Consumer attitudes to Demand Side Response and Direct Load Control

Literature Review

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Overview

Effective management of the distribution network and local balancing in a community context requires either a dynamic time of use tariff or direct load control. Automation is generally seen as the more effective route given the challenges in securing ongoing, reliable behaviour change and the complexity for customers in responding to dynamic tariffs. However there are known consumer concerns about ceding control in this way. The evidence shows that behaviour change should not be dismissed out of hand, that automation is still to be preferred where possible and that consumer concerns with direct load control can be addressed for many customers by providing over-rides and other assurances.

For heating, a commitment to maintaining temperature within certain bounds can provide that assurance. For other loads automation is still seen as presenting potential safety or other concerns.

Given that consumers with night storage heating already feel they have limited control this is not necessarily such an issue for them and as highlighted in the main report it could actually lead to improved comfort.

In the Fintry context the focus to date has been on heating loads and the use of temperature monitors would allow commitments to be made around comfort. In a community context the ability to engage with the community and to develop with them the necessary over-rides and assurances should help address the concerns that might otherwise arise with ceding control.

Introduction

The Smart Fintry project has explored the policy and consumer issues associated with attempting to match demand and locally generated energy within a community. The main report includes feedback from the focus groups held with Fintry residents. However this was a small group and they were at an early stage in the journey. This annex therefore seeks to supplement that evidence with a literature review on the consumer issues associated with the use of Demand Side Response (DSR) and Direct Load Control (DLC). This covers:

- Evidence on the major sources of load that could be used for DSR / DLC and where consumers are most happy to time shift;
- Evidence on the balance between automation and behaviour change;
- Evidence on consumer concerns about ceding control;
- Evidence on consumer experience of dynamic DSR / DLC programmes.

In discussing DSR most commentators consider two forms of tariff – static time of use tariffs (where the tariff pattern varies through the day but on a regular pattern) and dynamic tariffs (where the price may vary from day to day – eg there may be a set number of high price periods each year notified in advance). As discussed in the regulatory section of the main report, network charges currently lend themselves to a static time of use tariff while wholesale prices point more to a dynamic tariff. If distribution networks wish to make more use of demand side services to help with network management this is more likely to take the form of DLC – but could be given effect through a dynamic tariff plus automation. More generally, local balancing, particularly where wind is involved, would require some form of dynamic tariff or DLC.

Given this context, this literature review focuses in particular on the evidence around dynamic time of use tariffs and DLC.

Sources of load

Sustainability First have carried out a major project on electricity demand side with a total of 13 papers available on their website covering different consumer and policy dimensions. This includes a paper on what demand side services household customers could offer (2012) which covers both the technical potential and consumers' willingness to shift different sorts of load. This highlights the importance of on-peak electric heating where there is some potential to shift load (and to reduce peak load through insulation) and hot water where more work is required.

Of the electricity used for space heating they find that around half is used in the economy 7 off-peak period (11pm-7am) and half is used on-peak. This is despite the fact that GB wide around 2 million homes have storage heaters and just 0.5m use direct electric heating. However they note that for many homes with storage heaters they will not be the only source of heat and direct electric heating may be used in combination with other fuels. This creates an opportunity to better manage that on-peak load to try to avoid the system peak. Although not mentioned in their report, there are some other tariffs (such as economy 10) which allow for an additional boost to storage heaters during the afternoon as observed in the Fintry data and which again could be considered for load shifting.

In terms of other sorts of load, they quote the EPRG survey which found that appliances which consumers would be most willing to time shift are washing machines, tumble dryers and dish washers. The load consumers are least willing to shift is cooking.

In their overview paper (2014) Sustainability First note that there may be limited match between what currently contributes to peaks (heating, lighting, cooking, TV and consumer electronics) and

what householders are generally willing or able to shift (washing machines, tumble driers, dishwashers).

Automation versus behaviour change

Frontier Economics and Sustainability First (2012) carried out a review of international experience on demand side response for DECC. The review found that the greatest and most sustained shifts in electricity demand occurred where households have certain flexible loads such as air conditioning, and responses by these loads are automated. Without automation, a combination of economic incentives and real-time interactive information (such as in-home displays) delivered the greatest responses. There is limited evidence on whether DSR persists over time if it is not automated or directly controlled.

The report looked at 15 static time of use tariff trials and found that in all but 3 cases there was a reduction in peak usage but with a broad range (0-22%). For dynamic tariffs (critical peak pricing or critical peak rebates) the response was typically more marked (5-38%) with critical peak pricing showing a stronger effect. While the strength of the price signal is an important determinant of the level of impact it is not the only factor and information is also important. 12 of the pilots examined used direct load control aimed at critical peaks.

The pilots considered were predominantly in North America and, to a lesser extent, Australia and focussed on consumers with air conditioning which, although less directly relevant to DSR in the UK, have some parallels with heat pumps. Both technologies have heavy electric demand which can only be shifted if the consumer is willing to forego an element of comfort in exchange for a financial return. The report discusses the use of Economy 7 in GB as an example where customers are willing to accept automated control.

In terms of government policy Ofgem /BEIS (2017) recognise the important role of automation in encouraging demand side response and in particular the need for standards around smart appliances.

The latest review of international experience by BEIS (2017) reiterates the benefits of automation. It also considers opt-in versus opt-out schemes and notes that while opt-out will lead to a higher enrolment in schemes it leads to a smaller % actually responding. The primary motivation for most consumers to enrol in DSR programmes appears to be financial, but environmental and other drivers are also significant. The involvement of trusted third parties is found to encourage participation.

The message around automation is reiterated in the Sustainability First overview paper (2014c) where they say: *"In the longer-term, automation is likely to be the most effective and reliable way of realising household DSR potential, but this will require customer buy-in and ability to override. 'Ease of use' and sense of 'being in control' are critical".*

In another of their papers focussed on longer term opportunities (2014b) Sustainability First make the point that even if customers are in principle willing to change their behaviour, automation brings benefits in allowing a response when the consumer is not present (or asleep), when the options are complex (eg different heating options for different rooms) or where there is a desire to integrate DSR as part of a system including microgeneration.

Another Sustainability First paper (2014a) focuses on local energy issues and makes the point that DSR may be easier to deliver in the context of local supply and demand matching given that – as evidenced by the Isle of Eigg project – consumers can gauge the level of renewable energy

availability quite readily based on the weather and are motivated by what they see as more efficient use of “their” energy.

Ceding control

There is strong evidence in the literature about consumer concerns about ceding control in the context of automation or DLC, summarised in Fell et al (2014).

For example, Mert et al (2009) carried out a study across a number of EU countries on attitudes to smart appliances. This looked at options for load-shifting including e.g. delaying the start of washing cycles, intermediate interruptions of the operation of appliances, or utilising the thermal storage capacity of freezers. It found that major changes to daily routines, significant additional costs or loss of comfort will not be accepted easily. It looked at options around consumers setting start and finish time; responding to prompts on a good time to use appliances or full automation and found no one model was universally preferred.

They found that automation of devices such as the air conditioner, refrigerator, deep freezer, or central heating pump is accepted, but only if comfort is not lost and users keep full control. One major concern of consumers is that they feel uneasy leaving certain appliances switched on, when they are not at home or during night. Consumers are afraid of break-downs which might lead to flooding or fire. The perception of risk depends to a very high degree on their current behaviours. For example, consumers are typically not willing to run the washing machine when they are not at home or during the night, but are much less worried about the dish washer, although both appliances work very similarly. Safety issues were also raised in relation to smart freezers or refrigerators as people fear that food might be damaged.

Given these concerns, the study found that consumers need to understand the bigger picture (around renewables and the electricity grid) and the concrete implications of using smart appliances, to be motivated to adopt them. While financial benefits are likely to be the biggest driver, these bigger picture considerations can be an important motivator.

Fell et al (2014) present a framework, based on focus group discussions they held, for thinking about the different aspects of control as follows:

• Comfort (such as being able to obtain desired thermal conditions in the home).

• Timing (control over when people do things, such as running appliances like dishwashers).

• Spending (having a sense of control over how much money is spent on energy).

• Autonomy (a more general sense of directing events in one’s life, free of outside influence).

The majority of consumers viewed a fixed TOU tariff as increasing personal control, particularly over costs. Dynamic TOU pricing divided opinion, with some seeing it as providing more control over costs, while others were concerned about ease of use, the requirement for automation, predictability and flexibility. Almost everyone saw direct load control as reducing their control, either couched in terms of control over particular appliances or as impacting their autonomy more broadly.

The focus group included users of different types of heating and it was noted that participants with night storage heaters in particular were dissatisfied with the level of control they currently had over when their homes were heated.

In the larger consumer survey they subsequently undertook (Fell et al 2015) they were unable to establish any clear evidence of the importance of these different sources of concern in different

contexts (reflecting in part the strong inter-linkages between them). However it could still provide a useful framework for exploring the consumer perspective in future focus groups.

Stenner et al (2017) show a link between levels of consumer distrust in their supplier and take-up of direct load control services in the Australian market. They argue that steps to build trust can help take-up.

Consumer experience

Fell et al (2015) carried out an online consumer survey of a representative sample of just over 2000 bill payers in Great Britain to test attitudes to different forms of DSR/DLC. Specifically they looked at static and dynamic tariffs with and without automation, and then also direct load control of heating. The conclusion was that there was significantly more support for the DLC option than the other tariffs with 37% saying they would sign up (and 30% saying they would not). The authors note that this could be seen as surprising given known concerns about ceding control but that it shows that they can be addressed. In particular the option they had presented committed to limiting temperature variations to 1 degree centigrade (ie a very specific commitment) and that it only applied to heating.

They also found that with automation to respond to price signals, a dynamic time of use tariff (normally the least preferred) was as acceptable as a static tariff. They argue this is likely to reflect the complexity that otherwise exists for consumers dealing with such tariffs.

A number of trials have been carried out by GB distribution network operators funded by Ofgem's Network Innovation Competitions.

NorthernPowerGrid (2015) in their Customer Led Network Revolution project carried out a number of pilots ranging from direct control of washing machines through the installation and monitoring of 320 air source heat pumps with either time of use tariffs or direct load control. They also looked at using hot water storage to balance on-site PV generation. In general they found a high level of acceptability and interest – although they encountered some technical performance issues with the heat pumps.

As part of the project they estimated the value to the DNO of having direct control over certain loads on heavily loaded parts of the network. They estimated this at £15 pa. for hot water or for a heat pump, £4 for a dryer and £2 pa for wet appliances. This was based on interruptions of several hours for 10-15 days every 1 in 3 years. This gives an indication of the value that could be accessed by communities.

UK Power Networks (2015) in their Low Carbon London project looked at residential DSR as an alternative to network reinforcement. This was the first large scale dynamic time of use tariff (with around 1100 customers) and was modelled to replicate dealing with a constraint and also "wind twinning". Customers were notified the day before if a particular period would be low, medium or high price The response delivered was significant with a large majority modifying their consumption in response to prices. Wet appliances were noted as easiest to shift. At the end of the pilot 91% of participants agreed that the dynamic tariff should be offered to everyone.

The consumer research that they carried out highlighted that an explanation of the reasons for the dynamic tariff is needed to build consumer trust – with out that consumers found the lack of predictability annoying (albeit that some said it made it more of a "game") with an assumption that suppliers were picking the timing to suit them. The IHD was found helpful but generally timers were

not as they were seen as adding further complexity. Having fixed roles for use of various appliances limits the flexibility.

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