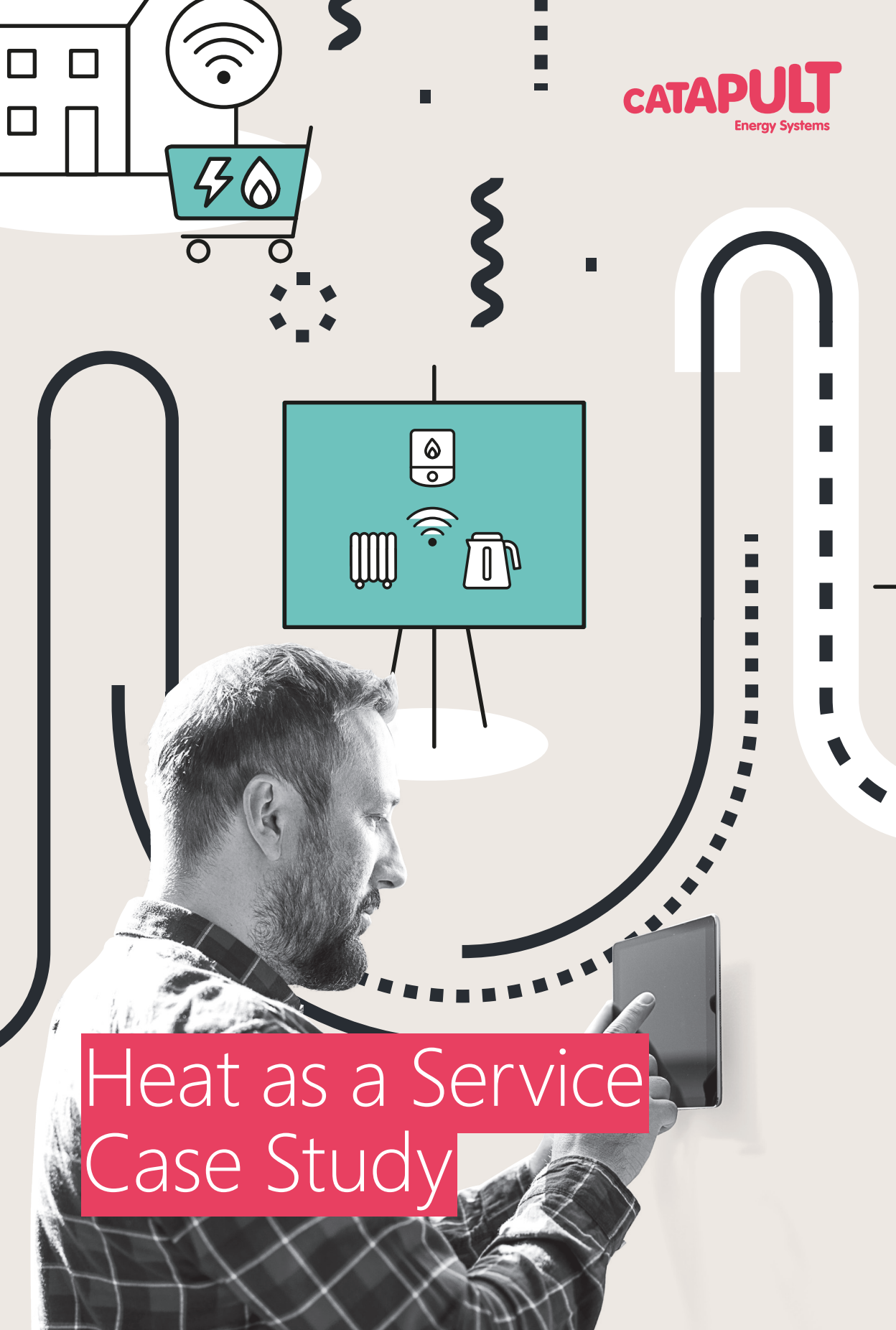
CATAPULT
Energy Systems



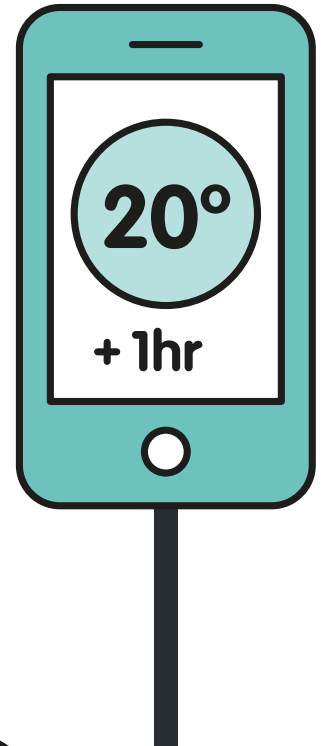
Heat as a Service Case Study

Whole system implications of heat as a service business model for demand-side management of electric heating demands.

The current trajectory of the energy system, specifically domestic heat, in the UK does not deliver the decarbonisation required to meet the country's legally binding targets. Most future pathways that achieve decarbonised domestic heat involve some level of electrification to utilise renewably generated electricity and there are opportunities in the energy sector to develop new market arrangements and business models to support this.

The Energy Systems Catapult has completed considerable research into the Heat as a Service (HaaS) customer proposition to support decarbonisation of heating. This study compliments this research by examining a new business model that could potentially deliver HaaS to consumers. We aim to understand whether the HaaS business model that utilises demand-side management (DSM) is commercially viable in today's market and what the wider energy system implications of such a business model are.

The study was conducted using the EnergyPath® Operations tool. The EnergyPath® Operations is a whole energy system tool that represents the UK energy systems (markets, policies, homes, data and technologies) in a simulation environment to explore new configurations of those systems in a broader, quicker, cheaper and safer way than trials.



The EnergyPath® Operations is a whole energy system tool that represents the UK energy systems.

Heat as a service with Demand-Side Management

Today, domestic customers are billed based on kWh used and they are completely in control of their electricity and gas consumption.

We consider a different scenario, where customers have a contract with an Energy Service Provider (ESP) who, in exchange for a fixed price, provides them with an outcome: a home heated to the temperature they want at the times they require it. In return for reducing their exposure to high energy bills, the ESP then takes some control over the customers' heating system. We term this demand-side management (DSM). In our simulation, we consider a simple DSM mechanism structured to maintain consumer comfort: so at the ESP's discretion they can dynamically choose to start heating the building at an earlier time.

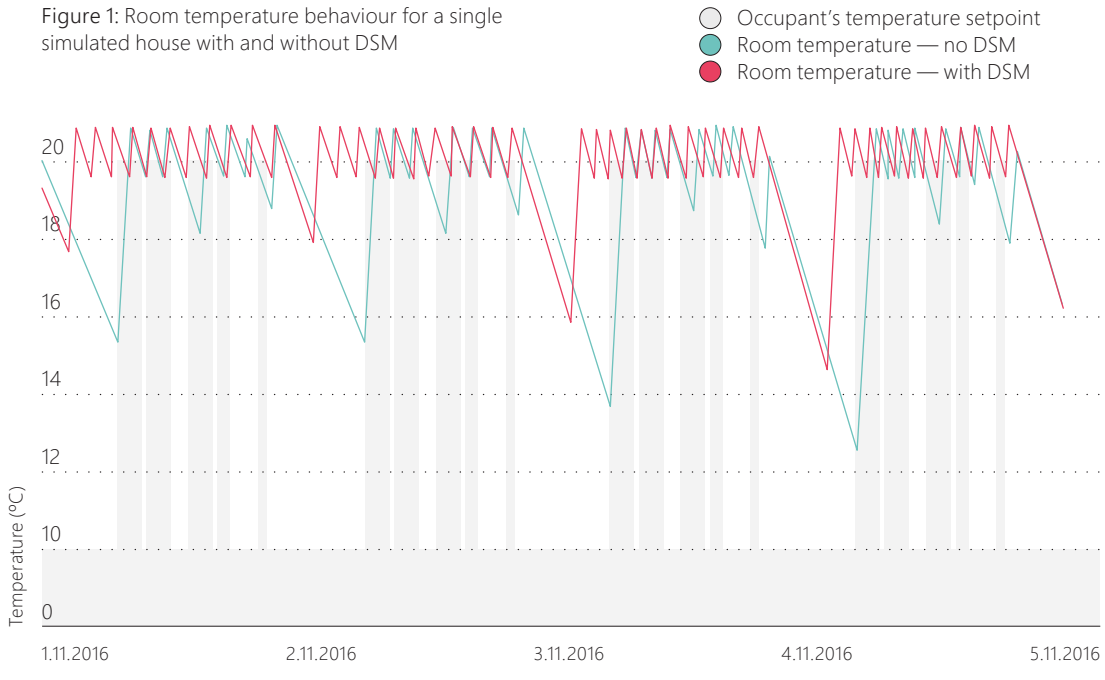
We consider a portfolio of houses with electrified heating (via air source heat pumps) supplied by one ESP who is the first to adopt the HaaS model.

Most aspects of the energy market, i.e. price fluctuations and rest-of-market behaviour, are comparable to the present day. However, TNUoS and DUoS charges were levied based on actual time of energy use, determined via smart metering. This is not the case in the UK today, but is currently in discussion and likely to happen once the smart meter rollout and infrastructure set-up is complete.

This gives the ESP an incentive to manage their customers' heating systems to avoid peak energy charges across the wholesale electricity market and TNUoS and DUoS charges. In effect, each customer's house is used as a "heat battery".

Figure 1 demonstrates the difference between utilising and not utilising DSM in maintaining the temperature the house occupier has requested in their heating service contract. In both cases the temperature in the house reaches the customer's setpoint when they have requested heating, but additionally when DSM is enabled the customer is warm for longer as the ESP chooses to start heating earlier to avoid peak energy charges.

Figure 1: Room temperature behaviour for a single simulated house with and without DSM



Use more energy but incur less cost

The HaaS business model can generate small savings on the cost to provide electricity to the customer. As shown in figure 2, over the 6 months of the EPO simulation, the total cost to the ESP with DSM was £12 per house lower than where DSM was not used (£378 vs £390 per house respectively).

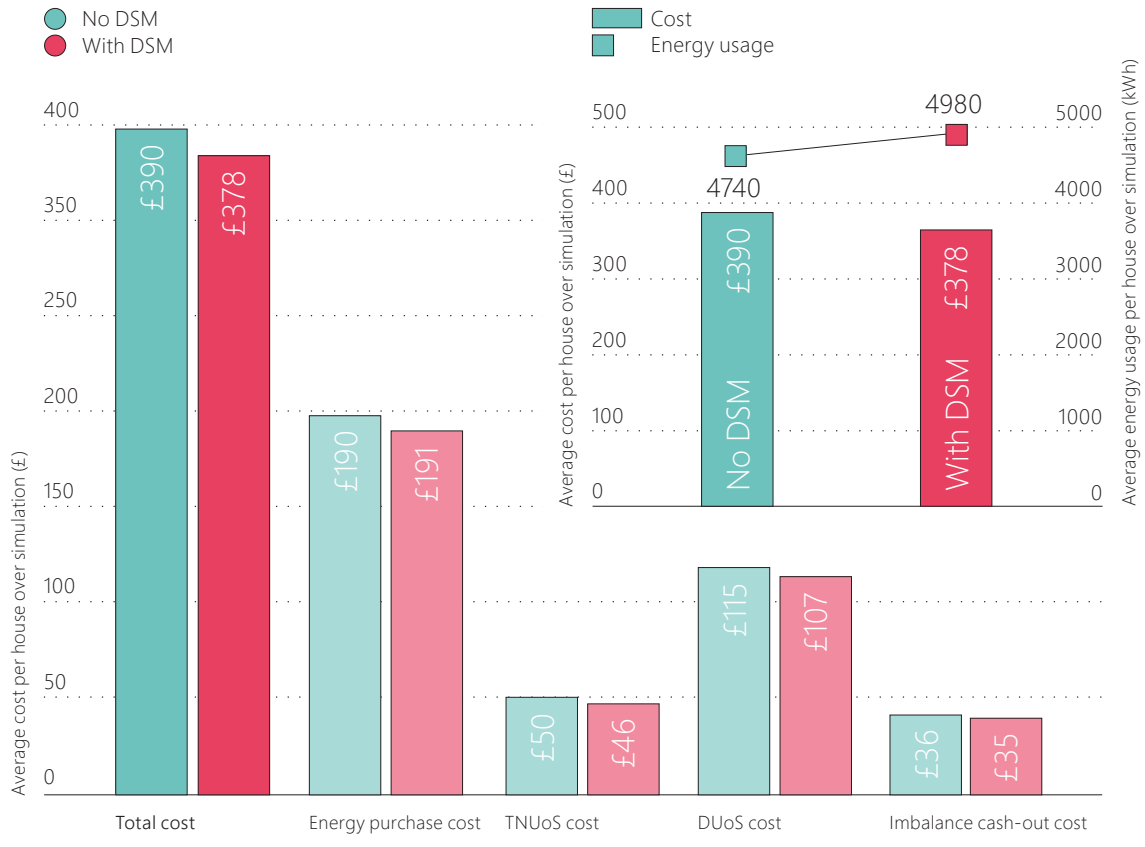
However, the average energy consumed per household increased from 4740kWh to 4980kWh when DSM is enabled, illustrating that this DSM scheme leads to greater energy usage since houses are kept warm for longer.

The savings from using DSM represent a 3% reduction in the cost to provide energy to the customer. As an indicative value, if the saving were maintained and the scheme were scaled up to half the electricity customers in the UK (28million), this would lead to a total saving of £168m, though it must be remembered that this is a heavily simplified simulation intended to give indicative results only.

Although the overall cost to provide energy to the ESP decreased by using DSM, further analysis shows that cost savings were predominantly from reducing the time-ofuse-dependent TNUoS and DUoS charges (figure 3) by shifting the majority of the electric heating load out of peak times.

Figure 3: Cumulative cost to the ESP with and without demand side management, and energy consumption in each case per house

Figure 2: Components of cost to ESP with and without DSM



Managing peak loads

The adoption of the HaaS-with-DSM scheme also has potential benefits for electricity network operators, even though it may decrease their revenue from DUoS and TNUoS.

Figure 4 shows the effect of DSM on the time-profile of electricity demand, illustrating how the heating component of energy consumption is shifted earlier into the overnight lull in demand. This leads to a reduction in peak load, which would be beneficial for reducing the need for network reinforcement.

In summary, present-day market arrangements constrain system-level outcomes – in this case, they do not allow network operators to minimise network reinforcement by incentivising suppliers to use demand flexibility (DSM) to shift load within-day. Adopting a whole-systems perspective helps to identify changes to the structure of the energy system that may improve outcomes, such as that described in this case study, which can then be tested through simulation.

Benefit across the energy sector

This initial simulation study has examined the potential savings available for a firstmover ESP providing HaaS to customers with air-source heat pumps through a relatively simple DSM scheme.

Although these conclusions should be treated as preliminary, they suggest that the HaaS with-DSM approach has scope to address a number of challenges facing the UK energy system in the near future.

Savings of up to 3% on the cost to supply energy to its customers are combined with a small reduction in peak electricity demand, potentially reducing the need for network reinforcement.

The design of the DSM scheme in this study also guarantees (and potentially enhances) customer comfort. Some of these benefits could be realised in today's market but changes need to be made to improve the viability of the DSM opportunity.

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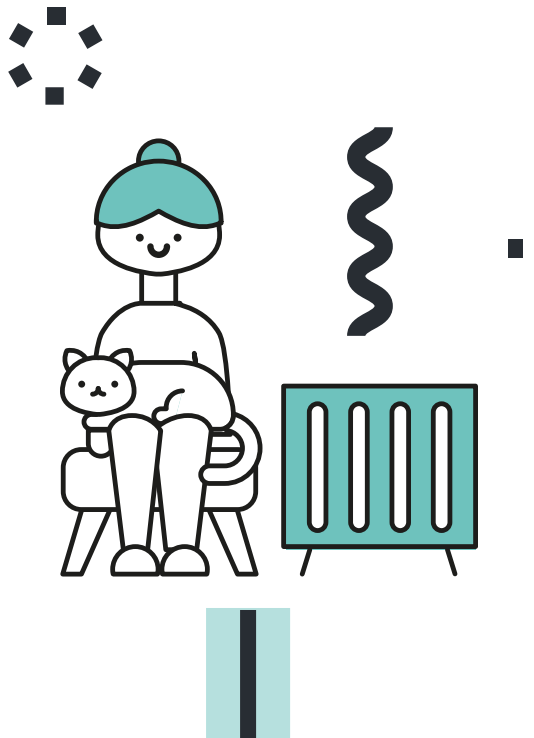
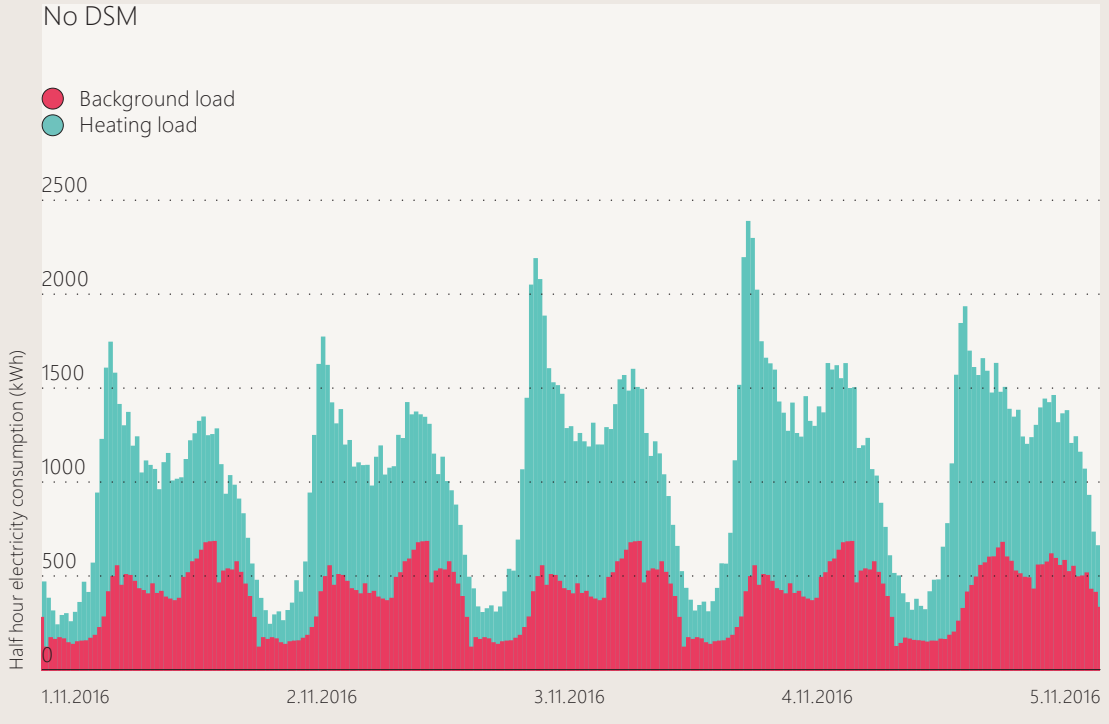
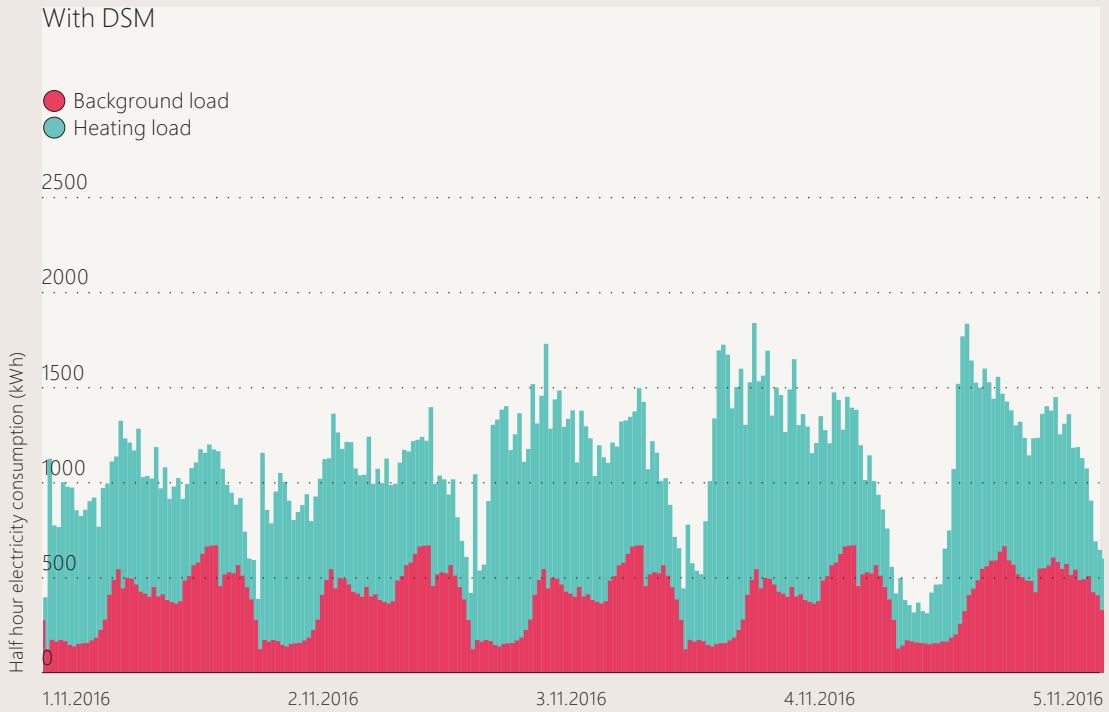


Figure 4: Electricity consumption profiles with and without DSM, for a four-day period of the simulation





Unleashing innovation
and opening new markets
to capture the clean growth
opportunity.

Get in touch with the
Dynamic Energy System
Architecting team to find
out more about our whole
energy system simulation tool
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Energy Systems Catapult was set up by Government to accelerate the transformation of the UK's energy system and ensure UK businesses and consumers capture the opportunities of clean growth. The Catapult is an independent, not-for-profit centre of excellence that bridges the gap between industry, government, academia and research. We take a whole systems view of the energy sector, helping us to identify and address innovation priorities and market barriers, in order to decarbonise the energy system at the lowest cost.