REGEN

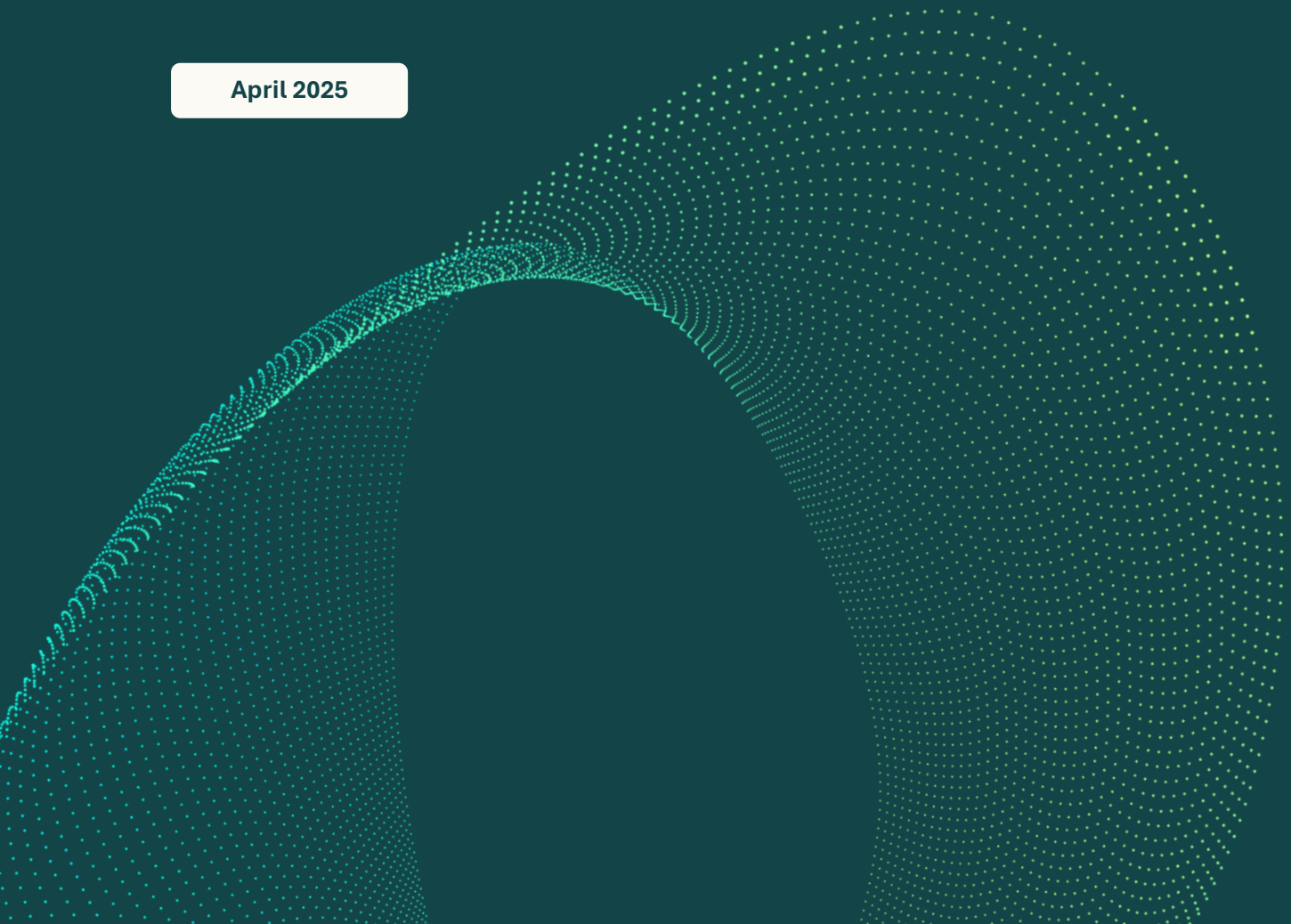
Consumer Scotland
Luchd-Cleachdaidh Alba

Rapid evidence assessment

Ensuring a just transition for consumers in the GB retail market

A summary of rapid evidence assessment findings on the impacts, challenges and opportunities for Scottish consumers within the future GB retail energy market.

April 2025



About Consumer Scotland

Consumer Scotland is the statutory body for consumers in Scotland. Established by the Consumer Scotland Act 2020, it is accountable to the Scottish Parliament. Consumer Scotland's purpose is to improve outcomes for current and future consumers. Its strategic objectives are:

- To enhance understanding and awareness of consumer issues by strengthening the evidence base
- To serve the needs and aspirations of current and future consumers by inspiring and influencing the public, private and third sectors
- To enable the active participation of consumers in a fairer economy by improving access to information and support.

About Regen

Regen provides independent, evidence-led insight and advice in support of our mission to transform the UK's energy system for a net zero future. We focus on analysing the systemic challenges of decarbonising power, heat and transport. We know that a transformation of this scale will require engaging the whole of society in a just transition.

Regen is a membership organisation with more than 200 members who share our mission, including clean energy developers, businesses, local authorities, community energy groups and research organisations across the energy sector. We also manage the Electricity Storage Network – the industry group and voice of the grid-scale electricity storage industry in GB.

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Executive summary

The retail energy market in Great Britain is expected to undergo significant changes to support consumers in the transition to a net zero energy system. Through this transition, consumers will increasingly engage with new smart tariffs and services, data and digitalisation, consumer protection and technological and business model innovation for a low-carbon future.

Not everyone will experience these changes in the same way. Consumers in vulnerable circumstances, for instance, face distinct and evolving barriers to participating in a new retail energy market and net zero more broadly. Consumers in Scotland, particularly in the north, face disproportionately high bills compared to the UK-wide average due to significant geographic and housing factors, which pose additional challenges to participating in and benefiting from a smarter, more engaged retail energy market.

Using a systematic literature review methodology, this report analyses the current research and evidence base on the retail energy transition in Great Britain across academia, policy documents, innovation projects and thinktank reports. The aim is to understand what we know about the potential impacts of retail energy innovations for net zero on different groups and people – and emerging solutions for ensuring the transition works in the interests of consumers directly.

More than 150 documents are reviewed in total, across four key themes:

1. Tariffs and services for the future
2. Data and digitalisation
3. Consumer protection
4. Inclusive innovation and market design.

This body of research is then critically appraised, with recommendations for where more evidence is needed to inform policy, regulatory and market decisions for a fairer future for consumers in the retail energy market.

From this extensive systematic literature review, we identify five key gaps which require further attention:

1. **Current user experience of new tariffs, services and technologies**, particularly for those in vulnerable circumstances, through qualitative (interviews and focus groups) and more quantitative (e.g. survey) techniques.
2. **Scottish-specific cases**, recognising that Scotland has its own challenges, consumer perspectives and experiences of new tariffs and services that are currently underrepresented in the literature outside of Scottish Government, Citizens Advice Scotland, Consumer Scotland and limited academic publications.

3. **Scottish-specific data**, particularly on bills and costs that are aggregated to regional and local authority levels, to support more accurate understanding of current consumer challenges and more informed development of new models, services and reforms.
4. **Demonstration of more innovative models** such as Energy-as-a-Service or dynamic social tariffs, which are yet to permeate the market with consumers in vulnerable situations, particularly in Scotland – and synthesis of the evidence from other regions or countries where these models have become more commonplace.
5. **Consumer perspectives on trade-offs and 'fairness' in the retail energy market**, as well as views on which outcomes should be prioritised for any changes to consumer protections and wider regulation, through direct engagement and deliberative (e.g. citizen's panel) methodologies.

Foundations for a future retail market

In addition to the evidence assessment, we develop a set of four core 'foundations' for ensuring that a future retail market is designed in a fair and just way. These foundations are synthesised from across the literature reviewed:

Foundation 1: Reshape retail market incentives to focus on consumer outcomes and inclusive innovation. Delivering retail innovation that meets the needs of different groups will require inclusive innovation processes across the board, built on more dedicated consumer-centric outcomes driving retail market activity (rather than cost competition).

Foundation 2: Future-proof energy support mechanisms for the net zero context. As UK and Scottish governments refresh their fuel poverty and other bill support schemes, doing so in a way that also enables consumers in vulnerable circumstances to participate in and benefit from the changing energy system will need to ensure that support is designed with this changing energy system in mind, lowering bills while enabling access to new services, technologies and dynamic pricing.

Foundation 3: Embed and consolidate consumer protections across new and emerging services. While different technologies have different opportunities and challenges, there is a need to clarify and consolidate consumer protections, making it easier for consumers to understand their rights and take action should things go wrong. For consumers in vulnerable circumstances, this should also include an explicit 'no detriment' commitment to ensure bills do not rise and adverse impacts are mitigated.

Foundation 4: Tackle digital literacy and inclusion to enable more people to benefit from smarter services and offerings, while ensuring those who cannot participate are not penalised. One of the key barriers to accessing new technologies and services, and maximising their benefits, is digital literacy and inclusion. This must be a priority for all levels of government, retail and regulation, with protections for those who cannot or prefer not to flex their energy demand.

Contents

Section 1:

Introduction

Getting the retail market ready for net zero.

The UK energy system is undergoing rapid and fundamental changes to achieve its critical net zero targets.[1] These changes will impact all corners of the economy and society – including how people use and interact with energy in their homes and communities.

This transition is happening against a backdrop of historically high energy prices, driven by the rising cost of gas.[2] More than 980,000 households were estimated to be experiencing fuel poverty in Scotland as of 2023, equivalent to 39% of all households, with UK-wide energy consumer debt exceeding £3.7 billion as of winter 2024.[3, 4]

The transition to a cleaner energy system presents an opportunity to lower bills and better protect consumers.[5] By creating a more resilient, renewables-based energy supply that reduces overreliance on gas for heating and power generation, consumers can be better shielded from price shocks such as those seen from 2021 to 2024.[6]

1.1. The net zero transition will impact different consumers in different ways

Delivering net zero in a way that protects consumers is not solely about where energy comes from. Successful decarbonisation means enabling people from all backgrounds to transition from fossil fuel boilers to low and zero-emission forms of heating, reduce demand through energy efficiency, and swap petrol and diesel cars for electric vehicles (EVs), public transport

[1] UK government, 2024. Clean Power 2030 Action Plan.

[2] UK parliament, 2024. Gas and electricity prices during the energy crisis and beyond.

[3] Scottish government, 2023. Cost of Living (Tenant protection) (Scotland) Act 2022: First report to the Scottish Parliament.

[4] Ofgem, 2025. Debt and arrears indicators.

[5] E3G, 2025. The UK's Clean Power Mission: Delivering the prize.

[6] Office for Budget Responsibility, 2023. Fiscal risks and sustainability: July 2023.

and active travel.[7] To meet these aims, consumers will be expected to engage more actively with smart technologies, flexible tariffs, new services and offerings from energy suppliers.[8]

Not everyone will engage with this new energy system in the same way. The energy crisis exposed deep inequalities within the energy market, disproportionately affecting people on low incomes and experiencing wider vulnerabilities.[9, 10]

Research shows that those groups most impacted by high bills also face additional barriers to participating in a net zero energy system.[11, 12, 13] Standard-rate electricity is currently three to four times more expensive than gas for a typical domestic consumer, which could increase bills for some households as they move to low and zero-emission forms of heating.[14] Some people will find it difficult to engage with new, smart technologies and tariffs due to challenges of affordability, digital access, literacy and trust.[15]

While not everyone will be required to use their energy smarter or more flexibly, overcoming these barriers through innovation, regulation and targeted support will be critical to ensuring that net zero is delivered in a way that is accessible to everyone, protects the interests of already disadvantaged consumers and avoids exacerbating or creating new social, health and economic inequalities. It will also be critical to achieving the Scottish government's statutory target to eradicate fuel poverty by 2040.[16]

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[7] UK Climate Change Committee, 2025. Seventh Carbon Budget.

[8] Nesta, 2025. How different households use energy and how much it costs them.

[9] National Energy Action and Energy Action Scotland, 2022. The hardest hit: Impact of the energy crisis.

[10] New Economics Foundation, 2022. The Unequal Impacts of the Energy Bill Crisis.

[11] Sherriff, G., Butler, D., & Brown, P. 2022. 'The reduction of fuel poverty may be lost in the rush to decarbonise': Six research risks at the intersection of fuel poverty, climate change and decarbonisation. https://doi.org/10.3351/ppp.2022.3776894798

[12] Sovacool, B.K., Upham, P., Martiskainen, M. et al. 2023. Policy prescriptions to address energy and transport poverty in the United Kingdom. Nat Energy 8, 273–283. https://doi.org/10.1038/s41560-023-01196-w

[13] Institute for Community Studies, 2024. Our journey to net zero: understanding household and community participation in the UK's transition to a greener future.

[14] UK government, 2024. Quarterly energy prices.

[15] Citizen's Advice, 2022. Access Denied: Digital exclusion and disadvantage in the energy market.

[16] Scottish government, 2021. Tackling fuel poverty: A strategic approach.

1.2. **The retail market requires significant reform to enable a just net zero transition**

The retail market will play a pivotal role in enabling this consumer transition. As the main interface with consumers in the energy system – i.e. who we buy our energy from and pay our bills to – suppliers will need to evolve to deliver the new tariffs, services and protections that support people's switch to low-carbon energy fairly and affordably.[17]

The energy crisis exposed deep issues of supplier resource and resilience. Between 2021 and 2022, 29 suppliers failed due to soaring wholesale prices, affecting over four million consumers and adding £2.7 billion (approximately £94 per household per year) to bills through the 'supplier of last resort' mechanism.[18] UK and Scottish government intervention was essential to ensure consumers could pay their bills and suppliers could stay afloat. Public spending exceeded £50 billion for the 2022-23 financial year alone.[19]

The UK retail market is not currently designed with a just net zero transition in mind. Since privatisation in the 1980s, the driving philosophy of the UK retail market has been to increase competition between suppliers to achieve 'lowest cost' bills for consumers. This has long been the core ambition of successive governments and the energy regulator, Ofgem.[20]

Because of this focus on cost competition (and, more recently, customer service), suppliers have been broadly incentivised to provide the cheapest possible tariffs, working on slim operating margins to do so. Since introducing the energy price cap, price competition in the market has become less significant in differentiating suppliers, particularly through the energy crisis.[21] Switching remains 44% lower as of winter 2024 than in September 2021 (although this is beginning to thaw), with low satisfaction in energy suppliers across the board.[22]

With this narrow focus on cost, there are limited incentives (or resources) for supplier innovation or specialism to unlock the new tariffs, services and models that the net zero transition will ultimately require.[23] Despite a challenging environment, some suppliers have

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[17] Energy Systems Catapult, 2022. Clean Energy Retail: The role of energy retailers in the net zero transition.

[18] UK parliament, 2022. Regulation of energy suppliers.

[19] Office for Budget Responsibility, 2023. The cost of the government's energy support policies.

[20] UK government, 2024. Putting consumers first: Empowering and protecting energy consumers.

[21] Ofgem, 2025. Energy price cap.

[22] Ofgem, 2025. Retail market indicators.

[23] Stonehaven, 2023. Reinventing Retail Energy.

innovated by developing new tariffs for heat pumps, EV charging and solar and battery storage, although this varies widely across the market. [24, 25]

Given these challenges, the UK retail market requires reform to deliver net zero and protect consumers. Reforms are under way across energy markets to meet decarbonisation challenges and unlock value for consumers in the process (see Figure 1). The Energy Act (2023) gave Ofgem a new net zero duty, prioritising protecting current and future consumers through the net zero transition. The Review of Electricity Market Arrangements (REMA) is exploring reforms to the wholesale market with a view to passing the value of lower-cost renewables on to consumers (Appendix A: Wholesale market reform and other relevant consultations).[26]

More comprehensive retail market reform is expected to follow, with various ancillary changes already in train: the Department for Energy Security and Net Zero (DESNZ) recently consulted on Ofgem's role, Ofgem has recently consulted on a refresh of its Consumer Vulnerability Strategy, and regulation is being developed for suppliers on different technologies and services (e.g. flexibility and heat networks). [27, 28, 29]

Central to the success of these reforms – and a just net zero transition – will be rebuilding a more resilient, innovative retail market that delivers for different consumers, particularly those in vulnerable circumstances. This will include ensuring that new tariffs, technologies and services are accessible, designed inclusively to meet the needs of diverse groups and people, with adequate consumer protections that reflect the opportunities and challenges of a new, smarter energy system.

1.3. **Overview of this report**

This report aims to understand the potential impacts of a future UK retail energy market on different consumer groups in Scotland and emerging solutions in regulation, markets and innovation that could help to secure a just transition for consumers. It systematically reviews more than 120 articles across academic, innovation and policy literature to understand the current landscape of the retail energy market in Great Britain and the challenges consumers may face through Scotland and the UK's net zero transition.

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[24] Kattirtizi, M., Ketsopoulou, I. and Watson, J. 2021. Incumbents in transition? The role of the 'Big Six' energy companies in the UK. https://doi.org/10.1016/j.enpol.2020.111927

[25] Energy Saving Trust, 2024. Smart time-of-use tariffs: all you need to know.

[26] UK government, 2024. Review of Electricity Market Arrangements: Second consultation.

[27] Ofgem, 2024. Consultation: Consumer Vulnerability Strategy refresh.

[28] UK Department for Energy Security and Net Zero, 2024. Heat Networks regulation: Implementing consumer protections.

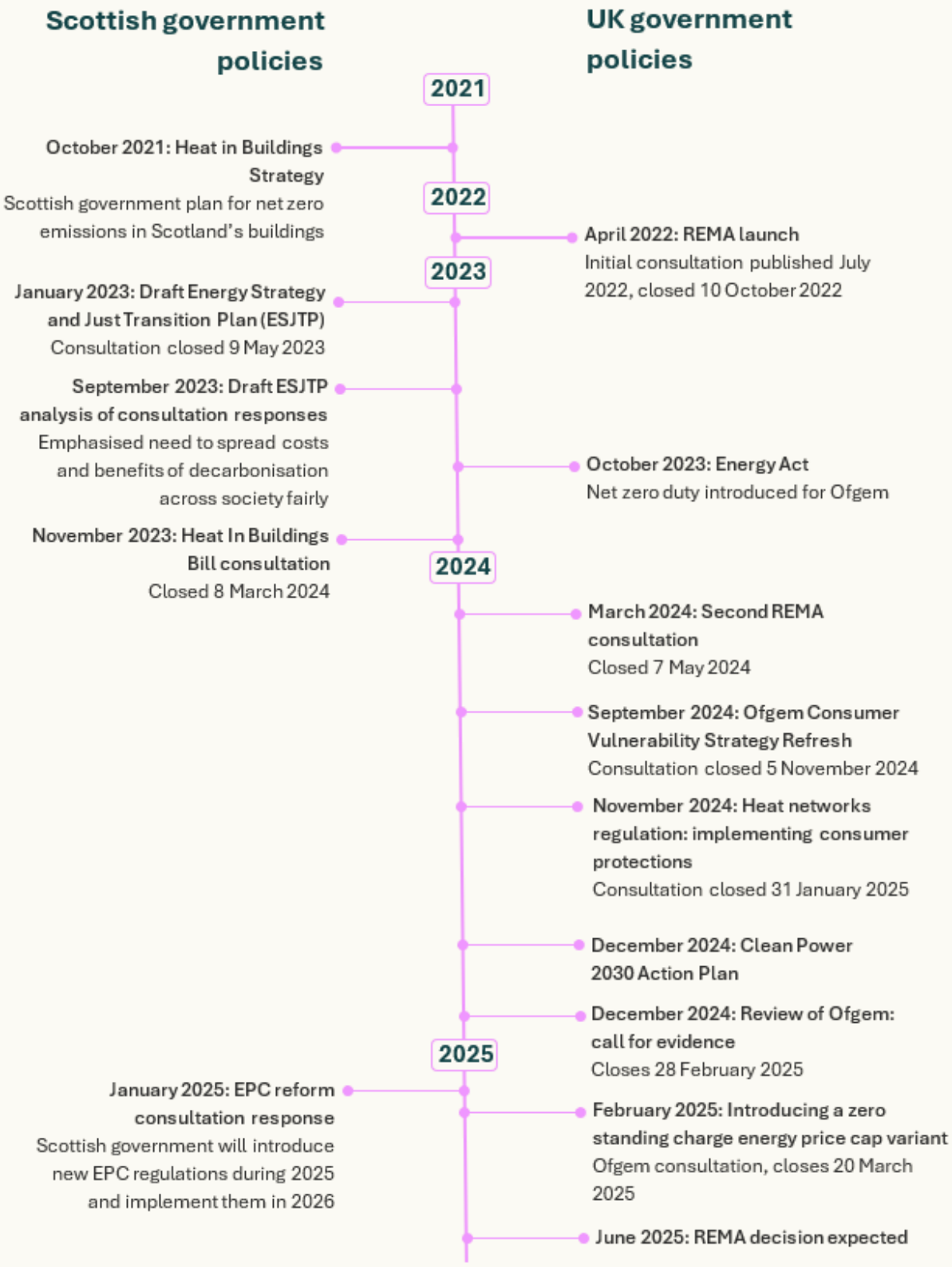
[29] UK Department for Energy Security and Net Zero, 2025. Review of Ofgem: call for evidence.

It then explores emerging solutions and reforms and the impacts these could have on consumers, with critical lessons for policymakers, energy suppliers and advocacy organisations in delivering a just net zero transition across four main themes:

- Tariffs and services for the future
- Data and digitalisation
- Consumer protection in the future retail market
- Inclusive energy market design.

Figure 1

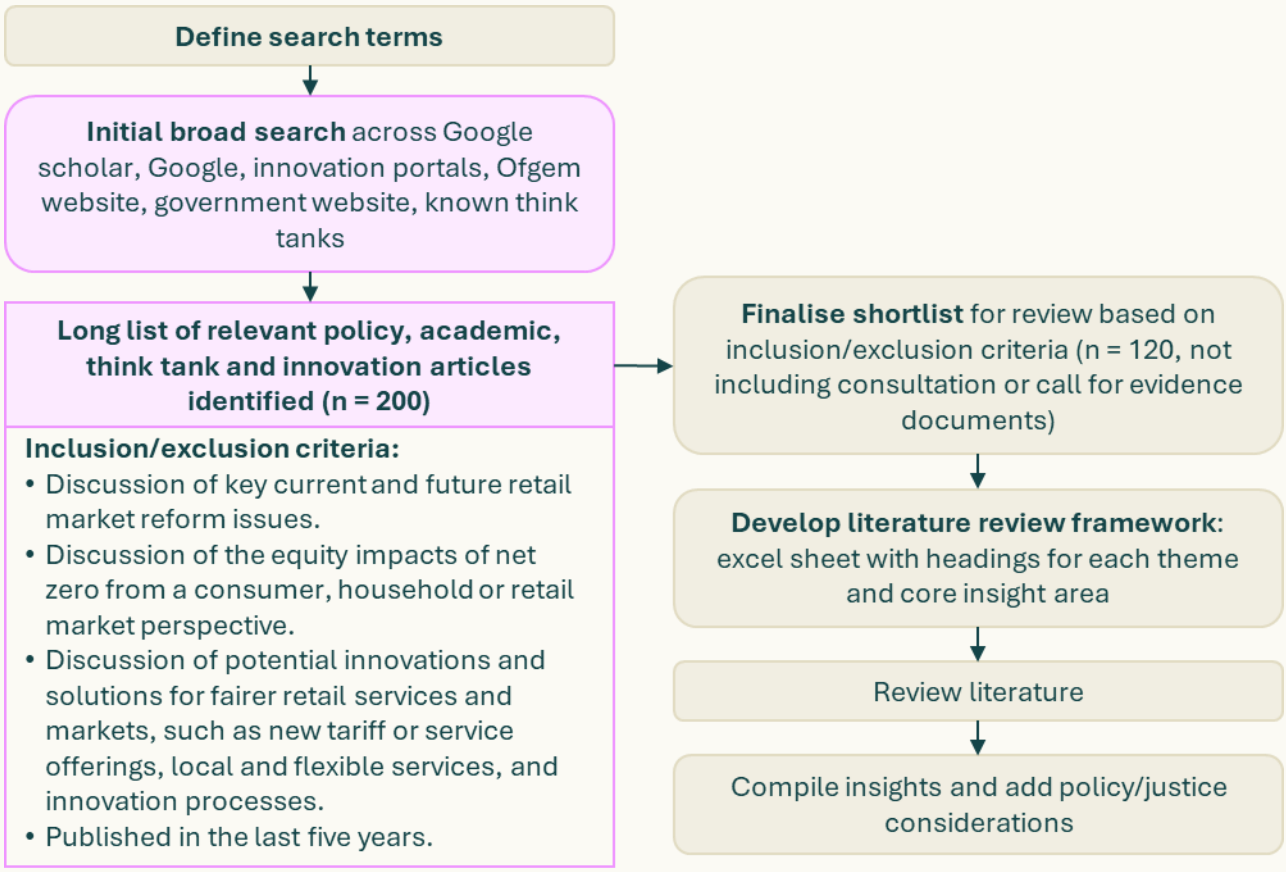
Timeline of key policy consultations and changes



1.4. Methodology

Figure 2

Rapid evidence assessment process



This report uses a systematic literature review methodology to arrive at core insights (Figure 2). This is based on a robust academic systematic review process, with some additions made.

Search terms and sources of information were compiled at the outset of the review. These were deliberately broadly defined to ensure that a wide range of literature across a number of sectors and disciplines could be captured. Initial sources for the review included:

- **Academic:** Google Scholar, Energy Research and Social Science, Energy Policy, Nature Energy, Applied Energy.
- **Thinktanks and advocacy:** Young Foundation, Stonehaven, Resolution Foundation, Regulatory Assistance Project, Citizens Advice, Energy Systems Catapult, Centre for Sustainable Energy.
- **Policy:** UK government policy, committee research (e.g. the Committee on Fuel Poverty), Ofgem consultation and summary reports, Scottish government policy announcements and equivalent research from the Scottish Fuel Poverty Advisory Panel.

- **Innovation:** Energy Networks Association Smarter Networks Portal, innovation project summary reports from, e.g. the National Energy System Operator and Scottish and Southern Electricity Network's CrowdFlex, Energy Systems Catapult's Inclusive Smart Solutions.

From each source, 'snowballing' was then used to identify further insights via citations in research identified via the initial search. Relevant documents were compiled into a longlist of literature before inclusion/exclusion criteria were applied. To ensure that the review was broad enough to capture useful insights yet focused enough to provide relevant and current information, these criteria were:

- Includes discussion of key current and future retail energy market reform issues
- Includes explicit discussion of the equity impacts of net zero from a consumer, household or retail energy market perspective
- Includes discussion of potential innovations and solutions for fairer retail services and markets, such as new tariff or service offerings, local and flexible services, and innovation processes
- Was published in the last five years.

Some exceptions were made to the final criterion. This was for two main reasons. First, some 'seminal' reports on key themes (such as engagement and inclusive innovation) were published prior to the five-year timeframe. Because these were often referenced in more recent reports, they were deemed relevant to include as a foundation for much of the research and evidence developed since. Second, some topics have seen less consumer-relevant research in recent years, particularly on tariff insights for those in vulnerable circumstances. Older studies were leveraged for relevant insights in these areas, although the need for more up-to-date insights is noted where these are drawn from.

We also excluded policy consultation and call-for-evidence documents within the systematic review, although we do include these throughout to provide a clear steer on 'live' discussions and current thinking among key decision makers (Ofgem, UK government).

To compile and analyse insights, we developed a **literature review framework**. This framework was a spreadsheet with headings for each core theme and question asked in this work, including columns for article metadata. This allowed us to systematically analyse and compare insights across different literature and themes easily.

1.4.1. Insights from the evidence

The most recent and directly relevant policy insights came from grey literature (such as thinktanks and policy advocacy organisations) and innovation project reports. Academic literature provided an extensive grounding in the challenges relating to vulnerability, energy justice and the wider interlinkages between fuel poverty and net zero. Policy documents from

Ofgem and similar organisations provide insights into current policymaking activity and thinking.

This trend largely reflects the delay in the academic publishing cycle, which can sometimes take several months (or years). Thus, insights can be less explicitly linked to current policy debates. In contrast, grey and innovation literature tends to be up to speed, although it can sometimes be politically or advocacy motivated. As such, this review combines insights from the two to ensure a balanced perspective on identified debates and solutions.

All emerging solutions presented in this paper were identified via the literature review process, suggested by one or several authors and publications. However, while much of the literature provides robust insight into different issues, themes and solutions, some of the literature reviewed stops short of detailing potential distributional impacts and/or current policy implications.

Several articles also considered solutions without expressing support or opposition. As such, this report does not quantify support or weight of evidence on different topics – it presents what was found with some critical discussion of potential challenges or opportunities, identifies relevant 'live' policy discussions and highlights where future research may be useful. These should not be taken to reflect the views of Regen or Consumer Scotland.

Section 2:

Energy market impacts on different consumers

Understanding how different people are affected by the energy market today and potential challenges presented by future reform.

The energy transition presents new opportunities to lower bills and pass value on to consumers.[30] Yet different people and groups will engage with the shift to a smarter, more active energy system in different ways – and face different barriers to doing so. For instance, those already experiencing fuel poverty face challenges in affording the upfront costs of heat pumps or other low-carbon technologies.[31]

There is a clear need to ensure that those already disadvantaged in the energy system today by disproportionately high prices, energy debt, and wider social, economic, and health issues can also participate in the transition and be protected from adverse outcomes.[32, 33]

Ofgem and suppliers are responsible for protecting consumers in vulnerable circumstances as part of their supply licence obligations.[34] The Energy Act (2023) gave Ofgem a new net zero duty: to protect current and future energy consumers through the net zero transition.[35]

Protecting consumers – and enabling them to participate in and benefit from the clean energy transition – means first understanding the additional barriers they face and the potential adverse impacts net zero could create for them.

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[30] E3G, 2025. The UK's Clean Power Mission: Delivering the prize.

[31] Institute for Community Studies, 2024. Our journey to net zero: understanding household and community participation in the UK's transition to a greener future.

[32] Middlemiss, L. 2022. Who is vulnerable to energy poverty in the Global North, and what is their experience? https://doi.org/10.1002/wene.455

[33] Calver, P., Mander, S. and Abi Ghanem, D. 2022. Low carbon system innovation through an energy justice lens: Exploring domestic heat pump adoption with direct load control in the United Kingdom. https://doi.org/10.1016/j.erss.2021.102299

[34] Ofgem, 2019. Supply licence guide: safety and vulnerability protections.

[35] UK government, 2023. The Energy Act (2023).

2.1. **Impacts of energy markets and the net zero transition on different consumer groups**

Extensive research has outlined the challenges and inequalities that exist in the retail market today – and that may impact consumers in the future through the net zero transition.[36, 37, 38, 39, 40, 41, 42] Within the UK retail market, the main focus of addressing these challenges has been supporting consumers in 'vulnerable circumstances'.

Ofgem's Consumer Vulnerability Strategy, which is currently being refreshed, defines vulnerability as 'consumer circumstances which make them less able to represent or protect their own interests, or more likely to suffer detrimental impact' in the energy system.[43]

For many, vulnerable circumstances can be enduring, for example, long-term physical health or mobility issues. However, vulnerability can also be transient. Many people will fall into and out of vulnerability or disadvantage, driven by different factors over time, such as bereavement, unemployment or external price shocks.[44, 45]

Beyond vulnerability, some organisations have argued for more nuanced approaches to delivering an inclusive energy transition. The Centre for Sustainable Energy, for example, applies a 'capabilities lens' to understand household readiness for a smart energy transition, based on people's circumstances, mindset, values, living conditions, local networks and existing use of energy.[46]

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[36] Bouzarovski, S., Burbidge, M., Sarpodtar, A. and Martiskainen, M. 2022. The Diversity Penalty: Domestic energy injustices and ethnic minorities in the United Kingdom. https://doi.org/10.1016/j.erss.2022.102716

[37] Narayan, U., Higginson, S., & Eyre, N. (2023). How can energy demand advance racial justice? The case of the UK. 589–600.

[38] Regen and Scottish and Southern Electricity Networks, 2024. Vulnerability, just transition and future energy scenarios.

[39] Institute for Community Studies, 2024. Our journey to net zero: understanding household and community participation in the UK's transition to a greener future.

[40] Institute for Community Studies, 2024. Our Journey to Net Zero: Understanding household and community participation in the UK's transition to a greener future.

[41] Al Kez, D., Foley, A., Khald Abdul, Z., Furszyfer Del Rio, D. 2024. Energy poverty prediction in the United Kingdom: a machine learning approach. https://doi.org/10.1016/j.enpol.2023.113909

[42] Middlemiss, L., Snell, C., Theminimulle, S., Carregha, T., Morrison, E., Chzen, Y., Kennedy, K. and Owen, A. 2024. Place-based and people-centred: Principles for a socially inclusive net zero transition. https://doi.org/10.1002/geo2.157

[43] UK Department for Energy Security and Net Zero, 2024. Heat Networks regulation: Implementing consumer protections.

[44] Citizen's Advice, 2023. Ripping off the band-aid: Ways to reform the retail energy market.

[45] Consumer Scotland, 2024. Consumer Scotland's approach to working with consumers in vulnerable circumstances.

[46] Centre for Sustainable Energy, 2025. The smart capabilities lens.

The net zero transition creates scope for new drivers of vulnerability, inequality and exclusion in the retail market.[47, 48, 49] These include (but are not limited to):

- **Capital costs of new technologies**. The high costs of low-carbon technologies such as heat pumps will make the transition challenging for those on lower incomes, leaving them more exposed to future fossil fuel price shocks.[49]
- **Electricity prices.** While discounted low-carbon heating tariffs do exist, standard-rate electricity for a typical consumer in Great Britain remains four times higher than gas prices today, which risks increasing heating costs for some households.[50, 51]
- **Potentially limited ability to flex energy demand.** Making the most of time-of-use tariffs may be challenging for people who cannot flex their demand at peak times with low prices, such as single-parent households or shift workers (e.g. nurses).[52]
- **Digital exclusion and literacy.** Almost 3 million UK households still lack access to the internet, with a further 11 million people citing that they do not have basic digital skills such as email and browsing.[53]
- **Rising network and policy costs.** In particular, the expected increase in gas network decommissioning costs could fall on a dwindling number of lower-income and vulnerable consumers who cannot afford to electrify their home heating demand.[54]
- **Increased risk if things go wrong.** People in vulnerable, low-income, or disadvantaged circumstances already face tough social, economic, health and personal challenges, which could be worsened if new technologies or services fail to meet their needs.[55, 56]
- **Pressures of poverty and socioeconomic disadvantage may limit capacity to engage with new technologies and behaviours.**[57] In addition to affordability, wider stressors may create additional challenges in time, resources and ability for those in

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[47] Energy Systems Catapult, 2021. How can innovation deliver a smart energy system that works for low income and vulnerable consumers? Project InvoLVe

[48] Knox, S., Hannon, M., Stewart, F. and Ford, R. 2022. The (in)justices of smart local energy systems: A systematic review, integrated framework and future research agenda. https://doi.org/10.1016/j.erss.2021.102333

[49] UK government, 2023. The Energy Act (2023).

[50] UK government, 2024. Quarterly energy prices.

[51] Savage, T., Akroyd, J., Mosbach, S., Hillman, M., Siekler, F. and Kraft, M., 2022. Universal digital twin-the impacts of heat pumps on social inequality. https://doi.org/10.1016/j.adapen.2021.100079

[52] Powells, G. and Fell, M. 2019. Flexibility capital and flexibility justice in smart energy systems. https://doi.org/10.1016/j.erss.2019.03.015

[53] Chambers, J., Robinson, C., and Scott, M. 2022. Digitalisation without detriment: A research agenda for digital inclusion in the future energy system. https://doi.org/10.3351/ppp.2022.5254227477

[54] Regulatory Assistance Project, 2023. Decompression: Policy and regulatory options to manage the gas grid in a decarbonizing UK.

[55] National Energy Action, 2023. Making heat pumps work for fuel poor households.

[56] Institute for Community Studies, 2024. Our journey to net zero: understanding household and community participation in the UK's transition to a greener future.

[57] Kukowski, C. A. and Garnett, E. E. 2024. Tackling inequality is essential for behaviour change in net zero. https://doi.org/10.1038/s41558-023-01900-4

more complex, vulnerable or marginalised circumstances to engage with novel or innovative services.

Table 1

Barriers to net zero for different groups[58]

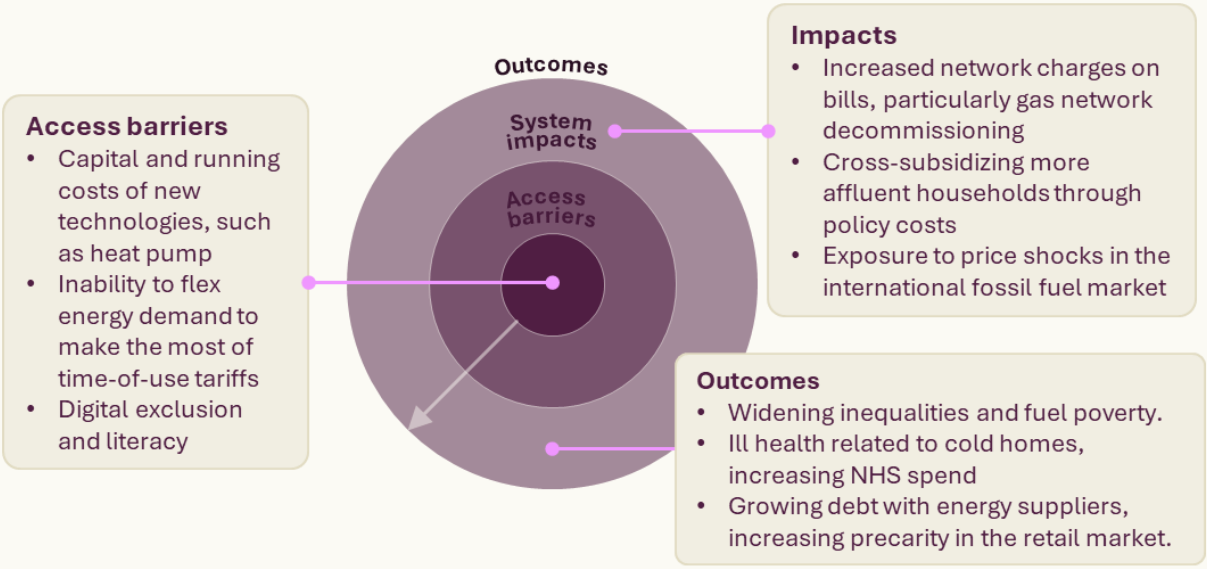
Group	Barriers to net zero
People on low incomes or means-tested benefits	The capital costs of new technologies may be too high, with limited scope for finance; higher electricity costs may increase energy bills; existing energy debt; time and resource pressures to engage with new technologies or behaviours.
People with mobility or physical health issues	Potential limited inability to flex or reduce energy demand to capitalise on e.g. time-of-use tariffs; dependence on medical equipment may increase bills.
People with mental health issues and/or facing social exclusion	Lack of confidence or social support networks may cause some to disengage with new technologies or services.
People from minority ethnic communities, particularly for whom English is not a first language	Lack of confidence or trust in engaging with suppliers or new technologies and services; lack of clarity on rights and consumer protections; existing injustices in housing quality and service provision.
Digitally excluded	Limited access to information or new 'smart' technologies and services.
People of a pensionable age	Lack of confidence in engaging with suppliers or new technologies and services; often digitally excluded.
Single-parent households	Limited capacity to flex energy demand; capital costs of new technologies may be too high; higher electricity costs may increase energy bills.
People with caring responsibilities	Limited capacity to flex energy demand; lack of clarity on rights and consumer protections; capital costs of new technologies may be too high.
People living off the gas grid	Reliance on older heating systems, including non-smart meters, direct electric and oil heating; vulnerability to supply interruptions.

[58] Information in this table is compiled from the review of evidence referenced within this report so far. While different sources can focus specifically on different social, cultural, personal or demographic factors, the ones included here are those which featured in multiple articles and explicitly in Ofgem/UK government literature (e.g. Ofgem's Consumer Vulnerability Strategy Refresh 2024).

People in the private rented sector	Lack of clarity on rights and consumer protections, or autonomy in the retail market.

Figure 3

Impacts of different net zero barriers



These challenges do not only impact consumer bills. Living in cold, damp homes with inadequate heating has been linked to early-onset asthma in children and excess winter mortality rates, as well as a range of respiratory, cardiovascular and mental health challenges.[59] According to the Institute of Health Inequities, fuel poverty costs the NHS over £2.5 billion per year across the UK.[60]

Without addressing these challenges in the retail energy market, there is a strong risk that net zero exacerbates current social and economic inequalities while increasing ill health, energy debt and wider economic precarity.[61, 62]

[59] Energy Action Scotland, 2023. Health, housing and fuel poverty.

[60] Institute for Health Inequities, 2022. Fuel poverty, cold homes and health inequalities in the UK.

[61] Stewart, F. Friends with benefits: How income and peer diffusion combine to create an inequality 'trap' in the uptake of low-carbon technologies. https://doi.org/10.1016/j.enpol.2022.112832

[62] Institute for Community Studies, 2024. Our journey to net zero: understanding household and community participation in the UK's transition to a greener future.

However, if the transition is done well, there is scope to improve outcomes for those most excluded in today's market. Lessons are already emerging from European innovation programmes on delivering this in practice.[63] Beyond vulnerability, the climate and energy literature has argued for more directly linking social inequalities and climate priorities, with survey and focus group research outlining wider public desire for this approach.[64, 65]

2.2. **Scottish-specific challenges**

The retail energy market and associated regulation remain a reserved issue, with consumers in Scotland operating within the GB-wide energy system. As such, consumers in Scotland face similar broad challenges to consumers in other parts of the country.[66]

However, some unique challenges exist, especially in more remote rural areas. The highlands and islands face significantly higher energy bills and rates of fuel poverty than the rest of Scotland and the UK.[67] In addition to the higher cost of living in remote areas, this is due to two main energy-specific drivers:

- **Less energy-efficient housing stock:** Energy efficiency is significantly worse than the Scottish average across highlands and islands local authorities. In Orkney, 17% of homes are rated Energy Performance Certificate (EPC) F-G compared to 4% Scotland-wide. This means people must use more energy to stay warm, or restrict heating to unhealthy levels.
- **Rurality and off-gas grid:** As of 2023, 65% of highlands and islands households were not connected to the gas network, relying instead on more expensive oil, liquified petroleum gas (LPG) or electricity-based systems (e.g. night storage heaters) for heat (Figure 4).

These create challenges for net zero retail market participation. For instance, less efficient homes create a 'poverty premium' for those in low-income situations by increasing energy bills, and may be less suitable for low-carbon heating systems such as heat pumps.[68] The

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[63] Regulatory Assistance Project, 2024. Flex-ability for all: Pursuing socially inclusive demand-side flexibility in Europe.

[64] Whitmarsh, L., Verfuerth, C., & Westlake, S. (2023). *net zero: Direct costs of climate policies aren't a major barrier to public support, research reveals*. The Conversation. August, https://theconversation.com/net-zero-direct-costs-of-climate-policies-arent-a-major-barrier-to-public-support-research-reveals-210851

[65] Irwin, S. 2024. Addressing hardship and climate change: Citizen's perceptions of cost-of-living, social inequalities and priorities for policy. https://doi.org/10.1111/spol.13071

[66] Ofgem, 2025. Standing charges and unit rates by Direct Debit, 1 January to 31 March 2025.

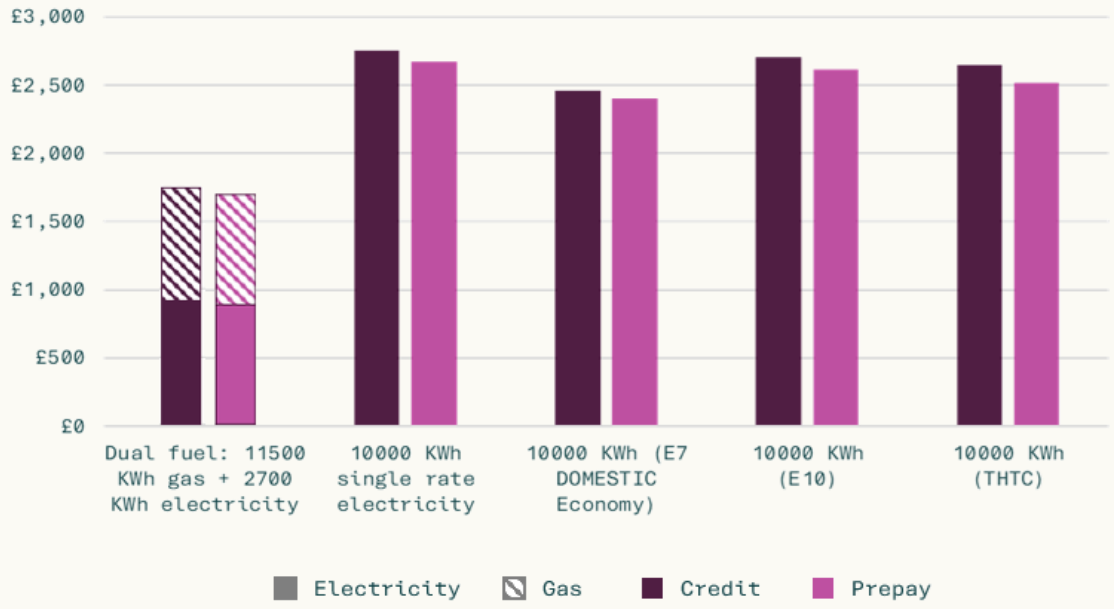
[67] Scottish government, 2023. Scottish islands: data overview 2023.

[68] Evans, J., Robinson, C., and Davies, S. 2024. Energy inefficiency as a 'poverty premium'. https://doi.org/10.1016/j.erss.2024.103824

disproportionate impact of high prices in the highlands and islands may have pushed consumers further into energy debt and disadvantage, increasing financial barriers. Rurality can also present connectivity and transport challenges, with smart meter uptake significantly lower in rural Scotland than in other parts of the UK (Figure 5).[69]

Figure 4

Annual bills for dual fuel and electric heating systems in the North of Scotland, January 2025[70]

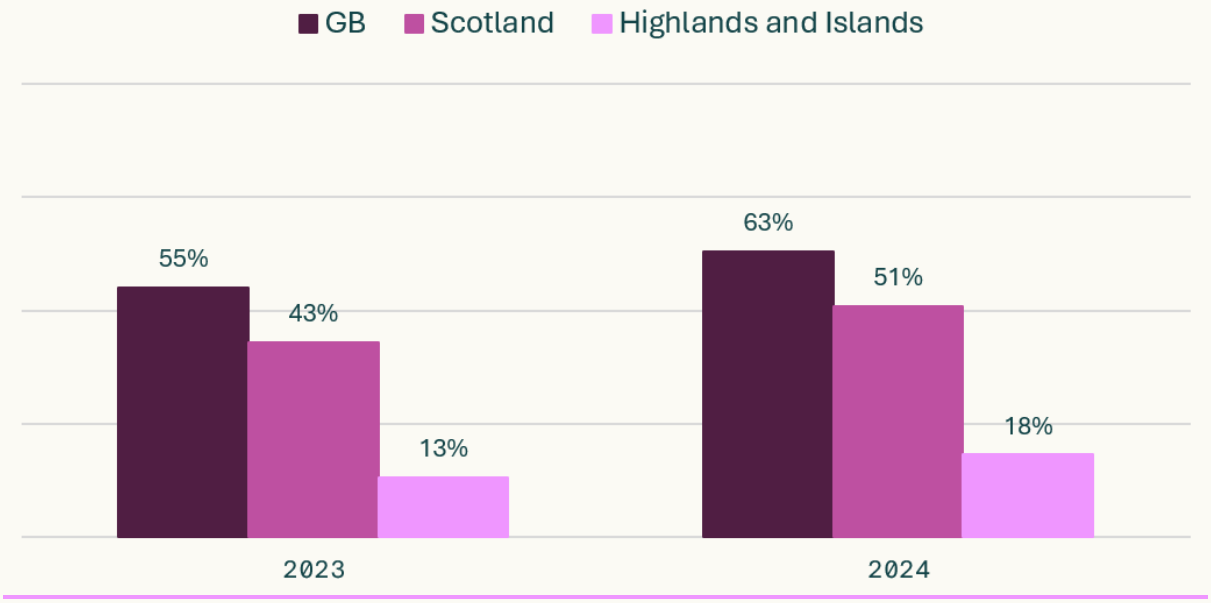


[69] UK parliament, 2023. Cost of living: Impact on rural communities in Scotland.

[70] Note: These figures are modelled based on tariff data from Ovo, EDF, Scottish Power, Octopus and Utilita. Economy 7 and Economy 10 figures assume 60% off-peak use, while the Total Heat Total Control (THTC) figures assumes 70% use on the lower heating rate, based on a North of Scotland fuel poverty charity's assessment of real energy bills.

Figure 5

Installed domestic smart meters since 2023



Data source: DESNZ, 2024. Smart meter statistics

To deal with these challenges, innovation towards net zero has been taking place in the highlands and islands, including schemes designed to lower bills and develop local energy systems. Heat Smart Orkney, for instance, connected electric and water immersion heaters in 72 households to a local wind turbine, using excesses generated by the turbine during curtailment events to power secondary heating units.[71]

2.3. Evidence assessment

The potential impacts of the net zero transition on different groups are well documented, using a range of robust analytical techniques, qualitative and quantitative approaches, conceptual frameworks and lived experience research.

Less covered in the literature are the impacts of net zero interventions for specific groups – i.e. how the transition is playing out for consumers who are interacting with smart or low-carbon retail services, and what their experiences and impacts are, particularly in low-income or vulnerable situations. Some user experience cases do exist, such as the Centre for Sustainable Energy's survey of over 23,000 users in the National Energy System Operator (NESO) Demand

[71] Heat Smart Orkney, 2020. Final project report.

Flexibility Service, although there is less evidence covering the breadth of tariffs, services, innovations or technologies expected to play a role in the future retail market.

Case studies and insights exist from some research and innovation programmes, such as from National Energy Action's 'Making heat pumps work for fuel poor households' and the Scottish government's fuel poverty lived experience research, [72, 73] although these are usually with a small participant group, with limited synthesis of low-income user experience research or data.

[72] Scottish Government, 2020. Lived experience of fuel poverty: research.

[73] Savage, T., Akroyd, J., Mosbach, S., Hillman, M., Siekler, F. and Kraft, M., 2022. Universal digital twin-the impacts of heat pumps on social inequality. https://doi.org/10.1016/j.adapen.2021.100079

Section 3:

Tariffs and services for the future

Engaging with a new energy system.

3.1. Current policy and challenges

Innovation in tariffs and services will be critical to delivering net zero in a way that is affordable and accessible for all consumers. Reflecting this, in 2024 Ofgem consulted on ways to enable more innovation within the retail market.[74]

More consumers are expected to use time-of-use tariffs, flexing their energy at certain times of the day to help balance the system and capitalise on lower energy costs.[75] Suppliers are increasingly exploring financial offerings that enable installations without excessive upfront costs to support households in adopting new low-carbon technologies.[76] New tariffs designed for specific technologies, such as EVs or heat pumps, already offer discounted rates during set times of the day.[77] Energy-as-a-service models have been developed that charge users based on achieving a set level of heat or comfort in the home rather than fixed unit prices.[78]

With this shift, the role of suppliers will evolve from purely providing energy to households at a fixed cost, into wider service, finance and technology providers. Questions remain about how accessible new tariffs and services will be to low-income, vulnerable and disadvantaged consumers. Against a backdrop of high prices, soaring fuel poverty and growing energy debt, support will be required to provide affordable energy while also enabling people to benefit from new services and offerings.[79] This means not only enabling innovation in the retail market, but ensuring that future energy bill and fuel poverty support is designed with the net zero context in

[74] Ofgem, 2024. Consultation: Innovation in the energy retail market.

[75] NESO, 2024. Clean Power 2030.

[76] IMS Heat Pumps, 2024. Understanding Heat Pump Tariffs in the UK.

[77] Good Energy, 2025. Renewable Heat Pump Tariff.

[78] Energy Systems Catapult, 2019. Heat as a Service: An introduction.

[79] UK government, 2024. Quarterly energy prices.

mind.[80] Ofgem and DESNZ have been exploring options for rebalancing policy costs on energy bills, tackling high electricity prices (predominantly through REMA) and a possible social tariff.

3.2. Live discussions and solutions

3.2.1. Flexibility and time-of-use tariffs

One of the key developments in the retail energy market has been the growth in time-of-use tariffs and flexibility services. Through time-of-use tariffs, consumers are incentivised to save money by using energy when energy prices are lower, which helps to balance more variable energy generation associated with a renewables-based system.[81] These can be attached to specific technologies – for example, to encourage EV charging at certain times.[82]

There are two main forms of time-of-use tariff:

- **Static**, which provide lower prices at set times of day or within a week over a long contractual period (e.g. Economy 7)
- **Dynamic** or 'pass-through', which provide close to real-time (half-hourly, day-ahead) prices to consumers so they can adjust their consumption when renewables are more abundant or costs are lower (e.g. Octopus Agile).

Static time-of-use tariffs have been operating for some time and can encourage people to use energy at off-peak rates. Economy 7 tariffs, for instance, provide lower prices overnight and are well-demonstrated by people who use night storage heaters. Dynamic tariffs are more novel to the UK market and require a smart meter to take full advantage of their benefits.[83]

To support a clean power system, NESO expects a significant increase in consumers participating in demand-side flexibility through smart tariffs, appliances, EV charging, smart heating systems and responding to national demand turn-down events.[84] If planned well, smart services to enable consumers to use their energy more flexibly can drive overall system

[80] Institute for Community Studies, 2024. Our journey to net zero: understanding household and community participation in the UK's transition to a greener future.

[81] Carmichael, R., Gross, R., Hanna, R., Rhodes, A. and Green, T. 2021. The Demand Response Technology Cluster: Accelerating UK consumer engagement with time-of-use tariffs, electric vehicles and smart meters via digital comparison tools. https://doi.org/10.1016/j.rser.2020.110701

[82] Scottish Government, 2020. Lived experience of fuel poverty: research.

[83] Energy Saving Trust, 2024. Smart time-of-use tariffs: all you need to know.

[84] NESO, 2024. Clean Power 2030.

efficiency, resulting in cost savings for everyone – even those on non-smart tariffs.[85, 86] However, maximising the value of flexibility and smarter tariffs for those who may benefit will require overcoming some key barriers to access. Without innovation to meet different consumers' needs and circumstances directly, there is a risk of creating a two-tier energy system where wealthier households benefit from innovative tariffs and flexibility services while lower-income consumers remain on higher-cost legacy tariffs.[87]

Specifically, households are at risk of exclusion from flexibility and time-of-use tariffs if they:

- May struggle to flex their energy demand due to lifestyle, work, medical needs or caring commitments [88, 89]
- Live in the private rented sector without direct control over their energy tariffs or metering [90]
- Have a non-smart prepayment meter rather than a smart meter, which is more prevalent among lower-income households or those with energy debt [91]
- Lack confidence in digital technologies or are digitally excluded, or face additional social and economic pressures which make it challenging to engage with new systems or technologies.[92, 93]

While some consensus exists in the literature, the picture on the ability to flex due to lifestyle differences is more nuanced. Analysis of UK Time Use Survey data from 2014-15 found that socioeconomic factors were less important in determining how people used their energy compared to the general timing of activities in the home.[94] Once people are using time-of-use tariffs, this suggests that there may be fewer differences in the timing of interaction – yet some lifestyle challenges (as well as the other barriers noted above) may still preclude certain people

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[85] Regen, 2024, Electrification: Local grid challenge

[86] Note: These savings are typically assumed to come through reduced need for network investment, which can reduce network charges paid on energy bills, and reduced wholesale costs through shifting peak demand, reducing costs for balancing the energy system.

[87] Nesta, 2025. How different households use energy and how much it costs them.

[88] Citizen's Advice, 2022. Access Denied: Digital exclusion and disadvantage in the energy market.

[89] Hardmeier, M., Berthold, A. & Siegrist, M. 2024. Factors Influencing People's Willingness to Shift Their Electricity Consumption. https://doi.org/10.1007/s10603-024-09561-2

[90] Smith, A., Torres Contreras, G. A., Brisbois, M., Lacey-Barnacle, M. and Sovacool, B., 2023. Inclusive innovation in just transitions: The case of smart local energy systems in the UK. https://doi.org/10.1016/j.eist.2023.100719

[91] Fawcett, T., Palmer, J., Terry, N., Boardman, B. and Narayan, U., 2024. Using smart energy meter data to design better policy: Prepayment meter customers, fuel poverty and policy targeting in Great Britain. https://doi.org/10.1016/j.erss.2024.103666

[92] Powells, G. and Fell, M. 2019. Flexibility capital and flexibility justice in smart energy systems. https://doi.org/10.1016/j.erss.2019.03.015

[93] Chambers, J., Robinson, C., and Scott, M. 2022. Digitalisation without detriment: A research agenda for digital inclusion in the future energy system. https://doi.org/10.3351/ppp.2022.5254227477

[94] Torriti, J. and Yunusov, T. 2020. It's only a matter of time: Flexibility activities and time-of-us tariffs in the United Kingdom. https://doi.org/10.1016/j.erss.2020.101697

from engaging and benefiting overall without the use of smart home energy management technologies (See Section 4: Data and digitalisation).

There are a growing number of flexible and time-of-use tariffs on offer in the UK retail market, but they are still relatively niche. The majority of energy consumers in Great Britain are charged the same rates regardless of when they use energy.[95] As of winter 2024, only 9% of consumers in Scotland were on a time-of-use tariff.[96] Part of the reason is a general lack of awareness, while some note that they do not want to have to think about energy consumption on a day-to-day basis.[97] Previous research with fuel-poor households has also demonstrated that such groups face additional social pressures which can inhibit them from engaging with new and different tariffs, services or models.[98, 99]

The biggest cost savings from dynamic time-of-use tariffs tend to occur when coupled with technologies such as heat pumps, battery storage or EVs.[100] Modelling from Nesta suggests that this is true even when heat pump users do not turn down their consumption in response to price signals, since there tend to be far more hours of cheap electricity in a given year than higher price times.[101] This means those who cannot afford to transition to low-carbon heating or EVs may lose out on significant savings, although they could still benefit from lower prices on some time-of-use tariffs compared to longer-term, static tariffs.[102]

An innovation project led by Warmworks in Dumfries and Galloway likewise found that the installation of batteries in social housing, allowing users to charge at cheap times and use during higher prices, brought bills down significantly for consumers involved in the trial.[103] This suggests that full retrofits are not necessarily required but the installation of battery technologies alone could serve as a first step to smarter, flexible energy use that benefits consumers in vulnerable situations.

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[95] Citizens Advice, 2022, Room for Reform: Embedding Fair Outcomes for Tenants in Tomorrow's Retail Energy Market

[96] Department for Energy Security and Net Zero, 2025. Public attitudes tracker: Energy bills and tariffs, winter 2024, UK.

[97] Energy Saving Trust, 2024. Smart time-of-use tariffs: all you need to know.

[98] Lorenc, A., Pedro, L., Basheda, B., Dize, C., Fernow, I. and Dias, L., 2013. Tackling fuel poverty through facilitating energy tariff switching: a participatory action research study in vulnerable groups. https://doi.org/10.1016/j.puhe.2013.07.004

[99] The above citation is from 2013, outside of the five-year publishing timeframe of this review. It was included as it provides useful, direct insights into lived experience of fuel poor households on tariffs and active energy behaviours. However, there is a need for more up-to-date research in light of the cost-of-living and energy crises.

[100] Citizen's Advice, 2017. The value of time-of-use tariffs.

[101] Nesta, 2024. Can time-of-use tariffs make heat pumps cheaper to run?

[102] Hussain, A. and Paula Torres, M., 2019. Time to pick up pace of dynamic electricity pricing.

[103] Warmworks Scotland, 2021. Domestic Battery Storage Project: Project Report.

There is a risk that time-of-use tariffs increase prices for consumers in vulnerable circumstances if not used effectively.[104] If consumers are not completely clear on how time-of-use tariffs work and are not confident in engaging with them, exposure to higher prices may cause some distress. If time-of-use signals are misunderstood, misused or simply not suitable for consumers' circumstances, bills could, in turn, increase.[105] Better insights are needed into how consumers use time-of-use tariffs today, particularly for those in vulnerable circumstances.

The viability of flexible heating will be limited for the significant number of households with poor fabric efficiency.[104] Trials are under way to understand the limits of adjusting home heating schedules to capitalise on lower price periods, pre-heating houses to maintain 'comfortable' spaces throughout different pricing periods to ensure that spaces are neither too warm during pre-heat phases nor too cold during high-price periods. A household's ability to shift is, therefore, the product of two factors: how fast the house loses heat (i.e. the fabric efficiency) and the occupant's personal comfort ranges.[106, 107]

The additional challenges faced by Scottish consumers in the Highlands and Islands in particular means that there is a need for a better understanding of how households with poorer energy efficiency, lower incomes and in wider vulnerable circumstances can realistically interact with flexible tariffs and heating systems – and the broader support needed (e.g. smart meters, energy efficiency) to make these viable.

National flexibility events, such as the Demand Flexibility Service (DFS), saw low barriers to entry, but there were still challenges.[108] In winter 2023, NESO launched its first DFS trial, designed to encourage consumers to adjust their energy consumption to alleviate pressures on the energy system. The Centre for Sustainable Energy surveyed more than 23,000 households who participated in the trial, finding that even those identified in the literature as having barriers *could* participate, although at a lower rate than higher-income groups. Those with health conditions, renters and low-income groups reported slightly worse experiences and lower

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[104] Savage, T., Akroyd, J., Mosbach, S., Hillman, M., Siekler, F. and Kraft, M., 2022. Universal digital twin-the impacts of heat pumps on social inequality. https://doi.org/10.1016/j.adapen.2021.100079

[105] Knox, S., Hannon, M., Stewart, F. and Ford, R. 2022. The (in)justices of smart local energy systems: A systematic review, integrated framework and future research agenda. https://doi.org/10.1016/j.erss.2021.102333

[106] There is evidence that EPCs are an unreliable predictor of heat loss/retention. [Commercial study, Switchee, 2023] [Few, J. et al, The over-prediction of energy use by EPCs in Great Britain: A comparison of EPC-modelled and metered primary energy use intensity, *Energy and Buildings*, Volume 288, 2023] This is partially due to the mixing of metrics, but also the 'performance gap'. The Scottish government consulted on EPC reform and has committed to including a specific metric, 'Heat Retention Rating' – however, this will still be modelled rather than actual heat loss tests.

[107] Nesta and Centre for Net Zero, 2024. HeatFlex: the untapped potential of automated heat pump flexibility.

[108] Centre for Sustainable Energy, 2024. Smart and fair: Working with the smart energy capabilities lens.

benefits.[109] This survey gives strong insights into experiences of national flexibility events, but there is limited similar evidence on users of time-of-use tariffs or flexible heating services.

Emerging solutions

Solution 1: Evolve the retail market to include dynamic time-of-use tariffs that are accessible to diverse groups, clearly understood and limit exposure to financial risk.[110] Examples from Spain show how time-of-use tariffs can be designed to offer flexibility benefits to different households while shielding low-income or vulnerable groups from potentially increased costs through a combination of dynamic pricing and a social tariff mechanism (see case study on Spain's Voluntary Price for Small Consumers Scheme on page 29). This will also require improving smart meter rollout and robust consumer protections (see Section 4: Data and digitalisation and Section 5: Consumer protection).

Solution 2: Continue to support/prioritise the energy efficiency improvements of fabric upgrades of homes.[111] A core element of reducing bills and ensuring flexibility does not lead to adverse impacts will be improving the energy efficiency of homes overall. For many in vulnerable circumstances, particularly rural Scotland, efficiency will be a prerequisite for realising any benefits from flexible, electrified heat that helps improve comfort and save money. In addition, a representative heat flexibility trial for Scotland to better understand feasibility and impacts is required.[112]

3.2.2. Heat- and Energy-as-a-Service

Heat- and Energy-as-a-Service models are those in which consumers pay for energy as a 'subscription' rather than investing up front in specific technologies and paying for energy separately. This essentially shifts the responsibility for installing, financing and maintaining low-carbon technologies and energy efficiency measures to the supplier (or service provider). Consumers pay the service provider for using these systems without owning them directly. In the case of Heat-as-a-Service, consumers will typically pay for an outcome (e.g. warmth in the home) rather than units of energy.[113] Heat-as-a-Service, Energy-as-a-Service and other bundled finance options are seeing renewed interest, with innovation projects ongoing across the UK (Appendix B: Energy-as-a-Service case studies).

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[109] Powells, G. and Fell, M. 2019. Flexibility capital and flexibility justice in smart energy systems. https://doi.org/10.1016/j.erss.2019.03.015

[110] Savage, T., Akroyd, J., Mosbach, S., Hillman, M., Siekler, F. and Kraft, M., 2022. Universal digital twin-the impacts of heat pumps on social inequality. https://doi.org/10.1016/j.adapen.2021.100079

[111] Sunderland, L. and Gibb, D. 2022. Taking the burn out of heating for low-income households.

[112] 4D heat modelled "off-gas grid area on the Isle of Skye, to explore the ability of flexible demand from heat to absorb wind power" [See SSEN heat strategy, p.10, and NIA_NGSO0033]

[113] Energy Systems Catapult, 2019. Heat as a Service: An introduction.

Energy-as-a-Service has long been touted as a solution to capital cost barriers to low-carbon technology uptake but has failed to capture the market. [114] While Energy- and Heat-as-a-Service models have become increasingly prominent in the commercial and industrial sectors, they have yet to take hold at scale in the domestic retail energy market.[115] This is partly due to current market incentives, which promote efficiencies and 'lowest cost' rather than meeting consumer needs or outcomes, and the complexity of having to navigate multiple regulatory frameworks (e.g. energy supply, financial conduct) to implement.[116, 117]

Given the limited availability of these services, there are limited consumer insights to date. Smaller-scale trials have demonstrated that consumers in vulnerable circumstances generally preferred purchasing a service (e.g. hours of warmth) over kilowatt hours of power.[118] Some qualitative research has also suggested that consumers view 'as-a-service' models as potentially useful in overcoming financial barriers to installing heat pumps.[119]

Yet there are potential logistical challenges – primarily maintaining the right to switch suppliers without locking consumers into long-term contracts. Those in the private rented sector may also struggle to participate in energy-as-a-service models because landlords are ultimately responsible for installing technology or long-term contractual arrangements.

Overall, there remains a lack of demonstration of as-a-service models in the energy market in Great Britain, particularly for consumers in vulnerable circumstances. Further research into user experience of such models from other markets where they are more prominent (e.g. Denmark) and wider consumer perspectives would support a more informed policy discussion and supplier innovation.[119]

Emerging solutions

Solution 1: Demonstrate the viability of Energy-as-a-Service for consumers in vulnerable circumstances.[120] Many commercial Heat-as-a-Service models seek to remove upfront costs, in theory enabling the uptake of low-carbon technologies for those who do not have access to upfront capital. With the right policy support, or linking up with existing grant and subsidy

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[114] See p. 82, Scottish Government, Heat in Buildings Strategy

[115] Deloitte, 2019. Energy-as-a-Service.

[116] Climate Exchange, 2021. The potential of Heat as a Service as a route to decarbonisation for Scotland, http://dx.doi.org/10.7488/era/809

[117] UK government, 2024. Putting consumers first: Empowering and protecting energy consumers.

[118] Citizens Advice, 2022, Room for Reform: Embedding Fair Outcomes for Tenants in Tomorrow's Retail Energy Market

[119] Lorenc, A., Pedro, L., Basheda, B., Dize, C., Fernow, I. and Dias, L., 2013. Tackling fuel poverty through facilitating energy tariff switching: a participatory action research study in vulnerable groups. https://doi.org/10.1016/j.puhe.2013.07.004

[120] Clark, T., Hadfield, M., Pavlova Joveski, M., Burns, F., Dunne, H. and Conway, J. 2024. Heat pumps on subscription. http://dx.doi.org/10.7488/era/3637

schemes, a targeted and funded social Heat-as-a-Service structure could help guarantee that those on lower incomes or in vulnerable situations can benefit directly.[121]

Solution 2: Further demonstrate the business case for Energy-as-a-Service, including the role of flexibility in delivering savings to consumers and revenue to service providers. As-a-Service models remain novel to retail energy market in Great Britain. The business case and benefits of as-a-Service models will likely rely on savings associated with flexibility and time-of-use tariffs. As-a-Service providers could also play a role in aggregating and delivering flexibility in demand-side response events.[122]

3.2.3. Finance and bundling

To overcome the challenges of up-front capital costs of new technologies such as heat pumps, suppliers are increasingly exploring finance and bundling options. Various options have been proposed to spread (or avoid) the costs of installing low-carbon technologies (Table 2). These include traditional finance arrangements, similar to how gas boilers are typically funded today, 'leasing' options, where consumers pay a monthly rental fee, or subscription models closer to Heat-as-a-Service.[123]

Table 2

Current heat pump financing options

Adapted from Clark et al. 2024, Heat pumps on subscription[124]

Option	Overview	Indicative cost
Finance only	No up-front cost. Monthly financing of new heat pump. Customer owns the appliance.	£180/month over five years
Leasing	Leasing scheme with fixed monthly payments. Includes annual maintenance. Customer does not own the appliance.	£90/month, 15-year commitment
Subscription	Financing lease in which customer pays a monthly fee which includes a fixed cost per unit of energy delivered. Customer does not own the appliance.	£200/month, 15-year commitment

[121] Suggestion added by Regen as something not covered within the literature reviewed here.

[122] Crawley, J., Higginson, S., Moore, G. and Eyre, N. 2023. Summary of findings from heat pump flexibility expert workshop.

[123] Clark, T., Hadfield, M., Pavlova Joveski, M., Burns, F., Dunne, H. and Conway, J. 2024. Heat pumps on subscription. http://dx.doi.org/10.7488/era/3637

[124] Hussain, A. and Paula Torres, M., 2019. Time to pick up pace of dynamic electricity pricing.

Similar to Energy-as-a-Service, some suppliers are exploring 'bundling' options, where the supplier installs the technology or provides efficiency and retrofit services, as well as supply energy, within a single contract. One example of existing bundling is Centrica Hive EV Charging, which combines a smart EV home charger with Hive EV Charging software that synchronises with the consumer's energy tariff via the Hive app.

This differs from 'as-a-service' models in that the consumer is ultimately still responsible for the upfront costs, which are paid back over time via a finance arrangement, similar to mobile phone or broadband contracts.[125] This can also happen across utility sectors, e.g. an energy supplier also providing broadband services, which research suggests consumers find convenient.

While providing a new way to pay for technologies or works in the home, financing and bundling may rely on consumer credit, and will increase monthly expenditure significantly.[126] As a result, such models may be less accessible for consumers with poor credit or risk aversion to loan agreements. They will also lead to higher overall monthly costs as consumers are not just paying for energy but for the technologies and works as well. Financing options will thus be less suitable for lower-income households who are more likely to rely on targeted grants or subsidies for capital costs (e.g. ECO4, Home Energy Scotland grant) but can then feasibly benefit from as-a-service tariffs or packages.

3.2.4. Social and default tariffs

The UK government is currently reviewing the future of fuel poverty support in England, while The Scottish government has been exploring options for delivering on its legally binding target to eradicate fuel poverty by 2040.[127] In light of the energy crisis, implementing a social tariff has been central to these discussions, recognising that the current patchwork of bill support is unsustainable in the long term.[128, 129]

A social tariff provides low-cost energy or exemptions from certain costs on the energy bill for consumers in low-income or vulnerable circumstances. If designed well, a social tariff could be key to ensuring that those in low-income or vulnerable situations can fairly transition to low-carbon heat – helping to shield consumers from higher electricity costs and avoiding penalising those who cannot participate in smarter services.

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[125] Citizens Advice, 2017, Future for all

[126] Scottish government, 2023. Scottish islands: data overview 2023.

[127] UK government, 2025. Review of the Fuel Poverty Strategy.

[128] UK Parliament, 2023. Debate on energy social tariffs.

[129] Scottish government, 2025. Energy: Social Tariff Working Group.

Social tariffs may preclude some consumers from accessing the benefits of flexibility or net zero.[130] Multiple social tariff options have been tabled by thinktanks, advocacy and research organisations, each with its own challenges, particularly around reaching the right people.[131, 132] Within the net zero context, however, it is crucial that any social tariff doesn't preclude or disincentivise those in vulnerable situations from engaging with or benefiting from smart systems, dynamic pricing, energy efficiency or low-carbon technologies. By only providing social discounts on fixed or 'no frills' tariffs, consumers eligible for a social tariff may be encouraged to avoid more dynamic options and miss out on wider potential savings.[133]

More people participate in flexibility or time-of-use when this is the default tariff.[134, 135] Energy providers must offer a 'default tariff', ensuring that no-one is cut off at the end of a contract or when moving into a new property. This is the tariff consumers use when they have not actively selected a different tariff or service. It is estimated that 86% of all households are on default tariffs as of winter 2024, which are typically set at the energy price cap level.[136]

Building a time-of-use component into the default tariff, as in Spain, Italy and Ontario, could enable more people to benefit from flexibility, although can make it more challenging for low-income consumers to budget for their energy bills accurately.[137] Meta-analysis of international time-of-use tariff research has shown that, if enrolment is opt-out rather than opt-in, uptake increases significantly (although much of this is based on survey insights rather than commercial tariff data, without breakdown of differences across social or demographic groups).[138] This would also rely on the sufficiently advanced rollout of smart meters to ensure that people can realistically be sent and respond to accurate price signals.

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[130] Regulatory Assistance Project, 2024. Flex-ability for all: Pursuing socially inclusive demand-side flexibility in Europe.

[131] The Scottish Fuel Poverty Advisory Panel, 2023. Social Energy Tariffs.

[132] New Economics Foundation, 2023. Delivering a National Energy Guarantee.

[133] Nesta and Centre for Net Zero, 2024. HeatFlex: the untapped potential of automated heat pump flexibility.

[134] Nicholson, M., Fell, M. J and Heubner, G. M., 2018. Consumer demand for time of use electricity tariffs: A systematized review of the empirical evidence. https://doi.org/10.1016/j.rser.2018.08.040

[135] Hussain, A. and Paula Torres, M., 2019. Time to pick up pace of dynamic electricity pricing.

[136] Ofgem, 2024. Future default tariffs: Call for Evidence.

[137] 4D heat modelled "off-gas grid area on the Isle of Skye, to explore the ability of flexible demand from heat to absorb wind power" [See SSEN heat strategy, p.10, and NIA_NGSO0033]

[138] Sunderland, L. and Gibb, D. 2022. Taking the burn out of heating for low-income households.

3.3. **Evidence assessment**

For tariffs and services, there is strong survey evidence on people's perspectives of time-of-use tariffs. There is likewise useful insight from small-scale innovation studies into how users view and interact with new models, such as Heat-as-a-Service and flexibility.[139, 140]

However, there is less experiential data, particularly for consumers in vulnerable circumstances or in Scotland who are already using smarter tariffs and technologies today (partly because some are innovative and not widely deployed yet). The Energy Systems Catapult's 'Living Lab' and Inclusive Smart Solutions programmes include some *small-n* insights, although there is limited synthesis of experiences and perspectives from current active time-of-use tariff users in the wider GB market – and more specifically in Scotland. More insights into how consumers in vulnerable circumstances are interacting with different tariffs and models would provide useful grounding for future policy debates.

Social tariff options have been modelled and draw on useful case studies from other countries to illustrate potential effects. This research has tended to come from thinktank and advocacy organisations, with less present in the academic literature in a UK context (reflecting that this is a more recent 'live' discussion).

Spain's Voluntary Price for Small Consumers Scheme (PVPC)

In 2022, Spain introduced the refreshed PVPC scheme, which is the default tariff for most Spanish consumers.

This scheme has three main tariff structures: a **normal rate**, where prices vary with the market at every hour throughout the day; a **'nocturnal' rate**, which provides lower prices at night; and a **super off-peak rate**, which divides the day into thirds with prices varying at fixed times (closer to a static time-of-use tariff).

The biggest savings are generally from the normal rate (hourly settlement), which is communicated and measured through smart meters a day in advance.

Those in vulnerable situations also benefit from an additional **social rate**, which discounts 25% of the overall energy bill after time-of-use balancing occurs, ensuring that consumers in vulnerable circumstances can still benefit from participating in dynamic pricing.

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[139] Citizens Advice, 2022, Room for Reform: Embedding Fair Outcomes for Tenants in Tomorrow's Retail Energy Market

[140] Fawcett, T., Palmer, J., Terry, N., Boardman, B. and Narayan, U., 2024. Using smart energy meter data to design better policy: Prepayment meter customers, fuel poverty and policy targeting in Great Britain. https://doi.org/10.1016/j.erss.2024.103666

Section 4:

Data and digitalisation

A smarter, fairer energy system.

4.1. Current policy and challenges

The UK government, Ofgem and NESO have committed to using data and digitalisation to unlock new benefits for the GB energy system.[141] This can enable more efficient network operation, upgrades and utilisation of renewable generation to accelerate the net zero transition while minimising costs for consumers.[142]

The planned introduction of Market-wide Half-Hourly Settlements (MHHS) at the end of 2025 will make the settlement process timelier and more accurate, meaning consumer bills will better reflect actual usage and energy system impacts.[143] Building on this foundation, opportunities exist to incentivise demand-side response (DSR), encouraging demand to shift to match supply and better use existing network capacity and renewable generation. Some of this can be automated, while some will require consumers to make conscious decisions to turn their energy use up or down at certain times.[144]

The increased availability of data can also support innovative assets and services, including smart technologies and dynamic price tariffs, which can increase DSR benefits, especially when managed by aggregators.[145, 146] For networks, greater access to demand data can support better investment planning and the move to a more distributed energy system, managing constraints through local flexibility markets.[147]

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[141] UK government Department for Energy Security and net zero, 2024. Digitalising the energy system.

[142] UK government, 2024. Clean Power 2030 Action Plan.

[143] Ofgem, 2024. Electricity settlement reform.

[144] Good Energy, 2025. Renewable Heat Pump Tariff.

[145] Glaa, 2022. Digitalisation in the Context of Electricity Market Reforms and Liberalisation: Overview of Opportunities and Threats

[146] UK government, 2025. Developing an energy smart data scheme: Call for evidence.

[147] SP Energy Networks, n.d. DSO Strategy for RIIO-ED2

For these benefits to be realised, a significant increase in data availability and sharing is still required across the system, including from smart meters and network monitoring.[148] The following consultations have considered how to achieve this alongside data security and consumer protection:

- Ofgem's RIIO-ED3 framework consultation considers funding for networks to deliver data and digital solutions, including whole-system benefits from distribution flexibility
- A Data Sharing Infrastructure is being developed to facilitate secure sharing of energy data between Ofgem licensees – due to be completed in 2028
- New regulations for smart assets and services have been proposed in the UK government's smart and secure electricity systems consultation, including requirements for interoperability
- The energy smart data scheme consultation advocates for a UK government-led approach to ensure public engagement and security in all new data-sharing initiatives
- A consumer consent solution is being developed by Ofgem to manage permissions for sharing energy use data, including with third-party providers of additional services.

Increasing digitalisation and automation of the retail market will significantly impact different consumer groups, including costs, benefits and barriers to participation.[149] Of particular concern is the impact on digitally excluded people, many of whom already have trouble engaging with the energy retail market and could be unable to benefit from new smart services. Almost three million people in the UK – 1 in 20 adults – do not use the internet at all, while a further 11 million – 1 in 5 adults – lack basic digital skills like email or browsing access.[150]

4.2. Live discussions and solutions

4.2.1. Smart and digital standards and codes of conduct

A digitalised system open to new smart assets and services will require new standards and regulations to incentivise engagement.[151] Consumers need to know that their data is protected, that they can easily switch suppliers and that new players, like aggregators, can be trusted. As consumers in vulnerable circumstances are likely to face particular harm when things go wrong, robust solutions will be critical in giving them the confidence to engage –

[148] UK government, 2024. Putting consumers first: Empowering and protecting energy consumers.

[149] UK government, 2023. The Energy Act (2023).

[150] Citizen's Advice, 2022. Access Denied: Digital disadvantage and exclusion in the energy market.

[151] Citizen's Advice, 2024. Use of AI within the energy sector call for input.

particularly those with complex needs.[152] These groups are also likely to have less understanding or capacity to engage with complex new processes or understand their rights and recourse to action in the event of any issues.[153]

Emerging solutions

Solution 1: Standardise tariff data to support both price and service comparisons.[154] For consumers to access the best value in the retail energy market, understanding and navigating the different offers available is crucial but can often be difficult, especially as new types of service develop.[155] Standardising offer metadata and compiling it in a public database could make comparison easier. Standardised terminology and clear estimates of costs and benefits could also build consumer confidence in navigating the market.[156] Digitally disadvantaged consumers already find it difficult to access existing price comparison services and new solutions should incorporate accessibility (see Section 4.2.4: Accessing the smart energy transition).[157]

Solution 2: A consumer consent solution is being developed to manage consumer data sharing with third parties. This will allow consumers to share their energy data with trusted third parties, in addition to suppliers, to receive tailored services for managing their energy bills. It will be delivered using a consumer-facing digital interface and although accessibility for the digitally excluded has been recognised as important, it has not been thoroughly addressed. Citizen's Advice has suggested using assisted digital approaches, such as an AI assistant to support the visually impaired and those with low digital confidence.[158] Managing consent could also present challenges for the private renting sector in deciding what control tenants or landlords should have over data sharing from a property and its associated assets.[159]

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[152] Energy Systems Catapult, 2021. How can innovation deliver a smart energy system that works for low income and vulnerable consumers? Project InvoLVe

[153] Powells, G. and Fell, M. 2019. Flexibility capital and flexibility justice in smart energy systems. https://doi.org/10.1016/j.erss.2019.03.015

[154] Centre for Sustainable Energy, 2024. Smart and fair: working with the smart energy capabilities lens.

[155] DESNZ, 2024. Putting consumers first: empowering and protecting energy consumers

[156] Crawley, J., Higginson, S., Moore, G. and Eyre, N. 2023. Summary of findings from heat pump flexibility expert workshop.

[157] Citizens Advice, 2022. Access Denied: Digital Disadvantage and Exclusion in the Energy Market

[158] Citizens Advice, 2024. Citizens Advice response to Ofgem consultation on a Consumer Consent Solution

[159] Citizens Advice, 2022. Room for Reform: Embedding Fair Outcomes for Tenants in Tomorrow's Retail Energy Market

4.2.2. Increasing trust in the energy system and new technologies

Alongside standards, additional solutions will be needed to encourage customers to become more active participants in the energy system, as this change will require them to trust and engage with more players and technologies.[160] Exposing consumers to smart meters and appliances, specialised suppliers, dynamic-price tariffs, aggregators and local grid operation will necessarily introduce concepts and terminology most consumers are currently unfamiliar with.

If managed poorly, this could result in consumers feeling confused and uncertain of the differences between offers and which is best for them. It could also miss out on the opportunity to incentivise DSR based on wider system benefits, including lower baseline bills, faster decarbonisation and greater sustainability.[161]

Mistrust is likely to be greater for vulnerable groups,[162] including those more reliant on energy who are at higher risk if things go wrong, e.g. people dependent on medical equipment. People who have had negative experiences with suppliers through the energy crisis may also be less trusting of new technologies as a result. Smart assets can also be seen as invasive, especially by people with energy debt experiences who may associate new technologies with new ways of chasing payments.[163]

Emerging solutions

Solution 1: Improve and coordinate advice services using digital tools, data collection and guidance from government and DNOs. Trusted, independent energy advice organisations will be crucial for informing different consumers and businesses of the smart energy transition and how they can engage – and providing recourse to action. Digital tools such as Home Energy Scotland's home energy check can make tailored support widely available but could be developed alongside alternative contact channels to maintain accessibility. Training and information from electricity distribution network operators (DNOs) and government could help ensure advice organisations provide up-to-date and consistent support for consumers to engage with smart energy.[164]

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[160] Chambers et al., 2022. Digitalisation without detriment: A research agenda for digital inclusion in the future energy system

[161] Crook T., 2024. Powering participation

[162] Bouzarovski, S., Burbidge, M., Sarpodtar, A. and Martiskainen, M. 2022. The Diversity Penalty: Domestic energy injustices and ethnic minorities in the United Kingdom. https://doi.org/10.1016/j.erss.2022.102716

[163] Chambers et al., 2022. Digitalisation without detriment: A research agenda for digital inclusion in the future energy system

[164] Centre for Sustainable Energy, 2024. Working with the smart energy capabilities lens

Solution 2: Building evidence and case studies showing clear costs and benefits of new digital services.[165] Using more data to track how different households experience the smart energy transition could allow suppliers to adjust their approaches where needed and collate publicly available case studies, demonstrating clear costs and benefits for different consumers to encourage uptake.

4.2.3. Artificial intelligence

Ofgem is working to develop guidance and regulations for using AI, algorithms and machine learning in the energy sector, in line with broader government principles for safe, transparent and fair AI use.[166] Beyond optimising network flows and enabling more efficient operation to reduce baseline bills, the following use cases for AI in the retail market are under discussion:

- **Analysis of consumer energy use data** to provide tailored suggestions for the most appropriate tariffs or ways to improve energy efficiency, enabling less-engaged consumers to access lower bills without needing to do their own research[167]
- **Identification of vulnerable consumers** to suppliers or other providers of support, although misidentification or manipulation remains a concern
- **Automatic adjustment of energy use** from smart assets such as heat pumps or EVs to maximise benefits from real-time dynamic pricing, lowering bills and constraints without consumers having to think too much about consumption. Concerns remain around how much control consumers will then ultimately have over their data and how it is used for other purposes (e.g. marketing).[168]

AI could help to reduce bills, but safeguards are required to overcome challenges of consumer control and trust.[169] Focus group research from Ofgem and Thinks found consumers generally have a low understanding of AI but are open to its benefits in low-risk uses, provided safeguards are in place.[170] For some people, AI can help reduce the need for

[165] Powells, G. and Fell, M. 2019. Flexibility capital and flexibility justice in smart energy systems. https://doi.org/10.1016/j.erss.2019.03.015

[166] Ofgem, 2024. AI in the energy sector guidance consultation

[167] Ambrosio-Albala et al., 2020. From rational to relational: How energy poor households engage with the British retail energy market

[168] Ofgem, 2024. Understanding consumer attitudes on AI use in the energy sector.

[169] Clark, T., Hadfield, M., Pavlova Joveski, M., Burns, F., Dunne, H. and Conway, J. 2024. Heat pumps on subscription. http://dx.doi.org/10.7488/era/3637

[170] Ofgem, Thinks, 2024. Understanding consumer attitudes on AI use in the energy sector

people to think about their energy consumption by automating flexibility or demand reduction.[171]

Yet this may mean that some consumers endure cold or unhealthy situations due to a perceived lack of control over their energy use. People who are less digitally engaged, including some older people, can be less trusting of AI due to feeling out of control of their energy use and could miss out on its benefits.[172]

Lived experience research with a pilot programme for automated load control has pointed to the need for close collaboration between providers and consumers to ensure informed consent and optimise the benefits of the system, both for households and the energy network.[173] Recent citizen's jury research with 20 members of the public from various sociodemographic backgrounds has likewise re-emphasised the need for clarity in data ownership, noting that end users should have ultimate agency over how their data is used and ensuring that optimisation was truly tailored to their needs.[174]

This creates a further, fundamental question of 'digital justice'.[175] As suppliers develop new tariffs, services and offerings based on AI, whose data they use to train and develop these services will directly impact how well they work for different consumer groups. For example, if AI is being trained for a new heat pump tariff based predominantly on usage data from middle- to high-income households, automated services that use this particular AI are unlikely to be suitable for less affluent households or those who work shifts.[176]

Emerging solutions

Solution 1: New regulations and guidance. Ofgem favours an outcomes-based approach to regulating AI proportional to risk, recognising that system-wide uses could affect many consumers in the case of a fault. Guidance is needed on best practice, including the use of

[171] Nesta and Centre for Net Zero, 2024. HeatFlex: the untapped potential of automated heat pump flexibility.

[172] Broader trust in energy suppliers and scepticism in some groups towards smart meter rollout may likewise impact who can participate in new AI-driven services.

[173] Middlemiss, L. 2022. Who is vulnerable to energy poverty in the Global North, and what is their experience? https://doi.org/10.1002/wene.455

[174] Seymour, V., Xenitidou, M., Timotijevic, L., Hodgkins, C. E., Radcliffe, E., Gatersleben, B., Gilber, N. and Jones, R. 2024. Public acceptance of smart home technologies in the UK: a citizen's jury study. https://doi.org/10.1080/12460125.2023.2298617

[175] EnergyREV, 2020. Smart Energy: Thinking about outcomes, digital infrastructure, and people

[176] Sunderland, L. and Gibb, D. 2022. Taking the burn out of heating for low-income households.

appropriate, representative and accurate training data, assessing and testing unintended consequences and ensuring the protection of personal data.[177]

Solution 2: Informed customer participation and control. The ability to opt out of AI uses, especially automated asset control, has been highlighted as crucial for gaining consumer acceptance.[178] AI uses must also be explainable and present clear costs and benefits for consumers to facilitate informed decisions. Data privacy, human oversight and retaining human agents for potentially complicated or sensitive services, such as complaints or support requests, are also cited as important.[179, 180, 181,]

4.2.4. Accessing the smart energy transition

Beyond trust, other barriers to participation exist. As more deals and services have moved online, it has become increasingly difficult for digitally excluded people to access the energy retail market.[182] Digital exclusion is primarily driven by the inability to afford internet access or devices, or the lack of digital or literacy skills needed to navigate online systems.[183] There is a widely acknowledged risk that consumers in vulnerable circumstances will be unable to afford smart assets or services and, therefore, could miss out on the benefits of data and digitalisation.[184] Accessing smart energy benefits can be particularly challenging in the private rental market, where short-term contracts, lack of clarity on rights and responsibilities, and bill-splitting arrangements add complexity.[185]

The smart meter rollout is a key enabler of digitalisation, with 65% of GB meters 'smart' and 58% of GB meters 'smart' and in 'smart mode' as of 2024.[186] This number is generally lower in Scotland, particularly in the Highlands and Islands regions due to connectivity challenges (Figure 6).[187] Smart meters already overcome some accessibility barriers by not requiring

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[177] Clark, T., Hadfield, M., Pavlova Joveski, M., Burns, F., Dunne, H. and Conway, J. 2024. Heat pumps on subscription. http://dx.doi.org/10.7488/era/3637

[178] Nesta, Centre for net zero, 2024. HeatFlex: the untapped potential of automated heat pump flexibility

[179] Hussain, A. and Paula Torres, M., 2019. Time to pick up pace of dynamic electricity pricing.

[180] UK Parliament, 2023. Debate on energy social tariffs.

[181] Regulatory Assistance Project, 2024. Flex-ability for all: Pursuing socially inclusive demand-side flexibility in Europe.

[182] Citizens Advice, 2022. Access Denied: Digital Disadvantage and Exclusion in the Energy Market

[183] Chambers et al., 2022. Digitalisation without detriment: A research agenda for digital inclusion in the future energy system

[184] Energy Systems Catapult, 2021. How can innovation deliver a smart energy system that works for low income and vulnerable consumers? Project InvoLVe

[185] Citizens Advice, 2022. Room for Reform: Embedding Fair Outcomes for Tenants in Tomorrow's Retail Energy Market

[186] DESNZ, 2024. Smart meters in Great Britain, quarterly update September 2024: statistical bulletin

[187] Ofgem, 2024. Q1 2024 Smart Meters Statistics Report.

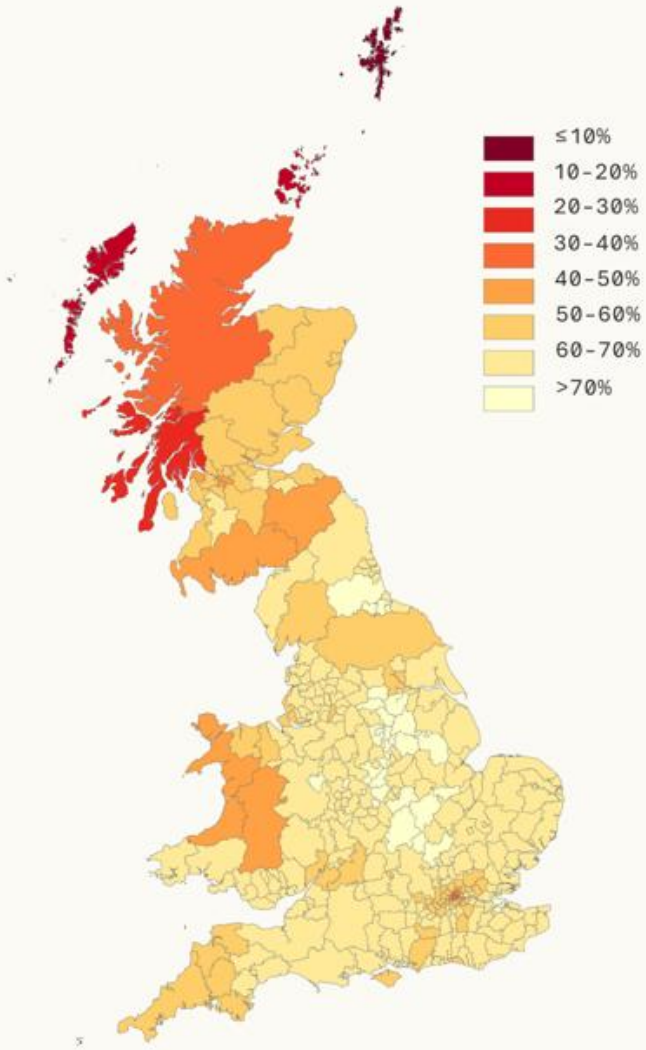
domestic network connections and providing In-Home Displays. Continuing the rollout will be essential for system digitalisation.

Emerging solutions

Solution 1: Improving digital access through existing and new solutions. In many areas, community organisations and charities already provide support for the digitally excluded. The Good Things Foundation charity coordinates a National Data Inclusion Network of over 5,000 local hubs, a National Databank providing internet access to those struggling with affordability and a National Device Bank providing refurbished devices to those lacking their own. Partnerships with this and similar organisations could help suppliers or DNOs increase the uptake of digital solutions.

Figure 6

Smart meter rollout by local authority as of Q1 2024.



Data source: DESNZ, 2024. Smart meters in Great Britain, quarterly update March 2024

4.2.5. Local flexibility

Current challenges to local flexibility centre around making it work at scale and increasing participation beyond expert individuals, middle-class homeowners and businesses.[188] Increased access to data can be used to match local generation and demand, reducing distribution network constraints and creating markets for flexibility and distributed renewable generation at a local level. This is another avenue for savings for consumers, where they can be paid for adjusting consumption in response to a local price signal. Local aggregators and flexibility providers can also automate this process.

Project Local Energy Oxfordshire (LEO) tested several local-flex solutions, including incentivising residents in a block of flats to shift their demand to use power from council-owned solar panels on the building. They concluded that, to make participation simple for flex-providers unfamiliar with the energy system, clear 'plain English' explanations and standardised ways to access the market, such as a flex market online platform, are crucial.[189] Explaining the benefits of local flexibility for the wider energy system contributed to positive responses and participation in DSR trials.

Emerging solutions

Solution 1: Develop the role of aggregators to deliver predictability and economies of scale for networks and simple, clear incentives to participate for local flex providers.[190] Clear communication of the wider social and system benefits of flexing energy use is important, alongside standardised methods for engaging with the market that are simple to use and maximise financial benefits for consumers and system benefits for network operators.

4.3. Evidence assessment

From the evidence reviewed, there is strong coverage of consumer perspectives on data, digitalisation and artificial intelligence in the energy system. This is particularly strong on small-scale qualitative data, such as focus group research.[191] Small-scale innovation trials and lived

[188] Iskandarova et al., 2022. Tangled transitions: Exploring the emergence of local electricity exchange in France, Switzerland and Great Britain

[189] Local Energy Oxfordshire, 2023. Project LEO Final Report: a digest of key learnings

[190] UK Parliament, 2023. Debate on energy social tariffs.

[191] Nicholson, M., Fell, M. J and Heubner, G. M., 2018. Consumer demand for time of use electricity tariffs: A systematized review of the empirical evidence. https://doi.org/10.1016/j.rser.2018.08.040

experience research have also provided direct consumer insights into some data uses for smart offerings,[192, 193, 194] advocacy organisations such as Citizen's Advice have included insights from consumers directly to inform these discussions in various consultation and call-for-evidence responses.

However, there is less research in two key areas. First, there is limited large-n consumer attitudinal data on digitalisation and artificial intelligence in UK energy, making it challenging to identify wider trends or identify geographic, social and economic differences in perspectives. There is likewise a lack of analysis of how algorithms and AI are currently being used in the energy market and real-world impacts on different consumers. A synthesis of latest evidence, including insights into supplier/technology provider models and user experience, could better support the discussion about viable next steps in policy and suppliers/technology provider practise.

[192] Suggestion added by Regen as something not covered within the literature reviewed here.

[193] Hussain, A. and Paula Torres, M., 2019. Time to pick up pace of dynamic electricity pricing.

[194] The Scottish Fuel Poverty Advisory Panel, 2023. Social Energy Tariffs.

Section 5:

Consumer protection

Putting people first in the future retail market.

5.1. Current policy and challenges

The energy crisis, growing debt, and noted supplier misconduct regarding the involuntary installation of prepayment meters have made consumer protection a prominent issue on the national political agenda.[195]

In the context of the retail energy market in Great Britain, consumer protection is a set of laws and regulations under the respective Electricity and Gas Standard Supply Licence Conditions that ensure consumers are treated fairly, protected from harm and have access to the information they need to make informed decisions. Primary responsibility for consumer protection in the retail market currently lies with Ofgem, which sets and enforces the licence conditions all energy suppliers must adhere to.[196]

5.1.1. Consumer protection and net zero

Consumer protection will be critical to ensuring that consumers in vulnerable circumstances do not face adverse outcomes from new tariffs, technologies or services to achieve net zero. The Energy Act (2023) gave Ofgem a new 'net zero duty', making the protection of current and future consumers through the net zero journey a core regulatory function.[197]

Consumers are being asked to participate in the energy market in new and different ways: moving from a system of 'flick the switch, pay your bill' to something more active and engaged to capitalise on time-of-use tariffs and smart technologies.[198]

Innovation in tariffs and services will also be required to deliver net zero overall. Suppliers, innovators and the regulator have to strike a balance between ensuring new services and

[195] Ofgem, 2024. Ofgem sets out prepayment meter expectations to energy bosses.

[196] Ofgem, 2024. Licences and licence conditions.

[197] UK government, 2023. The Energy Act (2023).

[198] Regulatory Assistance Project, 2024. Flex-ability for all: Pursuing socially inclusive demand-side flexibility in Europe.

offerings are accessible to everyone while ensuring those in vulnerable circumstances are shielded from any potential negative impacts from new or 'riskier' propositions.[199]

Various recent policy consultations and calls for evidence have sought to address these core issues specifically, including:

- The UK government's Review of Ofgem: Call for evidence reviews the type of regulator Ofgem needs to be to protect consumers and meet future challenges
- Ofgem's Forward Work Programme 2024-2025 sets out their Consumer Interest Framework designed to clarify Ofgem's responsibility to consumers
- Heat networks regulation: implementing consumer protection closed in February 2025 and is awaiting Ofgem's response.

5.2. Live discussions and solutions

5.2.1. Embedding consumer outcomes in the regulatory framework

The prevailing UK approach to consumer protection in the retail market has been to improve transparency and competition between suppliers to reduce bills, underpinned by the enforcement of minimum customer service standards and retrospective application of penalties for supplier misconduct.[200] These are guided by overarching principles, although enforcement of these is generally reactive, with limited detail within Ofgem documentation on how suppliers should deliver against these principles in practise.

Citizens Advice have argued that current regulation is reactive and lacks focus on consumer outcomes through the net zero transition.[201] Regulation by Ofgem in the retail market is currently based on a core set of consumer principles.[202] However, organisations such as Citizen's Advice have suggested that these principles are too broad and lack an adequate focus on the outcomes that different consumers need and the experiences they have.[203] The

[199] Energy Systems Catapult, 2022. Smart Consumer Protection Manual.

[200] UK government, Department for Energy Security and net zero, 2024. Putting consumers first: empowering and protecting energy consumers.

[201] Citizen's Advice, 2020. Raising the bar: How a new Consumer Duty could improve standards in the energy retail market.

[202] Ofgem, 2024. Our roles and responsibilities.

[203] Citizens Advice, 2022. Room for Reform: Embedding Fair Outcomes for Tenants in Tomorrow's Retail Energy Market

approach also remains reactive to misconduct or market events rather than proactive in driving positive outcomes.[204]

Emerging solutions

Solution 1: Evolve the current principles-based approach to focus on consumer needs and outcomes, suitable for the net zero context (e.g. comfort in the home, affordability, trust in energy suppliers and technologies).[205] While maintaining Ofgem's core principles, this would shift the goalposts for suppliers away from the principles of reducing costs/increasing competition towards more tangible engagement with and delivery of consumer needs and impacts. Citizen's Advice have long advocated for a Consumer Duty, similar to that employed by the Financial Conduct Authority, which would put onus on energy suppliers to achieve outcomes that consumer wish to see.[206] This is under active consideration in the recent Review of Ofgem call for evidence.

5.2.2. Protections for those using new technologies

As consumers will be encouraged to interact with new tariffs, technologies and services in a future retail market, there is a need to understand how they can be effectively protected in doing so should things go wrong.[207] Current consumer protections held by Ofgem are somewhat agnostic to technologies (outside of specific cases, such as heat networks), while responsibility for advertising, consumer engagement and finance are dispersed across a number of regulatory bodies.

There is a lack of protection for consumers if new low-carbon technologies, particularly low-carbon heating systems, cause adverse impacts.[208] When installing new home technologies or accessing dynamic tariffs, problems can arise given the novelty of some technologies and users' unfamiliarity with how they operate. Standard rate electricity prices likewise remain four times higher than gas today, which could increase prices for some users moving from fossil fuel boilers to low-emission forms of heating. This could be especially

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[204] Citizens Advice Scotland, 2017. Leading by example: a principled journey through regulation.

[205] Clark, T., Hadfield, M., Pavlova Joveski, M., Burns, F., Dunne, H. and Conway, J. 2024. Heat pumps on subscription. http://dx.doi.org/10.7488/era/3637

[206] Centre for Sustainable Energy, 2024. Smart and fair: working with the smart energy capabilities lens.

[207] Energy Systems Catapult, 2021. How can innovation deliver a smart energy system that works for low income and vulnerable consumers? Project InvoLVe

[208] Savage, T., Akroyd, J., Mosbach, S., Hillman, M., Siekler, F. and Kraft, M., 2022. Universal digital twin-the impacts of heat pumps on social inequality. https://doi.org/10.1016/j.adapen.2021.100079

problematic for those already experiencing fuel poverty, people with health or ability issues which require higher energy use, or those less confident engaging with new technologies.[209]

There is no clear, unified consumer code or social obligation for energy supply or services, which complicates the process of enforcing standards or raising action.[210] Some consumers may end up with multiple suppliers or 'bundling' arrangements where they have different contracts for technology hardware or services. Multiple codes of conduct and social obligations currently exist for those involved in electricity supply, yet these are varied and without any clear central process for consumers who wish or need to take action in the event of issues arising.[211, 212]

Although examples have emerged through innovation projects, there are no standardised consumer protections for DSR and flexibility. Flexibility services for households are still relatively novel and, therefore, lack robust, industry-wide consumer protections. Through innovation projects such as HOMEflex and the Energy Revolution Integration Service, some processes have been developed to ensure consumer protections are fit for smarter, flexible innovations.[213, 214, 215] Some evidence has also been synthesised from different European markets,[216] although there is limited understanding of how these are being developed more widely in the UK and Scottish contexts.

Emerging solutions

Solution 1: Consolidate existing consumer codes and social obligations to protect all consumers regardless of how or where they get their energy. Consolidating the multitude of existing codes of conduct and social obligations, refreshed for the net zero context, could provide stronger clarity for consumers on their rights and recourse to action, supporting greater

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[209] Institute for Community Studies, 2024. Our journey to net zero: understanding household and community participation in the UK's transition to a greener future.

[210] Citizens Advice, 2022. Room for Reform: Embedding Fair Outcomes for Tenants in Tomorrow's Retail Energy Market

[211] Al Kez, D., Foley, A., Khald Abdul, Z., Furszyfer Del Rio, D. 2024. Energy poverty prediction in the United Kingdom: a machine learning approach. https://doi.org/10.1016/j.enpol.2023.113909

[212] UK Department for Energy Security and Net Zero, 2024. Heat Networks regulation: Implementing consumer protections.

[213] Flex Assure, 2018. Demand-side code of conduct.

[214] Energy Systems Catapult, 2021. How can innovation deliver a smart energy system that works for low income and vulnerable consumers? Project InvoLVe

[215] Flex Assure, 2023. HOMEflex code of conduct.

[216] Kukowski, C. A. and Garnett, E. E. 2024. Tackling inequality is essential for behaviour change in net zero. https://doi.org/10.1038/s41558-023-01900-4

trust and efficiency in the process overall.[217] This should also include robust protections for those using local heat networks, recently consulted on by Ofgem with a decision due to be published this year.[218]

5.2.3. Identifying consumers and targeting support

Understanding who is engaging with the energy system, and who may need additional support to do so, will be critical to protecting consumers on the net zero journey. While rules and regulations around consumer protection within the market are important, other mechanisms also exist to protect people through the energy transition. The main vehicle for identifying and targeting consumers in vulnerable circumstances today is through the Priority Service Register (PSR) which identifies consumers in potentially vulnerable situations based on consumers self-reporting their circumstances or issues.[219]

The Priority Service Register is inadequately promoted or joined between organisations or sectors. Different utilities, suppliers and social and health services hold their own versions of the PSR. Data matching between these organisations is not straightforward – many hold data in different formats, while data protection rules can prove challenging to overcome.[220] A majority of the UK population (up to 80%, including over 60% of people classed as being in vulnerable situations) are also unaware the PSRs exist across energy or wider utilities, which risks many of those eligible for additional support or protection missing out.[221]

The PSR and associated support do not consistently account for vulnerabilities in the net zero transition.[222] While many conditions for PSR eligibility are also indicators of potential vulnerabilities under net zero, there remains a need to better target PSR uptake for those who face additional barriers to net zero specifically, based on a strong understanding of how net zero may impact different groups and in what ways. This can also support the targeting of new tariffs, services and support. As outlined earlier in this report, barriers are well-understood,[223],

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[217] Citizen's Advice, 2022. Zero Sum: how to prioritise consumer protection so no-one is left behind on the path to net zero.

[218] Ofgem, 2024. Heat networks regulation: implementing consumer protections.

[219] Ofgem, 2024. Joining your supplier's priority service register.

[220] Consumer Scotland, 2024. Energy affordability policy – October 2024.

[221] Vulnerability Registration Service, 2023. 80% of UK adults have never heard of the Priority Service Register, new research reveals.

[222] UK government, 2023. The Energy Act (2023).

[223] Citizen's Advice, 2023. Ripping off the band-aid: Ways to reform the retail energy market.

[224], [225] although there remains a lack of insights into how these can be proactively implemented by suppliers and other utilities, particularly in the Scottish context.

Local social, health and third-sector organisations have a critical role in supporting and protecting consumers through the transition that is not recognised today.[226] Consumers often raise energy-related issues to fuel poverty charities, community energy organisations, health and social services or the local authority – not to their suppliers.

Such organisations, anchored locally within communities, provide critical social infrastructure for engaging with people in the most desperate circumstances and advocating for them with suppliers and other energy system actors. They also exist as trusted local actors who can access groups who may otherwise be reluctant to call their supplier during hardship or for information about new services or technologies.[227]

However, such organisations face distinct challenges in delivering this role – a lack of deep energy retail expertise (outside of fuel poverty or Citizens Advice bureaus) and short-term, precarious funding all create pressures for third sector and charitable organisations on a day-to-day basis. Although some partnerships with e.g. NHS and wider community wealth-building approaches exist (see the Warm Homes Prescription case study on page 46),[228] these remain novel in the UK sector.

Evidence based on engagement with such organisations, particularly in the third sector, has uncovered some of these challenges.[227] However, the role and challenges of the Scottish third sector – particularly those who rely on Scottish Government support – in serving the trusted intermediary role through the energy transition are less well understood.

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[224] UK Department for Energy Security and Net Zero, 2024. Heat Networks regulation: Implementing consumer protections.

[225] Consumer Scotland, 2024. Consumer Scotland's approach to working with consumers in vulnerable circumstances.

[226] Simcock, N. and Bouzarowski, S. 2023. A cure-all for energy poverty? Thinking critically about energy advice. https://doi.org/10.1177/0261018323121918

[227] Centre for Sustainable Energy, 2024. Working with the smart energy capabilities lens

[228] Energy Systems Catapult, 2024. Warm Homes Prescription.

Warm Homes Prescription

Pioneered by the Energy Systems Catapult, the Warm Homes Prescription model is a partnership between the NHS and local energy advisors to identify and provide energy bill support to people in vulnerable circumstances, ensuring they have the costs covered for the basic amount of energy they need to stay healthy and warm.

It works as follows:

- NHS teams (including social prescribers and complex care teams linked to GP surgeries) identify eligible patients
- Patients are contacted by the NHS and offered a 'warm home prescription' to be delivered by local energy advisors, who credit their energy account
- Patients can immediately start heating their home to a healthy temperature
- Further home energy upgrades are arranged where possible.

The model was successfully trialled with 823 vulnerable and low-income individuals in Aberdeen, Middlesborough, Gloucestershire and London in 2022/23, with ambitions to roll out further.

Emerging solutions

Solution 1: Better integrate PSR data across organisations, utilities and sectors. Efforts are being made to address this as a key focus of Ofgem's Consumer Vulnerability Strategy. The UK government also announced plans to establish the 'Share Once Support Register', which links various PSR initiatives in the utilities sector so that anyone registered in one is automatically registered with all.[229]

Solution 2: Establish new methods for identifying and targeting consumers at risk of exclusion through the net zero transition.[230] SSEN's Vulnerability Future Energy Scenarios project provides a novel methodology for proactively predicting future vulnerabilities based on granular spatial modelling of core vulnerability predictors.[231] Other methodologies have likewise been developed to help better predict fuel poverty and wider socioeconomic

[229] UK government, DESNZ, 2024. Putting consumers first: empowering and protecting energy consumers.

[230] Added by authors.

[231] Scottish and Southern Electricity Networks, Regen, 2024. Just transition, vulnerability and network planning.

challenges.[232] Ofgem, suppliers and networks could adopt or adapt this methodology to better predict and track vulnerabilities as they emerge through the net zero transition.

Solution 3: Establish new roles, data and information-sharing models among local anchor institutions, suppliers and networks.[233] Better connecting these organisations would be a positive step, although further work is needed to ensure that any central role they are expected to play in the energy transition is reflected in budget and resources.[234]

5.3. **Evidence assessment**

The vast majority of evidence relating to consumer protection comes from advocacy organisations such as Citizens Advice and research organisations such as the Energy Systems Catapult. These are typically based on case study and qualitative research, either with consumers or expert stakeholders, which is to be expected given the nature of consumer protections and difficulty modelling, analysing or quantifying new ideas.

Some comparisons have been made across regulatory regimes, particularly insights from Hampton et al. (2022)[235] on customer engagement strategies, although these stop short of identifying potential solutions or testing new protections with affected consumers. Consumer perspectives on consumer protections in general are lacking, with proposed solutions often critically (and in good faith) extrapolated from consumer experiences by different organisations to arrive at policy positions. No research was identified in this review which spoke to different enforcement regimes for consumer protection, representing a significant gap in the energy retail space.

There are some innovation insights into various codes of conduct around new services, such as flexibility.[236, 237] However, there remains a lack of understanding or demonstration for how codes of conduct can be effectively unified, reformed or scaled to meet the dynamic challenge of the energy transition.

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[232] Regen and Scottish and Southern Electricity Networks, 2024. Vulnerability, just transition and future energy scenarios.

[233] Introduced here by the authors as a logical progression of data sharing challenges and the role of local organisations in fuel poverty and energy transition support.

[234] Centre for Sustainable Energy, 2024. Working with the smart energy capabilities lens

[235] Hampton, H., Foley, A., Del Rio, D. F., Smyth, B., Laverty, D. and Caulfield, B., 2022. Customer engagement strategies in retail electricity markets: a comprehensive comparative review. https://doi.org/10.1016/j.erss.2022.102611

[236] Energy Systems Catapult, 2021. How can innovation deliver a smart energy system that works for low income and vulnerable consumers? Project InvoLVe

[237] Citizens Advice, 2024. Citizens Advice response to Ofgem consultation on a Consumer Consent Solution

For identifying consumers and targeting support, there is a clear gap around understanding different vulnerabilities through the net zero transition and how to identify and target those potentially most in need of additional support – and embed this in supplier and utility activities. Some methods, such as Vulnerability Future Energy Scenarios, are being developed. However, there is limited engagement with those groups specifically on how processes such as the PSR can be better shaped and promoted. There is also a gap around the role of the Scottish third and charitable sector to understand their perspectives and current activities within the net zero transition.

Section 6:

Inclusive energy market design

Ensuring consumer needs are met in the retail innovation process.

6.1. Current policy and challenges

Innovation in the energy retail market is a live topic. Ofgem launched a consultation on this in October 2024 (now closed) which explored ways to incentivise further innovation in the supply of energy to deliver net zero.[238] In this consultation, Ofgem recognises the additional challenges that certain groups will face to engaging with energy retail innovation, specifically those on low incomes, with digital access and literacy challenges, and those in the private rented sector:

- Cost
- Lack of awareness and understanding
- Not being the target audience for innovation
- Potential inability to shift consumption or lower overall demand
- Literacy, numeracy and digital literacy challenges
- Digital exclusion
- Residential status
- Unintended adverse consequences.

Inclusive innovation is a key theme of the current refresh of Ofgem's Consumer Vulnerability Strategy.[239] Within the strategy refresh, Ofgem outlines the justification for inclusive innovation towards net zero and outlines a set of outcomes against which success can be measured (below), applicable to both networks and suppliers.

[238] Ofgem, 2024. Consultation: innovation in the energy retail market.

[239] Ofgem, 2024. Consultation: Consumer Vulnerability Strategy Refresh.

Theme 4: Encouraging positive and inclusive innovation

Outcome: Vulnerable customers should have access to inclusively designed innovative solutions, particularly those that can help them participate in the transition to net zero.

Sub-outcome 1: Vulnerable customers should have access to innovative solutions that deliver positive outcomes.

Sub-outcome 2: Innovative solutions should be inclusively designed to limit the barriers to take up or adverse outcomes for vulnerable customers.

Source: Ofgem Consumer Vulnerability Strategy Refresh consultation, 2024.

6.2. **Frameworks and principles for inclusive innovation**

How innovation is delivered is critical to its effectiveness for people in their homes and communities. This is especially true for those on low incomes, with mobility issues or in other marginalised or vulnerable circumstances, who face additional barriers to engaging with the future energy system.[240]

Inclusive innovation is not solely about technology or business models but about recognising the different needs, barriers and opportunities for marginalised or disadvantaged groups, by actively working with them as partners throughout the innovation process.[241]

Within the academic literature, particularly in planning and citizen engagement, there are some seminal concepts of what inclusive innovation looks like in practise – some of which have been applied to clean energy questions in the UK. Arnstein's 'ladder of citizen participation', for instance, has been applied to innovation around smart local energy systems (SLES).[242]

[240] Consumer Scotland, 2024. Consumer Scotland's approach to working with consumers in vulnerable circumstances.

[241] Energy Local, 2023. Inclusive Innovation: Empowering Diversity in a World of Ideas.

[242] Gooding, L., Devine-Wright, P., Rohse, M., Ford, R., Walker, C., Soutar, I., and Devine-Wright, H. 2023. The best-laid plans: Tracing public engagement change in emergent smart local energy systems. https://doi.org/10.1016/j.erss.2023.103125

Heeks et al. (2014)[243] adapted Arnstein's model to put forward a ladder of inclusive innovation, which outlines the varying levels of meaningfully inclusive innovation (Figure 7). This ranges from innovation that happens with a marginalised group in mind, but without engaging them, through to effective co-creation and enabling the target group to lead and shape innovation from the outset.

Figure 7

Ladder of inclusive innovations

Source: Adapted from Heeks et al. (2014)

Reviews of energy innovation programmes suggest that engagement and inclusion in innovation has tended to be limited to communicating information about the project and engaging with people through a range of in-person and virtual methods.[244] In some cases, such as Project LEO in Oxfordshire, engagement and innovation have taken a more active engagement approach (i.e. with broad community participation, supported by trusted third-sector organisations). Yet

[243] Heeks, R., Foster, C., and Nugroho, Y. 2014. New models of inclusive innovation for development. https://doi.org/10.1080/2157930X.2014.928982

[244] Seymour, V., Xenitidou, M., Timotijevic, L., Hodgkins, C. E., Radcliffe, E., Gatersleben, B., Gilber, N. and Jones, R. 2024. Public acceptance of smart home technologies in the UK: a citizen's jury study. https://doi.org/10.1080/12460125.2023.2298617

this has still tended to focus on securing buy-in for technology deployment rather than deliberative co-creation – despite innovators noting inclusion as a key priority.[245, 246]

6.3. Live discussion and solutions

As outlined, Ofgem has been openly consulting on encouraging wider supplier innovation, with a focus on inclusivity and vulnerability.[247, 248]

There have been some conscious efforts to embed inclusive innovation principles within retail energy innovation. The Energy Systems Catapult is leading a UK government-funded programme to develop Inclusive Smart Solutions, focused on tackling the barriers that consumers in vulnerable circumstances face to engaging with a smart, flexible energy system.[249] This programme takes an approach focused more on meaningful engagement and co-design with low-income and vulnerable groups, starting with the needs of consumers in question before iteratively testing new technological solutions with them.[250]

Wider frameworks and processes for inclusive innovation also exist, although there has been less application of these consistently to retail energy challenges.[251, 252] From the research reviewed in this work, however, some common principles have emerged to guide inclusive innovation in the retail energy market. Inclusive innovation should be:

- People-centric: engaging with affected groups meaningfully to co-design workable solutions which dismantle barriers to market participation
- Outcomes-focused: developing services and solutions which meet and reflect different consumer needs (rather than testing solutions with them)
- Iterative: responding and adjusting services based on the experiences of those consumer groups with whom new products or services are being developed

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[245] Energy Systems Catapult, 2019. Heat as a Service: An introduction.

[246] Seymour, V., Xenitidou, M., Timotijevic, L., Hodgkins, C. E., Radcliffe, E., Gatersleben, B., Gilber, N. and Jones, R. 2024. Public acceptance of smart home technologies in the UK: a citizen's jury study. https://doi.org/10.1080/12460125.2023.2298617

[247] Nesta and Centre for Net Zero, 2024. HeatFlex: the untapped potential of automated heat pump flexibility.

[248] Broader trust in energy suppliers and scepticism in some groups towards smart meter rollout may likewise impact who can participate in new AI-driven services.

[249] Energy Systems Catapult, 2023. Inclusive Smart Solutions.

[250] Sunderland, L. and Gibb, D. 2022. Taking the burn out of heating for low-income households.

[251] Nesta, 2018. How inclusive is innovation policy?

[252] Digital Promise, 2019. Designing a Process for Inclusive Innovation.

- Targeted: using granular insights and data to understand consumer circumstances or experience with new solutions, rather than relying on 'average consumer' information.

Current guidance does not outline how inclusive innovation can be delivered in practise.[253] While Ofgem has outlined desirable goals and outcomes for inclusive innovation, its proposed strategy stops short of outlining what inclusive innovation looks like or processes, principles and actions to ensure this is delivered consistently. Justification, outcomes and definitions of success are clear within the strategy, yet there is no outline of what 'good' looks like or how this can be achieved by the suppliers, innovators and other stakeholders involved.

The Universal Service Obligation is argued to be limiting supplier innovation and specialism. Although suppliers can offer additional, non-standard products to niche customer groups, the Universal Service Obligation means that all suppliers must offer energy supply options to all domestic consumers. While ensuring some level of consumer protection, this limits the scope for specialisation and innovation for suppliers that wish to develop services and offerings solely for a specific place or group of consumers.[254]

Allowing this specialisation is argued to enable more competition and ensure that more customer segments can have their distinct needs reflected. However, a need remains to ensure that any change to the Universal Service Obligation does not simply lead to suppliers designing services purely for more affluent, profitable consumer groups – leaving consumers in vulnerable circumstances with a more limited range of choices.[255] Principles of inclusive innovation would likewise need to be central to wider supplier obligations to ensure a consistent level of best practise.

Emerging solutions

Solution 1: Develop and embed best practise guidance for inclusive energy market design and innovation.[256] Examples of delivering inclusive innovation exist, along with assessing the shortcomings of previous innovations and market offerings. With the live conversations on innovation today, there is an opportunity to embed these more fundamentally in the future UK retail market.

[253] Assessment of current Ofgem strategies included here by the authors.

[254] Stonehaven, 2023. Reinventing Retail Energy.

[255] Citizens Advice, 2023. Ripping off the band aids: ways to reform the retail energy market

[256] Included by the authors as a potential step to embed inclusive innovation practices across the sector.

6.4. **Evidence assessment**

There is strong evidence, largely based on case study and interview research, that energy innovation projects have (or have not) embedded citizen engagement and inclusivity in their activities.[257, 258] Insights also emerge from more deliberately inclusive innovation processes, such as the Inclusive Smart Solutions programme.

However, there is less understanding of inclusive innovation within the wider retail market specifically. Outside of Ofgem literature and some innovation strategies, there is no synthesis of suppliers' innovation activities or insights into consumer experiences, which may make it challenging to raise the standard across the sector either in regulation or best practice guidance.

[257] Seymour, V., Xenitidou, M., Timotijevic, L., Hodgkins, C. E., Radcliffe, E., Gatersleben, B., Gilber, N. and Jones, R. 2024. Public acceptance of smart home technologies in the UK: a citizen's jury study. https://doi.org/10.1080/12460125.2023.2298617

[258] Consumer Scotland, 2024. Consumer Scotland's approach to working with consumers in vulnerable circumstances.

Section 7:

Future research agenda

What we know, what we don't know, and what we need to know.

This report has set out some of the key developments, policy context, challenges and emerging solutions for delivering a fair net zero transition for UK retail market consumers. It has reviewed extensive academic, grey, innovation and policy literature, highlighting evidence for how different consumers may be impacted through the transition and opportunities for further evidence to be developed.

Specific evidence gaps are discussed for each section throughout. Across the literature, however, there were some common themes where a future research agenda might support a more informed policy discussion:

1. **Current user experience of new tariffs, services and technologies**, particularly for low-income and vulnerable households, through qualitative (interviews and focus groups) and more quantitative (e.g. survey) techniques
2. **Scottish-specific cases**, recognising that Scotland has its own challenges, consumer perspectives and experiences of new tariffs and services that are currently underrepresented in the literature outside of Scottish Government, Citizen's Advice Scotland, Consumer Scotland and limited academic publications
3. **Scottish-specific data**, particularly on bills and costs that are aggregated to regional and local authority levels, to support more accurate understanding of current consumer challenges and more informed development of new models, services and reforms
4. **Demonstration of more innovative models** such as Energy-as-a-Service or dynamic social tariffs, which are yet to permeate the market with consumers in vulnerable situations, particularly in Scotland – and synthesis of the evidence from other regions or countries where these models have become more commonplace
5. **Consumer perspectives on trade-offs and 'fairness' in the retail energy market**, as well as views on which outcomes should be prioritised for any changes to consumer protections and wider regulation, through direct engagement and deliberative (e.g. citizen's panel) methodologies.

7.1. Foundations for retail market reform

While there is an opportunity for further research, the work reviewed here has pointed some key, overarching messages across the four themes. These are synthesised into four 'foundations' for a future retail market to deliver a just net zero transition for consumers. These can be leveraged to inform future policy discussions and positions.

Foundation 1: Reshape retail market incentives to focus on consumer outcomes and inclusive innovation. Delivering retail innovation that meets the needs of different groups will require inclusive innovation processes across the board, built on more dedicated consumer-centric outcomes driving retail market activity (rather than cost competition).

Foundation 2: Future-proof energy support mechanisms for the net zero context. As UK and Scottish governments refresh their fuel poverty and other bill support schemes, doing so in a way that also enables consumers in vulnerable circumstances to participate in and benefit from the changing energy system will need to ensure that support is designed with this changing energy system in mind, lowering bills while enabling access to new services, technologies and dynamic pricing.

Foundation 3: Embed and consolidate consumer protections across new and emerging services. While different technologies have different opportunities and challenges, there is a need to clarify and consolidate consumer protections, making it easier for consumers to understand their rights and take action should things go wrong. For consumers in vulnerable circumstances, this should also include an explicit 'no detriment' commitment to ensure bills do not rise and adverse impacts are mitigated.

Foundation 4: Tackle digital literacy and inclusion to enable more people to benefit from smarter services and offerings, while ensuring those who cannot participate are not penalised. One of the key barriers to accessing new technologies and services, and maximising their benefits, is digital literacy and inclusion. This must be a priority for all levels of government, retail and regulation, with protections for those who cannot or prefer not to flex their energy demand.

Appendix A: Wholesale market reform and other relevant consultations

While a full-scale retail energy market reform is yet to happen in Great Britain, significant reforms are underway in the wholesale electricity market (i.e. in which generators, storage and flexibility providers buy and sell electricity to balance the energy system). Initiated in 2022, DESNZ is expected to publish its decision on the landmark REMA in June 2025.[259]

Decisions on these non-retail market elements will have considerable impacts on consumers. Far-ranging changes are under consideration as part of the REMA reforms, with the express purpose of unlocking an estimated £40 billion per year investment in renewables to deliver a clean power system that passes value to consumers directly.[260] This includes changes to the capacity market, balancing mechanism, ancillary services and Contracts for Difference scheme among several other areas – many of which currently sit on the consumer bill.

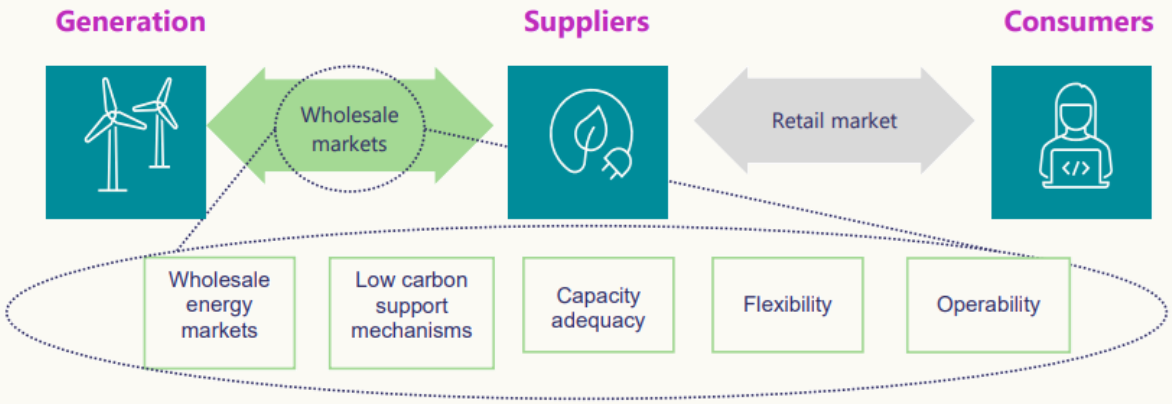
Two of these changes are likely to have the most direct impact on consumers: reforms to the **Contracts for Difference scheme** and the potential introduction of **locational marginal pricing**.

[259] Cornwall Insight, 2024. What is REMA?

[260] Carbon Brief, 2024. Analysis: How the UK plans to reach Clean Power by 2030.

Figure 8

Overview of wholesale and retail markets



Contracts for Difference

A primary focus of REMA has been to extend the Contracts for Difference scheme, which is the main revenue support mechanism for larger renewable generators. Contracts for Difference guarantee a minimum price (the 'strike price') that generators receive for their electricity over a period of 15 years. Projects backed by the Contracts for Difference scheme receive a consumer subsidy when prices are lower than the strike price, but can pay back to consumers when wholesale prices exceed it. NESO and UK government agree that the Contracts for Difference will need to be extended and increased to spur the investment required for Clean Power 2030.[261]

Contracts for Difference can serve as a price 'hedge' for consumers against any future shocks or volatility. Under the Contracts for Difference mechanism, renewable generators can pay consumers back in times of high wholesale market prices, such as in 2021-2023.[262] Through the energy crisis, many renewable generators made payments back to consumers via a Contracts for Difference levy. As well as getting more renewables online to bring down bills across the board, Contracts for Difference can insulate consumers from price volatility through this payback mechanism.

There is a need to strike a balance between Contracts for Difference prices that are high enough to stimulate investment but which do not require excessive public funding.

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[261] NESO, 2024. Clean Power 2030.

[262] Regen, 2024. Progressive Market Reform for a Clean Power System.

Generators bid competitively for revenues from the Contracts for Difference through a competitive auction process, known as Allocation Rounds. Allocation Rounds 7-9 are expected to increase strike prices and capacity volumes to stimulate investment at the scale required for 2030.[263] As Contracts for Difference are paid via energy bills, there is a need to ensure that prices offered in these auctions balance value for both consumers and generators.

Locational marginal pricing

Perhaps the most contentious of the REMA options has been the potential introduction of locational marginal pricing. In short, locational marginal pricing proposes different prices for energy in different 'zones' of the country based on transmission network constraints, generation levels and demand. Ofgem is minded to deliver a zonal model of locational marginal pricing, although resistance across the energy sector in Scotland exists.

Locational marginal pricing could lower bills for some consumers. The idea of locational marginal pricing is to incentivise investment in renewables in areas of high demand (i.e. cities or industrial clusters). This can reduce constraints on the transmission network, reduce network losses and promote more efficient balancing of the energy system – which creates lower prices. In theory, areas where generation and network constraints are high but energy demand is lower, such as in the North of Scotland, would benefit from lower wholesale prices – and by extension, consumer bills – than areas with low generation and high demand, such as South-East England.[264] The impact of this would be especially strong for people who rely on older electric heating systems, who often face higher energy bills than the national average.

Locational marginal pricing would be a significant change to the energy market, creating uncertainty and potentially delaying investment in renewable projects. While proponents of locational marginal pricing argue that it would help reduce bills, developers of renewable projects argue that locational marginal pricing could create significant uncertainty for developers by fundamentally rewriting the rulebook while the energy transition is in full swing. Most of the projects needed to deliver Clean Power 2030 are already in the development pipeline.[265] Industry representatives, such as Scottish Renewables, are concerned that such a fundamental change could create a hiatus in net zero investment until the new rules became clearer – delaying the transition and exposing consumers to further price volatility.[266]

Various sensitivities in the modelling of locational pricing making the level of benefit for consumers difficult to predict. It is still unclear how locational marginal pricing would be implemented or when. Depending on the scale and complexity of a new locational model,

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[263] NESO, 2024. Clean Power 2030.

[264] Barnes, F., Brauer, F and Tahir, F., 2024. GB electricity wholesale market reform: impacts and opportunities for Scotland.

[265] NESO, 2024. Clean Power 2030.

[266] Scottish Renewables, 2024. Review of Electricity Market Arrangements (REMA): Second consultation launched.

consumer benefits may take some time to realise. As networks build new infrastructure to deal with constraints, the savings for consumers in the North of Scotland may decrease – although benefits could still accrue from more efficient balancing of the energy system.[267]

Rather than such a radical overhaul of the wholesale market while the energy transition is fully underway, the Scottish energy sector and other industry voices are increasingly converging on a more progressive market reform agenda that delivers the clean power transition at pace and passes the value of renewables onto consumers directly.[268] However, the UK government, NESO and Ofgem appear to favour the switch – with a decision expected in June 2025.

From this decision, there will be a distinct need to understand how consumers may be impacted in practise and explore options/mitigations to deliver value from this change in the market to different consumers directly.

7.2. **Policy and environmental costs**

Not linked to wholesale market reform or retail reform but critical to bills and future consumers is the current discussion on how to pay for policy and environmental costs. Environmental levies are recouped on the electricity bill, disincentivising consumers from switching to low-carbon heat. Environmental and policy costs comprise roughly 16% of the electricity bill, including the Feed-in Tariff, Renewables Obligation, Warm Homes Grant and the Energy Company Obligation.[269] This contributes to electricity prices being higher than gas.

The government has committed to reviewing levies and electricity costs, but the timescales are unclear.[270] There are two main options for redistributing policy costs: moving them from electricity to gas or shifting to general taxation. Moving levies onto the gas bill would provide the strongest financial signal to switch to cleaner heating. However, those with the lowest incomes would be unfairly affected if they cannot switch to low-carbon heating. To ensure those groups are not penalised, additional government support would be required.[271]

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[267] LCP Delta, 2025. Zonal pricing in Great Britain.

[268] Regen, 2024. Progressive Market Reform for a Clean Power System.

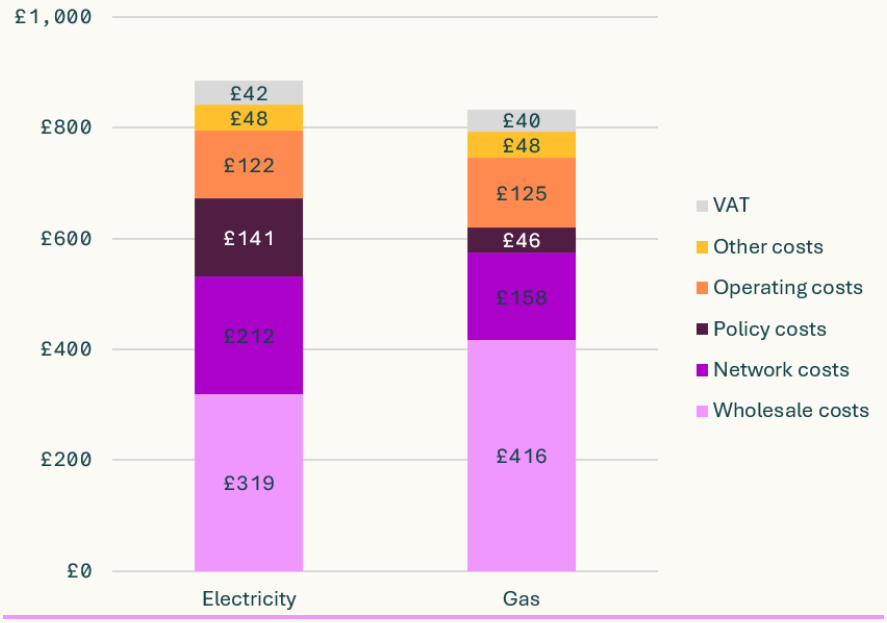
[269] Nesta, 2024. What's in an energy bill?

[270] 20 October 2023 - Debate on energy social tariffs

[271] E3G, 2025. The UK's Clean Power Mission: Delivering the prize.

Figure 9

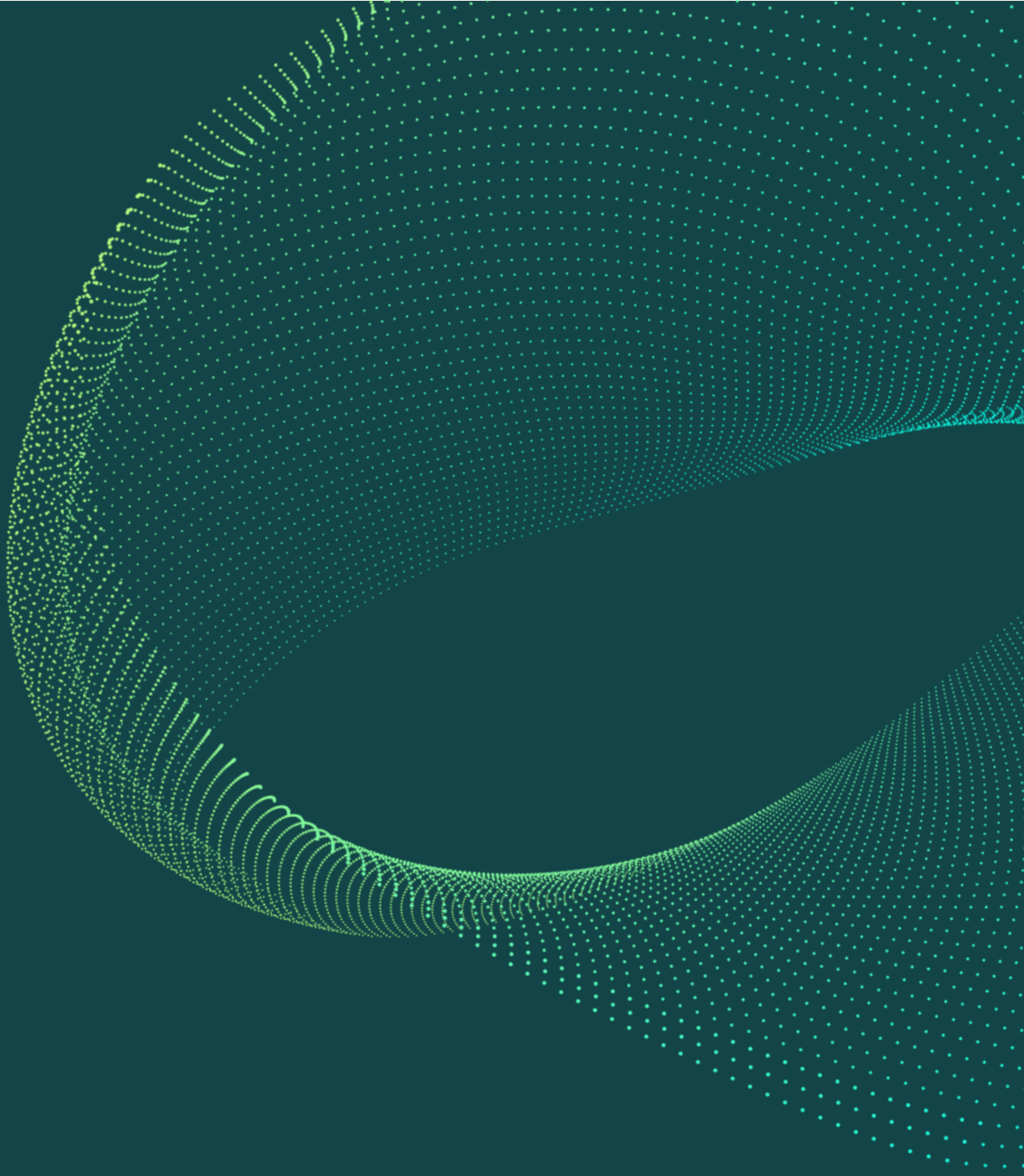
Average GB annual bills



Data source: Nesta, 2024. What's in an energy bill?

Appendix B: Energy-as-a-Service case studies

- **Financing with smart tariffs:** The 13 Green Home Finance Accelerator pilot projects are due to wrap up in February 2025. One project, led by E.ON, is looking specifically at Energy-as-a-Service and aims to provide innovative finance propositions with optimised energy tariffs and flexibility/grid services to reduce energy bills with no upfront costs.
- **Heat-as-a-Service in high-rise buildings:** vTherm Hub is being developed by Vital Energi with the University of Birmingham as part of the heat pump-ready programme. Given the inherent restrictions in heating options in high-rise buildings, Heat-as-a-Service could prove essential in these housing types.
- **Heat-as-a-Service for shared ground source heat pumps, with no upfront cost:** The Rossendale Net Zero Terrace Street, a Net Zero Living-funded project, is developing a community heat model to enable shared boreholes and ambient heat loops. All infrastructure and retrofit will be paid back via a standing charge by householders, aiming for no upfront cost to the homeowner, landlord or tenant.
- **Heat-as-a-Service as a way to grow demand-side response:** Energy Systems Catapult found that "widespread uptake by consumers had the potential to enable coordinated demand-side response of heat pumps through service providers managing their customers' heating systems in avoiding peak electricity usage".
- **Low-carbon technology installation financing:** Octopus Energy is trialling finance options for the installation of low-carbon technologies and includes a maintenance plan as standard.
- **Maintenance and guarantee:** See Aira and Centrica's inclusive maintenance plans and/or guarantees, which include full design and installation of heat service models, customer support, remote monitoring and scheduled maintenance visits.



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