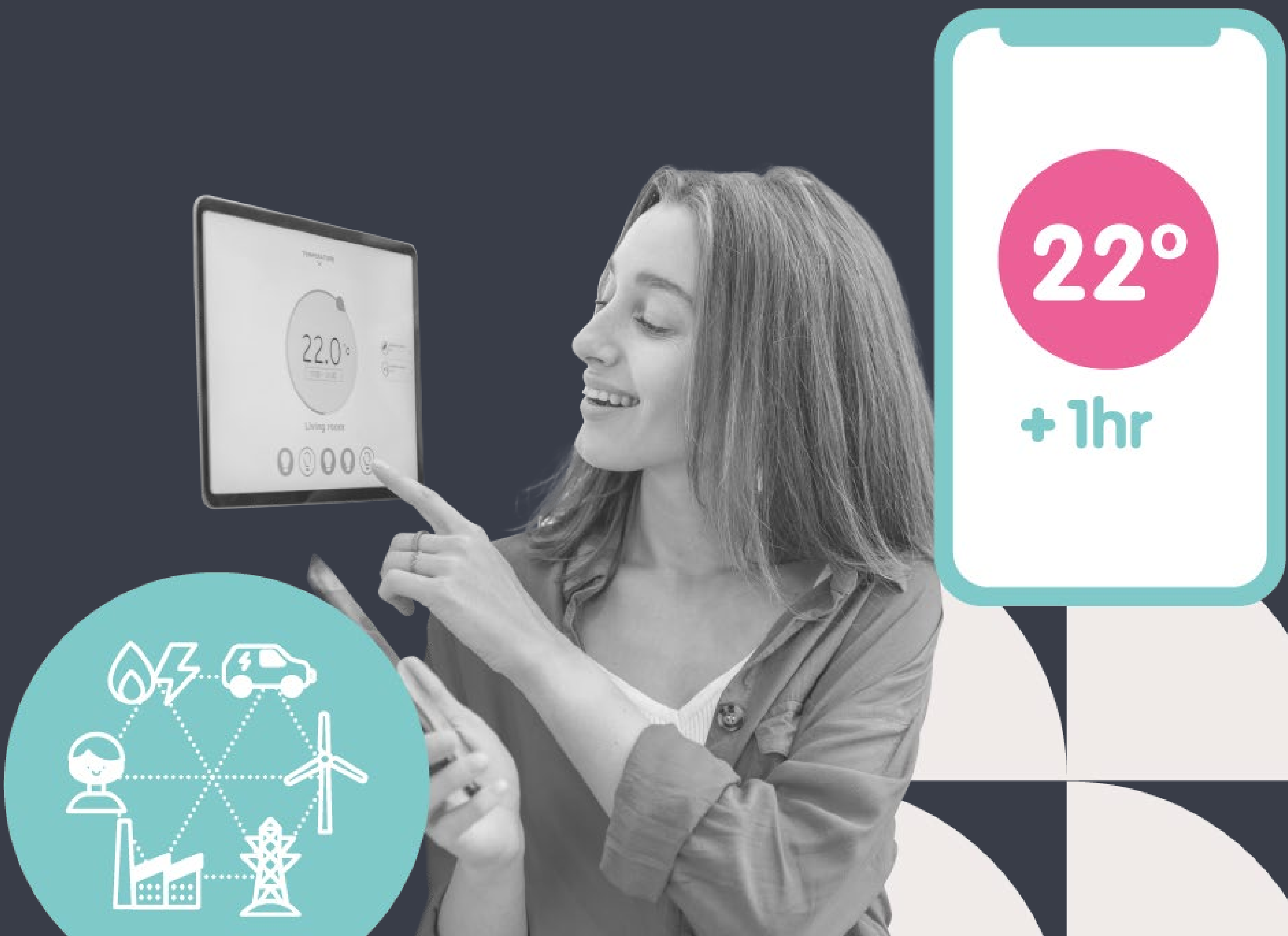
Alternative Energy Markets Innovation Portfolio

Final Report for Phase 1

December 23



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1. Summary

Unlocking new sources of electricity system flexibility will be vital to manage the integration of intermittent renewable generation and help meet net zero targets while keeping down bills. This project developed and tested innovative retail propositions against a range of 2030 market scenarios in order to identify how to best elicit flexibility from households, with a view to informing consumer trials in the near future.

The Alternative Energy Markets Innovation Programme (AEMIP) was launched by the Department of Energy Security and Net Zero (DESNZ) and aims to support innovative demand side flexibility propositions in a future energy system. Phase 1 is supporting the design of innovative tariffs, products or services (demand side flexibility propositions) under alternative energy market scenarios of a future energy system.

Working as a collaboration between Energy Systems Catapult, OVO Energy and CEPA, the project brought together a wide range of expertise and experience from across the energy sector and built on existing work such as the Catapult's Clean Energy Retail report and OVO's retail propositions, such as Power Move and Shift & Save.

1.1 Our approach

Our approach built on the rich variety of expertise and experience in our consortium. We used "design thinking" to develop the propositions. This involved identifying core principles to underpin ideation and guide the design of propositions that would be appealing to consumers. The market scenarios provided by DESNZ were an input into the design-led approach but did not specifically shape individual propositions - we then mapped the propositions to the market scenarios, to ensure that they were compatible and relevant. We believe that this approach led to a broader range of proposition ideas that were innovative and clearly rooted in consumer need.

Through structured workshopping, we identified over 100 consumer proposition ideas to unlock flexibility, which we then refined and prioritised into nine propositions to test with consumers and assess against feasibility criteria. This allowed us to identify five winning proposition ideas to explore as part of this project:

- **Have A Green Day** – a digital platform that empowers consumers to optimise their household activities to access the greenest energy and the lowest possible bill.
- **Smart Shift & Save** – by integrating their smart plugs into an intelligent flex system, consumers are rewarded for allowing selected appliances to be turned off when the grid is under pressure.
- **Pay As You Green** – targeted at more consumers on pre-payment meters (who more often tend to be in vulnerable situations), this proposition uses an app with a "traffic light" system and push notifications to help shift energy usage away from carbon incentive, expensive or heavy usage times.
- **FlexBat** – equips consumers with a mini home battery that stores energy directly from the grid taken during times of more abundant (and cheap) low carbon power and at carbon intensive times it takes over the load.

- **Let's Get Moving** – rewards consumers with a monthly financial reward when they are able to shift their non-essential energy usage out of the daily weekday peak period of 4pm – 7pm, allowing them to save money and carbon.

Additionally, we developed a "baseline" reference proposition – Pure Flex – to use as a comparator with the other propositions. This passes scenario price profiles directly through to the consumer in real time, and serves as the most flexible *hypothetical* proposition to test how much potential flexibility could be delivered. However, our consumer research suggests that, in reality, most households do not want a pass-through tariff.

DESNZ provided five market scenarios reflecting different permutations of consumer bill inputs: wholesale market arrangements; distribution network charges; and policy costs. We added a "wildcard", which represented a future market scenario in which the most dynamic charging elements of each of the other scenarios are present.

For propositions where consumers were exposed to the underlying (time of use) pricing, we used least cost optimisation modelling to simulate how consumers might flex their demand in response to the scenario-proposition combination. For the other propositions, consumers were shielded from the underlying price signals. So we modelled an optimised profile where consumers responded to the signals built into the proposition independently of how strong those signals were. Our modelling prioritises simplicity and breadth over depth, to provide insights to guide Phase 2 planning rather than pre-empt Phase 2 results.

1.2 Results

Propositions

Modelling of the propositions produced key outputs including the amount of energy shifted, the impact on peak demand and the reduction in customer bills – as captured below:

Proposition	Amount of energy shifted (MWh)	Impact on peak demand (MW)	% reduction in customer bill from original demand profile charged at flat unit rate
Benchmark: Pure Flex	*Results vary by scenario and location* Range of **7%** (no flex technologies) up to **17%** (EVs)	*Results vary by scenario ad location:* Increase in peak demand between **+7%** (no HP or EV) up to **+36%** (EVs)	*Results vary by scenario and location:* Savings range between **2%** (HP) and **8%** (EV)
Flex Bat	*Results vary by scenario and location* Range of **7%** (HP) to **28%** (EV)	*Results vary by scenario and location* Increase in peak demand between **+68%** (HP) and **+140%** (no HP or EV)	*Results vary by scenario and location:* Savings (excluding battery capital costs) range between **0.5%** (no HP or EV) and **6%** (HP)
Pay as You Green	*Same results across all scenarios and locations* Range of **3%** (no HP or EV) to **8%** (EVs)	*Same results across all scenarios and locations:* Range of **-8%** (no HP or EV) to **+35%** (EVs)	*% changes are the same across all scenarios and locations* Savings range between **1%** (no HP or EV) and **6%** (EV)

Proposition	Amount of energy shifted (MWh)	Impact on peak demand (MW)	% reduction in customer bill from original demand profile charged at flat unit rate
Smart Switch and Save	*Same results across all scenarios and locations* Range of **2%** (no HP or EV) to **3%** (HPs and EVs)	*Same results across all scenarios and locations:* Range of **-13%** (no EV or HP), **-12%** (EVs) and **-6%** (HP, all fuel poor)	*% changes are the same across all scenarios and locations* Savings range between **0.4%** (HP) and **1.3%** (EV)
Let's Get Moving	*Same results across all scenarios and locations* Range of **3%** (no HP or EV) to **4% (**EVs)	*Same results across all scenarios and locations* Range of **0%** (EV, no HP or EV) to **+3-4%%** (HP)	*£ changes are the same across all scenarios and locations* Savings range between **0%** (no HP or EV) and **38%** (EV)
Have a Green Day	*Same results across all scenarios and locations* Range for main case (15% smart) of **2%** (no HP or EV) to **9%** (EVs)	*Same results across all scenarios and locations* Range for main case (15% smart) of **-2%** (no HP or EV) to **+33%** (EVs)	No impact on consumer bill as the proposition does not offer monetary rewards

Our approach allowed us to identify and test novel propositions - such as bundling battery provision into the tariff (Flex Bat) and a variable price pay-as-you-go tariff (Pay As You Green). Our analysis in Phase 1 does not lead to the conclusions that such propositions would be *unfeasible* under current market and policy arrangements. This is partly because the price profiles provided to use were not so different from the status quo.

Having tested a much wider range of ideas with consumers, some of which fundamentally changed how they purchase energy, we learned that the most popular propositions were those that were simple, and which rewarded consumers for flexibility in predictable ways. We believe that the final propositions stretch mass market consumers to engage with flexibility as a normal part of their lifestyle, which is not commonplace today among existing offerings. These propositions increase personalisation, blend assets and behaviour change, and make flexibility accessible to underrepresented consumers. In doing so, they could help accelerate the provision of energy flexibility from homes.

Scenarios

Our analysis allowed us to develop insights into the effectiveness of the different market scenarios at facilitating flexibility. Based on the results from the modelling of propositions where propositions have direct impacts on consumers (i.e. Pure Flex and Flex Bat), we found that Scenario 5 (our "wildcard" scenario", which combines nodal pricing with dynamic policy costs) facilitated the most flexibility. This was followed by Scenarios 2b ("dynamic policy costs") and Scenario 3 (nodal pricing). This suggests that scenarios with greater price volatility have more potential to encourage flexibility.

The impact of the scenarios on modelled demand shifting are summarised in the table on the next page. It is not possible to isolate the effect of a single pricing component in a scenario. But we can make the general observation that – for the propositions that pass underlying prices to consumers – scenarios with more price volatility (5 and 2b) elicit more demand response in our modelling; and scenarios with less price volatility (2a) elicit less demand flexibility.

Scenario	Baseline	Baseline + EV	Baseline + HP	Fuel poor	Fuel poor + EV	Fuel poor + HP
Minimum annual demand shifted (same for all scenarios)*	2%	3%	2%	2%	3%	2%
*Maximum annual demand shifted:***						
1 (status quo)	19%	20%	22%	18%	20%	20%
2a (policy costs removed)	18%	18%	19%	18%	17%	19%
2b (dynamic DUoS and policy costs)	21%	22%	24%	21%	20%	23%
3 (nodal or zonal pricing)	18%	20%	22%	18%	21%	23%
5 (nodal pricing, dynamic DUoS & policy costs)	22%	23%	24%	21%	22%	24%

*Notes: * Minimum demand shifted was achieved under Smart Switch & Save. ** Maximum demand shifted was achieved under FlexBat.*

As noted above, it has not been possible to determine whether a given scenario "enables" (in a binary sense) particular propositions. Any pairing of price scenario and proposition leads to a maximum financial reward[1] that a supplier would be willing to offer its customers while still expecting to achieve a target level of profitability. Our modelling offered one perspective on this, albeit limited by the more deterministic way some of the propositions were modelled. Trials - as proposed for Phase 2 of the programme - could offer much greater insight.

Overall, we found scenarios had a relatively small impact on the outputs, relative to much clearer differences for different demand profiles. This pattern was observed across all propositions, with the exception of Flex Bat. The lack of variation between scenarios can be explained partially by the similarity of wholesale prices in all location and scenario combinations. We expect that more differentiation between the volatility of price profiles for each scenario would yield more differentiation in flexibility unlocked by each scenario.

We explored how to model the propositions against Scenario 4 ("green power pool / split markets"), but identified fundamental concerns with the coherence of the underlying policy assumptions. This, in turn, meant we could not discern the basis for the price profiles provided. We also found that this market design was not likely to facilitate retail innovation since – in the design set out for us by DESNZ – there were no system cost savings, and enforcing the design assumptions would require heavy-handed policy intervention that could discourage retail innovation. This led us to conclude that the green power pool / split market concept, as set out for us by DESNZ, raises material concerns about whether it could be implemented in practice.

[1] The nature of the 'financial signal' depends on the proposition design: it could be the difference between tariffs at different times (e.g. the Pay As You Green proposition) or rewards for reducing demand at particular times (e.g. the Smart Switch & Save proposition). In the case of the Flex Bat proposition, it's the discount at which the supplier provides the mini-battery.

We, therefore, agreed with DESNZ that focusing on the remaining scenarios would allow us to provide the most useful and realistic insights.

Any modelling – including ours – is limited by the assumptions and inputs that underpin it. We highlight, in particular, the limitations of: assuming that consumers optimise their electricity costs; that they do so under "perfect foresight" of future prices, and that those prices do not change in response to shifts in demand; keeping each consumer's total demand unchanged over the course of a day (i.e. we did not model demand reduction, only shifting); and using average demand profiles whereas individual consumers would have more/less peaky patterns.

Barriers

We identified ten key barriers across a range of categories: infrastructure, market, practicality, policy and regulatory. Most impactful among them was the risk of slow achievement of full smart meter coverage / delay to market-wide half hourly settlement, and the reliability of consumer participation. We set out in this report potential solutions to these barriers.

1.3 Key insights

The project identified valuable insights – both in terms of how to unlock domestic flexibility and also in terms of opportunities for further, more refined, analysis and research that can be taken forward in Phase 2 of the programme, which will involve testing with a cohort of consumers.

Fundamentally, the modelling showed that both the determinants of the energy bill (wholesale market arrangements, network charging and policy levies) and the type of customer proposition can affect the amount of flexibility that can be unlocked. In particular, scenarios with more dynamic pricing saw the largest effect on shifting and consumer savings for certain propositions (e.g. Flex Bat under Scenario 5 and 2b).

However, our consumer analysis showed that simplification of proposition design is important to consumers. A highly dynamic proposition that is confusing to consumers risks not delivering the scale of flexibility suggested by the modelling. Automation and other technology solutions may help mitigate these risks by offering consumers simplicity without unduly dampening the flexibility potential. Our research revealed some consumer concern about automation, but it is widely accepted in other sectors. So there may be value in exploring this tension via real-world trials – noting that there have been previous trials of energy automation itself.[2]

We observed wider system impacts which need to be fully considered and mitigated. In particular, flexibility propositions led in some instances to new and higher peak demand periods. Sometimes the new peak represented a shift of many hours and this could be beneficial for the system. However, on other occasions the peak is shifted by less than two hours, creating a higher evening peak – the opposite of the intended outcome of reducing system stress. This is a known limitation of the assumption of "perfect foresight". In practice, consumer behaviour will not reflect perfect forecast in this way, and prices could respond dynamically to changes in

[2] For example, the Catapult worked with Evergreen Smart Power to trial demand flexibility from EVs, as part of the government-funded Flexibly-Responsive Energy Delivery (FRED) programme.

supply and demand. But the potential for unintended consequences such as these should be further tested in the real world.

Engagement between DESNZ and project consortiums during the early stages of the project allowed for iteration and improvement of the scenarios in order to maximise the opportunity to test for flexibility. This resulted in various refinements, including dropping Scenario 4 ("green power pool / split markets").

In the remaining scenarios, the similarity of wholesale prices in all location and scenario combinations meant limited differences between scenarios and the status quo, which limited the differences in the modelling outcomes. However, underlying prices do affect the potential financial viability of propositions for suppliers and the rewards that suppliers could offer to consumers under a proposition whilst remaining financially viable. Fundamentally this comes down to the predictability of the underlying prices and of consumer demand (i.e. flexing their energy use in response to price signals), and to the extent that suppliers are able to "hedge"/match the variability in underlying prices with that of consumer demand – this should be tested further in the real world.[3]

Moreover, the modelling results are a function of the specific price scenarios provided by DESNZ. **Our findings cannot be generalised for the application of the underlying policies.** For example, the scenario with dynamic network charges has one of the highest modelled demand shifting, but we cannot say that dynamic DUoS is necessarily more effective at eliciting flexibility than another source of price signals.

Clarity on outcomes being sought – including decarbonisation, local network constraint management, bill reduction – and their relative priorities will be important to ensure policy interventions are well targeted. Iterative testing within a real-world environment will be important to reveal actual responses and knock-on effects (both on flexibility, and other factors) from different subsets of consumers.

Whilst the project has to a large extent focused on the price signals that can unlock needed flexibility from consumers, here are also non-price barriers to proposition development and rollout. These will benefit from exploration within the next phase of the project and the ongoing retail market review.

[3] For example, markets with locational pricing typically also feature hedging instruments – either as part of the market design or in addition to it – that can help market participants achieve a desired level of exposure to the locational prices. We are not aware of hedges that exist to address locational variability in network tariffs. For further details see: CEPA and TNEI (2021) Locational Energy Pricing in the GB Power Market and ESC (2022) Informing the REMA Debate: International Learnings on Investment Support for Clean Electricity.

2. Introduction

2.1 Overview of the project

The UK must transition to a smart and flexible energy system in order to reach its commitments to decarbonise the power system by 2035, maintain security of supply, support energy independence and achieve net zero at the least cost by 2050. To support the development of this flexible system, the Department for Energy Security and Net Zero (DESNZ) set up the Alternative Energy Market Innovation programme (AEMIP). This programme seeks to stimulate and demonstrate domestic demand side flexibility propositions (tariffs, products and services) in a future energy system where electricity market arrangements are likely to be different from those in place today.

The aim of AEMIP is to demonstrate the value that domestic demand side response solutions can bring to consumers and proposition providers in enabling a smart and flexible future energy system. The programme objectives are to:

- design and simulate innovative domestic flexibility propositions under potential alternative energy markets and quantify the additional flexibility available to the system and the benefits to participating consumers;
- contribute to the evidence base for growing domestic flexibility; and
- demonstrate how these propositions can work to deliver a flexible energy system, combining domestic flexibility propositions with low carbon assets and smart energy innovations.

To deliver the aim and objectives of AEMIP, Energy Systems Catapult partnered with energy supplier OVO Energy, and subcontracted CEPA,[4] bringing together a team of experts across retail, policy, proposition design, consumer research and energy simulation.

2.2 Overview of our approach

This project builds on Energy System Catapult and OVO's Clean Energy Retail Report,[5] which looked at different propositions for energy retail companies to support consumers, setting out challenges, opportunities, and wider policy and regulatory changes. Using that work as a starting point, the project partners developed a breadth of propositions, building on tariffs (including those that already exist at OVO such as Power Move and Shift & Save), products and services intended to test the effectiveness of different propositions for different consumer segments. We also assessed the financial viability for suppliers under different market scenarios, which were provided by DESNZ (the scenarios are discussed further in Section 4).

Our approach to delivering the project is summarised in the figure on the next page.

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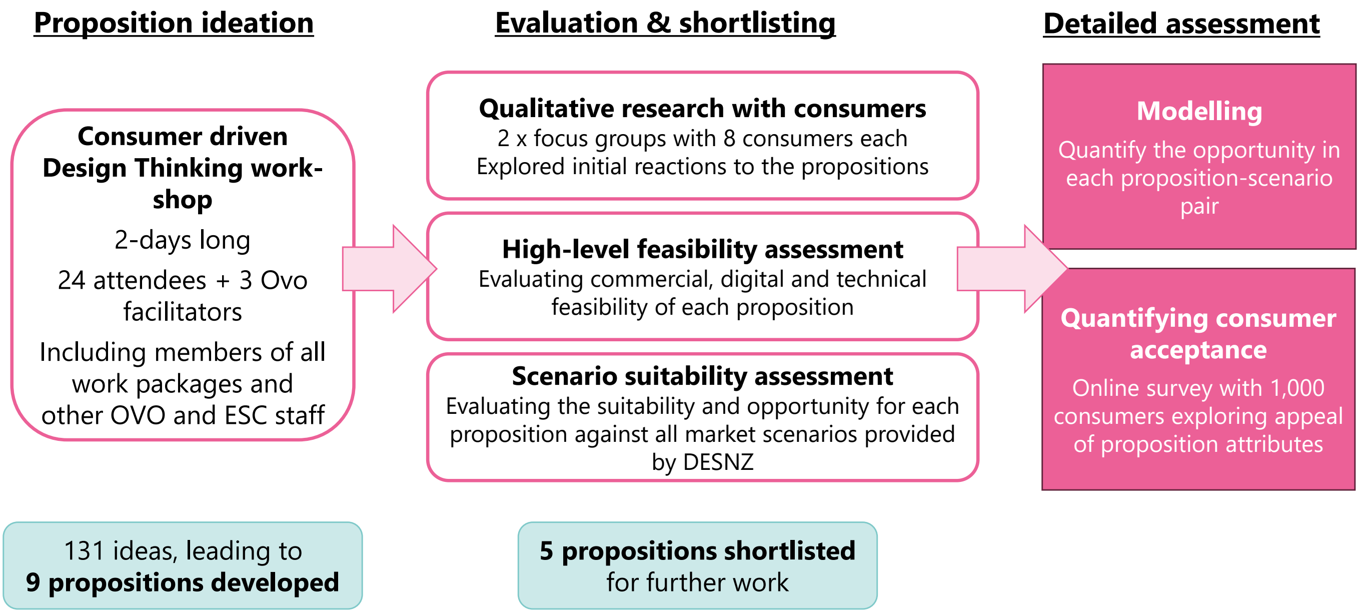
4 https://www.cepa.co.uk/

5 ESC (2022) Clean Energy Retail: the role of energy retailers in the net zero transition

Figure 2.1: Overview of our approach



Section 3 gives an overview of the propositions developed. To develop the propositions we used Design Thinking principles that encompassed expansive thinking (brainstorming) and reductive refinement techniques (to focus ideas). Our Design Thinking process made use of the "Double Diamond" approach, which is used by OVO, to guide our activities in designing propositions. This involved Empathise and Define stages to assess consumer needs and review and refine scenarios with input from DESNZ. This work was followed by Ideate and Build stages, iterative activities informed by market scenarios, consumer needs and testing, and commercial and technical feasibility assessment. We then assessed a long list of propositions for down-selection of propositions through consumer research and testing, combined with due diligence based on Energy System Catapult's expertise in digital and data transformation, technology and business model innovation.

Section 4 offers our assessment of each proposition under each of the DESNZ scenarios. The short-listed propositions, combined with pricing scenario data from DESNZ, were modelled to quantify their potential impact on consumer flexibility and estimated system and consumer impacts. The model uses least-cost optimisation, constrained by consumer characteristics, coupled with sensitivity analysis, to manage the uncertainty of consumer demand elasticity and other input variables. It prioritises simplicity and breadth over depth, to provide insights to guide Phase 2 planning rather than pre-empt Phase 2 results.

Section 5 describes the types of barriers we have identified to the implementation of these propositions, including policy, regulatory and infrastructure barriers, with detail of potential solutions.

Section 6 explores our insights from project delivery, including proposals for furthering testing in Phase 2, as well as insights for energy policy.

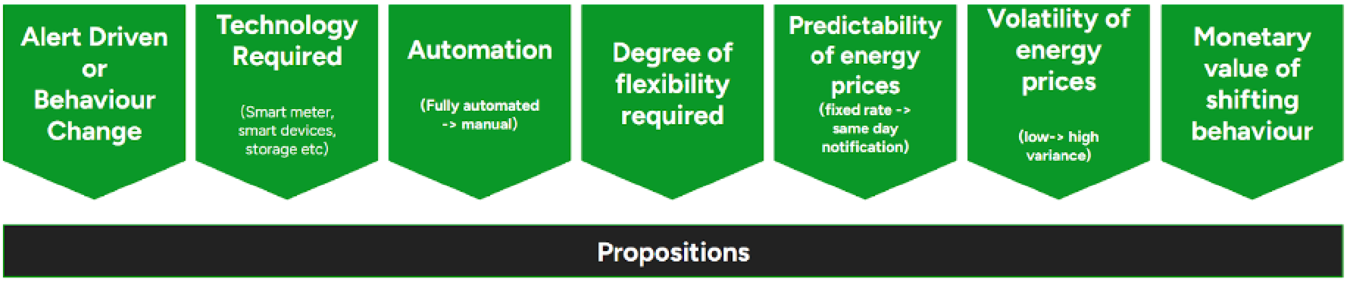
Also included are annexes that draw on the deliverables provided throughout the project, with further detail on proposition design and feasibility assessment, consumer research and modelling approach.

3. Our consumer propositions

3.1 Proposition overview

As part of the design thinking process, over 100 possible proposition ideas were identified. These ideas were all rooted in consumer needs and could all be broadly mapped back to the seven pillars of flexibility, which are summarised below.

Figure 3.1: Overview of the "pillars of flexibility" that informed the proposition development



Source: OVO Energy

As part of the idea refinement process each of the concepts were gathered into themes and some similarities emerged. A high-level overview of these themed ideas is captured in the table on the next page.

From this extensive list, nine propositions were taken into consumer research and a feasibility assessment.[6] Each of the nine propositions is relatively agnostic of the market scenarios, so could be tested across all alternative market scenarios. Annex A summarises our feasibility assessment of the nine propositions, and includes a high-level description of the long-listed propositions.

Five propositions were then short-listed for quantitative modelling. Those propositions are described in detail in the next sub-section.

[6] As per project guidance from DESNZ, each proposition required the consumer to have a smart meter and to opt in for half hourly settlements.

Flexibility pillar	Idea theme	Examples of ideas generated
Alert driven or behaviour change	Consumers receive a reward for shifting their usage into or out of specific times. This could be on an alert driven basis or a consistent behavioural change	1) Community based scheme with collective target and community-based reward 2) Head-to-head style challenges to encourage gamification using Artificial Intelligence (AI) 3) Those living in proximity to renewable generators receive alerts with discounts / free renewable energy 4) National weather forecast that also shows high / low availability of energy and offer of nationwide incentives for shifting
Automation	Using smart devices and an app to automate when energy intensive tasks are performed, scheduling them during the lowest cost / greenest times of day	1) Overlaying personal advice and incentivised behaviour change challenges to support with shifting 2) Using lifestyle data to provide a personalised schedule and using technology to automate energy use 3) Cheapest price guarantee or the supplier pays the difference
Technology	Using asset and digital technology to maximise home efficiency	1) Solar customers receiving a 'sunshine benefit' with a guarantee [x] kWh of free energy every month 2) Those with solar or battery storage have an option to “donate” excess to fuel poor homes 3) Using smart in-home-devices to provide shifting alerts 4) Consumers can rent flexible assets with a guarantee of lower bills or their money back 5) Digital twinning used to simulate consumers’ home consumption vs a fully optimised digital twin (option to upgrade home tech or receive a shifting schedule for behaviour change) 6) Heat as a service, offering with air source heat pump and tech solutions 7) Rental schemes to make solar, air source heat pumps, and electric vehicle ownership affordable (this may include comfort as a service ideas)
Predictability of energy prices	Ability to set fixed prices ahead of time	1) Prepaid energy packages tailored based on how much energy is consumed and when it is consumed
Volatility of energy prices	Low to high variance of prices	1) Consumers receive a risk payment to allow full exposure to price volatility 2) Part ownership in a wind or solar farm to manage the risk of volatility 3) Consumers become their own energy trader and can choose which sources their energy comes from 4) Ability to rent home storage assets and sell back excess 5) Tariffs that are tailored off-peak users or on-peak users, encouraging shift in usage to off-peak periods 6) Tariffs that guarantee low-cost energy during off-peak periods for vulnerable consumers 7) Fully personalised energy tariffs blending time-of-use, alert driven benefits and automation via tech
Monetary value of shifting	Scale of the rewards for flexible energy use	1) Periods of free / low-cost energy to encourage behaviour change, consumers alerted via app 2) Collective shift events to encourage mass shifting with a collective goal and personal reward 3) Gamification for those who are successfully participating in shifting events, prize draw for those involved to win decarbonisation tech such as solar panels
Degree of flexibility required	Low to high level of flexibility required	1) Fully personalised approach to flexibility, consumer offered a blend of assets, hints and tips, shifting notifications and rewards for habitual behaviour change 2) Bill comparison showing opportunities for saving money

3.2 The winning ideas

3.2.1 Proposition 1 - 'Have A Green Day'

A **digital platform** that empowers customers to optimise their household activities to access the greenest energy. 'Have A Green Day' allows customers to blend behaviour and asset automated flexibility to optimise how and when their home uses energy. This unique offering gives consumers more control and fosters trust with the energy retailer as they are rewarded for making consistent changes to their consumption habits. Providing a transformative solution that makes sustainable living accessible and rewarding for all.

Key Features:

- **Task scheduling:** Users schedule their weekly activities, such as laundry, cooking, charging electric vehicles. The process takes into account OVO's expert insights on renewable grid conditions to identify optimal time slots for each activity. This helps users align their activities with periods of lower energy demand, reducing their carbon footprint.
- **Shifting notifications:** The platform provides real-time notifications and alerts to users regarding any unexpected changes in grid conditions. This allows users to take advantage of periods of low-cost energy generation by performing energy-intensive tasks like laundry or EV charging during these times.
- **Budgeting tool:** Users can set personal energy budgeting targets and the scheduler will optimise their energy consumption schedule to help them achieve this target, this will recommend a combination of manual behaviour change options as well as automated changes where smart tech is available.
- **Smart tech marketplace:** Consumers can buy discounted smart tech such as smart thermostat, smart plugs, solar or air source heat pumps to drive their homes efficiency.
- **Personalised insights:** Users have the flexibility to input their preferences and constraints, such as preferred time ranges for specific activities. The system employs artificial intelligence to create a customised schedule that accommodates these preferences while still prioritising eco-friendly time slots.
- **Rewards:** By adhering to their optimised schedules, users earn bill credits.
- **Gamification:** A "streak" feature encourages users to consistently follow their optimised schedules. As users maintain their streak, they unlock additional rewards and benefits, fostering a sense of accomplishment and commitment to sustainable practices.

Pricing Structure

Consumers do not receive a monetary reward but are incentivised in the app with credits or 'streaks'. Unit rates and standing charges are calculated from modelling as described in Annex C.

3.2.2 Proposition 2 - 'Smart Shift & Save'

When the energy grid faces high demand, it can experience stress. But with 'Smart Switch and Save,' consumers can be part of the solution. Customers can integrate their Smart Plugs into an **intelligent flexibility system**. When the grid needs a breather, the smart plug system springs into action, automatically turning off selected appliances connected through these smart plugs.

Consumers will be rewarded for this flexibility and will also receive alerts during peak demand times, with practical tips on how to further conserve energy.

Key Features:

- **Automation:** Smart plugs automatically turning off selected appliances when the grid is under strain.
- **Behavioural change:** Monthly 'on call' payments for making devices available for turn down events.
- **Practical insights:** Practical tips on how to change energy behaviour to further reduce energy and receive further rewards.
- **Financed smart plugs:** Smart Plugs can be purchased directly from energy retailer or cost can be added via instalments as part of the energy bill.

Pricing Structure

Baseline unit rates and standing charges are calculated from modelling as described in Annex C. If consumers reduce their demand below their calculated baseline for those periods with the top 5% demand, then they are provided with a reward for every unit reduction in electricity consumption below that threshold. The reward for any demand reduced below this baseline during a high demand period is 50% of the unit cost for that period (which will be the same for all periods, on account of the static tariff).

3.2.3 Proposition 3 – 'Let's Get Moving'

We all want to do our part in helping reduce carbon emissions from energy use, while keeping our energy costs down. But it's hard to know what more you should do. 'Let's Get Moving' makes it simple: reduce your energy use during the peak weekday period of 4pm to 7pm and you'll get a reward of £20 a month. At these times of peak demand, there's often not enough renewable energy to go around, meaning dirtier, carbon-heavy power fires up to fill the gap. Our mobile app will alert you ahead of those peak times, giving you plenty of warning to shift your energy use to cleaner times and helping you save money.

Key Features:

- **Consistent behaviour response:** Let's Get Moving keeps things simple by asking consumers to shift energy demand out of the peak time of 4-7pm on weekdays.
- **Fixed reward:** Consumers who are able to use less than 12.5%[7] of their daily electricity demand during the peak 4-7pm period earn a monthly reward of £20.
- **Shifting notifications:** Consumers will receive alerts sufficiently in advance (several hours ahead) of the weekday peak period, to remind them of the need to schedule energy-intensive tasks like laundry or EV charging outside of peak times.

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[7] 12.5% is selected as a target that was both meaningful in a cost/carbon reduction perspective whilst being achievable for the customer to maintain engagement. Our consortium is aware that the average peak usage is ~18.5% of daily demand. A 10% target has been tested previously in a mini closed trial, and was found to be too difficult to achieve. For the purpose of designing this proposition, we selected an ambitious target of 12.5% to testing the balance of an achievable target with one that delivers cost and carbon savings. A single target and reward may not be optimal – e.g. there may be value in a tiered targets, although this would add to the complexity of the tariff.

- **Personalised insights:** Users are encouraged to input their preferences and constraints, such as preferred time ranges for specific activities into an app. The app employs artificial intelligence to help consumers understand what activities could be rescheduled to get under the 12.5% peak electricity use cap. The app also helps consumers understand whether they are on track to achieve the monthly reward.

Pricing structure

Baseline unit rates and standing charges are calculated from modelling as described in Annex C. Consumers are incentivised to shift their demand outside of the peak 4pm to 7pm weekday window. In accordance with the proposition design and in consultation with OVO, the following parameters were assumed: for a given weekday, if a consumer's total demand during the peak period is less than 12.5% of their total demand for the day, they receive a reward.

The potential reward for each weekday is pro-rated from an annual total of £240 per year (i.e. £20 per month, the figure which is used in marketing this proposition to consumers).[8] The pro-rated reward is just under 92p per weekday.

3.2.4 Proposition 4 - 'Pay As You Green'

Typically, consumers who use pay-as-you-go meters may be more vulnerable or in situations that do not allow them to take advantage of other flexibility propositions. Pay As You Green is a customer friendly pricing proposition specifically for customers on PAYG meters, which enables customers to choose to shift their usage using a **"traffic light" system** on their app: carbon intensive, expensive or heavy use times are signalled in red on the app. Green times are signalled in green, and moderate conditions in amber. Push notifications alert customers to shift usage. The benefit to them? Their cash top up to their account goes further! If they shift to a green time, their £10 top up is stretched a little so they have more energy for their money.

Key Features:

- **Traffic light energy rates:** A user-friendly interface displaying Red (peak), Amber (mid-peak), and Green (off-peak) time blocks.[9]
- **Rate display:** Energy rates presented for each time block to help customers make informed energy consumption decisions.
- **Personalised energy allocation:** Customers can allocate energy usage to different time blocks based on their schedules and preferences.
- **Energy tracker dashboard:** An interactive dashboard offering insights into energy consumption patterns and potential cost savings.

[8] The figure of £20 per month was suggested as part of the proposition development process. As explained in Section 4, the figure does not affect the amount of demand shifting in the model, but affects the consumer reward and commercial viability for the supplier. Different reward rates could be tested in Phase 2 if this proposition is taken forward.

[9] Pay As You Green is intended as a proposition that requires relatively little ongoing engagement from consumers, hence the assumption of fixed pricing periods. This distinguishes it from propositions such as Have A Green Day, which has dynamic pricing to reflect live system conditions.

- **Rate change notifications:** Push notifications alert customers in advance of upcoming rate changes (between Green, Amber and Red periods), ensuring transparency and preparation.
- **Educational resources:** Access to tutorials, FAQs, and informative content to help customers understand the benefits of the proposition.
- **User-driven behaviour insights:** Insights into how customers' behaviour and energy usage patterns adapt to the pricing system.

Pricing Structure

Baseline unit rates and standing charges are calculated from modelling as described in Annex C. We model Pay As You Green as a time of use tariff, with two different tariff periods: a cheaper 'green' tariff and a 'red' tariff which is more expensive.[10] Our tariff has been modelled on Economy 7,[11] a time of use tariff currently available to pay as you go customers.[12]

In line with Economy 7, the green tariff is available between midnight and 7am. We also assume that the ratio between the green and red tariffs is equal to the ratio between Economy 7 and standard rates provided in Economy 7 tariffs.[13]

3.2.5 Proposition 5 - 'FlexBat'

Many energy customers are unable to take advantage of the carbon reducing assets on the market. FlexBat equips home owners with a **mini home battery** that stores energy taken during time periods when renewables are plentiful on the grid. At carbon intensive times, for example peak periods, FlexBat takes over the load, meaning customers are not drawing from the grid, thus helping to decarbonise peak time use and providing them with eco-friendly energy all controlled through a user friendly mobile app.

Key Features

- **Mini battery:** Customers are provided with a discounted mini battery (of standard sizes for each property type, e.g. EV or heat pump ownership). In return, OVO retains access to 20% of the battery's capacity.[14]
- **Energy storage and management:** FlexBat intelligently stores excess renewable energy during off-peak hours and releases it during peak demand periods, reducing reliance on the grid and optimising energy consumption.

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[10] For simplicity, we did not model an 'amber' tariff.
[11] More information on Economy 7 is available online here.
[12] This assumption was made since we were not provided with the system data that was used to derive the price profiles. Should this proposition be taken forward to Phase 2, it would be worth exploring how to adjust the "green" times to match times of abundant renewable generation on the system.
[13] We apply a discount of 50%. This is approximately equal to the average discount provided by suppliers. Source https://www.moneysavingexpert.com/utilities/economy-7/.
[14] The figure of 20% was suggested as part of the proposition development process as a *quid-pro-quo* of providing the battery at discount. This is a high level assumption to account for the fact that there may be times when customer value and system value are out of balance, and to give the supplier a means to deal with that situation. Different ways of sharing battery capacity between the customer and OVO could be tested in Phase 2 if this proposition is taken forward.

- **Peak demand management:** The solution allows customers to seamlessly shift their energy usage away from peak demand periods, contributing to grid stability and reducing the risk of blackouts.
- **Split tariff:** FlexBet allows the consumer to benefit from the battery optimising to reflect the dynamic prices on the system at any point. At the same time, consumers are changed a flat rate for their non-battery electricity use, giving them price stability for the activities that cannot be easily shifted. Consumers will also pay back for the battery for an incremental surcharge on their electricity bill.
- **Mobile app interface:** FlexBat comes with a user-friendly mobile app that provides real-time insights into battery levels and energy consumption.
- **Carbon emission reduction:** FlexBat enables users to actively participate in reducing carbon emissions by using more renewable energy and minimising the need for fossil fuels during peak periods.
- **Environmental impact energy tracker:** Users can track their environmental impact, including carbon emission reductions achieved through the use of FlexBat, contributing to their sense of accomplishment.
- **Scalability:** The system is designed for scalability, allowing users to expand their energy storage capacity as needed to adapt to changing energy demands.

Pricing Structure

To model the Flex Bat proposition we have assumed that consumers receive a battery which charges and discharges every day, based on price signals from the underlying price profiles (i.e., the 'Pure Flex' profiles). 80% of the battery capacity is used by the consumer and 20% of the battery capacity is reserved for the supplier.

Flat unit rates are as per the other propositions – see Annex C for further details. We did not model the impact of the surcharge to recover the upfront cost of the battery.

4. Assessment of the propositions against scenarios

This section summarises our findings in terms of the impact the propositions had on consumers, the electricity system and on suppliers under each of a set of pricing scenarios. We present quantitative findings from our modelling, as well as qualitative insights from our consumer research.

4.1 Modelling overview

The five propositions described in Section 3 were modelled alongside a sixth reference proposition, named 'Pure Flex'. In Pure Flex consumers faced the underlying prices of each scenario (pure pass-through of costs), whereas the propositions described in Section 3 involved the supplier shielding consumers from some of the underlying prices.[15] As such, Pure Flex offers a benchmark of maximum expected flexibility, against which the other propositions could be considered.

Project propositions fall into two groups, the first which passed an element of dynamic time of use pricing to the consumer (FlexBat, Pay As You Green, and the Pure Flex benchmark) and the second where tariffs encouraged flexibility in static periods of the day (Smart Switch & Save, Let's Get Moving, and Have A Green Day). The first group were modelled using a least cost optimisation model, whereas the second were modelled by defining optimum consumer behaviour and modelling impacts.

The model used demand profiles for six consumer archetypes:

1. Non-fuel poor consumers with no Low Carbon Technologies (LCTs)
2. Non-fuel poor consumers with an EV
3. Non-fuel poor consumers with a heat pump
4. Fuel poor consumers with no LCTs
5. Fuel poor consumers with an EV
6. Fuel poor consumers with a heat pumps

Demand profiles were based on historical data (June 2022-June 2023) from OVO consumers in each category, averaged to preserve anonymity. We also made a number of assumptions about the extent to which different types of electricity use could be shifted – these are described in Annex C along with further explanations of the modelling approach. Annex D presents detailed modelling results.

4.1.1 Scenario overview

Each proposition was assessed using a least cost optimising model against five pricing scenarios. Four scenarios were provided by DESNZ, while the fifth ("wildcard") was created by us by combining different elements of the other DESNZ profiles (see further details below).

The scenarios considered are summarised in Table 4.1. Our chosen wildcard scenario represents a future market in which the most dynamic charging elements of each of Scenarios 1 to 3 are

[15] In the case of FlexBat, shielding takes the form of the supplier providing a mini battery.

present. This includes: nodal wholesale pricing, time variant capacity market and renewable support costs, and locationally granular seasonal forward distribution use-of-system (DUoS) charges. We refer to the wildcard scenario as 'Scenario 5' throughout the rest of the report.[16]

Table 4.1 includes a further scenario – referred to as 'Scenario 4', which had been initially considered as part of this project. However, we agreed with DESNZ to not model this scenario owing to concerns that some of the underlying assumptions of the scenario could not be achieved in practice.

Table 4.1: Assumptions underlying DESNZ future market scenarios price profiles

Scenario	Wholesale market	DUoS forward looking charges	Policy costs[17]
Scenario 1	Current arrangements	Current arrangements	Current arrangements
Scenario 2a	Current arrangements	More locationally granular annual RAG times and rates	Renewable support costs and capacity market costs covered by general taxation. Social support costs remain as per current arrangements.
Scenario 2b	Current arrangements	More locationally granular seasonal RAG times and rates	Renewable support costs and capacity market costs moved to dynamic rates. Support costs remain.
Scenario 3	Generation-only nodal pricing, with opt-in to nodal pricing available for domestic consumers.	More locationally granular annual RAG times and rates	Current arrangements
Scenario 4	*Split market[18]*	*More locationally granular annual RAG times and rates*	*Current arrangements*
Scenario 5	Nodal pricing for both generation and consumers (building on Scenario 3)	Granular seasonal DUoS charging (as in Scenario 2b).	Renewable support costs and capacity market costs moved to dynamic rates (as in Scenario 2b)

Source: DESNZ price profiles

Comments on Scenario 4:

We explored various interpretations of Scenario 4 with DESNZ before agreeing to drop the scenario. The market design that DESNZ settled on featured an optional "green power pool", where renewable generators can decide to sell their energy. There would be no floor to this market, and DESNZ told us that generators would sell at long run marginal cost (or their Contract for Difference, if they had one), regardless of system conditions, for 6-month contracts. We identified a number of issues with this market design:

[16] Our wildcard scenario is not comparable to wildcard scenarios developed by projects for Phase 1 of AEMIP.
[17] Policy costs include renewable support schemes, capacity market costs, and social support costs such as the Energy Company Obligation, the Warm Homes Discount and Assistance for Areas with High Electricity Distribution Costs.
[18] This concept involved a 'split market' in which energy could be purchased from either the wholesale market, or a 'renewable futures pool' which was designed to pool supply risk from variable renewable energy generation.

Challenges of participating:

- In order to buy the full volume required for its customers, suppliers would have to buy both from the green power pool and from the wholesale market.
- In periods of scarcity (surplus) volume allocation is pro-rated, so suppliers will have to forecast the total pool availability, plus total pool contracted position, in order to forecast their allocated share. We expect that each supplier will have very limited information about the features of the generation participating in the pool (unlike in a Power Purchase Agreement, where the supplier has directly contracted with the generator and has a direct relationship with them), and the suppliers will have very limited information about other suppliers' activity, it is likely to be very complex to accurately forecast volume allocation from the pool.
- 6-month contracts are not long enough to provide price stability for suppliers.

Interaction between the markets serves to deliver little incremental value:

- The current (single) wholesale market is effectively a blend of the technologies and prices that are separated out in the pool / wholesale market arrangement in Scenario 4. In periods of surplus, low cost renewables depress the marginal price on the wholesale market.
- In Scenario 4, suppliers would be buying from the wholesale market in periods of renewable generation scarcity, and renewable generators would be selling to the wholesale market in periods of surplus. This would result in the wholesale market continuing to be a blend of technologies, set by the marginal price (whether that is wind, gas or another technology). From a supplier perspective, the cost of purchasing energy for a given period would continue to be a combination of the green power pool price and the wholesale market price, with added complexity and cost for imbalance forecasting and management.
- It is unclear how Scenario 4 would prevent the price in the green power pool from trending towards the wholesale market (DESNZ described participation in the pool being optional for generators). If based on an auction, the price that would clear the green power pool would be either the maximum of the Contracts for Difference or the market's view of expected wholesale prices for the period. In periods of renewable generation surplus, generators could offer their Contract for Difference price. In periods of renewable generation scarcity, they could offer a price much higher than this. This serves to result in a net increase in costs to consumers.

4.1.2 Limitations of the analysis

The findings we present in this section are influenced by the information available to us and pragmatic decisions we had to make for the modelling. In particular:

- Prices are set at the levels provided by DESNZ. This means that we did not model how prices (e.g. in the wholesale market) might change in light of consumers shifting this electricity use. The price profiles provided by DESNZ already assumed a particular "shape" to demand and to generation.
- Our modelling assumes consumers have "perfect foresight" of their demand and of prices within the day. This means that demand is only modelled to shift where a consumer is

guaranteed to reduce their electricity costs. In practice, and depending on the proposition design, it is possible that consumers could inadvertently shift demand into periods that turn out to be more expensive.

- Our modelling assumes that consumers only optimise their electricity costs. In practice, people balance (optimise against) a range of criteria, including convenience. Our proposition design and consumer research capture such non-price preferences, while the modelling only focuses on price.
- Our modelling only allows for demand to be reallocated within a day, not to be reduced in absolute terms. This may be different from how consumers respond to the propositions in practice – as evidenced by behaviour in response to the Demand Flexibility Service.
- Our modelling used averaged demand profiles for each consumer archetype.[19] In practice, each archetype will consist of consumers with different demand profiles – some of whom would stand to gain more from responding flexibly to the propositions and some of whom would stand to gain less. A supplier may target different propositions at different subsets of consumers, or could potentially offer different prices (rewards) to different consumers. The use of averaged demand profiles may smooth out some availability for flex individual consumers' electricity demand.
- The amount of demand available for flexibility for each asset type is a fixed assumption in our modelling, intended to offer a realistic modelling constraint on real-world shifting behaviours. These figures are detailed in Annex C. A different set of assumptions would produce different results.
- Where price differentials to the consumer apply only in a specified period and price is flat elsewhere, shifted demand is assumed to be equally shared between all equally priced half hours. This is a simplifying assumption reflecting our use of averaged demand profiles – individuals may behave in ways that could not be captured in the modelling (e.g. only shifting demand to periods when an EV is plugged in at home).

When discussing the modelling results in this section and in Annex D, we note findings that are likely to have been influenced by one of more of the above limitations.

4.2 Proposition impact overview

Table 4.2 summarises the modelling results by proposition.

By design, demand flexibility is only modelled when it reduces costs for consumers (in the propositions that involve a financial reward). A general observation from the modelling is that consumer savings are small relative to the amount of demand that is modelled to be shifted. This is true even for propositions such as FlexBat and Pure Flex that pass the underlying prices to consumers, which suggests that the small impact on consumer bills is due to limited price variability within each day – even in the more dynamic scenarios such as Scenario 5.

The modelling shows that targeting reductions in specific hours can have an unwanted impact on the peak demand on the system. We observe the peak demand increasing under several

[19] We were not provided with the demand profiles that were used to generate the DESNZ price profiles, so it is also possible that our consumer demand profiles would not aggregate to the same overall system demand pattern as that used to generate the prices.

propositions. This is, in general, not a result of the proposition incorrectly targeting high demand periods on the system. Instead, it is a consequence of demand shifts which lead to new peaks that are higher than the peak in the original demand profile. This effect is particularly evident for the heat pump profile where there are two distinct daily peaks, one in the morning and another in the evening.[20,21]

[20] There is no evidence from our modelling that even increased peaks would exceed absolute limits such as consumers' incoming fuse, and in reality any such exceedances would be unlikely as installers would limit ratings to safe limits.
[21] The difference in percentage peak change with FlexBat under different asset combinations is not simply due to the relative size of the battery compared to the original peak load. This potential variable was removed in the modelling, as the battery was sized as a fixed relation to peak load in the original profile for each input demand profile. The difference is due to a combination of EV flexibility availability and peakiness of price profiles.

Table 4.2: Summary of modelling outputs.

Proposition	Amount of energy shifted (MWh)	Impact on peak demand (MW)	% reduction in customer bill from original demand profile charged at flat unit rate	Impact on commercial attractiveness to suppliers
Benchmark: Pure Flex	*Results vary by scenario and location: Range of **7%** (no flex technologies) up to **17%** (EVs)*	*Results vary by scenario and location: Increase in peak demand between **+7%** (no HP or EV) up to **+36%** (EVs)*	*Results vary by scenario and location: Savings range between **2%** (HP) and **8%** (EV)*	*Direct pass-through of changes in costs to the customers means that there is no change to supplier net revenue position in the modelling*
Flex Bat	*Results vary by scenario and location* Range of **7%** (HP) to **28%** (EV)	*Results vary by scenario and location* Increase in peak demand between **+68%** (HP) and **+140%** (no HP or EV)	*Results vary by scenario and location* Savings (excluding battery capital costs) range between **0.5%** (no HP or EV) and **6%** (HP)	Since consumers' non-battery electricity use is charged on a fixed unit rate, the impact on supplier net revenue will depend on the difference between low price periods (in which the battery charges) and the static unit rate, and the high price periods (in which the battery discharge displaces imports from the grid) and the static unit rate.
Pay as You Green	*Same results across all scenarios and locations* Range of **3%** (no HP or EV) to **8%** (EVs)	*Same results across all scenarios and locations* Range of **-8%** (no HP or EV) to **+35%** (EVs)	*% changes are the same across all scenarios and locations* Savings range between **1%** (no HP or EV) and **6%** (EV)	Impact on supplier net revenue will depend on how customer demand is spread within green and red periods – which is uncertain even with rational customers as no signal within those periods
Smart Switch & Save	*Same results across all scenarios and locations* Range of **2%** (no HP or EV) to **3%** (HPs and EVs)	*Same results across all scenarios and locations* Range of **-13%** (no EV or HP), **-12%** (EVs) and **-6%** (HP, all fuel poor)	*% changes are the same across all scenarios and locations* Savings range between **0.4%** (HP) and **1.3%** (EV)	Impact on supplier net revenue will depend on where the reduced customer demand in the stress periods is shifted to – which is uncertain even with rational customers as no signal on how to spread demand across the other periods
Let's Get Moving	*Same results across all scenarios and locations* Range of **3%** (no HP or EV) to **4%** (EVs)	*Same results across all scenarios and locations* Range of **0%** (EV, no HP or EV) to **+3-4%** (HP)	*£ changes are the same across all scenarios and locations* Savings range between **0%** (no HP or EV) and **38%** (EV)	Impact on supplier net revenue will depend on where the reduced customer demand in the 'reward' periods is shifted to – which is uncertain even with rational customers as no signal on how to spread demand across the other periods
Have a Green Day	*Same results across all scenarios and locations* Range for main case (15% smart) of **2%** (no HP or EV) to **9%** (EVs)	*Same results across all scenarios and locations* Range for main case (15% smart) of **-2%** (no HP or EV) to **+33%** (EVs)	No impact on consumer bill as the proposition does not offer monetary rewards	Assuming that there is a reasonable correlation between 'green' periods and low underlying prices (wholesale, network, policy), a supplier should improve its net revenue position. That would be offset to some extent by the cost of providing any non-monetary rewards.

Source: CEPA analysis

4.3 Impact on the electricity system

The key outputs from the modelling capture the following system impacts:

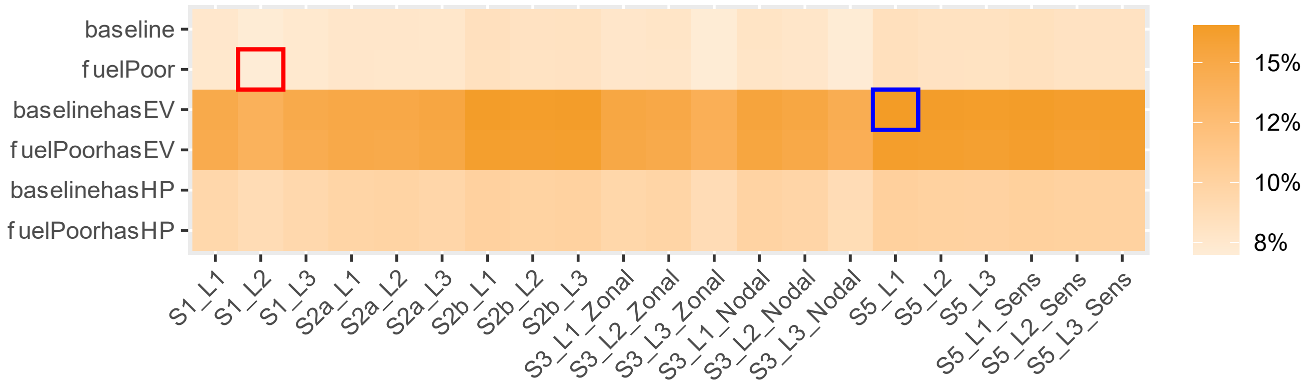
1. The amount of flexibility enabled by each scenario and proposition combination (kWh shifted as a % of original annual demand).
2. Changes in maximum demand observed in the year (% change in max demand found in any half hour period).

In the following sections, we present the modelled impact of scenarios and propositions on these two measures.

4.3.1 Cross scenario impact (Pure Flex)

The Pure Flex benchmark proposition gives good insight into the impact of the scenarios on consumer flexibility and system impact, since the scenario prices are passed through to consumers in full. The horizontal bands apparent in Figure 4.1 are due to the relatively small impact of different scenarios (horizontal axis), with much clearer differences evident for different input demand profiles (vertical axis). This pattern was observed across most of the propositions, the exception being FlexBat (see section 4.3.2).

Figure 4.1: Pure Flex – load shifted (as % of annual consumption).



Source: CEPA analysis. Highest observation indicated by blue, lowest by red.

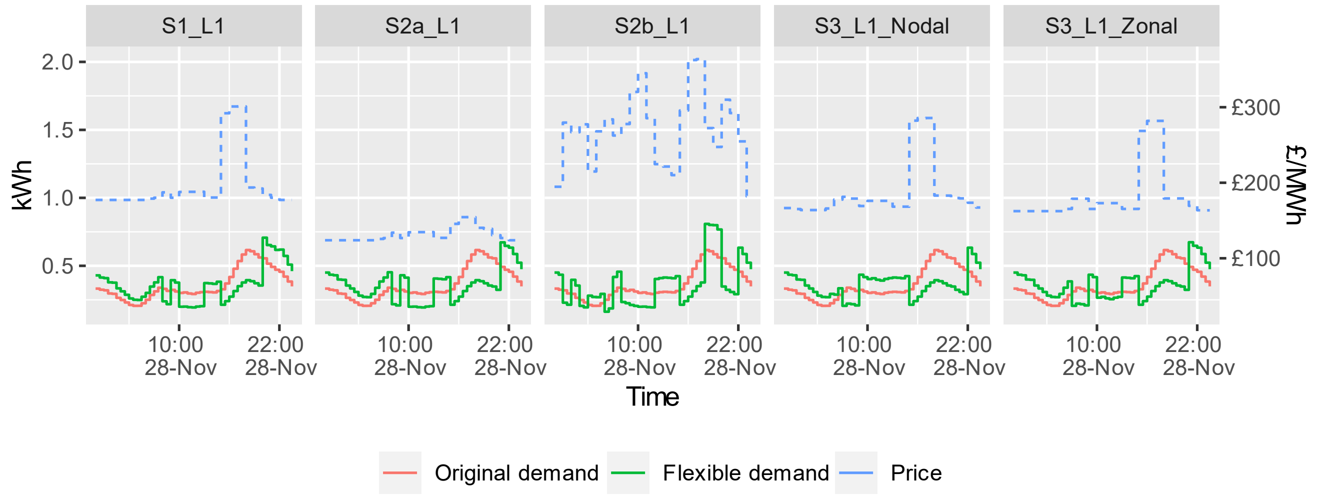
Considering the small variations within the horizontal bands, it is clear that the scenarios with greater price volatility have somewhat more potential to shift load, in particular Scenario 5 (nodal pricing plus variable network and policy costs) shows the most promising potential for demand flexibility, with scenario 2b next. But these differences are small.

The lack of difference between scenarios can be explained partially by the similarity of wholesale prices in all location and scenario combinations. We expect that more differentiation between the volatility of price profiles for each scenario would in turn yield more differentiation in flexibility unlocked by each scenario.

We illustrate below how the different price profiles captured in the scenarios interact with modelled demand shifting within-day (we did not model demand shifting across multiple days because our research and experience suggests that consumers are more likely to shift activities within the same 24 hour period).

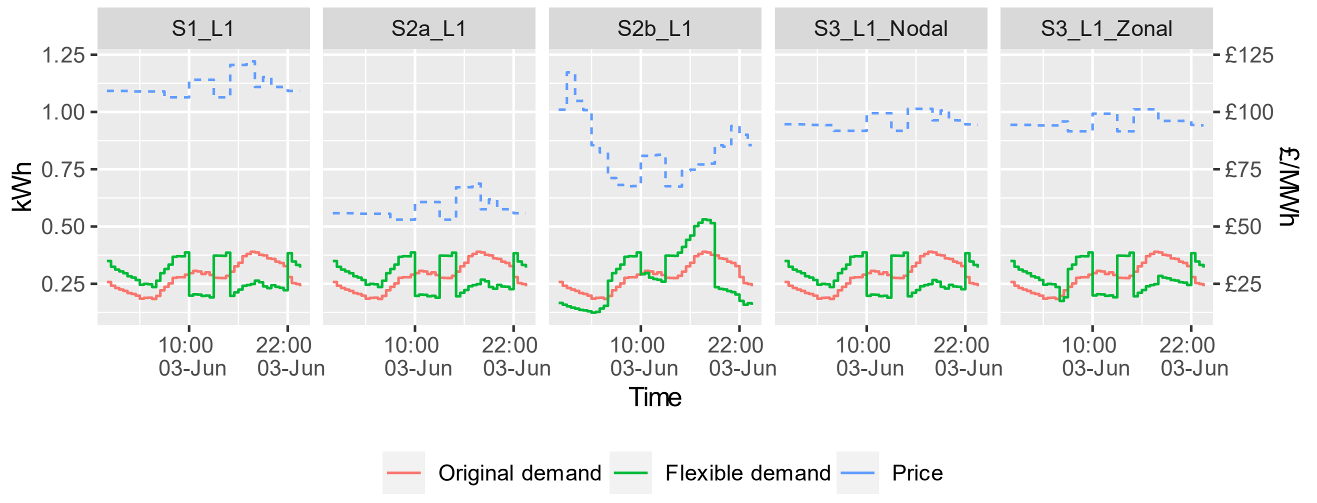
Figure 4.2 shows the observed flexibility on an exemplar winter day, and Figure 4.3 shows achieved flexibility on an exemplar summer day. The larger magnitude "spikes" in price profile on the winter day are due to recovery of capacity market support. As the flexibility is cost optimising within-day, although the magnitude of these spikes is much larger in winter, it does not necessarily drive changes in achieved flexibility. i.e. In our modelling, changes in *shape* of price signal affect flexibility achieved more so than changes in the *absolute magnitude* price signals.

Figure 4.2: Pure Flex – consumer impact (% bill reduction relative to providing no flexibility)



Source: CEPA analysis.

Figure 4.3: Pure Flex – consumer impact (% bill reduction relative to providing no flexibility)



Source: CEPA analysis. The flexibility observed in Scenario 1 can be treated as a benchmark. The difference between price profiles for Scenario 1 and Scenario 2a is the removal of policy cost recovery. Comparing S1 and S2a in both Figure 1 and Figure 2, flexibility changes little because the timing of the policy cost recover spike on the winter day coincides with the wholesale, so only the magnitude of reward for flexing would change, not the timing of such flexibility. There are very subtle differences in flexibility achieved on the winter day, which can be attributed to (the removal of) policy costs.

The difference between Scenario 1 and scenario 2b price profiles is the addition of dynamic recovery of network charges and policy costs, thus the difference in flexibility observed can be attributed to moving uniform recovery of those costs to recovery in specific timeslots (increasing the volatility of the combined price profile). This changes the price profile and thus timing of flexibility significantly. In particular, in winter we see the price profile is low around the traditional afternoon peak – driving a possible unintended consequence of higher peak demand.

The difference between Scenario 1 and Scenario 3 is a change in wholesale costs to locational marginal pricing (Nodal and Zonal), the difference in flexibility observed there can be inferred to be driven by this change. This is perhaps an underestimate of the difference as the locational wholesale prices given in Scenario 3 exhibit only small changes in volatility when compared to the Scenario 1 prices. It is also notable that the difference in shape of zonal and nodal price profiles is minimal, hence flexibility achieved is very similar.

In a real implementation, the flexibility drivers will interact, for example sometimes "peaks" in network or policy cost recovery will coincide with troughs in wholesale price and the drivers will cancel. Perhaps more often, they will coincide to provide a stronger signal. Our scenario 5 investigates the effect of such a combination; but a simplistic approach to attributing a certain amount of flexibility to a certain component and simply summing those effects is not possible.

While the different scenarios do not affect flexibility potential significantly, they do affect the potential financial viability of propositions for suppliers and the rewards that suppliers could offer to consumers under a proposition whilst remaining financially viable – see section 4.5 for further details.

4.3.2 Flex Bat

We see more shifting in Flex Bat relative to the other propositions. The average amount of shifting is in the range of 19-21% of total annual load, compared to 8-16% for Pure Flex and smaller volumes for the other propositions.[22] This is unsurprising as the proposition has the joint most periods in which shifting is incentivised (the battery is incentivised to charge every day) and there are no behavioural restrictions on shifting. Scenarios with more dynamic pricing (2b and 5) see the most shifting, as it is optimal to use the battery over more days in the year.

Since our modelling uses a set price profile, greater shifting has the perverse effect of leading to increases in the peak demand on the system. This occurs when there is a lack of alignment between day ahead prices and consumer demand.[23] The modelled size of the battery - sufficient to cover the peak demand period (see Annex C for details) - means that price signals can lead to large swings in demand. The impact on shifting and peak demand are likely to be smaller in the real world. There is likely to be a degree of forecast error for real consumers and, if the supplier

[22] These ranges cover the average of all scenarios and location for each consumer archetype.

[23] To some extent this could be due to the price profiles and consumer demand profiles being from different sources. However, it is entirely possible that the timing of peak demand for specific groups of consumers can differ from the system price peak – e.g. because the system price peaks will be influenced by the renewable generation profile.

provides smaller batteries than we had modelled, then the opportunity for shifting will be lower because of lower flexibility potential.

4.3.3 Pay as You Green

There is no difference[24] in system impacts between scenarios because the same incentive to shift (with the response being bounded by our flexibility assumptions) exists in every scenario. The volume of load shifted is larger than in some other propositions (e.g. Let's Get Moving and Smart Switch and Save) owing to the larger window of time, relative to those propositions, in which consumers can gain financial benefit from switching.

The proposition has the potential to increase a customer's peak demand because there is no incentive to limit demand increases during the 'green' (low carbon) tariff period. In situations where the green tariff period overlaps with the morning peak, demand shifted into this period can increase the consumer's daily peak (albeit there may be system operations benefits from this demand being shifted away from other times of the day, such as the evening peak).

4.3.4 Smart Switch & Save

The volume and pattern of changes in demand varies between consumer archetypes but is the same across all scenarios and locations. This is because the changes in demand are bounded by our flexibility assumptions (and propositions assumptions), and independent of the underlying price profiles that differentiate the scenarios and locations from one another.

The proposition has the smallest impact in terms of total demand shifted (1.7%-3.2%) relative to the other propositions. This is to be expected as only the highest 5% of demand periods are targeted for flexibility actions through this proposition (438 hours in a year, or an average of 8 hours per week). However, the proposition has a materially larger beneficial impact on reducing consumers' peak demand (between 5% and 12% lower). The size of the change depends on the specific load profile of a consumer – the proposition will be more successful for consumers with 'peakier' demand profiles, and less successful when demand is flat.

4.3.5 Let's Get Moving

For both the level of shifting and impact on consumers' peak demand, there is no difference across scenarios or locations. The proposition incentivises demand shifting in the range of 2.6% and 3.5%. This is more shifting than for Smart Switch & Save, but less than the other propositions. This is expected as Let's Get Moving targets more half-hourly periods than Smart Switch & Save.

Peak demand increases by 3-4% for the two demand archetypes with heat pumps, and is unchanged for the other four.

4.3.6 Have a Green Day

[24] In practice, we find minor variation across scenarios. We attribute this to 'noise' in the optimised results rather than structural differences due to scenario assumptions.

The more 'smart load' a consumer is assumed to have (see Annex C for an explanation), the more demand they are modelled to shift under this proposition.

In general, peak load on the grid is modelled to increase. The propositions targets demand shifting to periods in which there is more renewable generation on the system, but this is only one system characteristic and there could be conflicting impacts on other parts of the system (e.g. grid capacity) that a simple proposition is unlikely to be able to reflect accurately.

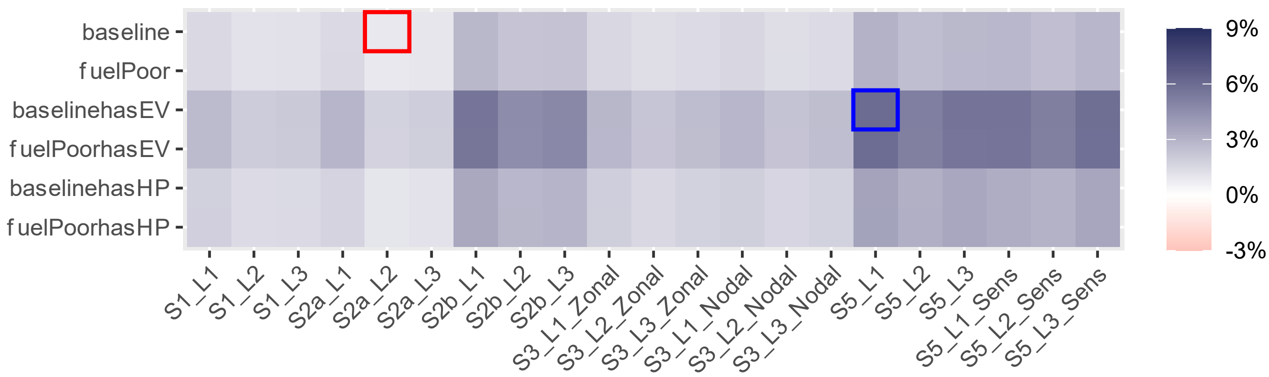
4.4 Impact on consumers

In this section we first look across the scenarios at the modelled consumer impact. We then bring in our consumer research to identify insights as to the types of propositions that appear most appealing to consumers (further detail on our consumer research is in Annex B).

4.4.1 Cross scenario impact (Pure Flex)

The Pure Flex benchmark proposition gives good insight into the impact of the scenarios on consumer bills relative to a situation in which consumers face the underlying price signals but do not respond by flexing their demand. Figure 4.4 shows that scenarios with more pricing volatility – 2b and 5 – deliver the greatest consumer savings under Pure Flex. However, greater impact is apparent from different potentials to flex demand, as noted from the horizontal bands.

Figure 4.4: Pure Flex – consumer impact (% bill reduction relative to providing no flexibility)



Source: CEPA analysis. Highest observation indicated by blue, lowest by red.

4.4.2 Consumer appeal of the propositions

Feedback on the propositions was sought from consumers through qualitative focus groups and a quantitative online survey.

Qualitative research was designed to understand which propositions appeal most to consumers and therefore could be prioritised through the AEM project. Two focus groups were convened, including 15 participants in total. Participants were selected to represent a mix of demographics, energy tariffs and low carbon technology use.

An online survey followed, using a conjoint exercise to explore the appeal of different attributes of flexibility propositions. Attributes tested in the conjoint exercise reflected the 7 pillars of flexibility services (Figure 3.1) and were designed such that each of the leading propositions could be built using different combinations of attribute tested. The survey was completed by a nationally representative sample of consumers.

Low energy bill savings limit appeal. High potential bill savings may motivate, even if they are not realistically achievable for all consumers.

Qualitative and quantitative research with consumers suggests that the greater the monetary reward, the greater the appeal. Our online survey included examples with fixed savings of 25% and fixed or variable savings averaging 15%, which had the largest influence on overall preference. In contracts modelled bill savings were typically lower than the lowest level of savings tested in the online survey (5%).

The simulated appeal of Let's Get Moving increased in line with the percentage bill savings represented by the fixed reward of £20 per month. The proposition may appeal more to those with low bills, where £20 per month could represent the higher saving levels tested in the conjoint (e.g. 15% or 25% savings). However, households would only receive the reward if they reduce their peak period consumption to less than 12.5% of their total consumption, something that modelling suggests is not feasible for household archetypes unless they have an EV or heat pump. Modelling suggests households with an EV or heat pump could meet this requirement, shifting 16-40% and 5-14% of their consumption, respectively. However, the higher overall electricity consumption of these households is likely to mean the fixed reward represents a smaller percentage saving on bills, likely decreasing the appeal of the proposition to these households.

The model assumes consumers take up every opportunity to shift consumption (up to the level of permitted flexibility) and that behaviour is agnostic to price level. But our focus group research indicated that consumers are unlikely to shift consumption on every possible occasion. Therefore, modelled savings may not be achievable. The decision to shift consumption and amount of consumption shifted would depend on a complex interplay of factors like time of day, season, the perceived effort, the given behaviour (e.g. cooking, cleaning, heating) and the household needs it must fulfil, and whether the perceived inconvenience is ultimately 'worth' the reward. This would intrinsically link shifting to price level, with greater inconvenience warranting greater rewards. Highlighting variable potential savings e.g. "5-25%" or "up to 20%" could encourage consumers to shift consumption where they feel the perceived inconvenience is acceptable in return for proportionate rewards. This could allow many consumers to benefit from flexibility services, even if the financial rewards are only minimal.

Propositions offering low potential savings for lower levels of shifting, such as Smart Switch and Save, may represent a smaller perceived inconvenience and may be more appealing than those requiring more shifting. Nevertheless, their low impact on the system and limited commercial potential may not make them viable.

Automated propositions tend to have higher appeal than those involving manual shifting. However, appeal is limited by low savings.

Our consumer research showed that propositions such as Smart Switch & Save and Have A Green Day would have greater appeal if they were paired with automated shifting via smart plugs and devices. This is driven by the increased appeal of less-frequent shifting and of smart plugs and devices over smart meters alone. However, modelled consumer savings was zero for Have A Green Day[25] and ranged between 0.4% and 1.3% for Smart Switch & Save - lower than the lowest level (5%) tested in the online survey.

Flex Bat represented similar, relatively low appeal. While this proposition enabled substantially more shifting than other propositions (an average of 18.5% for the non fuel poor consumer archetype), it did not deliver a corresponding increase in savings for consumers - modelling indicated an average bill reduction of just 2%. The net impact of this on bills would be smaller still once the cost of leasing the battery (spread over monthly bills) is accounted for, potentially decreasing appeal more.

While automated propositions tended to have higher appeal than those involving manual shifting, it is important to consider that openness to automation varies between individuals. Qualitative research showed that while some would be reluctant to allow any automation, others would be more open to fully automated services. Propositions with options to vary the degree of automation may be more widely appealing while enabling individuals to tailor the degree of automation to their own preferences.

Flex Bat enables most shifting and, with greater financial rewards, could appeal more, but other barriers may limit its relevance.

Modelling suggests Flex Bat enables substantially more shifting than other propositions. The low financial benefit estimated by our modelling may limit consumer appeal, but it is important to highlight additional barriers.

Access to and suitability of batteries may limit Flex Bat's relevance. For example, tenants may require landlord permission to install a battery and/or may need the landlord to leasing the battery on their behalf. This may also add complexity to service arrangements where the cost of leasing the battery is spread across bills. Targeting Flex Bat to homeowners could avoid these barriers. Our research also indicated that homeowners had a higher preference than tenants for an automated approach to getting the outcomes they wanted. Appeal was similar whether this was facilitated by smart plugs and devices or a battery.

The size of a battery and where it would be installed in the home also represent barriers. Some research participants felt there would be no available or suitable space in their home.

Finally, some participants questioned the credibility of batteries being rolled out at scale, reflecting on the smart meter roll out which they perceived as slow and poorly coordinated.

Incentivising shifting in multiple time periods could increase shifting overall.

Modelling found that the amount of shifting is influenced by the number of periods in which shifting is incentivised. Findings from the qualitative consumer research suggested that offering more opportunities to shift could encourage greater engagement for some households, particularly those who might find it too inconvenient to shift their consumption away from 'conventional' peaks, e.g. 4-7pm. Again, decisions of whether to shift consumption and to what extent depends on several factors and consumer may not choose to shift in all or many of those

[25] Instead, consumers received 'credits'.

periods. However, offering more periods in which shifting is incentivised creates more opportunities for households to shift consumption in ways compatible with their needs.

4.5 Impact on suppliers

Propositions have the potential to materially alter the shape of a consumer's demand profile, which may impact on the cost hedging consumer load. This is particularly relevant when considering differences between scenarios, as the cost of hedging and the risk of not being sufficiently hedged could be different for different scenarios. Those costs also vary between consumer types due to their demand profile and their ability to flex demand.

So, any pairing of price scenario and proposition leads to a maximum financial signal[26] that a supplier would be willing to offer its customers while still expecting to achieve a target level of profitability. (A supplier may accept a lower level of profitability in the short term for strategic reasons such as acquiring customers).

We did not model the financial impact of the scenario-proposition pairings on supplier finances given the number of assumptions that would have needed to be made. Instead, we identified qualitatively what the modelling results reveal about the impact that scenario-proposition pairings could have. This was done with an eye towards identifying areas that should be investigated and validated in Phase 2.

4.5.1 Cross scenario impact (Pure Flex)

In theory, there should be no impact to a supplier of a customer being on the Pure Flex tariff, which fully passes through underlying costs. However, as shown in Figure 4.2, there is an impact on the revenues a supplier earns as a result of a consumer switching from a static tariff to Pure Flex (or any tariff with time-varying prices).

When consumers pay the underlying price profiles, their bills will exactly reflect their own consumption patterns, so the scope for cross-subsidies between different types of consumers is reduced. The impact on a supplier of a consumer moving from a static tariff to Pure Flex could be positive or negative. It would depend on the assumptions made in developing static tariffs, the consumer's demand profile (before flexibility), and the amount of flexibility they provide.

4.5.2 Flex Bat

Through this proposition, the consumer can shift their electricity consumption by charging / discharging their battery. This has the effect of shifting the share of their demand that's charged at the static tariff and the share charged at the pass-through (Pure Flex) dynamic tariff.

In the way we have modelled this, the supplier could be out-of-pocket for their hedging costs to the extent that they have hedged the consumer's full load. However, the underlying costs to the

[26] The nature of the 'financial signal' depends on the proposition design: it could be the difference between tariffs at different times (e.g. the Pay As You Green proposition) or rewards for reducing demand at particular times (e.g. the Smart Switch & Save proposition). In the case of the Flex Bat proposition, it's the discount at which the supplier provides the mini-battery.

supplier will also change on account of the consumer shifting load away from the more expensive periods.

The impact on supplier revenue will depend on the relative magnitude of the difference between low price periods (in which the battery charges) and the static unit rate, and the high price periods (in which the battery discharge displaces imports from the grid) and the static unit rate. The direction of the net impact is uncertain as it depends on the price profile and shape of change in the demand profile.

There is an additional impact relating to the ability of the supplier to recover the cost of the battery. Under Flex Bat, 20% of the battery capacity is reserved for the supplier to use for arbitrage opportunities.[27] But, in doing so, the supplier will pay network and policy costs for charging that the battery that it would not recover when exporting electricity back onto the grid. Therefore, the supplier would need to access additional revenue streams that are not included in our modelling (e.g. local flexibility services procured by the Distribution Network Operator) to improve its financial position under this proposition.

4.5.3 Pay As You Green

The supplier receives less revenue from consumers shifting consumption to the cheaper period. To the extent that the peak and off-peak rates are cost-reflective, the supplier should be somewhat protected against this effect. However, the supplier would be impacted by the change in the consumer's load shape and commensurate change in exposure to the underlying costs (i.e. wholesale, network, policy). The overall impact on supplier net revenue will ultimately depend on how consumer demand is spread within the 'green' and 'red' periods – which is inherently uncertain.

4.5.4 Smart Switch & Save; Let's Get Moving

The net impact of each of these two propositions could be positive for suppliers. This would be the case if the supplier can set the level of the reward such that it is sufficient to incentivise demand-shifting, but smaller than cost saving to the supplier from consumers shifting to cheaper periods. The impact on a supplier's net revenue will also depend on where the reduced customer demand in the stress periods is shifted to. This is uncertain since the propositions do not provide any signal to consumers on how to spread demand across the other periods.

It is possible that, in response to the propositions (the potential for a reward), some consumers may reduce their total energy consumption. But it is unclear whether such a response would be permanent, since it is also possible that consumers' interest in outperforming the target would wane over time in the absence of further inducements.

4.5.5 Have A Green Day

Assuming that there is a reasonable correlation between 'green' periods and low underlying prices (wholesale, network, policy), the supplier's net revenue position should be improved by

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[27] The supplier would also receive a monthly payment from the consumer, which would incrementally pay back the upfront cost of the battery.

offering this proposition. This benefit would be offset to some extent by the cost of providing any non-monetary rewards.

4.6 Insights and implications for Phase 2

A key insight is that **differences in flexibility observed between model runs is primarily driven by differences in proposition and input demand archetypes, rather than differences in the market scenario**. Scenario price profiles are neither highly differentiated from each other nor do they offer significantly different prices intra-day.

Propositions that pass through dynamic underlying price signals – such as Pure Flex and Flex Bat – are most attractive to consumers (and have the greatest system impact) under the scenarios with the most volatile prices: Scenario 2b and Scenario 5. This suggests that dynamic wholesale prices, DUoS charges, and dynamic recovery of policy costs give rise to most potential flexibility for those propositions.

For propositions that shield consumers from the underlying price signals – such as Smart Switch & Save and Let's Get Moving – our modelling assumed behaviour that was indifferent to the financial reward for flexing demand. But this is a matter that should be tested empirically to establish the relationship between the financial reward offered and the strength of consumers' response.

5. Barriers to the rollout of propositions

So far in this report we have focused on the financial elements that would make propositions attractive for consumers to take up, and viable for suppliers to offer. In developing the propositions and in our consumer research, we also identified non-price issues and barriers that could undermine the rollout of propositions of the type we developed. These fall under five broad categories:

1. Policy
2. Market
3. Regulatory
4. Infrastructure
5. Practicality

The table that follows summarises those barriers, the scale of the issue they pose and suggests – at a high level – potential ways of addressing these barriers.

Table 5.1: Summary of barriers and issues identified

Barrier or issue identified	Categories	Strength of issue	Solution considerations
Risk of slow smart meter rollout and / or delay to Market-Wide Half Hourly Settlement	Infrastructure	**High.** All propositions rely on consumers having access to smart meters and half-hourly settlement. Delays or setbacks to these programmes could impact the ability to offer propositions reliant on half-hourly metering to measure and reward flexibility at granular level.	Propositions of the kind we developed could be more attractive to consumers who are otherwise disengaged / distrusting of the energy sector. Capturing the potential benefits from such propositions in Phase 2 can inform Ofgem and industry's sense of urgency to implement MWHHS.
Reliability of consumer participation	Market, Practicality	**High.** Dependent on the nature of the underlying price signal, both the consumer and/or the supplier could be exposed to high costs if flexibility is not delivered at the time/scale expected.	Phase 2 should consider a range of financial rewards to examine consumer response, and understand the linkages with the financial viability from the retailers perspective. Non-price factors also matter, such as timely communication that recognises participation (and rewards it, or notifies of the reward) could play an important role in encouraging ongoing behaviour change. Smart technology could help to sustain engagement: consumers may prefer to manually shift their consumption at first, but be more comfortable with automation over time.
Financial viability for retailers	Market, Practicality	**Medium-High.** If the financial value of flexibility for which consumer devices can access remains low, or if the value of flexibility in certain markets becomes diluted by mass adoption of flexible technologies, this could make the propositions commercially unviable on a mass market scale for suppliers.	Phase 2 should test the thresholds at which different propositions design become viable / unviable for mass rollout.
Data sharing and consent	Policy, Regulatory	**Medium-High.** Many data sharing/consent issues are fairly easily solvable in trial scenarios, but scaling up to include more consumers, particularly vulnerable or digitally excluded ones becomes very difficult through lack of data, or lack of consent to share data.	Guidance and support on data anonymisation best practice and data ethics, e.g. through a broadcast/workshop format, would be valued.
Financing technologies for particular consumer groups	Regulatory	**Medium.** Propositions that rely on consumers' ability to finance the installation of LCTs could pose problems for certain consumers who are facing financial difficulties (e.g. low credit score).	Test in Phase 2 options for the supplier to provide such LCTs as part of the proposition.

Barrier or issue identified	Categories	Strength of issue	Solution considerations
Limited consumer understanding and risk of consumer harm	Policy, Market	**Medium.** Many of the propositions relied on the consumer making multifaceted, informed decisions about their energy use or purchase. Tariff complexity and inability to adequately compare could increase disengagement. Our qualitative research found participants would not be inclined to take up ideas that are overly complicated.	Our qualitative research suggested online comparison tools could help consumers understand how they could benefit from different tariffs. However, for dynamic time-of-use tariffs these tools would need to incorporate a lot of information – e.g. when different devices are used – to give consumers an accurate idea of costs and help them make informed decisions. Consumer testing and user centric development methodologies, as well as building in from the outset clear plans for supporting customers in making informed decisions will be important.
Skills gaps (both "in house" and partnerships)	Practicality	**Medium.** Increasing complexity from more bespoke propositions raise considerations regarding the competencies within suppliers and their partners to meet consumer needs (e.g. educating consumers, analysing bespoke consumer data, relevant LCT installations.)	Reviewing the current market arrangements for the supply chain including suitable standards and qualifications for tradespeople installing LCTs, validation and assessment of competencies, exploring options for escalation routes through an ombudsman (or equivalent) and introducing a method for measuring performance (e.g. through reform of Energy Performance Certificates).
Digital complexity & openness (for developers and partners), and scalability	Regulatory, Infrastructure	**Low-Medium.** Many of the solutions would strongly benefit from industry standard digital elements which do not yet exist, but are being developed, such as data sharing infrastructure, and consumer consent dashboards. Industry standardisation initiatives should alleviate this in time. Timelines for development and rollout of propositions may not align with these initiatives, leading to potential duplication of effort.	This has not been deemed a major issue for the trial phase, but something the proposals should be aware of during their development. For phase 2, strategically selected partners will assist in the successful trial of particular propositions.
LCT development / cost – (e.g. batteries, smart controls)	Infrastructure	**Low-Medium.** Viability of propositions to be scalable by 2030 (which rely on additional technologies in the homes) will be impacted by technological development and associated cost curves.	Ensure continued monitoring of technological cost curves, particularly for high impact flexibility technologies such as batteries.
Home ownership status	Practicality	**Low-Medium.** Some propositions depend on ability for consumers to make changes in their home (e.g. installations) and degree of automation (difficult in multi-tenant property).	Exploration of solutions to tailor packages to particular situations (e.g. a landlord package) or to use technologies that are able to be transferred between homes (e.g. a wireless thermostat).

6. Insights

The main policy insight gained from Phase 1 is the relationship between price signals and the design of consumer propositions. Our modelling has shown that scenarios with more price volatility – such as Scenarios 2b and 5 – have the potential to elicit more demand-flexibility from consumers, particularly where such responses can be automated. However, our consumer research has highlighted people's preference for simple propositions with predictable pricing, as well as revealing some reservations about automation. Care must be taken, therefore, not to assume that exposing most consumers to more volatile prices would necessarily lead to more flexibility – as consumers may find these confusing. **This highlights the need to further explore how suppliers could translate underlying price volatility into simple and attractive consumer propositions** – a concept such as Flex Bat presents one possible solution.

In contrast, Scenario 2a in which policy costs are not recovered from electricity bills has been shown in our modelling to reduce the potential for bill reduction through flexibility. This is because the (modelled) standing charge would make up a larger percentage of the annual bill.

More generally, clarity on the policy outcomes being sought – including decarbonisation, local network constraint management, bill reduction – and their relative priorities will be important to ensure policy interventions are well targeted. Iterative testing within a real-world environment will be important to reveal actual responses and knock-on effects (both on flexibility, and other factors) from different subsets of consumers.

Our modelling has highlighted the importance of demand profiles on flexibility. Specifically;

- Our modelling used an averaged demand profile for each consumer archetype. Phase 2 offers the potential to test propositions against a diversity of real demand profiles. We recommend seeking to identify sub-groups of consumers for which the trialled proposition(s) is relatively more attractive. This would allow for a richer exploration of a range of outcomes that emerge from the proposition(s).
- Our modelling only captured how consumers might optimise their electricity costs. But our research has shown that non-price factors are likely to be similarly important in influencing the amount of flexibility delivered. We recommend that Phase 2 explores the potential to more realistically capture the level of flexibility that is delivered under different levels of financial reward (however such "reward" is defined in a proposition). This should look at both consumers' willingness to invest in new flexible assets, as well as their in-use flexibility once they own those assets, and whether such rewards can be achieved under the future market scenarios.[28]

Our work has highlighted the importance of suppliers as intermediaries between market prices and the consumer. As such, we recommend that Phase 2:

- As a complementary piece to the two consumer demand points listed above, explore how different underlying price signals would make propositions more or less financially viable

[28] While past research has tested the impact of different "rewards" on consumers investment and use of flexibility, to our knowledge this has not previously been combined with the kind of future pricing scenarios used for this project.

for suppliers with regard to the effect of differentiated demand profiles for consumers that belong to the same archetype. This by extension would also influence the amount of financial reward a supplier is able to provide to consumers under a given combination of price profile and proposition.

- Explore the role of suppliers in helping consumers make low carbon investment decisions. This can include the role that suppliers could have in helping consumers not only take up of propositions but also maintain flexibility response over the longer term (i.e. response not simply based on novelty).[29]

Lastly, we highlight the role of automation and technology. Both featured heavily in our consumer research and idea development, but it was not possible to test them within the confines of Phase 1. However, we recommend that real-world trials in Phase 2 test the effect of automation on the amount of flexibility delivered under the trialled proposition(s). The effect of both "lower fidelity" (e.g. a network of automated smart plugs) and cutting-edge (e.g. batteries) technologies should tested, with particular emphasis on understanding the extent to which they could provide the totality of consumer flexibility needs – i.e. whether behaviour change is still required in addition to automation to deliver maximum flexibility potential.

[29] Propositions that have built-in automation (e.g. Flex Bat) address this risk intrinsically, whereas a proposition such as Let's Get Moving face a greater challenge in maintaining consumer engagement.

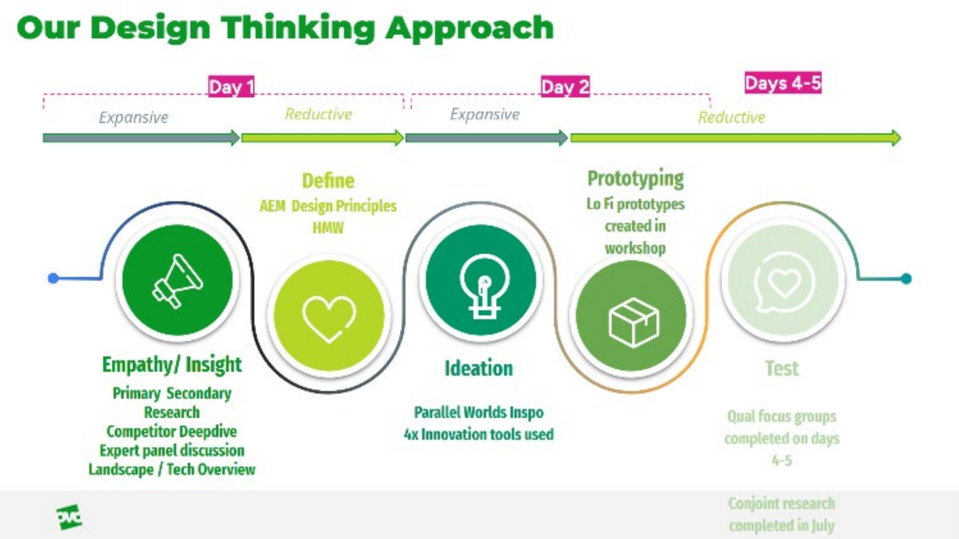
7. Annex A – Proposition development and short-listing

This annex summarises the process we went through to develop the propositions, presents the nine high-level propositions that were identified, and sets out the feasibility assessment that was used to inform which propositions were short-listed for further development and modelling.

7.1 Our design thinking process to develop the propositions

OVO are strong advocates of using a human centred design thinking process as an innovation methodology when designing customer propositions. This is a non-linear 5-step process which ensures that consumer needs are at the heart of the solution. As part of the AEM project, OVO organised a two day in person workshop with 24 attendees from across ESC, CEPA and OVO in attendance. The workshop was used to complete the first four steps of the design thinking process and was an immersive experience for those in attendance.

Figure 7.1: Overview of the proposition-development process



Day 1 – Empathy & Defining the Challenge

In preparation for the session, we completed an insight audit, bringing together all relevant pieces of consumer data / research that were relevant to the topic of energy flexibility and net zero. This information was sorted into four specialist areas:

- Consumer insight (pulling key learnings from primary and secondary research conducted by OVO and ESC which focused on consumer needs / views).
- Consumer personas (OVO shared seven proprietary consumer personas which highlight the range of attitudes towards sustainability and how different archetypes approach making greener choices).
- Competitor overview (looking at inspiration from other energy suppliers across the globe as well as looking at other industries that have solved similar challenges well).
- Subject matter expertise (we heard from a range of experts on the topics of energy market design, policy, sustainability, zero carbon assets, consumer innovation).

These insights were then shared at the workshop via informative presentations, a panel discussion and via videos showing direct consumer feedback on flexibility and sustainability. The workshop attendees were given tools and support to extract key insights from the empathy download and, as a result, were able to more deeply understand the consumer perspective and the "art of the possible" in terms of solving these challenges.

Armed with a clear understanding of consumer needs and a solid understanding of the future market scenarios, the workshop attendees were able to reframe the challenge into consumer-centric questions, for example : "how might we make it easy for consumers to use energy flexibly in a way that's good for them and the planet. Now and in the future". A set of design principles were then applied to ensure the group had a set of guardrails that would steer them towards solutions that could be mapped across to the future market scenarios.

Day 2 – Ideation & Prototyping

The second day of the workshop focused on expansive idea generation. Several ideation tools were used to encourage a depth of ideas from participants. Attendees were encouraged to use the insights they gained from Day 1 and to step outside their normal boundaries of thinking in order to generate solutions that meet the needs of consumers against the backdrop of the market scenarios. 131 ideas were generated and these were then grouped together in clusters of similar ideas or themes, and refined. Participants used the design principles to narrow down to a final set of concepts and these were filtered further using expected consumer appeal.

Attendees were each asked to design a lo-fidelity prototype and to prepare a pitch that would bring their 'winning' ideas to life.

Day 3+

Following the workshop, all of the ideas were reviewed and underwent additional filtering and mapping against the future market scenarios. A shortlist of ideas was then drafted into proposition summaries and these were shared with consumers on Day 4 at a series of qualitative focus groups hosted by ESC.

7.2 Overview of the high-level propositions

The images that follow summarise the output from our Design Thinking process in the form of nine propositions. Short-listed propositions were refined further, so the descriptions of those propositions below may not match the final description provided in Section 3.

Smart Switch & Save

Customers will be rewarded for participating in switch off events when the grid is experiencing some pressure.

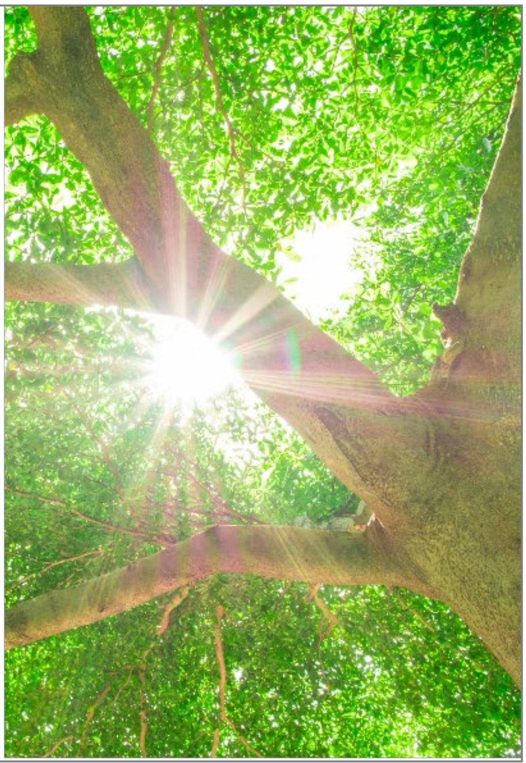
- Available to Smart Meter customers only - customers take part in switch off events when the grid is under pressure, like DFS events.
- Customers can opt in their Smart plugs, or Energy X will offer free/discounted Smart plugs to all.
- If customers opt in their Smart pugs, they will receive a monthly reward and Energy X will automate switch off of Smart Plugs/Appliances when the system is feeling stressed.
- Customers will be alerted when the system is stressed and will be asked to switch additional behaviours..

Have a Green Day

Optimise your household around the greenest times of the day

- Schedule your activities for the week, like the washing or the grocery shopping. Your schedule is automatically optimised for the greenest times of day, accounting for your preferences
- Receive points and credits if you manage to keep to your schedule. Build your Streak by hitting your target on consecutive days
- Receive notifications and alerts if expected grid conditions change, so you can take advantage of unexpected low cost generation to do your most energy intensive activities, like the washing or charging your Electric Vehicle

  Get end of day summaries of flexible behaviour
- Ability to set a cost budget and optimise your plan to your budget. Which means you will never pay more for your energy than you can afford if you follow the guidance and use the tools.



Let's Get Moving

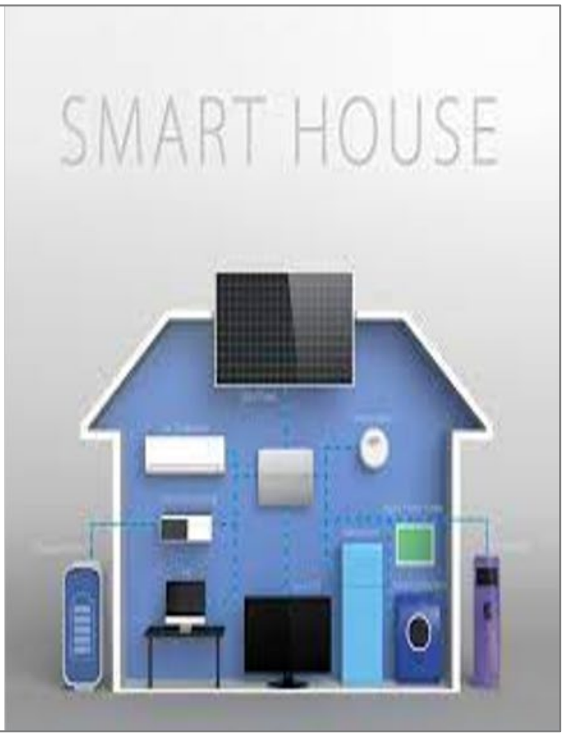
Rewarding customers for shifting consumption out of the peak 4pm - 7pm weekday period.

- Use **12.5% or less** of your **total** daily electricity usage between 4-7pm
- **£20** per month reward
- **Consistent** behaviour change over a month
- Receive **regular alerts** to help you stay on track

'Flex Bat'

Every customer will get a discounted mini battery with fuse box installed in their homes to automatically allow customers to avoid the 5pm-7pm peak!

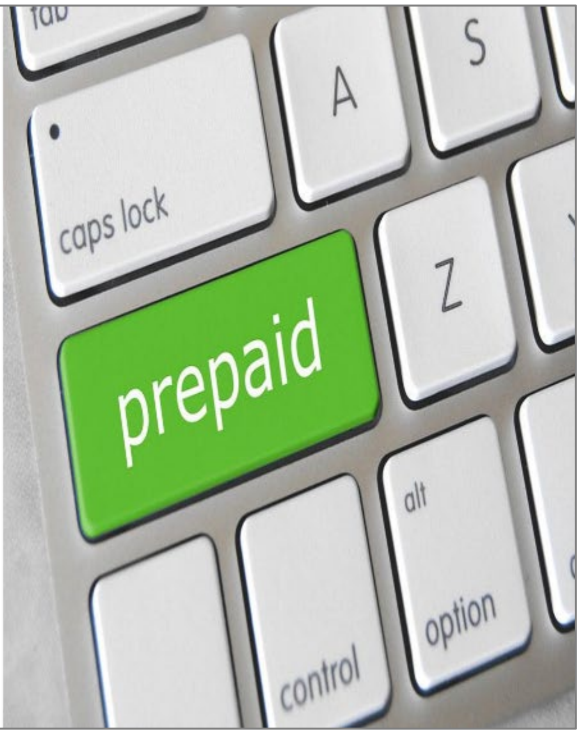
- All customers to receive a discounted mini battery for their home when they sign up to Energy X - paid via their monthly energy bills
- Energy X will install the battery in the home. Battery to be charged when grid is in negative/greener prices
- Customers will pull energy down from batteries at times of peak usage/grid not green
- Energy X to retain 20% capacity of the battery that they can tap into when demand is high on the grid and renewables are low. Customers will be paid for selling this energy back to Energy X. Making a profit!



Pay As You Green

Make your top up go further by putting more on the cheapest times of day

- Allocate your top-up to different times of day. In off-peak times you'll enjoy a cheaper unit price for your energy
- This means that £10 allocated to these times will go further, than £10 allocated to peak



The Agile Plan

Prices based on the wholesale cost of energy, whatever the time of day

- Your p/kWh **changes by hour**
- You're notified the **day before**
- **Prices can vary** across the day and there is benefits in using energy at times when costs are cheapest.

  Alerts will be provided to help you to shift your energy intensive tasks into cheaper time periods

When Life Gives You Mango's

Like choosing a Mango, Energy is best consumed in season. That's because winter and summer bring different household energy needs and also impact how much renewable energy is available and at what time of day. All of which impacts the size of your energy bill.

- Customers can buy seasonal heat and electricity packs which come with an optimised cost based on what time of day you use energy.
- If you need a top up you can 'buy out of season' but this will come at a premium to purchase these additional fuel packs as it is likely to include fossil fuels
- Alerts and advice will be provided on a daily basis to help you use your seasonal energy pack in the most cost effective way. I.e.. cost are low between 11am - 2pm do your energy intensive tasks between this time and stay on track with your prepaid pack.
- Any unused energy can be rolled over to the new season

Healthy Warm Heat Pump Home

Customers will have access to Heat Pump & AI to guarantee a warm, healthy home. Indoor air quality provided via heat pump and other monitoring equipment.

- This proposition helps customers keep the cold away- with a warm home seasonal promise.
- Incentive available to all customers to install Heat Pumps (electric heating)

  Switch to a heat pump and Energy X will guarantee your heating costs don't go up ('if they cost more than they would have done we'll refund you the difference')
- Storing of energy to be completed during specific energy events - keeping the heat neutrally connected.
- Indoor air monitor included as part of the package. .

See the Source (Energy Broker)

See exactly where your energy has come from and choose which energy you want to buy and when to consume

- Choose which blocks of energy you want to buy from a dashboard, including local renewable generators, oversees renewable energy and fossil fuel. This allows you to control cost and carbon
- You will receive real time alerts when renewables are high to allow you to buy an energy pack and complete your energy intensive tasks
- You'll receive hints and tips to access more of the power you want, and less of what you don't

7.3 Summary of our feasibility assessment

A feasibility assessment was undertaken to explore the practical potential of the nine propositions. Together with the consumer research presented in Appendix B, this informed the short-listing of options and their further development.

Each proposition was assessed through three lenses:

- **Commercial:** is it desirable to consumers, is it worthwhile for suppliers, and what would it take for it to be delivered?
- **Technical:** is the technology available at suitable scale, mature enough to provide reliable benefit, accessible, robust to changes in the wider system and able to be integrated into that system?
- **Digital:** is market-wide half-hourly settlement required,[30] are they supportive of Inclusive Smart Solutions for vulnerable customers, are the planned government digital infrastructure initiatives not required, assistive or critical? All propositions assumed the same level of digitalisation with growing capability over time.

The relative strength of each proposition was evaluated by scoring against these criteria, as outlined in the tables that follow.

[30] By design, this was a feature of all propositions.

7.3.1 Commercial

Criteria	Smart Switch & Save	Have a Green Day	Let's Get Moving	Agile	Flex Bat	Healthy Heat Pump	Pay as You Green	When Life Gives You Mangos	See the Source
Average Scores									
Consumer Desirability	2.67	1.50	1.83	1.33	1.50	0.83	1.33	0.33	1.50
Supplier Viability	1.25	1.00	1.50	2.00	2.25	0.50	1.50	1.25	0.50
Feasibility	2.20	2.20	2.00	2.00	2.00	1.60	1.40	1.60	2.20
Total Average	2.04	1.57	1.78	1.78	1.92	0.98	1.41	1.06	1.40
RANK	1	5	3	3	2	9	6	8	7
Consumer Desirability									
Consumer incentives	3	2	3	2	2	1	2	1	2
Consumer barriers	2	1	1	0	1	1	1	0	1
Complexity for consumers	3	0	2	1	3	1	1	0	1
Fairness	3	1	1	1	1	1	2	0	1
Total addressable market	3	3	3	3	1	1	1	1	3
Serviceable available market	2	2	1	1	1	0	1	0	1
Supplier Viability									
Supplier incentives	2	1	1	3	3	1	1	1	0
Cost to serve	0	1	1	2	2	0	2	2	1
Technical complexity	1	1	3	2	1	0	2	1	0
Number of revenue streams	2	1	1	1	3	1	1	1	1
Feasibility									
Resilience to fall in energy prices	3	3	3	1	2	3	1	1	3
Driver for low carbon	1	3	0	2	3	3	1	2	3
Need for partners	2	2	3	3	1	0	1	1	1
Regulatory barriers	3	2	3	3	1	1	3	3	2
Would this proposition encourage / enable more flexibility?	2	1	1	1	3	1	1	1	2

Consumer Desirability

Many of the propositions were deemed to present relatively high barriers for consumer participation in the absence of automation, due to the inconvenience of needing to manually schedule and manage their energy usage. While an automated storage solution could potentially help to alleviate this problem, propositions requiring a battery might also present a barrier to consumers in smaller homes, due to the physical space requirement, or to tenants who may need their landlord's permission to install the asset.

On a similar note, some of the propositions appeared to be better suited to a particular demographic (e.g. home owners, pre-payment customers, higher income households) whilst making it more challenging for others (e.g. tenants, families with children, lower income households). That said, several of the propositions appeared to be able to cater to a very broad consumer base, although it is likely that a range of different propositions will be needed to enable all types of consumers to participate in flexibility with greater ease.

Supplier viability

The commercial viability of many of the propositions would rely on revenue from selling flexibility into National Grid ESO ancillary services or to DNOs/DSOs. However, it may be difficult to guarantee that an expected number of consumers will comply with a turn-down signal in a timely fashion (or even at all) – particularly where consumers have to make a manual intervention to their energy usage – and so it may be challenging for the proposition provider to ensure that they are consistently able to provide a committed volume of flexibility. This poses a significant risk to supplier revenue. We interpreted this as another indication of the need for automation, although we also recognise the additional risks this may bring with consumers not necessarily wanting to 'lose control' of their service and assets (see Annex B for further details).

Feasibility

Propositions that offer a fixed or predictable financial incentive to consumers were considered to be relatively resilient to a future fall in energy prices. On the other hand, propositions which simply offer the consumer more daily opportunities to benefit from off-peak/lower unit prices were considered to be less resilient to falling energy prices, since the incentive for consumers to participate – potentially at their own inconvenience – is likely to be smaller if energy prices are lower overall and hence the monetary difference between peak and off-peak unit prices is lower.

Propositions that aim to offer consumers lower prices when higher quantities of renewable energy are available would appear to require a change in electricity market design to be able to reliably pass on the lower marginal cost of renewable generation to consumers – this has been considered when mapping the suitability of different propositions to different market scenarios.

Propositions that require the installation of batteries or heat pumps may be hindered by the need to obtain prior permission from DNOs and the possibility of refusal – particularly if many consumers wish to take up these propositions within the same local area. Although some of the propositions may be explicitly aimed at alleviating local network constraints, DNOs' standard processes for connecting assets such as heat pumps and batteries may need updating to allow this.

7.3.2 Technical

		Average Scores								
	Criteria	Power Move	Agile	When Life Gives You Mangos	Smart Switch & Save	Have a Green Day	See the Source	Flex Bat	Healthy Warm Heat Pump Home	Pay as You Green
	Technical Feasibility	2.80	2.80	2.80	2.80	2.80	2.40	1.40	1.40	1.40
	RANK	1	1	1	1	1	6	7	7	7
	Technical Feasibility									
1	Available	3	3	3	3	3	3	1	1	1
2	Reliable	3	3	3	3	3	3	1	1	1
3	Integration	3	3	3	3	3	3	2	2	2
4	Accessible	2	2	2	2	2	1	1	1	1
5	Robust	3	3	3	3	3	2	2	2	2

Considering the technical criteria, the propositions fell in to two simple categories; those where no significantly new technology was required, and those where new technology was required. Those where no new technology was required naturally score higher since there are less opportunities for barriers to arise, for example in the reliability, robustness or integration of new technologies.

7.3.3 Digital

Average Scores									
Criteria	Smart Switch & Save	Have a Green Day	Let's Get Moving	Agile	Flex Bat	Healthy Heat Pump	PAY Green	When Life Gives You Mangoes	See the Source
Digital Feasibility	1.75	2.25	2.50	2.25	1.75	1.00	1.25	1.25	0.50
RANK	4	2	1	2	4	8	6	6	9

Digital Feasibility									
Alignment to existing/in flight digitalisation initiatives	3	3	3	3	3	2	2	2	0
Complexity for consumers	2	1	2	1	2	2	1	1	0
Scalability	1	3	3	3	1	0	1	1	2
Data complexity/volume	1	2	2	2	1	0	1	1	0

The propositions were assessed according to their alignment with existing products on the market, initiatives currently under development, and digital requirements for building and scaling each particular solution. An element of customer appeal in a digital sense was also considered, thinking about the complexity of use for each option, and how they may support, or otherwise impact vulnerable consumers. The following government initiatives were considered when evaluating the propositions:

- Digital Spine feasibility
- V2X competition
- Automatic Asset Register
- Interoperable Demand Side Response
- Smart Meter System based Internet of Things Applications
- Virtual Energy System
- Consumer Consent Dashboard
- Smart Meter Data Repository.

Most of the propositions would be supported by these initiatives, although not all of them would be required as some are technology specific e.g. V2X. For 'The Agile Plan', other critical requirements included Digital Spine and Consumer Consent Dashboard.

Let's Get Moving, The Agile Plan and Have A Green Day are the most digitally feasible and scale well, as they are similar to pre-existing digital services and do not rely heavily on consumer interaction. Flex Bat and Smart Switch & Save are more challenging to scale as they rely on specific hardware (smart plug or small battery). Healthy Heat Pump faced similar challenges, particularly the element of 'guaranteeing your heating costs don't go up', as this would require a complex modelling process based on long term property performance data. Pay As You Green, When Life Gives You Mangoes and See The Source all received the lowest scores as they were very reliant on accurate carbon intensity data and fine grained locational pricing, and required the consumer to have a good understanding of their energy use.

8. Annex B – Summary of consumer research

8.1 Qualitative research

8.1.1 Design

Qualitative research was designed to understand which propositions appeal most to consumers and therefore could be prioritized through the AEM project.

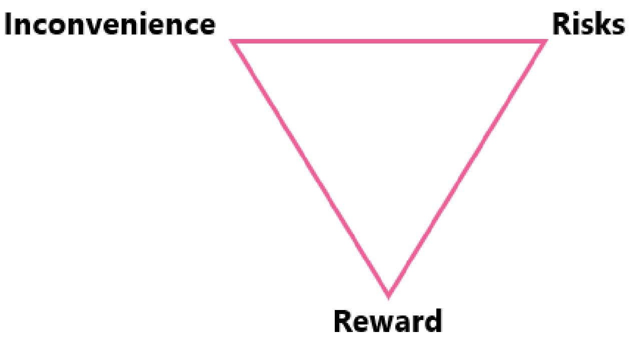
Two focus groups (n=8, n=7; participants represented a mix of demographics, energy tariffs and low carbon technology use) explored:

- Consumer understanding of energy flexibility and concepts related to future market scenarios e.g. split market, regional pricing.
- Appeal of – and concerns relating to – each proposition.
- Opportunities to improve propositions and address barriers.

8.1.2 Key findings

The findings outlined here centre around a common principle that consumers will accept inconvenience if the perceived risks are manageable and the reward is 'worth it'.

Figure 8.1: Inconvenience will be accepted if perceived risks are manageable and the reward is 'worth it'.



Consumers are more open to changing how they use energy than how they buy it.

Changes to how energy is bought are seen as needing complex adjustments to behaviours (increasing perceived inconvenience) and representing risks for consumers (increasing perceived risk). Focus group participants felt that understanding how to change behaviour and manage risks would require an understanding of the context in which propositions are offered. While some contextual factors were already understood or intuitive to understand, such as peak and off-peak pricing and increasing using of renewable energy, other factors like matching demand to supply and cost varying between seasons or locations were typically not. Building enough understanding of these factors to confidently navigate buying energy differently and managing the associated risks requires cognitive effort, another inconvenience which acts as a barrier to uptake.

For example, buying 'packs' of energy for future use (as in See the Source and When Life Gives You Mangoes) was seen as a complex behaviour change. Concepts like buying 'packs' and 'rolling over' energy from season to season were initially seen as similar to mobile phone tariffs, particularly mobile data – like kWh in energy, GB of data are not tangible units. However, participants felt translating these concepts to buying energy would entail greater risks, or greater effort to mitigate risks.

Buying too little energy could leave households unable to complete tasks or paying a premium for more energy. These risks could be mitigated by buying more than needed – as some did when buying mobile data – but this would involve higher costs for energy than for data. While unused energy could be 'rolled over', participants were reluctant to pay more than necessary in a given period.

"They should concentrate on what works for energy and not try to replicate the phone contract model."

Buying the right amount of energy for your needs would require understanding your energy consumption. Historic energy consumption data could help but participants felt granular understanding would be needed to work out how much to buy and how that might vary between seasons (further complexity not relevant to mobile phone tariffs). They felt most consumers would be unwilling to accept this added complexity.

Pay as you Green would change how prepayment meter consumers buy energy (allocating funds to peak and off-peak periods) but was more positively received than other propositions that change how energy is bought. The behaviour change was seen as relatively simple, risks minimal, and the purpose of reducing demand at peak times was easily understood.

Novel pricing structures were met with resistance. Split market and regional pricing concepts were viewed as adding complexity for consumers – participants explained that they do not currently place much (if any) importance on the source of electricity and nor would they want to, cost being a greater priority. Most felt they would struggle to navigate the complexity and risks of these concepts without greater understanding, which they did not feel inclined to build.

"People have no idea what's happening behind the scenes and where power is being generated."

Participants wanted financial reward for the inconvenience of shifting energy use.

Shifting energy consumption was seen as inconvenient. It can compromise household needs at a given point in time. It may require physical effort to change when or how energy is used. Whether these inconveniences are deemed acceptable depends on the reward – essentially, whether the perceived inconvenience is 'worth it'. Incidentally, making this assessment also requires cognitive effort.

"[Community support] is an interesting idea but I don't think it would get much uptake. If you're making a sacrifice then it's a reward that you deserve."

Participants felt rewards should represent net financial gain e.g. a direct monetary reward or saving on energy bills. Financial rewards were seen as highly relevant and almost universally appealing. Other benefits were recognised but not seen as substitutes for personal financial reward. For example, participants acknowledged the environmental benefits of reduced carbon emissions but explained that they would prioritise reducing their bills over reducing carbon, particularly given recent high energy prices.

"With rising costs I don't think people care whether it's renewable or not…they just want the cheapest price"

They also welcomed the idea of energy suppliers offering community support but did not view this as an alternative to personal financial reward – some elaborated that individual consumers would be inconvenienced by shifting consumption and so should be compensated directly.

Participants typically discussed financial rewards in terms of savings on energy bills. Some participants had taken part in DFS schemes that had offered an absolute saving if certain criteria were met, such as OVO's Power Move which offered consumers a fixed reward of £20 a month, but they tended to consider this in terms of the net impact (i.e. saving) on their energy bill.

When participants were asked what size reward they felt would be enough to motivate them to shift their consumption, responses were typically given in terms of percentage savings on energy bills rather than absolute values. Framing financial rewards as percentage savings appeared to help individuals consider potential rewards without having to translate absolute values into what might be different net impacts on bills - for example, if bills vary between summer and winter. It also enabled discussion between participants living in different types of homes and with different sizes of household. Percentage savings represented a more suitable metric than absolute values, which would have represented different savings depending on each household's bill.

"I think you would need to save about 25% on your winter bill to make it attractive"

It should be noted that rewards should not be disproportionately high. Households could be at risk if pursuing these rewards compromises basic needs (e.g. a warm home, showering or hot meals).

Inconvenience varies between households and situations. Participants wanted freedom to choose whether to shift their consumption.

Participants recognised that the inconvenience of shifting their consumption would vary depending on the time of day, the behaviour (e.g. cooking, cleaning, heating), the effort involved in changing that behaviour and the household needs that behaviour must fulfil, alongside other factors. They wanted to choose whether to shift their consumption on any given occasion.

Some felt it would be unfair if rewards for shifting consumption were only accessible to those who were willing and able to do so. They welcomed the idea of variable rewards at different times of day and on different days of the week that they could access when they felt able to shift their consumption.

"If it was at different times rather than always being in peak time when I know I need power, you could do your bit and turn off sometimes but not on times where it's just not feasible…I would rather a smaller reward for a smaller amount of time."

It is important to emphasise the variation of perceived inconvenience across different times, activities, people and situations. Analysing household energy use data could identify times of day and devices/appliances that represent greater opportunities for shifting, but to understand the likely extent of consumer engagement in flexibility it is important to consider the perceived inconvenience and impact on households at any given time. This is far more complex. Focus group participants indicated they would find some behaviours easier to change than others, but noted this would depend on other factors. For example, some parents felt it would be harder to change when or how they cooked than when they used the washing machine, but noted that sometimes the need to cook could be lower (e.g. in hot weather) and the need for washing higher (e.g. washing school uniforms for the next day).

Participants varied in their openness to automation of their energy consumption.

Regardless of the outcomes they want from their energy use (e.g. heating, cleaning, entertainment) and when they want those, focus group participants felt that in any flexible future they would want to maintain control over these. They understood the potential of smart technology and automation to incorporate flexibility into giving households the outcomes they need, when they needed, but varied in their openness towards services operating this way.

Some would prefer to manage flexibility 'manually' i.e. physically turning devices/ appliances on or off or using them at different times. They felt this would guarantee they always knew when certain outcomes would be delivered e.g. when a washing machine cycle would finish.

Others would welcome the convenience of automation provided they acted as gatekeeper, for example receiving alerts of shifting opportunities, deciding whether to take those up and allowing smart technology to action shifting on their behalf. Such approaches could use an "opt in" or "opt out" approach – while some reflected that the latter would require greater trust in the service, repeated success using the former could build trust over time.

8.1.3 Recommendations for quantitative research

Propositions should focus on incentivising consumers to change how they use energy, not how they buy it.

Propositions that substantially change how energy is bought are perceived as inconvenient and risky without considerable understanding of the context in which they are offered, which most consumers do not have and are not inclined to build. The purpose of propositions that encourage consumers to change how they use energy is already understood by some and is intuitive for others to understand.

Rewards should feel accessible and proportionate.

Shifting energy consumption is perceived as an inconvenience warranting reward. The perceived inconvenience depends on many factors and is only acceptable if the reward is 'worth it'.

Propositions should give everyone the option to choose whether to shift their consumption.

With the perceived inconvenience of shifting varying between households and from one instance to another, propositions should ensure two things: that households ultimately decide if and when to engage in flexibility, and that all households have opportunities to benefit from flexibility services.

Propositions that offer varying degrees of automation may appeal more widely.

Consumers vary in their openness to automation. Propositions which allow individuals to tailor the extent to which shifting is automated could cater to different preferences and allow individuals to accept increasingly more automation as they become more familiar with flexibility.

8.2 Quantitative research

8.2.1 Design

An online survey using a conjoint exercise was completed by a nationally representative[31] sample to explore the appeal of different attributes of flexibility propositions. Attributes tested in the conjoint exercise reflected the 7 pillars of flexibility services.

Pillar	Attribute
Alert driven or behaviour change	Getting the outcome you want
Automation	
Predictability of energy prices	Pricing structure
Degree of flexibility required	How often you'd need to shift
Technology required	Energy devices
Monetary value of shifting behaviour / Volatility of energy prices	Yearly savings on electricity bill
Monetary value of shifting behaviour [indirect]	Supplier support

Attributes and their levels were designed such that each of the leading propositions could be built using different combinations of attribute levels.

Yearly savings were framed in terms of percentages to reduce the potential confound of an absolute value (e.g. £20) representing a different-sized reward depending on the size of an individual household's energy bill.

Analysis explored differences between key groups:

- Those with vs without low carbon technologies.
- Those who reported struggling to pay energy bills vs those who did not.
- Homeowners vs tenants.

8.2.2 Key findings

Energy bill savings had the biggest influence on preference.

Exploring the relative importance of each attribute in terms of how its most appealing level contributes to overall appeal shows that the higher the energy bill savings, the greater the preference. Savings of 25% were most preferred, followed by variable savings with a mean saving of 15% (i.e. 5-25% and 10-25%) and fixed savings of 15%.

The qualitative research suggested some would welcome variable reward structures that allowed people to participate as much or as little as they felt able. Flexibility in potential rewards may encourage greater flexibility in energy consumption. Further research could explore whether

[31] Sample size: n=1000. Nationally representative on the basis of age, gender, region and income.

variable rewards with the potential for higher rewards (e.g. 15-35% or "up to 35%") encourages more shifting than fixed rewards of equivalent value (e.g. 25%).

The most preferred offering combined high savings with shifting around peak and off-peak pricing. Appeal was similar whether shifting was manual or automated, indicating an offer with potentially wide appeal.

Figure 8.5: The most preferred offering combined high savings with manual shifting around peak and off-peak pricing.

Most preferred offering
Avert Alert
Peak and off-peak
Shift once a week
Smart meter and smart plugs/devices
25% saving
Supplier donates £1

The most preferred offering used high savings to incentivise shifting around peak and off-peak pricing. Appeal was greatest when offered with the "Avert Alert" approach to getting the required outcomes, which involves more manual shifting. However, appeal was only marginally lower when offered with the "Easy Energy" approach, using smart technology and automation to incorporate flexibility into delivering the required outcomes.

The similar appeal of these offerings aligns with findings from the qualitative research. A 'core' proposition could use high potential rewards to incentivise shifting around peak and off-peak pricing. This could be offered with varying options for automation, e.g. using smart technology to action "opt in" or "opt out" decisions through to fully automated flexibility. This could allow individuals to tailor automation to their personal preferences and enable increasingly more automation as they become familiar with and trusting of the service.

Automated services may particularly appeal to homeowners.

Homeowners demonstrated significantly higher preference for Easy Energy (vs renters) and a slight preference for this over Avert Alert. This may reflect differences in the extent to which these groups feel willing or able to install the smart technology needed for automated propositions. Again, a 'core' proposition with varying options for automation may represent a widely-appealing offer that could be used differently by different groups.

Supplier support for community initiatives had little impact on preference.

A "supplier support" attribute offered varying levels of supplier donations to community causes (i.e. donations of £1, 50p or 25p for every £1 consumers saved). While preference increased as the donation increased, the highest donation amount still had little influence on overall preference. This echoes qualitative discussions of supplier support initiatives, in which participants welcomed the idea but not a substitute for personal financial benefit.

8.2.3 Potential real-life appeal of propositions

This section details analysis in which each of the shortlisted propositions was built using the relevant attribute levels tested in the conjoint, reflecting modelling outputs where appropriate. A market simulator model calculated each offering's total appeal relative to alternatives. Scores ranged from 100 (the most appealing combination) to 0 (the least appealing combination) and indicate *relative* appeal – a score above or below a certain threshold does not necessarily constitute a 'good' or 'poor' proposition.

Low energy bill savings limit the appeal of all propositions.

All propositions had relatively low appeal. This was driven by the low potential savings that modelling indicated consumers could access. In most cases, modelled savings were lower than the lowest level tested in the conjoint (5%).

Automated propositions tend to have higher appeal than those involving manual shifting.

Smart Switch and Save and Have a Green Day could both be offered at two levels: a basic level with more manual shifting, or with automated shifting via smart plugs and devices. For both propositions, the automated option has relatively higher appeal than the basic one. This is driven by the increased appeal of less-frequent shifting and of smart plugs and devices over smart meters alone.

Again, though, the appeal of these automated propositions is limited by low savings. The appeal indicated by simulations using conjoint data may even represent an overestimate: for Smart Switch and Save, modelled savings ranged between 0.4% and 1.3%, lower than the lowest level (5%) tested in the conjoint; Have a Green Day offers consumers ‘credits’ in return for shifting, rather than the personal financial reward that focus group participants highlighted they would expect.

Flex Bat represented similar, relatively low appeal. While this proposition enabled substantially more shifting than other propositions (an average of 18.5% for the baseline consumer archetype), it did not deliver a corresponding increase in savings for consumers – modelling indicated an average bill reduction of just 2.2%. The net impact of this on bills would be smaller still once the cost of leasing the battery (spread over monthly bills) is accounted for, potentially decreasing appeal more.

While automated propositions tended to have higher appeal, it is important to consider that openness to automation varies between individuals. Propositions with options to vary the degree of automation may be more widely appealing while enabling individuals to tailor the degree of automation to their own preferences.

8.2.4 Implications for Phase 2

A “core” proposition using high potential rewards to encourage shifting around peak and off-peak pricing could be offered with options to vary the degree of automation.

Conjoint findings suggest such an offer could be widely appealing, with high rewards having the greatest influence on preference and peak and off-peak pricing preferred over other pricing structures. Giving consumers options to vary the degree of automation involved could allow them to tailor how they make use of the offer to align with their personal preferences around automation. It could also enable increasing automation as consumers become more familiar with the service.

Offering variable pricing with the potential to access high rewards may drive greater engagement.

Further research could explore differences in uptake of – and engagement with – offers using variable reward structures with the potential for higher rewards (e.g. 15-35% or “up to 35%”)

compared to offers with fixed rewards of equivalent value (e.g. 25%). Variable rewards may encourage uptake, particularly among those who do not feel they could consistently or regularly shift their consumption. The potential to access higher savings may also encourage greater flexibility in energy consumption.

9. Annex C – Our modelling approach[32]

9.1 Overview of modelling approach

We modelled five retail propositions developed by the project: **Flex Bat** (FB), **Pay as You Green** (PAYG), **Smart Switch and Save** (SS&S), **Let's Get Moving (**LGM), **Have a Green Day** (HaGD).

For each proposition, the modelling simulated:

- a representative customer's half hour demand over a whole year for six customer archetypes; and
- six pricing scenarios covering wholesale electricity, network costs and policy costs, each for three geographical locations (18 price profiles in total).

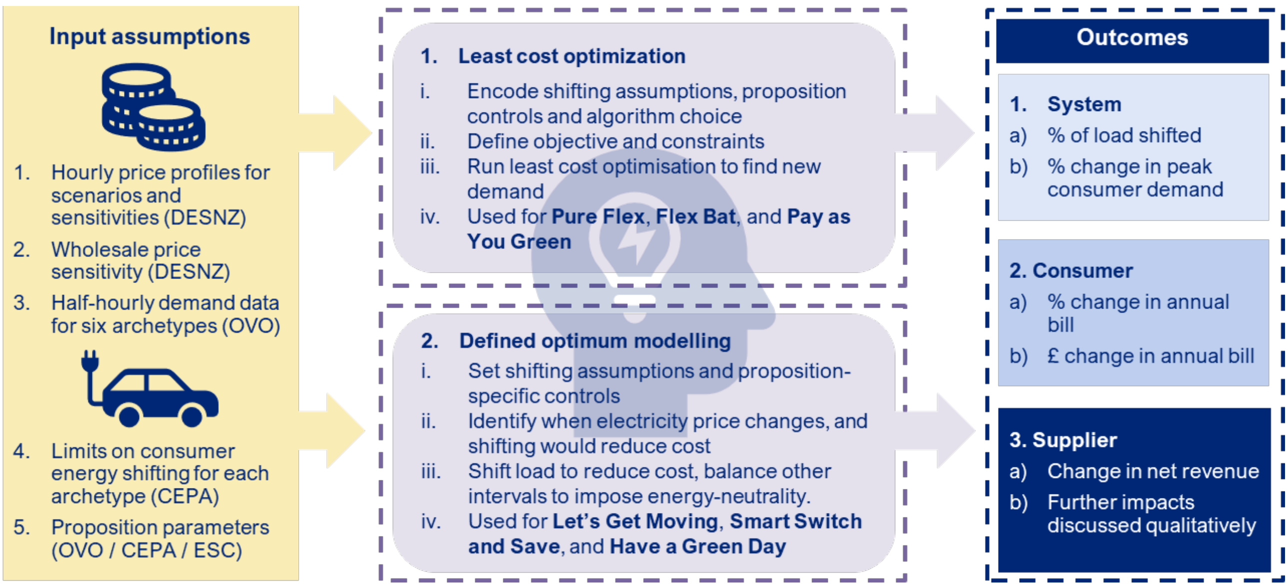
This makes a total of 540 model runs (5 * 6 * 18). In addition to the main runs, we:

- estimated a benchmark for bill savings from exposing customers to full pass-through of half-hourly price profiles (**Pure Flex**), and
- explored sensitivities on demand profiles and on wholesale prices.

Information on weather, generation outturn or demand profile underlying scenario price profiles was not available, meaning that effects of these could not be tested.

For propositions where customers were exposed to dynamic time of use pricing, least cost optimisation was used to determine flexed profile. For the other propositions, consumers were shielded from the underlying price signals so a defined optimum flexed profile for consumers was modelled, this is illustrated in Figure 9.1.

Figure 9.1: Modelling architecture.



Source: CEPA Analysis

[32] Modelling was carried out by CEPA.

9.2 Turning scenario price profiles into consumer prices

In most cases (all propositions excluding Pure Flex and Flex Bat), the proposition designs are such that consumers are not directly exposed to the underlying hourly price profiles. Instead, consumers will generally face a two-part tariff, composed of a standing charge and a unit rate per MWh used, which then has the proposition applied.

The two-part tariff is calculated using the following methodology, which is intended to ensure cost recovery for the supplier in the baseline – i.e. the consumer archetype which does not possess any 'smart' infrastructure and is not in fuel poverty. This represents an assumption that the supplier offers a single tariff to all consumer types.

In practice, this will lead to over / under recovery for consumers that have a different demand profile (i.e. including but not limited to the other demand archetypes within our modelling). However, this is unavoidable, and would occur for any methodology that doesn't use a customer-specific single unit cost for variable consumption. We outline the methodology below.

Total cost to the supplier

We summed each of the time variant components of the price profiles (individually for each scenario and location) for each half-hour.[33] This provides an annual profile of half-hourly variable costs faced by the supplier. We take the sum product of this price profile and the baseline consumer demand profile provided by OVO. This provides a forecast of the variable annual cost to the supplier of the energy consumed by that consumer archetype. To get a total final cost to the supplier, we add the fixed price costs (for each scenario and location).

Unit rate and standing charge

The price profiles provided by DESNZ do not include several cost categories that form components of consumers energy bills, for example supplier costs. We have used Ofgem's default tariff cap model[34] to estimate the typical proportion of the energy bill attributable to these costs. Using a historic average, from January 2019 to June 2023,[35] we estimate that these costs comprise 20.8% of the bill.[36] Therefore, to calculate the estimate average annual cost to consumer, we increase the total annual cost to the supplier by 26.3%.[37]

Unit rate and standing charge

We used Ofgem's default tariff cap model to estimate the typical split between the variable charge ('typical consumption') and the standing charge ('nil consumption'). We estimate the

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[33] This includes increasing the wholesale unit costs by 8.4% to account for wholesale costs not included in the price profiles, such as 'seasonal to monthly shaping' and 'imbalance'. We have used Ofgem's '*Model – Default tariff cap level v1.15'* to estimate theses costs. Available online here.
[34] Ofgem, "*Model – Default tariff cap level v1.15"*. Available online here.
[35] We do not use the values before January 2019, which are marked as 'for illustration only' in the source.
[36] This is based on data for 'standard credit' and 'other payment method' consumers. We exclude 'PPM' consumers as we were informed by OVO that it is unlikely that these consumers will be charged a premium, with additional costs of serving these meters to be met by government funding.
[37] The DESNZ price profiles provide a partial bill which we must uplift such that the omitted cost categories make up 20.8% of the bill. The uplift is calculated as: 20.8 / (100 - 20.8) = 26.3.

historic average (from April 2017 to June 2023)[38] for standard credit consumers with single-rate meters. We estimate that 87.3% of the bill should be recovered from variable charges. This total is divided by the total yearly demand for the baseline demand profile provided by OVO, to produce a unit rate per MWh.[39] The remaining 12.7% of the bill, total standing charge, is divided by 365 to produce a daily charge per customer.

We present each of the unit rates and standing charges in Table 9.1.

Table 9.1 Unit costs and standing charges

Location	Scenario 1	Scenario 2a	Scenario 2b	Scenario 3 Zonal	Scenario 3 Nodal	Scenario 5	Scenario 5 (sens)
Variable charge (£ / MWh)							
Location 1	140.4	82.7	143.5	131.9	134.2	138.1	193.0
Location 2	165.3	107.6	168.3	158.0	150.6	153.2	195.3
Location 3	159.8	102.0	162.7	136.6	132.2	134.7	159.4
Standing charge (£ / annum)							
Location 1	65.1	38.3	66.4	61.1	62.2	64.0	89.4
Location 2	76.6	49.8	78.0	73.2	69.8	70.9	90.5
Location 3	74.0	47.3	75.4	63.3	61.2	62.4	73.8

Source: CEPA modelling

9.3 Constraints applied in the model

Across all propositions, some cross cutting assumptions have been applied that are intended to reflect consumer behaviour with respect to shifting electricity demand. These are characterised as constraints in the modelling, and restrict how demand can move during the optimisation. The constraints are:

- **Constraint 1**: Total consumer demand will remain unchanged during each day.
- **Constraint 2**: Demand every half-hour cannot increase or decrease by more than the percentages reported in Table 9.2. Different assumptions are used for Have A Green Day where smart devices are used, which increase available shifting as described in the appropriate section.
- **Constraint 3**: Heat pump demand can only be shifted to earlier in the day.

Constraint 1 has been imposed to isolate the effect each proposition has on shifting demand as opposed to both shifting and reducing demand. Isolating this effect improves the focus on the consumer benefits of shifting demand rather than energy efficiency – e.g. choosing to use the

[38] The different time period used between this calculation and the calculation of the cost uplift reflects the availability of data in the source.

[39] We use the baseline demand profile in our calculation of supplier revenue recovery under the assumption that it provides the best available approximation of typical demand. However, as it represents the profile with the lowest annual demand out of our dataset, it is likely that bill costs would be higher. Given this, there is scope for observed consumer benefits to be higher than the results presented in Section 4.

washing machine at cheaper time as opposed to reducing the number of washing loads. We choose individual days as the time horizon for our optimisation methodology, as we consider it is a reasonable proxy for consumer behaviour.

Constraint 2 has been introduced to reflect the ability consumers have to shift demand within a given half an hour; we have assumed this varies with the type of load being shifted (see Table 9.2). We have assumed that 20% of the load for 'baseline' households without 'smart' infrastructure (e.g. an EV or heat pump) can be shifted up or down in every hour during the day. This reduces to +/-10% during the night. The lower assumption at night reflects that while consumers can schedule appliances to run during the night, when consumers are asleep there is less scope for shifting demand.

We assume that if consumers have smart appliances or a heat pump, then they can shift more load given the increased automation of these devices. As with baseload for normal appliances, we assume that less load can be shifted at night.

The largest amount of shifting potential is assumed for Evs and a consistent assumption is made for day and night. This is because consumers will be less sensitive to the timing of this consumption, as charging is decoupled from use of the vehicle.

Table 9.2: Permitted half-hourly shifting (% of demand archetype load)[40]

Demand archetype	Day	Night
Baseline (excluding 'smart' devices)	20%	10%
Fuel poor (excluding 'smart' devices)	20%	10%
Electric vehicle	50%	50%
Heat pump	25%	15%

Source: CEPA analysis.

We have introduced **Constraint 3** to limit the shifting of heat pump load to earlier hours in the day. This is because there is a conceivable benefit from pre-heating a home, given that temperature increases will be sustained for a period of time, but no benefit to shifting heating to later in the day, after the point at which the temperature increase is desired. This constraint has only been added to propositions modelled using the least cost optimisation.[41]

[40] These assumptions were developed by drawing on our collective experience of working on topics of energy customer behaviour and flexible technologies. The demand profiles are an average of many consumers, so – for example - a 50% shifting limit does not mean that a charge point is switched to 50%. Rather it is better interpreted as 50% of EVs that would otherwise be charging at that point are switched off. Ultimately, EV behaviour is evolving, the technology is developing, and propositions are nascent. We are conscious that when modelling a 2030 world, being overly prescriptive with historical data would represent a false level of accuracy, therefore we have not linked these assumptions to previous trials.

[41] The heat pump constraint has been included for the least cost optimisation propositions to avoid counter-intuitive outcomes from arising out of the optimisation. We have not included the constraint for the defined optimum runs as the results for these propositions are more deterministic, so do not encounter these counter intuitive results.

One proposition (Have a Green Day) was based on significant automation, which our modelling reflected by changing the demand shifting constraints. These are reproduced in Table 9.3.

Table 9.3: Have a Green Day – permitted half-hourly shifting (% by technology type)

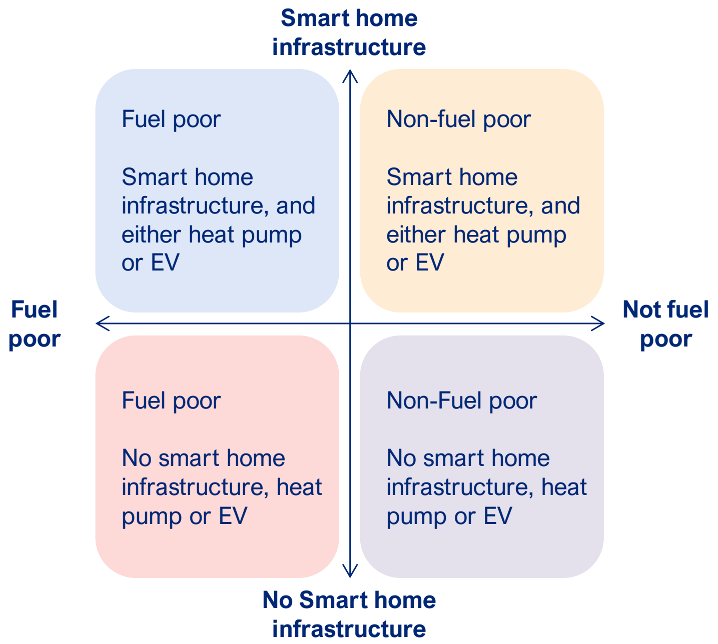
Technology	Day	Night
Smart load (up to 15%)[42]	60%	60%
Heat pump	25%	15%
EV	75%	75%

Source: CEPA analysis

9.4 Modelled demand profiles

Figure 9.2 depicts the consumer archetypes required to be modelled in this project. In addition, we have modelled a fifth archetype – non fuel poor consumer with smart home infrastructure but no EV or heat pump.

Figure 9.2: Consumer segments



Source: DESNZ

To construct demand profiles for the consumer archetypes, we used average, half-hourly consumption data for five consumer types, based on a subset of OVO's customer base. The categories are intended to be mutually exclusive:

- Customers who have not identified as having a heat pump or EV and are not eligible for the Warm Home Discount Scheme ('baseline' consumer archetype).

[42] A 60% shift of 15% of a consumer's load is 9% of total load, which is lower than our overarching assumptions for customer flexibility. We consider this appropriate for this proposition owing to the additional commitment and engagement which it involves, including the fact that number of hours in a day in which shifting is encouraged (6 hours) is higher than in other propositions.

- Customers who are eligible for the Warm Home Discount Scheme (our proxy for the 'fuel poor' consumer archetype).
- Customers who have self-identified as having an electric vehicle.
- Customers who self-identified as having a heat pump.
- Customers who self-identified as having a smart thermostat (a proxy for smart home infrastructure).

Table 9.4 provides summary statistics of the consumption data. As would be expected, the households with EVs or heat pumps have much higher annual consumption than those without. This is also reflected in the annual minima and maxima.[43] All profiles demonstrate varying degrees of seasonal variation, to the greatest extent for the consumers with heat pumps.

Table 9.4: Summary statics for consumer demand profiles

Consumer group	Annual consumption (kWh)	Minimum half hour (kW)	Maximum half hour (kW)	Winter %	Sampling population (customers)
Baseline	3,184	0.17	0.83	64	>100,000
Fuel poor	3,351	0.18	0.82	64	3,000
With electric vehicle	5,800	0.32	1.47	63	3,000
With heat pump	6,685	0.25	2.57	75	1,000
With smart thermostat	3,517	0.19	1.02	63	3,000

Source: CEPA analysis of OVO data

The data provided is for the period 1 June 2022 until 31 May 2023. To match the price profile, which are for the 2030 calendar year, we rearranged the demand profile into a single calendar year, bringing the second half in front of the first.[44]

The consumption associated with EV charging or heat pump operation is not individually identified. So that we could implement technology-specific flexibility constraints, we split out these loads by subtracting the baseline profile from the profiles of the EV and heat pump segments. Taking these estimates of half-hourly EV and heat pump demand, we were also able to construct demand profiles representing fuel poor households with EV or heat pump.[45] As such, there are six consumer archetypes in our simulations and reporting:

- baseline and fuel poor, the two archetypes which do not have LCTs (i.e. EV or heat pump)
- baseline with EV

[43] The demographics of the consumer groups may also contribute to this variation, e.g., households which have an EV or heat pump in 2023 are likely to be more affluent than the average consumer.
[44] Sequentially, this means that the demand profiles used in the modelling reflect 1 Jan – 31 May 2023 and then 1 June – 31 December 2022.
[45] At the time of the data extraction, there were too few customers eligible for Warm Home Discount Scheme who have self-identified as having an electric vehicle (or heat pump) to directly calculate an average demand profile.

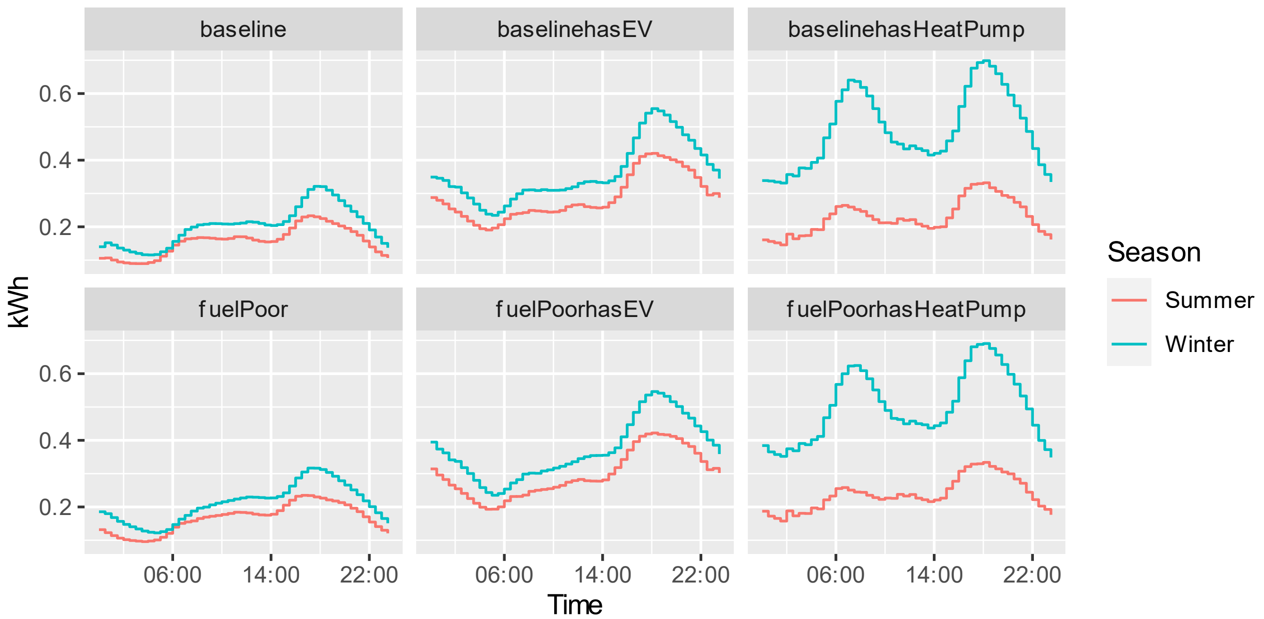
- fuel poor with EV
- baseline with heat pump
- fuel poor with heat pump

We decided not to use the demand profile for customers that have a smart thermostat. This was because the demand profile for this segment was very similar to the baseline profile.[46] Instead, we represent the consumer with smart home infrastructure through the flexibility constraints we apply in the optimisation (described above). We assume that these consumers would be capable of providing greater amounts of flexibility than consumers without smart home infrastructure.

The profiles are averages of the demand profiles of multiple consumers, and so the profile is smoother than could be expected for individual consumers. This has the potential to reduce the apparent opportunities for flexibility from individual consumers, since the averaged profile "shaves off" demand peaks and "fills in" troughs. We have sought to account for this in our flexibility assumptions, which define the consumer groups in the optimisation (i.e. the permitted half hourly shifting specified in Tables 9.2 and 9.3). These assumptions were developed on the basis that the demand profiles are averages, and so are intended to reflect the potential shifting behaviour across a population of consumers rather than that of individual households.

Figure 9.3 shows the average daily profiles for summer and winter, for each demand archetype. The demand profiles are an average of 1,000s of consumers so it is expected that there would be, for example, some EV charging in every hour of the year.

Figure 9.3: Demand profiles



The demand profiles are used in the half hourly optimisation under each proposition. We do not know the whole system demand assumed in generating the price profiles, so in some cases we also use these demand profiles to identify peak demand intervals when this is relevant to a proposition.

[46] This is most likely to be because the smart thermostats controlled gas heating rather than electric heating.

10. Annex D – Detailed modelling results

10.1 Pure Flex

Pure Flex is the proposition in which the consumer faces the underlying, half-hourly price profiles which vary throughout the day. This proposition shows the maximum level of flexibility and cost savings which could be achieved within the assumed flexibility constraints by an economically rational customer with perfect foresight, without the aid of a battery. It therefore serves as a benchmark for the other propositions.

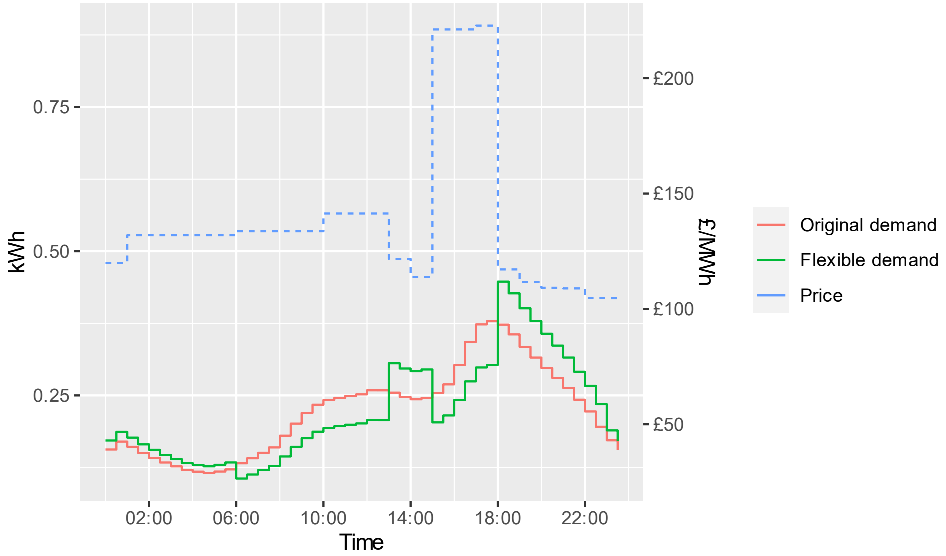
Our modelling of the Pure Flex proposition provides the following key insights:

- The largest system impacts on annual energy shifted and demand reduction are observed for EV consumers, followed by heat pump consumers, and those without either of these devices. Generally, the most successful scenarios are Scenario 5 and Scenario 2b, while the least successful scenarios are Scenario 3 and Scenario 3. However, there is variation within each scenario.
- The consumer impact results are generally consistent with the system impacts – Scenarios 5 and 2b provide the most favourable bill outcomes. Conversely, Scenario 2a is the least attractive for consumers on the Pure Flex proposition. The bill reductions are between 2% and 6% for the annual bill for EV consumers, between 1% and 4% for heat pump consumers, and 1% and 3% for households without these technologies.
- The consumer impacts highlight considerations for suppliers for the design of static tariffs relative to dynamic tariffs in ensuring that dynamic tariffs can appeal to the consumer groups for who the proposition can be most beneficial.
- The wholesale price sensitivity is generally favourable in terms of system impacts and consumer impacts. It produces similar, sometimes slightly improved, impacts relative to Scenarios 5 and 2b.

The outcomes we find under Pure Flex are exemplified by Figure 10.1 and Figure 10.2, which are for two different days of the year. All changes in demand are described relative to the original demand profile (red line) for the relevant customer archetype.

In Figure 10.1, there is a small morning peak in prices (blue line) and a much larger peak in prices the evening. The first 6 hours of the day offer some of the cheapest power, hence the flexible consumer increases load by 10% from the original demand profile, our assumption of the maximum amount of nighttime shifting. At 6:00 the load reduces in response to increasing prices, now by 20%, reflecting the daytime flexibility assumption (+/-20%). When the morning price peak passes, consumption ramps up, by c. 20%, between 13:00 and 15:00. These is a step change down in demand when the price spikes at 15:30 and as a result, consumption falls by 20% compared to the original demand profile. The period following the evening peak provides the cheapest prices of this particular day, and demand is flexed upwards by 20% (until 23:00) to benefit from the low price period and to compensate for the net reduction in demand earlier in the day.

Figure 10.1: Pure Flex – Example 1 (Scenario 1, Baseline consumer archetype)

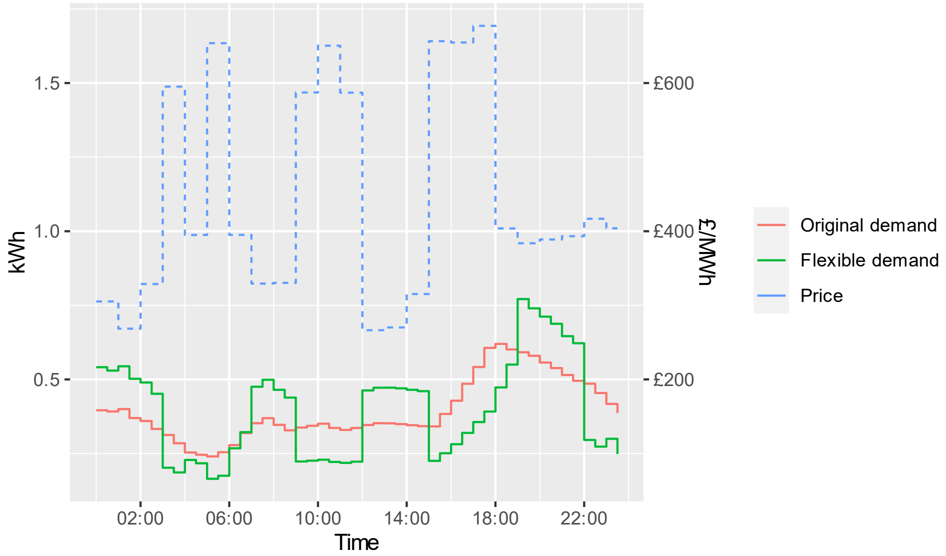


Source: CEPA analysis

Figure 10.2 shows a situation in which prices are much more volatile and there is more flexibility in the demand profile because it is for an EV customer archetype. The EV battery charges during the low-price periods (0:00-3:00, 7:00-9:00, 12:00-15:00) as well as 19:00 to 22:00 which is a local minimum. It charges less than in the original demand profile during the high price periods (03:00-04:00, 05:00-06:00, 09:00-12:00, 15:00-18:00), reducing the consumer's consumption from the grid. During 04:00-05:00 and 06:00-07:00 prices are close to the average price of the day and minimal deviation from the original demand profile is observed.[47] The result for this day also demonstrates the potential for flexibility actions to increase daily peak demand – on this day the consumer's peak demand is shifted to one hour later, however, the new peak is materially higher than the original.

[47] The description is drafted in terms of a single consumers, but since our modelling relies on averaged demand profiles it would be better understood as reflecting the population of consumers that fall into the baseline + EV archetype. The potential to offer flexibility 24/7 is because some percentage of vehicles from the population of this archetype is expected to be available in every hour of the day. References to charging / discharging do not reflect an assumption that such consumers would have vehicle-to-grid capability, although it is possible that this would be common by 2030.

Figure 10.2: Pure Flex – Example 2 (Scenario 5, Baseline + EV profile)



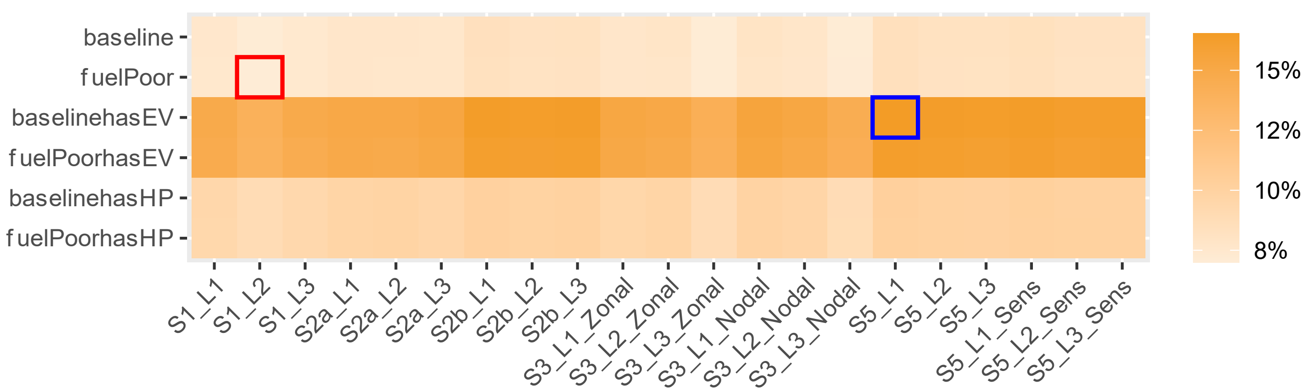
Source: CEPA analysis

10.1.1 System impacts

The impact of this proposition on the total volume of consumption which is shifted is shown in Figure 10.3. The values are rounded to the nearest integer and so do not show subtle differences between the scenarios. The largest amount of shifting is observed for the demand archetypes which have Evs (14%-17%), followed by those with heat pumps (9%-10%) and those without flexible technologies, baseline and fuel poor (7%-8%).

- The top combinations of scenario and location for shifting are Scenario 5, the Scenario 5 price sensitivity, and Scenario 2b for Location 1. This result is consistent across the demand archetypes.
- The bottom combinations of scenario and location for shifting are Scenario 3, Location 3 (Zonal and Nodal), and Scenario 1, Location 2. Again, these results are consistent across the demand archetypes, but there are subtle differences in the order.

Figure 10.3: Pure Flex – load shifted (as % of annual consumption)

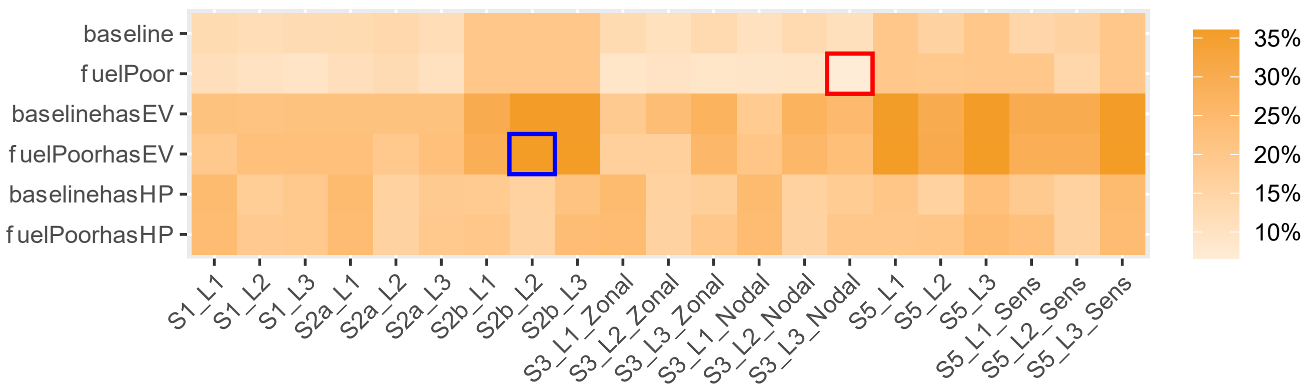


Source: CEPA analysis

Figure 10.4 compares the changes in consumer annual peak demand across the scenarios and locations. Here, we find greater diversity across the demand archetypes. As this metric reflects the difference between a single half hour demand before the proposition is applied (the highest demand for the year) and single hour demand of the proposition (also the highest one) and so it more sensitive to the idiosyncrasies of the demand profiles. Consistent with the annual shifting results, we see the largest impacts for EV consumers (36%-25%), followed by heat pump consumers (24%-16%), and those without flexible technologies (20%-7%).

- The top locations for peak demand reduction are Location 3, where the largest reductions are observed in the Scenario 5 price sensitivity, Scenario 5, and Scenario 2b. This is a macro result capturing all demand archetypes.
- The bottom combinations of scenario and location for shifting are Scenario 3, Location 2 Zonal and Location 1 Nodal, and Scenario 1, Location 2. Again, these results are a macro result based on all demand archetypes. It is notable that Scenario 1, Location 2 ranks poorly for both total annual shifting and peak demand reduction.

Figure 10.4: Pure Flex – change in consumer's annual peak demand (+ve = increase)



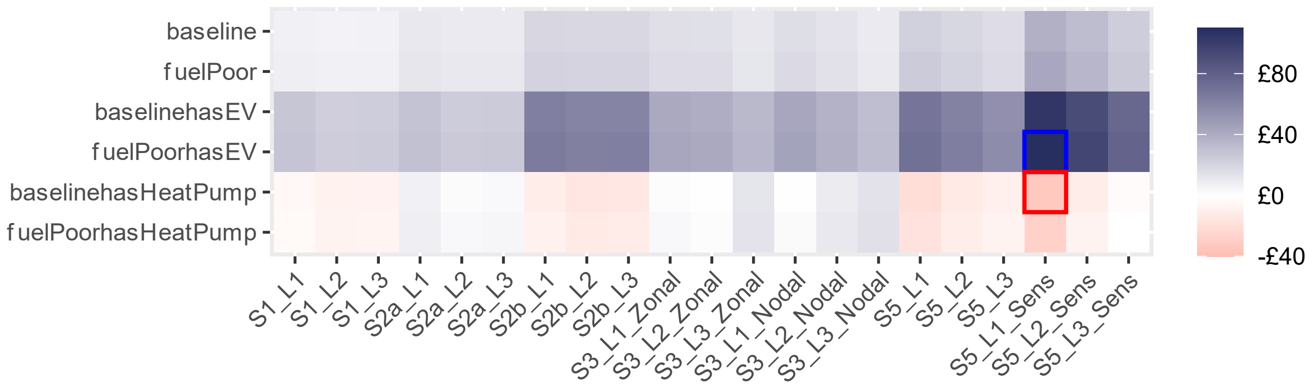
Source: CEPA analysis

10.1.2 Consumer impacts

The first consumer impact we show, in Figure 10.5, is the absolute change in consumer bills for adopting the proposition and acting flexibility in response to dynamic prices. This figure shows that the largest bill reductions are achieved by the consumers with EVs, which is consistent with these demand archetypes providing the largest system impacts. The baseline and fuel poor archetypes show smaller bill reductions.

There is an initially surprising result for the heat pump archetypes where the bill reduction is negative (i.e., an increase due to adopting the proposition). This happens because the bill impact is expressed relative to a counterfactual where the consumer is on a static tariff. In the overall modelling strategy, we explained that the static tariffs are calculated based on the demand of the baseline consumer archetype, reflecting the load shape of this type of consumer. The heat pump archetypes use more electricity in the winter months when wholesale electricity prices are generally higher. Hence, in £/MWh terms, a heat pump household will be more expensive for a supplier to serve than an average household without flexible technologies. Under static pricing with a single tariff for all customers, the supplier bears this risk, that a consumer (of any variety) could be more costly to serve than the average demand profile assumed during the tariff-setting process. In contrast, under Pure Flex the costs faced by the supplier are passed directly to the consumer. The result for heat pump consumers in Figure 10.5 reflects that even if they act flexibly, they will be worse off than had they remained on the static tariff. This observation reflects our assumption that the supplier sets a single static tariff for all customers that is calibrated according to the demand profile of the baseline customer. This is a simplifying assumption and does not affect the level of demand response induced by each proposition.

Figure 10.5: Pure Flex – consumer impact (absolute bill reduction relative to static tariff)

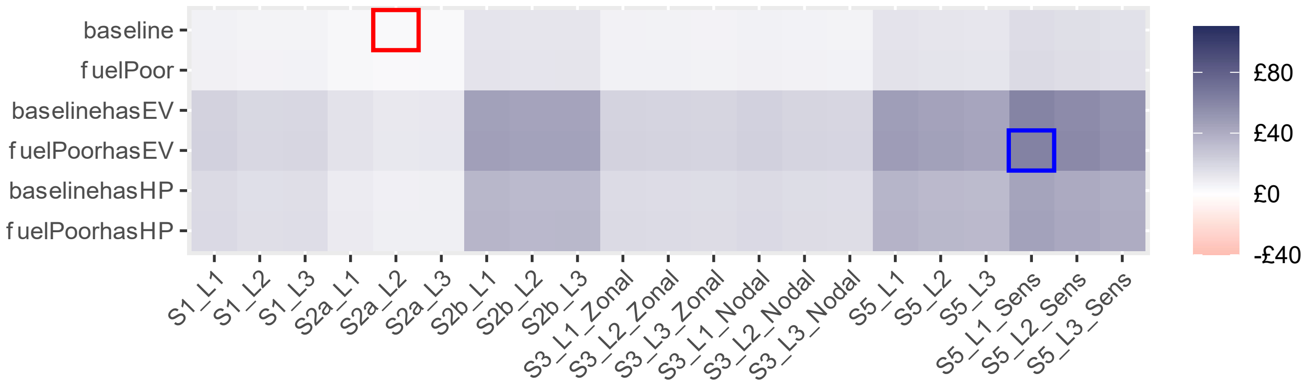


Source: CEPA analysis

An alternative way of looking at the bill reduction achieved through Pure Flex is to set the counterfactual as adopting the Pure Flex proposition but not providing any flexibility. This metric more explicitly shows the potential benefits to consumers from providing flexibly, as distinct from the impact of shifting from our static tariff to Pure Flex. This analysis shows the largest potential bill reduction for the EV archetypes (£11-£62), following by heat pump households (£7-£45) and those without flexible technologies (£3-17), consistent with the system impacts. Looking across the scenarios:

- The most favourable scenarios are the Scenario 5 price sensitivity, the original Scenario 5, and Scenario 2b. This is because these scenarios have the most variability in prices.
- The least favourable scenario is Scenario 2a. For every demand archetype, the bottom three combinations as Location 2, Location 3 and Location 1 for Scenario 2a. This is because Scenario 2a involves the removal certain policy costs from electricity bills, which causes a) lower bill (affecting the potential for absolute bill reduction), and b) the standing charge to be a larger percentage of the annual bill (reducing the scope for % bill reduction through flexibility).

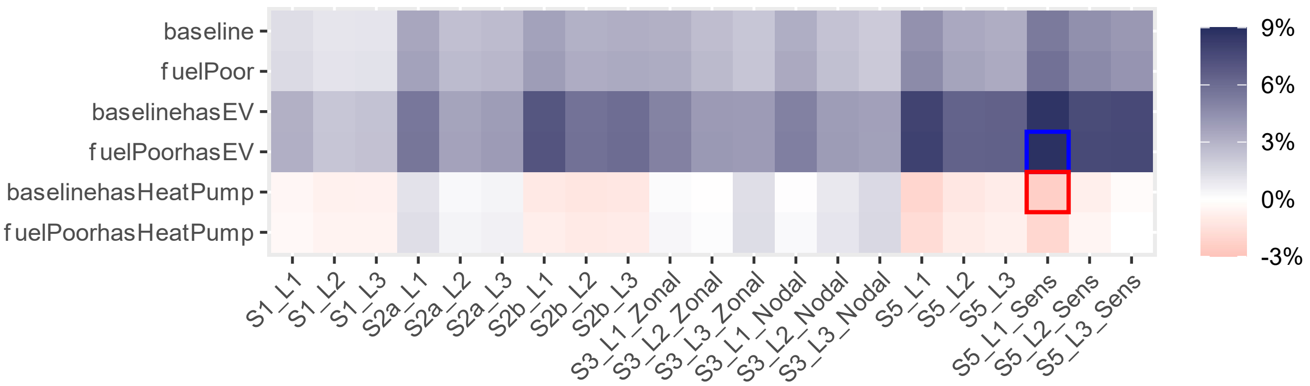
Figure 10.6: Pure Flex – consumer impact (absolute bill reduction relative to providing no flexibility)



Source: CEPA analysis

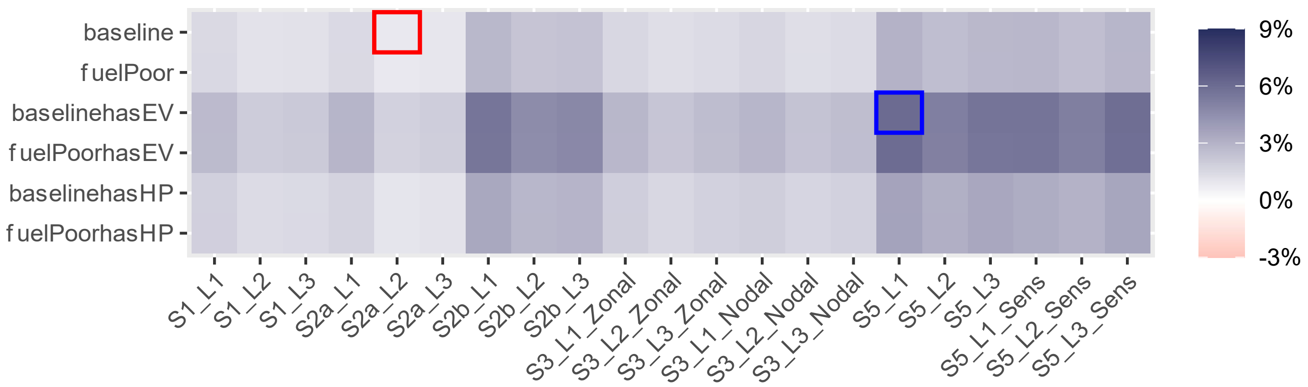
Below, we show the same results but with the bill reduction expressed in percentage terms. The interpretation in terms of the top and bottom scenarios and locations is the same as for Figures 10.5 and 10.6. Focusing on the comparison between acting flexibly and adopting Pure Flex but not providing any flexibility (Figure 10.8), the absolute bill impacts identified above correspond with reductions of 2% and 6% for EV consumers, 1% and 4% for heat pump consumers, and 1% and 3% for households without these technologies.

Figure 10.7: Pure Flex – consumer impact (% bill reduction relative to static tariff)



Source: CEPA analysis

Figure 10.8: Pure Flex – consumer impact (% bill reduction relative to providing no flexibility)



Source: CEPA analysis

10.1.3 Supplier impacts

In theory, there should be no impact to a supplier of a customer being on the Pure Flex tariff. This is because any savings which are achieved though the consumer's flexible actions to consume less during expensive periods and more when power is cheaper are passed directly through to the consumer. However, as shown above, there is a supplier impact from a consumer switching from a static tariff to Pure Flex (or any tariff with time-varying prices).

When consumers pay the underlying price profiles, their bills will reflect their own consumption profile and the scope for cross-subsidies between different types of consumers is reduced.[48] In practice, this impact to the supplier of a consumer moving from a static tariff to Pure Flex could be positive or negative. It would depend on the assumptions made in developing static tariffs, the consumer's demand profile (before flexibility), and the amount of flexibility they are able to provide.

10.1.4 Wholesale price sensitivity

The figures above indicate that the wholesale price sensitivity is generally favourable in terms of system impacts and consumer impacts. For system impacts, the Scenario 5 sensitivity locations are 'on par' with the original Scenario 5 and Scenario 2a (which share the same assumptions for the treatment of DuoS forward-looking charges and policy costs). In terms of consumer impacts, the results of the wholesale price sensitivity are again very similar to Scenarios 5 and 2b. Looking across locations under the price sensitivity, Location 3 demonstrates the largest consumer benefit of all scenarios and locations, exceeding the original Scenario 5, Location 3 by up to 0.3% of the consumer's annual bill. The consumer impacts in Locations 1 and 2 under the sensitivity are more similar to the original Scenario 5.

10.2 Flex Bat

Flex Bat involves a consumer receiving a battery which can be charged and discharged each day, based on price signals from the underlying price profiles (i.e. those used in Pure Flex).

Our modelling of the Flex Bat proposition provides the following key insights:

- We see significant shifting in the proposition relative to the other propositions. The average amount of shifting is in the range of 19-21% of total annual load, compared to 8-16% for Pure Flex and smaller volumes for the other propositions.[49] This is unsurprising as the proposition has the joint most periods in which shifting is incentivised (the battery is incentivised to charge every day) and there are no

[48] Note that cross-subsidy here refers to consumers on static tariffs not facing time-varying charges. Market-wide half hourly settlement would affect suppliers' exposure to demand at different times of the day, but would not change the cross-subsidy inherent in static pricing.
[49] These ranges cover the average of all scenarios and location for each consumer archetype.

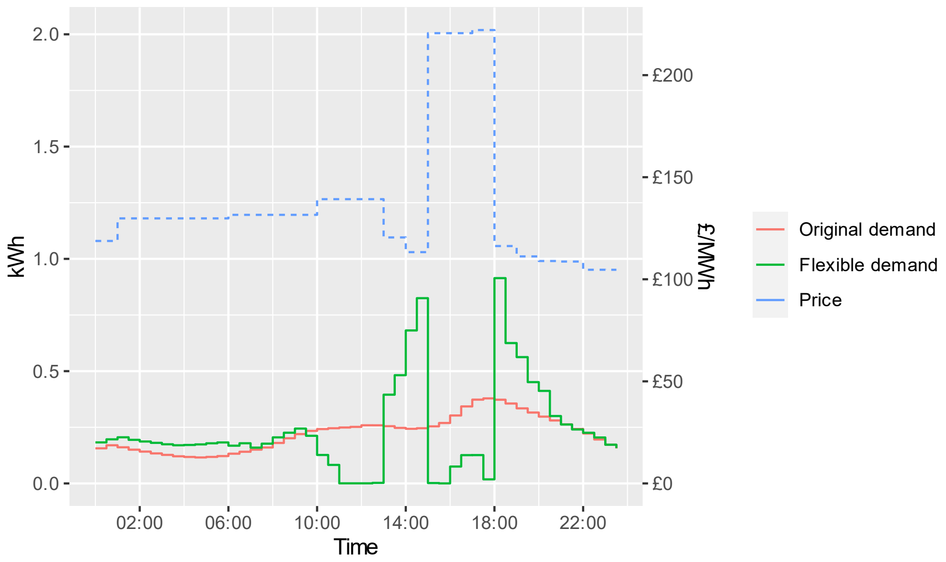
behavioural restrictions on shifting. Scenarios with more dynamic pricing (2b and 5) see the most shifting as it is optimal to use the battery over more days in the year.
- Perversely, greater shifting leads to increases in the peak demand on the system. This occurs when there is a lack of alignment between day ahead prices and consumer demand.[50] The size of the battery is large, sufficient to cover the peak demand period, meaning that price signals can lead to large swings in demand for the archetype consumer.
- In practice, the impact on shifting and peak demand are likely to be smaller in the real-world. There is likely to be a degree of forecast error for real consumers and if the supplier provides 'micro-batteries' then the opportunity for shifting will be lower because of lower flexibility potential.
- Consumer benefits in terms of bill savings are smaller in percentage terms than the amount of demand that is shifted. For example, the average amount of load shifted by the baseline consumer archetype is 18.5%, whereas the average change in annual bill is only 2.2%. This is because the battery responds to any arbitrage opportunity, even if the price reduction is small.
- Overall, the results from our modelling suggest that the time horizon for cost recovery of a battery, unless battery costs reduce significantly, is too long to make the proposition profitable.
- Similarly, the impact for the supplier is low, suggesting that revenue from the wholesale market would not be enough to subsidise installation costs. Although, income from other revenue streams (for example DFS) will increase the value to the supplier.

We expand on each of these points below.

To demonstrate this proposition, in Figure 10.9 we present an example of response by the baseline demand archetype to price signals on 3 January. The figure shows demand responding sharply to the afternoon price spike (occurring between 15:00 and 18:00 – driven by TNUoS forward looking charges and Capacity Market Support), shifting to either side of the period and making the overall demand profile much more volatile. Although this has a negative impact on the system (as the overall peak is higher), it represents rational behaviour for the battery, as there is no cost to shifting and the battery is arbitraging effectively. On this day, the largely flat price profile outside of 1500-1800 means that there is a minimal incentive to shift between periods outside 1500-1800, or to smooth the charging across those non-peak price periods.

[50] To some extent this could be due to the price profiles and consumer demand profiles being from different sources. However, it is entirely possible that the timing of peak demand for specific groups of consumers can differ from the system price peak – e.g. because the system price peaks will be influenced by the renewable generation profile.

Figure 10.9: Flex Bat – demand response to price signal (Baseline, Scenario 1 Location 1, 3 January)



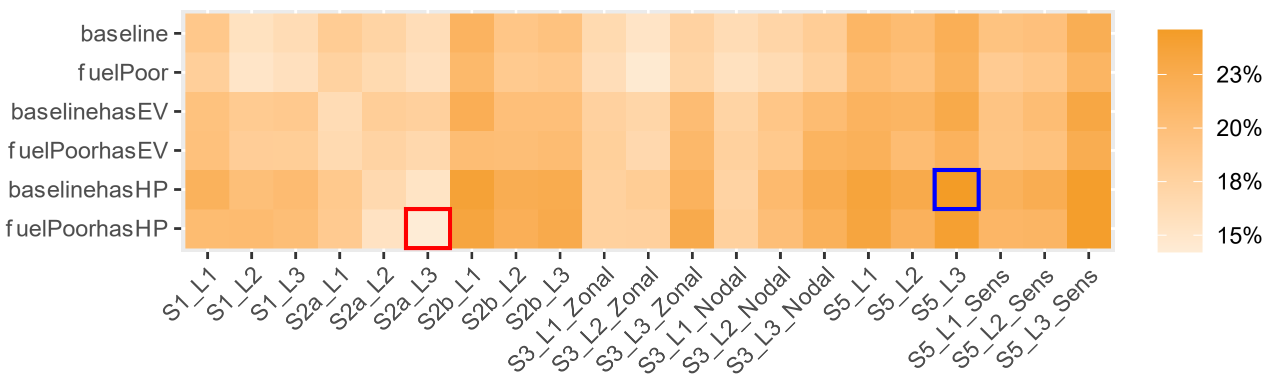
Source: CEPA analysis

Although the results from the model are very volatile, in practice a smoother demand profile would be expected. The battery size has been modelled to cover the max peak period for the year, providing a significant capacity which can be shifted. A smaller battery would lead to less shifting. The model also assumes perfect foresight, allowing consumers to perfectly arbitrage. In reality, there would be some level of forecast error which would smooth consumption. We could also expect some 'cannibalisation' of the high-low arbitrage value to apply as more flexible technologies are deployed.[51]

10.2.1 System Impacts

We report the amount of load shifted on the system in Figure 10.10 below. Values are presented across scenarios, location, and demand archetypes.

Figure 10.10: Flex Bat – load shifted on the system (%)



Source: CEPA analysis. Highest observation indicated by blue, lowest by red.

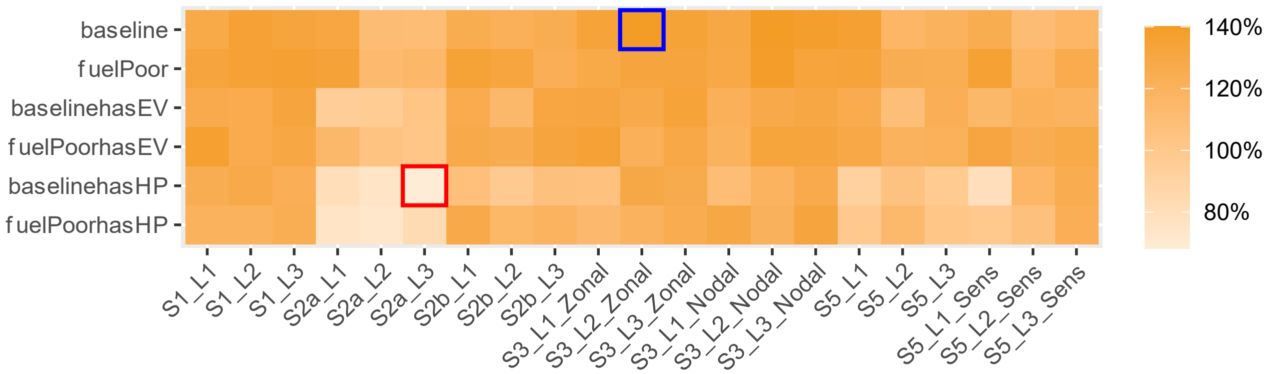
[51] However, as the FES Leading the Way scenario already features large volumes of flexibility, it is possible that much of the potential 'cannibalisation' may already be represented in the price profiles.

In Flex Bat, we see the most demand shifted of any proposition. This reflects that the battery boosts the flexibility potential compared to other propositions. The percentage of shifting ranges from 28% for the baseline with EV demand archetype in Scenario 2b location 3, to 7% for the fuel poor household with a heat pump in Scenario 2a location 1.

There is significant variance in the amount of load shifted across scenarios and locations within the same demand archetype. The level of variance is not seen in other propositions, with the exception of Pure Flex which is used as a benchmark. This is attributable to the direct exposure to the underlying price signals, as opposed to a flat unit price for each half-hour. This not only changes the time in which it is optimal to charge and discharge the battery, it also changes the number of days in which the battery is idle. The latter effect leads to the differences in load shifted that we see between the scenarios, with scenarios in which there is a lower level of overall shifting having an idle battery for a greater proportion of the year. For this reason, we see more shifting in scenarios in which pricing is more dynamic (i.e., 2b and 5), as the volatility of the price profiles provides more days in which it is optimal to use the battery.

Figure 10.11 reports the change in peak demand on the system for each demand archetype, scenario and location. In each of the demand profiles we see large increases in the peak demand on the system, increasing by over 100% for four of the six demand archetypes. This is reflective of sharp responses to price signals, which are facilitated by the battery. The impacts are mixed across scenarios and locations, but generally largest in Scenarios 5 and 2b, and lowest in 2a and some Scenario 3 locations. This is similar to Pure Flex.

Figure 10.11: Flex Bat – change in max demand on the system (%)



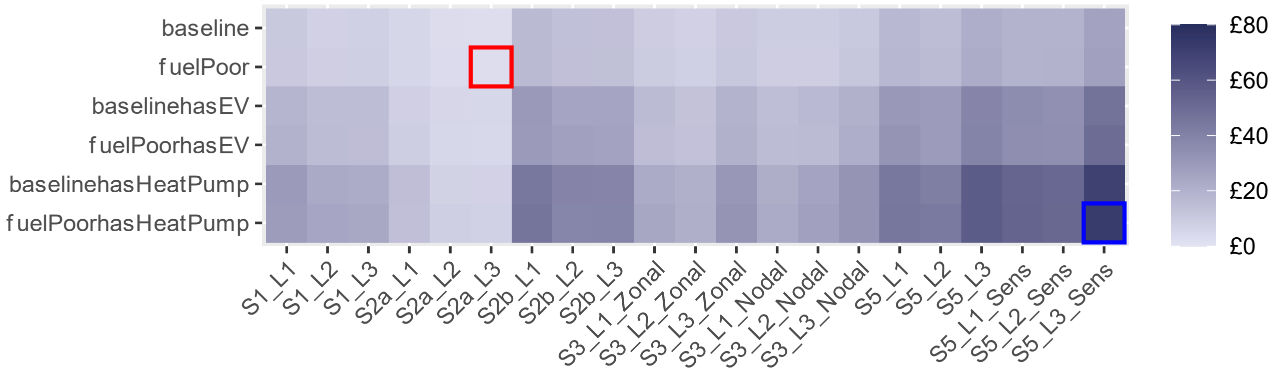
Source: CEPA analysis. Highest observation indicated by blue, lowest by red.

10.2.2 Consumer Impacts

We present the consumer impacts in Figure 10.12 (absolute £ reductions in bills) and Figure 10 (% reduction in bills). For all of the model runs, the impact to the consumer is modest relative to the system impacts, as well as being lower than for Pure Flex. Across scenarios and demand profiles consumers can save between 0.5% (£2.50) and 6.0% (£60) of their annual consumer bill. Savings are highest for consumers with heat pumps, who have the largest amount of demand which can leverage to capitalise on arbitrage opportunities. Savings are also highest for scenarios and locations with the most dynamic pricing, i.e., Scenario 5 and Scenario 2b.

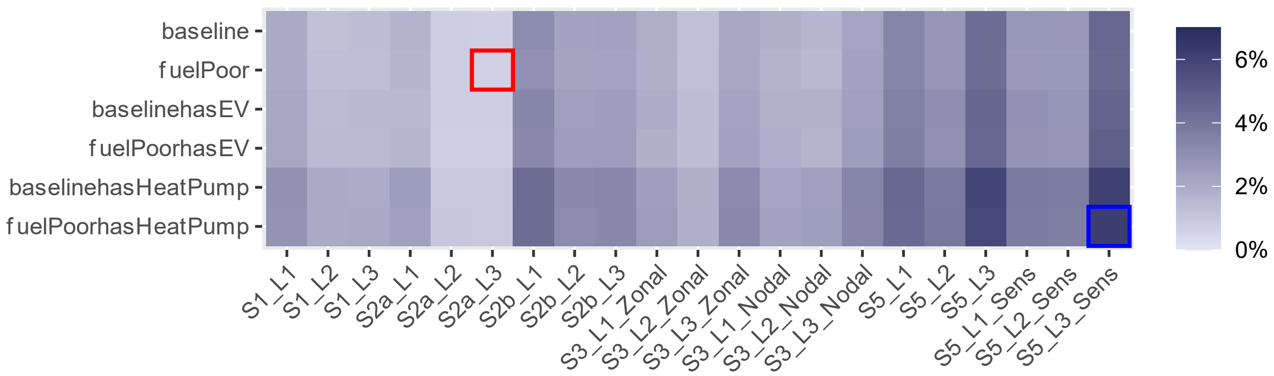
The results reported in Figure 10.13 only present the net consumer bill taking into account savings from shifted consumption. They do not include the cost of paying for a battery. The current cost of a 4 kWh battery can exceed £4,500[52]. Even when taking the highest savings from our modelling and the fact that the consumer would only need to fund 80% of the battery, the energy price savings from battery usage (i.e., excluding balancing and other flexibility services) would not pay for itself over its usable lifetime, unless battery costs reduce significantly, it is operated in conjunction with solar PV, or other revenue streams are found.

Figure 10.12: Flex Bat – consumer impact (absolute bill reduction)



Source: CEPA analysis. Highest observation indicated by blue, lowest by red.

Figure 10.13: Flex Bat – consumer impact (% bill reduction)



Source: CEPA analysis. Highest observation indicated by blue, lowest by red.

10.2.3 Supplier Impacts

[52] Based on the 4 kWh Powervault 3.

Through this proposition, the consumer can shift their electricity consumption by charging / discharging their battery. This has the effect of shifting the share of their demand that's charged at the static tariff and the share charged at the pass-through (Pure Flex) dynamic tariff. In the way we have modelled this, the supplier could be out-of-pocket for their hedging costs to the extent that they have hedged the consumer's full load. However, the underlying costs to the supplier will also change on account of the consumer shifting load away from the more expensive periods. As such, the impact on supplier revenue will depend on the relative magnitude of the difference between low price periods (in which the battery charges) and the static unit rate, and the high price periods (in which the battery discharge displaces imports from the grid) and the static unit rate. The direction of the net impact is uncertain as it depends on the price profile and shape of change in the demand profile.

The Flex Bat proposition specifies that 20% of the battery capacity is reserved for the supplier to use for arbitrage opportunities, similar to those available to the consumer. However, the net revenue figure for the supplier will be reduced by the fact that the supplier will pay network and policy costs for charging electricity that it does not recover when exporting electricity back onto the grid. If the supplier can capitalise on other revenue streams not included in our modelling (e.g., for demand flexibility services) then the revenue figure could be higher.

10.2.4 Wholesale price sensitivity

The wholesale price sensitivity shows advantageous impacts for Flex Bat, but the outcomes are very similar to the original Scenario 5 and Scenario 2b. On aggregate across the consumer archetypes, Location 3 shows the largest amount of load shifted.

The Scenario 5 sensitivity generally underperforms in terms of impact on maximum demand. The more volatile prices in the wholesale price sensitivity change the optimised dispatch of the battery, but because prices and demand are from different sources it does not necessarily follow that greater demand reductions (relative to the original scenario) in the high price periods correspond with lower annual maximum demand for a particular consumer group.[53]

Corresponding to the system impact results, Location 3 of the sensitivity shows the largest bill impacts of all scenarios and locations. The impacts at between 0.2 and 0.4% higher than Location 3 under the original Scenario 5. Bill savings are smaller at Locations 1 and 2.

10.3 Pay as You Green

PAYG is a time-of-use tariff with two unit rates: a cheaper off-peak price for 'green times' and a more expensive peak price intended to cover period in which there is more demand

[53] The price profiles were provided by DESNZ and reflect modelling for 2030; whereas the consumer profiles are historical averages, based on a subset of OVO's customers for the period 1 June 2022 until 31 May 2023.

on the system. In line with Economy 7, we assume that the green tariff is available between midnight and 7am every day.

Our modelling of the Pay as You Green proposition provides the following key insights:

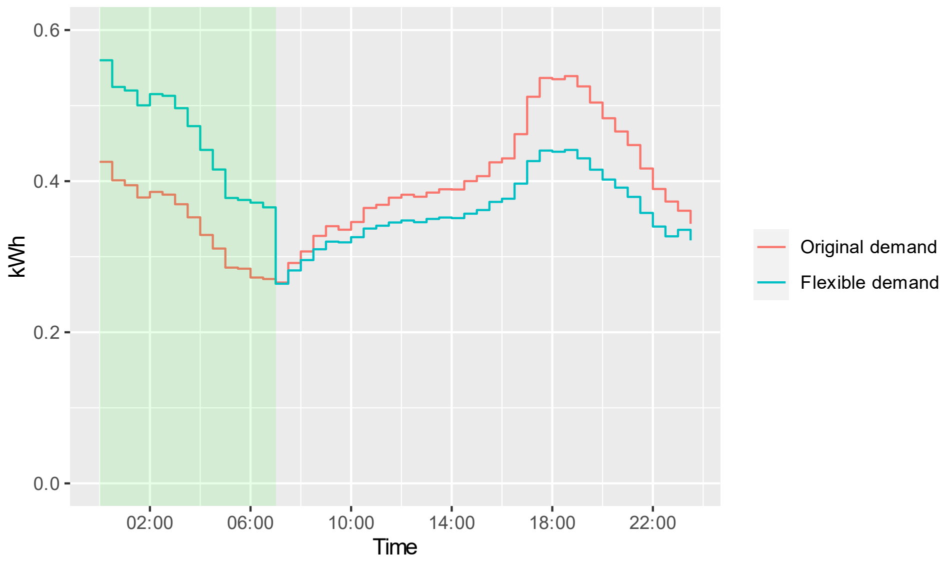
- There is no difference[54] in system impacts between scenarios because the same incentive to shift (with the response being bounded by our flexibility assumptions) exists in every scenario.
- The volume of load shifted is larger than in some other propositions (i.e., Let's Get Moving, and Smart Switch and Save) owing to the larger window of time, relative to those propositions, in which consumers can gain financial benefit from switching. financial benefit from switching.
- The proposition has the potential to increase a customer's peak demand because there is no incentive to limit demand increases during the green tariff period. In situations in which the green tariff period overlaps with the morning peak, the upwards flexibility can be large enough to increase the consumer's peak demand for the day (albeit, it may have shifted it from another time, which may be beneficial for power system operations).
- The percentage change in consumer bills is the same across the scenarios because the percentage price difference between the green tariff period and the rest of the day is the same. The variations between the consumer archetypes directly reflects the volume of shifting that each consumer can undertake within our flexibility assumptions.

We expand on each of these points below.

An example of the demand shifting which can occur under this proposition is shown in Figure 10.14. The figure depicts the demand profile of a fuel poor household which has an EV. The flexibility potential of the EV means that considerable load can be shifted to the 'green' tariff period, reflected in the upwards step-change in early morning demand. This leads to a lower evening peak but a (slightly) higher daily peak demand due to the increase in overnight EV charging. A similar situation is observed for heat pump consumers, where the cost saving from pre-heating the home before sunrise can lead to the morning peak being higher than the previous, evening peak.

[54] In practice, we find minor variation across scenarios, however we attribute this to 'noise' in the optimised results rather than structural differences due to scenario assumptions.

Figure 10.14: Example of the Pay as You Green proposition (Fuel Poor + EV, Scenario 5 Location 1, 11 March)



Source: CEPA analysis

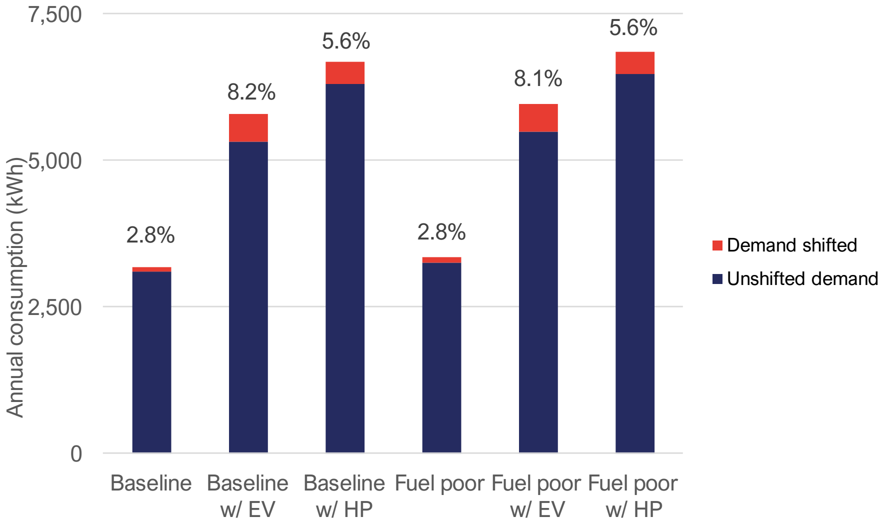
10.3.1 System Impacts

Figure 10.15 shows the total volume of energy shifted for each consumer archetype under this proposition. The volume shifted differs by consumer archetype but, in percentage terms, is the same across all scenarios because the shifting is constrained by our flexibility assumptions and these are consistent across scenarios.[55] The largest total shifting is observed for EV households, reflecting the generally greater ability to shift EV load across both night and day. Similarly, greater shifting is also observed for the households with heat pumps than for the baseline and fuel poor households. Some of the difference in the amount of shifting between EV and heat pump households is due to the additional constraint on heating load which means that this load can only be brought forward in time.

This volume of shifting is higher than under Let's Get Moving and Smart Switch and Save but lower than for Pure Flex. Broadly, this is a function of the length of time for which the proposition encourages shifting. By offering a lower tariff for the first seven hours of the day, Pay as You Green incentives increased load for seven hours of each day. This is greater than for all other propositions except for Pure Flex, and Flex Bat.

[55] The incentive which consumers respond to under this proposition is a binary decision to move consumption from a relative more expensive period (the daytime) to a cheaper period (the night). This incentive does not vary across scenarios.

Figure 10.15: Pay as You Green – load shifted (for all scenarios and locations)



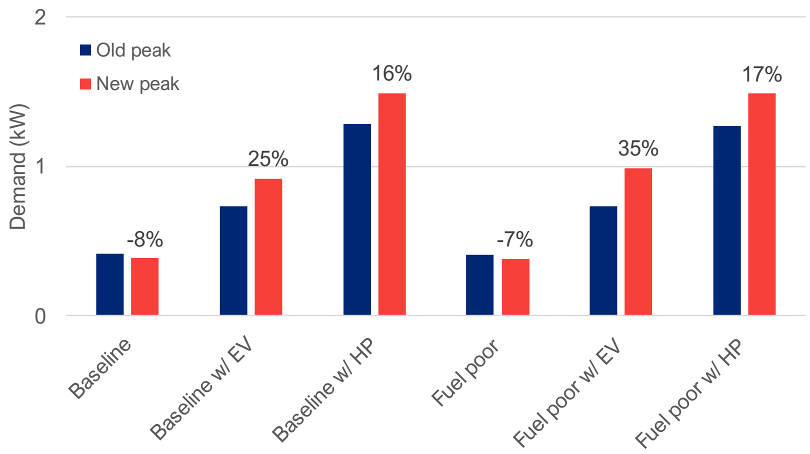
Source: CEPA analysis

Figure 10.16 shows the change in annual peak demand from the application of the proposition. Again, these are the same across all scenarios as they are bounded by our flexibility assumptions. There are increases are for EV (+25-35%) and heat pump households (+16-17%), but reductions in the annual peak demand of the baseline and fuel poor households (7-8% lower). These results reflect individual half hours which may not necessarily represent the general consumer behaviour seen under the proposition. Nonetheless, they highlight the risk of propositions which are not dynamically connected to the peak demand of the system or individual consumers.[56]

In the case of our heat pump households, the increase in annual peak demand occurs when the window of the proposition (midnight to 7am) overlaps with the morning peak, which, in the winter, is much more pronounced than for the other load profiles. Similarly, the increase in annual peak demand for the EV households is associated with a day on which demand was already relatively high around 02:00 (e.g. due to EV charging overnight). Applying the proposition leads to a step-change increase in demand to capture the lower overnight price, leading to higher annual peak demand. The impacts are larger for EV households than heat pump households owing to the greater freedom which we allow for shifting EV load relative to heat pump load (as discussed in Section 10.3 above).

[56] In the future, the concept of 'peak demand net of renewables' will be increasingly interesting as this has implications for the firming requirements as well as the CO2 intensity of the system. In this modelling, the wholesale price is essentially a (rough) proxy for 'peak demand net of renewables' but the pricing of this proposition is not dynamically linked to it.

Figure 10.16: Pay as You Green – change in peak demand (for all scenarios and locations)



Source: CEPA analysis

10.3.2 Consumer Impacts

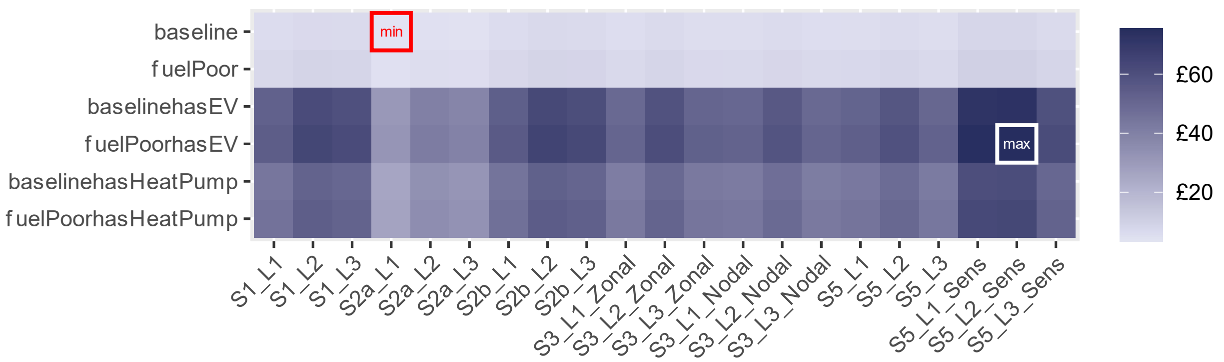
The consumer bill impacts are commensurate with the shifting behaviour observed above since the potential savings through this proposition are directly dependent on the volume of energy which can be moved. Hence, the bill reductions are largest for EV households, followed by heat pump households, then fuel poor and baseline. The bill changes vary in absolute terms depending on the scenario and location, as shown in Table 10.1.

Table 10.1: Pay as You Green – impact on consumer bills (+ve number indicates bill reduction)

Metric	Scenarios and locations	Baseline	Baseline EV	Baseline HP	Fuel poor	Fuel poor EV	Fuel poor HP
Bill change (%)	All	1.1%	6.0%	4.4%	1.4%	6.0%	4.4%

Source: CEPA analysis

Figure 10.17: Pay as You Green – consumer impact (absolute bill reduction)



Source: CEPA analysis

10.3.3 Supplier Impacts

The supplier receives less revenue from consumers shifting consumption to the cheaper period, corresponding with the changes in consumer bills set out above. To the extent that the peak and off-peak rates are cost-reflective, the supplier should be somewhat protected against this. However, they will be impacted by the change in the consumer's load shape and commensurate change in exposure to the underlying costs (i.e., wholesale, network, policy). The overall impact on supplier net revenue will ultimately depend on how customer demand is spread within green and red periods – which is uncertain even with rational customers as no signal to prioritise consumption within those periods.

10.3.4 Wholesale price sensitivity

As the system impacts are agnostic to the price level, the wholesale price sensitivity does not have an impact on system usage for the Pay as You Green proposition.

Similarly, there is no difference in the % of the consumer bill that is saved. However, as the higher wholesale price feeds into a higher unit cost faced by the consumer, the absolute savings increase, exceeding £75 per annum for fuel poor households with EVs. As there is, to some degree, an inverse relationship between consumer benefits and supplier benefits, the larger reduction in consumer bills can lead to less income for the supplier. However, as with other propositions, the supplier could benefit through changes in the underlying costs which it faces due the change in the consumer's demand profile. These benefits would be expected to be greater in the wholesale price sensitivity as the prices which could be avoided by shifting consumption to the night would be higher than in the original scenario.

10.4 Smart Switch and Save

Smart Switch and Save incentivises consumer to reduce demand during times when the power system is under pressure. It does this through a monetary reward any demand reduced below a baseline, based on historical consumption, during a high demand period. The opportunities to receive the reward are naturally ad hoc as they depend on power system conditions.

Key insights from the Smart Switch and Save proposition

- The volume and pattern of changes in demand varies between consumer archetypes but is the same across all scenarios and locations. This is because the changes in demand are bounded by our flexibility assumptions (and propositions assumptions), and independent of the underlying price profiles which differentiate the scenarios (and location) from one another.
- The proposition has a modest impact in terms of total demand shifted (1.7%-3.2%) relative to the other propositions. This is to be expected as only the highest 5% of demand periods are targeted for flexibility actions through this proposition (i.e., 438 hours in a year, or 8 hours per week, on average).
- The proposition has a materially larger, beneficial impact by reducing the consumer's peak demand on the system (between 5% and 12% lower). The size of the change

depends on the specific load profile of a consumer – the proposition will be more successful for consumers with 'peakier' demand profiles, and less successful when demand is flat.

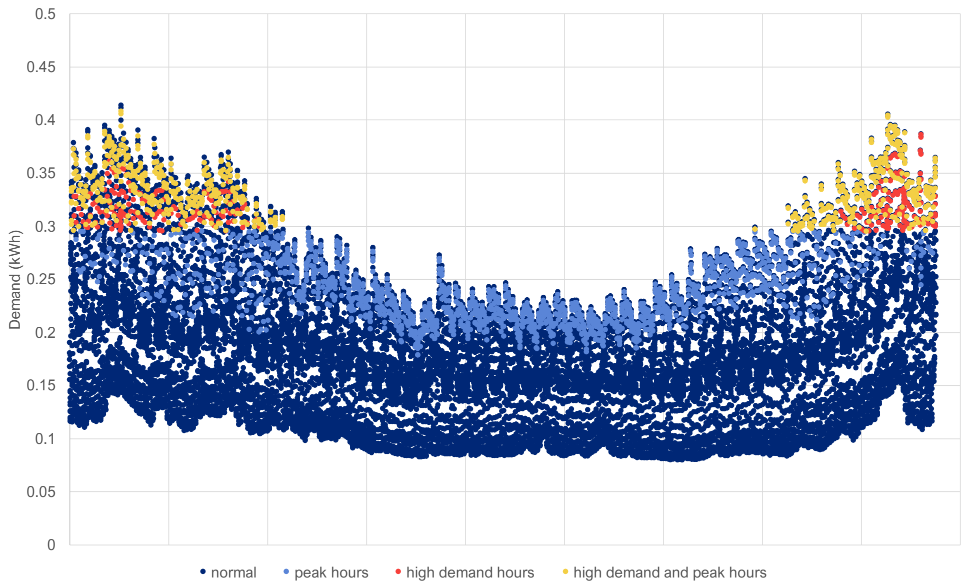
- The impact to the consumer's bill is very low. This results from the low level of shifting within the proposition, and the percentage.
- The overall impact to the supplier may be positive, if reduction in load during high demand times offsets the modest reward received by consumers.

We discuss these points in more detail below.

10.4.1 System Impacts

The nature of the system impacts under this proposition can be understood by way of reference to Figure 10.18. It shows the half-hourly demand for the baseline archetype (pre-modelling) for the whole of the modelled year. The hours in which shifting is incentivised are denoted in red and yellow (yellow denotes when they overlap with the peak 4pm to 7pm window). These hours are clustered around the start and the end of the year (i.e., winter in the Northern Hemisphere). The change in the peak is significant as the proposition targets demand in these hours, with the redistribution across the day leading to a net decrease in the peak load.

Figure 10.18: Classification of demand periods (baseline demand profile, annual profile)

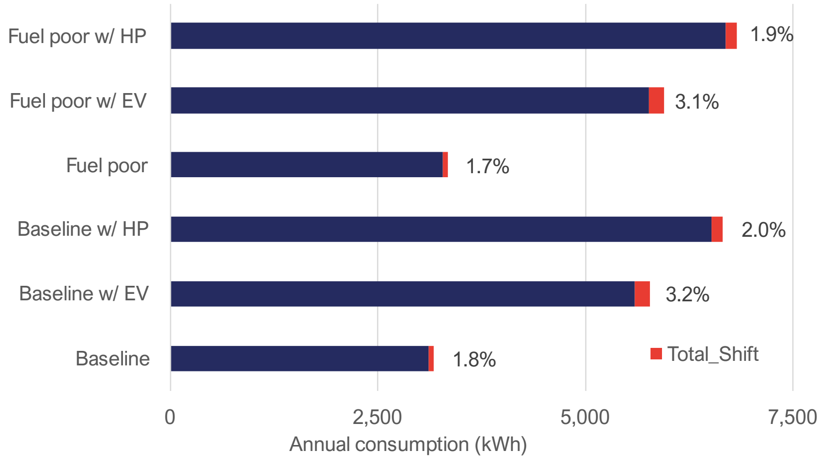


Source: CEPA analysis

Demand curves that have a larger difference between the maximum demand in an hour that is targeted and the maximum demand for non-targeted hour in the same day have the largest potential for reduction in the peak demand in the system. It is likely this is driving the larger reductions seen in the baseline and baseline with EV demand profiles. The heat pump profiles normally witness a peak in the morning and a larger peak in the afternoon (due to regular household heating patterns), meaning that if only the afternoon peak is targeted, the overall reduction in peak demand will not be as significant.

With this in mind, Figure 10.19 presents the amount of load shifted within a year, for the Smart Switch and Save proposition. We have reported one value for each demand archetype because, as consumers are not exposed to the underlying price profiles, the incentives to shift behaviour are constant across scenarios and locations. This leads to the same results across all scenarios and locations for demand shifting in terms of volume and peak demand.

Figure 10.19: Smart Switch and Save – load shifted (for all scenarios and locations)



Source: CEPA analysis

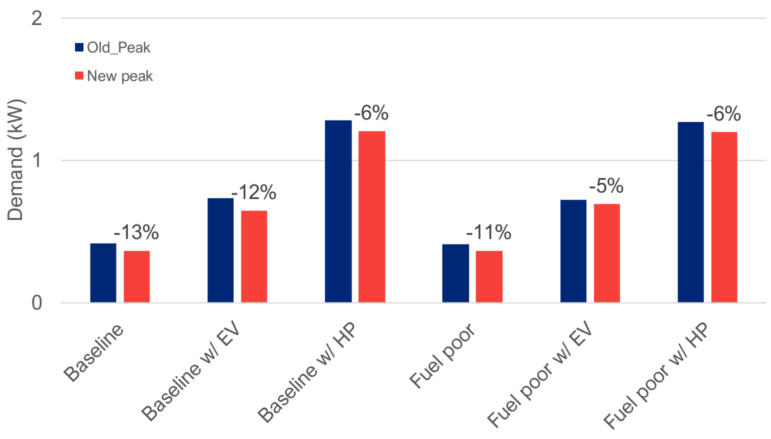
Across the demand archetypes we observe that the total volumes of load shifted is modest, never exceeding 3.2% of total demand. This is principally because the proposition only incentivises demand shifting in a small subset of hours: 5% of the total.

Consumers with EVs shift the most demand, in keeping with the behavioural constraints set out in Section 10.3 load is assumed to be the most elastic, as consumers can shift the time period in which they charge their car more easily than other electricity demand (for example cooking or heating their home).

Our modelling has assumed that consumers only shift their demand; however, empirical evidence from OVO suggests that they may also reduce the amount of demand they consumer overall, reducing the amount of shifting. Despite this, it is debateable whether sustained reductions would be seen if the consumer has to keep actively changing its demand pattern, as over time consumer's interests may wane.

Figure 10.20 presents the change in the half-hourly peak demand on the system for each of the six demand archetypes. It shows that the impact of the Smart Switch and Save proposition on the peak demand on the system is sensitive to the demand profile. The peak reduces for each of the demand archetypes, ranging from a -5% reduction for fuel poor households with EVs, and a 13% reduction for baseline consumers.

Figure 10.20: Smart Switch and Save – change in peak demand (for all scenarios and locations)



Source: CEPA analysis

The relatively large shifts in peak demand vs total demand shifted reflects the design of the proposition which directly targets peak demand. The peak demand results are also a function of the demand profiles and the extent to which high demand periods are clustered within the winter months (as explained above). When, for a given consumer archetype, the demand periods occur on the same day, the amount of peak reduction which can be provided may need to be curtailed so as not to exceed the flexibility constraints outside of the peak, which limit the demand increase which is possible.

10.4.2 Consumer Impacts

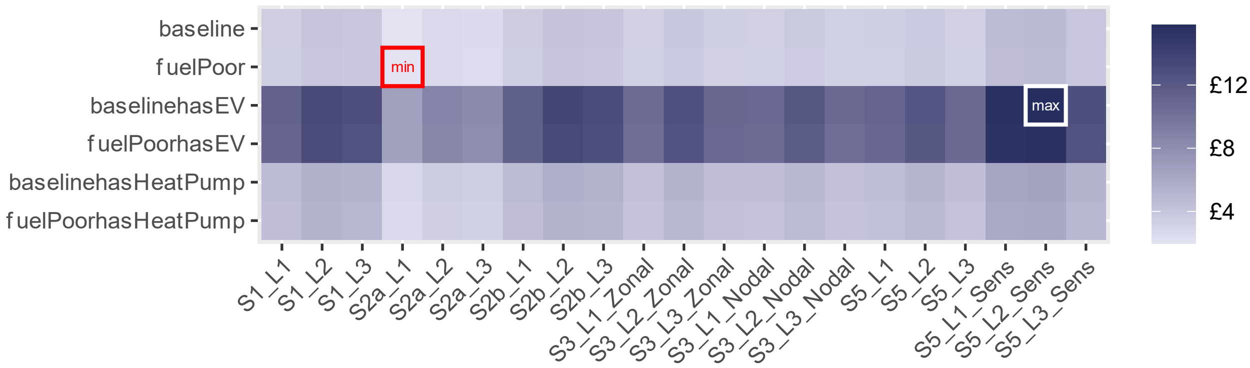
The Smart Switch and Save proposition has a small impact on consumer bills, as shown in Table 10.2 below. The magnitude of the impact on the absolute level of the bill is perfectly correlated with the size of the unit cost for scenario and location. The scenario with the highest unit cost (Scenario 5 Location 2, wholesale sensitivity) has the highest absolute reduction, and the scenario with the lowest cost (Scenario 2a Location 1) has the lowest. This is to be expected as the reward for shifting is a function of the unit cost (50% per unit below the baseline).

Table 10.2: Smart Switch and Save – impact on consumer bills (+ve number indicates bill reduction)

Metric	Scenarios and locations	Baseline	Baseline EV	Baseline HP	Fuel poor	Fuel poor EV	Fuel poor HP
Bill change (%)	All	0.7%	1.3%	0.5%	0.6%	1.2%	0.4%

Source: CEPA analysis

Figure 10.21: Smart Switch and Save – £ impact on consumer bills



Source: CEPA analysis

10.4.3 Supplier Impacts

The net impact of Smart Switch and Save could be positive for suppliers. This requires the reduction in cost to the supplier from consumers shifting to cheaper periods exceeding the cost of the reward provided to consumers for shifting their load. The impact on a supplier's net revenue will also depend on where the reduced customer demand in the stress periods is shifted to. This is uncertain as, even with rational customers, the proposition does not provide any signal on how to spread demand across the other periods.

10.4.4 Wholesale price sensitivity

As with Pay as You Green, Let's Get Moving and Have a Green Day, the wholesale price sensitivity does not affect the size of the system impact; as the shift in demand are independent of the size of the unit cost.

The percentage reduction in the consumer's bill is also the same across the scenarios. However, as the unit cost is higher under the wholesale price sensitivity, the absolute saving is greater, albeit still relatively modest for the year (under £16 in each case).

10.5 Let's Get Moving

Let's Get Moving provides consumers with an incentive to shift their demand outside of the peak 4pm to 7pm weekday window. If consumers reduce their total, monthly consumption during the peak period to less than 12.5% of their total, monthly consumption, then they will receive £20 per month. We apply the proposition on a daily basis, with a daily reward of 92p.

Key insights from the Let's Get Moving proposition -

- For both the level of shifting and impact on the peak, there is no difference across scenarios or locations.
- The proposition incentivises demand shifting in the range of 2.6% and 3.5%. This is more shifting than for Smart Switch and Save, but less than the other propositions.

This is expected as Let's Get Moving targets more half-hourly periods than Smart Switch and Save.
- Peak demand increases by 3-4% for the two demand archetypes with heat pumps, and is unchanged for the other four.
- The absolute impact on consumer bills is the same across scenarios and locations. The bill impacts are zero for baseline and fuel poor archetypes as the level of the threshold (12.5%) is too low for them to feasibly shift enough demand to receive a reward within the assumptions of our model. The impact is higher for EV (16%-40%) and heat pump households (5%-14%). This is realistic given the size of the reward and that the load of these households is more elastic, so consumers are better able to respond to price signals.
- Providing a flat reward (which is not linearly related to the amount of demand shifted) provides a greater risk to the supplier that the proposition will be unprofitable.

We discuss these points in more detail below.

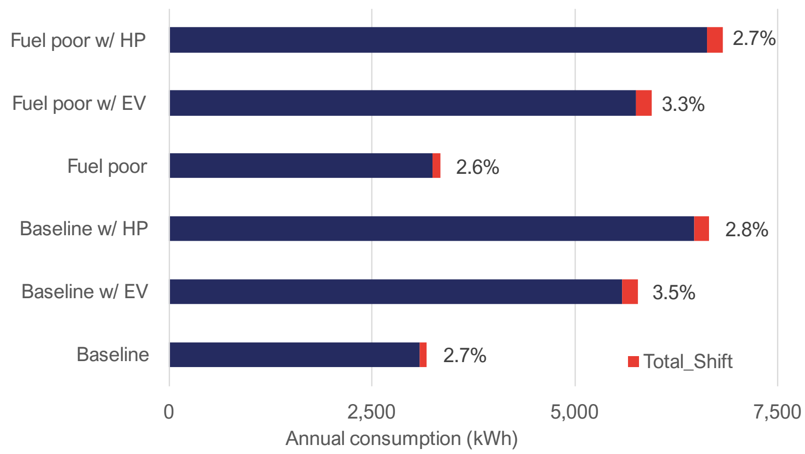
10.5.1 System impacts

Figure 10.22 presents the amount of load shifted within a year for the Let's Get Moving proposition. As with Smart Switch and Save, we report one figure for each demand archetype, given that results are the same across scenarios and locations.

For Let's Get Moving we see slightly more shifting than in Smart Switch and Save, although total load shifted does not exceed 3.5% for any of the six demand archetypes. The relative increase in shifting is caused by the number of time periods in which the proposition targets; Let's Get Moving targets the weekday 4pm to 7pm peak (c. 9% of total half-hourly periods), whereas smart switch can save targets only 5% of all time periods. The higher level of shifting observed for consumers with heat pumps and EVs is a result of our consumer behaviour assumptions.

Our model does not allow excessive shifting, whereby consumers reduce consumption during the peak beyond the threshold (i.e., below 12.5% of daily demand) – i.e. never overshoot in their demand reduction. This would increase the amount of shifting borne out in practice, and suggests our modelling provides a lower bound of the potential for load shifting incentivised by the proposition.

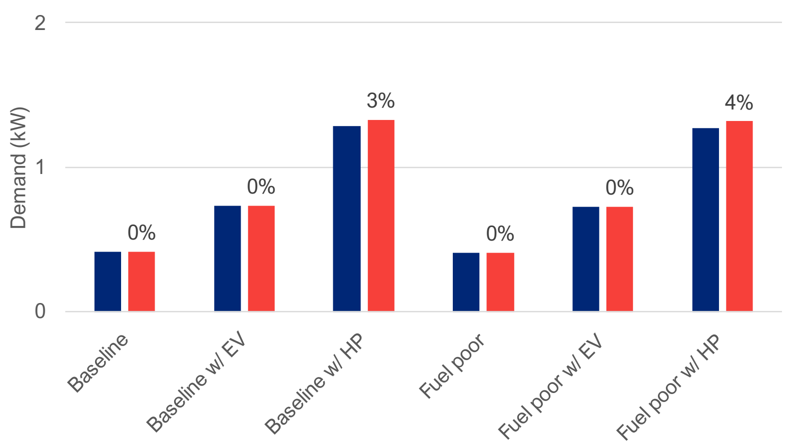
Figure 10.22: Let's Get Moving – load shifted (for all scenarios and locations)



Source: CEPA analysis

Figure 10.23 presents the change in the peak demand on the system under the proposition. The Let's Get Moving proposition does not result in reduction in peak demand for any demand archetypes. There is actually an increase of 3-4% in peak demand for the two archetypes with heat pumps. The increases in peak demand are a result of the targeting of the proposition. As some high demand periods during winter are not in the 4pm to 7pm window, there is actually an incentive to increase demand during these periods as opposed to reduce it. This effect is the most pronounced for profiles in which demand is spread more evenly across the day, or in which there is high demand outside the traditional peak period.

Figure 10.23: Let's Get Moving – change in peak demand (for all scenarios and locations)



Source: CEPA analysis

10.5.2 Consumer impacts

The consumer impacts are in proportion to the ability of the demand archetypes to achieve the reward. We have modelled the outcome for a successful consumer who achieves the reward whenever it is physically possible to do so, i.e., within the bounds of the flexibility constraints. In practice, not all consumers will be successful all the time, so, in a way, this result reflects an upper bound outcome for consumers on this proposition. However, through self-selection, we could expect that the proposition would generally retain consumers able to meet the reduction in most months, with those unable to meet the reduction potentially seeking a different offer.

Table 10.3 reports the change in consumer bills (absolute and percentage) for each of the six demand archetypes. The absolute change for each archetype is consistent across scenarios and locations. This is because the reduction in the bill is equal to the level of reward achieved. As, across scenarios, there is no difference in the ability of a consumer to achieve the reward, and we are modelling the successful consumer, the reward will be the same. Changes in the bill percentage reflect that a consistent reward will be a different proportion of bills which are different sizes.

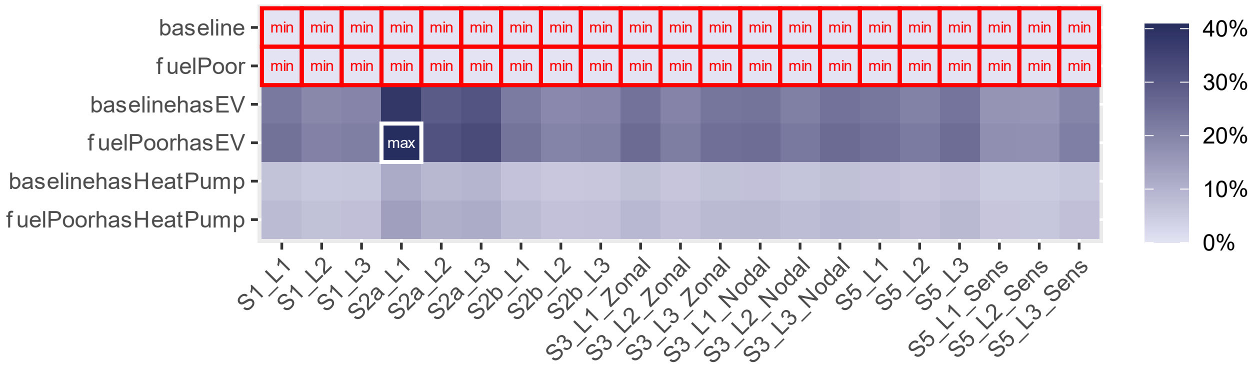
We can observe that, given the specified target level (12.5%), baseline and fuel poor consumers are never able to shift enough load to receive the reward. Consumers with EVs and heat pumps have a much better success rate, with baseline EV consumers receiving over £195 and fuel poor EV consumers receiving over £215 across the year (out of a possible £240[57]).

Table 10.3: Let's Get Moving – impact on consumer bills (+ve number indicates bill reduction)

Metric	Scenarios and locations	Baseline	Baseline EV	Baseline HP	Fuel poor	Fuel poor EV	Fuel poor HP
Bill change (£)	All	0.00	197.70	68.05	0.00	217.01	84.60

Source: CEPA analysis

Figure 10.24: Let's Get Moving – % impact on consumer bills (no bill impact for baseline & fuel poor customers)



Source: CEPA analysis

57 Note that similar products to the Let's Get Moving proposition in current market conditions are experimental and may be loss making or unsustainable I the long term. However, suppliers offer them since they provide some value in terms of carbon savings, customer engagement and brand advocacy. To support rewards of £20 or more per month, there would be a need to unlocking more value from a future market than is possible under current conditions.

10.5.3 Supplier impacts

The impact of Let's Get Moving is similar to that of Smart Switch and Save and could be positive for suppliers. This would require the reduction in cost to the supplier from consumers shifting to cheaper periods exceeding the cost of the reward provided to consumers for shifting their load. The impact on a supplier's net revenue will also depend on where the reduced customer demand in the peak period is shifted to. This is uncertain as, even with rational customers, the proposition does not provide any signal on how to spread demand across the other periods.

10.5.4 Wholesale price sensitivity

As with other propositions, the wholesale price sensitivity does not affect the propositions impact on the system.

As the proposition provides a binary reward, which is not proportional to the amount of consumption reduced, the absolute reduction for each demand archetype is not affected by a higher wholesale price. However, as the consumer's bill will be higher in this scenario, the percentage reduction is lower.

10.6 Have a Green Day

Have a Green Day seeks to encourage households to optimise their energy consumption around the greenest times of day. It does this via an app which would allow a consumer to receive notifications about when the grid is expected to be most green and schedule their energy-intensive activities accordingly. Due to there being uncertainty around the amount of flexibility which consumers might be able and willing to provide through this proposition, we modelled three level of 'smart' load (15%, 7.5%, and 3.75%).

Key insights from the Have a Green Day proposition:

- Consumers with more smart load shift demand more than consumers that do not.
- In general, there is a negative impact on the peak load on the grid.
- This shows that, even when targeting 'green' times, as opposed to 'red' times, propositions need to target time periods effectively to have a positive impact on the grid.

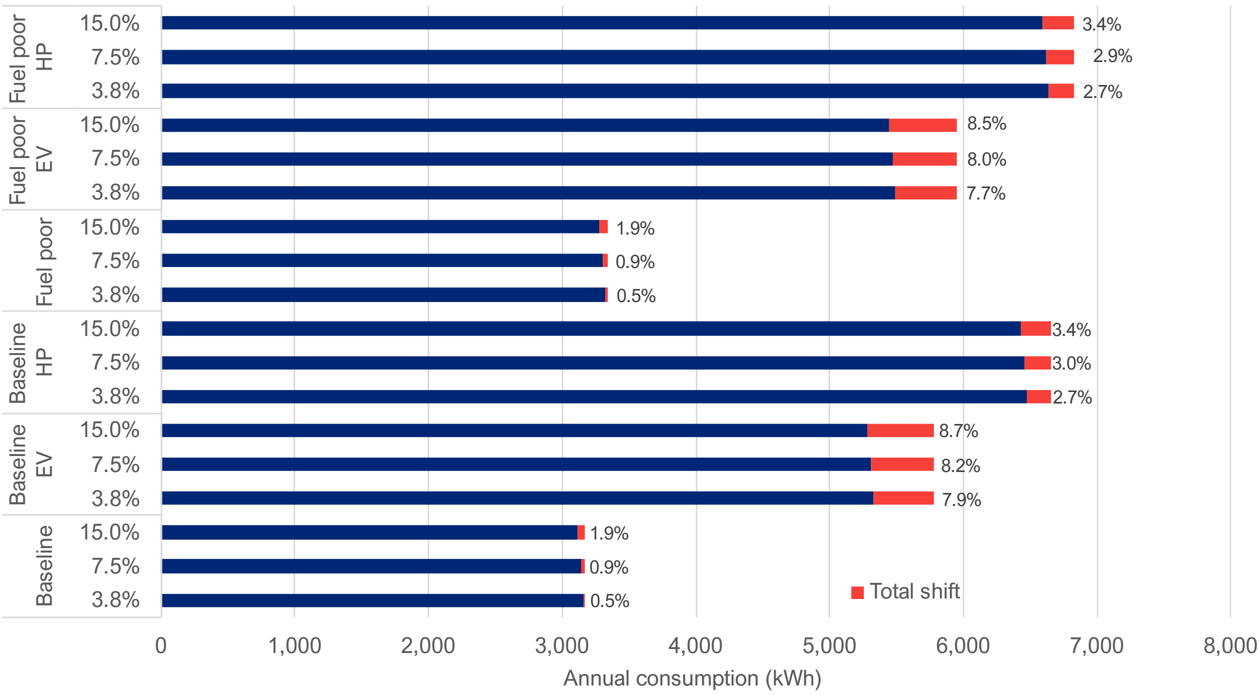
We discuss these points in more detail below.

10.6.1 System Impacts

We present the amount of load shifted for consumers enrolled in the Have a Green Day proposition in Figure 10.25. For each demand archetype we present three figures, which correspond to the different amounts of smart load which we assume (i.e., 15%, 7.5%, and 3.75%).

As would be expected, for each of the demand archetypes, the model run in which we assume the largest percentage of smart load (15%) sees the most shifting. These households are assumed to have the most smart devices, so have more load which can be scheduled for greener times on the grid. Across demand archetypes, the fuel poor and baseline household with an EV shift considerably more load than the other archetypes.

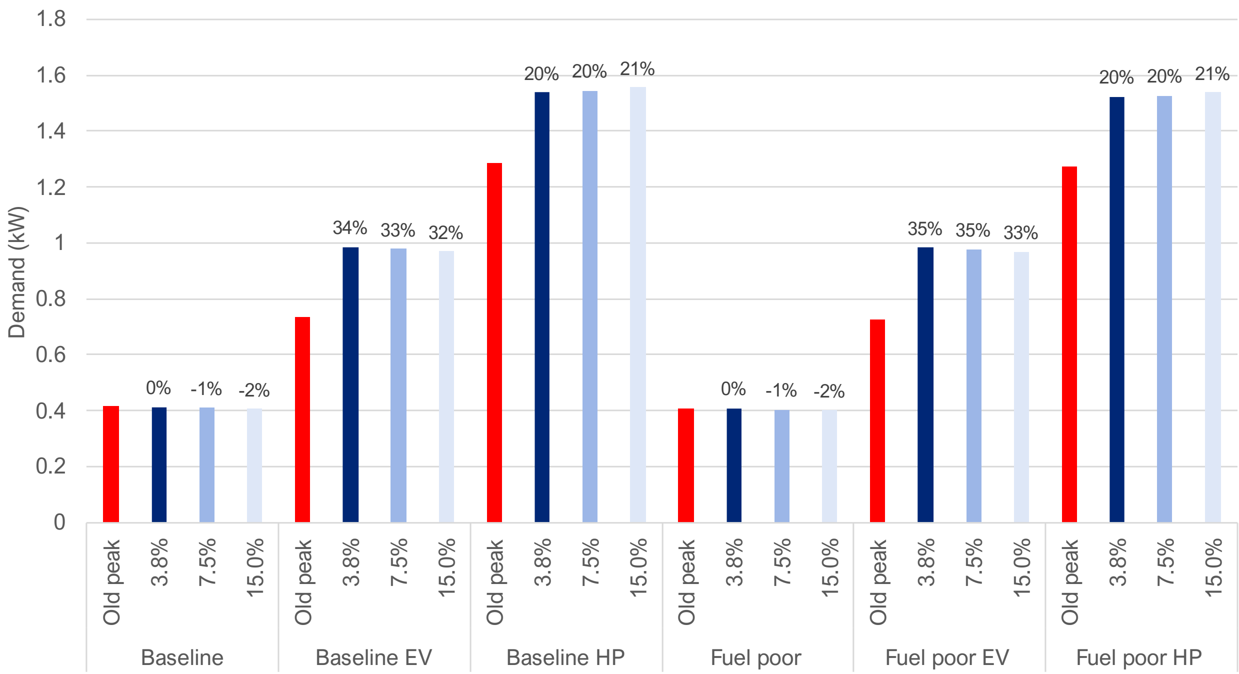
Figure 10.25: Have a Green Day – load shifted (for all scenarios and locations)



Source: CEPA analysis

The next figure, Figure 10.26, presents the change in peak load on the system.

Figure 10.26: Have a Green Day – change in peak load (for all scenarios and locations)



Source: CEPA analysis

Across the demand archetypes s, there is at best a limited reduction in the peak demand on the system – up to 2% reduction for customers without EV or HP. For EV customers peak demand increases by about 33%, and there is a c. 20% increase in peak demand for HP customers. This result is a product of the decoupling of the demand profiles from the data used to determine 'green times'. Any misalignment between the individual and aggregate demand profiles can incentivise demand shifting which could have a negative impact on the system. This is an issue which applies in practice as well as in our modelling.

It is notable that this effect is evident in both this proposition, which targets demand increases during 'green' times, and propositions which try and reduce demand during 'red' times. The prevalence of this outcome across propositions underlines the critical importance of effective targeting to reduce peak demand on the system.

10.6.2 Consumer Impacts

Have a Green Day has no direct impact on consumer bills. Consumers are encouraged to shift based on in-app incentives and notifications of when the grid is most 'green' as opposed to promises of rewards or cost savings.

The main impact on consumers is envisaged as positive feelings from living an environmentally sustainable lifestyle, which is not captured in our modelling. In practice, a supplier may need to provide the consumer with more tangible inducements to remain engaged in the proposition. This could take the form of tailored user experience, such as energy tips, which a consumer may find informative and convenient. Beyond this, small payments or other material gestures, such as a free coffee or film ticket, could serve as a reward for daily engagement, or for achieving in-app "streaks". These have not been included in the proposition as modelled, but could be implemented practice.

10.6.3 Supplier Impacts

Assuming that there is a reasonable correlation between 'green' periods and low underlying prices (wholesale, network, policy), the supplier's net revenue position should be improved by offering this proposition. This benefit would be offset to some extent by the cost of providing any non-monetary rewards.

10.6.4 Wholesale price sensitivity

The wholesale price sensitivity does not change the system or consumer impacts for Have a Green Day. This is because the system impacts are agnostic to the size of the unit cost faced by the consumer, and there are no tangible rewards or monetary discounts involved in the proposition.

11. Annex E – Understanding the modelled peak shifting

This annex offers further detail on changes in the timing of peak demand in our modelled propositions/scenarios, providing insight into the outcomes that are summarised in Annex D. We split this analysis between:

- propositions where the consumer responds directly to the underlying half-hourly price profile – Pure Flex (a benchmark) and Flex Bat; and
- propositions where the consumer does not face the underlying half-hourly price profile (Pay as you Green, Smart Switch and Save, Let's Get Moving, and Have a Green Day).

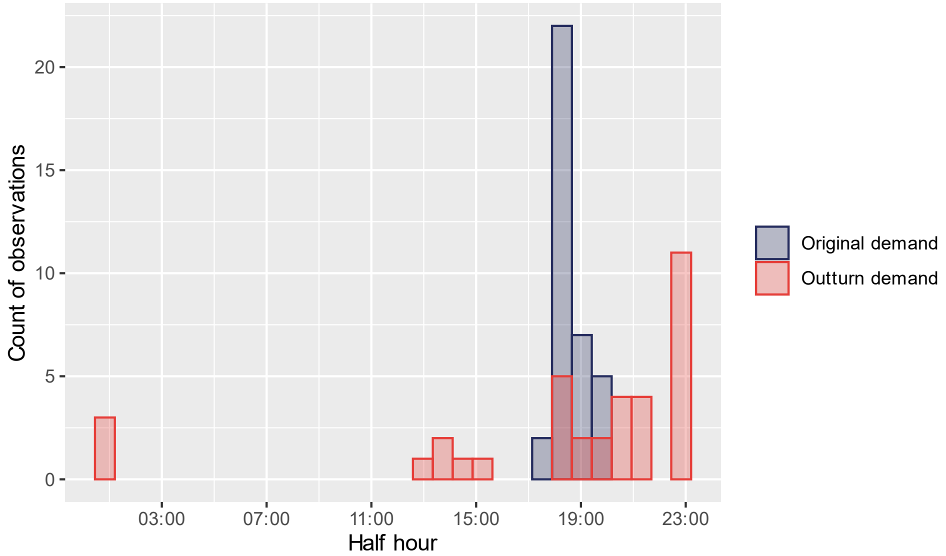
This analysis focuses on the top 10% of days in terms of total energy consumed. These days were identified by calculating daily energy consumption (in kWh), then filtering for the top 10% (i.e., 36 days), for each consumer archetype.

11.1 Pure Flex and FlexBat

Pure Flex and Flex Bat show the most variation in this peak shifting analysis as under these propositions consumer behaviour is optimised (to varying degrees) in response to the underlying, half-hourly price profiles.

Figure 11.1 shows the time interval in which the daily peak demand falls in the top 10% of days by peak daily demand, for the baseline with EV consumer archetype with the Pure Flex benchmark proposition. The histogram for the original demand profile is shown in navy; outturn demand is shown in red. This figure shows that in the original demand profile, daily peak demand (in the top 10% of days by peak daily demand) was exclusively between 18:00 and 20:00. The impact of the proposition is to materially reduce the incidence of daily demand peaks in the 18:00-20:00 window. The peaks are pushed in both directions, but more commonly later in the day. The statistical mode changes from 18:30 to 22:30, a typical shift of four hours.

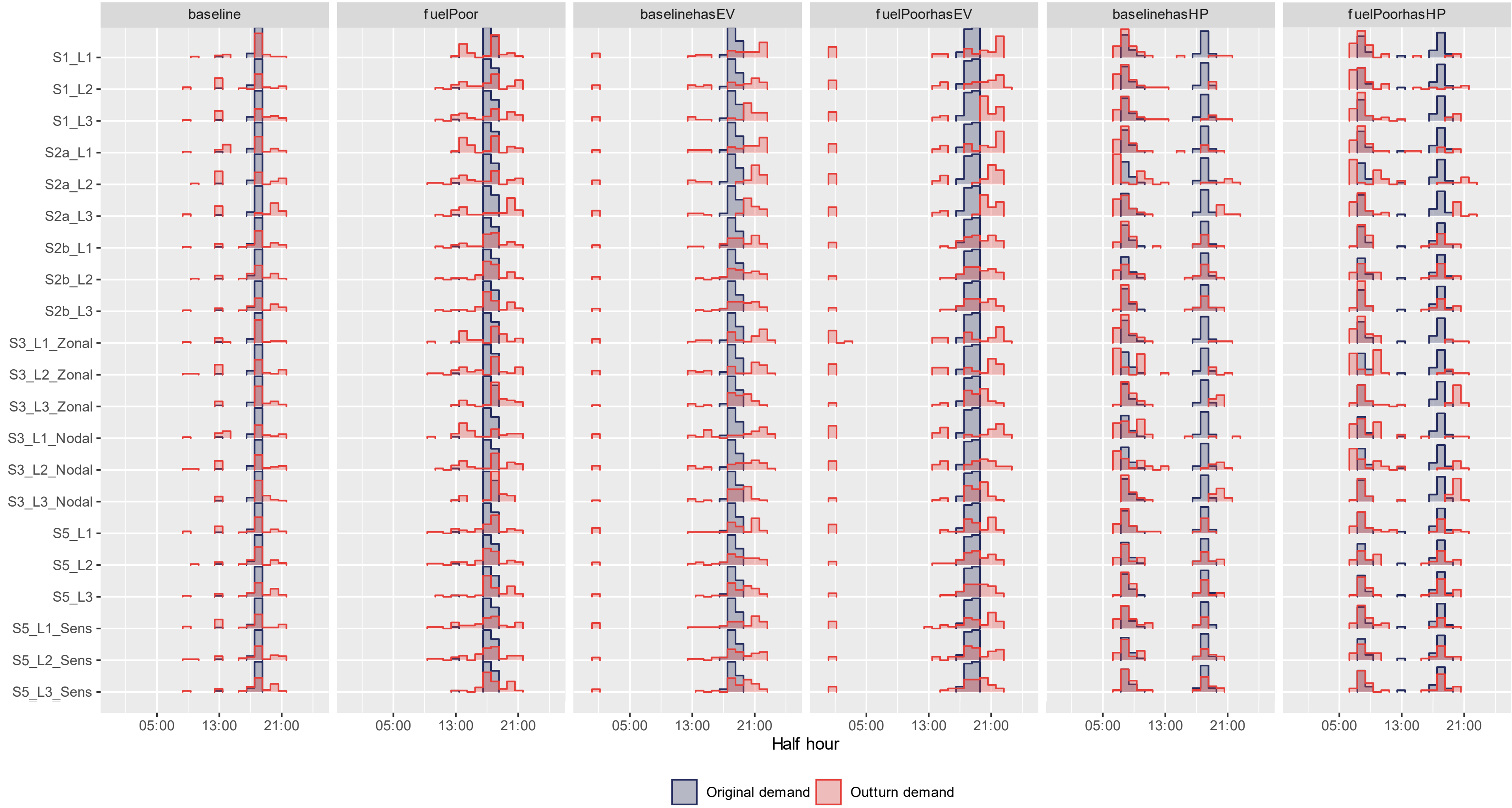
Figure 11.1: Histogram of daily peak demand (Pure Flex; baseline + EV; top 10% of days)



Source: CEPA analysis

To expand this analysis across the Pure Flex model runs, we show a similar analysis in Figure 11.2 for every combination of consumer archetype and scenario. This analysis differs slightly from Figure 11.1 in that it is a density plot rather than a histogram. A density plot shows the proportion of observations in each "bin", whereas a histogram depicts the number of observations. The density plot was chosen for visual clarity given the large amount of information in the single figure. For example, being a density plot it does not need y-axis labels. Commentary on Figure 11.2 is provided on the following page.

Figure 11.2: Distribution of daily peak demand (Pure Flex)



Source: CEPA analysis

Points of interest in Figure 11.2 are:

- The extent of overlap between the navy plots and red plots. The less overlap there is, the more effective the proposition is at shifting load out of the original peak period. Conversely, perfect overlap of navy and red would reflect no change from the proposition (there are no example of this here).
- Similarity down each column (i.e., "baseline", "fuelPoor", etc), which would indicate consistent results across scenarios.

Our main observation about Figure 11.2 is the broad similarity across scenarios. For example, the effect seen in Figure 11.1 of peak demand being shifted to later in the evening is generally true across the scenarios for the consumer archetypes with EVs. The most common shifts are delays in the peak of up to 5 hours. On a handful of occasions, the peak is brought forward by 19 hours (which can also be interpreted a push back in demand from the day before).

For the consumer archetypes with heat pumps, there is a general trend in the peaks being shifted from the evening to the morning, a shift in the peak to 10 hours earlier. In a few cases, some of the evening peaks appear to instead be shifted to 2-4 hours later in the evening (e.g., Scenario 3, Location 3 (zonal and nodal); Scenario 2a, Location 3). These consumers have a sizable number of daily peaks in the morning in the original demand profiles; Pure Flex tends not to have much impact on shifting these. Any change in the incidence of morning peaks is due to evening peaks being moved to the morning. The fact that even in the original demand there are daily peaks in the morning indicates the on a given day the morning and evening peaks can be similar to one another (at least in the winter). This being the case, only a small amount of flexibility is potentially required to shift the daily peak from the evening to the morning. A shift from evening to morning peak does not mean that the household is pre-heating for the evening peak in the morning.

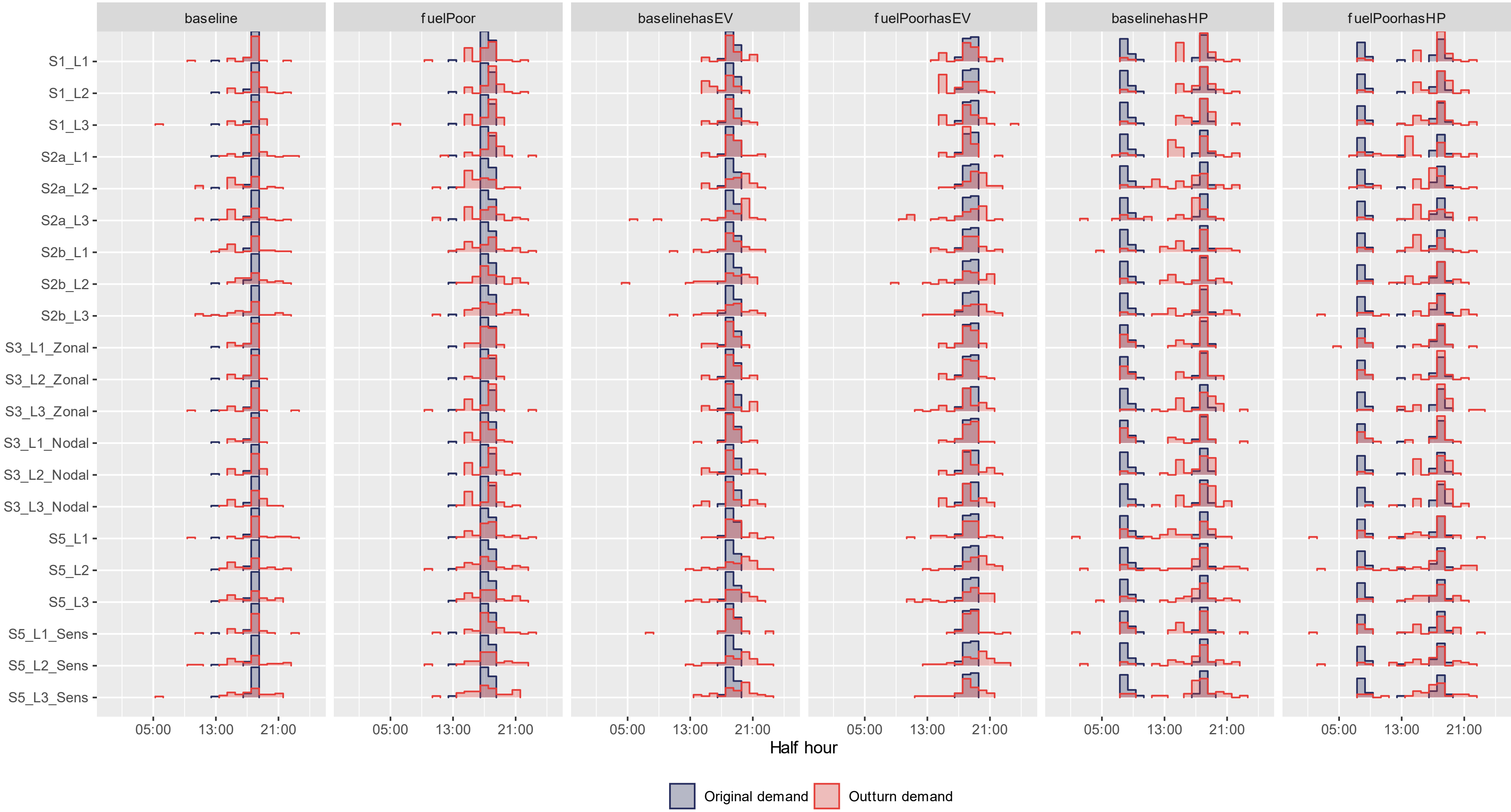
Pure Flex is generally less effective at shifting the evening peak for the baseline and fuel poor consumer groups, as depicted in the overlap between navy and red for these consumer groups. This is consistent with the results in Chapter 4 where the change in consumer annual peak demand was generally less for these consumer groups than for those with EVs or heat pumps. It reflects our modelling assumption that the demand of these consumer groups is less flexible than consumers with smart technologies. To the extent that demand is shifted it is generally by 2-4 hours later in the evening. In some scenarios, peak demand for the fuel poor archetype is shifted forward by 3 to 5 hours to the early afternoon.

Figure 11.3 on the following page shows the same analysis for Flex Bat. The directional trends for the EV archetypes and households without technologies are broadly similar as for Pure Flex, but the lengths of the shifts are less. The main peak shifts are:

- For households without technologies, the most typical shifts are between 5 hours earlier and 2 hours later.

- For EV households, the shifting behaviour tends towards delays in daily peak demand of less than 5 hours, often less than 2 hours.
- For heat pump households, there is much less shifting of the peak from evening to morning than was the case for Pure Flex. The more common shifts are in the range of 5 hours earlier to 10 hours later. The latter observation reflects days when the daily peak has switched from being in the morning to occurring later in the day.

Figure 11.3: Distribution of daily peak demand (Flex Bat)



Source: CEPA analysis

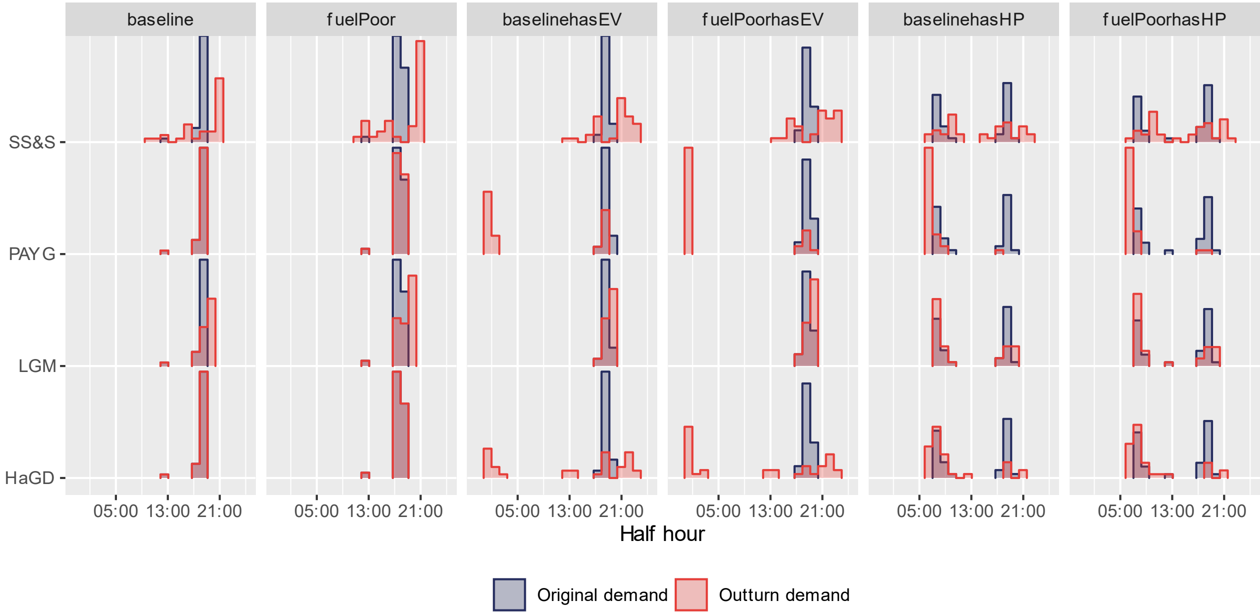
11.2 Smart Switch and Save, Pay as you Green, Let's Get Moving, and Have a Green Day

The analysis of the remaining propositions is more straightforward because there is no variation between scenarios because the offering is the same in each scenario and consumers are not directly exposed to the underlying half-hourly price profiles. An important caveat on these results is that they are heavily influenced by our assumption that shifted energy is evenly distributed through offsetting flexibility in all other intervals of the day.

The uniform results for Smart Switch and Save, Pay as you Green, Let's Get Moving, and Have a Green Day and shown in Figure 11.4. The figure shows that:

- **Smart Switch and Save** is (by design) effective at shifting peak demand. The length of the shift is generally in the order of 4 hours in either direction; for the heat pump consumers there are larger shifts of up to 10 hours in either direction. These observations reflect our assumption about the even redistribution of offsetting flexibility – the peak reduction is compensated through demand increases either side of the original peaks, such that the shoulder intervals typically become the new peaks in the outturn data.
- **Pay as you Green** is not effective for peak shifting for the consumer archetypes without smart technologies. While there is shifting generally, it is not enough to change the time of daily peak demand. This is a function of our flexibility assumptions which provided lower flexibility thresholds for these consumer groups. The ability to reduce and shift the peak is constrained by the volume of energy which can be shifted to the "green" period (i.e., 0:00-07:00). For the EV and heat pump archetypes there are also some incidences of no shifting of the peak demand period in the top 10% days for the same reason. Where there is shifting, the peak shift for heat pump consumers is 10 hours earlier and 20 hours earlier for EV households.
- **Let's Get Moving** is moderately effective at peak shifting. For the EV consumer archetypes and consumers without smart technologies, peak demand is generally delayed (pushed later) by <2 hours. This is also true for the heat pump households, however for those archetypes there are also some incidences of daily peak demand shifting to the morning (by 10 hours).
- **Have a Green Day** is not effective for peak shifting for the consumer archetypes without smart technologies. For the EV households, the shifts observed range from 20 hours earlier to 5 hours later. For the heat pump homes, the most common shifts are 10 hours earlier (i.e., peak demand shifting to earlier in the day).

Figure 11.4: Distribution of daily peak demand (SS&S, PAYG, LGM, HaGD)



Source: CEPA analysis

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