Smarter, Greener, Cheaper

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Joining up domestic energy efficiency policy

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Executive Summary

Key findings

Reducing energy use and improving the energy efficiency of the UK's homes could provide some of the cheapest ways of meeting the country's carbon targets, as well as helping householders to counter the effect of rising energy bills. This report looks at potential improvements to current energy policy to reduce energy waste in the domestic sector. The report finds:

- International examples of energy efficiency programmes have delivered cost-effective alternatives to building new power generation or supplying more gas to heat homes. Studies of different energy efficiency programmes show costs range from £8 to £40 to save a MWh of electricity (see Figure ES1). This compares to around £80 to generate a MWh of electricity using a gas-fired power station.
- Moreover, such energy efficiency programmes offer a significantly cheaper way of reducing carbon emissions than some of the more expensive renewable and low carbon technologies that are currently subsidised in the UK (see Figure ES2).
- Behavioural energy programmes, which encourage people to use less energy in their homes without installing any new equipment, are potentially even more cost-effective than installing technical measures, such as insulation. Such schemes aim to change how people use energy, and could include measures as simple as turning off the heating when you leave the home or washing clothes at a lower temperature. Behavioural programmes include: 'nudging' schemes

that compare a household's energy use to a more energy efficient neighbour; providing simple advice on how households can cut energy use; or community schemes to cut energy use by a group of households. International examples show that comparative billing can deliver cuts in energy use at a cost of just £16 per MWh of energy saved. One rigorously-tested, but still small-scale, UK example of comparative billing combined with energy-saving advice has cut gas use at a cost of just £11 per MWh. While evidence on the potential of such behavioural programmes is limited, particularly on a national scale, their potential should be explored. It is hoped the roll-out of smart meters will allow more rigorous testing and expansion of such programmes.

Figure ES1. Cost of reducing energy demand in energy efficiency and behavioural programmes (£/MWh)

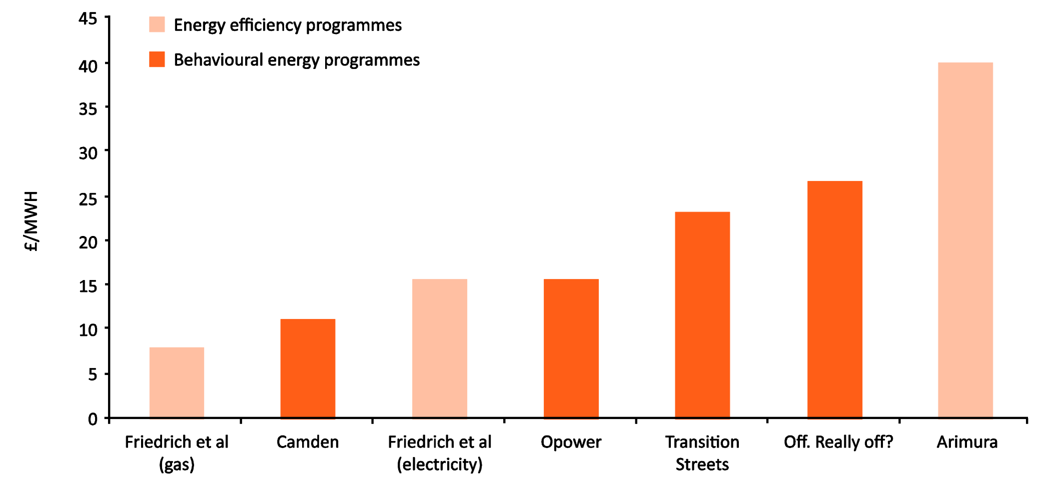
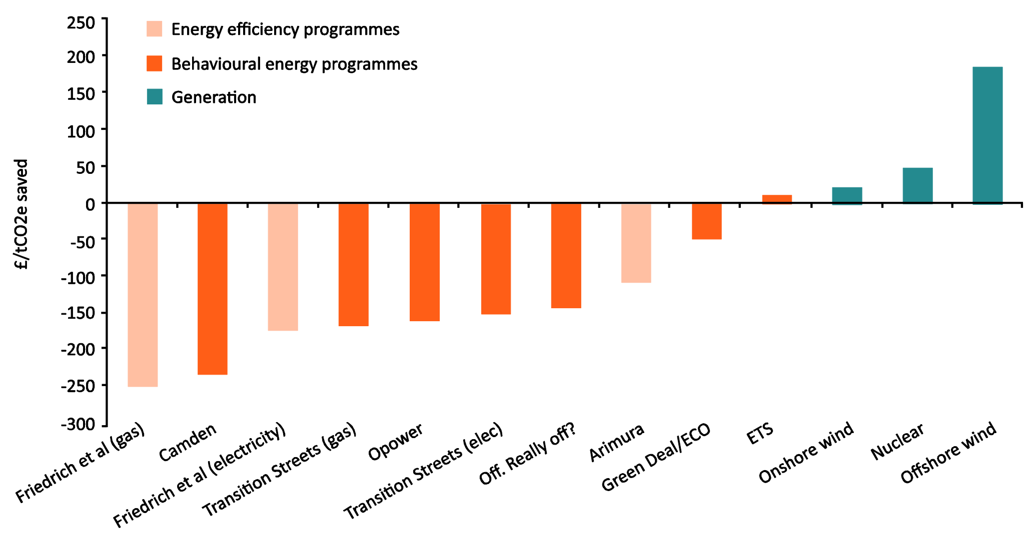


Figure ES2. Cost of low carbon generation vs energy efficiency in reducing carbon emissions



- This report considers three options for encouraging the greater use of behavioural energy programmes in the domestic sector:[1]
    - A Premium Payment or Feed-in-Tariff for electricity efficiency (EEFIT).
    - Using the proposed Capacity Mechanism (part of wider Electricity Market Reform) to incentivise long-term demand reduction.
    - Changes to the Energy Company Obligation (ECO) to allow behavioural programmes to compete for subsidy if they can demonstrate energy savings.

Our analysis found that changes to the Energy Company Obligation offered the best option for supporting the greater use of behavioural energy programmes in households. Unlike the other approaches, ECO could support programmes that help cut both electricity *and* gas use. Its structure could allow third parties, such as charities and companies who are expert in behaviour change, to compete for the ECO subsidy. It may also help lower the overall cost of the ECO programme, which is paid for through energy bills.

Background

Over the past 30 years, reducing energy demand and improving energy efficiency in the UK's homes has been less of a priority for policymakers than supporting new supply. The challenges of cutting carbon emissions and helping households deal with rising energy bills means that energy efficiency is receiving more policy attention. The establishment of the Energy Efficiency Deployment Office (EEDO) in the Department for Energy and Climate Change (DECC) and the current consultation on how to incentivise reductions in electricity use reflect this. At the same time, the government is introducing the Green Deal and has replaced the main domestic energy efficiency policy, the Carbon Emissions Reduction Target (CERT) with the Energy Company Obligation (ECO). While CERT has successfully subsidised cheaper energy efficiency measures like loft insulation and cavity wall insulation, ECO will focus on subsidising more expensive technologies like Solid Wall Insulation. The government hopes that households will now pay for the cheaper measures themselves through the new Green Deal. Government estimates that the subsidies for measures through ECO will add around £50 to every household's energy bills, although there are fears that because the policy supports expensive insulation measures such as solid wall insulation, the real cost could be more than £90. Of course, those households who benefit from the energy efficiency measures will likely use less energy and therefore benefit from lower bills.

Alongside these changes, energy suppliers are starting to install smart meters in homes across the UK. By 2019, every home in the UK should have a smart gas and electricity meter. This technology will be able to send electronic data about households' daily or even half-hourly energy use to suppliers (unless customers opt-out). At the same time, data about energy use will be available immediately to households through in-house displays, allowing immediate feedback on which activities consume the most energy. The hope is that this will help people understand where they could cut down energy use without changing their lifestyle. However, the literature suggests that installing smart meters will not, on its own, lead to significant energy savings. Smart meters are a technology that could *enable* energy savings, by helping householders better understand their energy use and make appropriate savings, but they will need further support to cut energy use.

Currently, it is difficult and potentially expensive to prove that energy efficiency programmes, including programmes that aim to change how households use energy, have led to real savings. Data from existing electricity and gas meters is not frequently collected. Smart meters offer the opportunity to make it easier to prove when customers have made real reductions in energy demand.

The potential rewards to successfully reducing demand are considerable. A 5% annual reduction in energy use would lead to customer savings of £7.8 billion over the next two decades. The most-rigorously tested UK example of comparative billing and energy efficiency advice saw households cut energy demand by 6%. This could lead to a saving of £76 on the average household energy bill[2] (although caution is needed over whether small-scale schemes can be replicated on a large scale). Reducing demand and improving energy efficiency also offer some of the potentially most cost-effective ways of meeting the UK's carbon targets. There is significant potential for reducing energy use in the UK's homes. DECC analysis has identified potential for annual savings of around 80TWh, out of annual domestic energy use of 500TWh. While policymakers should be cautious about whether such savings can be realised (and how much it will cost to deliver such dramatic changes in household energy use), further exploration of measures to cut energy waste is imperative.

Public acceptance of smart meters

Despite the promise, there are major concerns that the smart meter roll-out could face considerable public opposition. There are worries about the overall cost of the programmes (currently estimated at £11 billion), whether the technology is mature enough and, crucially, whether people will want more detailed data on energy use to be available to energy companies. If the planned roll-out of 53 million smart meters over the next seven years is botched or a large number of households decide not to make their data available, the potential of the technology to help deliver energy and carbon savings will be severely curtailed.

Overcoming opposition and suspicion of what happens to the new data generated by smart meters will require a sophisticated communications approach which emphasises the infrastructure improvements that smart meters represent as well as the potential bill (and carbon) savings. It will require motivating civil society groups, encouraging word-of-mouth success stories and reacting quickly to any problems. This report includes findings from an expert roundtable on how to help ensure public acceptance of smart meters.

Policy recommendations

It is imperative that different policy instruments – including ECO, Green Deal and smart meters – complement each other to deliver the cheapest possible energy and carbon savings. The following policy recommendations provide steps to ensure domestic energy efficiency policy is joined up:

1. Allow behavioural energy programmes to compete for ECO subsidy. Behavioural energy programmes that can demonstrate real savings in electricity and gas demand in homes should be eligible for subsidy under the new Energy Company Obligation. Smart meter trials that use behavioural techniques to change energy behaviour and can demonstrate energy savings should also be included.

Considerable uncertainty about the costs of such programmes remains, so such an approach should only be eligible for a limited proportion of the ECO subsidy at first. However, if the 'pilots' do prove to be cheaper than some of the more expensive 'technical measures' currently subsidised under ECO, such as solid wall insulation, it will bring down the overall cost of the programme to consumers and therefore help keep energy bills lower. Such an approach could also increase awareness of smart meters and encourage households to request installations. To encourage greater innovation, policymakers could allow third parties, such as charities and energy services companies to compete for part of the subsidy (through ECO's proposed brokerage system).[3]

There are genuine concerns about whether behavioural programmes can ever deliver energy savings on a national scale, how energy savings can be proven and whether such savings can be sustained over a long period. The piloting of behavioural schemes through ECO will help develop rigorous methodologies on how energy savings can be verified and if they are additional (i.e. would not have happened anyway). The pilots will also allow policymakers to discover which techniques for changing behaviour work and, importantly, how much they cost. If such schemes prove successful, they should be rolled out more widely and could include programmes that combine behavioural measures with technical improvements, such as improved insulation or replacing light bulbs. A more detailed discussion about how such a scheme would be rolled out is in the final section.

2. Support for energy efficiency through the Energy Bill. Measures to subsidise changes in energy behaviour in the domestic sector through ECO should not preclude introducing an energy efficiency feed-in tariff (EEFIT), to offer fixed payments for verifiable reductions in electricity demand (as the government is consulting on). Such an instrument should allow electricity demand reduction programmes to compete with new low carbon generation, potentially bringing down the overall cost of meeting the UK's carbon targets and energy bills. However, it is unlikely such a measure will support behaviour change programmes in homes.

A new Capacity Mechanism for electricity generation is unnecessary and risks further distorting the electricity market. However, if such a mechanism is introduced, it should allow short-term 'demand response', where shortfalls in generation can be met with pre-agreed reductions in demand, to compete against subsidising back-up power stations. However, it would be wrong to use this instrument to support long-term reductions in demand. The EEFIT offers a better alternative.

3. Communicating the benefits of smart meters. Government must take a sophisticated communications approach to supporting the roll-out of smart meters. In practice this means:

- Working with community and civil society groups to act as champions for the technology, alongside a national advertising campaign that reassures people about the risks and highlights the potential benefits. This should be seen as a complement to the marketing activities of suppliers and not competition. The Digital Switchover should be seen as an appropriate model.
- Where possible, the communications strategy should be co-ordinated with energy companies so that it reflects where the roll-out is taking place. This means working on a city-by-city and regional basis and encouraging different suppliers to co-ordinate roll-out schedules, where such an approach is possible and does not sacrifice the operational efficiency of the roll-out.
- The success of smart meters depends on government and suppliers providing messaging that shows the smart meter roll-out is both an important infrastructure upgrade *and* an opportunity for people to save money on energy bills. As different messages will work for different people, it also needs to make the environmental case for the new technology. It should also be cautious about over-promising what the technology can achieve.

- Smart meter communications must be co-ordinated with other government energy efficiency programmes, such as the Green Deal and Energy Company Obligation. This campaign should highlight that these programmes are working together to help people reduce energy bills, upgrade the UK's infrastructure and improve people's homes.

4. Avoid constraining rules on tariffs. Ofgem and the government's proposals to 'simplify' the energy retail market risk undermining the potential of smart meters to offer innovative tariffs that reward cuts in energy use or switching energy use to different times of day. Ofgem's proposals should be reviewed in the context of the smart roll-out as a matter of urgency.

Introduction, Background and Scope

Energy efficiency and energy conservation[4] have often been overshadowed in debates about UK energy policy. Attention has instead focused on increasing (and decarbonising) generation. In particular, policymakers have been reluctant to tackle how people use energy in the home, assuming that rational households will take up 'low or no cost' measures by themselves when looking to save money on their bills.

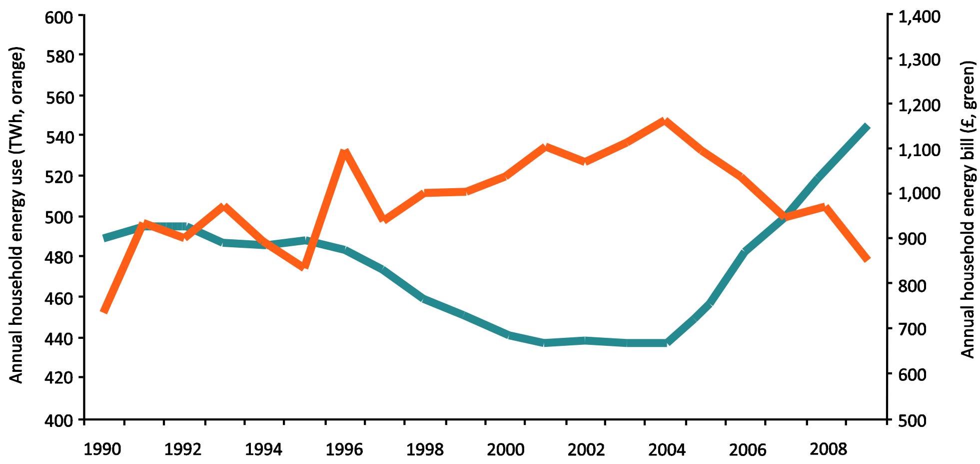
There is a long-term trend for UK households to become more energy efficient. While service demand from households has increased by 50% since 1990 (service demand is, broadly, the services or benefits we get for a unit of energy), overall energy demand has actually decreased by 5% (see Figure 1).[5] This translates to an average improvement in efficiency of 2% per annum.

Alongside this long-term improvement in the energy efficiency of the domestic sector, since 2004 there has also been a sharp reduction in overall demand, as Figure 1 shows. There are two most likely drivers of this reduction. Firstly, energy prices have risen significantly since 2004 (see Figure 1), mainly caused by the traded price of gas, but also increasing costs of environmental and social policies and infrastructure improvements. Secondly, UK governments have increased efforts on energy efficiency through obligations on energy suppliers to support a major programme of insulation and other technical efficiency measures.

Despite these improvements, considerable potential remains to improve the energy efficiency of UK households. The Energy Efficiency Strategy identified 56TWh of cost-effective savings by 2020 in the sector (current domestic annual demand is around 500TWh), mainly through technical measures. It added that there was further potential for savings through changing how people used energy in the home.

The Coalition is taking significant policy steps to try to improve the energy efficiency of the wider UK economy, and in particular to improve the UK's energy inefficient houses. The government is introducing the Green Deal to provide loans for energy efficiency improvements, and replacing the Carbon Emissions Reductions Target (CERT), a subsidy scheme for home insulation and other measures. At the same time, the government has also mandated that every home in the country should have smart gas and electricity meters by 2019 (see Box 1).

Figure 1. Annual UK domestic energy demand vs annual household energy bill



The roll out of smart meters is a major infrastructure project, which is expected to cost around £11 billion. It will see around 53 million gas and electricity meters in the UK replaced over the next seven years. The full roll-out will begin in 2014, but there is a substantial foundation programme in the next two years. At its peak, hundreds of thousands of new meters will be being installed every week.

Box 1. What is a smart meter?

'Smart meters' are electricity and gas meters that are able to transmit data about energy use to suppliers electronically, without the need for manual readings, as is the case with existing 'dumb meters'. This should lead to an end to estimated billing and the opportunity for new tariffs that reward people for shifting their energy use to different times of day. Smart meters can also transmit real-time energy use data to householders via an in-house display (IHD), which will also be offered to households as part of the roll-out. Existing in-house displays, which simply clip-on to existing meters, are not technically 'smart', as they are not able to transmit data electronically to suppliers.

Smart meters offer significant opportunities to change how households and businesses use energy. This report will consider how the roll-out of smart meters, and the improved data they will provide, could allow innovation in energy efficiency policy, potentially leading to both lower bills and cost-effective decarbonisation. It will consider how to learn as much as possible about the technology during the foundation phase and how policy should develop to take advantage of the roll-out.

Alongside efforts on energy efficiency, the Coalition has also sought a richer understanding of how to change people's behaviour beyond using financial incentives and regulation, using understandings from behavioural economics. The establishment of the Behavioural Insights Team (BIT) in the Cabinet Office is a welcome development. The BIT has already looked at ideas to 'nudge' and encourage people to use less energy,[6] and is continuing a series of controlled policy experiments to test what interventions might lead to low-cost energy (and carbon) savings.

Scope

As well as opportunities, there are considerable risks with the roll-out of the smart meter programme, many of which were identified in a report by the National Audit Office.[7] Many of the aspects of Department of Energy and Climate Change's (DECC) chosen design have been controversial. These include:

- Whether 2019 is too soon to roll-out a relatively immature technology across the country, and whether this deadline risks increasing costs for energy consumers unnecessarily.
- Whether the roll-out should have been delivered by suppliers or Distribution Network Operators.
- Whether it is cost-effective or necessary to have mandated gas meters *and* In-House displays in the roll-out, or whether such measures add unnecessary costs.
- Whether the centralised Data and Communication Company (DCC) is the correct institution to manage the flow of data from smart meters, or indeed if such a body is at all necessary.
- The complexity of the computing architecture. Making sure meters are secure and deliver information effectively from the millions of meters to centralised systems is a huge challenge for government and suppliers.

While there are important doubts about whether these policy choices represent the most cost-effective approach, they are beyond the scope of this report. This report will consider the opportunities created by the roll-out of smart meters for policy innovation in the UK. While it will discuss opportunities in the non-domestic sector, its main focus is on household energy use.

The report will also consider the risks of a backlash against the roll-out and how government and suppliers can ensure that the public accepts the introduction of smart meters. This will be crucial if policymakers want to capture the full energy and carbon saving benefits of the new technology. If smart meters are seen as inconvenient, expensive, cumbersome and invasive – and households choose not to have them installed – they risk becoming an expensive failure.

Current Policy Approach

Energy efficiency policy for the domestic sector in the UK has two key characteristics. Firstly, particular energy efficiency policies have tended to be isolated from each other in both design and delivery (and further separated from policy on generation). Secondly, there has been a focus on supporting *technical* improvements to energy efficiency (installation of new technologies in homes and businesses, such as insulation) and less attention on how people make decisions about how they use energy, or 'energy behaviours'.

Energy efficiency policies have not always provided a cohesive direction to participants in the energy market, either suppliers or consumers. Partly, this is a result of overlapping and competing aims associated with energy efficiency policy. Do policymakers encourage energy efficiency to try and deliver the cheapest possible carbon reductions or because of concerns about fuel poverty? Often policy measures have been designed to try and achieve both tasks. Despite its name, the Carbon Emissions Reductions Target (CERT) also aimed to improve the quality of homes for the poorest households. While an understandable objective, the effect of this is to make the carbon savings more expensive than they might have been. At the same time, different policy measures have developed separately. It is not yet clear how the development of the Green Deal and Energy Company Obligation has fully considered how the roll-out of smart meters could change how people use energy. Equally, taxation policy provides unclear signals to households. While a carbon price is applied to domestic electricity through the EU Emissions Trading Scheme (ETS) and other policies, there is no such signal on gas used for domestic heat.[8] There is a low rate of VAT on energy efficiency materials, such as insulation,[9] but the full rate of VAT is charged on household improvements. The Energy Efficiency Deployment Office was set up in 2012 within DECC, partly in an attempt to overcome these problems of overlapping and sometimes conflicting policy instruments. The launch of the Energy Efficiency Strategy and the consultation on demand-side measures as part of Electricity Market Reform highlight the increasing policy efforts in this area.[10]

Secondly, energy efficiency policy has tended to focus on supporting and subsidising the installation of particular technologies and less on how those technologies interact with how people use energy in the home. If your policy aim is to reduce energy use, it is no use supporting the installation of a new boiler or double glazing, if the householder simply maintains the same level of energy use, but lives in a warmer home ('comfort-taking'). This weakness is not unique to energy efficiency policy, and is based on a presumption that individual actors will respond rationally to particular incentives that is the prevailing economic approach of UK central government.[11] Behavioural economics has challenged such an approach and its understandings are particularly relevant to energy policy. Policies such as CERT have focused on encouraging and subsidising technical measures. Where they have tried to encourage changes in behaviour, it has sometimes been clumsily introduced. It is no use supporting the distribution of in-house energy displays which give real-time feedback to households on which activities are the most energy-consuming, if they are never connected and people are not shown how to use them or what the displays are showing them.

The risk of a focus on technical measures is that the theoretical savings delivered by a particular technology may not be delivered in reality. One example was the mass mail-out of energy efficient light bulbs by energy suppliers to customers as part of the CERT obligations. Many languished in drawers or were thrown away, forcing a change in the rule[12]. While the installation of cavity wall insulation may be less vulnerable to such an approach, the technology's ability to deliver savings will only be possible in combination with how the household reacts to the improved efficiency of their home. Rebound effects, such as comfort-taking, where households take advantage of lower energy bills by increasing overall energy use (therefore undermining energy and carbon savings), are real and difficult to overcome.[13]

This focus on technical measures is understandable. Data on how people actually react to new measures is difficult to collect, particularly with the current system of 'dumb' energy meters. This leads to a reliance on nominal savings, demonstrated on a small number of properties, which can be easily plugged into a model and scaled up to a national level.[14] But these savings could be reinforced in combination with giving people better information about where they waste energy and/or showing them how to stop doing so.

'Energy behaviour' programmes take understandings from behavioural economics and focus on how people use energy are and how their energy using habits might be changed. In many ways, they are the equivalent of an emerging technology and more research is needed to assess their full potential. Behavioural programmes can work in different ways (See Box). They can be as simple as providing clear advice on a leaflet on how to cut energy use or as complex as creating peer pressure among a community where the frugal use of energy becomes the 'social norm'. Examples of different behavioural measures are included in Box 2.

Box 2. Behavioural Energy Programmes

Techniques to reduce energy demand without installing new equipment include:

Information: Energy efficiency advice; historical energy consumption comparisons (comparing energy use with earlier periods); benchmarking of energy use with an efficient household. This could also include better billing and new ways of transmitting information, for example through Internet-based devices. It could also include real-time feedback through in-house displays linked to dumb or smart meters. Such displays typically provide real-time data on energy consumption, both in energy used and the cost of that energy (they may also include carbon used).

Commitments. Customers making a public commitment or pledge to reduce energy consumption.

Additional financial incentives (beyond the savings from using less energy). These could include community-based competitions where a group is rewarded if they are able to reduce the amount of energy used across the group. This tries to harness the potential of 'social norms' to change behaviour.

A full discussion of the different understandings from behavioural economics is beyond the scope of this paper. The MINDSPACE approach provides a useful framework to consider these issues[15].

One of the reasons that energy behaviour programmes have not been more widely used is that it is currently hard to prove that energy savings have taken place. The improved granularity and reliability of data that it is hoped will be provided by smart meters should allow much more sophisticated scrutiny of how people use energy.[16] They should allow rigorous testing of whether particular measures, either technical or behavioural (see Table 1) or both in combination, have actually led to energy savings.

Table 1. Examples of technical energy efficiency measures and energy behaviours[17]	
Examples of 'technical' energy efficiency measures	**Examples of 'energy behaviours'**
Cavity wall insulation, solid wall insulation, loft insulation, energy efficient lighting, more efficient boilers, more efficient appliances such as fridges and dishwashers.	Turning down a thermostat on heating controls, washing clothes at a lower temperature, turning off your heating when you leave the house, turning televisions off standby.

Potential of smart meters to change how households use energy

Smart meters offer significant potential for improving how households use energy. Experience in the UK and internationally has demonstrated that smart meters combined with other interventions can deliver significant reductions in energy use.

However, the installation of smart meter technology by itself does not necessarily lead to energy savings. Equally, some interventions that provide improved information to consumers without smart meters can struggle to deliver energy savings. This is not surprising. Households need information about what they can do to reduce energy use, while the real-time feedback of a smart meter demonstrates that the changes they have made actually make a difference. At the same time, smart meters can show which activities lead to higher energy use, but it may require additional information for households to be able to do anything about it. Smart meters are an 'enabling' technology that needs to work in combination with other steps.

The government estimates that the smart meter roll-out will see consumers cutting electricity use by 2.8% and gas use by 2% (this is in addition to savings delivered by other energy efficiency programmes, such as the Energy Company Obligation). This is expected to provide an overall saving to consumers of £4.4 billion over the course of the programme (on top of the other benefits from smart meters, such as meters not needing to be read and easier switching (see Table 2)).[18] The Impact Assessment does not provide a breakdown for what total energy savings in TWh will likely be achieved by the smart meter programme, however supporting documents for the Energy Efficiency Strategy suggest savings, compared to business as usual, of 8TWh in 2020 (UK household energy use was around 500TWh in 2009). It is worth pointing out that other DECC analysis has identified potential for annual savings of around 80TWh from changes in behaviour such as turning down thermostats and using appliances more efficiently.[19] Such figures based on bottom-up analysis of potential savings should be treated with caution as it is not clear whether savings in some households can be replicated on a national scale or whether such behaviours can be changed and sustained. However, they do indicate considerable potential for demand reduction without adversely affecting lifestyles.

Table 2: High level costs and benefits of smart meter programme			
Costs	**£ million**	**Benefits**	**£ million**
Smart meter costs	£ 4,521	Energy savings	£ 4,427
Communications costs	£ 2,833	Supplier cost savings	£ 8,471
Installation	£ 1,577	Carbon savings	£ 1,129
System costs	£ 688	Network Benefits	£ 884
Other	£ 1,233	Peak load benefits	£ 778
Total	**£ 10,852**	**Total**	**£ 15,689**

If the expected reductions in energy use from smart meters do not materialise and costs are slightly higher than expected, the policy will likely have a negative net present value (NPV) (i.e. it will have cost more than its benefits). However, if the energy savings are as high as the most successful international and UK smart meter and smart meter-like programmes or if they help achieve the potential energy savings from changes in household behaviour identified by DECC, it could deliver huge cost savings for consumers and offer a very cheap way of decarbonising (see Table 3). It is worth stressing that smart meters will only likely deliver savings if they are combined with suitable interventions, as discussed in Box 1. There remains a great deal of uncertainty about what level of savings smart meters can deliver alongside other interventions and the studies listed in Table 3 may not be directly comparable to UK example and may suffer from selection bias (i.e. those who volunteered to take part in the project or have a smart meter installed may be more likely to take energy saving action). However, they provide a useful description of the scale of potential savings from smart meters and behavioural programmes.

Table 3. Savings from different smart meter programmes and potential savings in the UK if same level of energy savings was achieved		
Study (region where programmes took place)	**Range of annual savings**	**Potential energy saving if applied to all of UK (over 19 year period)[20]**
UK Smart Meter Impact Assessment	Electricity 1.5-4% (central 2.8%) Gas 1-3% (central 2%)	£2.0-£6.7bn (£4.4bn central)
ACEEE[21] (US)	4-12%	£6.3-£18.8bn
ACEEE[22] (US)	0-19.5%	£0-£30.6bn
Darby[23] (international)	0-15%	£0-£23.5bn
Fischer[24] (international)	5-12%	£7.8-£18.8bn
ESMIG[25] (Europe)	5-8.7%	£7.8-13.6bn
ESMCBT[26] (Europe)	5%	£7.8bn

Energy Demand Research Project

In the UK, the Energy Demand Research Project (EDRP) was a joint scheme between five energy suppliers and the government to test various interventions. The trial applied a range of measures aimed at reducing energy demand to more than 60,000 homes in the UK, including 18,370 homes which were fitted with smart meters. These include clearer bills, community payments for demand reduction, comparative billing and households making commitments to reduce energy use. The trial was not designed specifically to test the smart meter roll-out, although it has been used to inform it. While the research has provided some very useful insights, it had major shortcomings.

Firstly, there was not a central design; energy companies were generally left alone to test their own measures. This meant that it was more difficult to establish which measures had delivered which savings. Secondly, it failed to publicly report the costs of each measure. This makes it impossible to assess the measures' cost-effectiveness.

The EDRP trial showed that only two interventions significantly reduced demand in energy use without a smart meter. That was using clip-on IHDs (where the devices are just clipped on to existing 'dumb' meters) and comparative billing, where energy consumption is compared against a similar household.[27] The EDRP found that electricity savings were 2-4% higher with a smart meter *and* an

IHD than with a smart meter alone. Other interventions, such as those listed in Box 1, were only successful in combination with a smart meter.

The trial found that customers "need to know what to do", i.e. they need information about how to cut energy use. What was interesting is that quality and the quantity of the advice mattered. Some of the most successful energy-saving tips were delivered in regular, simple chunks rather than a large booklet. Other less successful advice booklets were too long or comprehensive and required more effort from households. The trial did not show that information delivered online could lead to significant savings, although this area requires further assessment.

The EDRP trial found that financial incentives to cut energy use, such as prizes, were rarely successful and any energy savings disappeared once the incentive had been paid. This supports findings in some of the literature, which show that a focus on financial savings reduces the potential for long-terms savings as other motives, such as environmental, are overshadowed. However, some well-designed trails based on financial incentives have led to considerable success in changing behaviour.[28] This underlines the need for better quality evidence.

Another key, but unsurprising, conclusion is that different people and households react to different methods. The more tailored the information, the more likely it is to be successful. The Smart Meter Impact Assessment recognises this and calls for multiple interventions: "the greater the variety and layering of engagement activities, the greater the impacts of the roll-out". This raises a difficult challenge for policymakers.

The EDRP trials and the literature show there remains considerable uncertainty about what behavioural energy programmes reduce energy demand. This indicates the need for further, better-designed trials to test the success of particular interventions and encourage further innovation in changing energy-using behaviour.

Time of use

In addition to the potential cuts in overall energy demand, it is also hoped that smart meters can encourage people to change *when* they use energy. If successful, such 'load shifting' would smooth out the peaks of demand during the day, i.e. people would shift activities such as putting on the dishwasher or washing machine until during the night. Smart meters would allow energy companies to charge different price at different times of the day to encourage this shift ('time of use' tariffs). Potentially, households could also agree to an interruptible contract, where a sudden shortfall in overall demand would be met with fridges and other appliances with the capability being turned off automatically (rather than firing up power plants). The EDRP found that shifting of up to 10% of peak demand away from peak times was possible using time of use tariffs.

This has important implications for the current proposals for reform of the retail market currently being considered by Ofgem and by the government through the Energy Bill. Ofgem is currently consulting on proposals to limit energy suppliers to only offering four tariffs, in an effort to simplify the energy market for consumers and encourage greater rates of switching.[29] The government has gone further and said that suppliers will have to put customers on the cheapest tariff for their choice of plan.

A full discussion of the Retail Market Review and the government proposals is beyond the scope of this report.[30] However, such a move to limit the number of tariffs has important implications for smart meters. Firstly, smart meters are likely to make it much easier for households to switch suppliers, as the data on energy consumption will be more easily available and more detailed. Secondly, it will allow much greater innovation in the types of tariffs that suppliers can offer. People could be rewarded for limiting their overall energy use, shifting when they use energy to off peak times (at night or at weekends) or reducing their energy use at short notice.

However, it is not clear that Ofgem's proposals will allow such innovation to take place, once again undermining the potential benefits of smart meters. Ofgem should review its proposals in the light of smart meters as a matter of urgency.

The Cost of Energy Efficiency

Energy efficiency and reducing energy demand are not free. While many energy efficiency technologies are often portrayed as a low, zero or even negative cost options (i.e. it delivers cost savings to consumers), this often does not reflect the costs involved in giving people the means and motive to make behaviour changes or install equipment. While the marginal carbon abatement curve[31] shows that many energy efficiency measures offer potentially negative cost carbon reductions (they are negative because they also avoid the cost generating electricity or supplying heating fuels), such an approach does not necessarily include the cost of convincing a large number of households to take up these measures. Such persuasion is not easy. Households are suspicious of energy companies, they are stuck in habits of how they use energy and they can be unsure whether efficiency measures will be worth the hassle. Overcoming these barriers takes resources.

Lessons from current UK energy efficiency policy

The main policy measure to improve the energy efficiency stock of UK households is the Carbon Emissions Reduction Target (previously known as the Energy Efficiency Commitment), which was replaced by the Green Deal and Energy Company Obligation (ECO) at the end of 2012. CERT was a compulsory obligation on the largest energy suppliers to install a certain number of energy efficiency technologies that began in 2008. As the scheme was refined, a certain percentage of improvements had to be targeted as the poorest households (the so-called Super Priority Group). Alongside it was the Community Energy Saving Programme (CESP), which obliged both generators and suppliers to reduce the bills of some of the poorest households in the UK, in particular using more expensive methods, such as solid wall insulation. These programmes ended in December 2012. The major lessons include:[32]

1. CERT led to a major increase in the number of annual installations of cavity wall insulation and loft insulation. DECC's assessment found that it increased the supply chain capability for energy efficiency measures and the level of energy efficiency measures would not have been achieved without CERT. Householders would not have driven the market by themselves.

2. CERT was less successful at targeting more expensive energy efficiency measures such as solid wall insulation. This is unsurprising. By setting a specific carbon target and allowing suppliers to choose from a list of eligible measures, they inevitably chose measures that would deliver the cheapest carbon reductions.

3. However, this focus on cost-effectiveness did create problems. The mass mail-out of light bulbs was a rational response to the original rules, but it did not appear an effective way of cutting carbon. This highlights the risk of not thinking about behaviour and technical measures together when tackling energy efficiency.

4. Lack of transparency. Energy suppliers were not compelled to reveal the cost of energy efficiency measures installed under CERT or CESP. This was decided for commercial confidentiality reasons and the expectation that a competitive market would lead to cost-effectiveness, but has made it difficult to verify the overall cost to consumers. Proposals for the ECO have learned from this mistake and suppliers will be obliged to provide information about the costs of meeting the obligations. Several energy suppliers have argued that it has become increasingly difficult and costly to find enough people to take up the measures.[33] Initially, the suppliers convinced people to insulate their homes with a discount on the product and installation. Towards the end of the obligation, the firms had to

give them away for free or even pay people to have measures installed as the supply of willing households dried up (particularly the poorest households).

Green Deal and Energy Company Obligation

The Green Deal is the Coalition's flagship energy efficiency policy.[34] It allows householders to install energy efficiency measures at no upfront cost and pay for the measures through their electricity bill. Crucially, it allows the debt to remain on the property even if the property is sold. It has a list of around 40 approved measures that are eligible, each of which is expected to meet the 'golden rule' where the expected benefits of energy savings will outweigh the costs of installing the measure over the period of the loan.

Alongside the Green Deal, the government has updated CERT and renamed it the Energy Company Obligation (ECO). Again, large energy suppliers will be required to deliver a certain amount of carbon savings through approved measures. ECO is divided into three sections:

1. Carbon Savings Obligation. Where suppliers will have to deliver a specific amount of carbon reductions. All households are eligible.

2. Within the Obligation, 15% of the overall measures have to go to households in the poorest areas under the Carbon Community Savings Obligation. Of this, 15% will have to go to poor households in rural communities.

3. Affordable Warmth. This will oblige companies to provide insulation and heating measures to poor and vulnerable households in private tenure.

Effectively, ECO creates four different obligations (CSO, CSCO, rural CSCO and Affordable Warmth) and therefore four different markets in energy efficiency. Within these, the government has chosen which technologies will be eligible to meet the obligation. This is complex, but in broad terms, solid wall insulation (which is expensive) is permitted under the CSO, but not easy-to-install cavity wall insulation or loft insulation.

Cost-effectiveness of ECO and CERT

The ECO/Green Deal Impact Assessment attempts to estimate how much it will cost to reach the proposed carbon reduction target of 27.8MtCO2e of savings between January 2013 and March 2015, when the first phase of ECO is finished. It estimates that the marginal cost (i.e. the final, most expensive measure to satisfy the overall target) of meeting the Carbon Saving Obligation target (20.9MtCO2e) will be just under £80 per ECO 'point' (roughly a tonne of CO2 reduced).[35] The marginal cost of meeting the Carbon Saving Communities part of the overall target (6.9MtCo2e) is around £55/tCO2. This difference comes because the CSC has a lower target, but it is worth noting that the cost curve for the CSC is much steeper than that for the CSO, reflecting the difficulty (and therefore extra cost) of identifying low income households who are willing to have insulation fitted. This is despite the fact that cheaper measures, such as cavity wall insulation, are eligible for CSC.

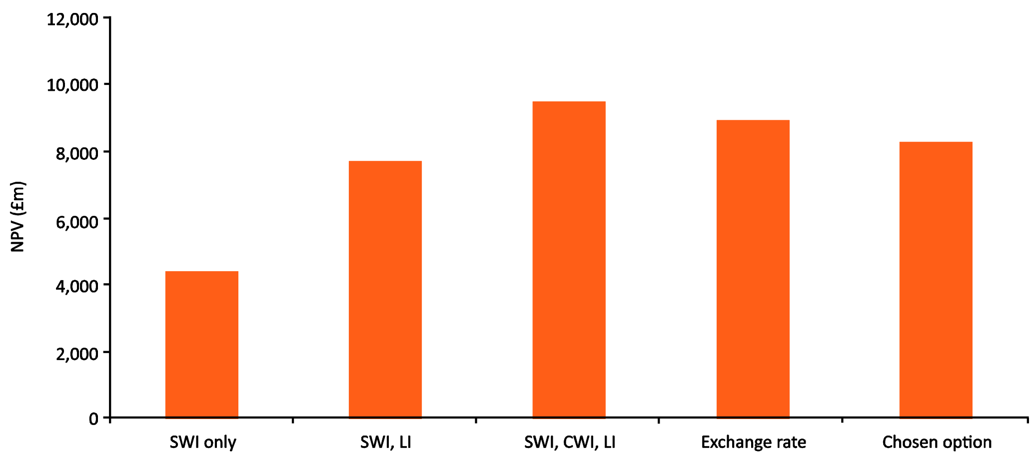
There are two key points to take from the Impact Assessment. Firstly, there remains considerable uncertainty about how much the measures will actually cost. The range of marginal costs for the CSO element goes from £70/tCO2 to £120/tCO2. Suppliers' ability to keep the overall cost of meeting the obligation as low as possible will have considerable impact on household bills (it is estimated ECO will cost the average household an extra £53 on bills by 2020, although those who have measures installed will see greater reductions in energy demands, bringing down bills). As CERT and CESP have demonstrated, identifying low income households and convincing them to install measures is not easy. Reasons for this vary between households, but it is often because households are renting, want to avoid the hassle of work being done, complexity of knowing and proving if the household is eligible or are simply unaware of the potential cost savings. Work by the consultancy NERA, commissioned by trade group Energy UK, argued that DECC's assumptions for ECO were too generous and said the actual cost to consumers would, on average, add between £69 and £94 per year[36] to energy bills. Of course, until the programme has finished, it is impossible to know for sure what the costs will be.

ECO's further specification that some of the measures must be targeted at suitable poor rural households is likely to make these costs even greater. While these measures have been installed for perfectly legitimate reasons of making sure the poorest households benefit from better-insulated houses, they do mean that the overall cost of meeting the carbon targets will be higher (and therefore add additional cost to all billpayers). This is perhaps an inevitable trade off of combining carbon cutting and fuel poverty objectives in a single policy.

The second key point is that the choice of which technologies are eligible for ECO points has also increased costs. By focusing on expensive measures like Solid Wall Insulation, rather than cheaper methods such as Cavity Wall or Loft Insulations, it will likely increase the overall cost to billpayers. This decision has been made to ensure that the subsidy system of ECO does not crowd out the Green Deal market. However, there is a risk that the Green Deal will not provide enough of an incentive on its own to motivate households to take action on energy efficiency.[37] If this happens, the overall cost of energy demand reductions, and therefore carbon savings will cost more than necessary (as fewer cheap measures such as loft insulation and cavity wall insulation will take place). Many insulation firms have voiced concerns about this, warning that the shift from CERT to ECO could devastate the insulation industry. While outcomes for consumers, not producers, should be the government's concern, the uptake of measures under the Green Deal must be monitored carefully.

The Impact Assessment modelled eight different options for ECO, depending on which technology was allowed to be subsidised under the obligation.[38] The marginal cost to meet the target ranged from £157/tCO2 for the strictest option (broadly only allowing Solid Wall Insulation (SWI) to count) to £57/tCO2e for cheapest (including cavity wall and loft insulation (CWI, LI), see Figure 2). Therefore the decisions on which technologies are eligible have considerable impact on the overall cost of the scheme for billpayers. As can be seen, the most 'open' option with the largest number of technologies available (Option 3) delivered the greatest net present value (i.e. was the lowest overall cost to consumers). However, DECC's preferred option (Option 8, as described above with the four different obligations) was chosen because of fears that a too 'open' approach would mean the policy would be subsidising technologies that would be built anyway.

Figure 2. Estimated benefit of different Energy Company Obligation options (NPV, £m)



There remains considerable uncertainty about whether the market for the Green Deal will be able to deliver the anticipated level of savings. CERT and CESP had considerable success in driving the market for loft and cavity wall insulation and the findings from a review of the policies found that it was unlikely that this would have happened without the obligation. Will a household that has been reluctant to take up energy efficiency measures under CERT (where they are free or even being paid for) now decide that it wants to take out a loan to pay for the measures (including a likely 7% interest rate) through the Green Deal?

Reducing energy demand by changing energy behaviour

While the Green Deal, ECO and CERT support the installation of technical measures to improve the energy efficiency of homes, there has been less attention on changing how households use energy. Evidence suggests that there could be significant potential in behavioural energy programmes to reduce energy use.[39] Research as part of DECC's Energy Efficiency Strategy looked at 44 different 'energy behaviours' and their potential for reducing demand in households.[40] The most important were measures such as turning down the thermostat from 20 °C to 18 °C. It is estimated this could save 33TWh a year from total energy use in UK homes (out of an annual total of around 500TWh), with little effect on people's quality of life. Other measures such as delaying the start of turning on the heating until November and installing water efficient showerheads also delivered considerable savings.[41] However, there is a lack of evidence on how much it would cost to get people to take up these measures and whether they are the kind of measures people would choose to take up.

The reluctance to incentivise or subsidise behavioural energy programmes exists for several reasons. Partly, it reflects an assumption that a competitive market will reward suppliers who help their customers cut energy use. While suppliers have increased their energy efficiency offer in recent years, such pressures will only go so far. Secondly, policymakers often assume consumers should act 'rationally' to reduce unnecessary energy use. Behavioural economics, including studies of how people use energy, has challenged this premise. Habits, social norms and knowledge about how to save energy all play a part. Thirdly, it is difficult to assess whether savings would have happened anyway (additionality). Demand reduction programmes that have not established a clear baseline, rely on people gathering the meter-readings themselves, or nominal estimates based on *ex-post* surveys. These are potentially unreliable. Fourthly, verification that the savings have happened is not easy in a system that relies on dumb meters that are not frequently read (and there is no financial incentive for the companies to do so). Fifthly, there is a question of how sustained the energy saving has to be before it can be counted. If a home in a demand-reduction programme displays an immediate reduction of 5% in electricity use compared to business as normal, is that a real reduction in demand or just temporary? Should it only be counted if it is maintained for three years, for 10 years? It is hoped that smart meters can overcome at least the last three of these factors by providing the technology and data that can verify whether real savings have been made. It is worth pointing out that verifying that energy savings have actually taken place is also problematic when you are considering technical measures like insulation, but the government still subsidises such measures. Overcoming problems of additionality and sustaining energy savings will be discussed in the final section.

Cost-effectiveness of different energy efficiency and behavioural measures

Unfortunately, while there is considerable evidence on the potential energy savings from various efficiency and behavioural programmes in the UK and internationally, there is scant evidence about how much these measures cost to introduce. Therefore it is difficult to ascertain whether they offer cheap ways of lowering bills and decarbonising or expensive ones. Initiatives that report considerable energy savings include measures such as spending two hours in homes or knocking on doors across an estate to provide energy efficiency advice. Often these are programmes run by charities. These are intensive activities and are potentially expensive at scale. There is certainly potential for behavioural programmes, even if they are time intensive, to deliver cost-effective energy and carbon savings. However, such projects still need rigorous, longitudinal or controlled data to demonstrate the actual energy savings they have delivered. The challenge for policymakers is to encourage such endeavours, test them properly and reward them when they can demonstrate energy savings.

This research has identified examples of behavioural programmes that have useful information about energy savings and, crucially, the costs of achieving those savings. It then compares them to the best evidence about the cost of energy efficiency programmes. A summary of these programmes is included in Table 4. The first four are behavioural programmes and the last two, the best international examples of *ex-post* assessment of large-scale energy efficiency programmes, which may include both behavioural and technical measures.

Table 4. Comparison of cost-effectiveness of behavioural and energy efficiency programmes

Programme (jurisdiction)	Electricity or gas?	Summary of programme
Opower (US)	Electricity	The most rigorously tested example of a large-scale effort to reduce energy demand through a non-financial, 'nudge' approach. Opower run a comparative billing programme that sends modified bills to households comparing their energy use with those of an energy efficient neighbour. This 'social norms' approach has now been delivered in

		hundreds of thousands of homes across the US, and has been shown to reduce electricity consumption by, on average, more than 2%.[42] The intervention cost 3.3 US cent per kWh saved.
Camden Council, London	Gas	One of the most promising UK examples of a natural controlled experiment in changing energy behaviour. The Local Authority was able to reduce demand for gas delivered through its district heating system by 6% over a 15 month period.[43] This was achieved by sending households bills that compared their energy use to those in similar properties *and* by giving them simple tips on how they could save energy. Unlike other efforts, this was a well-designed, controlled study which removed selection bias by the use of anonymous and randomised meter reads. This activity remains at a small scale (the first study looked at fewer than 600 homes) and has the advantage of a single energy provider (the Local Authority), but it offers robust evidence that such behavioural energy programmes can deliver real, cost-effective savings. The intervention cost less than £3 per household. This translates to 1.13p per kWh saved. Interestingly, it found that social norm information delivered by email was not as effective as that in a hard copy. Moreover, social norms do not appear to work in conjunction with financial incentives.
Off. Really Off?	Electricity	This was an advertising campaign in Germany that aimed to get people to turn electrical equipment off standby in homes and offices when it was not in use. Outcomes were self-reported. The programme was estimated to save 26million kWh at a cost of 890,000 EUR. This gives a cost of 3.4 EUR cents for each kWh saved.
Transition Streets[44]	Electricity/gas	In this programme in Totnes, Devon, neighbours joined teams that worked to reduce energy use. If they made

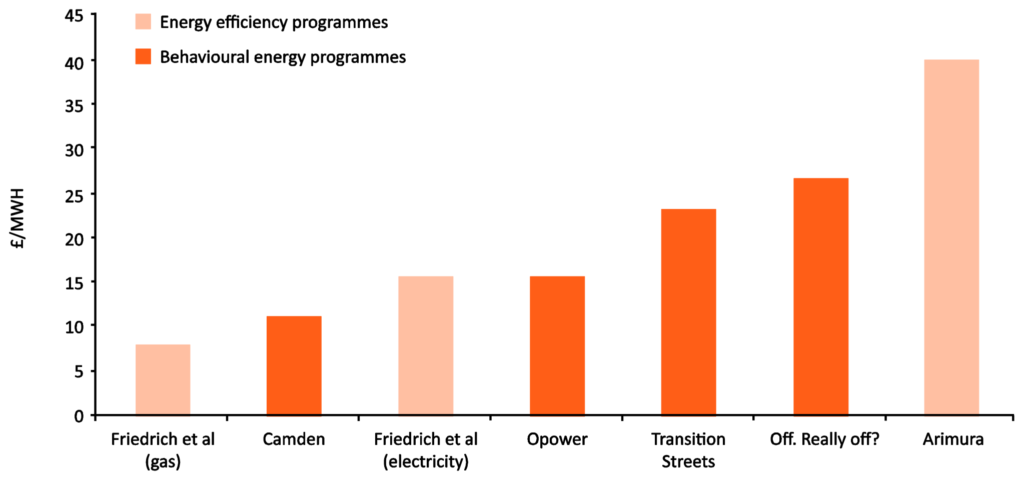
		some energy efficiency improvements, they were eligible to apply for a grant towards solar PV installations. Close to 500 households participated. Each household visit cost £75 and saved around 1.3tonnes of CO2 per household. This is estimated to cost around 2.3p per kWh saved.
Friedrich et al[45]	Electricity/gas	This is a review of the cost effectiveness of energy efficiency programmes across the US. It looks at 14 state programmes for electricity and six for gas. This includes both domestic and non-domestic programmes. This is estimated to cost 2.5US cents per kWh of electricity saved and 1.3/kWh of gas saved.
Arimura et al[46]	Electricity	This looked at US utility electricity efficiency and demand side management programmes over an 18-year period. It found the cost of the programmes was around 6.4 cents per kWh saved.

It is worth stressing that the different studies listed above are not directly comparable. Some of the meta-studies include programmes that also reduce energy use in the non-domestic sector. Some of the programmes look only at electricity and others only at gas use. Some are based on measured savings, while some are based on estimated savings. As a result, policymakers should be cautious about basing too many policy decisions based only on a few data points. However, they provide the best available guide to the potential magnitude of costs of energy efficiency.

With these caveats, Figure 3 (see overleaf) compares the cost of the programmes listed above.[47]

The figure shows that there is considerable range in what different programmes cost to reduce energy output by a MWh. It also suggests that reducing gas use may be more cost-effective than cutting electricity use. This supports findings in work for the Energy Efficiency Strategy that found most of the energy-saving potential from changes in behaviour was in reducing gas used in heating space and hot water in homes.

Figure 3. Cost of reducing energy demand in energy efficiency and behavioural programmes (£/MWh)



What is important in terms of wider energy policy is how the costs compare to a. the wider costs of energy generation, and b. the wider costs of decarbonisation. In terms of generation, a new CCGT plant would cost around £80/MWh while new offshore wind generation costs around £150/MWh,[48] indicating that energy efficiency offers a potentially cost-effective alternative (even if subsidised).

In terms of saving carbon, a comparison of different technologies is shown in Figure 4, including the estimated overall cost per tonne of carbon saved of the Green Deal/ECO programme.[49]

Figure 4. Cost of low carbon generation vs energy efficiency in reducing carbon emissions

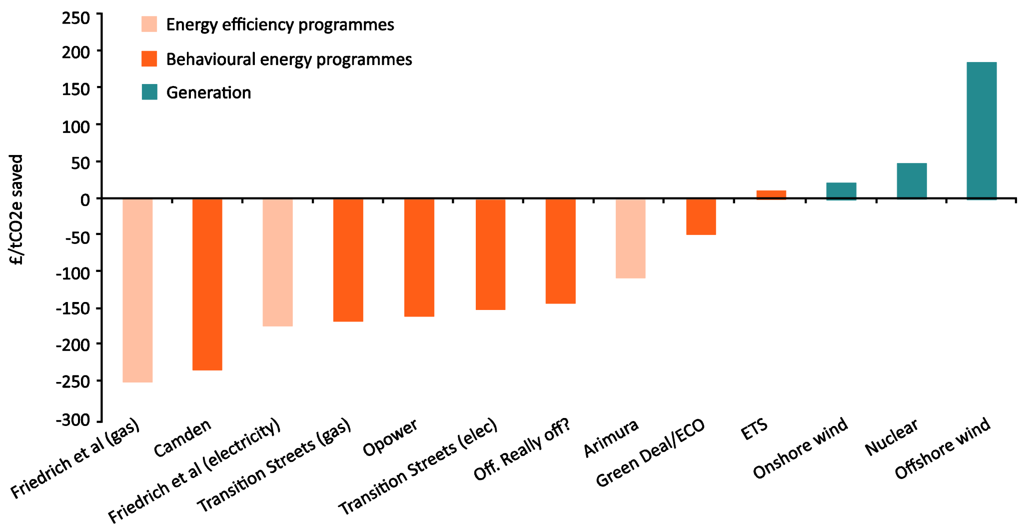


Figure 4 shows several things. Firstly energy efficiency programmes actually offer negative cost carbon savings. This is because they save the cost of building and running the marginal electricity plant, which in this exercise is considered efficient CCGT (or in the case of gas for domestic heat, the long run cost of fuel). Therefore in terms of cheap decarbonisation, they should be a priority. Even if efficiency programmes were incentivised to the cost of £40/tCO2 saved they would still be cheaper, in terms of carbon reductions, than building new nuclear, often seen as the lowest cost low carbon technology.[50]

The second point about Figure 4 is that it suggests – and it is worth stressing that evidence is still very tentative at this stage – that behavioural energy programmes offer some of the cheapest decarbonisation options, potentially cheaper than some of the technical energy efficiency measures. However, they currently are not currently eligible for subsidy under the Energy Company Obligation. Policymakers must be cautious about allowing their immediate introduction to avoid some of the pitfalls demonstrated by the clumsier aspects of CERT, such as the mass mail out of light bulbs. However, if they can be demonstrated to deliver real savings – and smart meters may allow that to happen more easily – then they could offer a cheaper alternative, or even complement, to some of the expensive technical measures. How this might be incentivised is discussed in the final section.

Box 3. Energy efficiency as a way to meet the 2020 Renewable Energy Target

Avoiding building new plant could also avoid the cost of building expensive new renewable generation to meet the EU's Renewable Energy Target (where by 15% of UK's energy demand must come from renewable sources in 2020).[51] Reducing electricity demand by 6.66MWh in one year, would mean that 1MWh of renewable energy (and 5.66MWh of additional, most likely fossil fuel-fired energy) would not be required. This means less of the most expensive marginal renewable plant, most likely offshore wind would need to be built. If marginal offshore wind will cost £169/MWh, you could spend up to £25.35/MWh delivering the 6.66MWh of reduced demand and *it would still be a more cost-effective way to meet just the renewable energy target*. In addition, you would deliver seven times the carbon savings against the offshore wind approach, as well as avoiding the cost of generation of the other 85%. At £25.35/MWh, this would likely allow subsidy of solid wall insulation, as well as many of the cheaper technologies as a cheap way of meeting the RE Target. It would also be likely to incentivise some of the most resource-intensive demand-reduction programmes, where experts go into people's homes to advise on how to save energy.

Will the Public Accept Smart Meters?

The smart meter roll-out is a huge infrastructure programme. Its success in enabling cost-effective energy and carbon reductions depends on its ability to change consumer behaviour; the way people use energy. This success rests on the extent to which homeowners accept smart meters, making public acceptance crucial for policymakers. The government consulted on consumer engagement with smart meters earlier this year and proposed a Central Delivery Body, funded by suppliers, to educate people about smart meters and encourage them not to opt-out of having them installed.

Currently, just under half of the population say they know what smart meters are. 32% say they support the introduction of the technology, while 20% are opposed (often due to concerns about cost and privacy). 48% are therefore undecided, underlining the importance of the communications strategy and foundation stage for building confidence in smart technology.[52] International examples highlight the risks of a backlash if smart meter roll outs are not done well.[53]

Policy Exchange hosted a round table discussion in September 2012 with 20 stakeholders to consider these issues in greater detail. It looked at the risks that the roll-out presented, as well as some of the potential benefits. It considered good examples of where consumers were engaged in energy efficiency and demand reduction activity and what lessons can be learned from this. This discussion has been used as a basis for identifying potential roles for the government, suppliers and the CDB in smoothing the acceptance of the technology. The participants took part on the basis of anonymity (a list of participating organisations is provided at the end of this document).

Difficulties of getting people to accept smart meters

Many participants stressed that getting people to accept new smart meters, or even in-house displays was likely to be difficult. In one example when free energy display monitors had been installed in homes by a charity, many households had disconnected them when they were checked a few months later (even though they did not include the 'smart' function of being able to transmit information about energy use). Other trials by suppliers had also been difficult. In one example, even when households were contacted first by phone, a representative had explained what was going to happen and the potential benefits, and *the customer had agreed to the installation*, still 6% of households refused to have the meter installed when the engineer turned up. Less sophisticated approaches were even less successful: "You can't just knock on the door and say 'trust me'. They won't."

Box 4. Previous major UK energy infrastructure changes

Switch from coal gas to natural gas

The discovery of natural gas in the North Sea led to the end of the use of gas created from coal (coal gas or 'Town Gas') in UK homes. In order for this switch to take place a new national distribution grid was required, as well as the transformation of gas-using equipment in UK homes. The project took 10 years and cost £100 million during the 1960s. During the process, many dangerous appliances were discovered and replaced. The huge programme had the advantage over the proposed smart meter roll-out of being directed by a single, government-controlled body, the British Gas Corporation. It was also successful because it was moving to a superior technology for customers; natural gas was much cleaner than coal gas and potentially cheaper. Smart meters must be able to show that they are a better technology for consumers if they are to be accepted.

Economy 7

In the later 1970s, in an effort to encourage greater use of electricity at night to balance the baseload provided by nuclear-generated electricity, the government established the Economy 7 tariff, which offered cheaper energy if it was used during the night. This encouraged the take-up of storage heaters, which stored cheaper electricity during the night, and then emitted the heat during the day, when it was needed. It also required new electricity meters to be fitted. Several million storage units were sold and millions of customers are still on the Economy 7 tariff. This shift suggests that major changes in infrastructure and how people use energy are possible. However, the take-up of Economy 7 was driven by a clear economic incentive and was also left to householders' discretion, rather than a mandated roll-out. Economy 7 has lessons for the potential time-of-use tariffs and potential acceptance and take-up of new technology, if the incentives are clear.

The main reason for this reluctance was trust about what would happen to information that smart meters generated: "Trust about what is happening to the data is huge," said one charity representative. Other participants agreed, with major worries that the data was going to the energy companies. Several participants stressed it particularly difficult with vulnerable groups, such as the elderly and those living in social housing: "The paradox is that the better the technology, the greater that fear will become," said one participant.

Overcoming this initial suspicion was not easy. It often required long engagement. One charity, which had experience installing both energy meters and running demand reduction programmes, often spent up to two hours with households (it was only at the end of this process that they would talk about behaviour change). But such an approach can be successful. The charity had expected an in-house display uptake of 50% from 8,600 homes visited. In fact, partly as a result of its sophisticated approach, 8,000 households requested the device. Of course, the cost of such an intensive approach across the whole country could be very high.

Establishing programmes within existing social networks was also effective. One charity saw high levels of participation and significant reductions in energy use through running a programme through a major company and its employees. It was not able to repeat this success in a social housing project, underlining the difficulty of a one-size-fits-all approach. This underlines the complexity of behavioural change programmes (and how sophisticated the communications campaign for the smart meter roll-out must be). Other participants stressed that the poorest communities were the most difficult to identify and convince, suggesting that "it will require high quality local community engagement [to convince them of the benefits]."

While many participants agreed that trust, both about what was happening to the data and who was installing the meters, was the major barrier to acceptance of smart meters, there were other important factors:

- **Disruption.** The installation of smart meters will likely reveal particular problems with people's energy and gas infrastructure. This may require new pipes or additional work. While this is obviously a good thing for safety, there is a risk that the disruption will be linked to the smart meter installation. Of course, such disruptions happen as part of the normal process of replacing meters. However, because of the speed of the roll-out (at its peak several hundred thousand new meters will be being installed every week) there is a risk that the scale of disruption will undermine acceptance of the technology.
- **Cost.**[54] Some participants in the discussion raised the issue of the cost of the overall programme, and people's suspicions that they may be paying money for a technology they do not need. While the Impact Assessment shows a clear overall net benefit from the programme, its success depends on a major IT system and the proposed energy savings being delivered. If these do not materialise, it is likely to face considerable criticism. Other participants said worries about the cost of the meters were less of a factor, as people would not be paying for them upfront. One who had experience of installing energy efficiency measures, including energy displays, said: "The barrier is not about cost, it's about imposition and spying in the home."

- **Technology risk.** Several participants raised the issue that the technology that was currently being installed was simply not delivering some of the expected benefits. Some consumers have found that the in-house display was unable to provide accurate price information. Others had found that sometimes the meters had not delivered accurate bills. "This causes high levels of frustration". Other concerns are that the technology will not make switching between suppliers any easier. These concerns were reinforced, and perhaps caused by worries about the current lack of clear technical standards. This underlines how the technology must be successfully shown to work during the Foundation Phase.
- **Confusing overlap with other policy areas**. Several participants said there was a lack of general awareness about other energy efficiency programmes (such as CERT, ECO and Green Deal) and there was a risk that the public would be bamboozled by how the different programmes interacted with smart.

Communication challenges

One of the key messages from participants is that there was a great deal of uncertainty about which methods will allow people to welcome smart meters (even before they consider changing how they consume energy). In short, it is not clear what works. This is, of course, inevitable. Human behaviour is complicated and different approaches will work for different households with different levels of energy literacy and trust of energy suppliers. Participants said there were several key communication challenges that needed to be considered:

1. Should the government messaging concentrate on a simple message that the roll-out is an infrastructure upgrade? Or should it include more complex messages about the opportunities for consumers, through new tariffs, demand reduction and environmental benefit?

There was no clear consensus on which approach was best. Some participants argued that successful international examples, such as Spain, have described the roll-out as an infrastructure project. Later messages can then focus on demand reduction. Several participants said that if the claimed benefits from smart meters (accurate bills, easier switching, clear pricing on the IHD) failed to deliver, this would cause even greater resentment about the roll-out and the associated costs: "The reality is over-promising, overly-high expectations. " One participant argued that government and suppliers needed to give the impression of a centrally-driven roll-out to get the platform established "to make it feel like a structured and central programme". Beyond that, he said it was important to allow markets for innovation in demand reduction to flourish.

Others argued that if the approach was limited to describing it as an infrastructure upgrade it was a wasted opportunity. They argued the smart meter roll-out offered a once-in-a-generation chance to talk to householders about how they use energy and help them save money where they can.

2. Can the communications approach take advantage of the potential of regional roll-outs?

Some participants argued that it was a mistake to choose a supplier-led roll-out rather than by the regional distribution network. While there is some merit in this argument, this decision has already been taken by government and reversing it would be expensive and time-consuming.

However, some participants recommended that some element of local roll-outs should be retained where possible (see Box 5 for research on how this might work). Such an approach would allow the message to be targeted, for local civil society groups and charities to be mobilised, and response and advice teams to be in place. Some participants argued that the best chance of public acceptance of smart meters was if their potential was spread by word of mouth. Many felt that smart meters were unlikely to be popular if households felt they were being foisted on them. One participant pointed out that 15 years ago suppliers would have been well-placed to lead a geographical roll-out as their customer base was still closely linked to historical areas. However, post-privatisation switching has reduced this geographical reliance. The roll-out therefore needs to try and find some way of taking advantage of the potential of a geographical approach where it can (within the agreed roll-out plan). Such an approach was successful as part of the Digital Switchover (see Box 5).

Box 5. Digital Switchover

The change from an analogue to digital television signal was carried out from 2008 until 2012. Households were required to upgrade their TV equipment or buy a set-top box to receive digital signals. While the smart meters roll-out is a much more complicated and larger project, there are potential lessons from what is generally seen as a successful, smooth programme. Key lessons from the switchover include:[55]

- A centralised, impartial delivery model. For the switchover this was Digital UK, which was set up solely to deliver the programme. This is an equivalent to the CDB proposed for smart meters. Digital UK was given a clear, single purpose.
- Making sure roll-out of infrastructure and communications were matched. The switchover was done on a regional basis and communications matched that approach. Later switchovers learned from previous experience. This led to a potential underspend of 30% compared to the budget of £201million.

- Important that the programme worked with the market. The programme rode the wave of natural rates of switchover to digital, which were already happening reflecting the clear benefits of the new technology in terms of more channels and clearer signals.
- A clear, attainable and secure timetable.
- Layered communications approach. Digital UK worked with community groups and grassroots organisations to explain what was happening, particularly to vulnerable groups. Retailers were also trained, as well as housing providers. On top of this, there was a national support service via phone and Internet.

There are important lessons for the roll-out of smart meters. The foundation stage will be crucial to show that the roll-out can 'work with the market' and demonstrate clear benefits. It is not yet clear that there is the same existing appetite for smart meters that there was for new digital televisions. The success of the switchover will also depend on working with local groups to act as champions and informal advisors. It will also require intensive, practical support for vulnerable customers.

3. Should messages focus on financial benefits or environmental benefits of smart meter roll-out?

Some participants argued that public communications that focused exclusively on the financial benefits of smart meters were risky. Firstly, if promises of lower bills were not realised (perhaps because wholesale price of energy had gone up, even though use had gone down), it was likely to lead to disillusionment. Secondly, if in-house displays showed that a particular action only saved a small amount of money, such an action may be seen as not worth the effort. There were also doubts about whether changes based on financial incentives would be sustained, while communications that included an environmental message would lead to attitude or value changes that could lead to more sustained environmental behaviour (and spillover from energy into other areas). Such environmental spillovers are well established in the literature on behavioural economics.[56]

Others said that motivations can change. One group who delivered demand reduction programmes said that money was often an initial motivator, but then environmental concerns took over later. The important thing was clear messaging that their actions were having an effect, be it on environmental impact, energy use or cost: "People like looking at graphs. If it is going the right way, they get excited about it."

Other participants argued that it was a false choice between environment and energy. Charities that went into people's homes to talk about energy use used both messages, depending on individuals they were talking to. This underlines the need for a flexible, layered approach to communications. Other stakeholders said they were sceptical the environment was a widely-held motivator: "Feedback from customers is we don't care about carbon, we care about costs. Environment is just a nice spin off," said one.

One sub-issue was whether demand-reduction programmes could work best by promoting competition or co-operation. Some were suspicious that a competitive approach, whereby neighbours' energy consumption was compared, would work. However, several examples were produced showing how competition did deliver significant savings. Moreover, competition could often lead to greater co-operation between neighbours as they shared tips about how to best save energy. If such a wider culture in the efficient use of energy is created (a social norm, in the behavioural jargon) there is a much higher chance that high potential savings can be delivered by the smart meter roll-out.

4. How to make people feel they are in control of the data.

Successful examples of people welcoming energy displays in their home, and acting on the information they provide, often depended on people feeling they were in control of the data, some participants argued. Where it was established, significant reductions could be delivered. Where it was not, people ignored or disconnected the devices. Again, this underlines the need for sophisticated communications showing people what will happen to the data and giving them clear instructions about how they can opt out of having a smart meter and choose the level of availability of data.

Currently, the government has proposed allowing suppliers to access monthly and daily consumption data for consumers (unless the household wants to opt out). However, for more granular, half-hourly data consumers will have to explicitly opt-in to allow suppliers to access it. More information is needed about how consumers react to these decisions during the foundation phase, in particular how the opt-in of half-hourly data could limit suppliers' ability to offer time of use tariffs.

Box 6. Incorporating a regional approach

Green Alliance, a think tank, has argued for a 'post-plan' approach where suppliers would provide the CDB with details of where they plan to do their roll-out a year in advance, and then the communications work would focus on areas where there is overlap of roll-outs at the same time (such an approach was successful with the digital switchover).[57] Green Alliance has also called for a proper 'smart town' pilot, where one town goes through the whole process at the same time and the impact of the roll-out is properly assessed. This would include general level of acceptance of smart meters, as well as the success of energy efficiency measures. As there remains great uncertainty about which messages work, such a pilot-led approach is crucial as long as it is properly assessed. One participant argued that the messages around the smart roll-out need to be grounded in real-life experiences and successes, not optimistic projections of what could happen, if they were to convince people of the benefits. A local approach would make such an aim more likely.

5. Presentation of data will be important in success of smart meters

Some participants stressed that the way data is presented, both on the smart meter display and in billing, was crucial to the success of the technology. Unsurprisingly, there remained great uncertainty about what 'worked', with different approaches likely to work for different households. Money saved or energy use or carbon would work for different people. The EDRP study found that cost information was seen as more useful than details about kW of consumptions, while CO2 options on in-house displays were not perceived as useful or, indeed, widely noticed.

Others said this problem of people responding to different information in different ways was possible to overcome. The important thing was making the data clear: "People will respond to graphs, they don’t care if its money, or energy or whatever, smiles are smiles, frowns are frowns." If the graph is going down and that is presented as a good thing, that will likely lead to continuation of that behaviour, one participant said.

This clear presentation of data will be helpful in shifting when people are using energy and moving it away from times of peak demand. The example of community-based meters in one part of Denmark was given, where streets are given traffic light signals depending on whether local wind turbines were providing energy to the grid or not. When they are giving energy to the green (and so energy was cheaper), the signal was green. When they were taking energy from the grid it was red. Therefore people were encouraged to reduce energy use. The behaviour was reinforced because it worked at a community level: "People like to see that they are doing well as a community, they are a 'good' neighbourhood."

Conclusions

1. The most clear conclusion from the round table is that it is not yet clearly established 'what works'. This applies equally to how you encourage acceptance of smart meters in people's homes and how you deliver demand reduction programmes. As one participant said: "There is still no trigger for acceptance of smart meters". On one level this is not surprising: this is a new technology; there is confusion about what is actually a smart meter is; there are few examples of successful programmes; there remain doubts about the technology; and there are major concerns about privacy. Moreover, what works in one household will not necessarily work in another. One charity ran a very successful project through members of staff at a company, but was unable to replicate the model at a social housing group. Other successful efforts at getting energy efficiency technology installed and trying to change behaviour required visits of more than two hours to build the necessary trust.

2. You need a system that rigorously tests different approaches

Some criticised the EDRP trials for failing to co-ordinate efforts, although they provided some useful and new information. It was seen by some as a missed opportunity. Greater co-ordination of trials was one possibility: "What's needed is a coordinated push, aligning the incentives of the key players, to run some field trials. The early smart meter rollout is a good opportunity to do this – the meters are being installed anyway, we could test out the key questions and get some answers to inform the later stages," said one participant. Options on how better piloting could be encouraged are discussed in the next section.

3. The communications strategy must incorporate different messages

Recognising the concerns of the public and the uncertainty about what messages will influence different households underlines the difficulty of how government communicates the roll-out. There was support for presenting the roll-out as an infrastructure upgrade, while others felt the need to highlight the energy-saving potential. Others stressed the danger of over-promising.

The government's communications approach must take a 'layered' approach to reflect this uncertainty. That means its messaging must be about an infrastructure upgrade (including being honest about potential disruption, while stressing why this is overall a good thing for customers). But it must also demonstrate the potential cost-savings, as well as the environmental arguments. This reflects that different groups will react to different messages. Any communications must also show that people have the opportunity to opt-out if they want to, providing the best chance of empowering them within the current framework.

The most important aspect of the roll-out is that consumers accept smart meters and there is not a mass opt-out. If that happens, the potential of the technology for cost-effective energy and carbon reductions will be severely limited.

Of course, all of these messages do not have to be included in a single television advert or billboard. This is why there needs to be multiple messengers (see below) championing different aspects of the roll-out. DECC's survey of public opinion showed that the more people learned about smart meters, the keener they were to have them installed. This highlights the need for a layered approach.

4. Community and civil society groups must be harnessed to act as champions for the technology, alongside a national advertising campaign

Acceptance of smart meters is more likely if it is partly driven by word of mouth (although the speed of the roll-out risks making this difficult). The government therefore has to build in as many ways of encouraging positive news about smart meters as possible between social networks. Firstly, this means its communications strategy should be about more than just a national advertising campaign (although this is important). It needs to be in touch with community groups, voluntary organisations, consumer groups and local authorities and empowering them to act as champions of the opportunities of smart meters, as was successful in the Digital Switchover. This is particularly important for vulnerable groups, who seem the most resistant to intervention. Getting civil society groups to act as champions for the technology should be a crucial part of the role of the CDB, alongside national campaigns.

Such an approach is most likely to be successful if communication efforts are focused on a particular area at one time. Therefore, where possible, the communications strategy should be co-ordinated with energy companies so that it reflects where the roll-out is taking place. This means working on a city-by-city and regional basis and encouraging different suppliers to co-ordinate roll-out schedules, where such an approach is possible and does not sacrifice the operational efficiency of the roll-out.

At a wider level, a full 'smart town' pilot during the foundation phase, as advocated by Green Alliance, where efforts are co-ordinated and properly tested, could provide useful lessons for a wider roll-out and examples of the potential benefits and risks of smart.

5. Linking smart meter communications with other energy efficiency programmes

In the past, there has been a failure to link different energy efficiency programmes together at both a policy and communications level. Awareness is still low about both smart meters and the Green Deal and government's messaging must make sure it does not confuse people about different programmes. Both programmes should be championed as part of a wider effort to improve people's homes and deliver energy savings. This requires messages about building better infrastructure and helping people save money. The CDB should therefore not simply base its communications on smart meters, but place smart meters in the context of a wider message about making the UK a more efficient economy.

This will require clever messaging, both on a national and local level. Limiting the CDB and the civil society ambassadors it supports to talking only about smart meters seems to risk confusion in the long-run.

Joining Up Energy Efficiency Policy

This paper has shown that energy efficiency schemes offer a cost-effective way of cutting carbon. Moreover, behavioural energy programmes potentially offer an even more cost-effective way to reduce emissions, as well as helping households lower their bills, although caution must be taken about whether such programmes can deliver savings on a national scale. However, the roll-out of smart meters should make it easier to test if such behavioural programmes work and how much they cost. This section considers what policy changes are necessary to take advantage of the potential of behavioural programmes and ensure smart meters deliver the maximum possible benefits in terms of reductions in domestic energy use (and therefore lower bills and carbon emissions). Assuming the problems with public acceptance identified in the previous section can be overcome, it is still unlikely that installing the technology by itself, even with the in-house display, will automatically lead to the hoped for savings.

Currently, energy companies are incentivised to reduce the amount of energy their customers use through the competitive market. If suppliers can help households cut energy use, it is more likely that customers will not switch to a rival. In recent years, there has been increased competition between different suppliers over the energy saving packages offered to households. However, it is not clear to what extent these 'energy services' packages distinguish suppliers from each other and to what extent price remains the main reason for switching. Moreover, suppliers can meet CERT obligations by providing insulation or other measures to non-customers, potentially adding further confusion.

Under the current market arrangements, energy suppliers will only offer packages to a certain level. If government wants to encourage further action on energy efficiency, it is likely to have to subsidise it (or create obligations for suppliers to do more). CERT showed that a large increase in insulation take-up is only likely with policy support, and this is likely to be the same for some of the behavioural programmes. The key test for emissions policy is whether such subsidised activities offer a cost-effective way of meeting climate goals compared to other policy instruments, such as subsidising low carbon generation. The evidence suggests this may be the case.

Energy efficiency is currently subsidised through obligations such as CERT, but these measures concentrate on implementing technical measures rather than delivering proven energy reductions. However, it is possible to structure markets to reward wider demand reduction programmes, including behavioural programmes, by allowing them to receive payments to do so. There are potential difficulties with such an approach (additionality, measurement, timeframe – see Box 8) although smart meters may allow many of these problems to be overcome.

This report considers three options for subsidising behavioural programmes through changes to the current energy policy structure:[58]

1. **A premium payment of feed-in-tariff for energy efficiency (EEFIT)**. An EEFIT would give a fixed payment to programmes that can deliver proven demand reductions in electricity use.[59] The government is consulting on how such a mechanism might work as part of Electricity Market Reform. It has still to indicate what level of support such an approach might receive. Such an approach would only support reductions in electricity use.

2. **A demand reduction payment** through the proposed Capacity Mechanism, another part of the Energy Bill. The Capacity Mechanism has been established to ensure there is an adequate supply to power generation in the UK and that back-up plant is incentivised to be available when there is a sudden drop in demand. Such a situation is more likely with a greater quantity of renewable energy on the system.

There are two possible elements to how a new Capacity Mechanism could be used to support energy efficiency measures. Firstly, the Capacity Mechanism could incentivise short-term 'demand response' to compete alongside back-up generation. When there is a potential shortfall in generation – a situation which is likely to become more common as more renewables are introduced to the system – large energy users could agree to reduce demand quickly for a reduced electricity price. This happens already within current market arrangements through interruptible supply contracts. Some argue that creating such an incentive could also allow 'aggregators' to bring together a large number of households who are prepared to cut energy use at short notice for a price.

Secondly, there is a proposal that long-term, sustained reductions in demand could also bid in to any capacity mechanism. This has been suggested as one of the options in the current consultation on demand reduction.

3. Another option is to **score demand reduction programmes through an amended Energy Company Obligation**. As discussed, ECO, in its current form, subsidises particular technical measures based on the nominal savings from them. However, it does not yet reward behavioural energy programmes. Moreover, it does not require the energy efficiency measures it does subsidise to demonstrate actual savings. As discussed, proving that energy savings have taken place and are additional is not straightforward. Potential ways of overcoming this have been successful in other countries and are discussed in Box 6. The advantages and disadvantages of the three options are compared in Table 5.

Table 5. Comparison of different policy options to support domestic behavioural energy programmes

	Capacity mechanism	**FiT through EMR**	**Brokerage system**
Allows reductions in electricity and gas use to compete?	No. Electricity only	No. Electricity only	Treats gas and electricity the same and reveals cheapest carbon savings
Linked to supply measures?	Mixes demand and supply in Energy Bill	Mixes demand and supply in Energy Bill	Demand mechanism only
Demand-side response vs demand reduction	Focus of capacity is about short-term demand response. Including long-term reduction would be difficult.	Would focus on long-term reductions in energy use	Would focus on long-term reductions in energy use

Domestic and non-domestic?	Both, but likely to be dominated by non-domestic, at least in the short-term.	Both, but likely to be dominated by non-domestic, at least in the short-term.	Domestic.
Opens up market to new players?	Depends on design. Large contracts may only attract large players.	Depends on design. Large contracts may only attract large players.	Could be piloted on small scale and allow charities, Local Authorities, smaller companies etc to compete for funding through brokerage.
Places a cap on potential energy savings?	Depends on design. Likely only rewards short-term savinsg.	No. Rewards continued reductions in demand.	Yes, as once supplier obligation is met no incentive to go further.

This analysis suggests that to encourage behavioural energy programmes in the domestic sector, changes to ECO offer the best approach. The advantages of this approach are:

- It would allow demand reduction on both gas and electricity use to be scored alongside each other. The other options, because they are being considered as part of the electricity market reforms, would only focus on reductions in electricity use. The ECO approach would focus on the cheapest possible carbon reductions, be they reduced demand for gas or electricity. Evidence of the cost-effectiveness of the energy efficiency and behavioural programmes described above suggests that achieving reductions in gas use may often be cheaper than reductions in electricity use.
- Such a mechanism reflects how households actually think about energy use. Many people pay their energy bills together and consider their energy use together, so such an approach would reflect this and allow organisations to offer demand reduction programmes in the round, rather than just focusing on electricity or gas separately.
- By taking advantage of the brokerage system (see Box 7), it would allow as wide a number of organisations as possible to compete on delivering energy efficiency at small and large scale. Many charities already run programmes that aim to reduce demand. Equally, there are many firms, such as Energy Service Companies (ESCOs), who may offer domestic equivalents of the

shared-saving contracts they run with businesses. By allowing different participants to compete, it would encourage innovation in how such programmes could be delivered (it may be difficult for small players to be able to bid for a large Energy Efficiency FIT contract). This could stimulate innovation in the type of leaflets given to customers, the type of internet app that provides information on use, encourage community schemes, prizes, bill comparisons and a combination of behavioural and technical measures. It could allow aggregators to co-opt a group of households and offer them discounted energy if they only use a certain amount of energy in a month. Such innovation will reveal the cost of demand reduction programmes and hopefully reduce the overall cost of meeting the obligation, keeping bill rises to a minimum. The only criterion for entry is that programmes can demonstrate that they have led to real savings. This will help overcome the lack of understanding about what really works in terms of reducing demand and changing energy behaviours in households.

Box 7. ECO Brokerage System

ECO has established a brokerage mechanism to allow a wider number of organisations to gain access to the subsidy beyond the major energy suppliers. In effect, the large energy suppliers may have to 'buy' a proportion of their obligation through the brokerage system (as they have, to a limited extent, with CERT). This, in theory, should allow the market to find the cheapest possible installation of energy efficiency measures approved under ECO by allowing many different participants to compete. It is not yet clear how much of the ECO market will have to go through the brokerage and government is consulting on different options. If behavioural programmes by third parties, including charities, were allowed to compete for some of the ECO subsidy through the brokerage, they should also have to bear the risk that the scheme was not successful and would therefore not be able to receive the subsidy.

Table 5 shows that there are considerable advantages to modifying the ECO as suggested above, at least for households. The drawback of the approach is there is a potential cap on savings. Once the obligation is met, there is no incentive to go further. However, because we are at an early stage in testing behavioural demand reduction programmes, it is unlikely that such a limit will be breached in the immediate future. Moreover, having such a cap may also protect consumers as it limits the potential overall cost of the programme. As CERT has shown, the marginal costs of the targets can be very high, particularly if lots of sub-targets are included.

This paper also supports the establishment of an EEFIT to compete alongside new generation (and therefore make overall carbon reductions cheaper) as it will offer a potentially cost-effective way of reducing carbon compared to some of the more expensive renewable energy technologies. However, it is likely that such a system will be dominated by the non-domestic sector at first. Supporting demand reduction programmes through ECO would complement such an approach, but with a focus on reducing household demand. Of course, there remains considerable uncertainty about which type of demand reduction incentives will work in the UK context and policy formation (as well as the technology of smart meters and the understanding of behavioural economics in energy use) is at an early stage. Therefore, it is sensible to pilot different approaches properly to discover which is the most successful, usable and cost-effective.

Policy Exchange has argued that there is no evidence that a Capacity Mechanism is necessary within the current market arrangements.[60] The main rationale for such a move is that governments will not allow the high prices that will be necessary for power plant that only run occasionally to cover its full operating costs.[61] In effect, the government is going to fix the market because it does not trust itself to allow the market to function properly and for prices to reveal costs. The risk of saying you are going to introduce a Capacity Mechanism is that investors will delay building a new plant until they can get the best price possible. This, paradoxically, increases the risk of a supply 'crunch'.

However, if the government does decide to go ahead with a Capacity Mechanism, it should allow demand response to compete alongside back-up plant. However, it is not clear that such a mechanism is best suited to longer-term demand reductions and risks making an already complicated mechanism even more complicated. Policy Exchange does not recommend using the proposed Capacity Mechanism for reducing long-term demand.

Phased introduction of a demand reduction incentive through ECO

ECO is about to be introduced so significant changes to the entire structure are inadvisable. However, a staged approach to move from subsidies for nominal savings for technical measures, as exists currently, to rewards for proven savings is possible:

1. Firstly, government should allow behavioural energy programmes to qualify as a measure under ECO. As we have seen, such programmes offer potentially cost-effective ways of reducing consumption, compared to technical measures. Such programmes would have to demonstrate tangible energy savings, based on clear baselines. This could include properly designed trials in the

foundation stage of the smart meter roll-out that test behavioural interventions to be scored in ECO[62] where they deliver energy savings.

This would incentivise more rigorous testing of smart meter-linked interventions than we have seen previously, providing a greater evidence base for what works in changing behaviour (as well as rewarding successful programmes) and how much it costs. It would also connect ECO and smart meters, and therefore behavioural and technical measures. It might also lead to greater public acceptance of smart meters as households might welcome greater support to reduce energy use. It could also help push a wider message about a concerted government and supplier effort on energy efficiency. There may be concerns from energy companies that they risk making investments in systems to set-up and support behavioural energy programmes which do not deliver real savings, and therefore have wasted money. However, the alternative of basing subsidy on a 'no regrets' strategy where companies would get the subsidy even if no savings were delivered could lead to unsatisfactory schemes capturing some of the subsidy. Basing subsidy payments on demonstrable savings places the risk with the company that operates the scheme that it must show real savings.

To reflect uncertainty about the potential of such behavioural programmes, government might restrict them to a limited proportion of the ECO obligation at first, with the majority of support remaining on technical measures.

2. If such a move proved successful and cost-effective, the next step would be to reward combinations of behaviour change and technical measures to be eligible under the obligation. This could include programmes that educate people how to use energy efficiently while also installing energy efficiency measures (some charities already do this). It could also be as simple as energy companies paying customers to reduce energy use through new tariffs, as long as they thought it offered a cheaper way of meeting the obligation (this underlines the flexibility in tariffs that are offered, see earlier discussion of the Retail Market Review).

Because such measures provide greater certainty that they delivered real energy savings (because they would have to be backed by rigorous data, rather than assumptions about saved energy), they could be eligible for more ECO points than the simple installation of technical measures based on nominal savings.

3. The final stage, perhaps in a future incarnation of ECO when smart meters are more fully rolled-out, would be that the entire obligation would have to be backed by demonstrable savings in energy (and carbon). At this stage, it is hoped that the pilots and programmes tested in the first phase will

have provided greater evidence on which behavioural measures deliver what level of savings. If this evidence is clear, such behavioural measures could then score the savings on a 'nominal' basis, as happens currently with technical measures. This could reduce the cost of such measures and therefore the overall cost of the programme. However, government must be cautious about such an approach and there must be rigorous auditing systems put in place to ensure that such savings can be demonstrated, even if only on a sample basis.

If such an approach can be developed, it would allow a more technology neutral approach than is currently provided through ECO, with behavioural measures competing alongside technical measures, including innovative new energy saving devices not yet on the approved list of measures.

Box 8. Practicalities of proving cuts in demand have taken place

One of the complexities of a market that rewards demand reduction is proving that such reductions would not have happened anyway, ie that the cuts in energy use are additional. A reduction in energy use could be the result of several factors, unrelated to any intervention. This could include warmer weather reducing the demand for heating. Such a problem is not impossible to overcome and methodologies have been successfuly used in the United States. There are two broad options for making comparisons:

1. Compare energy use for individual households following the intervention to energy use after the intervention. This requires suppliers (or whoever runs the programme) to establish a baseline. The data would have to be normalised depending on weather.

2. Compare the energy use of those households who get the intervention to a control group who do not. This is the approach used by Opower in the United States. Households with similar charactersitics are identified and those who do not have the intervention are used to provide a benchmark (this allows for factors such as different weather in different years to be less important). Any energy savings from those within the group who have the intervention are then scored, and would paid a subsidy.

Such approaches are not perfect and may not account for changes such as different levels of occupancy. Robust methodologies need to be developed before behavioural programmes can be rolled-out nationally and allowed to fully compete with insulation measures for subsidy, which is why the first step for government should allow new pilots to be subsidised through ECO (see recommendations). It is worth stressing that current support for technical measures relies on assumed or 'nominal' savings rather than actual savings. A comparison approach based on real energy (and therefore carbon) savings helps tackle problems like the rebound effect.

Long-term measurement

Another problem is ensuring that the changes people make in behaviour are sustained. While there is a reasonable certainty that insulation will continue to work for several decades (although no guarantee it will lead to overall reductions in energy use), there is a concern that behavioural steps will 'wear off' and people will revert to old habits.

Currently, there is some evidence that changes in how people use energy are sustained over a period of more than two years.[63] Improved data collection, aided by smart meters, should make it easier to monitor whether changes in behaviour have been sustained (although checking will add extra cost). The subsidy could be paid for each year the savings can be shown to continue compared to a baseline of benchmark.

Conclusion

This paper argues that, in order to incentivise the low cost carbon savings reducing energy demand may offer, further policy is needed. This includes subsidising programmes that use behavioural understanding and can demonstrate real energy savings to test if such schemes can actually work in a UK setting. This will require careful, rigorous, properly controlled trials.

Smart meters make such trials easier to run and prove real reductions in demand. But it is imperative that government and suppliers' handling of the roll-out and the communications around the roll out are well-designed. If this fails, the potential of cost-effective demand reduction – and the associated carbon savings – are severely limited.

Endnotes

[1] The government is currently consulting on market-wide measures to support energy efficiency in the electricity sector. Premium Payments and the Capacity Mechanism are both included in the consulation.

[2] Based on average bill of £1,260 a year. DECC (2011) *Estimated impacts of energy and climate change policy on energy prices and bills*.

[3] The brokerage system will allow the large energy suppliers to meet some of their obligation by buying energy efficiency measures from third parties through a market.

[4] This report uses the term 'energy efficiency' broadly to represent energy reduction or conservation and the more efficient use of energy, unless a more precise defintion is required.

[5] DECC (2012) *Energy Efficiency Statistical Summary*

[6] Cabinet Office (2011) *Behaviour Change and Energy Use*

[7] NAO (2011) *Preparations for the roll-out of smart meters*

[8] For fuller examination of conflicting carbon prices across the economy see Newey, G. (2011) *Boosting Energy IQ: UK energy efficiency policy for the workplace*. Policy Exchange

[9] This low rate of VAT is being challenged by the European Commission.

[10] DECC (2012) *The Energy Efficiency Strategy: The Energy Efficiency Opportunity in the UK*

[11] Norman, J. (2008) *Compassionate Economics.* Policy Exchange.

[12] DECC (2011) Evaluation synthesis of energy supplier obligation policies

[13] Jenkins, J., Nordhaus, T., Shellenberger, M. (2011) *Energy Emergence: Rebound and backfire as emergent phenomena*. Breakthrough Institute; Cabinet Office (2011); Sorrell, S. (2007) *The Rebound Effect: as assessment of the evidence for economy-wide energy savings from energy efficiency.* UKERC

[14] Of course, often these technologies *will* deliver real energy savings. DECC is also rightly cautious about making too optimistic claims about what levels of savings the measures will result in.

[15] Dolan, P., Hallsworth, M. Halpern, D., King, D., Metcalfe, R., Vlaev, I. (2012) *Influencing behaviour: The mindspace way*. Journal of Economic Psychology (33) pp264-277

[16] Such measurement can take place with existing 'dumb' meters, but requires more frequent meter reading which is more expensive or self-reading, which is less reliable.

[17] Moreover, there is not a simple division between behaviours and energy efficiency measures. The action of installing energy efficient light bulbs is a behaviour, as well as a technical measure. However, it is useful to separate the two when considering policy measures.

[18] DECC (2012) *Smart meter roll-out for the domestic sector: Impact Assessment* p. 75

[19] DECC (2012) *How much energy could be saved by changing everyday household behaviours?* Total is based on Policy Exchange calculations avoiding double-counting of measures. Such steps are not expected to affect quality of life.

[20] These figures are based on Policy Exchange calculations. The model used to assess the smart meter programme's cost-effectiveness is not publically available. The assumed savings in this table are calculated by comparing the savings shown by the study to the electricity savings assumed by DECC's figures and extrapolating demonstrated savings to the savings from the particular studies. Savings are over 19 years.

[21] Erhardt, Martinez, Donnelly, Laitner (2010) *Advanced metering initiatives and residential feedback progams: A meta-review for Household Electricity Saving Opportunities.* American Council for an Energy-Efficient Economy

[22] Foster, B., Mazur-Stommern, S. (2012) *Results from recent real-time feedback studies*. American Council for an Energy-Efficient Economy

[23] Darby, S. (2006) *The Effectiveness of Feedback on Energy Consumption*. Environmental Change Institute, University of Oxford.

[24] Fischer, C. (2008) *Feedback on household energy consumption: a tool for saving energy?* Energy Efficiency (2008) 1:79-104

[25] VaasaETT (2011) The potential of smart meter enabled progams to increase energy and systems efficiency for European Smart Metering Industry Group. Available at: http://www.decc.gov.uk/en/content/cms/tackling/smart_meters/sup_res/int_evidence/int_evidence.aspx

[26] Commission for Energy Regulation (2011) Electricity Smart Metering Customer Behaviour Trials. Findings report. Available at: http://www.cer.ie/en/information-centre-reports-and-publications.aspx?article=5dd4bce4-ebd8-475e-b78d-da24e4ff7339

[27] Interestingly gas consumption was reduced during the EDRP trial even without an IHD, probably reflecting that most gas consuming behaviours in the home (central heating, thermostat changes) happen less often.

[28] Dolan, P., Metcalfe, R. (2012) *Neighbors, Knowledge, and Nuggets: two natural field experiments on the rol of incentives on energy conservation* [Working paper available on request from metcalfe@uchicago.edu).

[29] Ofgem (2012) *The Retail Market Review – updated domestic proposals*. The document recognises that its current proposals may have to be revisited as smart meters become more ubiquitous.

[30] See Littlechild, S. (2012) *Ofgem's Procrustean* Bed. Oxera for a discussion of these issues.

[31] DECC (2012) *The Energy Efficiency Strategy: The Energy Efficiency Opportunity in the UK*

[32] DECC (2011) *Evaluation synthesis of energy supplier obligation policies*

[33] SSE, British Gas and Npower pointed out the rising costs of CERT, in particularly the obligation to treat vulnerable households, as part of the explanation for increasing energy prices in 2012. Alistair Philips-Davies, Generation and Supply Director at SSE, told the Energy and Climate Change Select Committee that the annual cost of meeting the obligation had risen from £100 to £200 million in 2012. See http://www.publications.parliament.uk/pa/cm201213/cmselect/cmenergy/uc554-i/uc55401.htm

[34] Policy Exchange advocated a Green Deal-style system in Caldecott, B., Sweetman, T. (2009) *Warm Homes*.

[35] The Impact Assessment measures the cost of the marginal ECO point (p.58). An ECO point is equivalent of a tonne of CO2 savings over the lifetime of the measure. DECC used its Green Deal Household Model to estimate the cost curve for reaching a certain carbon targets, although it recognised there was considerable uncertainty about how much it would cost to reach a particular target.

[36] NERA (2012) *The cost of the Energy Company Obligation*. Prepared for Energy UK.

[37] As the Green Deal Impact Assessment note, it is almost impossible to accurately model what the likely impact of the creation of a new market, such as the Green Deal. The potential demand will only be realised once it is put in place.

[38] Although it only provided results for five options.

[39] Ofgem (2011) Energy Demand Research Project Final Analysis

[40] Work for the Committee on Climate Change has also identified considerable savings from simple changes in behaviour.

[41] DECC (2012) *How much energy could be saved by changing everyday households behaviours*. Interestingly, savings from measures commonly suggested, such as not overfilling kettles, had less potential.

[42] Allcott, H. and Mullainathan, S. (2010) *Behaviour and Energy Policy*. Science: 327 (5970), pp.1204-1205

[43] For more detail on the programme see Dolan, P., Metcalfe, R. (2012) *Neighbors, Knowledge, and Nuggets: two natural field experiments on the rol of incentives on energy conservation* [Working paper available on request from metcalfe@uchicago.edu).

[44] Ward, F., Porter, M., Popham, M. (2011) *Transition Streets: Final Project Report*. Transition Town Totnes.

[45] Friedrich, K., Eldridge, M., York, D., Witte, P., Kushler, M. (2009) *Saving Energy Cost-Effectively: A National Review of the Cost of Energy Saves Through Utility Energy Efficiency Programmes*. American Council for an Energy Efficienct Economy.

[46] Arimura, T., Newell, R., Palmer, K. (2009) *Cost-Effectiveness of Electricity Energy Efficiency Programmes*. Resources for the Future.

[47] The calculations use an exchange rate of £1 to $1.6USD and EUR1 to £0.78.

[48] Mott MacDonald (2010) *UK Electricity Generation Costs Update*.

[49] The cost of generation technologies is based on Committee on Climate Change figures using Mott McDonald data. The cost of carbon calculation is based on the technology replacing the current marginal plant, which is CCGT with a CO_2 intensity of 0.37gCO_2/kWh. Replacing domestic gas use was measured at 0.185gCO_2/kWh. The long-run cost of electricity was £80/MWh and the long-run cost of gas was £54.3p/MWh (DECC figures).

[50] There is considerable uncertainty about what new nuclear will cost in the UK and the level of subsidy.

[51] For further discussion see Moore, S (2010) *2020 Hindsight*. Policy Exchange.

[52] DECC (2012) *Quantitative Research into Public Awareness, Attitudes, and Experience of Smart Meters*

[53] In California, opposition to the roll-out was so aggressive some residents blocked a street to prevent the meters being delivered, leading to the arrest of 30 people. There have also been setbacks in Australia.

[54] Policy Exchange polling found that when asked for 'the most helpful thing politicians can do to improve your life for you and your family', the top personal priority was reduce energy bills. This underlines the political imperative that policies, in particular low carbon policies, do not add to bills unnecessarily and, where possible, help lower bills.

[55] Digital UK (2010) *Digital UK's ten transferable lessons from the UK's digital television switchover programme*; Digital UK (2012) *Switchover's biggest year: Report for the year to 31 March 2012*.

[56] Jackson, T. (2005) *Motivating Sustainable Consumption: a review of evidence on consumer behaviour and behavioural change*. A report to the Sustainable Development Research Network.

[57] See Phillips, R. & Scott, F. (2012) *Smarter communications: strengthening consumer engagement on smart meters*. Green Alliance.

[58] The government consultation on energy efficiency in the electricity sector looks at the first two options.

[59] Benton, D (2011) *Decarbonisation on the cheap*. Green Alliance.

[60] Less, S. (2010) *Re-monopolising power?*. Policy Exchange

[61] When there is a high level of renewables on the system, some plant, probably gas, will only run occasionally to meet peak demand when the wind is not blowing nor the sun shining. In theory, this could mean that such gas plants would have to charge very high prices at times like this to cover their annual operating costs (although it is likely overallcosts of such a system will be lower as renewables will provide power at a very low cost when they are operating). If such 'peaking plant' was not able to charge such high prices, it would just close down, creating risk of power cuts.

[62] These could be trials that are agreed with the Behavioural Insights Unit to avoid some of the pitfalls of the EDRP.

[63] DECC (2012) *Smart meter roll-out for the domestic sector: Impact Assessment*.

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