C R E D S

Demand response: success isn't just about numbers

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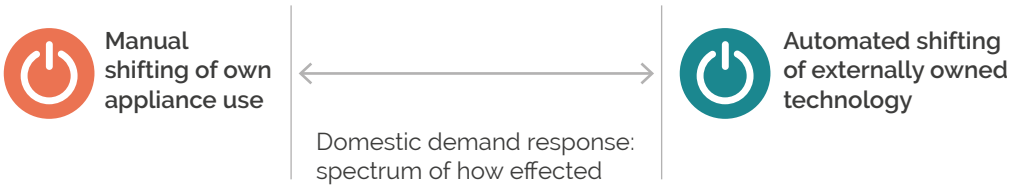
Summary

According to the Climate Change Committee we could be using almost twice as much electricity in 2050 as today, and most of this will be from renewable sources. These changes are partly due to increased demand as transport and much of heating become powered by electricity and partly due to needing to move away from fossil fuel based generation. Matching demand with renewable supply from variable sources like wind power will likely mean that electricity demand will have to be moved around in time and decreased during periods when the system cannot provide it. This is known as demand response.

It is almost certain that households will have a role to play in demand response, and various trials and commercial schemes have been implemented in recent years to ascertain how successful it could be. As all of this gets underway, we ask: what is the best way to implement domestic demand response on a large scale and how can less well-off households be factored in fairly?

Normally a demand response scheme is viewed as successful if a large amount of energy has been shifted. Here, we highlight other outcomes beyond the energy shifting results, and the design choices which lead to them. We use two case studies of demand response trials in low-income households to raise ethical, practical and financial questions and the need to trade off objectives that are not just about energy use. We encourage scheme designers to take into account not just the shifting potential but the full list of considerations presented here.

Demand response can be carried out manually – by the household; automatically – by technology like a smart home system or a battery; or by an outside party switching appliances on and off. These options can be thought of as a spectrum where at one end the household does this energy shifting themselves using their own appliances, and at the other end an external party installs some technology (e.g. a heat pump) and operates it remotely.



There are also options in between the two ends, for example where householders buy equipment to facilitate demand response. However for low income households who cannot afford to buy a large battery or may not have space in their home for a big heat store, demand response is likely to be one of the two ends of the spectrum: either a manual approach, or being part of a scheme which both provides and controls the technology.

Our recent research compares these two ways of effecting demand response in low income households. We were not trying to state which approach is right or wrong, but to highlight the design choices and consequences to think about as more domestic demand response schemes get underway, so that low income households are factored in fairly. Our case studies are two real UK demand response trials: Energywise shifting trial [1], from the manual side of the spectrum, and NEDO smart communities demonstration project [2], from the third-party automation side.

The Energywise project, run by UK Power Networks, explored how social tenants in East London could participate in energy saving opportunities. One initiative called the 'shifting trial' incentivised households to reduce their electricity use at certain times using bill rebates. NEDO (the Japanese New Energy and Industrial Technology Development Organization) ran a trial in Greater Manchester in which air source heat pumps were installed in each property, and operated remotely. The heat pumps were switched off at certain times of day to simulate a real demand response market and investigate how many minutes of demand response could be achieved before the homes got too cold. The results below also bring in other studies and go beyond the two case study trials to anticipate what might happen in a non-trial setting.

The first and often only aspect to be considered is the energy shifting result. Typically, the end result is this:

Design choices and consequences	Manual shifting of own appliance use	Automated shifting of externally owned technology
Likely amount of demand response obtained	Low	High

Demand response schemes such as Energywise which encourage low income households to move their energy consumption themselves do not shift much energy. This is partly because there is little to be shifted, as these types of households do not typically have electric cars and heat pumps which use a lot of electricity.

Instead if, as in the NEDO initiative, an external party installs and operates a heat pump in a low income home, there is a lot of energy to be shifted and this can be automated so that the demand response can be achieved without the householder doing anything.

But this is not the whole story. Look behind the results and there is a lot going on…

Firstly we will focus on the householders. In what ways do they benefit or lose out?

Design choices and the consequences for households

Design choices and consequences	Manual shifting of own appliance use	Automated shifting of externally owned technology
Who controls energy use?	Household	Mostly an external organisation
Empowerment of household to manage energy?	Yes – active management of energy required	No – household discouraged from disrupting external control
Penalty if flexibility not possible	Household faces high electricity price	Not yet clear who pays for high electricity cost but household likely to contribute
Disruption to daily life	Could be high and likely to disproportionally affect women	May be unanticipated consequences such as overheating outside of peak times
Benefits to household	Actively participating households save a little money on energy	All households get new heating system

For the household, managing their own energy shifting is a double-edged sword. On the plus side, with the right training (more on this later), they are empowered not only to manage their own energy but more widely to take part in the energy transition and make a positive impact on the environment. On the minus side, new burdens are created for them. We found that women, who still do the majority of the domestic chores, are especially affected. For example, the evening meal falls in the time they are encouraged not to use electricity. How is this compatible with cooking? How should parents get their children ready for bed without electricity? Is it acceptable to make a cup of tea or will that cost too much?

Installing a new heating system and operating it remotely removes involvement in demand response from the householder almost entirely. Is this a positive or negative feature? We cannot say, but in the NEDO trial which used this approach and achieved a high demand response, many households did not understand how their heating worked or even that they were in a demand response trial. It is worth noting in a minority of homes, the occupants took back control by disconnecting the communications technology to opt out of shifting. To achieve the high level of shifting the trial relied on occupants not getting involved, and when they did anyway, this decreased the demand response.

Next we will look at other parties aside from the households.

Design choices and consequences for other parties

Design choices and consequences	Manual shifting of own appliance use	Automated shifting of externally owned technology
Resource intensive?	Yes – on upskilling households to manage energy	Yes – on equipment (e.g. heat pumps and associated infrastructure), and call-outs
New areas of responsibility for certain parties	New responsibilities mostly fall on household	Housing maintenance teams must maintain new infrastructure,local authorities coordinate housing and technology

At first glance it may seem that manual demand response is by far the cheaper option to implement, requiring minimal new technology. However, we found that both types of demand response in low income households require significant financial resources from other parties. An intensive engagement scheme was carried out in the Energywise trial enabling households to take part in the demand response and gain a greater understanding of household energy management. Outside of a trial context it is not clear how this participant engagement would be resourced. Since previous work (e.g. [3]) suggests that low-income households are less likely to switch energy tariffs, if the engagement were not heavily resourced then these households may not join in. As the energy system changes and pricing structures change alongside, households who do not join in are likely to be left worse off.

In contrast, in the NEDO trial resources were invested into technologies including heat pumps, communications, and network reinforcement – but also into call-outs where residents, not understanding the technology, either unplugged it or interacted with it, causing problems. Is it fair to expect householders to not interact with their heating system?

It is also worth reflecting on where responsibilities lie in these two types of demand response, and whether these responsibilities are new for the parties involved. New responsibilities are not necessarily a bad thing but they need factoring in. With manual demand response, the household gains new responsibilities of energy management. Energywise illustrated that they may or may not be able or willing to take on this new task. If households are not involved and instead energy shifting is reliant on technology, there are new responsibilities over this technology and its maintenance. In the NEDO case this placed a new responsibility on housing associations to maintain heat pumps.

In summary, there are many aspects to think about in design of domestic demand response. Questions raised span ethical, financial and practical considerations, involve a number of parties, and present a series of trade-offs.

We encourage scheme designers to engage with these trade-offs, to look beyond the headline numbers of how much energy shifting is available and to consider the wider set of design choices and consequences highlighted here.

Full table

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References

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2. NEDO, Implementation Report for Smart Community Demonstration Project in Greater Manchester, UK. 2017.
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About CREDS

The Centre for Research in Energy Demand Solutions (CREDS) was established as part of the UK Research and Innovation's Energy Programme in April 2018, with funding of £19.5M over five years. Its mission is to make the UK a leader in understanding the changes in energy demand needed for the transition to a secure and affordable, low carbon energy system.

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