Energy Demand Research Project: Final Analysis

Executive Summary

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Rev No	Comments	Checked by	Approved by	Date
2.2	Final version	David Ross	Andrew Cripps	21/06/11

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Job No 60163857 Date Created June 2011

Executive Summary

This section summarises the overall findings and conclusions from the Energy Demand Research Project (EDRP). EDRP was a major project in Great Britain to test consumers' responses to different forms of information about their energy use. Four energy suppliers each conducted trials of the impacts of various interventions (individually or in combination) between 2007 and 2010. The interventions used were primarily directed at reducing domestic energy consumption, with a minority focused on shifting energy use from periods of peak demand. The project involved over 60,000 households, including 18,000 with smart meters. Measures were generally applied at household level but one supplier also tested action at community level.

The final analysis collates and builds on suppliers' findings and additional analysis of the data on energy consumption and consumer feedback, together with a review of the wider literature to identify the interventions that have proved most effective in reducing consumption, and key messages about how such interventions can best be delivered. The report provides a unique source of information particularly pertinent to the forthcoming national roll-out of smart meters. It sets out the quantitative savings that were achieved through a range of interventions enabled by smart meters, demonstrating the potential of smart metering as an enabling platform for measures to influence consumer behaviour.

1.1 Introduction

EDRP was launched in July 2007 and has been managed by Ofgem on behalf of DECC. The trials were undertaken by four energy supply companies: EDF Energy Customers Plc, E.ON UK Plc, Scottish Power Energy Retail Ltd and SSE Energy Supply Ltd (EDF, E.ON, Scottish Power and SSE). The Government allocated £9.75 million to the trials, match-funded by the energy suppliers taking part.

This report presents a final analysis of the findings from EDRP. The project was designed to help understand better how domestic consumers react to improved information about their energy consumption over the long term. This included investigating the impact of measures to reduce energy consumption and, in some cases, to shift energy demand from periods of peak demand.

The analysis presented in this report has been undertaken in the context of the Government's proposed roll-out of smart meters – hence there is a greater focus on the smart meter trials. The trials started prior to the Government's decision to roll out smart meters and so were designed to trial a range of different interventions. Nevertheless, much useful information has been acquired in support of the plans.

The trials have been made up of different combinations of measures and explored the responses of around 60,000 different households. The trials began in 2007 and finished towards the end of 2010.

This report presents the following.

- Findings reported by the energy suppliers on changes in energy consumption, resulting from the introduction of the interventions, and consumer feedback on the interventions.
- AECOM's evaluation of the energy suppliers' findings.
- AECOM's additional analysis of the energy suppliers' energy consumption data and consumer feedback. This builds on the work done by the suppliers to extend and clarify the impact of the various interventions tested.
- An assessment of the findings of the trials in the context of the academic and professional literature on trials of similar interventions (including a detailed literature review).
- The key practical and technical issues identified by the energy suppliers associated with the installation and operation of smart meters in EDRP and possible implications for the national roll-out of smart meters.

1.2 Summary of the trial design

The trials were constructed through a call for tenders to energy suppliers to bid for matched government funding to conduct trials on energy demand reduction. The brief was not prescriptive of the size, content, design, methods or form of analysis of the trials. This process resulted in commissioning of four essentially independent trials being conducted and analysed by the energy suppliers (EDF, E.ON, Scottish Power and SSE) and their academic advisors.

The energy suppliers each divided their trials into a number of trial groups to test the impact of different interventions. The interventions included the following (assessed either individually or in combination with each other).

- Energy efficiency advice.
- Historic energy consumption information (such as comparison of energy consumption with earlier periods).
- Benchmarking of the customer's consumption against the consumption of comparable households.
- Customer engagement using targets (commitment to reduce consumption).
- Smart electricity and gas meters.
- Real-time display (RTD) devices that show energy use (including audible usage reduction alarms).
- Control of heating and hot water integrated with RTD.
- Financial incentives (including variable tariffs) to either reduce consumption or shift energy demand from periods of peak demand.
- Other digital media for delivering information (web, TV).

Table 1.1 provides a summary of the number of households who participated in the trials and the sub-set that had smart meters. The number of drop-outs during the trials ranged from 5% to 36% depending on the energy supplier. The analysis sections provide further details of the number of households included in the analysis for each of the different interventions and in-trial years.

Table 1.1 Number of households participating in EDRP

Energy supplier	*Total number of households*	*Households with smart meters*
EDF	1979	1879
E.ON	28450	8055
Scottish Power	3028	1330
SSE	27887	7106
Total	61344	18370

In addition, SSE assessed the effect of community engagement on behaviour and electricity demand reduction. This was undertaken in three villages: one each in England, Scotland and Wales. Each community had the same target and incentive: a £20,000 community project prize for achieving an average 10% reduction in electricity consumption over a three month period compared with the same three month period in 2007-8. Household-level interventions were provided, e.g. smart meters, RTDs (clip-on and linked to smart meters) and web access were common interventions deployed in the three communities. In addition, communities were given free rein to pursue other interventions and activities to achieve their targets (in individual dwellings, by insulation, new appliances, etc. or at community level).

1.3 Behaviour change

This report uses a simple theoretical framework based on the *means*, *motive* and *opportunity* for householders to change their behaviour (i.e. for householders to reduce energy demand, they must know what to do, have a reason for doing it and have the resources to do it). The wide range of behaviours that affect domestic energy demand may be characterised in terms of "*opportunity*" – the time required and the cost associated with them, and sometimes also the required space in the home. Therefore, a simple division of energy efficiency measures into "behaviour change" and "installation" does not adequately represent the range of options for saving energy. Insulation, for example, is not a behaviour, but installing insulation is a behaviour. Turning down a thermostat is a (no-cost) behaviour but it requires a thermostat to be installed.

The literature review conducted for this project shows that most changes seen in trials of energy demand reduction incentives tend to be – in the short term at least – those that require little investment of time or money. The EDRP customer surveys document a wide range of behaviours that householders used to reduce energy demand. While the trials do not allow changes in behaviour to be definitively tied to specific supplier interventions, the resulting changes in energy demand have been demonstrated more clearly than in past GB studies and – in some cases – for the first time.

1.4 Energy demand reduction seen in EDRP

Below is a summary of the changes in energy demand seen in the different interventions trialled in EDRP. The summary also takes account of a thorough review of findings from trials of similar interventions in the wider literature.[1]

1.4.1 Interventions without smart meters

With two exceptions, there was no significant reduction in energy consumption when the intervention did not include a smart meter.

The exceptions are interventions either using clip-on real-time displays (RTDs) of electricity consumption or "benchmarking" each customer's consumption against typical consumption in comparable households. In these two cases it was only SSE that found a significant reduction (in electricity consumption only, not gas consumption), and the effect was small (around 1% savings).[2]

The other trials found no statistically significant effect of RTDs, energy efficiency advice (on paper or online), historic feedback (on paper or online), self-reading of meters or financial incentives to save energy in the absence of smart meters.

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[1] The findings presented in this executive summary are statistically significant. In interpreting the findings from EDRP we have considered the quality of the interventions, their delivery, the data and the design of the trials. Those interventions that did not show statistically significant savings might nevertheless be able to save energy in some customer groups and/or if implemented differently.

[2] Only the SSE trial included benchmarking. Although a small effect, this is one of the clearest pieces of evidence for an effect of benchmarking (the literature is generally positive but allows no quantification). There is concern that those who consume less than the benchmark amount may start to consume more; therefore, careful consideration needs to be given to how benchmarking might usefully be deployed in the population in general.

1.4.2 Interventions with smart meters

In contrast, interventions using smart meters were successful more frequently and with larger percentage savings in energy consumption. This may be explained partly by some aspect of receiving the smart meter (e.g. interaction with the installer or the positive image of getting new technology) but also the different options that were available once a smart meter was installed, e.g. more sophisticated RTDs (fitted by an installer), and more frequent and accurate historic feedback and billing.

Real-time displays

RTDs provide live data on energy consumption (kW and cost) and usually other information such as CO_2 emissions and energy consumption over specified periods. Some RTDs have audible alarms or visual signals to alert the customer to high consumption. The combination of smart meters and RTDs consistently resulted in energy savings of around 3% but with some higher and lower savings, depending on fuel, customer group and period.

In the case of electricity consumption, providing an RTD is the more important factor: savings were generally 2-4% higher than with a smart meter only (with a full range of 0-11% for some periods and customer groups) and these effects were persistent to the end of the trial. The percentage savings were greatest in the EDF trial and this may be because the accompanying advice was more effective. Only the Scottish Power trial showed no positive effect of RTDs with smart meters and this may be related to the fact that the meter replacement was presented as a routine replacement rather than as a smart meter or part of a research trial.

In the case of gas consumption, the smart meter itself (e.g. the information provided on consumption and cost) or some aspect of the experience of getting a smart meter appears to be a positive mechanism, resulting in savings of around 3%. E.ON found that these effects were persistent into the first quarter of the second in-trial year (i.e. for 15 months) and for one or two further quarters in some groups. The literature and other EDRP findings indicate that this effect may require support over time from other interventions (e.g. advice or billing information) to be sustained for longer periods.

The RTD findings are consistent with the literature. The effect of smart meters in isolation from other measures on gas consumption has not been investigated before but is in keeping with theoretical considerations, that real-time feedback is more relevant to electricity consumption than to gas. Applications of gas (e.g. heating and hot water) tend to be subject to more occasional adjustments having long-term effects (e.g. changing a thermostat setting in response to getting a smart meter or RTD).

The EDF survey data showed that customers expected, and could have benefited from, more engagement and instruction during installation of smart meters and RTDs. More generally, the written instructions may sometimes have been unclear or too complex, especially for people in the trial context (who were sent the device, rather than making an active decision to buy it). Hence support from the installers may be particularly important. This raises the possibility that greater savings might have been achieved with different procedures at this early stage.

In addition, EDRP provided the following evidence on the relevance of different aspects of the RTD, evidence that could be used in pursuing higher savings. Customer surveys about RTDs showed that cost information was used and valued more than unit (kW) information, and electricity information more than gas (this may be due in part to the order in which button pushes accessed different types of information, electricity generally being the default display). Displays of CO_2 emissions were generally not widely noticed or used or perceived as useful. Displays of temperature data were generally rated positively and may have been particularly useful in the early stages in responding to advice to reduce thermostat settings.

This is consistent with the literature, which additionally shows that portability of the RTD is a benefit (at least initially) and that appliance-specific feedback can have additional effects on energy savings (the latter was not tested in the

EDRP). The literature also identifies two key points that were not explored further in EDRP, but which are relevant to engaging consumers about RTDs:

- householders may find RTDs more useful in confirming savings after attempts to reduce consumption, rather than using an RTD to initiate savings;
- RTDs can be used to check that everything has been switched off before going to bed or leaving the house.

The mains powered RTDs (i.e. those connected to a smart meter), which displayed both gas and electricity consumption and tended to have more sophisticated functions, were consistently (across trials) more likely than clip-on RTDs to be fitted, retained, used and rated positively. Having an RTD also tended to result in more positive perception of the smart meter. The SSE survey found that reasons for not using the RTD differed between clip-on displays, not connected to a smart meter (where the functionality of the device itself was the dominant reason) and mains RTDs (where the usefulness of the information provided was dominant).

The audible alarm of high consumption in EDF's trial caused no incremental reduction in consumption and attracted only negative response in the customer survey. A "traffic lights" visual signal of consumption level, in contrast, was often the most positively rated feature. This is consistent with the limited evidence in the published literature.

There is nothing in the literature on the effect of an RTD with integral heating controller so the EDF trial of this device (combined with provision of advice) was the first test of its kind. There was no reduction of electricity consumption (data on change in gas consumption were not available). The customer survey revealed a positive response to the device but this may be because customers valued it mainly as a heating controller and did not use it so much as an RTD to view energy consumption information.

Energy efficiency advice and historic feedback

EDRP used generic written advice (not personalised to the customer) – mainly on paper but also via the web, a dedicated TV-based web page and RTDs. Advice was sent at varying frequencies and in varying amounts and styles. Historic feedback was principally a graphical comparison of consumption in the current bill/statement period and the same period the previous year. The EDRP findings for generic advice and historic feedback are consistent with the literature insofar as an effect of these interventions was not always seen and, when it was seen, the reduction in consumption was up to 5%. This was important to confirm in the UK context, given the previous dependence on evidence from elsewhere.

The particular combination of advice and historic feedback on consumption that EDF deployed (along with smart meters) reduced electricity consumption by 2.3% overall[3] in the first in-trial year.[4] The effect was persistent into the second in-trial year (4.0% saving). The E.ON trial found some weaker evidence of savings due to advice, in combination with smart meters and monthly feedback on consumption, but it is difficult to quantify because of the particular schedule of interventions. The other trials detected no effects of advice, historic feedback or the combination.

The effects observed by EDF occurred in spite of a survey finding low customer engagement with the material provided. This perhaps gives a clue as to why the EDF trial was effective: information was provided in simple, short statements, over a period of time – minimal but well presented and easy to absorb a little each month. The SSE advice booklet, in contrast, was comprehensive but required more effort from householders and was provided once

[3] When dual fuel and electricity-only customers were considered separately, the reduction was significant only for dual fuel customers (4.6% saving) and not for electricity-only customers (0.9% saving). However, in the second in-trial year, savings were significant for both dual fuel (2.4%) and electricity-only customers (5.0%).

[4] Gas consumption could not be assessed.

only, at the start of the trial. There was greater engagement with the SSE booklet if an RTD was also provided, so some of the effect attributed to the RTD may have been due to the RTD prompting interest in the advice and/or the advice helping householders to use the feedback from the RTD.

Similarly, the historic feedback was more obvious to customers in the EDF trial (large, in colour and on separate sheets) than that provided by E.ON. The SSE survey data did show that customers found the information on bills more useful if they also had advice, which further helps to explain the effect on consumption found by EDF. The survey also showed that many customers found the bill data and RTDs to be complementary, with a value in providing both.

The message is that advice should be provided as a fundamental requirement, and historic feedback can be useful, but the details of delivery, and combination with other interventions (e.g. smart meters and real-time feedback), are critical. EDRP has taken a step forward in understanding these details but there is more work to do and the optimum approach is likely to vary between customer segments, and to change over time as more energy knowledge becomes commonplace and people become more familiar with their consumption levels.

Incentives to reduce consumption

EDRP found no reliable or persistent effect of either financial incentives to reduce energy consumption or general statements of commitment to reduce consumption.

The literature provides little substantive evidence on financial incentives to meet a consumption reduction target except for the general (and obvious) point that sufficient incentive will prompt people to reduce consumption, but only for as long as the incentive is kept in place. Three EDRP trials employed financial incentives to reduce consumption but only Scottish Power saw reductions in consumption when the incentives were applied – only in the case of credit customers with smart meters and only for short periods. The Hawthorne effect[5] is a sufficient explanation of the Scottish Power findings. There are also concerns in the literature that using the financial motive in this way could focus householders' attention on financial savings and that this could reduce the chances of seeing long-term savings because other motives to reduce consumption are suppressed by the financial motive.

Similarly, having householders make a commitment to reduce consumption (without a specific target or reward) did not have any detectable effect on consumption. There is no directly comparable evidence in the literature but, in short-term trials, there is tentative evidence of savings prompted by realistic but stretching targets (without a reward), combined with frequent feedback.

Web-based interventions

EDRP used web-based services to provide advice, billing information and historic feedback (delayed by only a day but not real-time feedback), but without any effect on consumption.

The literature shows the potential benefits of online services to help consumers reduce energy demand, but also shows that the potential is rarely realised. EDRP also found this, with neither of the suppliers that used web-based interventions (EDF and SSE) seeing any energy savings as a result. The trials also showed that a major reason for failure is likely to be lack of engagement with the web sites, not necessarily a lack of effect among those who did use the sites.

[5] People may change their behaviour merely because they know they are being observed or tested, regardless of any specific attempts to change their behaviour. This "Hawthorne effect" tends to be short-term but can be reinstated by regularly changing the intervention, which is what happened in the Scottish Power trials.

Evidence on the provision of online real-time feedback is limited and, as yet, inconclusive in the literature. It was not tested in EDRP but surveys suggested that the online provision of feedback would have been more effective if real-time data had been provided.

1.4.3 Overview of changes in energy demand

A range of different smart meter-enabled interventions were demonstrated to deliver energy consumption reductions, and smart metering was demonstrated generally as a necessary enabling platform for behaviour change measures. While the savings were sometimes small in percentage terms, the absolute savings scaled up to national level would be substantial.

- The positive savings from smart meters depended on providing consumers with appropriate additional interventions, as discussed above.
- The provision of an RTD was particularly important in achieving savings in electricity consumption. Gas savings could be achieved through installation of a smart meter without further intervention, although evidence of persistence was not as strong as for electricity savings with RTDs.
- Electricity savings can be promoted through provision of advice and historic feedback on consumption but they cannot be relied upon on their own: one EDRP trial found significant savings with these two interventions in combination with smart meters and another found significant savings in combination with benchmarking against the consumption of a peer group (without smart meters).
- Financial incentives and commitment to reduce consumption, in contrast had either no effect or a very short-term effect.
- Delivery of information through the web or customers' TVs was also not successful in reducing consumption.
- Savings were generally persistent where the trial was long enough to test this, especially electricity savings from the combination of RTDs and smart meters. In contrast, any savings from financial incentives rapidly dissipated when the incentive was withdrawn.

However, the impact of an intervention depends on the detail of deployment: how a particular intervention is delivered and how it is combined with other interventions. Savings are not guaranteed simply by implementing a particular type of intervention and the following points need to be considered.

- A smart meter can provide key data and an RTD can relay that information. However, further information, advice and prompts are likely to be required if the impact is to be maximised.
- RTDs will have less impact if customers are relied upon to fit them: a significant proportion will simply not be fitted. Furthermore, where they are fitted, guidance needs to cover how to use the information that RTDs provide, not just how to access the information.
- *Consumers need to know what to do*: what *means* should be deployed to save energy. Some consumers already know (at least in part), others need further information. This information can be delivered through generic written material (on paper or online, before, during or after smart metering installation), verbal advice as part of the installer visit and by consumers being encouraged to experiment with an RTD to see the savings that could be achieved from a particular end-use of energy.
- *Quality matters*: information needs to be clear, easily seen amongst other material sent by suppliers, and presented in an attractive way. It also needs to be relevant and timely (e.g. appropriate to the season) and kept up to date as the options for action change (e.g. because of new technology or incentives). The design of RTDs and the explanation of how to use them are similarly essential to effective customer engagement, satisfaction and savings.

- *Quantity also matters*: a balance needs to be struck between providing sufficient information and avoiding information overload. For example, regular small nuggets of information appear to be more effective than a single delivery of comprehensive information (to provide information in manageable amounts and to maintain behaviour change prompts over an extended period).
- *People and households are not all the same*: the literature suggests that the more closely an intervention can be tailored to particular households or individuals, the more effective it is likely to be. Possible options range from full energy audits to a few selected pieces of advice, offered during smart meter installation. There is also potential to use the web more effectively: although web (and TV) interventions were unsuccessful in EDRP, information on the web could work for consumers more engaged with such forms of information and particularly if they receive tailored information (including real-time feedback and online audits).
- Quality, quantity and tailoring of interventions are relevant to all points in the customer journey: from engaging with an intervention at all (e.g. reading advice or installing an RTD), to the initial impact of the intervention and sustaining actions over a longer period.

Community engagement can also be an effective tool, making use of social networks and social capital, and moving social norms away from acceptance of energy wastage. It may, however, require a higher initial investment and will not necessarily work in all localities. Local support from a combination of experts and peers can help consumers to understand what to do, appreciate reasons for taking action (reasons that make sense to them personally) and provide the resources (time, space and money) necessary to take action: means, motive and opportunity.

1.5 Load shifting

Two trials (EDF and SSE) tested time-of-use (TOU) tariffs for electricity (i.e. tariffs that vary with time of day and sometimes season) in combination with smart meters and other interventions (advice, historic and real-time feedback, and incentives to reduce overall consumption). These trials showed effects on shifting load from the peak period, with bigger shifts at weekends than on weekdays. Estimates of the magnitude of shifting effect vary with trial but were up to 10%. The EDF trial showed that the effect is stronger with smaller households (1 or 2 people), thus providing a clear focus for where such interventions should be targeted. The effect was weaker in the SSE trial and this may be because awareness of the intervention was limited and it was seen as overly complex.

Neither of the TOU tariff trials involved any automation of energy-consuming appliances to facilitate load shifting. No data were gathered during the trials to provide evidence on what appliances or behaviours were responsible for the observed shifting.

The literature shows that time of use tariffs can also bring about reductions in total energy consumption. However, the evidence is almost exclusively from studies in hot regions (where the dominant energy demand is for air conditioning) and cold regions with electric heating. The limited evidence from the UK suggests small reductions (3% or less) in overall electricity demand and no such effect was detected in EDRP.

1.6 Population segment effects

Across all the trials, there was limited evidence of how different population segments were affected by the interventions. However, the following themes could be seen in the findings.

- Smaller households were more likely to save energy overall and to shift consumption from the evening peak period.
- E.ON's 'fuel poor' (FP) and not 'fuel poor' (NFP) groups are difficult to characterise – they differed in the fuel poverty index for their postcode and it is not known how many households were actually fuel poor in each group.

Nevertheless, the FP group is likely to be generally less affluent, with more pressure on energy costs. A generally more positive response to interventions in the FP group most likely signifies their greater motivation to save money.

- SSE found significant variation in energy consumption reduction with demographic group (based on the Mosaic classification) but the analysis did not permit identification of specific Mosaic groups that had a higher or lower propensity to reduce consumption. In no case did Mosaic group have a significant interaction with a trial intervention, i.e. the effects of interventions did not vary with demographic category.
- SSE also found variation in consumption reduction with postcode but again the analysis did not permit identification of specific locations that had a higher or lower propensity to reduce consumption. Also, savings did not depend on the more systematic geographic variables included in the analysis so the details of any location effect are difficult to define. In no case did location have a significant interaction with a trial intervention, i.e. the intervention effects did not vary with location.
- There were also some differences in savings between customers who purchased only electricity from the supplier responsible for the trial and those who also purchased gas from that supplier. These differences are difficult to explain with any certainty but they were not due to electricity-only customers not having gas heating because most of them did.
- Only SSE included prepayment smart meters (for electricity only) in its trial, with one trial group being given smart meters and an RTD. This group made savings similar to those in the credit customer groups.
- Scottish Power made more extensive investigations of prepayment customers but not with smart meters. These customers did not make savings relative to the control group under any interventions.
- Prepayment customers tend to have lower consumption anyway and therefore less scope to reduce. However, they may be more practiced at monitoring consumption, more aware of costs and have greater (financial) motivation to save energy. With these counterbalancing factors, savings appear to be possible (as shown by SSE) but not always achieved (as shown by Scottish Power). Logically, efforts to help prepayment customers reduce consumption might focus on means and opportunity, the motive already being present, but this was not explored in the trials.

1.7 Practical and technical issues

The primary purpose of EDRP was to investigate consumer behaviour and it was not set up as a technology or roll-out trial. The equipment used was what was either readily available or could be developed for use in the time available. Nevertheless the experiences of the installation and use of the equipment from EDRP provide valuable practical lessons for mass roll-out of smart metering.

Overall, the equipment employed worked well. Many of the practical problems encountered were reported as due to the ‘pilot’ nature of this project (e.g. equipment faults, data communication losses between the household and supplier, and managing the large volume of energy meter data received). Indeed, given the subsequent advances in technology, a number of the issues identified would not be encountered if starting EDRP today. The remaining issues identified are already informing work under the smart metering programme. It is also worth noting that some of the issues identified (access to properties, billing errors) would be encountered in “business as usual” meter replacement activity, whether smart or not, although over a longer period and therefore more easily managed.

A significant issue will be the customer interaction with the smart metering equipment (including RTDs). All trials reported some customers having difficulties in understanding the new equipment provided. This is not simply about the design of equipment, although that has been improving: care is needed in how RTDs are ‘sold’ and explained to

the wide cross-section of population such that they know how to access and use the data that the display provides, and take an interest in doing so.

1.8 Further evidence development

Measuring changes in energy consumption and the associated household behaviour is a complex business. Carrying out research to attribute changes to particular experimental interventions is more complex still and this is reflected in uncertainties that remain on the subject of how to change householder behaviour. The literature shows some engagement of consumers with behaviour changes that require relatively little time and money to implement. If substantial savings are to be realised across wide segments of the population there is a need for consumers to move along a pathway of behaviour change, so that changes requiring more investment of time and money also occur more frequently.

In particular, the specific combinations of interventions that are most effective in achieving reductions in energy demand, and the details of how and when they should be implemented, are only partly understood. It is becoming clear that electricity and gas consumption are not affected in the same way but the details are only now starting to emerge. The way in which different segments of the population can be engaged, and how they will respond to interventions, also merits further investigation. The key questions concern getting consumers' attention, motivating them to take action and providing them with the necessary knowledge and resources.

The development of knowledge will need to be partly around the design of equipment and the associated user guidance – to establish the ideal balance of complex functionality and simple, attractive products. Equally, the media of communication could be enhanced, looking at approaches ranging from optimising the use of web-based approaches to person-to-person spread of knowledge and motivation through communities. The use of community-based approaches has been shown to be effective but, to be viable for application at national level, further research and analysis is needed to determine whether there are "key ingredients" for more cost-effective versions of the community approaches used to date and to provide good practice guidance.

Time-varying tariffs may play a role in managing energy demand, in controlling total and peak-time consumption. The optimum tariff levels and ratios, and the role of advice and technology in supporting behaviour change, are as yet poorly understood.

Some questions may be answered by further analysis of the EDRP data. More broadly, if specific issues are identified, more in-depth processing of the energy or survey data is certainly possible. Based on the experience of EDRP, much useful knowledge could also be gained from monitoring and evaluation of the smart meter roll-out. In particular, there is great potential for achieving energy savings through the installation process but the optimum level of interaction between households, installers and (if involved) energy advisors needs to be established.

There is also a need to understand better the impact of energy behaviour change interventions in the context of other policy initiatives targeting household energy use. For example, the Green Deal, Feed-in Tariff (FIT), Renewable Heat Incentive (RHI), Energy Company Obligation (ECO) and the Community Energy Saving Programme (CESP) will change the context in which behavioural interventions are played out. Changing the physical form and fabric of the property (Green Deal), the supply of electricity and heat (FITs and RHI), and the social, legal and financial context (CESP and Green Deal) will change the means, motive and opportunity of householders to engage in behaviour change. This, in turn, will impact on the efficacy of different packages of behavioural interventions in different ways. The capacity to evaluate the impact of existing behavioural change packages, and to develop and test new packages of behavioural interventions on a continuing basis will be important. In addition, there is a possibility that smart meters themselves, independently of any effects they have on energy demand, will be a useful tool for evaluating the impact of other policy initiatives.