



CORNWALL INSIGHT

CREATING CLARITY

Consumer-led engagement in electricity flexibility

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Edwards

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2 Foreword by Smart Energy GB

Great Britain has made ambitious commitments, to a clean power system in 2030 and to achieving net zero by 2050. It is widely established that those goals cannot be achieved without a smart energy system, at the heart of which sits smart meter enabled households.

Smart Energy GB has already worked with Cornwall Insight to set out the 'size of the prize' in our August 2023 report *The power of flex: Rewarding smart energy usage*. We found that households who could flex their energy usage stand to save up to £115 on electricity costs in 2030 or £375 in 2040, and that households who aren't able to flex their energy usage will also benefit financially from system-wide savings.

Our core business at Smart Energy GB is consumer engagement, so these results raised a question for us – how many households would need to be brought along this journey in order to deliver on those collective goals?

This paper seeks to understand how many, of different types of households, are able to deliver enough household flexibility to support our energy system, whilst acknowledging there are some unknowns that will impact whether they will be persuaded to do so consistently and at scale. For example, we don't yet know how many people will install enabling 'green tech' like heat pumps and EVs; or whether there will be enough compelling Time of Use and automated services that households will be willing to sign up for and change their energy use behaviours accordingly. We also don't know exactly what the policy settings or market conditions will look like in 2030 or in 2050. However, what we do know is that the mass market consumer engagement required to change the way millions of homes use energy, takes time and effort. If we want to bring large numbers of consumers along on that journey, within the timeframes set, we need to start today.

This will be a collective effort. At Smart Energy GB, we have evolved our marketing and communications to incorporate energy flexibility as a message to engage people with smart meter installation and usage, and that activity is working more effectively than anything we have deployed since before Covid. We know others across industry are working hard at this dilemma as well, with Government, Ofgem and NESO jointly publishing the Clean Flexibility Roadmap this summer.

We're thrilled to be working with Cornwall Insight again, leveraging their insight on how the energy market can deliver practical benefits for the nation, for households and for consumers. We hope that this paper will contribute one piece to the wider puzzle as to how we unleash the consumer benefits of household energy flexibility.

As always, we find that smart meters are at the heart of that clean energy system we are all striving for.

Dan Brooke

CEO, Smart Energy GB

3 About Cornwall Insight

Getting to grips with the intricacies embedded in the energy market can be a daunting task. There is a wealth of information online to help you keep up to date with the latest developments, but finding what you are looking for and understanding the impact to your business can be tough. That's where Cornwall Insight can help, by providing independent and trusted expertise.

We offer a range of services to suit your business' needs, including:



Analysis

Our market insight reports cover the full breadth of the energy industry to help you keep pace in a fast moving and complex market. Our experts collate all the "must-know" developments and break-down complex topics, in a way that is easy to understand.



Consultancy

We provide a range of advisory, research and bespoke consulting services to support organisations through their business and financial planning, strategy development, investment due diligence, policy design, risk management and regulatory assessments.



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Cornwall Insight's training courses are delivered by industry experts and range from an introduction to the sector through to advanced-level learning. Our trainers make the courses fun and engaging by using practical examples and interactive tasks.

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4 Introduction

This research aims to understand how consumer-led engagement in electricity flexibility could help achieve a decarbonised grid by 2030, and Net Zero by 2050.

Smart Energy GB (SEGB) has partnered with Cornwall Insight to better understand how different consumer cohorts with different technologies in their homes could contribute to energy flexibility in Great Britain.

Our detailed modelling aims to understand:

- The potential for consumer-led flexibility to support the requirements for electricity flexibility in 2030 and 2050
- The level of support that could be delivered by households with a range of low carbon technologies installed, including households with no low carbon technologies

We previously worked together in 2023 to identify the potential savings that could be achieved by households using energy flexibly. The [*Power of Flex: Rewarding smarter energy usage*](#) examined household flexibility, why we need it, and what the opportunity is for households and the nation.

Alongside other reports, it established that consumer-led flexibility could be a key factor in a decarbonised electricity grid or in achieving net zero targets.

Our latest report builds on this evidence to model how many consumers need to be involved in energy flexibility, when and to what extent, in order to achieve policy goals.

Policy development on how to facilitate more consumer-led flexibility is developing at pace. This includes questions about fairness, consumer behaviour change, product design and regulation. We don't seek to address these issues in this paper, rather we see this work as contributing a small piece to the much wider policy puzzle.

This report presents the findings of the research undertaken in Q4 2024 and Q1 2025.

More information on our approach can be found in section 6.

More information on the findings of our research can be found in section 7.

5 Executive summary

What is consumer-led flexibility and how can households benefit?

Consumer-led flexibility involves consumers increasing, decreasing or shifting their electricity use in response to a signal (for example a message from their energy supplier or a change in electricity price), to help manage the electricity system. This helps reduce energy costs and carbon emissions by maximising the use of renewable energy sources.

Our scenario based research undertaken in 2023 for *The Power of Flex* found that individual households could make financial savings as a result of using energy flexibly. For example, households with EVs, heat pumps and other smart-capable assets that respond to flexibility incentives saw a reduction of 14% in wholesale electricity costs in 2030, rising to 52% in 2040.

Even households that are not active in moving their consumption make savings because the overall wholesale market cost reductions translate into lower costs for all participants.

How much flexibility is needed across the system?

Consumer-led flexibility can contribute to achieving Great Britain's energy targets including:

- Clean Power 2030 – “In a typical weather year, the 2030 power system will see clean sources produce at least as much power as Great Britain consumes in total over the whole year, and at least 95% of Great Britain's generation”¹
- Net Zero 2050 – total greenhouse gas emissions would be equal to the emissions removed from the atmosphere

These targets require the rapid deployment of low carbon technologies and a variety of flexible generation and demand sources.

After accounting for current, planned and additional generation reasonably expected to be operational in the energy system, we identified a “gap” for other sources of flexibility still required in 2030. **This equates to around 10% of the modelled flexible capacity on the system**². This “gap” could be met by a range of generation technologies but implementation would require further investment and time to build new assets.

Consumer-led flexibility presents an alternative option, with several routes for implementation depending on the deployment of low-carbon technologies installed in homes in 2030.

This paper presents the findings of modelling undertaken to assess the potential for consumer-led flexibility to fill the flexibility “gap”.

Could households reasonably deliver the “gap”?

The modelling undertaken for this paper shows that households using low carbon technologies flexibly could meet the flexibility “gap” required to support a Clean Power 2030 electricity system.

¹ Clean Power 2030 Action Plan, UK government, December 2024, [Link](#)

² Modelled capacity refers to our modelling assumptions about the technologies that will be generating electricity in the future. Modelled *flexible* capacity specifically refers electricity generation responsively adjusting to changes in supply and demand. Our assumptions about the level and range of flexible capacity are driven by a range of technical and policy factors, which are further set out in our Technical Annex.

We found that that **one million fully smart homes**³ responding to system flexibility signals perfectly could technically meet the additional electricity flexibility requirements for 2030.

In reality we expect that a fully automated “perfectly” responding household is unlikely to be commonplace in 2030, because automatic response to flexibility signals is not currently widespread across a range of assets installed in a single household.

Alternatively, the equivalent of 10% flexible capacity could be achieved by:

- Lots of households making small changes to the time they use electricity, combined with;
- A smaller number of households with ‘green’ technologies installed (like heat pumps or electric vehicle chargers) shifting larger volumes to different time periods

For example, the mix of household usage could be made up of:

- One million homes with heat pumps
- Three million homes with electric vehicle smart chargers; and
- An additional 15 million homes engaging with home demand side response

A total of 19mn homes (out of 28mn household in Great Britain in 2030) undertaking automated response to flexibility signals using different technologies.

The need for engagement with flexibility signals may be higher still, if homes choose not to engage with every signal, either by overriding automated settings or by opting in/out on an ad hoc basis.

The modelling also found that household flexibility could contribute to Net Zero goals.

For 2050, our approach to modelling differed from the 2030 assessment. In order to understand how consumer-led flexibility could support Net Zero 2050, our modelling assessed the potential for consumer-led flexibility to reduce the need to build more flexible generation assets, based on reasonable expectations of uptake and capacity.

We found that of the 103GW of flexible capacity required in 2050, EV smart chargers have the highest potential to deliver that capacity (equivalent to 46% of modelled capacity), followed by heat pumps and fully smart homes. Consumer-led flexibility could therefore provide an alternative to building generation assets and reduce the investment required to meet Net Zero by 2050.

Conclusion

This report finds that households of different types and numbers could fill the “flexibility gap” but engagement with flexibility signals would need to be higher than current levels to achieve this. For example, the most recent Ofgem data⁴ shows that the number of domestic customers with smart Time of Use tariffs is 664,000 (2.3%, January 2025). While engagement is increasing, further changes would be required to unlock the potential to fill the “flexibility gap”.

³ Our modelled fully smart home has a range of technologies installed, including an electric vehicle smart charger, heat pump, solar PV, battery storage and participates in home demand side response.

⁴ Ofgem, State of the Market Report ([link](#))

As consumers are unlikely to engage with every flexibility request, and different households will be able to shift different amounts of electricity in different ways, these findings emphasise the importance of achieving a wide range of actions from different sources of flexibility.

The enabling policy and commercial interventions necessary to achieve this uplift in flexibility are not the subject of this paper, but this research aims to inform the approach taken. There is consumer appetite to engage with flexibility⁵ and the outcomes of the government Clean Flexibility Roadmap and its governance framework should help GB supercharge consumer engagement with energy flexibility.

⁵ BIT, Empowering Flexibility: unlocking consumer engagement in demand flexibility, 2025 ([link](#))

6 Approach

We have undertaken detailed modelling of the electricity system generation and demand in 2030 and 2050. Our approach reflects government aims to maintain security of supply, minimise costs and meet government targets.

Our modelling finds that the transition to renewable generation sources and additional power demand from technologies like electric vehicles and heat pumps is expected to increase the need for electricity flexibility – where generation or demand is adjusted to support the running of the system. Britain has a range of new and established technologies to deliver flexibility, including battery storage, gas peaker plants and pumped hydro, as well as a development pipeline for further build out of additional resources.

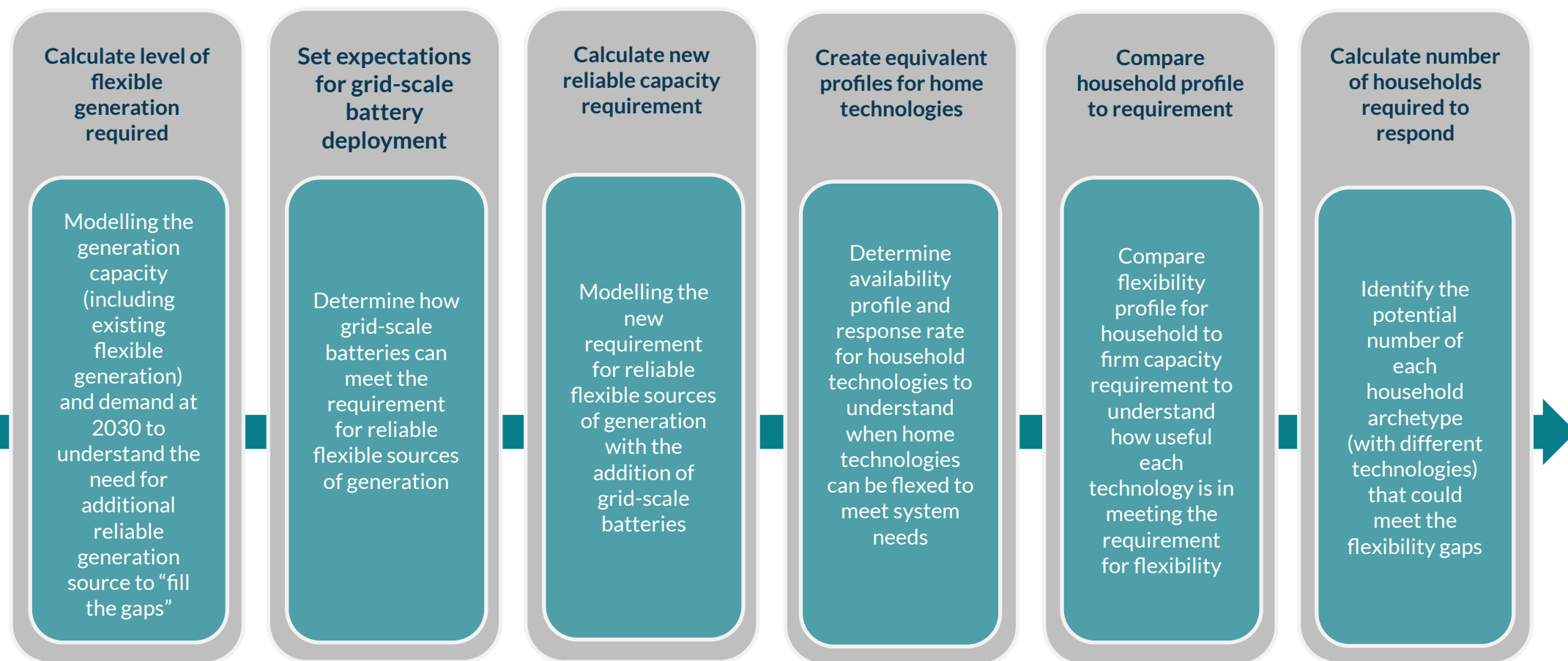
With 2030 on the horizon, our modelling assumes new flexible generation continues to be added to the electricity system (including grid-scale batteries) to meet this need. After accounting for current, planned and additional generation reasonably expected to be operational in the energy system, we identified a “gap” for other sources of flexibility still required. This “gap” could be met by a range of generation technologies, which would need to take into account investment and delivery timeframes.

To understand the potential for households to support flexibility requirements and reduce the requirement for investment in additional generation assets, we have modelled technologies and consumption patterns reasonably expected to be available in 2030 and 2050. We assume that households use electricity and low carbon technologies in a similar manner to today; consumers engage in the energy sector in a range of different ways reflecting their circumstances, access, motivations and technology developments. Electricity flexibility refers to moving consumption to a different time period or pre-heating a home, recognising parameters of comfort and convenience.

We have also examined the role households could play in 2050 in supporting electricity flexibility. Our modelling assessed the potential for consumer-led flexibility to reduce the need to build more flexible generation assets, based on reasonable expectations of technology uptake and capacity, and each technology’s ability to change consumption at times when flexibility is required across the system.

We have set out an overview of our 2030 modelling approach in Figure 1.

Figure 1: Diagram of modelling approach for 2030



We have modelled the opportunity for electricity flexibility from a range of household technologies, operating on an individual basis and when installed in combination. We have also considered the opportunity for demand flexibility for households without additional technologies installed, instead shifting everyday consumption patterns to different periods (e.g. use of washing machine or tumble drier).

We provide an overview of our approach below:

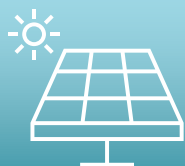


We have modelled home **electric vehicle smart chargers** which are capable of responding to price signals by moving their charging periods to a different time of day. The vehicles (assumed to be pure battery EV only) are required to meet a minimum state of charge at a specified time each morning, and are assumed to be making a range of different journeys. EV charger engagement with flexibility is limited to periods when the vehicles are expected to be plugged in at home.

Electric vehicle smart charging is the most effective individual technology in meeting system flexibility requirements, because its ability to change consumption patterns aligns more to the times of day when flexibility is required and its individual consumption load is bigger (assumed to be a 7kW charger).



Heat pumps can engage with flexibility signals while maintaining thermal comfort by pre-heating homes in advance of reducing their electricity demand from the system. Our approach constrains heat pump pre-heating overnight (to prevent over heating at night), and limits the number of times the heat pump can turn on and off in one day. Our modelling finds that heat pumps have a reasonable ability to change consumption at the times when flexibility is needed across the system. We have assumed heat pumps will have a smaller individual load than EVs (on average).



Solar and battery storage combined provide a similar benefits to heat pumps, in the times of day they are available to provide flexibility in response to the system requirement. Solar PV and battery storage provides a slightly larger consumption load compared to heat pumps, so this technology could provide higher levels of system support if homes choose to engage with market signals.

This technology is generally better suited to reducing home consumption rather than exporting to the electricity grid, reflecting the final consumption levies that are applied to household bills, meaning the savings made from reducing household consumption are greater than payment for exporting electricity. Reducing home consumption is still a valuable form of flexibility, reducing the need for additional generation.



Moving everyday consumption (home demand side response) to a different time period can provide support to the wider electricity system, and does not rely on any additional flexibility technology. This type of flexibility provides a lower peak reduction on an individual basis compared to heat pumps or EV chargers, but as it does not require the purchase or installation of assets, the potential number of households that can engage is significantly higher.



Our fully smart home has a range of technologies installed, including electric vehicle smart charging, heat pump, solar PV, battery storage, and everyday consumption changes

7 Results

Our modelling finds that **one million fully smart homes responding perfectly to system flexibility signals could also meet the additional electricity flexibility requirement to support Clean Power 2030.**

Alternatively, flexibility needs can be met in 2030 by lots of homes making small changes to the time they use electricity, combined with a smaller number of households with technologies installed that are capable of shifting larger volumes to different time periods, such as EVs and heat pumps.

We define a fully smart home as one with an electric vehicle and smart charger, heat pump, solar PV, battery storage installed and where these devices automatically respond to flexibility signals without the consumer needing to take action, other than to set the system up.

However, we recognise that in 2030 a fully automated system is unlikely to be accessible for most consumers, and that a proportion of households may not engage with flexibility services or choose to opt out of some or all signals.

Therefore, the number of households “signed up” and capable of responding to flexibility signals would need to be higher than the figures represented here, with an *equivalent* of one million fully smart homes responding to each signal.

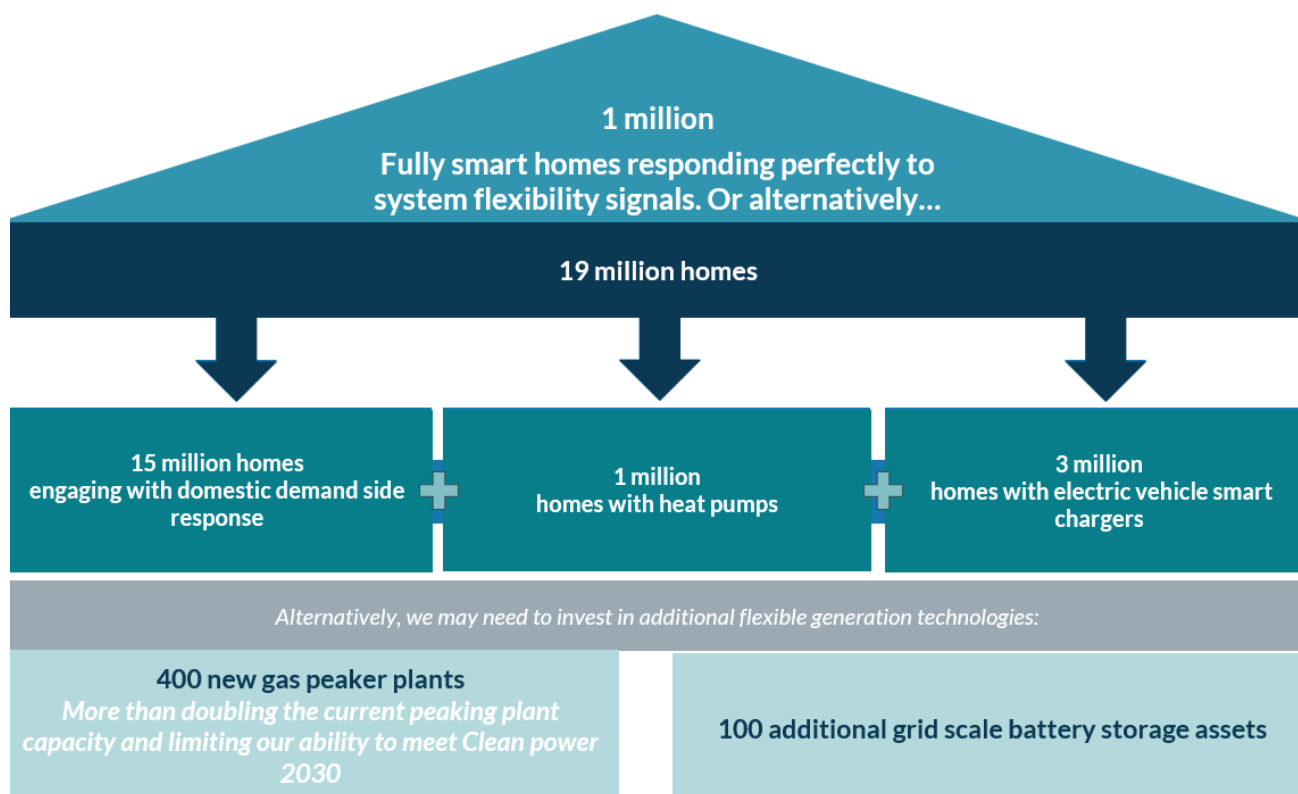
In reality we expect consumers with a variety of technologies (or no specific technologies), consumption patterns and engagement with the energy market to interact automatically or manually with flexibility signals, all of the time, sometimes or not at all. The “gap” in flexibility could still be met, but with more homes engaging.

Figure 2 highlights the mix of households that could support the additional flexibility needed to reach Clean Power 2030.

In the absence of homes responding to flexibility signals, we may need to invest in additional flexible generation technologies to “meet the gap”, for example 400 new gas peaker plants, more than doubling the current peaking plant capacity on the network and limiting our ability to meet Clean Power 2030. It can take anywhere from six months to around six years to build a new gas peaking plant, and could cost more than £2bn⁶ in upfront costs.

⁶ Cornwall Insight estimates

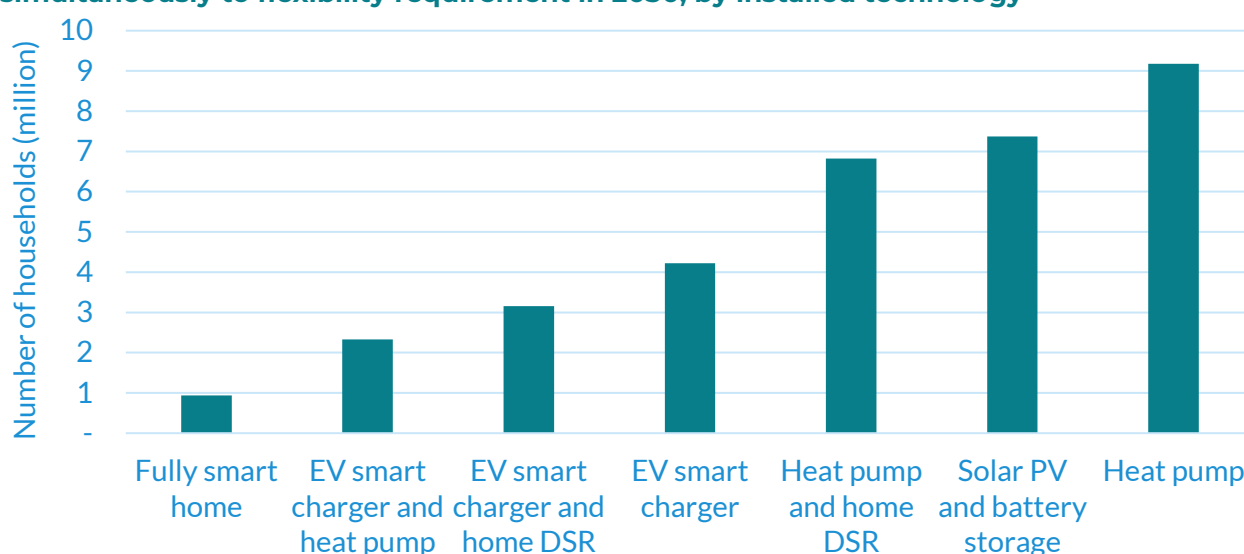
Figure 2: Potential for households to support additional flexibility needed to deliver Clean Power 2030



Source: Cornwall Insight

Figure 3 provides further examples of the number of households with different combinations of technology installed that have the potential to meet the additional flexibility requirement needed to deliver Clean Power 2030. In some instances, this is higher than the number of each technology expected to be installed in 2030, emphasising the importance of a range of actions from different sources of flexibility.

Figure 3: Number of households with potential to meet Clean Power if responding simultaneously to flexibility requirement in 2030, by installed technology



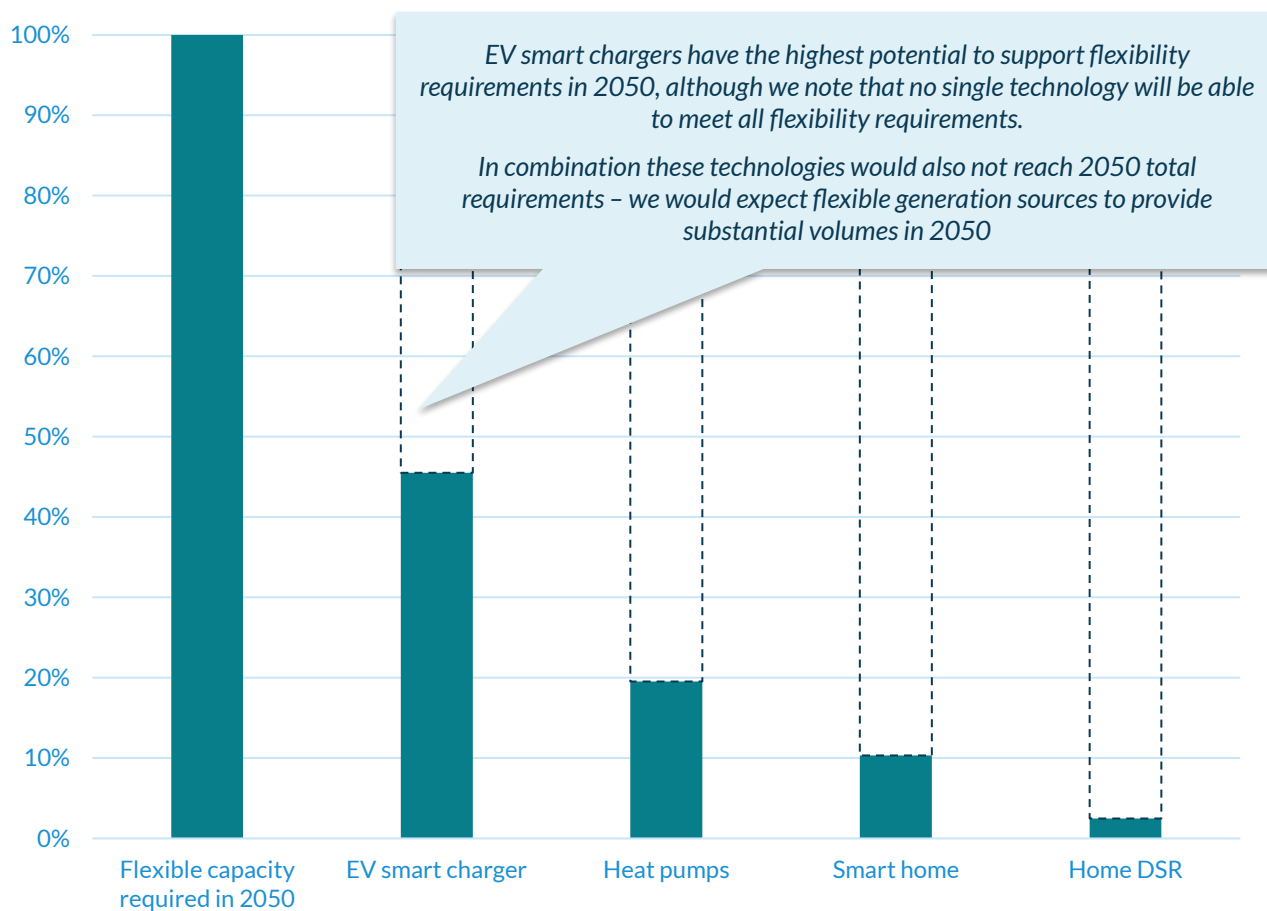
Source: Cornwall Insight

Looking ahead to 2050, there is no “gap” in flexibility due to the timescales analysed. Instead, our modelling shows that 103GW of flexible capacity will be needed from all types of flexible generation and demand sources.

Figure 4 outlines the flexibility potential from households with different technologies installed in 2050, and their relative ability to support the overall requirement for flexible generation. EV smart chargers provide the highest potential for delivering flexibility, equivalent to 46% of the modelled flexible generation capacity in 2050 if responding perfectly and simultaneously to flexibility signals, reflecting their number, capacity and ability to flexibly change their consumption pattern (within certain parameters). While this is unlikely at this scale (not all households will use EV charging for flexibility purposes), it demonstrates the potential for household flexibility to reduce the need to invest in traditional flexible generation assets.

With a greater number of electric vehicles and heat pumps connected to the electricity system in 2050, it is clear that there is potential for many more homes to contribute to electricity flexibility.

Figure 4: Equivalent proportion of the total level of all flexible capacity that could be provided by household technologies and the remaining gap to meet with other flexibility sources



Source: Cornwall Insight. The total number of "Smart homes" is expected to be limited by the expected national take up of the individual technologies installed

8 Conclusions

Substantial increases in the number of household low carbon technologies are required to meet Net Zero. In February 2025 the Committee on Climate Change (CCC) advised in the Seventh Carbon Budget⁷ that, under its Balanced Pathway, half of homes should be heated using a heat pump by 2040, while three quarters of cars and vans on the road would need to be electric. The transition to electric technologies will substantially increase annual electricity demand, rising to more than double 2023 levels by 2050⁸. Build out of new low carbon generation capacity will be required to meet the additional electricity demand, and the requirements for flexibility will continue to rise.

In 2030, our results show that using household low carbon technologies flexibly could meet the additional demands for flexibility (or the flexibility gap). This could be achieved by a small number of houses shifting a lot of usage perfectly, or with a mix of more households shifting small volumes. While it is unlikely that all consumers will engage with every flexibility request, different households will be able to shift different amounts of electricity usage.

This emphasises the importance of achieving a range of actions from different sources of flexibility, including households making changes to daily routines in electricity consumption where they can, alongside “fully smart” households moving larger loads and everything in between. For example, we found that the aggregate impact of half of homes in Great Britain making small changes at the same time could be twice as high as that achieved by the estimated number of heat pumps installed by 2030.

In terms of 2050, the potential for households to play a role in delivering flexibility is expected to grow rapidly in the approach to 2050, as uptake of decarbonised transport and heating solutions continues and the need to balance the increase in renewable generation rises. Consumer-led flexibility could provide an alternative to building additional generation assets, reducing the need for additional investment in grid scale generation assets.

This paper has concentrated on understanding how different cohorts of consumers and households could meet GB’s electricity flexibility needs in 2030 and 2050. This is only one part of the story. We recognise that it does not consider important policy questions around how this could be achieved, for example what products, services and consumer engagement might be necessary to motivate consumer behaviour change of this scale, nor does it address questions about fairness. Rather, we believe this paper provides a useful input to understand the potential for consumer-led flexibility to support wider system needs, and is intended to provide a helpful contribution to policy and regulatory discussions which aims to establish how flexibility from distributed and consumer energy resources could support a Net Zero power system.

Energy flexibility could benefit all electricity users, even those who don’t directly engage. The level, balance, and equality of benefits will be determined by future government policy, alongside developments in technology and commercial proportions for flexibility services. Achieving the number and diversity of households that could engage in flexible behaviours would require a range of approaches through policy, interventions and consumer engagement to make this a reality.

⁷ Committee on Climate Change, Seventh Carbon Budget, [Link](#)

⁸ Committee on Climate Change, Seventh Carbon Budget, [Link](#)

9 Glossary

Term	Definition
Consumer-led flexibility	Consumers increasing, decreasing or shifting their electricity use in response to a signal, to help manage the electricity system
Home demand side response (DSR)	Moving everyday consumption to a different time period to provide support to the wider electricity system – this does not rely on any additional flexibility technology
Fully smart home	A fully smart home has an electric vehicle with home smart charging, a heat pump, solar PV and battery storage, and participates in home demand side response
Gas peaking plant	Gas-fired power stations designed to manage fluctuations in supply and demand, particularly during peak demand times
Generation capacity	The electricity that can be produced by a generator when it's running at maximum levels
Peak demand	The daily increases in demand on the electricity system, when households, commercial businesses and industry consumer electricity at the same time, usually on a weekday between 4-7pm
Time of Use tariffs (ToU)	Electricity tariffs where prices vary at different times of day. These are designed to encourage people to use energy outside of peak times when costs are typically higher. Similar to and off-peak transport tickets
Reliable generation	Source sources of generation which are always available, are controllable and are not reliant on environmental variables

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