RED Future Currents:
Designing for a changing climate

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Preface

One of the aims of the RED unit's energy project at the Design Council was to consider what light design could throw on energy policy as it related to domestic energy efficiency.

In May 2005 the RED unit and the London Climate Change Agency jointly organised a charette of policy makers, and those engaged in energy efficiency programmes, which looked at how a service design approach could inform the planning and delivery of domestic energy efficiency programmes. This charette was attended by a delegation of Canadian practitioners, including the head of the Canadian national programme for domestic energy efficiency, and included a videoed demonstration of domestic energy auditing using a blow door that the delegation had carried out in London.

Following the charette, and running alongside the RED unit's design work, a small team worked on how policy towards domestic energy could be strengthened by starting from a householder centred design approach. Until now UK policy has been supply side led, using regulations to improve the energy efficiency of appliances, and new build houses, and requiring local authorities and utilities to retrofit existing dwellings. This paper argues that current regulations are by themselves not enough, particularly as applied to the able to pay sector. What is required is an approach which engages the householder as an active producer and consumer - a co-creator - of energy in the home. For this to happen, new domestic technologies and support services are required, and a reconfiguring of the distribution network, and of the regulations governing it.

The argument is not posed as one between regulations and economic instruments, but rather in terms of the potential for carbon reductions of an emerging distributed energy system, that parallels many of the developments in the information and communication sector. Building on the work of the design team, it looks at the new role for the householder in such a system, and the regulatory and institutional innovations that would enable it to come about.

Many of the ideas in section 6-8 cross reference to other parts of the website, locating the results of the design work in the context of policy, and the paper should be read in conjunction with the website as a whole. It is presented here is a working draft inviting comments.

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1 222b Lee High Road

Think global, act local

222b Lee High Road is a typical inner London home. Lying along one of the arterial roads leading through Lewisham out towards Kent, it is a maisonette part of a house originally built for the middle classes at the dawn of the Edwardian era. It had generous reception rooms, four bedrooms, and good cheap rail services from Hither Green into town. Like many such houses in London, it was converted into two flats in the early 1980s. 222b is the upper one of these. It has a living room, a modern kitchen, a bathroom and two attic bedrooms. It is one of more than 3 million households in London, and one of 25 million in the UK.

It is hard to imagine that anywhere so ordinary could threaten the future of human life on the planet. Yet it is an excellent example of why Britain's contribution to global warming is going to continue to grow, unless we radically rethink our relationship with energy.

For two months in summer 2005, this Lewisham terrace was the base for a project on design and energy use by the Design Council's RED team. The team moved into 222b Lee High Road to help answer the question of how - in such a home, with people with limited time or income or both - ways could be found to transform the energy economy of a flat like this without people being expected to transform their lives?

The energy anatomy of a home

At 222b Lee High Road, as in every other British home, the main energy infrastructure is tucked away out of sight. The gas boiler is in a cupboard (along with the meter), the pipes run beneath the floorboards, and the ring main wiring is plastered over.

Indeed, one of the achievements of Victorian and early 20th century municipal reform was to hide away what had previously been among the most evident and time consuming elements of daily life. Power, water and waste were hidden, in pipes and sewers, under roads, in dustbins and within walls. We notice hidden systems of power only when things go wrong: when a fuse blows or the boiler leaks. But for the most part, energy, like waste, has been at the periphery of daily life. Only now are the environmental pressures of the 21st century demanding that they are brought out into the open again and re-examined.

The main uses of energy in the home are three-fold - to heat rooms (60%) to supply hot water (20%) and to provide light and power for everything else (20%). Energy use for space heating depends a lot on heat loss through the 'envelope' of the building –

windows and walls, ceilings and floors – as well as the many large and small holes that can be found in almost all homes. The picture below shows 26 ways in which heat escapes and cold comes in.

It is difficult and time-consuming to check out all these things. If it is cold in winter, most people turn up the central heating or put another blanket on the bed. But not everyone. For 17% of London's households, fuel costs take up more than 10% of their income.[1] If anything, they have to keep the heating down. For the great majority, however, costs are not a constraint. Indeed, up to half of UK householders do not even look at their energy bills, especially those who pay by direct debit.

So what happens when you start to pay attention to the energy anatomy of a home? 222b was built in an era when coal was cheap and climate change was not even on the radar. Its single glazed windows and solid brick walls bleed heat in the winter, and even more goes up the now redundant chimneys. The loft space above the attic is inaccessible and unlagged. Originally, in the early days of electricity, the maisonette rooms would have had half a dozen central ceiling lights and a couple of sockets. Now they have 20 sockets and sunken lights in the kitchen. The average UK house has 35 appliances and multiple lights in every room.

This is a complex machine, but it has quite inadequate diagnostics or controls. The primitive electricity meter, tucked away in a kitchen cupboard, was based, as in almost every British home, on essentially Victorian technology. It gives virtually no useful information on how much energy is being used at any moment in time, how that energy is being used, or where in the flat.

Energy diagnostics

We concluded that what was needed was a house doctor, an energy specialist who could give the flat a check-up and advise on treatment, like a medical doctor. But we discovered that energy is still waiting for the comprehensive and sophisticated treatment available under the NHS. Instead there is only a fragmented form-filling service, with basic measures largely geared to those in fuel poverty. This is an important social agenda, but, from a climate change point of view, the primary problem is the 'non fuel-poor', those able to pay for energy saving investments, who account for 80% of domestic energy use.

For them, like us at 222b, only a basic diagnostic is available. We rang Lewisham Council and found that we could get a free home energy check from the local South London Energy Efficiency Advice Centre. We completed a questionnaire and sent it off to a centre in the Midlands for processing. Two weeks later we got back a letter saying

we should put in double glazing, loft insulation, draught proofing of doors and windows, better heating controls and low-energy light bulbs, together with a list of local installers. The problem was that these suggestions involved a programme of work with different trades and significant investment for what was only a modest cost saving. The whole business seemed more chore than pleasure. It didn't fit with the economy of everyday life.

We tried a second free survey - this time from the local utility company, which was much the same. It involved 20 minutes on the telephone and gave us a rough figure for potential carbon savings. But unless you were into climate change already, it all remained abstract and impersonal, which is why the take-up rate for this type of survey is so low among those who don't qualify for free home energy 'retrofits'.

For a more personalised service you have to pay. We had one visit from an energy house doctor from the National Energy Service (£120 for 40 minutes) who rated our flat at 56 out of 120 on a standard measure of energy efficiency, (the so-called SAP rating) compared to 57 for the average London owner-occupied house, and around 80-100 for a current new-build.[2] But it turned out that this was only a partial measure that took no account of energy appliances in the house, or of the amount of air leakage.

So we invited in another specialist, from an American firm Stroma Technology which is expert in air leakage (£120 for an hour). He brought with him a 'blower door' which used a strong fan to depressurise the flat, and allowed us to see (with the aid of a smoke torch) where the air leaked in from outside. Our flat was like a sieve. The holes were everywhere. Cold air came down the chimneys, through the gaps in the floorboards, through the electric plugs on the wall, the large air vents in the kitchen and second bedroom, by the pipes, through the ceiling, under the doors. He told us that with the 20-mile-an-hour wind made by the fan, the air in the flat would change 40 times an hour. If the air had been water, the flat would have sunk in less than two minutes. When the computer results were fed into the National Energy Service's rating model, 222b's SAP score fell to 45 out of 120. An estimated six tonnes of carbon dioxide were being emitted a year from heating, lighting and powering the flat.

The first target the specialist suggested was to cut air changes to five an hour. But how? His company did not offer a retrofit service. Which local builder to approach? What trade? It would be easier just to turn the gas central heating up a notch or two, or buy an electric fan heater.

Even for those with a concern for climate change, the complexity and obscurity of their domestic energy economy, and of the remedial treatment required, means that energy is likely to remain in the 'pending' tray if it gets on the agenda at all.

2 Keeping the home fires burning – the domestic energy problem

222b Lee High Road, a typical British home, lies at the heart of the current climate change dilemma.

The UK is off course to meet the government's target for reducing carbon dioxide emissions. The current generation of nuclear power stations are ageing and due to be phased out, and the concern is that renewable energy will not fill the gap. But the country could do away with the pressure to meet its climate change targets by building new nuclear power stations if only we bought and used energy in a smarter way. The problem is that, after some years of trying to unleash the potential of energy saving, that smarter way still remains elusive.

Along with transport, the domestic sector is one of the largest users of energy and contributors to emissions. Households are responsible for 28% of total final energy demand, 34% of electricity use, and a quarter of UK carbon dioxide emissions [3]. Heating our often poorly insulated and draughty flats and houses, and using our TVs, dishwashers and the rest means we are pumping over 40 million tonnes of carbon dioxide into the atmosphere every year.

Unlike in industry, where big savings have been achieved,[4] energy use by households has been steadily rising by an average of 1% p.a. since 1970. The efficiency of buildings, heating systems and electrical appliances has improved substantially, but these gains have been cancelled out by rising demand for more appliances and warmer houses. As a result, energy use per household is the same as it was in 1970. Yet because there are now a third more households in the UK, total domestic energy use has increased by almost a third itself.

Increasing prosperity and technological innovation have brought a particularly sharp rise in the demand for electricity – currently the most polluting energy source. We now use 70% more electricity for lights and appliances than we did in 1970.[5] This trend is likely to accelerate, as the continuing digital revolution means an explosion in the number of electronic devices in the home. Plasma TV's require six times the energy of a conventional set. Meanwhile TV makeover programmes are encouraging new trends in energy use, such as outdoor lighting.[6]

Until recently, the climate implications of rising electricity demand were masked by the 'dash for gas' in the 1990s, which saw the mothballing of coal-burning power stations. However, this trend stopped in 2000, and has since reversed as rising oil and gas prices make coal burning attractive again.[7] While the UK's Kyoto commitment will be

met, the government's own target – to reduce 1990 carbon dioxide emissions by 20% by 2010 – is set to be missed by a wide margin, despite the recent growth in renewable energy.[8]

Reducing energy use through greater efficiency is potentially the cheapest way of reducing carbon dioxide emissions – the so-called 'no regrets' route. Yet policy to seriously tackle domestic energy use in the able to pay sector is still limited. A recent report on low-carbon scenarios for the UK by the Tyndall Centre for Climate Change Research argues that: 'the most intractable sectors in terms of energy demand reduction are international aviation and the household'. (Tyndall Centre, 2005).

As a result, there is a gathering argument that the only solution is to build a new generation of nuclear power stations. The government has signalled that the debate on nuclear power will open next year.[9] There are grave drawbacks to nuclear power - its costs, its waste, its hazards and vulnerability to terrorist attacks, quite apart from its life cycle CO2 emissions and dependence on restricted uranium resources. But for central policy makers it is easier to deal with the few constructors and operators of large projects than with the distributed complexity of residential consumers. It is an organisational issue. Improved domestic energy efficiency scores against nuclear on almost every count except that of policy and organisational simplicity. For government, nuclear is the easy technical (though not political) option. Our task, therefore, using a design approach, was to explore what policies and institutional mechanisms could deliver a domestic strategy with similar or better energy and climate change impacts as a nuclear programme, without the latter's costs and hazards.

The change required

Why has improved domestic energy efficiency proved so difficult to achieve?

The problem is not a technological one. The recent 40% House project by the Environmental Change Institute at Oxford University demonstrates that emissions from the domestic sector could be cut by 60% by 2050, in line with the government's long-term plans, without reliance on unknown technological advances.[10]

Certainly, changes in policies and incentives are needed. However, the issue is deeper than policy change. What is needed is a transformation in the way that everyone – government, industry and, most of all, householders themselves – thinks about energy.

Currently, householders are at the margins of a sophisticated but highly centralised system. We are passive consumers, for whom active energy management is virtually impossible because our energy use is so intangible to us. Energy companies have

focused on the low margin business of delivering energy commodities, rather than developing the services that would help consumers visualise and manage their energy use better.

Thus we live in a world in which people commonly say they feel helpless about climate change, asking what they, as just one person, can do. It is impossible for individuals to grasp the scale effect of millions of people switching off lights, choosing more efficient appliances or installing solar water heating. Yet the only alternative to centralised, technological fixes is mass behaviour change, which in turn requires motivation, information and feedback and, above all, support.

Design has a crucial role to play in all of these areas. The RED team energy project has explored that role, and points to some exciting directions for the development of new products and services.

3 The limits of energy efficiency policies

Government policy recognises the significance of the domestic sector. The 2003 Energy White Paper stated that: 'The cheapest, cleanest and safest way of addressing our energy policy objectives is to use less energy', and called for a 'step change' in energy efficiency.[11] The White Paper looked to residential households for a reduction of 4-6 million tonnes of carbon by 2020, from a mixture of energy efficiency and small-scale renewable energy.[12] In the Climate Change Programme, domestic energy efficiency measures alone are expected to provide annual emissions reductions of 4.4 million tonnes of carbon by 2010.[13]

Yet, as we have seen, energy use by households – and emissions – continue to rise.

What is the problem? Part of the issue is the target group for policies. Since 1997 the government has given priority to eradicating fuel poverty.[14] This is not the same as reducing overall energy consumption and emissions. The great majority of domestic energy is used by households that are not fuel-poor. Tackling climate change means addressing the wasteful amongst the 'fuel rich'. Many of these are owner-occupiers, who now make up 70% of households in the UK.

However, the problems posed by the limits of current energy efficiency policy go deeper, and can be seen in three key areas – the Energy Efficiency Commitment, energy services, and market transformation for appliances.

The Energy Efficiency Commitment

Since the early 1990s successive governments have set up a range of measures to try to induce greater energy efficiency and to reduce consumption in the domestic sector, ranging from Energy Efficiency Advice Centres to the Home Energy Conservation Act. Some of these initiatives, such as Warm Front, were aimed specifically at tackling fuel poverty. The most important instrument is the Energy Efficiency Commitment (EEC), set up in 2002.

The EEC is funded by a levy on domestic energy bills whose yield has now risen to £450 million a year, an average of £18 per household (or 15% of the BBC license fee). These resources are allocated, along with targets for energy efficiency improvements, to the utilities, which are then allowed to deliver those efficiency gains as they see fit by a variety of means – via referrals from local authorities, through street-by-street door knocking, through social enterprises, or by direct mailing and information on the back of bills. They typically offer households free or subsidised energy efficiency measures

60% of the claimed savings to date have come from insulation, with most of the rest coming from low energy light bulbs.[15]

In theory, between 2002 and 2005, the EEC achieved DEFRA's planned annual reduction of 1% in domestic carbon emissions, that is 1.2 million tons of carbon (MtC) over the three years compared to total residential emissions of 40.4 MtC. The actual impact of the EEC on energy use and emissions is not measured directly, but rather estimated through a domestic energy model, and there is some debate about the accuracy of the assumptions underlying the model.[16] However, there is no doubt that the EEC has had significant impact on domestic energy efficiency. Almost 40 million compact fluorescent light bulbs (CFLs) have been distributed, and 750,000 lofts have been professionally insulated.

Yet in spite of EEC, domestic energy demand continues to rise. Since 2002, electricity demand by households has risen by almost 1% and gas use is up by over 5% (DTI 2005a, Table 1.1.5). A resurgence of coal burning since the 1990s has also pushed up the carbon coefficient of electricity, putting upward pressure on overall emissions. There is little sign in short of a downward 'step change'.[17]

The EEC is, at best, running to stand still in the face of the trend towards increases in domestic energy use and carbon emissions. It is delivering much needed help to many low-income households, but it has failed to engage deeply enough with the mass of householders to spark the revolution in energy use that is needed.

All energy efficiency schemes have struggled to get people to the first point of contact. Few people seek out energy efficiency advice and support proactively, so schemes like EEC have to rely on expensive repeated mass marketing mail-outs. But response rates are often low (one utility gets a 1% response rate on ordinary mailings). Intensive area-based schemes such as Warm Zone do have higher response rates, but even here take-up rates for measures are around only 15% and only one or two measures might be taken.[18]

The EEC incentivises utilities to follow up mass, shallow marketing with quick and shallow audits and a standard package of measures, now often consisting mainly of roof and cavity wall insulation.[19] The focus is largely on reducing energy use in space heating. The most commonly used type of energy audit may also underestimate the importance of other measures, such as draught-proofing.[20] Most importantly, this approach cannot look at each house as a whole, and does not attempt to engage the householder as an active manager of their own energy use in any serious way.

Ultimately the EEC is driven by utilities, partner organisations and insulation installers, rather than householders themselves. As the review of the scheme for 2002-2005 notes:

> 'The EEC...would appear to have done little to encourage consumers to consider their energy demand and their effect on the environment. The structure of the EEC 2005-2008, in terms of the way it encourages suppliers to promote energy efficiency, has seen little change. It would therefore seem likely that this trend will continue.'[21]

Energy services

The EEC works against the grain of the market, effectively trying to get utilities to reduce the demand for something – energy – of which they generally want to sell more. As James Meek puts it:

> 'One of the great failures of Britain's electricity market is that the companies which supply households with electricity compete to sell electricity at the lowest price, rather than competing to power, heat and light our homes at the lowest price. It's as if restaurants competed to stuff customers with the cheapest possible food without either party noticing or caring that, each time, two-thirds of the meal was left on the plate.'[22]

The true chef would be offering a meal of *energy services* consisting, as implied, of the kinds of services that the customer actually wants to consume directly. The market for such services is quite well established in the industrial sector, where energy services are sometimes called contract energy management (CEM).[23] CEM is also used to some extent in the commercial and public sectors.

However, there has been a complete failure of the domestic energy services market. It is not hard to see how such services might work. For example, a domestic energy services offering might involve a company installing a boiler, or even a domestic combined heat and power (dCHP) unit in a home, and retaining ownership of it, charging the householder for the heat (and power) services instead of for the physical asset.[24] This would give the energy services company an incentive to install the most energy-efficient equipment and maintain it to a high standard.

A debate has raged about whether this market failure occurs because customers have the right to change utilities with only 28 days notice, meaning that companies have little incentive to invest in longer term energy services contracts.[25] The more likely reason is that, until recently, utilities had little incentive to offer complex energy services in a market with low margins. However, smaller profit margins in energy retail, arising from

rising oil and gas prices, along with the prospect of large investments in transmission and distribution, have led some in the utilities to begin to see the point in energy service offerings.[26] But a corporate culture built around selling energy rather than energy services will take some time to change.

In the meantime, the only domestic energy services on any scale are the commercial offering of energy efficiency measures. In the UK this market is dominated by double-glazing, with sales of £3.3b in 2004,[27] But double glazing is among the most expensive energy efficiency measures on the market. It usually has less impact than cavity wall or loft insulation, or replacing a boiler, and it is a sector whose growth has slowed because of saturation in the replacement windows market.

Market transformation

Market transformation refers to changes in the way markets operate. It involves a combination of labelling appliances of different standards of efficiency, procurement, rebates, minimum standards and education.[28] The biggest effects so far, backed up by European standards, have been seen in the sale of fridges and freezers. The energy consumption of an average 140 litre fridge in the UK home decreased by 29% between 1990 and 2001. European directives are due for other appliances, especially across electronics. The apparent success of energy appliance labelling has led to the labelling of houses, which will become mandatory at the point of sale in the UK in 2007.

However, market transformation also has its limits. The energy efficiency gains have been partially wiped out by people buying larger appliances, or simply more of them – the so-called 'rebound effect'. In the case of fridges about half the efficiency gains have been lost.[29] This pattern is partly driven by rating schemes themselves, since it is easier for manufacturers to achieve an 'A' rating in terms of kWh per litre in larger appliances than in smaller ones. Although they have been keen to develop highly rated products, manufacturers are not interested in selling appliances with lower overall energy consumption per se.

In this case, policy has attempted to drive the market through influencing manufacturers. As with EEC, the Government's market transformation strategy has achieved some impact, but is ultimately limited as it has not yet engaged householders directly, building awareness of and interest in energy use in appliances. A recent survey by the Association for the Conservation of Energy found that many people with labelled products did not know what the labels meant.[30]

More efficient, but more...

Some £500million a year is being spent on programmes to upgrade homes like 222b Lee High Road. Energy labelling of fridges and washing machines means that appliances are getting more efficient. But while these programmes have had some effect, they are not enough to stem the tide. Electricity and gas use have risen by nearly 20% since 1990, and the trend continues.

Our argument is that the step change in domestic energy consumption can only be achieved by giving a more central role to the householder, both as a consumer of energy and a producer. Energy efficiency schemes have been designed to deliver insulation and low energy light bulbs rather than behaviour change. They work in a way that minimises the involvement and awareness of energy users – us. The problem is that we want our houses warmer than ever before, and we want more gadgets using more electricity. And even though the fridges we buy are more efficient than they used to be, they are also a lot larger, so again, total energy use goes up.

Indeed, domestic energy policy is itself mimicking the energy system. A mix of centralised complexity, mass delivery of a standardised product, and the passive householder has framed the policy responses. Government is not attempting to connect with householders as active consumers, managers and producers of energy, and neither are the utilities. These are the characteristics of an energy system that has developed over the last 100 years.

4 From National Grid to decentralised energy

A decentralised past

At the end of the 19th century, electricity and town gas technologies began to offer the possibility of mass consumption of energy in the home. But the key to realising the potential was the delivery infrastructure. For electricity, this came through a series of developments - the invention of metering in 1880, the advent of alternating current (AC) and transformer technologies in the 1890s – heralding the possibility of moving power over long distances. Economies of scale in generation moved the industry to ever-larger power stations.[31]

Not surprisingly, the tendency was towards centralisation. In the early 20th century there were 135 different power companies in London alone, most with differing standards, but consolidation meant that competition quickly declined. Dominant firms argued that electricity distribution was a 'natural monopoly', a position that was soon accepted by politicians.

With the end of World War II the electricity system was nationalised. High voltage transmission was rationalised into a single National Grid, which was linked in turn to the lower voltage distribution networks that delivered 240 volt current to homes. Supply and demand were balanced through central control.

By the 1960s much the same had happened with the natural gas system that replaced town gas. A national system of high-pressure mains feeding a lower pressure local supply infrastructure was controlled by a central authority.

In key respects, the network did not change with the deregulation and privatisations of the 1990s.[32] Vertically integrated regional electricity and gas boards were unbundled into separate wholesale generating companies, distribution network operators (DNOs), and retailing utilities. Competition in wholesale electricity markets accelerated the dash for lower-cost gas generation, and prices came down, but the deep characteristics of the system remained essentially the same:

Scale

Generation is in large power stations located away from centres of population. These enjoy economies of scale, but are wasteful of primary energy. Only 38.5% of the energy consumed in UK power stations is converted into electricity. A further 8.5% of this electricity is lost in transmission and distribution.[33]

Central complexity

Electricity is difficult to store, yet variations in demand are substantial, so balancing supply and demand is complex. The complexities of running a synchronised electricity system are managed at the centre, through forward bidding for half-hourly periods of supply in the wholesale market.

One-way, controlled access infrastructure

While generation and retailing are competitive, the infrastructure is still under the control of private monopolies. Local distribution networks are owned and run by distribution network operators, who charge for access and use, under regulation. Transmission and distribution systems are designed for a one-way flow of power from power stations to customers, from high-voltage to low-voltage.

Low-margin mass market

Retailing utilities are selling an undifferentiated product (gas, electricity) to a mass market, segmented crudely by tariff (direct debit, bill, key). Margins are low (or sometimes negative), and customer turnover is expensive for the utilities. This means that while competition is intense, it is on the basis of special offers, side benefits, such as air miles, and Nectar points. Directly comparable information on the price of energy from different suppliers is difficult to obtain, often only available through third parties.

Passive consumers

In contrast to central complexity, domestic energy customers play a standardised and passive role. Almost all have meters that are virtually unchanged from the Victorian era, giving no feedback that is useful for amending behaviour or information on system costs. The majority of domestic customers take little interest in their energy use, especially when energy prices are low. Up to half of UK householders do not even look at their energy bills.

A decentralised future?

Now, at the beginning of the 21st century, there are emerging signs of new possibilities for organising energy. Calls for the system to be made more flexible and decentralised in various ways are growing.[34] The key idea is that energy- especially electricity – should be generated locally where it is needed, and on a smaller scale.

Economies of small scale

Small-scale generation means that the heat currently wasted in large power stations can be captured and used locally, with major environmental benefits in the form of lower carbon dioxide emissions. Combined heat and power (CHP), especially gas-fired,

is a mature technology which can convert upwards of 90% of primary energy into useable electricity and heat. Small mass produced generators are forecast to have costs similar to current energy provision, with pay back periods of four to five years.[35]

Local power generation also much reduces the need for long-distance transmission lines and pylons, and avoids the associated losses and expensive investment. A recent study by Mott Macdonald for the DTI shows that widespread decentralised power would significantly reduce the costs of renewing distribution systems.[36]

Open access, multi-directional infrastructure

Decentralised generation would mean local distribution networks changing from being passive, one-way instruments for delivering electricity from power stations to homes and businesses, to being active, two-way systems for moving and managing power between them. The electricity system would come to resemble the internet.[37] Just as internet service providers act as hubs to manage information traffic, two-way distribution networks would allow local balancing between the demand for power and its generation.

Decentralised complexity

There are huge implications for many renewable technologies, again with major emissions benefits. Because renewables like solar photo-voltaics (PV) or wind are intermittent – generating power when the sun shines or the wind blows – they are penalised by the current system, which is designed for a steady flow of power. More active local distribution systems, designed to balance intermittent power from a range of different renewable technologies against changing demand, would maximise the potential economic benefit of renewables.[38] They could also be combined with 'intelligent appliances', including fridges or washing machines, that could respond to system conditions by turning themselves off during peak load periods.[39]

Waking up and smelling the coffee

Beyond the growing debate about decentralised energy, its potential has actually been demonstrated in the Surrey town of Woking.[40] The pioneering borough council has constructed a series of 60 local energy generation systems, including gas-fired combined heat and power, micro-wind turbines and photo-voltaic arrays. These systems serve the council itself, but also local hotels, a shopping centre, a doctor's surgery and some social housing. Woking even has the UK's first hydrogen fuel cell, which powers the local sports centre and swimming pool.

Combined with thermal stores to manage the heat load across the year, Woking's local energy systems can operate independently of the National Grid, in 'island generation' mode. This guarantees security of supply in the event of national system black-outs.

The Council has also begun to move the local distribution system in the direction of internet-style two-way management, as the different local generation sites in the town can also trade power, thanks to an agreement with the distribution network operator, EDF Energy.

As a result of the decentralised approach, Woking Borough Council claims a cut in carbon dioxide emissions of 77% in 15 years. Customers buying electricity directly from the local power systems also enjoy lower prices than those on offer from the mainstream utilities. This is because they don't have to pay the supply margins, transmission and distribution charges that make up a third of the retail cost of conventional electricity.

An unfinished revolution – the role of the consumer in the new system

In many ways, our existing energy system (especially the electricity system) resembles mass-manufacturing industrial models from the Fordist era – a standardised product produced at scale under a high degree of centralised control, to be sold to consumers whose main role is to buy progressively more of the product. As long as the logic of this model applies to both energy itself and to domestic energy policy, there is little prospect for a 'step change' in tackling emissions.

The decentralised energy revolution has huge potential. But new technological possibilities will not, on their own, produce fundamental underlying change in the role of the passive consumer. In some ways, a current selling point of systems such as that in Woking is that the consumer doesn't necessarily have to notice any changes, or behave any differently.

It is true that installing renewables such as solar PV cells at the household level in particular can act as a real catalyst for changes in behaviour and attitudes towards energy.[41] But, as explored below, these are seen as expensive investments only for enthusiasts, not part of the mainstream energy consumer world.

For a real change in energy use – one that will lead to active consumers seeking ways to make deep and progressive cuts in emissions – the consciousness and role of home energy consumers needs to change alongside the technology. What is needed is a radical transformation in the role of households as energy consumers, managers and producers. Without this, we will not achieve the '40% House'.

5 Designing for a climate of change

More of the same is not a solution

A transformation in the role of households in the energy system is unlikely to happen through just intensifying the existing mechanisms.

The billions of pounds worth of expenditure needed will not be available through public funding. The Energy Efficiency Commitment model of financing measures from an on-bill levy has opened a new route, but is vulnerable to criticism as a stealth tax, and in any case, as we have seen, has not been used in such a way to engage householders in new roles.

Regulation can support a change to greater householder engagement. There are reduced rates of VAT on energy efficiency materials. However, the government has so far resisted calls for more direct fiscal incentives, such as stamp duty or council tax rebates for more energy efficient homes.[42] There are signs that other forms of regulation are now being explored. More efficient condensing boilers are now mandatory where old ones are being replaced. From 2007 houses will have to be energy labelled when sold. It is not yet clear what the effect of this latter change will be. However, it is not possible to create a new culture simply through regulation. Indeed, in creating motivation for behaviour change, carrots are usually more effective than sticks.[43]

This is also why we cannot expect the market as currently configured to deliver the low-carbon demand side energy revolution. Although many energy efficiency measures will pay for themselves through lower bills within five to ten years, energy costs typically make up a small percentage of living costs, so financial incentives to take up offers are weak. In 1996, when prices were higher than they are now, fuel costs were still less than 10% of disposable income for around 80% of households.[44] Despite recent price hikes, a relatively small number of households are switching suppliers to seek lower prices.[45] We have also seen that there is virtually no market for domestic energy services. What markets do exist in energy efficiency are heavily supply-driven, almost all in double-glazing.

The value of design

What is needed is not so much *more* spending, regulation or market offerings, as a different kind of each, repositioning the energy system around the householder. The revolution in domestic energy has to be one that puts the householder at the very centre.

This is where design, which starts from a user-centred approach, comes into its own. User research in design goes beyond shallow market research tools, working through a dialogue with potential consumers to identify practical products or services that speak directly to their lifestyles and desires. As Cottam and Leadbeater (2004) put it:

> 'The design process is a set of techniques and approaches that puts users at its heart, works from their perspectives, engaging with articulated knowledge, latent perceptions and emotional responses.'[46]

Thus design can contribute by ensuring that tackling climate change works with the grain of modern life, rather than against it.

Through the eyes of the householder

Our focus was on owner occupiers, and we started by spending time with a small sample of householders, discussing how, if at all, they thought about energy, how it connected to their lives and aspirations, how much they used and how they managed it, and whether they had invested in energy saving.

The sample was not chosen to be scientific but rather to look at the issue from different perspectives. It included young and old, single and married, better and less well off - a policeman, a former garment worker, a health and safety officer, a waste manager, a journalist, two housewives, and a design engineer. We were looking for insights that could run alongside the mapping of attitudes that a number of consumer surveys had already undertaken.

For example, DEFRA had carried out a survey of public attitudes (not restricted to owner occupiers) towards the environment in 2001. This found that 80% made no connection between their has and electricity use and climate change, that 60% had done little or nothing to save energy, and of those that had, 81% said they had done so to save money, as against only 15% who had been motivated by its impact on the environment.. In other words, a third of the sample had reduced energy use because of costs, and only 6% had done so for environmental reasons.[47]

Our interest was in how far there were factors other than the price of energy that might have an effect on the domestic energy economy, how energy use and production might connect with other parts of their lives and motivations, how in short the generation, distribution and use of energy in the home - and its connected infrastructure and appliances - could be re-designed to encourage householders to invest in and manage it differently. Put simply, how could the issue of domestic energy, which for most people

is no more than a necessary chore, claim a more significant place in the daily life and budgets of the household.

A number of important design leads came out of our user research:

- **The importance of making energy *tangible*, or visible.** This in turn implies a need for information about energy use. Whereas the centralised energy system was intelligent at the centre and did not require the householder to have any feedback on use and the impact of changing behaviour, distributed energy requires information in the home. There is a rich agenda here, taking in home energy rating and going to smart meters, energy statements; control panel, online tools and beyond.

- **Design for *control*** – the importance of being able to influence the use of energy across a range of functions and appliances easily and quickly.

- **The importance of understanding and appealing to *multiple motivations*** (not just the limited financial version of paybacks). People have complex motivations linking to aspirations, long-term security and their position in relation to others. For example, rather than seeing micro-renewables in terms of an investment whose high capital costs and long payback times currently make them unattractive, the designer might seek to create a new aesthetic for micro-renewables, re-casting them in terms of consumer goods, as the latest must-have purchase. Domestic combined-heat-and-power systems (micro CHP) or photovoltaic panels (PV) have to be objects of desire as well as saving carbon dioxide emissions.

- **Collaboration is a potentially valuable force for change.** Acting together can save money, as well as allowing the sharing of knowledge and information on service providers. Alone, enthusiasts remain enthusiasts, but as part of an energy collaborative they are a powerful motivating force. The internet is an ideal platform to support such distributed intelligence.

A design agenda

Using these insights, the RED team worked in three areas, which this paper will go on to look at in turn:

The first focused on designs for helping to transform passive consumers to *active managers* of energy. The focus was particularly on motivation, aesthetics, information and feedback, and ranking.

The second involved considering how to open up *home production* of energy, or micro-generation, This also involves re-thinking motivation, given that most options still have high costs and long paybacks.

The third area was the *support services* that the new energy economy will need. What will be required to help householders manage their new role in the energy revolution and help them find their way through what could be a new complexity?

Such support services are unlikely to be fully funded from public sources, so a further section explores the economics of such an approach.

Finally, we go back to the question of policy and regulation and ask what types of measures will be needed to support these ideas and the emergence of a new kind of energy actor to spearhead the transition to a low carbon energy system.

6 The householder as active energy manager

For domestic energy consumers to genuinely become co-producers of climate change solutions, they have to become co-creators of their own energy services.[48] Co-creation implies a radically different role for consumers, not just being on the receiving end of a gas or electricity market, but actively managing their energy use and production.

Information and feedback

However, you cannot manage something that you cannot see or measure. Perhaps the most basic barrier to transforming the householder into an active manager of energy is that energy is invisible. Currently the householder has virtually no immediate information about use, or feedback about the impact of behaviour change. Standard metering and billing systems in energy are very basic. The metering technology in most homes is antiquated, virtually unchanged since the Victorian era. Both give extremely limited information and fail to allow tracking of the customer's own usage over time, or comparison with others.

A major challenge is therefore to make energy tangible and visible, and to design for easy control of all the systems in the home.

The one point at which consumers *are* told about their quarterly usage (or an estimate) is on their bills. However, many householders, especially those paying by direct debit, do not even look at their bills. And on bills, information about energy use is bundled together with information about money, which puts some people off. Bills also give virtually no information about changing energy use patterns over time, or in relation to benchmarks. Messages about saving energy are often hidden on the reverse side of bills.

This issue led the RED team to the idea of a separate periodic energy statement, **My Energy_Report**. My Energy Report would arrive at a different time from bills, be compiled by an independent organisation that collates all information across all the householder's current suppliers and gives breakdowns of cost and impact in terms of greenhouse gas emissions. It would also compare spend and emissions to customised national benchmarks, as well as providing information about usage in the current quarter with previous time periods. The aim would be to engage the householder's attention using transparent and independent information, separately from bills.

For real time feedback, however, metering becomes the key tool. Metering technology has now far outstripped what is in most people's homes. Many 'intelligent' or 'smart' meters are now on the market, allowing real time feedback on usage and comparison of

energy use in any one period with previous periods, or averages. Individual appliances can be metered either directly, using devices such as Electrisave[49] or even remotely through Powerline technologies that combine electricity supply with broadband. Systems for remote control of appliances already exist at the top end of the market.

The evidence is that, just through increased awareness of use and good direct feedback, smart metering instigates energy savings in the range of 3-15%.[50] Across all households, a 5% saving would be equivalent to the total expected savings from the second round of the Energy Efficiency Commitment. Smart meters can also handle the measurement of exports from home electricity generation.

Yet, despite calls for smart metering to be more widely promoted,[51] government is applying no pressure on utilities to supply better metering. In a recent case, a company tried to work with interested utilities on providing intelligent meters under the EEC, but this was ruled out by Ofgem, which does not recognise behaviour change as a valid energy saving measure.[52]

Nor is there significant consumer demand, in part because of the aesthetics of metering. Even intelligent meters seem designed more for building engineers than modern consumers. These devices are still designed around their function, looking like, and sold as, technical devices, often with small monochrome digital interface screens.

The RED team wanted to approach the issue of feedback in a different way, making a distinction between metering and monitoring. They wanted a feedback system for energy information which at the same time be an object of desire.

A prototype developed with the system engineers More Associates gives a choice of graphical representations of appliance electricity use, from algae whose blooms shrank and grew with varying power use by each appliance, to bubbles moving up the screen at a speed reflecting total electricity use in the home. A touch-sensitive screen allows the user to interrogate the monitor for further information about each power use, and it would be possible to use the screen to turn appliances off remotely. This **Home Dashboard** concept offers the prospect of making home energy management aspirational, combining tangibility and control in technically sophisticated but beautiful energy monitors – a device that not only gives you finger tip control over appliances and heating, but also something you'd love to see hanging on your wall.

The RED Team envisaged the Home Dashboard being used in conjunction with other tools, like the **Energy Tracker**. This would be downloadable software for use on a home PC that interfaced with the digital output of the Home Dashboard. Once set up with data on the dimensions and building structure of a real home, the Energy Tracker would

provide the householder with a benchmarking system against which to assess the data on the Dashboard. It would have an 'Action' section loaded with expert advice tailored to the information coming out of the software. For example, if electricity use on lighting were way above what would be normal for the UK benchmark home of that type and number of inhabitants, the user would be guided towards advice on energy saving light bulbs.

Invest to Save

One step beyond Energy Tracker is **Virtual House**. This would build on existing websites, such as the Open University's interacting energy house,[53] and use building science data from reputable bodies, such as the Building Research Establishment. Virtual House would be an online product where the user chooses a dwelling type (such as 'Victorian three-bedroom' or '1960s five- bedroom), and then calibrates the model to a close approximation to their own real house with a few key data points such as room measurements and layout.

They can then enter information on their heating system, insulation, appliances and lighting, and build an accurate model of their own house, with energy use, costs and emissions automatically calculated at each step.

Having set up his or her Virtual House, the user can then begin to play. Appliances with different energy labels and sizes can be brought in using drag-and-drop icons.[54] Even major items like new wind turbines, a solar roof, of conservatories could be added. This would enable people to try out different measures on screen, getting an idea of how each would impact on their energy bills and emissions, getting information on payback times. Virtual House could be linked to manufacturers' website to provide on line energy ratings and to other websites giving information on contractors and installers in the local area, maybe with peer-to-peer ratings on their reliability and courtesy (see below).

Home energy rating and comparison

Like Energy Tracker, Virtual House could also be used for a deeper aspect of information and feedback, allowing householders to compare their energy use against different benchmarks and rate themselves against others. The model could show different housing types, ages and regions, so that someone living in, say, a two-bedroom Victorian upper maisonette in Birmingham could look at their own heating energy use and related emissions against a West Midlands average for that type of property. The website would allow people to post their own energy use patterns, along with tips to share with others.

Taking comparison one step further, such web-based applications could offer information about other real houses. It is clear that a major issue with energy data is who is in control. Recent trials with detailed feedback on water and electricity use via broadband and digital TV attracted very few households willing to take part. Major factors were fear of a lack of control over who gets to see information, and not trusting utilities.[55] But a system that allows people to volunteer data on their houses is different. This could be done, for example, by users of Virtual House who have had the online data on their home energy performance confirmed by an independent certified auditor. This begins to introduce the element of motivation associated with 'keeping up' with others.

Of course, this rating aspect of home energy performance may be stimulated by the introduction from 2007 of mandatory rating at the point of sale. The idea of **Visible Energy Rating** is that this will be taken up by estate agents and property websites. It would be simpler than a quantitative SAP rating - rather providing a set of braod categories A,B,C... as with the energy rating of white goods. It would appear on the For Sale boards outside a house, and in the estate agents particulars. High average ratings may even be used by local councils as a draw to promote their area as a good place to live.

Long-term motivation

Motivation is, of course, central to the energy revolution. Why would householders *want* to become active managers of their own energy?

One idea that has been put forward is for a system of 'domestic tradable quotas' (DTQs)[56] (sometimes called 'white certificates'), where everyone gets an annual or monthly carbon ration that runs down more quickly the more energy they use. The ration could be stored on a carbon ration card that had to be used to buy petrol or diesel, or pay for gas, heating oil or electricity. The idea is essentially the same as the 'cap and trade' European Union emissions trading scheme (EU ETS) for industries and power stations, applied to the domestic sphere.

A Domestic Tradable Quotas Bill has already been put forward. However, it is not yet on the government's agenda, and is unlikely to be so for some time. An alternative idea comes from turning the 'stick' of DTQs (where you progressively run down your ration), into the 'carrot' of building up carbon credits,[57] in a **Power Pension**.

Normally, when you improve the energy efficiency of your home and conserve energy, you reap the benefits in terms of lower energy bills. But when you move house you can't take with you the benefits of your energy efficiency measures. When houses are energy

labelled there might be a small premium on the sale price for a well-insulated house, but the householders we spoke to thought this would be minimal. The Power Pension would be a way of having some of the benefits of energy saving investments attaching to the person rather than the house.

Householders investing in energy efficiency measures could have the results certified by an independent auditor, and receive credits in proportion to the improved energy rating of the home. These credits would be convertible into long term energy bonds (similar to baby bonds) whose value could be realised as an 'energy annuity', a quota of free energy once the holder reaches retirement age.

The system could be funded out of the Climate Change Levy, supplemented by aggregating certified emissions reductions and selling them in the EU ETS market. To help those on low incomes, less able to make energy conservation investments, the government would offer assistance in the form of grants or low interest energy loans that still allowed a net positive Power Pension.

7 The householder as energy producer

Bringing the energy revolution home

Bringing the energy revolution home ultimately means making your own energy, transforming the role of the householder from consumer to producer.

Technologies for generating low- and zero-carbon electricity and heat on a domestic scale – often called *micro-generation* – are developing fast. These include renewable energy technologies. Solar water heating and photo-voltaics (PV) are fairly mature. Biomass boilers are available at the micro-scale. Micro-wind turbines are set to be commercialised in 2006. Micro-generation also includes gas-fired combined heat and power (CHP), where electricity is produced in the home and the waste heat is then used to heat water. Domestic CHP (dCHP) systems, no bigger than a washing machine, are now coming onto the market.

These new technologies are disruptive, challenging to a system that suffers from vested interests, skewed incentives and technological momentum, and raising the potential for a change in thinking.[58] The Green Alliance holds out the hope that micro-generation will:

> 'make the public co-producers of climate change solutions rather than passive consumers of energy...There's nothing like generating clean, green energy in-house to help close the gap in people's minds between the origins and impacts of energy, and the way they use it at home... The innovative new micro-CHP, the solar panels on the roof, the micro-turbine in the garden, are visible acquisitions through which people can proudly demonstrate their self-sufficiency and their commitment to climate action. Unlike hidden cavity wall insulation, they can get people talking, and act as daily reminders to keep the energy use down. The bottom line is that, as visible purchases, they have far more feel-good factor and commodity value than lagging'.[59]

The potential impact of micro-generation is enormous. For example, if just a third of the households in the UK each installed a 2 KW wind turbine, this would match the generating capacity of all Britain's nuclear power stations.[60] If 12 million households installed dCHP systems, CO2 emissions would go down by 33 million tonnes a year.[61]

However, despite this potential for both cultural change and emissions impact, domestic and community-level energy generation in the UK is growing at a snail's pace. By contrast with the rapid expansion of commercial wind power, there are only around 80,000 micro-renewable installations across the whole of the UK.

Driving down the costs of micro-renewables

At the moment, this potential is being held back by a multitude of barriers – planning restrictions and lack of information on products, reliable suppliers and installers.[62] However, one reason predominates – cost. Micro-generation has been marketed as an investment, but the cost of systems is high, payback periods are long, and the level of grant support still relatively low.[63]

Take micro-wind turbines. These technologies are just on the verge of becoming more widely available, but will still cost between £1,500 and £2,500 for a system. As with other new technologies, including solar PV cells, volume will drive down costs, but companies are unwilling to invest in the plant and processes for volume manufacturing until they know there is a mass market – precisely the market that will not develop as long as prices remain so high. This is the classic dilemma facing any new product making the move from niche to mass consumption.

The RED team envisaged how some skilfully formed alliances could kick-start a campaign to drive down the costs of home energy technologies. In the **One Million Roofs** scenario, a joint venture between the government and the BBC, the idea is to get one million UK households to pre-commit by contract to getting a wind turbine or equivalent solar panels installed on their roof financed by low interest loans paid off on their utility bills. The power will be fed back into the grid. The BBC screens programmes following the evolution of One Million Roofs. Environmental campaigning groups take up the idea once they realise that it may well lead to micro-wind power replacing nuclear. The guarantee of a mass market quickly leads to manufacturers setting up large scale, low cost production and offering a product at a tenth of the niche market price.

Under this scenario households could become net producers of energy and with adequate resale prices, energy would become an income rather than a cost. This would offer a new approach to fuel poverty, with low income households, either individually or as group, accessing low cost finance to invest in income earning micro generation.

New energy mutuals

Central to this scenario is the resale price. As things stand, householders have no guarantee that they will be able to sell any of the electricity that they may produce above and beyond what they use. For example, when the wind is blowing at night, but demand in the home is low a micro-wind turbine may produce more power than is actually used, as would a household's solar PV cells on a hot summer's day with everyone out at work or school.

The electricity regulator, Ofgem, is sceptical about the case for making utilities buy excess power, saying that it is: 'not persuaded that creating such an obligation would be desirable...A secure supply of electricity is a social necessity; exporting electricity from domestic premises is not.'[64] Those that can find a utility willing to buy their excess usually get a much lower price than that they have to pay when buying electricity. This is despite the fact that households producing as little as 1,000 kWh of electricity a year from renewable sources may be eligible for Renewable Obligation Certificates. By contrast, countries with guaranteed and high renewable feed-in tariffs ('REFITs'), such as Germany, Spain or Italy, are experiencing a renewables boom.[65]

Without a guaranteed price for exported power, renewables remain unattractive as an investment for the householder. But beyond this, the electricity system itself – designed for central generation and one-way distribution - is a major barrier. With current meters, exporting power would involve meters running backwards, which is currently illegal.[66] Connecting to the local distribution system is a complex business, while applying to claim Renewable Obligation Certificates involves filling in a 25-page questionnaire.[67]

This needs to change. But the RED team also looked to the potential of group collaboration as another way forward. With some minor changes in regulations, **Home Energy Trading Schemes (HETS)** could be set up allowing enthusiasts to sell or donate surplus electricity to one another. In addition to the benefits of peer support and shared information on energy performance or installer reliability, HETS would help members capture benefits from micro-generation more fully than individuals could. It also builds on the desire expressed by several participants in our user research to 'get one over' on the utilities.

Members of any one particular HETS would have to be connected to their own micro grid, or to the same existing distribution network, to avoid having the complexity of working across the transmission system and two distribution networks.[68] The concept works on the principle that there are times when local generation in surplus will differ for different types of technology and different users. Schools for example, will have peak load during the day, unlike homes. Wind tends to be stronger on cloudy days, and weaker on sunny days when PV produces most. The HETS, which effectively becomes a second energy supplier for members alongside their utility, balances demand and supply, and pays a fee for the use of the local distribution system. HETS members could also choose to donate excess power to other members, say the local school, or maybe the hospital. Or it could be pensioners on Income Support. Larger, more advanced HETS could operate power storage facilities, such as small pumped hydro systems.

Costs could be covered through a small administration fee, waived for those on benefits. In addition, micro-generation from renewables above 500 kWh qualifies for Renewables Obligation Certificates (ROCs). While these could not be sold on the ROCs market, because the excess power is going for free to other members of the mutual, the ROCs could be claimed and then retired at the government's buyback price of £40 per MWh.

Such group intermediaries would prefigure the way that utilities will eventually become organisations for moving power around, rather than one-way suppliers.[69] Indeed, HETS could be set up by the more far-sighted utilities, such as Good Energy, which is already offering higher prices for micro-generation from renewables.

8 From ESCOs to HOUSECOs – support services for the new energy system

Re-inventing energy services

Micro-generation, smart energy monitors, intelligent appliances, Power Pensions and online energy modelling all point to a more active role for the householder. This is far beyond knowing how much loft insulation you should have. It means that much of the complexity that was previously managed at the centre of the energy system will move to the household level. Expecting people to handle this complexity is all very well, but many, if not most, will need support. Energy auditing and meter installation need trained professionals, and some people need help even fitting loft insulation.

Yet at present, the support economy for energy is weak. On the one hand, market drivers, such as financial and fiscal incentives, are weak. Equally, householders' knowledge about energy performance, and links to climate change, remains poor. Energy conservation also loses out to competing priorities. Householders have other things that are higher on their list of priorities, such as gardens, or decorative make-overs.

On the other hand, domestic energy services face several barriers. There can be negative perceptions of energy efficiency measures, especially with period properties, with the fear that energy-efficient alternatives are unattractive or will reduce property values. Above all there are issues of trust. Many energy efficiency measures involve contractors (insulation fitters, plumbers), where problems stem from variable quality, reputation, a confusing array of qualifications and schemes, and insufficient policing. These problems can extend to the new markets for micro-generation and renewables. On the other side, there are shortages in key skill areas (including plumbing), especially in London and the South-East.[70] Shortages of skilled labour and high overhead costs also push up costs of installation and building work in London.

For most householders, as was underlined in our user research, the hassle factor outweighs motivation. Energy saving measures require up-front investment and effort, sometimes carrying out installation, or organising it with contractors. As long as the financial incentive is weak, only the minority who are relatively knowledgeable about climate change and committed to taking action on it will undertake measures. This analysis is backed up by the experience of Energy Efficiency Advice Centres.

These barriers and the lack of conventional drivers point to the need to re-think domestic energy services. A whole new model is needed, not so much of energy services companies – ESCOs – as whole-house environmental services companies –

HOUSECOs. Indeed, while the focus here is on energy, the model could and should be widened to take in other aspects of domestic resource and materials use – waste, water, chemicals, food and even travel planning.

The design approach points to the importance of starting with the user's desires and motivations, giving particular importance to the need for the householder to feel in control, with a package tailored to their own situation – less npower than iPower. Thus, beyond the extrinsic issues of price or payback, the intrinsic qualities of a package of energy services can play a decisive role. This is particularly important in an era in which need is no longer sufficient to engage consumers, but where addressing wants is essential. In this context, the whole concept of a 'utility' begins to look redundant.

Offerings of home environmental services for the able-to-pay householder will have to be completely different in appearance and feel to existing energy efficiency packages. New aesthetics, tailored assessments, sophisticated feedback, and the support of groups will have to replace mass mailshots, shallow audits and standardised insulation. The key will be to hook the interest and awareness of the householder, stimulating *them* to spend time and money on managing their energy choices and use.

These issues have major implications for the service model. Traditional utility activity may be less relevant than experience in areas like retail, concierge services or financial services, even though many senior figures in utilities are searching for a way in. As Simon Skillings, Director of Strategy and Energy Policy, E.ON UK, puts it:

> 'Somehow or other, we've got to find a commercial answer that makes us money and makes our customers' lives better by them consuming less energy. If I knew the answer, I could go away and collect my Nobel prize right now.'[71]

For example, HOUSECOs could follow the example of the "new concierge services" developed by groups like 10-UK. The key to such services is trust, and the knowledge that the service provider is on the side of the householder in navigating the complexities of the market. In this new 'support economy' economies of trust become more importantr than economies of scale.[72]

HOUSECOs would offer a premium service, involving full "hand-holding" from assessment, design, project management, servicing follow-up and leasing of equipment. Another route might be to base the points of service contact around the internet, as with EasyJet and Amazon.

Successful HOUSECO services will have to be 'deeper' than the current offerings from utilities or social enterprises in energy efficiency. Ideally, such a service would offer different levels of support, addressing different segments of the market. At various stages of the service, HOUSECOs could offer information and resources for a more DIY approach for individuals or groups who want to be more active. The economics will also have to be very different from the existing approaches such as EEC. This point is explored further in the following section.

Elements of a new home energy service

An ideal new home environmental service would have the capacity to take the householder right through a process that included the following elements:

- Comprehensive audit
- Advice and information tailored to the outcome of the audit
- Choice of appliances, products and installers
- Management of installations and quality control
- Finance options
- Follow-up audit with certification of emissions
- Regular check-ups
- Help with behavioural change.

First point of contact

The most difficult challenge for a HOUSECO will still be getting to the first point of contact, since motivation is still weak and fragmented. Much current provision for able-to-pay households relies on the householder being proactive (eg, approaching an EEAC). However, some utilities have started to advertise energy services proactively.[73]

Experience from the UK is that schemes approaching the householder directly, working property-by-property, stimulate higher rates of action, but it is still difficult to get take-up. This has even been the experience in Canada, where the federally-funded *EnerGuide for Homes* package offers an excellent pressure-testing based energy audit, with follow-up and a cash incentive. The programme allows an assessment of the whole house and recommends a package of measures fitted to each particular house. It has achieved average carbon dioxide emissions reductions of 27% per home and cuts in energy bills of between 30% and 50%. Nevertheless, a total of only 14,600 households had been retrofitted up to January 2005.

The market for home environmental services will be segmented and will need marketing to make it appeal to different groups. Some fair trade product companies have been successful in expanding outside their committed niche market by identifying those who

might be interested in buying fair trade if the product is as good as mainstream products (mostly women aged 25-45).

The marketing message - energy savings, cost reduction, climate impact, intelligent household management, aspirational products and service - will need to differ according to market segment. Certainly, for some, 'energy efficiency' has negative connotations, is seen as a tired concept, and is already being re-branded (eg, 'Smart Energy').

Marketing the service is also closely bound up with the first point of contact. The RED team proposed that a good approach would be to utilise one of the most powerful marketing techniques - viral marketing. **Energy Parties** would use the approach of Ann Summers or Tupperware parties to capitalise on friendship networks. It would also mean that householders meet the service expert, the House Trainer, in small groups of friends and family, giving people confidence and making the whole experience of audits, receiving information and buying products more fun.

The energy (or environmental) audit

The audit is a crucial point in the service relationship, and can really impact on the subsequent motivation of the householder. Undertaken on site, it provides a detailed energy diagnostic of the particular house, and suggested actions (with their costs and returns). Equally important it establishes a relationship between the householder and the service provider, and provides evidence of the quality of support that is offered.

Crucially, the audit also establishes the possible scope of metrics. For example, the EnerGuide for Homes programme in Canada is meticulously assessing homes before and after measures so as to be able to establish verifiable emissions reductions for use in carbon trading at some point in the future. Shallower audits could not do this.

In the UK, as we learned from the experience in 222b Lee High Road, there are a number of different professional audit types and energy rating standards (see box). This contrasts with the situation in Canada, where only one is used. The advent of the Energy Performance Report in 2007 may drive the adoption of a single standard.

The ideal audit would combine elements of accuracy, fun, impressiveness and a neatly packaged report for the homeowner at the end. The audits we had done in Lewisham ranged from brief telephone or self-completion questionnaires about energy use and building condition, through to thorough audits by professionals with follow up advice on-site. The former are cheap, but give minimal information and motivation. While they

fit an EEC mode of energy efficiency programme, they are unlikely to work well for an able-to-pay offering.

Home visits by professionals, especially those involving pressure tests are more accurate, and are also much more impressive for the householder. Home visits that can give on-the-spot results also have a big impact. Again, the Canadian EnerGuide for Homes audit scores highly, with a four–page colour report of results and suggested measures printed off for the householder at the end of the audit. Above all, however, the audit must be seen not just as a technical assessment, but a central part of the marketing of the service. Auditors' skills in relating to householders will be as important as technical accuracy.

SAP v NHER – UK Energy rating systems

The Standard Assessment Procedure (SAP) is the Government's recommended system for the home energy rating. It will form the basis for the Home Energy Performance Report at the point of sale. The SAP energy cost rating is based on energy costs for space and water heating only. A SAP rating is required for all new-build dwellings and those which are undergoing significant material alteration (such as the addition of an extension). Housing associations and councils which own stock are all required to submit average SAP figures for their regions so that government can monitor the amount of energy used, and associated carbon emissions, from domestic dwellings in the UK.

The current version of SAP is 'SAP2001' (v9.70). It has a scale of 1 to 120. 1 being very poor, and 120 being excellent. A typical SAP for an average house in England is about 45. A 'SAP2001' rating on a house built to current Part L building regulations would be closer to 80-100 or more SAP points.

The National Home Energy Rating rating takes into account the local environment and the effect it has on the building's energy rating. The NHER calculates the costs of space and water heating as well as cooking, lights and appliances. This is why the NHER is more accurate than the SAP. The NHER was conceived as a rating with a scale of 0.0 to 10.0, 0.0 being poor, and 10.0 being excellent.

The NHER rating can only be calculated using computer software as supplied by National Energy Services (NES). It first emerged in 1983 at the Energy World Exhibition in Milton Keynes, and later the government used a simplified version of this model which could be calculated by hand. This became known as SAP.

Following up

The audit opens the door to the service. Any number of advice options could be taken. An ideal service would be able to help with the full range of questions and problems

that householders might have, including advice on appliances, conserving energy through behaviour change, on reading bills, installing smart meters or energy efficiency measures, changing boilers, even on how to export electricity from a solar PV system. Comprehensiveness is a key selling point, as existing services often suffer from offering only particular products, or separate energy efficiency from home generation. For the householder these distinctions are arbitrary. They live in the whole house, and experience its peculiarities every day.

Two of the most important follow up areas will be how to get energy efficiency or home generation installations done, and how to finance them.

Installing energy measures

In some energy efficiency programmes (including many of those funded through EEC) the utility or sub-contracted organisation handles the relationships with contractors and negotiates bulk discounts. At the other extreme, (as with many EEAC phone based services), the householder may get little if any information about installers. In the middle, some organisations and local authorities do keep lists of approved contractors to try to tackle the problems of lack of trust.

What most householders want above all is a simple, reliable, hassle-free way of tracking down the most trustworthy contractors. People with less knowledge of building work will also want some form of hand-holding. Home environmental service providers could rely on the trust established with householders through the auditing and advisory stages, and use long-term contracts, help with parking and so on, to retain the best installers. National and local accreditation schemes would help. For example, a scheme for London with the backing of the Mayor's brand would be valuable.

Another approach would be to build on the potential of collaboration in peer-to-peer installer recommendation, through e-Bay type systems, such as www.contractors.com in the USA.

The RED team came up with a package backed by a major retailer to provide confidence and convenience, and offering the benefit of bulk discounting, yet ensuring that the householder remains firmly in control. The result was **Job Done** – a group buying and home installation management system that is on the side of the home owner, and run and quality-assured in this scenario by a home improvement retailer such as B&Q.

Home-owners wishing to make energy efficiency improvements (or have other jobs done) can sign up online. When there are six people within an area signed up, the collective job is managed and quality controlled through a local project manager (who

would also look after any grant applications associated with energy efficiency work or renewables installation). People can encourage friends or neighbours to join their group to speed things up. There would be incentives to get more members ('Get 15 people and get a 20% discount'). All home-owners are required (or incentivised) to give feedback on contractors and project managers after the work is done.

The JobDone concept has been pioneered both in Canada and the UK, and combines benefits for all those involved, in addition to the service for the customer. The installers sub-contracted by the retailer get a steady stream of work, bundled in smallish areas, so cutting down their travel costs considerably. The retailer negotiates issues like parking with the local authority, and the JobDone brand is valuable as well. For the retailer the scheme also makes sense. Costs are largely covered by a fee from the customer, and by a small fee from the sub-contractors to be part of the system. But the valuable part of it for the retailer is the related sale of insulation, draught-proofing and other building materials.

Finance

Although the target market is able to pay for energy efficiency measures, or even wind turbines and solar PV cells, the Canadian experience suggests that the availability of low interest loans with repayments made via utility bills is a significant incentive for take up.

Energy efficiency measures and micro-generation involve an initial investment, which then yields a flow of savings or revenue. Although the amounts involved are smaller, the complexity can be of a similar level as mortgages, and models from financial retailing – such as the home visit from the financial adviser, with a laptop to display options - are obviously relevant.

Re-visits and continuous service

The fullest energy services concept – contract energy management (CEM) – involves a continuous service, where the service provider takes over and runs all aspects of energy for the client within certain contracted limits. This could be a top-end market offering for home environmental services too.

Certainly, some form of follow-up visit is essential. In Canada, follow-up audits and the prospect of a cash-back incentive within 18 months of the initial audit are a good driver to remind householders to undertake measures. They also enable verification of emissions reductions, as opposed to estimates based on models.

Periodic visits can be a spur to changing energy use behaviour and maintaining changes. They can be opportunities to learn about new home energy monitoring

technologies, and help with queries about bills. While the marginal costs of such later visits are low in relation to the initial contact and audit, the regular contact with householders can also be valuable for other institutions as well, which can help with the economics of the service.

Overall, the HOUSECO concept is not just about a 'deeper' version of existing energy efficiency programmes, but rather is a repositioning of a distributed system, with the householder as active agent.

9 The economics of the new energy support service

The economics of existing energy services

The economics of domestic sector energy efficiency are currently dominated by the Energy Efficiency Commitment, running at £450 million a year, and funded via a levy on customers' bills. However, while total EEC resources are considerable, they are spread thinly.

There are no national figures for the EEC spend per household. In the Newham Warm Zone programme, the average spend was around £290 per household receiving measures, of which EEC funding was only £83 per household. The majority of resources go to fully fund measures on priority households – effectively those in fuel poverty. For the fuel rich who have access to an EEC funded programme, the subsidy on offer may be in the region of £50-100. Because they have made up their quota of non-priority households, some utilities are now offering little more than the equivalent of two free low-energy light bulbs.

At the other extreme there are the paid-for specialised professional services. The professional auditors we used for surveying 222b Lee High Road cost between £120 and £180 an hour simply for auditing services. The renewables advisory company, Encraft, offers services ranging from online advice on single renewable technologies at £55, up to a full project specification from £295, with home visits costing an extra £200.[74] Few domestic households use these services, and as with the contract energy management market, the demand is mainly from companies.

A business model for the able- to- pay sector

New support services for those able to pay cannot work on the basis of the EEC and similar schemes. The kinds of services and products discussed in the preceding sections are too expensive. Also, as the examples above show, there is little current demand for the existing commercial 'deep' auditing services. A household environmental service relying on householders paying a realistic sum for the service must make offerings that effectively provide benefits that the householder would pay more for elsewhere, or separately:

- *Information*

  Home environmental services would provide economies of information on the whole range of energy measures, including new technologies. The value increases even further if energy is bundled into a wider package of environmental support service, realising economies of scope.

- *Cheaper products*

  HOUSECOs can negotiate discounts with suppliers, from basic insulation products right up to appliances. If clients can find others to form groups of, say, five or ten, then discounts can be bigger.

- *Certainty and quality*

  The service slashes transactions costs by removing uncertainty around installers.

- *Client control*

  Unlike existing programmes, the HOUSECO service would be built around client choice. Clients effectively co-design the whole approach taken to energy management, and which measures happen when. The approach allows the integration of energy work with other building or plumbing work (eg, managing the fitting of PV at the time of roof repair).

- *Outcome incentive*

  The service would carry with it an outcome incentive in the form of contribution to investment costs (as in the Canadian model) or a contribution to the Power Pension.

For the HOUSECO, the two primary sources of revenue would be client payments and a public contribution to the audit fee. These would be supplemented by a number of other revenue sources:

- *Selling access*

  A deep service model involves access to a household, which is valuable to other organisations trying to engage the attention of, or obtain information from, that household. Acting on behalf of other commercial organisations may quickly reduce trust, but selling access time to non-commercial bodies such as charities or local authorities may be feasible. The Green Communities programme in Canada successfully followed this route in the 1990s when federal funding was cut.

- *Discounts*

  Any discounts negotiated with suppliers can be shared with the users on a 50:50 basis.

- *Aggregating*

  If energy efficiency measures or renewable energy installations lead to verified carbon dioxide emissions reductions, then a programme could investigate the possibility of tapping into the growing offset market.[75] A related option from 2008 might be to negotiate involvement in the EU emissions trading scheme. Verified

emissions reductions – currently worth around 23 Euros (£16) per tonne of carbon dioxide – could be aggregated and sold onto the market, although the costs of verification would have to be put against this return. A service offering a leasing option for micro-renewables could sell or trade the excess power, and also realise the ROCs.

There is a strong case for public financial support for deep environmental support services, especially if they are run as not-for-profit social enterprises and if they succeed in mobilising large amounts of private investment in energy conservation and renewable generation, and accelerating the delivery of government policy.

This could be financed, for example, from an expanded EEC or out of the Climate Change Levy, only a small part of which is currently ear-marked for use in the climate change sector through the Carbon Trust.

10 Policy for co-created energy services

The new energy system will largely be delivered through commercial or social enterprises. But it will also need supporting regulation and policy. In this section we highlight just some of the policy changes that will be needed. Again, we follow the design principle – start from householder, whether as energy purchaser, producer or taxpayer. The following policy ideas are grouped according to the issues explored above – householders as active energy managers, as producers of energy, and policies for a new generation of home environmental services.

Policies for active household energy management

We have argued that transforming householders into active managers of energy is about creating a culture, which can only be done through connecting with individuals' aspirations and what has meaning for them. Regulation, however, can play an enabling and supporting role, in two particular ways. One is in aligning financial and fiscal incentives with that culture, rather than working against it. The second is by raising the bar on energy information.

Creating incentives for energy retrofits

This could work in a number of ways. Many have argued for council tax or stamp duty rebates to be linked to energy saving investment.

The new Home Energy Performance Report, due in 2007, will be a useful tool for raising awareness, both of a dwelling's current state, and what might be done to raise its energy rating. This brings homes into the same orbit as appliances.[76] But a much greater impact could be achieved by making it a requirement for obtaining a mortgage to raise the energy rating on the mortgaged property to a specific standard. The costs of deeper audits and of the retrofits would be folded into the housing transactions (just as structural surveys are) and repayments would become part of the mortgage.

The incentive effects would be two-fold. First, where the works required are significant it would have the effect of reducing the price of the house. This itself would be an incentive for the seller to undertake the work beforehand. Second, if the requirement was coupled with the proposal for a power pension, there would be a further incentive for the seller to make the retrofits and claim the credit, or forego the credit to the buyer if the work was not done.

Action on metrics

Ofgem is soon to start requiring information on bills about energy use over the previous five quarters, which is a step in the right direction. However, this remains a secondary

function for bills, which are designed for a different purpose. Information on gas, electricity and water remains fragmented, and bills come at different times.

For independent, imaginative and integrated representation of data from all energy and water use together in one place (see My Energy Report above) the current rules on data held by utilities would have to be changed. This would also be the case for the comparison of data by locality. It is now possible to discover how much a house down the road sold for, but not how much energy it uses. There is a strong case for requiring utilities to make public a register of usage by groups of households in a way that does not breach the Data Protection Act.

At the heart of the data issue is smart metering, already a technological reality for electricity. We need policies to accelerate its take-up. This could be simply through legislation requiring minimal standards. Some have suggested that this could best be achieved by transferring responsibility for metering from utilities to distribution network operators, as in other countries.[77] However, this would leave little space for the development of a market for the kind of monitors we described above, in which manufacturers compete to produce ever more intelligent and handsome products that householders actually want to own and use. Responsibility for metering – just as with other appliances – should lie with the householder,.

Related to this is the future of appliance labelling. Boardman et al (2005) point out the need to shift labelling from energy *efficiency* to energy *conservation*. However, with the possibility of a new generation of more intelligent appliances, that can sense system conditions and adjust appliance load accordingly, there is a good case for a new appliance intelligence rating, perhaps from 'dumb' to 'smart'.

Policies for household production of energy

A whole range of measures would help the growth of micro-generation, both renewables and low-carbon CHP. Many of these are currently under discussion in government consultations.[78]

They include provision for two-way metering, a guaranteed and high renewable feed-in tariff for surplus power, permitted development status for renewables like wind turbines and solar PV cells, and simplifying the export of power and the claiming of Renewable Obligation Certificates. There is also an urgent need for accreditation and standards schemes in new technologies, along with support for training more installers.

Home generation opens up the possibility of individuals and groups swapping or trading power across the distribution network in Home Energy Trading Schemes

(HETS), but there are still some regulatory and policy barriers. Such groups would encourage the further growth of micro-renewables, and so should be assisted, but at the same time they need to be regulated. The licensing regime would have to be amended,[79] and to help HETS, the government could require distribution network operators to waive their service charges.

Policy for new home environmental services

Current thinking about energy services revolves around the need to create the possibility of longer-term contracts to incentivise utilities to offer such services. Ofgem is currently running a limited experiment in allowing such contracts.

However, other policies may be just as important for stimulating and supporting the emergence of home environmental service companies, or HOUSECOs. Given the need for new business models outside of the standard utility approach, these are as likely to come from other sectors, such as retail, concierge services or other consumer services.

This is also a sector where social enterprises could do well. As argued above, there is a case for public support for HOUSECOs if they mobilise household investments leading to emissions reductions. Funds for such support could be hypothecated from the Climate Change Levy or from an expanded EEC. EEC3 should be designed so as to tax the profligate and support those who invest in energy conservation. This could be done, for example, by a levy on energy *usage*, in relation to benchmarks for housing type and size. To ensure that vulnerable groups unable to take action do not get penalised, there could be a cap for pensioners and those on benefits.

As with existing energy efficiency schemes and the home renewables sector, the growth of HOUSECOs will depend on skilled labour. Support for training is a key requirement, not just in technical skills, but also, crucially, in people skills.

Beyond resources, as a new sector, HOUSECOs would benefit from the creation of accreditation schemes, standards and charter-marks. These could be both national and regional (for example, the Mayor of London could use his powerful brand to set a high aspirational standard for HOUSECOs in the capital).

11 Climate change and culture change

Climate change is the greatest environmental threat we have faced. It also represents a major opportunity. The imperative to reduce carbon emissions means that we are having to radically re-think energy policy and look beyond simply delivering low cost commodity energy.

In the UK we are approaching a crossroads. One road is curiously familiar, leading back towards the already travelled territory of nuclear power: massive corporate (or even government) investment in large-scale electricity generation, plugging into the ageing, centralised system for one-way delivery of electricity to homes and businesses. Elements of this model even drive much of the current policy towards renewable power, which is taking the form of large windfarms feeding into the National Grid.

The other road takes us into terrain that is now commonplace in communications but is less familiar in energy. Here everything is turned on its head. Complexity is distributed to the margins, not concentrated at the centre. Electricity flows in multiple directions through the distribution networks. Energy needs are no longer provided by utilities, but rather active, intelligent users *and* producers of energy are supported by home environmental services companies. Householders get more of the power, heat and light that they want out of less carbon.

As is to be expected, changing a system is much harder than changing (or in this case reviving) a technology. There are multiple points of resistance and skewed incentives. The transformation requires both technological innovation and cultural change. The signs of system shift are already there, and the opportunities for new services are clear. Design will play a key role as a midwife of this change..

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Notes

[1] GLA (2004) *Green light to clean power: The Mayor's Energy Strategy* p 27
[2] Ibid. p. 24.
[3] 2004 data. DTI, *Digest of UK Energy Statistics*, July 2005, pp 14, 21. In London residential households account for 44% of energy demand. GLA (2004) *Green light to clean power: The Mayor's Energy Strategy* p 13.
[4] Partly because of de-industrialisation, especially in the steel industry (Mitchell and Woodman pp 25-34). See also Climate Group 2005
[5] Boardman et al 2005 p 11 and Ch.s 3 and 4
[6] Looking ahead, there is potentially huge new source of electricity demand – domestic air conditioning. Global warming will bring higher summer-time temperatures, especially in cities. Demand for air conditioning could rise sharply with an increase of a few degrees in temperature (Levermore et al 2004). In the USA, about 40% of electricity demand is from air conditioning.
[7] "Carbon dioxide emissions rise despite climate change pledge", *The Guardian* Tuesday August 2, 005
[8] DEFRA 2005, *Review of the Climate Change Programme – A Consultation Document* Section 3
[9] "Decision on nuclear power by end of 2006" *Financial Times* 29/9/2005
[10] Boardman et al 2005 p 5
[11] DTI 2003 p 32
[12] DTI 2003 p 33
[13] To put this into perspective, the EU Emissions Trading Scheme is expected to deliver emissions reductions for the UK of around 2 million tonnes. (Mitchell and Woodman 2004 p 8)
[14] The number of households living in fuel poverty (defined as households spending 10% of more of their disposable income on fuel) has come down since 1997. However, in 2003 the main anti-fuel poverty programme, Warm Front, was criticised by the National Audit Office report for failing to target its grants adequately to reach the fuel poor (*Warm Front: Helping to combat fuel poverty* Report by the Comptroller and Auditor-General, HC 769 Session 2002-2003: 25 June 2003). Similar problems have arisen in the Warm Zones schemes (*Warm Zones External Evaluation Second Report* EST/NEA/CSE August 2004). Recent rises in fuel prices have undone many of the gains of fuel poverty schemes.
[15] Ofgem, A Review of the Energy Efficiency Commitment 2002-2005, August 2005
[16] Claimed savings for the EEC are calculated using the BRE Domestic Energy Model (BREDEM), and depend especially on assumptions about how much of the improved thermal efficiency of housing and heating systems simply leads to higher indoor temperatures rather than lower energy use – so-called "comfort taking". For poorer households comfort taking can be more than 50% of theoretical energy savings (NAO 2004 p 25). There is also some uncertainty about whether people know how to use new heating systems when they are installed. A recent survey of people living in housing association homes showed that 32% of respondents did not know how to use heating controls in their homes (ACE 2003). Independent assessments of claimed savings from earlier energy efficiency programmes found that actual savings were a half to a third of what was expected (NAO 2004 p 25). There are no independent assessments of the claimed savings of EEC1. The assumption underlying the BREDEM model are being changed for EEC2, with lower impacts for loft insulation and low energy light bulbs, for example (DEFRA, 2004, pp. 2-3). The Association for the Conservation of Energy notes that: "If the illustrative mix of measures under EEC 1 were subjected to this new set of assumptions, the TWh figures would fall back down from 81 TWh to 66TWh." (ACE 2004, p 2).
[17] Indeed, previous energy efficiency predecessors to the EEC produced significant claimed savings over the 1990s, but could not prevent electricity use increasing 14% between 1994 and 2001 (NAO 2004, p 23, DTI 2005a). Moreover, the emissions impact of the EEC may bring diminishing returns going forward. While EEC2 has somewhat larger targets than EEC1, there is likely to be a shift towards a fairly narrow focus on cavity wall insulation, which will largely save on lower-emission gas, rather than electricity. And as we have seen, electricity is the fastest growing element of domestic energy use.
[18] The Newham Warm Zone, one of the more successful such schemes, achieved take-up of energy efficiency measure in over 12,000 households out of Newham's total of 92,000 ("EDF Energy East London Warm Zone – An introduction"). Similar rates apply to Powergen's Heat Streets project.

[19] The utilities are incentivised to focus on the single measures that deliver the maximum benefit for the lowest cost. This is currently cavity wall insulation. As a result schemes are heavily supply driven. If a house has a single-skin brick wall, as do Victorian-era homes in the inner cities, it will tend not to benefit from the EEC.
[20] This topic was aired at a charette at the Design Council on 25th May 2005, based on the approach of the Canadian Energuide for Homes programme. There was some agreement that the BRE model underlying the SAP Level 1 audits should be re-examined. Interestingly, householders often want draught-proofing measures that the EEC programme does not offer.
[21] Ofgem 2005 p. 71
[22] James Meek, "Back to the future" *The Guardian* 4/10/2005
[23] 70% of UK industrial energy use was covered by CEM in 2003. The industrial energy services market in the UK, Germany and France is estimated to be worth more than 2 billion Euro ("Energy management services in Europe to 2006", *Datamonitor* 20/3/2003)
[24] Green Alliance 2004, pp 16-17
[25] Ofgem's position is that the 28 day rule applies only to the supply of gas and electricity, not to energy services – see Ofgem 2005a Nevertheless, they have embarked on a 2-year trial pilot suspension of the 28 day rule for up to 4% of customers for any one utility, to encourage long term energy services contracts.
[26] For example, British Gas is currently making a loss on its retailing operations.
[27] Mintel (2005) *Residential Energy Efficiency (Industrial Report) - UK*
[28] Boardman et al 2005 pp 15-16. The development of energy labelling for homes, to be introduced in 2007 as part of a Home Condition Report used in selling a house, is modelled on appliance labelling, clearly with the hope that it will have a similar effect.
[29] Ibid p 50
[30] ACE 2003
[31] Patterson 2004, pp 1-3
[32] ibid p 7
[33] Greenpeace 2005, p. 24
[34] e.g. Awerbuch 2004, Green Alliance 2004, Patterson 2004, Greenpeace 2005.
[35] Markvart and Arnold 2005
[36] DTI (2004) *System Integration of Additional Microgeneration*
[37] Parliamentary ref.
[38] Awerbuch (2004).
[39] Awerbuch (2004), Responsive Load submission?
[40] A, Jones (n.d.) "Woking: Energy Services for the New Millennium" http://www.forumforthefuture.org.uk/uploadstore/GenH_Jones.pdf
[41] Greenpeace 2005, p 36, Green Alliance 2004.
[42] Braintree Council in Essex became the first local authority to offer a reduction in Council tax of £100 for those households commissioning cavity wall insulation
[43] Halpern et al 2004
[44] English House Condition Survey 1996
[45] "Power switching on the up" *Utility Week* 12 August 2005, p 16
[46] Cottam and Leadbeater 2004, p.29
[47] DEFRA 2001
[48] The concept of co-creation in health services is explored at length in Cottam and Leadbeater 2004
[49] http://www.electrisave.co.uk/
[50] Darby 2005, Energywatch 2005 *Get Smart: Bringing Meters into the 21st Century*
[51] Energywatch 2005 *Get Smart: Bringing Meters into the 21st Century*
[52] Personal communication, DIY Kyoto
[53] http://www.open2.net/home/go?jsp=interacting. See also http://www.h2ouse.org/tour/index.cfm
[54] Such functions could draw on appliance labelling information and on the SEDBUK online system for boiler efficiency measurement.
[55] *Utility Week* 9 September 2005, p 23
[56] e.g. Tyndall Centre 2005, p 55; Green Alliance 2004; Boardman et al 2005 p 101

[57] Halpern et al 2004 note that carrots are more effective at motivating than sticks.
[58] Greenpeace (2005) *Decentralising Power: An energy revolution for the 21st century* p 15. Catherine Mitchell has used the term technological momentum to describe the UK power system.
[59] Green Alliance 2005, p 6
[60] Greenpeace *Connect* Autumn 2005, p. 2
[61] Presentation by Powergen, CHP Association members briefing, 5th July 2005
[62] e.g. Renewable Power Association 2005, London Assembly 2005, pp 12-15, Green Alliance pp 25-27
[63] In the UK in the last 5 years [check], only £13 million has been spent in support of micro-renewables.
[64] Ofgem 2005b, pp 19-20
[65] Presentation by Andrew Lee, Divisional Manager, Sharp Solar Solutions, to a Renewable Power Association conference on Micro-Renewables, 9th June 2005.
[66] Ofgem 2005b, p
[67] Green Alliance 2004, p 21
[68] On microgrids and their capacity to load share with micro generation, see Markvart and Arnold (2005)
[69] Jeremy Rifkin (2002) *The Hydrogen Economy*
[70] For example, 70% of plumbers in the UK are over 55 years old and there is an estimated shortage of 5,500 plumbers in the south-east of England. This is a problem not only for the fitting of condensing boilers, but also for solar thermal water heating systems.
[71] Quoted in *The Guardian* 4.10.05
[72] See Maxmin and Zuboff (2002)
[73] For example, British Gas places banner adverts for boiler servicing and other measures on Yahoo.
[74] **http://www.encrafthome.co.uk/ourservice/pricing.html**
[75] At present, this would not yield much income. Currently, offset companies such as Climate Care buy offsets at around £6.50 per tonne of carbon dioxide, and savings from a programme might be in the region of 1-2 tonnes per household. However, the demand for offsets is growing, and a premium rate might be negotiable with a large corporations.
[76] This is a strong point made by Boardman et al 2005. They make the argument that market transformation should also be applied to housing, with a much higher rate of demolition and replacement.
[77] Energywatch 2005. In many other European countries, the networks arte in the hands of local public authorities. In the UK they are run by private monopolies who have an incentive to minimise investment in intelligent metering
[78] DTI, 2005b, Ofgem 2005b
[79] Currently HETS would have to become licensed suppliers, at considerable cost, to partially supply members, as so-called "meter-splitting" is only permitted to licensed suppliers. Ofgem should consider creating a new category of HETS which are permitted to partially supply but not to be fully licensed.