent need for a policy rethink on the way in which government policies are paid for by surcharges on energy bills. These, at present, include the Renewables Obligation (RO), Carbon Emission Reduction Targets (CERT) and the new Energy Company Obligation (ECO), the EU Emissions Trading Scheme (EUETS) and the feed-in tariff (FIT). A commitment is needed from the government that significantly more households will be lifted out of fuel poverty by these policies than are forced into fuel poverty from the higher energy prices. That is a challenging objective and is likely to require that the majority of the additional charges are paid by better-off households.

Coupled with this analysis is the proposal that the utilities should transfer some or all of the funding of the ECO (the replacement for CERT) into a pooled fund for local authorities and action on low carbon zones. The assumption, which would have to be tested, is that the local authorities would achieve greater reductions in fuel poverty than the utilities would have done, with this pooled money. A further source of funds will come as the EUETS allowances are auctioned, rather than distributed to the utilities for free (yes – they are charging customers for something that they received for free) and from carbon pricing.

It is essential that carbon pricing revenues, generated to discourage activities such as carbon-intensive electricity production, are recycled to encourage demand reduction:

The emphasis on individual and community action points to a downstream focus to target individual energy use, through end user taxes or downstream permits. The challenge of the regressive nature of carbon pricing will be addressed through explicit revenue recycling and increased support for behaviour change (Eyre et al 2010, p281).

## Local authorities

The devolution of responsibility down to local authorities is part of the government's agenda of localism and the big society. The role of local authorities is vital in terms of confirmed delivery: there needs to be an identified authority with responsibility for ensuring that targets are met. This is true whether the standards relate to the individual building or to personal responsibility. The scale of the task in terms of the whole building stock, the size of the carbon reductions and the extent of fuel poverty means that the process cannot be left to hopeful chance. There has to be a set of targets agreed with local authorities to make sure that the changes are delivered. Local authorities are the perfect agents for this as, between them, they cover the whole country, are close to their communities and businesses and are responsive to them. In addition, there are about 450 local authorities in the UK which means that a lot of activity can start promptly and in parallel. It is important to combine responsibility,

---

performance assessment and incentives, but this will need to be supported by additional funds from central government.

For policy on reducing the threat of climate change, there is a new Memorandum of Understanding (MoU) between the government and the local authorities – effectively an extension of the Nottingham Declaration. The MoU sets out how DECC and the Local Government Group will work together to help and encourage all councils to take firm action to:

- o reduce the carbon emissions from their own estate and operations;
- o reduce carbon emissions from homes, businesses and transport infrastructure, creating more appropriate renewable energy generation, using council influence and powers; and
- o participate in national carbon reduction initiatives at the local level, particularly the roll out of the green deal, smart metering and renewable energy deployment.

All these fine words and aspirations may not, in reality, result in much action. For policy, ‘encourage’ must be the weakest of all terms. There is no mention of policy on fuel poverty or social equity outcomes here or in the recent Carbon Action Plan (DECC 2011c), which is doubly disappointing. The government appears to be wilfully blind to its legal obligations on fuel poverty, though the recent appointment of Prof John Hills to undertake a review of fuel poverty definitions and targets may result in a new momentum.

The equitable delivery of low-energy buildings is likely to require local authorities and communities to have a pivotal role and will be influenced by several pieces of draft legislation, including the Localism Bill and green deal and the recent Energy Act 2011. The present indicators are that collectively they will not deliver the structure and support needed to even begin to tackle fuel poverty, let alone eradicate it by 2016. The likelihood of having an equitable future is even more problematic than having a low-carbon one. There are strong synergies between these policies, but they are not being reflected successfully in Government plans.

The Government has removed the national indicators introduced by the Labour Government, before they could be effectively tested and assessed. Some similar replacements are now required at least for per capita carbon emissions and levels of fuel poverty, otherwise, national targets and local activity will remain unsynchronised.

The concept of LCZ is described above. While it would, most likely, be administered by local authorities, it would be delivered in conjunction with the private sector and link with utility funding (the ECO part of green deal). A strong and immediate response is needed to tackle



fuel poverty – the 2016 target is horribly close - and this would be achieved by having a clear strategy, across all levels of Government, based on a market transformation philosophy.

Contributory local authority actions could include:

- o comprehensive EPC labelling to link with an energy-efficiency database of all properties;
- o enforcing legislation on minimum standards, initially through the housing health and safety rating scheme (Boardman 2007, p46), then, focusing on the privately rented sector and all other properties;
- o implementing a second decent homes standard;
- o receiving a financial incentive from central Government, similar to that previously incorporated in national indicator (NI) 187, to reduce the number of properties (of any tenure) that are F and G-rated and to increase the number that are A, B or C-rated. This could be similar to the Government bonus paid for six years from 2012-13, for each new home with an additional payment if it is affordable. This bonus extends to homes that have been empty for a long time (CLG 2011b). An F or G-rated home is unhealthy, so bringing that up to a higher standard of energy efficiency would be ensuring that it has a useful life in future;
- o working with local contractors to deliver the green deal, particularly the ECO (CSE 2011).

A focus on local authorities provides additional opportunities in relation to:

- o publicising exemplars;
- o Building Control Officers as independent mentors for each building and ensuring it is on a trajectory to 2050;
- o working with innovative ideas from local communities (below);
- o Assembling data bases, implementing low carbon zones, monitoring the implementation of minimum standards, eradicating fuel poverty are all issues that could be devolved to the local authority.

## Property owners

Property owners already have major responsibilities in relation to their building, for instance for health and safety, the provision of fire escapes, disabled facilities and so forth. The *Achieving zero* proposal is that they now assume total responsibility for the level of energy efficiency of their building, but not the energy consumption of their tenants. The greater use of EPCs and minimum standards will help property owners appreciate the task ahead of them, as they have, at present, no clear way of judging the scale of the improvements required to the energy-efficiency of their buildings: the vast difference between improvements worth a couple of SAP points and jumping four bands on the EPC is not understood.

le. The Zeitgeist is changing.

---

## SUMMARY

The blight of fuel poverty affects what can and should be done. With continually rising fuel prices, increasing numbers of households are being brought into fuel poverty: even at the end of 2009 it was over 5.5 million in the UK, or 20% of all households. By the end of 2011, this could be as high as 6 million households. The failure of past and present energy efficiency programmes to impact on the growth of this number indicates the scale of what is now required and that alternative policies have to be considered. The political and legislative imperative of the Climate Change Act 2008 is joined by that of the Warm Homes and Energy Conservation Act 2000. Policies have to tackle both together, through improving the energy efficiency of the housing stock, dealing with the worst ones first.

The delivery of a building stock with minimal energy demand and low carbon emissions will require a raft of new policies, together with commitment from all in society – we all live and work in buildings. The three most influential groups are the UK Government, local authorities and people, whether at home or at work, with strong supporting roles for the private sector, including the utilities. The tone and momentum of the debate is set by central Government policies, but much of the delivery depends upon local government having and meeting local targets. It is probably local authorities, and only local authorities, that can take responsibility for implementation in a comprehensive, inclusive way. Their administrative responsibility is separate from actual delivery, but even so this will be challenging for many local authorities. It is, however, the only way to ensure complete geographical coverage and that all the fuel poor (even those who are self-effacing and hidden) are incorporated. Without a strong local actor, large-scale energy efficiency programmes will fail to secure a high degree of take-up across the country. All property owners have to be involved and the sooner the better.

In all of this, people have to be supportive and in agreement, not least as voters. Achieving this relationship between voters, politicians and radical policies will not be easy: the timetable is too tight to wait for a major shift in public opinion to be brought about, but without it the politicians will be wary of passing the legislation. Meanwhile, 2050 is approaching and climate change is worsening. Some senior decision-makers will have to demonstrate commitment, conviction, courage and charisma – in other words leadership.

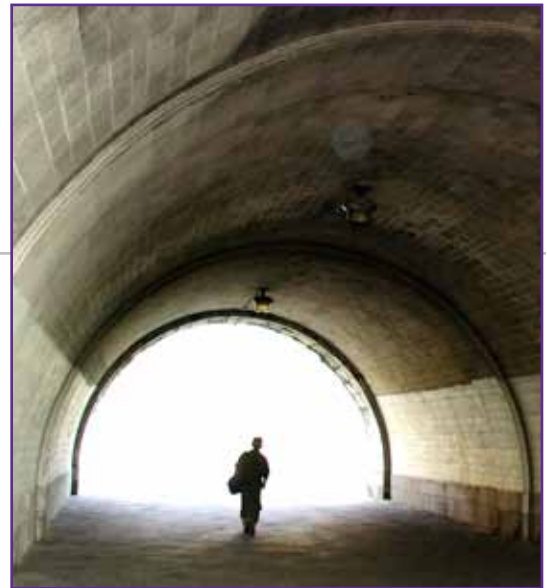
The recession may be working in favour of these greater lifestyle changes: most people are becoming more used to a careful, less extravagant style of living. With constrained budgets, the increases in fuel prices are more noticeable. The green deal is forcing people to be more self-reliant as there are less grants available. The Zeitgeist is changing.



# 6

## Template for action

Achieving zero carbon emissions is essential for the whole of the UK's building stock by 2050 and, therefore, the challenge for each owner and occupant of the 26 million homes and 2 million businesses. Net zero carbon emissions will result from the combined effects of reduced demand for energy and the decarbonisation of the fuels used. This report focuses on the potential for demand reduction together with some fuel switching at the point of use. When the resultant level of energy demand can be established, it will be appropriate to look at the way the energy can be supplied and at what level of carbon emissions. Not the other way round. *Achieving zero* is, therefore, about the contribution to zero carbon emissions that can come from very low-energy use in buildings.



Buildings are seen as providing opportunities for quick, substantial and cost-effective savings and should, therefore be a primary focus for policy. An enormous amount of energy is consumed in buildings causing the release of a large quantity of greenhouse gas emissions – about 40% of all UK energy and carbon dioxide emissions. The 2050 target of 80% reduction in greenhouse gas emissions cannot be achieved without major changes in the way energy is used in our buildings and sourced. In addition, policy on buildings provides a useful two-way experience for users: we have to both lead on and learn from the changes.

Some of the proposals listed in this report are just minor adjustments of existing policies and can be implemented almost immediately, while others will take time to deliver and will involve working with people to prepare for the tasks ahead. The preparations for longer-term policies and the associated announcements have to be made now, in order for there to be time for people, communities, industry and all levels of the government to make the necessary adjustments, both mental and practical.

Quite a few of the proposals are occurring in the UK at present – labelling buildings, minimum standards for some products – but they are individually weak, because they are isolated. This report highlights the powerful effect of combining and strengthening policy into a coherent strategy. With a thoughtful, equitable approach, the strategy will deliver greater energy efficiency, energy demand reduction, lower peak load and cuts in carbon emissions and, most importantly, higher energy services, thus contributing to limiting climate change, fuel poverty eradication and greater energy security.

This chapter brings together the proposals made earlier and shows how they combine in a market transformation strategy. It is the first attempt at the policy framework for *Achieving zero* in UK buildings by 2050.

## CORE STRATEGY

The underlying framework is a set of policies on total energy consumption for each sector. The matrix of policies is built on two existing sub-divisions (table 6.1):

- o the separate responsibilities and opportunities of the property owner and the occupant. The former is concerned with the fabric of the building, whilst the latter incorporates all energy-related human behaviour;
- o the split of energy uses between those that are regulated and covered by the energy performance certificate and the remainder that are included in total energy consumption, under the display energy certificate for businesses and, it is proposed, personal carbon allowances for residential.

Table 6.1: Proposed over-arching policy instruments

	<b>Property owner</b> Theoretical energy use: mainly gas	<b>Occupant</b> Actual energy use: includes all electricity
<b>Residential</b>	<b>Minimum standards based on EPC</b>  82% of all energy in 2009	<b>Personal carbon allowances</b>  100% of all energy
<b>Business</b>	<b>Minimum standards based on EPC</b>  69% of all energy in 2009	<b>Display energy certificates</b>  <b>100% of all energy</b>





The four policy cells in table 6.1 cover all energy use in all UK buildings in a clear and simple relationship. Over time, the proportion of energy use that is the property owners' responsibility and covered by an EPC is dropping, as properties become energy efficient. This, in turn means that the two policies on the right hand side grow in importance, though, at the moment, neither is ideal. For DEC's the problem is that it is not possible to link them to a minimum standard, only to hope that peer pressure and taxation are sufficiently influential. Though businesses are increasingly recognising the financial benefits of lower energy bills and carbon footprints and, unilaterally, taking action. At some point, the probability is that minimum standards will be required for total business energy use and this will require further policy development.

The proposal to use personal carbon allowances is politically controversial, although this policy is well-designed for the role of raising awareness amongst householders and capping residential emissions, together with certainty of reductions for the government. Providing that PCAs include private travel, they are progressive and so protect the fuel poor. There are few policies that do this.

If PCAs are to be introduced – and it is difficult to think of any other way to restrain electricity use in the home with any certainty – then several preparatory policies will be required to enable people to understand their present carbon footprint. All of the other policies – labels, minimum standards, smart meters – help to inform the householder and raise awareness about energy consumption. There will still need to be systems that link energy services with carbon for the individual user and fuel.

The Committee on Climate Change considers that it should be mandatory for each business property to have an EPC and a DEC by 2017 (CCC 2011b, p122) – a recommendation that is also part of the core strategy for this report, though the timing may need to be earlier.

## **Adding value to the property**

A central tenet of these proposals is that energy-efficient properties should be worth more and the better the performance, the greater the market premium: they are more comfortable, provide a better working or living environment and cost less to heat and light. If this link could be established, there would be much greater investment in energy efficiency improvements and micro-generation and an acceptance that it was a sensible thing to do. It would, literally, become an investment. The impetus for undertaking energy efficiency improvements, at the

---

moment, is, at best, linked to the speed with which the investment is paid back through lower energy bills. That alone is not creating the necessary momentum. The incentive has to be created through broader concerns, particularly the value of the property.

There are some tentative signs, here and abroad, that more energy-efficient buildings are beginning to command higher prices and rents. But the process is uncertain and too slow for the radical changes that are required over the next 39 years to meet the 2050 emissions target. The market is clearly not delivering energy-efficient homes at the necessary rate.

The best and most certain way to create a link between value and efficiency is deemed to be through the introduction of minimum energy-efficiency standards for existing buildings. This would immediately result in the market recognising the value of buildings that already meet the standard and poorly-insulated properties would lose value in line with the expenditure required to upgrade them in a defined timeframe.

## **Equity and fuel poverty**

Another basic principle is the importance of equity and of helping the fuel poor. This supplements the political imperative of reducing the likelihood of catastrophic climate change. There are useful synergies between these priorities if the focus is on capital investment in energy efficiency: the benefits to the fuel poor of a warmer, healthier and more comfortable home combine with the benefits for the planet of less pollution as a result of lower energy consumption. An area-based approach, through low carbon zones (LCZ -chapter 5) is the recommended route to helping the fuel poor quickly and effectively.

The increase in fuel prices that result when the government's policies are funded by the utilities, has to be curtailed or capped, because of the detrimental effect on the fuel poor. The principle has to be established and accepted that these surcharges must lift more people out of fuel poverty than are tipped into it by the extra costs. Helping the planet must not be at the expense of today's disadvantaged. The first example of this potential conflict comes with the design of the new energy company obligation – if a large proportion of this goes to the better-off, as proposed, the policy will be regressive.

About a third of the 6m fuel poor households live in rented accommodation, so policies on minimum standards for privately-rented landlords and a new decent homes standard for social housing will result in their homes being improved. The other two-thirds are owner occupiers, mainly elderly people who own the property outright and no longer have a mortgage. The challenge of helping this latter group is greater as they are capital rich, but income poor. A



zero-interest loan would help with the finance, but not the hassle of getting the work done. The area-based solution of a LCZ, organised by the local authority, seems to be the most appropriate answer.

The recommendation is that the LCZ would be publicised as an environmental measure, for the good of society and future generations. It would not be linked to poverty in any communication. This should encourage even the most reluctant and self-effacing households to participate ‘for the good of the community’. Also, word of mouth and the views of neighbours are powerful enforcers, as the warm zones programme has found. A major investment programme, such as LCZ, however funded, has the effect of producing considerable employment that has to be local. This is understood and welcomed by the community.

### **Demand reduction before new supply**

There is little fuel switching within the strategy proposed in this report. The objective of switching large numbers of households and businesses to electric heating to take advantage of decarbonised electricity is questioned, largely because of the cost of additional generation, transmission and distribution requirements that would all increase fuel bills. This would be at a time when the household should be investing in major energy efficiency improvements to the fabric of the property. A more practical and realistic approach, particularly in the short-term (the next 15 years or so), is thought to be to decarbonise the natural gas network through the introduction of bio-methane from anaerobic digestion plants, whilst significantly reducing demand. This would allow the existing investment by the property owner in the gas heating system to continue to be used, which is particularly important at a time of household cash constraint. In reality, most boiler replacements are distress purchases, so the opportunities for a switch to heat pumps would have to be created by policy and imposed – probably an expensive and unnecessary process.

*Shading over windows reduces the need for energy-intensive air-conditioning units*



---

The quantity of green gas that could exist is not well established, but could be a quite high proportion of gas use when properties have been made highly energy-efficient and demand significantly reduced. For both these reasons, the demand for imported gas would be substantially less and energy security increased. Green gas qualifies as a renewable resource.

The effect of the decarbonisation of the electricity supply has not been built into this report, because of its uncertainty and, potentially, prohibitive cost for consumers and due to the higher priority of demand reduction.

One of the major findings of the UKERC study into the effect of changing behaviour was that: *the cost of decarbonisation to the level of UK targets is much less in the Lifestyle scenario than other scenarios. ... The direction of the effect is obvious, but the scale is more significant than identified in analyses that assume “business as usual lifestyle change” (Eyre et al 2010, p288).*

It is peak electricity demand that determines many generation investment decisions, but a focus on reducing peak loads, for instance through more efficient lighting, is rarely brought into the debate. Lighting in buildings constitutes a third of peak electricity demand and a strong emphasis on reducing lighting loads in businesses could help to narrow the purported capacity gap. This could be achieved in part by a focus on lighting controls in buildings, such as movement and daylight sensors that reduce energy wastage; and in part by improving the efficiency of light provision by encouraging the use of LED technologies. Intelligent appliances (in the home and business) that can be switched off remotely for a few minutes when demand is high would also reduce peak demand, but not necessarily total demand.

As identified in relation to peak electricity demand, there is a need for greater synergies between the debates on demand reduction and how that demand should be supplied. Otherwise there is a risk of unnecessary expenditure. The most cost-effective solution is always to reduce energy demand first and this is preferred by building users, as it provides a more comfortable environment.



## MARKET TRANSFORMATION

### Labelling properties and datasets – identifying the choices

Labelling is the first action in a market transformation strategy, as it is the pre-requisite of all policies that the good and the bad can be identified. Because properties are geographically separate (not all in one showroom, like fridges), it is essential that the labels are supported by comprehensive, publicly-accessible, good quality databases. With properties, the database is a crucial extension of the label.

Policies that extend the coverage of labels are a first priority in this strategy: all homes and businesses should have an EPC, waiting for these to be acquired at change of ownership will be too slow. In addition, all business premises should be required to have a DEC, not just public buildings. In both cases, the local authority should have the responsibility for assembling an address-specific database of the energy efficiency of all the properties in their area. This is likely to be of provisional standard initially, improved as additional data are obtained. The complete coverage of EPCs and DECs, together with the associated, publicly-accessible databases should be complete by 2013 for residential and 2015 for businesses. With residential properties, this is to ensure that all the fuel poor households have been identified and removed from fuel poverty by 2016, the requirement in the WHECA 2000. The Energy Act 2011 states that it will be illegal to rent out F- and G-rated properties from 2018, and this will require the assembly of considerable information to identify and enforce.

The full power of labelling can only be exploited when the performance information is communicated at each point of influence: it has to be provided in all advertising material - including shop-windows, signposts at the property, property details, websites - that is used in order to encourage potential customers to buy or rent the property.

The value of labels goes well beyond their direct influence on potential customers: they are most effective through the way they support other policies. The existence of publicly-searchable databases will enable the local authority to be proactive, for instance working with the owners of the worst properties and identifying the boundaries for an area-based LCZ. They will also enable the local authority to direct activity, such as retrofits funded by the utilities, to those properties where insulation measures are lacking and the household is likely to be in fuel poverty. Without labels and publicly-available, comprehensive databases, it will not be possible to ensure that policy is being effective and to identify where failings are occurring.

---

## REMOVING THE WORST

### Minimum standards and existing buildings

The combination of minimum energy standards and mandatory labelling has proved to be an extremely effective route for transforming a stock of products, speedily, with certainty and to the benefit of consumers. It can also be at nil or minimal cost to Government. The same opportunity exists to transform the building sector.

The proposal in this report is that minimum energy-performance standards should be extended to all properties, residential and business, whatever tenure, and that the minimum level is pushed upwards over time. To be zero-carbon by 2050, almost all properties need to be at the top of the A-band on the energy performance certificate, with a score of around 100. In reality, some properties will be better than 100 and producing more energy than they use (energyplus properties), whereas some will have difficulty getting up to 100, though they need to be close.

The Government has announced the first stage of this process in the Energy Act 2011, which states that:

from April 2018, it will be unlawful to rent out a residential or business premise that does not reach a minimum energy efficiency standard (the intention is for this to be set at EPC rating “E”).

While this is an important signal that policy is moving in the right direction, the policy needs to cover all buildings and tenures to achieve the required transformation. With businesses, there will be some important, early benefits as the worst 6% of properties produce 15% of business carbon emissions. The contribution to the fourth carbon budget (2023-2027) will depend upon the turn-over in tenancies in the worst buildings. While 63% of leases are for less than 5 years, the link with the least energy efficient properties is not known.

Similar policies are being introduced in the devolved administrations: in Wales all social housing should be in band C or better by 2016/17. This could be replicated in England through a second decent homes standard.

Ideally, the whole suite of minimum standard deadlines covering all types of building ownership would be announced soon, so that people understand that improving the energy efficiency of their property is no longer an optional extra, but a necessary and worthwhile investment. A firm commitment to the process by Government is arguably the most important statement towards *Achieving zero*, then people know this is a definite policy and both owners and retrofit providers can start planning accordingly. There are considerable retraining and job





creation implications for the latter which need time – and certainty - to deliver.

The proposal is that the minimum standards for all buildings are based on the energy performance certificates (ie the majority, but not all of the energy) and apply in the following sequence:

- o from 2018 onwards no F- and G- rated properties can be sold/let;
- o from 2025 no E- or D-rated;
- o from 2032 no C-rated;
- o from 2039 no B-rated.

This is a rapid sequence, but it will take time for the minimum standard to be effective over much of the stock, especially if it is only triggered by a change of occupant. In the owner-occupied sector especially, some people live in their homes for 40 years or more. The minimum standards will be most effective in the privately-rented sector, because of the short tenancies of most occupants. In 2009, there were 3.3m homes in England that were rated F (three-quarters) or G (one quarter) across all tenures (CLG, 2011c, Figure 16). Of these, roughly 400,000 would come onto the market in the first year of a new policy (based on Boardman 2007, pp48-9). As most of these are privately rented, some of which will come onto the market every year, the policy impact could reduce from then onwards. To uplift the average F or G property to an E band would imply an upgrade of about 10 SAP points.

The announcement will start to have a wider influence as the realisation spreads through property owners that action is going to be required, that it cannot be avoided and that upgrading the energy efficiency of the building is a way to improve the value of the property as well as save on running costs. With the stagnant property market at the moment, this could be a useful and popular realisation.

The other reason for introducing minimum standards is the need for equity. At the moment, about half of the fuel poor live in the least energy-efficient homes (F- or G-rated properties). These represent the dreadful, long tail of the distribution and are difficult to reach with existing policies. There has to be a positive focus, through minimum standards and low carbon zones, on these least energy-efficient properties.

As so many of the fuel poor under-use energy, the energy and carbon savings from imposing minimum standards on them will be reduced - they will take some of the benefit as extra warmth and other energy services. Research will need to closely monitor net costs to ensure that the benefits of energy efficiency outweigh any increases in rents or local authority rates.

---

## Minimum standards and products

The market transformation approach is already occurring with individual products as the European Commission is introducing minimum standards (together with labelling where it does not exist) for 40 product groups through the Energy-using Products Directive. The majority of these are using electricity, but some, such as windows and motors relate to the building and equipment more generally. The process is on-going and only complete for 12 product groups: the minimum standards on these will result in about 15-17% reductions in electricity use in the home and business by 2020. This is only the beginning of the process as the maximum effect of a minimum standard depends on the average life of the product: from a few years for a TV to 14 years for a fridge. Tougher standards have been mentioned in the recent EU Energy Efficiency Plan, if the savings are not being achieved by the individual Member State.

There are opportunities for the UK to unilaterally bring in more advanced standards, as occurred with the phasing out of incandescent bulbs. Lighting continues to provide major opportunities for reductions, for instance through promoting the replacement of compact fluorescent lamps (CFLs) with light emitting diodes (LEDs) and introducing a maximum level of lighting energy consumption (kWh/m<sup>2</sup>) for businesses. All of this activity will be useful, but is unlikely to be sufficient to deliver the required savings. This is partly because of the continuing growth in ownership of pieces of equipment in the home and in business, all of which is largely unconstrained by any policy and only indirectly through the CRC for business. In addition to education and awareness programmes, this constraint could be achieved through personal carbon allowances and publicity for the DEC with businesses.

The complete process could potentially halve electricity use per property in lights, appliances and equipment before 2050, despite higher levels of appliance ownership, more households and businesses and greater standards of energy service. The research in the residential sector is assumed to be applicable to businesses, as a high proportion of the technology is the same.

While product standards reduce the amount of electricity consumed per product in the delivery of an energy service, there is no policy to constrain total electricity use: levels of appliance ownership and the frequency of their use are entirely the choice of the occupant, with the only penalty being higher fuel bills received months after the energy is used. This lack of policy on the overall use of electricity is a serious omission, as it represents around half of all building-related carbon emissions and energy expenditure. This is a major reason for the proposals on DECs and PCAs so that the full range of energy uses is incorporated into policy.



## GROWING THE BEST

### Pulling the market

With a market transformation strategy, there have to be policies that both pull and push the distribution towards greater energy efficiency. Minimum standards ensure that the worst properties and products are the push factor. The pull comes from the effect of adding super low-energy properties to the stock, either as a result of new construction or through converting existing poor-quality buildings. The pull effect from new build is relatively weak, mainly because annual rates of construction are low. Cumulatively, over time, the result is a sizeable block of highly-efficient buildings which provide important exemplars for society and experience for the construction industry. In addition, there is only one, weak financial incentive to encourage activity – the stamp duty concession on new, zero carbon homes.

*Living in a passivhaus provides a modern standard of comfort without hurting the environment*

---

The standard of new construction needs to be improved, by making the Building Regulations more stringent and more extensive. The latter may have to happen as the European Commission is requiring that all new properties attain ‘nearly zero energy’ by 2020 (in the recast EPBD). This could be passivhaus standard, if not even better. The UK’s faltering steps towards low-energy new buildings need to be made consistent and strong and policies enhanced to cover all energy use as soon as possible.

The Zero Carbon Hub has proposed that compliance with the Building Regulations is based on the performance of the finished, occupied building. This is an excellent suggestion that would ensure the construction delivers the expected standard not some theoretical design. The transformational effect on the building industry could be considerable.

The number of existing buildings that have been converted to an A- or B-rated standard is low and entirely dependent on the owner’s commitment – there are no financial incentives, apart from lower fuel bills. It is recommended that there is a cash bonus paid to each local authority when the number of these properties in their area increases. It will be up to the council as to whether some of this bonus is passed on to the property owner.

Individual local authorities would also be encouraged to have directories and websites about the eco-renovated properties in their area and open days, to encourage local expertise, awareness and information sharing.

## **Procurement and exemplars**

Some websites are publicising what has been done and these networks are an important educational tool. The role of exemplars should be revisited within a comprehensive market transformational strategy, so that there are both new build and retrofit exemplars that reflect local circumstances, provide training for the construction industry and awareness-raising for the population.

Large-scale procurement schemes can act to pull the market forward quickly. Procurement can help develop new technologies, set an example and generally facilitate the commercial take-up of the most energy-efficient components, equipment and buildings. The Energy+ project was an excellent example of how to promote energy efficiency and shape procurement using the power of the web and networks and could usefully be replicated.



There is definitely a role for the public sector to lead by example as this demonstrates that the Government is committed to energy efficiency. It also helps to train the construction workforce in the necessary skills. The European Commission is going to require 3% of all public floor area to be improved annually to the standard of the best 10% of the Member State's stock – hopefully a target that is rapidly moving upwards.

It is proposed that all public buildings (widely defined) should become A- or B- rated as soon as possible, this includes social housing. This would reflect the intentions of the EU draft Energy Efficiency Directive, which proposes a 3% pa refurbishment rate for all public buildings (residential and business), based on floor area. The Directive is required because the EU is not on track to reach its 2020 target of a 20% reduction in primary energy demand.

With tenanted business properties, the subdivision of expenditure (for instance between common parts and private space) could be formalised through green leases. These aid the tenant by defining the expected requirements of space heating and lighting in the areas covered by the lease, eliminating the risk of the tenant paying higher than necessary costs because of the landlord's failure to insulate or because of poor construction standards.

## IMPROVING THE MIDDLE

The push and pull of the ends of the distribution are vital, but the great mass of properties in between must not be ignored. Undoubtedly, wide publicity about the introduction of minimum standards for existing buildings will encourage many property-owners to invest in energy-efficiency improvements. But this is unlikely to be sufficient.

The money to invest is there for many households, it is just spent on those things that at present add value to the property: new kitchens, smarter bathrooms, conservatories, loft conversions. Energy efficiency has to be moved to the top of this list through the use of subsidies and other incentives, such as personal carbon allowances, and policies like minimum standards.

### **Financial incentives – a useful inducement**

Financial incentives play various roles within a market transformation strategy. Their role is usually to 'sweeten' one of the major players – to lessen the resistance of that sector to a major regulatory change. There is a trade-off between financial incentives and regulations:





*Buildings of architectural importance have to be preserved without letting them become the slums of the future*

the stronger the regulation, the less need for financial incentives and vice versa. With buildings, the cost of the financial incentives is largely the Government's (as discussed in chapter 5) whether through direct capital grants or foregone tax receipts.

With buildings at present, grants and subsidies are mainly linked to the least energy-efficient buildings, usually to limit fuel poverty. However, grant-aided improvements have come to be seen as the norm for most householders: little other activity occurs. To consider using grants to grow the other end of the distribution – the best products and premises – would be a major change, but one that probably ought to occur, possibly in conjunction with the approach of the existing grants. Incentives are already being used to address the high capital costs of new technology (eg the feed-in tariff and renewable heat incentive) and are effectively bringing the prices down (DECC 2011h, p3). The benefit of financial incentives attached to developing a market is that they can be temporary, whereas incentives attached to the worst properties are more permanent.





There are a variety of roles that financial incentives could fulfil and these could be tailored to match the range of people's circumstances and the need to pull or push different segments of the market. The importance of financial incentives is directly related to the strength of other policies, such as minimum standards. If the latter are only triggered when the occupant moves and the property is put on the market (as proposed), then the role of financial incentives is to be effective with the great swathe of properties that remain occupied, unaffected by this trigger.

Market transformation is accelerated by the strategic use of incentives and *Achieving zero* includes many. The first three policies exist, the next two are in the pipeline, and the remaining are proposed here:

- o for private-sector landlords, the existing LESA should be properly and extensively advertised and extended, in conjunction with the 2018 minimum standard;
- o for businesses, the existing enhanced capital allowances for energy efficiency improvements, such as lighting controls, should be well publicised, as two-thirds of businesses do not know they exist;
- o for the better-off householder with capital, the feed-in-tariff and the renewable heat incentive are useful as they enable and encourage the 'early adopters' and, especially with visible technologies such as photovoltaics and solar thermal, make them part of the social norm;
- o for SMEs and residential property owners without capital, from late 2012, the green deal finance will provide the money for energy efficiency improvements to be paid back through savings from reduced energy bills. This is most appropriate for owner-occupiers in warm homes – the laggards;
- o for the fuel-poor, when CERT and CESP are replaced with the ECO in 2012, it should be completely focused on the disadvantaged and provide for generous levels of property improvement, ideally to SAP 81 (A- or B-rated property) to take most of them out of fuel poverty. However, the Government is proposing that only a quarter of the ECO is specifically targeted on the fuel poor;
- o for low-income owner occupiers with no capital, lifetime mortgages at zero interest rates would enable them to borrow money, but only repay the loan when the property is sold. This could be a government-subsidised loan through the Green Investment Bank;
- o for recent movers who upgrade the property at least one band within six months, there could be a stamp duty rebate;
- o for everyone: a council tax discount in the year that a major upgrade of at least one band is undertaken;
- o for energy-efficient owner-occupied properties: green mortgages with a lower rate of interest as there is less risk of default when energy bills are low;

- 
- o for local authorities: a financial bonus from the government if they reduce the proportion of F- or G-rated properties in their area and increase the number of A- or B-rated premises. This would be similar to the cash bonus given to local authorities for every new home;
  - o for all social housing, there would be a generous fund to introduce a second decent homes standard, to achieve a high level of energy efficiency (ideally SAP 81+). The installation should include low and zero carbon technologies that qualify the householder for the FIT and RHI, otherwise low-income households will be excluded from these policies;
  - o all energy efficiency products and retrofit work should be subject to a 5% VAT rate and no higher.

All of these are in addition to any normal financial benefits from lower energy bills, added property value and better quality of life in the building.

Under these proposals, policy is moving towards limited free installations of energy-efficiency measures solely for the fuel poor and for those in social housing. For all other activity and upgrading, the property owner is responsible and has to fund the investment by using the equity in the property or their own resources, supplemented by subsidies where necessary. The financial incentives reduce the burden to owners of upgrading buildings to meet the minimum energy standards, but do not replace the need for minimum standards to ensure all existing buildings are upgraded to near net zero carbon. If large incentives are not made available to support the transformation task, the minimum standards become more important and have to be applied more widely than the current association with the sale or rent process.

The money could come from receipts, as the EU ETS permits are auctioned or from a pool of money, deposited by the utilities, from which investment in demand reduction or new generating capacity could be drawn. Many of these demand reduction initiatives are more cost-effective than the provision of new capacity, but the difficulty is getting the same money available to both.

Care has to be taken not to transfer costs through fuel bills to those already facing financial stress, particularly those in, or at risk of falling into, fuel poverty. This does not mean a ban on policy instruments that increase fuel costs, just that the costs should only be levied on those with the ability to pay them. There should be an absolute cap on the contribution to Government policies levied on energy bills to protect the fuel poor. This is currently about £90 per annum for the combined costs of the renewables obligation (RO), EU emissions trading scheme (EUETS) and carbon emissions reduction target (CERT) and should not be allowed to rise for the fuel poor. The feed-in tariff is likely to add a further £20 per household pa. The aim should be to reduce the premium to the £80 deducted, per household pa in 2009. This



was already adding about 10% to the fuel bills of the fuel poor. As the fuel poor are extremely difficult to identify this is a problematic area. By far the best approach is not to levy the costs through utility bills.

## **Existing buildings, Building Regulations and consequential improvements**

The retrofit market is not only large, but provides the perfect opportunity to improve the energy performance of the building. The lack of building regulation coverage for the energy efficiency of the whole property, when being retrofitted, is a serious omission. These consequential improvements require improved energy efficiency in the whole building to offset the increase in energy use when it is enlarged. The net effect, irrespective of the purpose of the new space, should be for the same or smaller energy consumption for the total building. Again, the EPBD is introducing some standards, but these are too broad to have much effect, particularly because they only become triggered if 25% of the property is being affected. The proposal is that the UK government unilaterally toughens this standard and promptly introduces consequential improvements legislation in the building regulations for all properties.

It is often difficult for property owners to know what could and should be done to make their building more energy efficient. Recommendations are provided with every EPC, so the more extensive provision of EPCs will mean, automatically, that a wider group has been informed of what it would be cost-effective to do to their property. Consequential improvement regulation will also enhance the information provision, as all builders will quickly understand that improved energy efficiency actions for the whole building must be incorporated into any quote for building extensions.

A further proposal is that the local authority is notified of all alterations, so that the Building Control Officer can act as 'mentor' for the building, to ensure that the decisions taken by the householder (even with piecemeal alterations) are in support of lower carbon emissions. Then it will be clear that the building is on a sensible trajectory to achieving zero emissions by 2050.

## **Education and awareness**

The public are largely unaware of the challenges that face the UK if we are to reduce significantly our impact on the climate. There is little understanding in the broader community of the scale of the changes required to our own homes, business and lifestyles. Part of the skill required by government is to introduce this future perspective in a way that is acceptable and positive for the population.

---

All of these policies described in *Achieving zero* will contribute towards raising public awareness and education about energy efficiency and the need for demand reduction. The most important, however, will be the strength of the government's public commitment and sense of purpose, particularly in relation to announcements on minimum standards. The Government has taken the first step in relation to privately-rented properties (both sectors) and this should form the basis for a big publicity campaign – private landlords are relatively few in number, so the concept of imposing minimum standards on them is likely to be acceptable to the general public. This will lead, usefully, to an acceptance of the concept by other property owners.

In the immediate future, the problems of the recession and the increasing hardship of households and of business bankruptcies may mean that the government's message should be couched in terms of reducing the cost of fuel, as well as climate change. Both will be among the benefits, but the main concern for many people now is cutting their costs. The introduction of the green deal finance means that for both households and businesses there is a source of funds with which to achieve these reductions.

Making energy efficiency actions real to households and small businesses is important in building community support. Projects that create and celebrate local exemplar projects help build understanding at a scale that is relevant to the local community. The opportunity exists for government support for networks of exemplar projects, across a range of building types and technical solutions as the Technology Support Board has stated; and for the provision of associated communication materials aimed at empowering communities to take action. The pull effect of local examples and local solutions, combined with information about incentives, softens the push of minimum standards and other regulatory instruments.

Networking and information sharing could be particularly influential for businesses, where 'naming and shaming' in conjunction with the DECAs, league tables and disclosure in annual reports has to be made salient.

Education and awareness is the last of the policy components that constitute the market transformation approach.

## **TIMESCALES AND MILESTONES**

This research report has not included an extensive modelling exercise, but it is possible to give some indicative targets and timescales to identify whether the amount of demand reduction



is on track. As figure 2.4 showed, the Carbon Trust envisages a major shift in the distribution of business properties, so that almost all are A or A+ rated by 2050. The same transformation is required in the residential sector. With EPCs (not DECAs), this is equivalent to 100 on the scales for both business and residential. Little is known about the average rating of businesses, whereas UK residential properties had an average of SAP53 in 2009. Assuming both sectors had an average of 53 points in 2009, the following rate of progress would need to be achieved (Table 6.2). This is about a 12 SAP point improvement every 10 years - not much faster than the historical trend for homes of 1 SAP point pa between 2001 and 2009 (table 2.2). The DEC numbers for business will be declining, but as these are an index, based on a typical property, the average will stay as 100.

*Table 6.2: Target ratings on EPCs, UK, 2009-2050*

	<b>Homes (SAP) and businesses (SBEM)</b>
<b>2009</b>	53
<b>2020</b>	64
<b>2030</b>	76
<b>2040</b>	88
<b>2050</b>	100

As SAP and SBEM cover space and water heating, cooling and fixed lighting, all of these uses will be incorporated into policies to achieve the targets in table 6.2.

The proportion of all energy used in buildings that is non-regulated (mainly electricity) was shown in figure 2.3. This gives the rough average annual consumption for non-fixed lights, appliances, equipment, and cooking/catering as 3,300kWh for a home and 24,000kWh for a business. It is perfectly possible for this electricity use to be halved, per property, with tough product policies and expected technological advances (table 6.3). The reduction in total network consumption will be less than 50% when the growth in the numbers of households and businesses is factored in and could be of the same order as the reduction in electricity demand (32%) in the residential sector in the UKERC lifestyle scenario (Eyre et al 2010, p277). The latter was a modelled scenario with the trends determined externally to the model.

Actual electricity consumption could be monitored over the intervening years, but substantial reductions will not be achieved without strong product policies and a personal decision-making framework, such as PCAs and DECAs. The remaining electricity consumption required in 2050 would be the only energy demand from buildings.

Table 6.3: Electricity use in lights, appliances and equipment, UK, 2009-2050 (kWh pa)

	Homes	Business
2009	3300	24,000
2020	2850	21,000
2030	2400	18,000
2040	1950	15,000
2050	1500	12,000

Note: this electricity demand is approximately the remaining electricity that is not covered by the EPCs, as in figure 2.3

It is assumed that there will be some generation of renewable electricity on the premises (or in the community with CHP) and that this could potentially be in addition to the reductions in demand, so the net electricity demand per property will be lower than in table 6.3.

The potential is for half the properties to have a low or zero carbon system that produces electricity (mainly PV or CHP), which could easily represent 1,000 kWh per home with an installation and more for businesses. This building-integrated electricity generation will be sufficient to offset the growth in electricity demand from the additional properties that are to be built, provided the increase is no more than 40%. Hence total electricity demand will be approximately half of the present demand (table 1.1) amounting to about 100TWh.

The policies on building fabric, heating systems and products are all set in the context of considerable public involvement and commitment that engenders strong, positive responses to community scale action, regulatory requirements, information campaigns, personal carbon allowances and DEC. The net result would be that in 2050 the energy demand in buildings is reduced to 15% of its 2009 total, from 677TWh to 100TWh and all of this would be electricity. While this would be a formidable achievement, it is a rate of reduction that is not much faster than the 2.5%pa achieved in the residential sector between 2004-2009 (chapter 1).

The residual 100TWh is about twice the amount of renewable electricity supplied in the UK in 2010, The Committee on Climate Change believes that the supply of renewable energy could rise to 300TWh in 2030 (CCC 2011a, p15) and more by 2050. Thus, the energy demand for all buildings could be supplied by a relatively small proportion of the electricity generated from renewable sources in 2050 (less than a third).

This pattern of demand in 2050 with zero carbon electricity from renewables would result in the building sector *Achieving zero*.





## What to do first?

Between 2009 and 2010, there were the following detrimental trends, despite the effects of the recession (CCC 2011b):

- o the carbon intensity of electricity increased, albeit marginally (p93);
  - o carbon emissions from buildings increased by 7% (p131), an average of 8% growth in residential and 2% in business premises (pp22-23);
  - o the number of professional cavity wall and loft insulation installations fell by 30% (p131).
- As the recession lengthens, it may be having the effect of reducing capital expenditure in the energy-efficiency improvements, needed to save energy and lower running costs.

There are the following legislative targets looming:

- o 2016: fuel poverty to be eradicated (where reasonably practicable), as required by the Warm Homes and Energy Conservation Act 2000;
- o 2018: the letting of privately-rented buildings graded F and G on the energy performance certificate (residential and business) becomes illegal under the Energy Act 2011;
- o 2020: the UK has to deliver 15% of its energy coming from renewable sources re 1990, to comply with European legislation and is not on target to do this;
- o 2025: the mid-point of the UK's fourth carbon budget, which was accepted as legally binding by Parliament in May 2011 and which requires a 50% reduction in carbon emissions over 1990 levels.

Despite this, the Government has announced that in order to meet the fourth carbon budget in 2025 no new policies are needed in this Parliament (ie before the next election, no later than May 2015) – these may be fiscal policies only (HMG 2011, p181). This statement assumes the green deal is effective and that, in any case, it will be allowed to run for at least a couple of years (from October 2012) before remedial action is considered, if needed.

The Government does appear to be showing a considerable degree of complacency and is omitting policies that would, for instance, lock-in the effects of the recession, before there is an economic upturn. It is not clear why they might be justified in this degree of confidence. In addition, the first two commitments are independent of carbon targets and refer specifically to the housing sector and the disadvantaged and these are the focus for immediate action.

---

## 2016 and 2018 commitments

This study is coming out in early 2012, so that the present Coalition Government will be in power for up to 87% of the time before fuel poverty has to be eradicated in November 2016. Therefore, their aim should be to eradicate fuel poverty during their tenure, as policies nearly always slip and under-achieve. That would give their successors 6 months to finish off the task.

In conjunction with the recommendations of the Hills Review, due in Spring 2012, there should be a strategic plan that demonstrates how these two fuel poverty-related commitments will be achieved. As proposed here, this will include low carbon zones, so that action in each local authority area is occurring simultaneously and promptly. In order for these LCZ to be successful, the overall housing and low-carbon policy has to be stated, including a timetable for minimum standards of energy-efficiency for all properties, all tenures. The overall housing and low-carbon strategy will be instrumental in delivering the 2020 and 2025 carbon targets and for supplementing the green deal. Much of the following policy framework (as well as green deal) will only be effective in the context of a clear, firm statement on mandatory minimum standards.

Some of the other contributory policies that will help with the eradication of fuel poverty and in preparation for subsequent commitments can be implemented rapidly. They include:

- o enforcing the housing, health and safety rating scheme (HHSRS), which identifies the properties that are unhealthy to live in because of their high heating costs. This is already legislation and could be implemented immediately, by requiring local authorities to fulfil their duty to seek out and deal with F- and G-rated properties, in all tenures;
- o using the Home Energy Conservation Act 1995 legislation (in England) to require local authorities to report on the numbers of properties that are in each of the EPC bands, each year and, from 2013, requiring each local authority to report annually on the number of households in fuel poverty in their area, in all tenures, as a way of confirming the numbers in national models and the effectiveness of policies. This will mean that each local authority has to have a complete address-specific database of the energy-efficiency of all the properties in their area, including known information from the EPCs and DECs. Such a database provides a powerful base for local authority policy and should be publicly accessible;
- o providing an annual financial bonus for the local authority for the shift in the number of properties that are no longer F- or G-rated and for the additional A- and B-rated properties. This would be similar to the bonus being given for new homes;
- o implementing a second decent homes standard so that all social housing is in band B or better;



- o introducing low and zero-interest lifetime mortgages, through the Green Investment Bank, for low-income owner occupiers to upgrade the energy efficiency of their homes to a higher standard than would be permitted under green deal's golden rule;
- o introducing scrappage schemes, probably funded by the utilities, to ensure that the worst, least energy-efficient equipment in low-income homes is removed, just as the worst properties are being improved. The precedents are the successful fridgesavers scheme and the boiler scrappage scheme. Only the former was for low-income homes;
- o reducing VAT on energy-efficiency retrofits to 5% from the present 20%, both for materials and labour;
- o requiring the waste heat from new electricity generating plant to be used for a local district heating scheme;
- o promoting the use of waste in anaerobic digesters that provide green gas for the gas grid;
- o negotiating with the different business sectors (eg retail and offices) maximum lighting levels (in kWh/m<sup>2</sup>).

*The energy demand from buildings in 2050 is only 15% of today's level and this can be electricity from windfarms (on and off-shore), so there are no carbon emissions*

---

This has to be a large, radical programme, in order to lift over 1m households a year out of fuel poverty, despite rising fuel prices. Apart from complying with the legal obligation and providing considerable comfort (literally) to millions of UK households, this programme would have the additional benefit of creating considerable local employment.

## **Résumé**

The benefit of a more coherent strategy across all energy use in the whole building stock has been expounded in this analysis. The importance of a strong, firm direction has become clearer now that the fourth carbon budget has been made legally binding. This requires the UK to reduce its greenhouse gas emissions by 50% (over 1990) by 2025 (the average of 2023-27 period). As some of the recent savings have come from the recession, the focus should now be placed strongly on demand reduction as a result of private actions inspired by firm, clear Government policy.

This collection of policies and proposals will, together, move the distribution of energy use in the building stock towards greater energy efficiency. With so many new initiatives the speed with which this will occur is difficult to predict and there will be opportunities in the intervening years to review the effectiveness of the policy package, adjust policies where necessary and fill any newly-identified policy gaps. The biggest unknown is the political commitment to achieve demand reduction and the extent to which the Government can work with and lead the people.

While the outcome cannot be predicted with precision, it is reasonably certain that without these policies, the chances of Achieving zero carbon emissions in the UK building stock is almost non-existent: they are a necessary, but probably not sufficient set of policies. The template is sketched in.

What is quite certain is that the present piecemeal, open-ended, and un-co-ordinated set of policies and activities will not result in sufficient action, sufficiently quickly. A radically different perspective and expanded toolbox is needed if UK properties are to achieve net zero carbon emissions by 2050. There is a need for some challenging policies, but the technology is there, the framework has been identified, together with many of the individual policies. And, while 39 years is quite a long time, the interim 2020 and 2025 targets for renewables, energy efficiency and carbon emissions, are just around the corner. We must start building up momentum now.



---

# R

## ferences

---

Atherton, P (2011), powerpoint presentation at Falmouth Energy Week, University of Exeter  
[www.exeter.ac.uk/few/documents/presentations/Peter\\_Atherton\\_Keynote.pdf](http://www.exeter.ac.uk/few/documents/presentations/Peter_Atherton_Keynote.pdf)

Banks, N (2001), 'Socio-technical networks and the sad case of the condensing boiler', in Energy efficiency in household appliances and lighting, (eds) Bertoldi, P, Ricci, A and de Almeida, A, Springer, Berlin, pp 141-55

Banks, N (2008), Implementation of Energy Performance Certificates in the Domestic Sector, UK Energy Research Centre, Working Paper (DR/2008/001)

Bell, M, Wingfield, J, Miles-Shenton, D and Seavers, J (2010) Low carbon housing – Lessons from Elm Tree Mews. Joseph Rowntree Foundation

Bertoldi, P, Rezessy, S, Oikonomou, V and Benigna, B-K (2009), 'Feed-in tariff for energy saving: thinking of the design', paper presented to the ECEEE Summer Study, Act! Innovate! Deliver! Reducing energy demand sustainably. European Council for an Energy Efficient Economy

Boardman, B (1991), Fuel Poverty: from cold homes to affordable warmth, Belhaven

Boardman, B (2004), 'Achieving energy efficiency through product policy: the UK experience', Environmental Science and Policy, Vol 7, pp165-176

Boardman, B (2007), Home Truths, Report for The Co-operative Bank and Friends of the Earth

Boardman, B (2010), Fixing fuel poverty, Earthscan

Boardman, B, Attali, S and Labanca, N (2005a), 'Energy+ process: a good practice for energy efficiency', proceedings of National Conference on Italian Energy Policy, Bologna

---

Boardman, B, Darby, S, Killip, G, Hinnells, M, Jardine, CN, Palmer, J and Sinden, G (2005b), 40% house, Environmental Change Institute, Research Report 31, University of Oxford

Boardman, B and Houghton, T (1991), Poverty and power, Bristol Energy Centre

Boardman, B, Lane, K, Hinnells, M, Banks, N, Milne, G, Goodwin, A and Fawcett, T (1997), Transforming the UK cold market, Environmental Change Unit, University of Oxford, Research Report 16, DECADE project

Bordass & Leaman (2011), Design intent to reality, The Usable Buildings Trust  
<http://homepage.mac.com/aleaman2/UBToverflow/LondonMet16Mar2011.pdf>

BPF /IPD (2011), Annual lease review, British Property Federation  
[www.bpf.org.uk/en/files/bpf\\_documents/BPF\\_Annual\\_Lease\\_Review\\_2011.pdf](http://www.bpf.org.uk/en/files/bpf_documents/BPF_Annual_Lease_Review_2011.pdf)

BRE (2008), The impact of changing energy use patterns in buildings on peak electricity demand in the UK, Final report, Building Research Establishment, for DECC

Cabinet Office (2011), Behaviour change and energy use, July

Cardiff University (2011), Green Leases  
[www.greenleases-uk.co.uk/uk.php](http://www.greenleases-uk.co.uk/uk.php)

CCC (2010a), The fourth carbon budget – reducing emissions through the 2020s, Committee on Climate Change, December  
[http://downloads.theccc.org.uk.s3.amazonaws.com/4th%20Budget/CCC\\_4th-Budget\\_interactive.pdf](http://downloads.theccc.org.uk.s3.amazonaws.com/4th%20Budget/CCC_4th-Budget_interactive.pdf)

CCC (2010b), The CRC Energy Efficiency Scheme – advice to Government on the second phase, Committee on Climate Change, September

CCC (2011a), The renewable energy review, Committee on Climate Change

CCC (2011b), Meeting Carbon Budgets – 3rd progress report to Parliament, Committee on Climate Change  
[http://hmccc.s3.amazonaws.com/Progress%202011/CCC%20Progress%20Report\\_Print\\_Spreads\\_1.pdf](http://hmccc.s3.amazonaws.com/Progress%202011/CCC%20Progress%20Report_Print_Spreads_1.pdf)





Changeworks (2011), Fridgesavers

[www.changeworks.org.uk/projects/energy-project-archive/314/#8](http://www.changeworks.org.uk/projects/energy-project-archive/314/#8)

CLG (2007), Regulatory Impact Assessment, Energy performance of buildings directive, Articles 7-10, Department for Communities and Local Government, March

CLG (2008), Definition of zero carbon homes and non-domestic buildings, Department of Communities and Local Government

[www.communities.gov.uk/publications/planningandbuilding/zerocarbondefinition](http://www.communities.gov.uk/publications/planningandbuilding/zerocarbondefinition)

CLG (2011a), English Housing Survey, Headline report 2009-10, Department for Communities and Local Government, February

[www.communities.gov.uk/documents/statistics/pdf/1479789.pdf](http://www.communities.gov.uk/documents/statistics/pdf/1479789.pdf)

CLG (2011b), New Homes Bonus: final scheme design, Department for Communities and Local Government, February

[www.communities.gov.uk/documents/housing/pdf/1846530.pdf](http://www.communities.gov.uk/documents/housing/pdf/1846530.pdf)

[www.communities.gov.uk/housing/housingsupply/newhomesbonus/newhomesbonusquestions/](http://www.communities.gov.uk/housing/housingsupply/newhomesbonus/newhomesbonusquestions/)

CLG (2011c), English Housing Survey, Headline Report 2009-10, Housing Stock Tables, Department for Communities and Local Government

[www.communities.gov.uk/publications/corporate/statistics/ehs200910headlinereport](http://www.communities.gov.uk/publications/corporate/statistics/ehs200910headlinereport)

Climate Change Act 2008

[www.legislation.gov.uk/ukpga/2008/27/contents](http://www.legislation.gov.uk/ukpga/2008/27/contents)

ClimateXchange (2011), Environmental Change Institute, University of Oxford

<http://climatex.org/whats-new/>

COM (2011), 0109 final, Energy efficiency plan 2011, March

<http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CELEX:52011DC0109:EN:HTML:NOT>

COM (2011), 370 final, Proposal for a Directive of the European Parliament and of the Council on energy efficiency, 22 June

[http://ec.europa.eu/energy/efficiency/eed/eed\\_en.htm](http://ec.europa.eu/energy/efficiency/eed/eed_en.htm)

---

Consumer Focus (2011), Energy Performance Certificates failing to influence homebuyers and tenants, March

[www.consumerfocus.org.uk/news/energy-performance-certificates-failing-to-influence-homebuyers-and-tenants](http://www.consumerfocus.org.uk/news/energy-performance-certificates-failing-to-influence-homebuyers-and-tenants)

CSE (2011), Why Big Society and localism are vital to energy policy, Centre for Sustainable Energy, Bristol

[www.cse.org.uk/news/view/1538](http://www.cse.org.uk/news/view/1538)

CT (2010), Building the future today, Carbon Trust

Darby, S (2006), The Effectiveness of Feedback on Energy Consumption, A Review for DEFRA of the Literature on Metering, Billing and Direct Displays, Environmental Change Institute, University of Oxford

[www.defra.gov.uk/environment/energy/research/](http://www.defra.gov.uk/environment/energy/research/)

Darby, S (2010), Literature review for the Energy Demand Research Project, Environmental Change Institute, University of Oxford

[www.ofgem.gov.uk/Sustainability/EDRP/Documents1/SD%20Ofgem%20literature%20review%20FINAL%20081210.pdf](http://www.ofgem.gov.uk/Sustainability/EDRP/Documents1/SD%20Ofgem%20literature%20review%20FINAL%20081210.pdf)

DECC (2001), The UK Fuel Poverty Strategy, Department of Energy and Climate Change

[www.decc.gov.uk/en/content/cms/funding/fuel\\_poverty/strategy/strategy.aspx](http://www.decc.gov.uk/en/content/cms/funding/fuel_poverty/strategy/strategy.aspx)

DECC (2009), Renewable Energy Strategy, Department of Energy and Climate Change, July

[www.decc.gov.uk/assets/decc/what%20we%20do/uk%20energy%20supply/energy%20mix/renewable%20energy/renewable%20energy%20strategy/1\\_20090717120647\\_e\\_@@\\_theukrenewableenergystrategy2009.pdf](http://www.decc.gov.uk/assets/decc/what%20we%20do/uk%20energy%20supply/energy%20mix/renewable%20energy/renewable%20energy%20strategy/1_20090717120647_e_@@_theukrenewableenergystrategy2009.pdf)

DECC (2010), The Green Deal – a summary of the Government’s proposals, Department of Energy and Climate Change

[www.decc.gov.uk/assets/decc/legislation/energybill/1010-green-deal-summary-proposals.pdf](http://www.decc.gov.uk/assets/decc/legislation/energybill/1010-green-deal-summary-proposals.pdf)

DECC (2011a), Digest of UK Energy Statistics 2010, Department for Energy and Climate Change

[www.decc.gov.uk/assets/decc/11/stats/publications/dukes/2312-dukes-2011--full-document-excluding-cover-pages](http://www.decc.gov.uk/assets/decc/11/stats/publications/dukes/2312-dukes-2011--full-document-excluding-cover-pages).



DECC (2011b), Energy Consumption in the United Kingdom, Department of Energy and Climate Change

[www.decc.gov.uk/en/content/cms/statistics/publications/ecuk/ecuk.aspx](http://www.decc.gov.uk/en/content/cms/statistics/publications/ecuk/ecuk.aspx)

DECC (2011c), The Carbon Plan Action Summary, Department of Energy and Climate Change

[www.decc.gov.uk/assets/decc/What%20we%20do/A%20low%20carbon%20UK/1358-the-carbon-plan.pdf](http://www.decc.gov.uk/assets/decc/What%20we%20do/A%20low%20carbon%20UK/1358-the-carbon-plan.pdf)

DECC (2011d), Renewable heat incentive, Department of Energy and Climate Change, March

[www.decc.gov.uk/assets/decc/What%20we%20do/UK%20energy%20supply/Energy%20mix/Renewable%20energy/policy/renewableheat/1387-renewable-heat-incentive.pdf](http://www.decc.gov.uk/assets/decc/What%20we%20do/UK%20energy%20supply/Energy%20mix/Renewable%20energy/policy/renewableheat/1387-renewable-heat-incentive.pdf)

DECC (2011e), Boom and bust for solar must be avoided. Press notice 11/091, Department of Energy and Climate Change, 31 October

DECC (2011f), Carbon Emissions Reduction Target, (CERT), Department of Energy and Climate Change

[www.decc.gov.uk/en/content/cms/funding/funding\\_ops/cert/cert.aspx](http://www.decc.gov.uk/en/content/cms/funding/funding_ops/cert/cert.aspx)

DECC (2011g), Annual report on fuel poverty statistics 2011, Department of Energy and Climate Change, July

DECC (2011h), Feed-in tariffs scheme: consultation on Comprehensive Review Phase 1 – tariffs for solar PV, Department of Energy and Climate Change

DECC (2011i), Great Britain's housing energy fact file, Cambridge Architectural Research Ltd, Department of Energy and Climate Change

DECC and Defra (2011), Anaerobic Digestion Strategy and Action Plan – a commitment to increasing energy from waste through anaerobic digestion, Department of Energy and Climate Change and Department for Environment, Food and Rural Affairs

[www.defra.gov.uk/publications/files/anaerobic-digestion-strat-action-plan.pdf](http://www.defra.gov.uk/publications/files/anaerobic-digestion-strat-action-plan.pdf)

DEFRA (2011), Measuring and reporting of greenhouse gas emissions by UK companies: a consultation on options, Department for Environment, Food and Rural Affairs, May 2011

---

Durham (2011), Targeting fuel poverty and the Green Deal – How to build a local authority database to target and deliver the Green Deal, Energy Company Obligation and fuel poverty- a practical guide for local authorities. Durham County Council and Commission for Rural Communities

[http://content.durham.gov.uk/PDFRepository/Fuel\\_Poverty\\_and\\_Green\\_Deal\\_Targeting\\_Guide.pdf](http://content.durham.gov.uk/PDFRepository/Fuel_Poverty_and_Green_Deal_Targeting_Guide.pdf)

EC (2011), European Commission, information on energy labelling

[http://ec.europa.eu/energy/efficiency/labelling/energy\\_labelling\\_en.htm](http://ec.europa.eu/energy/efficiency/labelling/energy_labelling_en.htm)

EC (2009), 642/2009, Ecodesign requirements for televisions

<http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2009:191:0042:0052:EN:PDF>

EC, JRC (2011), The European Commission GreenBuilding Programme, European Commission Joint Research Centre

<http://re.jrc.ec.europa.eu/energyefficiency/greenbuilding/index.htm>

ECEEE (2011), Products covered and their status in the EuP process

[www.eceee.org/Eco\\_design/products/?sort=position](http://www.eceee.org/Eco_design/products/?sort=position)

ECI (2011), Midnight oil, Internal, University of Oxford Phase 1 report , for HEFCE

EPBD (2010), 2010/31/EU Recast Energy Performance of Buildings Directive

<http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2010:153:0013:0035:EN:PDF>

Environment Agency (2011),

[www.environment-agency.gov.uk/business/topics/pollution/134754.aspx](http://www.environment-agency.gov.uk/business/topics/pollution/134754.aspx)

E.On (undated), Challenge 100 – tackling fuel poverty for 100 families, in 100 homes, in 100 days

[www.eon-uk.com/media](http://www.eon-uk.com/media)

EST (2005), Warm Zones External Evaluation, Final Report, March

EST (2010), Getting warmer: a field trial of heat pumps, The Energy Saving Trust

[www.energysavingtrust.org.uk/Publication-Download/?oid=1801485&aid=4898250](http://www.energysavingtrust.org.uk/Publication-Download/?oid=1801485&aid=4898250)



EuroAce (2010), Making money work for buildings: Financial and fiscal instruments for energy efficiency in buildings, a report by Klinckenberg Consultants, September

Eyre, N (2011), powerpoint presentation at Falmouth Energy Week, University of Exeter  
[www.exeter.ac.uk/few/documents/presentations.pdf](http://www.exeter.ac.uk/few/documents/presentations.pdf)

Eyre, N, Anable, J, Brand, C, Layberry, R and Strachan, N (2010), 'The way we live from now on: lifestyle and energy consumption' Chapter 9 in Energy 2050 – Making the transition to a secure, low carbon energy system, (eds) Skea, J, Ekins, P and Winskel, M. Earthscan

Fawcett, T (2010), 'Personal carbon trading: a policy ahead of its time?' Energy Policy, 38(11):6868-6876

Fawcett, T and Parag, Y (2010) 'An introduction to personal carbon trading', Climate Policy, 10(4): 329-338

Good Homes Alliance  
[info@goodhomes.org.uk](mailto:info@goodhomes.org.uk)

Hansard (2011a), HC Debate, (Session 2010-12), Vol 528, col 177, 17 May, C Huhne, Secretary of State for Energy and Climate Change  
[www.publications.parliament.uk/pa/cm201011/cmhansrd/cm110517/debtext/110517-0002.htm](http://www.publications.parliament.uk/pa/cm201011/cmhansrd/cm110517/debtext/110517-0002.htm)

Hansard (2011b), HC Debate (Session 2010-12), Vol 527, col 1064, 10 May, C Huhne, Secretary of State for Energy and Climate Change 10.5.11, col 1063-4).  
[www.publications.parliament.uk/pa/cm201011/cmhansrd/cm110510/debtext/110510-0002.htm#11051066000002](http://www.publications.parliament.uk/pa/cm201011/cmhansrd/cm110510/debtext/110510-0002.htm#11051066000002)

Hansard (2011c), HC Debate (Session 2010-12), Vol 527, col 1109, Caroline Lucas, 10 May  
[www.publications.parliament.uk/pa/cm201011/cmhansrd/cm110510/debtext/110510-0002.htm#11051066000002](http://www.publications.parliament.uk/pa/cm201011/cmhansrd/cm110510/debtext/110510-0002.htm#11051066000002)

Hansard (2011d), HC Debate (Session 2010-12), Vol 527, col 1085, Dr Whitehead, 10 May  
[www.publications.parliament.uk/pa/cm201011/cmhansrd/cm110510/debtext/110510-0002.htm#11051066000002](http://www.publications.parliament.uk/pa/cm201011/cmhansrd/cm110510/debtext/110510-0002.htm#11051066000002)

---

Heffner, G and Campbell, N (2011), Evaluating the co-benefits of low-income energy-efficiency programmes, Results of the Dublin Workshop, 27-28 January, International Energy Agency, Paris

Hills, J (2011), Fuel Poverty - the problem and its measurement. Interim report of the Fuel Poverty Review. CASE

HMG (2011), The carbon plan: delivering our low carbon future, HM Government, December

Impetus (2008), Tackling fuel poverty using the Housing, Health and Safety Rating System, Report to the Energy Efficiency Partnership for Homes, London, April

Impetus (2009), The case for including energy efficiency investment in the fiscal stimulus package, a report for Greenpeace

Killip, G (2011), Implications of an 80% CO<sub>2</sub> emissions reductions target for the UK housing refurbishment industry, DPhil thesis, Environmental Change Institute, University of Oxford

Lainé, L (2011), Access for all – making the Green Deal a fair deal, Consumer Focus, March

LCC (2010), Final report, Low Carbon Construction – Innovation & Growth team, Department of Business, Innovation and Skills

LGA (2011), LGA briefing: Energy Bill report stage, House of Lords, Local Government Association, March

[www.lga.gov.uk/lga/aio/17124365](http://www.lga.gov.uk/lga/aio/17124365)

MacKay, DJC (2009), Sustainable energy – without the hot air, UIT, Cambridge

McIlDoon, D (2008), Northern Ireland Electricity Consumers: Orphans in the Energy Storm, a report for the NIAUR, Belfast

MTP (2010a), BNXS01: carbon dioxide emission factors for UK energy use, version 4.2, Market Transformation Programme.

<http://efficient-products.defra.gov.uk/cms/product-strategies/subsector/cross-sector#viewlist>





MTP (2010 b– says 2009 on cover, but 2010 inside), Saving energy through better products and appliances 2009-2030. Market Transformation Programme, DEFRA

[www.defra.gov.uk/publications/files/pb13559-energy-products-101124.pdf](http://www.defra.gov.uk/publications/files/pb13559-energy-products-101124.pdf)

NES (2009a), NHER Annual Report 2009, National Energy Services, Milton Keynes

[www.epcregister.com/schemeAnnualReports/2009/NES%20Annual%20Report%202009.pdf](http://www.epcregister.com/schemeAnnualReports/2009/NES%20Annual%20Report%202009.pdf)

NES (2009b), Seizing the opportunity, National Energy Services, Milton Keynes

[www.nesltd.co.uk/sites/default/files/documents/news/Seizing\\_The\\_Opportunity\\_Marketed\\_Sales\\_Dec09.pdf](http://www.nesltd.co.uk/sites/default/files/documents/news/Seizing_The_Opportunity_Marketed_Sales_Dec09.pdf)

NG (2009), The potential for renewable gas in the UK – a paper by National Grid, National Grid, January

[www.nationalgrid.com/NR/rdonlyres/9122AEBA-5E50-43CA-81E5-8FD98C2CA4EC/32182/renewablegasWPfinal1.pdf](http://www.nationalgrid.com/NR/rdonlyres/9122AEBA-5E50-43CA-81E5-8FD98C2CA4EC/32182/renewablegasWPfinal1.pdf)

NG (2010), 5-year forecast , National Grid

[www.nationalgrid.com/NR/rdonlyres/A2095E9F-A0B8-4FCB-8E66-6F698D429DC5/41470/NETSSYS2010allChapters.pdf](http://www.nationalgrid.com/NR/rdonlyres/A2095E9F-A0B8-4FCB-8E66-6F698D429DC5/41470/NETSSYS2010allChapters.pdf)

OJ, Official Journal of the European Commission

Commission Regulation (EC) no 642/2009: Ecodesign requirements for televisions

<http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2009:191:0042:0052:EN:PDF>

Old Homes, Superhomes

[www.superhomes.org.uk/](http://www.superhomes.org.uk/)

ONS (2010), Capital stocks, capital consumption and non-financial balance sheets, 2020, Office of National Statistics

[www.statistics.gov.uk/pdfdir/capstocks0810.pdf](http://www.statistics.gov.uk/pdfdir/capstocks0810.pdf)

ONS (2011), Construction Statistics Annual 2011, Office of National Statistics

[www.statistics.gov.uk/downloads/theme\\_commerce/CSA-2011/Opening-page-2011.pdf](http://www.statistics.gov.uk/downloads/theme_commerce/CSA-2011/Opening-page-2011.pdf)

Palmer, J and Boardman, B (1998), Delight, Environmental Change Institute, University of Oxford

---

Passivhaus (2011)

[www.passivhaus.org.uk/](http://www.passivhaus.org.uk/)

Raynes, P (pers comm), University of York

Raynham, P (pers comm) Lighting Education Trust lecturer

RICS (2009), Doing well by doing good? An analysis of the financial performance of green office buildings in the USA, research report, Royal Institute of Chartered Surveyors, March

[www.rics.org/site/download\\_feed.aspx?fileID=5763&fileExtension=PDF](http://www.rics.org/site/download_feed.aspx?fileID=5763&fileExtension=PDF)

Schiellerup, P (2002), An examination of the effectiveness of the EU minimum standard on cold appliances: the British case. Energy Policy 30, 327-332

Scottish Government (2010)

[www.scotland.gov.uk/Publications/2010/10/28091356/5](http://www.scotland.gov.uk/Publications/2010/10/28091356/5)

SWEA (2011), Target 2050 – future-proofing homes in Stroud District and beyond, Severn Wye Energy Agency

Treasury and BIS (2011), The Plan for Growth, The Treasury and Department for Business, Innovation and Skills, March

[http://cdn.hm-treasury.gov.uk/2011budget\\_growth.pdf](http://cdn.hm-treasury.gov.uk/2011budget_growth.pdf)

TSB (2010), £17m government investment in retrofitting to pave the way for low carbon housing, Technology Strategy Board, press release, 25 February

[www.innovateuk.org/content/press-release/17m-government-investment-in-retrofitting-to-pave-.ashx](http://www.innovateuk.org/content/press-release/17m-government-investment-in-retrofitting-to-pave-.ashx)

UKGBC (2008), Low carbon existing homes, UK Green Building Council, October

UKGBC (2011), Carbon reductions in existing non-domestic buildings. A UK-GBC task group on display energy certificates and the carbon reduction commitment energy efficiency scheme. UK Green Building Council

[www.ukgbc.org/site/resources/show-resource-details?id=997](http://www.ukgbc.org/site/resources/show-resource-details?id=997)



Vito (2009), Lot 19: Domestic lighting, Final Report, Vision on technology  
[www.eup4light.net/assets/pdffiles/Final\\_part1\\_2/EuP\\_Domestic\\_Part1en2\\_V11.pdf](http://www.eup4light.net/assets/pdffiles/Final_part1_2/EuP_Domestic_Part1en2_V11.pdf)

VOA (2010), Valuation Office Agency  
[www.voa.gov.uk/publications/annual%20reports/Annual\\_Report\\_2009-2010.pdf](http://www.voa.gov.uk/publications/annual%20reports/Annual_Report_2009-2010.pdf)

VOA (2011)  
[www.voa.gov.uk/thefacts/Key%20Facts-VOA-Setting-the-Record-Straight.pdf](http://www.voa.gov.uk/thefacts/Key%20Facts-VOA-Setting-the-Record-Straight.pdf)

Wade, J and Jones, E (2011), Local councils and the green deal. Impetus Consulting, funded by eaga Charitable Trust

WBCSD (2009), Energy efficiency in buildings – transforming the market. World Business Council for Sustainable Development  
[www.wbcsd.org/pages/edocument/edocumentdetails.aspx?id=11006&nosearchcontextkey=true](http://www.wbcsd.org/pages/edocument/edocumentdetails.aspx?id=11006&nosearchcontextkey=true)

WEP (2011)  
[www.windenergyplanning.com/new-uk-renewable-energy-tariff-rates-confirmed/](http://www.windenergyplanning.com/new-uk-renewable-energy-tariff-rates-confirmed/)

WZ (undated), Warm Zones cic, Annual review 2008-2009, Warm Zones, Newcastle

ZCH (2010), Towards zero. Zero Carbon Hub

CLG (2011a), English Housing Survey, Headline report 2009-10, Department for Communities and Local Government, February  
[www.communities.gov.uk/documents/statistics/pdf/1479789.pdf](http://www.communities.gov.uk/documents/statistics/pdf/1479789.pdf)  
May be wrong website

CLG (2011b), New Homes Bonus: final scheme design, Department for Communities and Local Government, February  
<http://www.communities.gov.uk/documents/housing/pdf/1846530.pdf>  
<http://www.communities.gov.uk/housing/housingsupply/newhomesbonus/newhomesbonusquestions/>

CLG (2011c), English Housing Survey, Headline Report 2009-10, Housing Stock Tables, Department for Communities and Local Government

---

## LIST OF ABBREVIATIONS

AD	anaerobic digestion
CCC	Committee on Climate Change
CERT	carbon emission reduction target
CHP	combined heat and power
CO <sub>2</sub>	carbon dioxide
CO <sub>2</sub> e	carbon dioxide equivalent
CRC-EES	carbon reduction commitment (energy efficiency scheme)
CT	Carbon Trust
DEC	display energy certificate
DECC	Department of Energy and Climate Change
DHS	decent homes standard
ECO	energy company obligation
EMR	energy market reform
EPBD	Energy Performance of Buildings Directive
EPBD2	Recast Energy Performance of Buildings Directive
EPC	energy performance certificate
EST	Energy Saving Trust
EU	European Union
FIT	feed-in-tariff
GD	green deal
GHG	greenhouse gases
GW	gigaWatt
HECA	Home Energy Conservation Act
HEED	household energy efficiency database
HHSRS	housing, health and safety rating scheme
LA	local authority
LCD	liquid crystal display
LED	light emitting diode
LESA	landlord's energy saving allowance
LLPG	local land and property gazetteer
NEED	non-domestic energy efficiency database
PCA	personal carbon allowances
PV	photovoltaics
RHI	renewable heat incentive
RMI	repairs, maintenance and improvements
RO	renewables obligation
SAP	standard assessment procedure (for homes)
SBEM	simplified building energy model (for businesses)
ST	solar thermal
UPRN	unique property reference number
VOA	Valuation Office Agency
WHECA	Warm Homes and Energy Conservation Act

## **Picture credits**

All pictures have been provided by Brenda Boardman with the exception of the following:

Mariano Lesser, p45

Phil Landowski, p36

Collwyn Cleveland, p101





Environmental Change Institute  
Oxford University Centre for the Environment  
South Parks Road, Oxford OX13QY

[www.eci.ox.ac.uk](http://www.eci.ox.ac.uk)  
[enquiries@eci.ox.ac.uk](mailto:enquiries@eci.ox.ac.uk)

Electronic copies of this report are available at : [www.eci.ox.ac.uk/research/energy/achievingzero/](http://www.eci.ox.ac.uk/research/energy/achievingzero/)