Engaging households in electricity flexibility – insights from the UK
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1   Introduction

This report is the result of a 2019 application for a Gill Owen Scholarship from Energy Consumers Australia. Gill Owen had a significant impact on the energy landscape on two sides of the planet – particularly with regard to consumer policy - and I have been struck by the respect and affection expressed towards her – and towards her partner David Green - by many of the people I met in the UK.

This project set out to explore policy and best practice in the UK for engaging consumers in demand side management. It has been considerably delayed by the Covid pandemic and, three years later, much has changed. Not least, the language of 'demand side management' has been replaced by 'flexibility' and the need to reduce evening demand peaks is now combined – in Australia at least - with a need to address daytime minimum demand. But the importance of harnessing households' ability to shift their energy use has not diminished, and nor has the question of how to achieve it been resolved.

> *"The academic or the engineering work basically goes, 'We need all the flexibility we can get,' which is not terribly helpful!"* (Interviewee 20).

This research builds on substantial contributions made by other researchers in Australia, the UK and elsewhere. But the motivation came from my own conversations with energy users about home energy management, demand response and virtual power plants. Many people want to help make the energy system work better, to enable a cleaner, cheaper and more reliable electricity supply. However, it is becoming increasingly clear that price signals alone won't achieve the levels of engagement needed - trust, fairness, agency and a stake in the system are needed to unlock their participation.

My aim is to understand how different business and governance models, and diverse modes of consumer engagement might engender trust in and shared responsibility for the energy system, and support households to engage positively with flexibility opportunities.

There are both parallels and significant differences between the energy landscapes in Australia and the UK. In both countries, there is a common perception amongst industry stakeholders that lack of engagement is a problem. But British scholars are exploring the diverse ways (beyond simply participating in a market) in which people do engage with the energy system, while, in Australia, one in three houses has rooftop solar – arguably demonstrating a very high level of household engagement.

As energy costs climb in Australia, household bills in the UK are already soaring, pushing huge numbers into poverty and driving the collapse of energy retailers**.** This crisis is sparking new conversations. While there is a danger that fears about energy security could delay or derail decarbonisation, there is also a new and urgent opportunity to explore what kind of energy system would serve the interests of the public.

This report is based on 40 interviews with academics, industry stakeholders and consumer advocates in Brighton, Oxford, Norwich, London, Manchester, Glasgow, Bristol, Reading, Rougeley and Eigg: experts in socio-technical change, demand response, community energy and energy efficiency; community energy organisations and advocates; representatives from energy retailers and aggregators; policy analysts and advocates for energy users and energy system reform. Most of these participants know far more than me and I have used their own words extensively throughout the report. Some are named and others are anonymised (as Interviewees 1 to 40), according to their preferences. I am grateful for their time and generosity.

The next two sections of the report set the scene. Section 2 gives a brief overview of the current status of residential energy flexibility in the UK energy market, describing the available loads, existing and potential tariffs (including bundled services) and initial development of consumer protections. Section 3 describes some of the barriers to engaging households in domestic flexibility. These include lack of information and challenges in accessing data, the insufficient and unpredictable value of flexibility combined with significant investment costs, major disruptions to households and their routines, and distrust of technology and the energy sector.

These include technical challenges and financial barriers, but technical innovation, investment and price signals *on their own* are not sufficient to motivate households to act; behaviour is driven by a combination of economic, social and cultural factors. The following sections develop the main themes of this report: engaging households – people – in flexible energy use, the importance of fairness (whether for its intrinsic value or its contribution to building trust) and the role of governance. The 40 interviews revealed a wide range of views about how to approach each.

Section 4 discusses different approaches to developing household engagement in the energy system and its importance to the provision of flexibility, drawing on evidence from five UK case studies and touching on the role of understanding, automation, community benefits and energy resilience. Section 5 describes different ways fairness is interpreted in relation to flexible energy provision, whether it matters if some households are "left behind", and approaches to combining flexibility with fairness. Section 6 explores how engagement in flexibility might be affected by different governance models, including Community Energy, various forms of public ownership, nested governance structures and systems of representation.

2   Domestic flexibility in the UK market

This section presents a very brief overview of the current status of residential energy flexibility in the UK energy market. This includes a summary of the key loads available for flexibility (2.1) and the available residential tariff offerings from retailers *Octopus* and *Ovo* (2.2). Section 2.3 describes some approaches to bundled energy services and Section 2.4 presents current and potential practice in regulation and consumer protection.

2.1   Key loads for residential flexibility

In Australia, the most significant residential loads for providing flexibility are heat pumps (for air heating and cooling), electric hot water (whether heat pump or resistive heating), household batteries and EVs, though widespread deployment of EVs and batteries is yet to happen. In the UK, the focus is on EVs and heat pumps (for air and water heating).

The UK EV market is more developed than in Australia, with nearly a million plug-in vehicles including 520,000 all-electric (Lily, 2022), far beyond Australia's fleet of 40,000 EVs (Schmidt, 2022). The growing availability of smart tariffs and smart chargers targeted at EV owners bodes well for EVs becoming a source of flexibility, rather than having a negative impact on the grid.

32% of all UK energy use (after losses) is in the domestic sector, predominantly space and water heating (BEIS, 2022). Most heating uses gas (78% of households use gas-powered hydronic central), with only 11% using electric heating (Sonnischen, 2022), while much of the UK housing stock, in common with Australia, has very poor thermal performance (Committee on Climate Change, 2019). There is growing awareness of the urgent need to electrify heating in order to reduce household carbon emissions. This has potential to provide a significant source of flexible demand.

"If your primary goal is to decarbonise, now in the UK, I don't think spending your time and effort on adding more renewable generators to the system is actually that helpful. I think you should be focusing on decarbonising the way we're heating our buildings […] You're gonna get much bigger bang for your buck, and probably the decarbonising of the electricity system is gonna happen anyway" (Tom Nockolds, Energy4All, Interview).

"Electric heating […] is gonna be potentially another big source of shiftable demand… we are expecting the vast majority of homes in the UK to end up with some sort of electric heating source" (Rachel Fletcher, Octopus Energy, Interview)

2.2   Octopus and Ovo

As in Australia, the competitive retail market for electricity in the UK is dominated by a small number of retailers (known as 'suppliers' in the UK). In Australia there are three; however, in the UK, the "Big Six" have now become the "Big Five": British Gas, E.ON, OVO Energy, EDF and Octopus Energy. Octopus Energy, launched in 2016 with the vision of *"using technology to make the green energy revolution affordable whilst transforming customer experiences"* (Octopus Energy, 2022c), now has 10.8% of the market share (Ofgem, 2022), supplying over 2 million customers (Octopus Energy, 2022b).

Octopus was established by technology entrepreneurs and is widely seen as an innovator in the retail market. Its success is built on the efficiency of its *Kraken* integrated customer relationship management (CRM) platform, which reduces overhead costs and is now being taken up by other retailers including E.ON and Origin Energy (Rachel Fletcher, Octopus Energy, Interview). Kraken has been further developed into the *KrakenFlex* platform, which combines CRM with management of behind the meter DER resources and is central to Octopus's strategy of "rebuilding trust through technology"(KrakenFlex, 2022).

Octopus' innovative tariff offerings include:

- *Octopus Agile:* Retail tariff with day-ahead half-hourly pricing, tied to wholesale costs (including negative 'plunge pricing') and capped (currently at 78p/kWh) (Octopus Energy, 2022a)
- *GO Tariff:* A 'dumb' TOU tariff designed for overnight EV charging
- *Intelligent Octopus:* An EV tariff which uses a smart charger to optimise charging depending on wholesale market costs and to provide flexibility to the network operator within constraints set by the user (time of departure, required state of charge). Driven by machine learning through their *Kraken Flex* platform.
- *Big Dirty Turn Down:* a behavioural demand response in partnership with the market operator, *National Grid ESO*, which rewards customers for reducing consumption to shave network peaks.

Significantly, Octopus are starting to move beyond electricity sales, combining smart tariffs with sales of smart appliances such as EVs and smart chargers or, in the future, heat pumps. However, despite Octopus' innovation and significant market share, the majority of their residential customers are on a flat tariff, with only 60,000 on any kind of a smart tariff. "*If we can't persuade people to switch out their gas boiler or switch to an electric vehicle, we ain't gonna hit our decarb targets […] how do we make that easy and affordable and an attractive thing for customers to do*?" (Rachel Fletcher, Octopus Energy, Interview).

The third biggest retailer with 13.8% of the market (Ofgem, 2022), OVO Energy also offers tariffs designed specifically for EV owners. The basic tariff, *OVO Drive* is a flat rate tariff, but they also offer an *Anytime* low-rate tariff exclusive to smart chargers (OVO Energy, 2022). Like Octopus, OVO are trialling offers bundling EV leasing with electricity supply and smart charging, and trialling flexibility aggregation of heat pumps.

2.3 Bundling energy services

One approach to the difficulty of engaging households in the complexity of flexibility services is for a third party to manage it for them

Examples of bundled or blended assets and services include (Laura Sandys, Interview):

- Dual fuel contracts
- Energy as a service (EaaS) or Heat or Comfort as a Service (HaaS / CaaS) where the provider invests in building fabric and electrification and uses flexibility income to repay the investment
- Electric vehicle (EV) sales or lease contracts that include 'free miles' allowing the EV supplier to aggregate flexibility across their fleet
- Residential tenancies with a social housing provider or private landlord that includes energy and smart tech which the landlord uses to provide flexibility services

One of the first companies to use domestic assets in the balancing market is Social Energy (Social Energy, 2022) who install solar and batteries in residential buildings and monetise the aggregated flexibility across their fleet. Their business models include a range of options for social housing, including an 'economic' model where tenants buy energy at a market rate, a 'fuel poverty model' with housing providers investing so that energy can be supplied free to tenants, and a 'funded model' with no upfront costs to landlord or tenant.

While some bundled services don't require consumers to understand the energy system, they may actively make it harder for households to make conscious decisions about their energy use. Consumer advocates raise concerns that bundling makes comparison of offers harder and may result in 'lock-in' (Citizens Advice, 2022b). While advocates of bundled services seek to remove current restrictions on energy resale, they increase the complexity and difficulty of regulation, and there are concerns that this could undermine consumer protections and reduce transparency: "*The tension with that is of course that you make consumer protection around what is an essential service more complicated than it currently is*" (Laura Dye, Interview).

2.4 Customer protections

Consumer advocates have identified a range of customer protection measures that would increase household's confidence to engage in flexibility. These are based on user research and include requirements for no-fee exit clauses in flexibility contracts, minimum levels for information provision and service quality, user control over their data, and assured security of supply (Citizens Advice, 2022c). In particular, households need clear information to be able to compare offers, which means calculating and presenting tariffs using standard terms and language (Citizens Advice, 2022a).

 As business models develop, regulation is needed to allocate liabilities between different actors – energy companies, aggregators, technology suppliers, etc. – in a way that households can understand. "*The point is I think there's quite a lot of risk. You see it with heat pumps and all kinds of things, people are just getting mis-sold things, or not being offered things they were expecting, or things not working the way they thought, and there seems to be no redress because the energy supply does this but they haven't structured the liabilities associated with the kit working and maybe that's a third-party provider has all that…*" (Interviewee 20).

However, some stakeholders see customer protections – or at least the perceived rigidity of regulations – as a barrier to the development of flexibility markets. "*I think the way through this is actually a much more Agile approach to regulation as well. Rather than putting a whole load of*

people in a room with wet towels coming up with what they think is the right answer on customer protections, could we not […] come up set of customer protection principles, minimum viable product, and then six months later – what have we learned? How might we improve these principles? What were the downfalls of them? What were the unintended consequences? And then let's update and evolve them" (Rachel Fletcher, Octopus Energy, Interview).

The trade association, Association for Decentralised Energy (ADE), representing aggregators and some suppliers, is contributing to the development of a set of voluntary standards for household flexibility products. The *Household Or Microbusiness Energy flexibility* (*HOMEflex*) project will build on their commercial flexibility guidelines (*Flex Assure*). The Centre for Sustainable Energy is contributing to development of *HOMEflex* with user research and guidance on protection of vulnerable households. ADE hope that a *HOMEflex* code of conduct, voluntary compliance scheme and dispute resolution process will avoid the need for extensive top-down regulation.

"Our understanding at the moment is that the initial formal regulations will likely be focused around technical aspects and cybersecurity aspects […] and consumer protection in a rather limited sense", while *HOMEflex* will include *"quite a lot of detail around how you actually engage with customers and the sorts of information you provide, and how you actually document the offers that you provide to a potential customer are based on legitimate figures and estimates and forecasts and whatnot"* (Interviewee 08). As well as providing reassurance for households, the intention is to protect aggregators and DNOs from potential reputational damage of rolling out flexibility schemes that don't work for consumers.

3   Barriers to flexibility

This section describes the diverse barriers to realising household flexibility that emerged from the interviews. These span the range of issues described by the EnergyREV study on the potential of Smart Local Energy Systems (SLES) to deliver flexibility (Vigurs, Maidment et al., 2022), shown in Table 1, but a greater focus is placed here on the barriers to engaging households.

Table 1 Barriers to flexibility (Vigurs, Maidment et al., 2022)

• The policy making ecosystem
• Knowledge and learning ecosystem
• A system not designed to incorporate flexibility
• Transitional complexity arising from incorporating more energy from renewables (and so creating a need for greater flexibility)
• Realising value from flexibility
• Barriers to new entrants (investors, community interest groups and flexibility service providers)
• Managing risk to the consumer
• Attitudes and beliefs
• Participation and behaviours

3.1   Visibility and transparency

As in Australia, a lack of distribution network visibility and transparency is a barrier to flexibility in the UK. There are a number of dimensions to this issue.

One aspect is the difficulty for third parties in accessing information to inform decision making about siting generation, take-off, flexibility services, etc. The quality and accessibility of information varies between network operators: *"Some of them are […] providing open-source heat maps of this is where you could potentially connect to the grid, this shows where we've got capacity, where we haven't, where we're completely full, where works needs to take place. That's brilliant, but probably only 50 percent of the DNOs do that. So, you kind of enter into a postcode lottery. If you happen to be in a forward-thinking DNO region […] you know you're gonna get pretty decent transparency; you can see what they're doing and they'll work with you. If you're in another area, you might not get that support"* (Tom Hoines, Younity, Interview).

Related to this is transparency of costs for grid connection. One Community Energy organisation gave an example where the non-contestable costs of connection were 10 times greater than the initial DNO estimate *"So, we've got a rough estimate. We can go off. We can get planning permission. We can go and recruit our community. We can set up a share offer. We can do all of this work. You then get to the full submission and pay your deposit and stuff, and the final non-contestable costs come back, […] this is an extreme example, but there was one where they shifted the decimal point. It was 'we think this work is going to cost between 180 and 250 grand' for a two-megawatt solar farm – tiny little thing. […] The full quote, the non-contestable, came back and it was two million quid"* (Tom Hoines, Younity, Interview). This lack of transparency affects connections for batteries and loads, as well as generation, and creates a significant barrier for small or community organisations seeking to deploy infrastructure.

As in Australia, but uniquely amongst European countries, UK smart meter installation and operation is the responsibility of suppliers (retailers) rather than distribution network operators (DNOs). As well as slowing deployment, this results in difficulties of data access for households, DNOs and aggregators *"…and they haven't been installed. […] The value of that information is for the distribution network operator to know what's going on when you're having two-way exchange of electricity [but] there are different suppliers for the street and then we have to negotiate how the data gets shared…"* (Interviewee 21).

The UK government estimates annual savings of GBP 16 billion through widespread deployment of smart meters, and plans to install them for all customers by 2024 (BEIS, 2020). Half of all residential meters were smart by the end of 2021 (BEIS, 2022) but much of the value from these meters flows to DNOs and suppliers. *"All those benefits are remote disconnection, better load management, utility compliance, better control, better efficiency. So it's commercial benefits, not residential benefits"* (Interviewee 25). Indeed, there is broader evidence that smart meters – at least in the way they are currently being deployed – may benefit incumbent energy businesses more than energy users, and support existing business models more than innovation (Sovacool, Hook et al., 2021).

3.2   Insufficient value of household flexibility

Insights from Project LEO (Section 4.2.1) and other demonstrations suggest that the economic value of flexibility at an individual household level is quite low, and may be insufficient – on its own – to motivate households. This may point to the need to develop markets to better value the benefits of flexibility across the whole electricity system, and enable households to access that value.

Flexibility trials often involve subsidies external to the market and so their findings should be treated with caution (Crawley, Johnson et al., 2021). However, a purely financial transaction may be inadequate, and broader, non-financial incentives and motivations may also be required.

> *"I think if we just focus on the finance and encourage people to do it for the finance, and unless something radically changes in the way the flexibility markets are created. That's never gonna be a huge amount of money in a way that enables people who are giving very small amounts of flex for it to be sufficiently-motivating. So what is it that you can do that adds to the value proposition? That might be around any of the social or the environmental benefits, or the community benefits"* (Saskya Huggins, Low Carbon Hub, Interview).

This is particularly true if the costs of developing household flexibility capacity are considered.

> *"The demand or value created by domestic electricity is still quite small at household level, and so, yeah, our business model is quite sensitive to how long it takes to get a customer and how long it takes and the cost to serve that customer"* (Felix Wight, Repowering London, Interview).

Meanwhile, Octopus Energy's smart tariffs allow households to opt out if the benefits are insufficient, and limit the market risk they are exposed to. *"We've thought about off-ramps for customers. Agile – we have capped the downside for customers on Agile as well"* (Rachel Fletcher, Octopus Energy, Interview). But the cost of these additional incentives is beyond the value generated by the flexibility they provide, and is currently borne by the retailer. "*These products are not commercially viable for a number of reasons. But one of the reasons is that we've, if you like, deliberately put them out there in a safe way, customers know that they are effectively participating in a learning experiment"* (Rachel Fletcher, Octopus Energy, Interview).

This lack of available value is partly due to the absence of suitable markets, particularly price signals from the distribution network operators (DNOs). *"If you think about the revenue stack, the demand side response and flexibility needs, you need wholesale price arbitrage, you need transmission system, ancillary services, and some kind of reward for alleviating constraints, managing constraints on the distribution system. And that third part of the equation, we do not have dynamic price signals at distribution level"* (Rachel Fletcher, Octopus Energy, Interview). There is an additional financial barrier to electrification which is that environmental tariffs are applied to electricity (not gas) bills – an effective subsidy of gas (Rachel Fletcher, Octopus Energy, Interview).

The future value of flexibility is also unpredictable. *"The challenge with flexibility services is the revenues – the forecastable revenue streams are always short term […] So, your flexibility contracts that you might secure under whichever format you go for – three to four years sort of seems to be the time scale"*(Tom Hoines, Younity, Interview). This is a particular challenge given the significant investment costs of flexibility infrastructure (Section 3.4).

3.3   Multiple disruptions

While household heating promises to provide a substantial source of flexibility, it cannot happen without electrification of space and water heating. In turn, substantial improvement to the thermal performance of the housing stock is needed to enable efficient electrical heating and keep ongoing energy costs affordable and at a level that can be met by renewable generation. Building regulations need updating to require smart, flexible technologies as well as improved energy efficiency (ADE, 2020), but the major challenge is retrofitting to older buildings. It has been estimated that electrification of existing housing would increase electricity demand to 30 times the UK's current

renewable generation, while insulating the housing stock would reduce this to a more achievable fourfold increase (Tom Nockolds, Energy4All, Interview).

The good news is that a fabric-first approach to household retrofits – insulation followed by electrification – will increase energy efficiency and deliver bill savings to households. And there are significant co-benefits, including increased resilience to climate change (Climate Change Committee, 2022) and improved comfort. However, households face a range of barriers to retrofitting insulation and electrification before flexibility is even on the agenda.

> "Electrification, of itself, is a necessary ingredient but it's not flexibility itself. We thought we were encouraging people to take part in innovation trials around flexibility of their heat pumps [but] the innovation for many people was just getting their heads around the idea of switching from gas or oil central heating to a heat pump – that required a big step change." (Saskya Huggins, Low Carbon Hub, Interview).

The multiple steps involved in retrofitting fabric improvements and new technologies to existing housing stock have an associated set of technical challenges, exacerbated by the imperfect marriage of new technologies with diverse housing stock and existing infrastructure. Every solar installation is site-specific and may need wiring and switchboard upgrades. Particular difficulties are encountered finding suitable locations for inverters and batteries in the UKs relatively small residential buildings. Heat pump systems operate at lower temperatures but higher flow rates than gas central heating, and their installation may require replacement of pipes and radiators. Heat pumps and smart controls have different control configurations leading to interoperability issues.

Moreover, each step can be hugely disruptive for households. Fabric improvements and heat pump installation involve significant work throughout the house, damage to décor, etc. Poorly designed or installed systems will fail to provide adequate heating, while the operation of well-designed systems will be different to more familiar heating systems. All this disruption is encountered before even starting to provide flexibility services.

> "It's not a surprise, I suppose, that galvanising community groups and householders to adopt these disruptive technologies and install all the kind of complicated control systems as well has proved much more difficult than we imagined." (Nick Banks, Environmental Change Institute, Oxford, Interview)

Some actors are recognising the extent of this necessary disruption and the corresponding need for giving households compelling reasons to engage. "I*n entering almost every home in the UK and conducting significant disruptive building works, the drive to win public hearts and minds should not be underestimated"* (TUC, 2022). This requires a process of long-term engagement and trust-building.

3.4   Technology costs

Most of the potential sources of significant household flexibility require major investment in new technologies, whether EVs and smart charging infrastructure, or electric heating (and insulation).

One exception is an old technology – electric "storage heaters" (resistive heaters embedded in blocks of concrete), originally installed in several 100,000's of social housing units in London to utilise off-peak coal generation. This old technology needs updating with control and communications technology, such as *HeatSage* (Connected Response Ltd., 2021) which is relatively low-cost in itself. However, retrofitting to old technology can be problematic, requiring multiple visits (and therefore increasing costs) due to faulty or non-standard equipment (Syed Ahmed, Energy for London, Interview).

Another is existing electric hot water systems, which typically involve 2 resistive heaters – one connected to an off-peak supply, and the other on the general supply. Retrofitting these with smart controllers could harness a large flexibility resource but, again, there are often problems with the existing infrastructure that add significant costs.

> *"The big finding for the project, I would say, is that most people's electrical hot water systems didn't work well or at all. [...] There'd be two immersion heaters in it, and one would be you could turn on anytime, and one would only turn on or off at peak times. Well, often the off peak one is broken. So most of what we did was get them fixed or try working with our landlords and the really dysfunctional supply chains"* (Felix Wight, Repowering London, Interview).

The costs for newer heating technologies are much more substantial. Installation of a heat pump supplying an existing hydronic central heating system costs around GBP10,000, but many systems need additional pipework or radiator upgrades that can increase costs considerably.

Government grants of GBP5,000 are currently available to replace a gas boiler with a heat pump. Octopus Energy believe this puts a cost-effective solution within reach, with the government incentive combining with private investment in research and training to support development of a market that can scale and reduce costs. "*All of our trajectories show that, with scale up, that cost without government subsidy: you should be able to get that down to more or less parity with [...] the cost of replacing a gas boiler which is about 3K. That's about innovating in the manufacture and the tech of the heat pump itself, really working on streamlining the install process and getting to scale. We are coming up with a microbore solution ...with microbores, you're not having to replace the pipe work. If we are right, we'll get to a point where, if your gas boiler goes, it would be a no-brainer to replace it with a heat pump*" (Rachel Fletcher, Octopus Energy, Interview).

> *"I'm not looking to trivialise the challenge, but I think we've made the mistake, on a number of occasions, of underestimating how quickly costs can fall when you start getting to scale"* (Rachel Fletcher, Octopus Energy, Interview).

However, much of the existing housing stock also needs significant improvement to the thermal performance of the building fabric, which can add substantial costs. A third of houses with lofts have less than 125mm of loft insulation and 30% of houses with wall cavities don't have insulation in the cavity (BEIS, 2022).

> *"The Climate Change Committee advice to the UK Government is saying something like £25,000 per property [...] but that takes it to a level of energy efficiency which many in the industry would say is not actually the optimal level, given how much more energy generation we would need to support that level of energy demand. So more common estimates are £50,000"* (Chris Carus, Loco Home Retrofit Community Interest Company, Interview).

In the able-to-pay sector, some environmentally motivated owner occupiers are making substantial investments to lower their emissions, increase comfort, reduce bills and, potentially, add to the future value of their properties. But, for many households, this is not an option.

> *"And when you're in fuel poverty, not everyone has the luxury of choices, and so you may want to do all of these, you may want to electrify your heating, you may want to improve your insulation, but if haven't got the capital to invest in it or access the right support, then that's going to be really, really tough call"* (Saskya Huggins, Low Carbon Hub, Interview).

With two thirds of UK households facing fuel poverty by the end of 2022 (Crerar, 2022), up from 13.2% in 2020 (BEIS, 2020), retrofitting insulation and heat pumps across the UK housing stock at the

necessary scale will need major investment, beyond the ability of households to pay. The Climate Change Committee has recognised the need to accelerate retrofits, but their recommendation of government grants to support 30,000 heat pump installations (Climate Change Committee, 2022) fails to meet the scale of the task.

> *"The scale of money that you're talking about is huge. It can't really be overstated about how much investment this needs"* (Interviewee 36).

While improvements to building fabric is essential to decarbonisation, they are unlikely to generate the same return for investors that other technologies can.

> *"Some aspects [...] you get a really fast return on investment and others is a much slower return, essentially. So the challenge is avoiding investors coming in and just cherry picking the stuff that they like, 'All right, we'll stick a load of [...] heat pumps in people's houses, and then we'll get all the money back really quickly'"* (Interviewee 36).

Moreover, even where returns are sufficient to attract private or corporate investment, there may be long-term debt implications for house owners or renters.

> *"And we need, for any of these projects to work, we have to demonstrate that it can help make rich people even richer. That's frustrating. And then I think there's some practical questions about asking people to take on essentially another mortgage in a lot of cases"* (Interviewee 36).

3.5   Distrust

Giving over control of household appliances to automation requires trust in the technology, which may be lacking for a range of reasons, including concerns about malfunction, *"I mean, the trouble with automation is you always have the fear of the headline of defrosted sausages [...] your energy company can turn off your power and you lose all your stuff in your freezer"* (Tom Hoines, Younity, Interview). Concerns about making 'wrong choices' encompass issues of interoperability and future support in a rapidly evolving market: *"I know one day I'm probably gonna get a heat pump, but I wanna know that I got VHS, not Betamax," <laughs>. It's all changing, it's all changing so fast, and there's a lot of money, and I really don't trust the technology"* (Saskya Huggins, Low Carbon Hub, Interview).

It is widely acknowledged that households trust different organisations to different degrees. Studies suggest that *"mistrust arises less from what is required of users or what kind of technologies are involved, than from what kinds of actors are involved and the relationships between them"* (Adams, Kuch et al., 2021). As in Australia, distrust of energy suppliers (retailers) is widespread in the UK. *"Between them they had around 4,000 different tariffs. So that, obviously, is a very strong indication that this so-called competitive market doesn't work because they're obviously trying to fool customers - and they successfully have"* (Colin Nolden, Environmental Change Institute, Oxford, Interview). The distrust often extends to the Distribution Network Operator (DNO), in part because people may not distinguish between the two. *"There was limited understanding about the role of the DNO. In particular a continued tendency to conflate DNOs with retail energy companies can cause a lack of trust"* (Coxcoon, Sansom et al., 2015).

Trust and distrust relate to particular actions as well as to entities. *"Consumers may trust energy suppliers [retailers] to provide a reliable energy supply, but not trust them to bill them fairly for that energy"* (David Shipworth, University College London, Interview). Conversely, community groups may be more trusted to distribute benefits fairly, but not to be the sole supplier of energy. *"So trust is this kind of nuanced thing"* (David Shipworth, University College London, Interview).

The involvement of trusted actors in the process of engaging households is an important element in successful trials. *"It's trust in who's the messenger, so we're finding that there is a really important convenor role that either ourselves or a local community group, could be low carbon, could be a resident's association, but somebody who's considered to be neutral, or has got the community that trust their heart is pretty really important."* (Saskya Huggins, Low Carbon Hub, Interview).

4   Engagement

This section discusses the role of household engagement in the energy system, starting with some different perspectives on the existing level and types of engagement and its importance to flexibility provision. Section 4.2 introduces five case studies from the UK, local initiatives from Oxford, Rugeley, Eigg, London and Wales with very different approaches to engaging households in flexibility. Sections 4.3 tackles the relationship between household understanding of the energy system and engagement, while Section 4.4 touches on whether automation can remove the need for engagement. Drawing on evidence from the case studies, Section 4.5 examines the potential for an appeal to community to motivate flexible behaviour. Finally, the question of how flexibility interacts with energy resilience is introduced in Section 4.6.

4.1   Are households engaged and do they need to be?

It is common to hear that households are not engaged in energy and don't want to be engaged. Famously, according to a 2016 Accenture survey, households spend an average of 8 minutes a year thinking about their energy bills. Reports from demand response trials, in the UK as in Australia, express frustration at the challenges and costs of engaging consumers.

> *"The main way people are [participating] is by switching between different suppliers - direct debit and a bit of attitude to go out and switch supplies is about all you really need to participate and otherwise it's just passive."* (Interviewee 20)

However, this view is contested. *"The starting point is often that the public aren't engaged around the energy transition or around climate change and such. And I think what our evidence shows is that people are engaged"* (Interviewee 10). The UKERC Observatory for Societal Engagement with Energy Transitions is exploring ways in which people engage with the energy system and how they shape potential visions of the future. *"The problem is not so much a deficit of public engagement, but rather a lack of recognition of and responsiveness to the diverse engagements that are already happening"* (Chilvers, Pallett et al., 2022).

People engage with the energy system through their everyday behaviours and changes to those behaviours, through traditional and social media, through participation in surveys, workshops and consultations, through community action and political activism, but "*policy-makers and other powerful actors have tended to privilege certain issues, models and subjects of participation in decision-making"* (Pallett, Chilvers et al., 2019).

There is a need to recognise, support and value these different forms of engagement and participation. "*Public engagement is now seen as crucial to realising low carbon policies and technologies, shifting to more sustainable behaviours and practices, and ensuring these urgent transitions are just, democratic and publicly accountable."* (Chilvers, Pallett et al., 2022)

However, the degree and type of household engagement that is necessary (or even useful) in facilitating residential flexibility is also contested. Given the apparent difficulty of engaging households in energy, and in flexibility in particular, one approach is to find alternative routes to flexibility, including through automation and aggregation.

"Anybody who thinks that we want to engage consumers is crazy. I mean: DO NOT ENGAGE CONSUMERS! […] I have no interest [in being engaged]. And I'm not in the business of being interested. I am a human being!" (Laura Sandys, Interview).

This approach underpins bundled products and Energy as a Service offerings, which may not require households to engage with the detail of energy generation and use. But, rather than enabling households to avoid engagement with the energy system, these products require a *different kind* of engagement: a particular type of transactional engagement that prioritises convenience and comfort and excludes consideration of environmental and social impacts.

Others see a need for increased engagement from households – or at least different types of engagement – to provide the flexibility necessary to drive the energy transition.

"The main reason is because we need to get carbon emissions out of the system, and the main way to do that is renewables and [so] we need to flex demand properly, […] particularly through timing of things and shifting demand. […] the system is changing […] and that changes the nature of meaningful participation in the system." (Interviewee 20)

Moreover, this type of engagement may contribute to building the social and environmental awareness necessary to drive the energy transition. "*Actually, it's gonna be quite important for people to feel like they're part of this. It's something which there's an opportunity to contribute, even if it's only a small amount, and that feels quite important as public*" (Interviewee 20).

4.2 Case studies in engagement

The selection of case studies here is in no way either comprehensive or representative of the large number of pilots and projects operating in the UK[1]. All of these operate within defined geographic boundaries, and they include Smart Local Energy Systems (SLES), although not all are based on 'smart' technologies, and they demonstrate diverse approaches to engaging households in flexibility.

4.2.1 Project LEO

Project LEO – Local Energy Oxfordshire (Local Energy Oxfordshire, 2022) – is an ambitious, multi-agency and multi-stranded trial of new technologies, local markets and business models, aimed at demonstrating smart local energy solutions and developing policy approaches to support the energy transition. Oxford is a university town with a long history of green politics with a relatively wealthy population in the city and surrounding towns, alongside some areas of high deprivation. LEO projects include a number of 'Smart and Fair Neighbourhoods' involving households and businesses engaging in flexibility services through both behavioural response and automation of DER.

Much of Project LEO's engagement activities have been led by **Low Carbon Hub** (LCH), a social enterprise that works with local community organisations, schools and businesses to develop community renewable generation projects across Oxfordshire. Using these existing relationships has enabled LCH to access a large pool of households who are already actively engaged with local and renewable energy and are keen to engage with flexibility services. Trust in the innovative flexibility offerings is increased by engaging with households through local community organisations and local government energy advisers, and by using a co-design process to develop business models and appropriate value propositions.

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[1] A detailed and more comprehensive analysis of the technologies, activities and business models of UK SLES (Braunholtz-Speight, Sharmina et al., 2022) has been carried out by researchers from the **EnergyREV** consortium.

Emphasising the community benefit of a balanced local clean energy system is central to Project LEO's approach to creating social licence for local energy infrastructure. This supplements the cash value of flexibility which is too small, on its own, to incentivise engagement, and includes indirect benefits - such as clean air, reduced bills for local schools, EV charging points – which are shared with households who are unable to engage directly.

Some of LEO's more successful engagement has been in new-build social housing where LEO's partner **Younity** (co-owned by Octopus Energy and MidCounties Co-Operative) is the default retailer for new tenants. Coupled with sign-up incentives for data sharing, including cash credits and free broadband connections, this has led to 24 of 60 households signing up to share energy data, with further future incentives envisaged for flexibility provision (Tom Hoines, Younity, Interview).

However, more broadly, levels of sign-up for technologies and for local energy markets have been low. While project LEO has tapped into groups of people keen to engage in flexibility, the technical and other barriers described in Section 3 have prevented widespread participation.

4.2.2   Zero Carbon Rugeley

The **Zero Carbon Rugeley** (ZCR) project involves development of a SLES in the town of Rugeley in the West Midlands of England, including the site of a former coal-powered power station. The project is exploring a wide range of activities, based around buildings and mobility, including energy efficiency measures in new builds and retrofitted to existing buildings; smart shared mobility options; trading of energy and flexibility services through a local market platform; an AI-based optimisation platform for operation, balancing and flexibility management at different spatial scales (e.g., street or suburb); and development of investment-ready business models.

Although the SLES aims to produce a scalable and replicable model for delivering clean, affordable energy to residents, a user-centric design process is central to the project, with the aim of ensuring that "*the wants and needs of the community are addressed. Zero Carbon Rugeley will create 'a bespoke Rugeley SLES', not simply an 'SLES for Rugeley'*" (Rugeley Power, 2020).

Rugeley's history as a coal town presents both challenges and opportunities, and provides learnings pertinent to the Australian context. The town was a centre for large-scale coal mining from the 1950's until 1995, with the last of its two coal-fired power stations closing in 2016.

As well as traditional engagement mechanisms, the project has used art-based activities, such as a *Rugeley Energy Heritage Performance Walk* (Engage Zero Carbon Rugeley, 2022), to frame the energy transition in the context of the town's mining and electricity generation heritage, drawing a continuous thread from the historic coal industry to future innovation.

"The Zero Carbon Rugeley project neatly uses the legacy of the coal-powered energy industry as an opportunity to reimagine the way a whole town generates, stores, uses and shares energy at a local level."(Saunders, 2022)

4.2.3   Eigg Electric

The Isle of Eigg measures 9km x 5km and lies in the Inner Hebrides, 10 miles off the West coast of Scotland, with a population of just over 100. It is powered by a community-owned microgrid. A 100kW hydroelectric plant supplies most of the load during winter and 170kW of solar PV meets much of the summer load, supplemented by battery storage, four small wind turbines and, when needed, two 64kW diesel generators. The system has been generating since 2008 and is owned and operated by **Eigg Electric Ltd**., a subsidiary of the Isle of Eigg Heritage Trust, the community organisation established in 1997 to buy the island from the then Laird.

As well as using batteries and generators to balance the system, a series of frequency-controlled space heaters in community buildings are used to dump excess generation (usually in winter due to high water flow), while under frequency is avoided through capacity limits and demand management.

Each household has a capacity limit of 5kW, and small businesses (holiday accommodation, farms, the shop) have a limit of 10kW. These are peak limits, and customers are presumed to keep well below them for much of the time. *"We thought five kilowatts and then that made it more equitable, but we're still looking to people not using five-kilowatts all the time"* (Maggie Fyffe, Isle of Eigg Heritage Trust, Interview). If a customer exceeds their capacity limit, a circuit breaker is tripped resulting in a visit from a technician and a fine. But fines are rare, *"last time, nobody could remember how much it was, and I said, 'I think it was ten pounds' so we charged them that"* (Neil Hollands, Eigg Electric, Interview).

As well as these fixed capacity limits, households and businesses are encouraged to manage their energy use to match time-varying generation, not through price signals - all customers pay a flat tariff *"initially set higher than the mainland due to competition rules, but now much less"* (Maggie Fyffe, Isle of Eigg Heritage Trust, Interview) - but through an appeal to community responsibility. A set of frequency-activated 'traffic lights' in the main town, showing green when generation is plentiful and red when it is constrained, are now supplemented by broadcast e-mail messages. *"In winter, when we're on the hydro most of the time, if […] the hydro drops off and the generator is coming on [we ask] 'Can you please keep your usage to a minimum until either it pours rain again (which will be pretty soon, because it's winter) or until we get the problem fixed', or whatever, and people do"* (Neil Hollands, Eigg Electric, Interview)

The island's universal acceptance of capacity limits and widespread co-operation with demand management requests is, at least in part, a result of the governance arrangements of Eigg Electric. *"…I think it is a real community system, so really people are invested in it"* (Maggie Fyffe, Isle of Eigg Heritage Trust, Interview). The residents' association is the controlling partner in the Heritage Trust (and, therefore, in Eigg Electric) with residents electing 4 of the 6 directors, and the community is consulted on significant decisions. *"Like, for instance, we've just put the maintenance team's hourly rate up and to enable us to do that, we've had to put the unit charge up, so obviously that goes to the community as a whole. We think we should put the wages up because they do a bloody good job, so that means an extra 2p on your unit charge. People love the electric system so much that they're quite happy to do that"* (Maggie Fyffe, Isle of Eigg Heritage Trust, Interview).

While the inclusive governance approach has been significant in achieving this level of buy-in, it is also relevant that (at least, for the approximately 80 people who lived here before 2008 with no mains electricity), this capacity-limited and demand-sensitive system represents a major increase in capacity and reliability. *"So every bit along the way it went through the residents to make sure everybody were on board, but everybody were just delighted with the idea of having mains electric"* (Maggie Fyffe, Isle of Eigg Heritage Trust, Interview).

Most recent arrivals – attracted by the strong island community and promise of a simpler life – have successfully adjusted to the microgrid and developed the necessary level of grid sensitivity and community responsibility, but some need education. *"So, there's been a few plots privately sold recently. And so, they get an architecture plan and they read, 'On Eigg Electric, you can get five kilowatts.' So, that means we can have immersion heaters, we could have electric heaters 'cause they think everybody's got five kilowatts all the time"* (Sue Hollands, Eigg Electric, Interview). *"So, people did understand, or most people did. We do come across – not specific problems, sometimes*

people need a bit more education. And, as I say, I think people need a bit more information" (Neil Hollands, Eigg Electric, Interview).

There may be additional challenges for businesses in managing their demand flexibly. *"We're already minimising our loads, so we have no room for flexibility"* (Interviewee 39). More significantly, the existing electricity network relies on residents and businesses using other energy sources; in particular, most residents use wood-burning stoves with back boilers for space and water heating, and bottled gas is widely used for cooking. A small trial of ground-source heat pumps and electric water heaters, each with an additional dedicated 5kW supply capacity, is underway and there is strong interest from residents and business in fully decarbonising the island's energy supply.

Eigg Electric has commissioned a feasibility study to explore the implications of widespread electrification of space and water heating and cooking on the generation, distribution and control requirements of the network. There is interest in exploring tidal generation to meet year-round demand. One significant question is whether the island's undergrounded distribution network will be adequate to the task. But perhaps the biggest challenge – as elsewhere in the UK – is the need for insulation of the islands largely stone-built buildings to facilitate electric space heating, and the associated need for widespread education. *"The Trust owns ten buildings – ten houses. So we can insulate those and we can help other people to be aware of the funding and where they can insulate their homes. We can't tell other people to insulate their homes, but if you're gonna have any kind of electrical space heating in this system, you have to have an insulated home. And it's such a huge job. The actual whole thing of increasing the system and isolating is so huge, it won't work unless we have, for lack of better terms, a zero or a carbon officer coordinator or whatever. There's got to be somebody – so, we got to find the funds to pay someone for, say, three years, to actually do that. It's the only way it'll work"* (Sue Hollands, Eigg Electric, Interview).

Importantly, the marine boundary of the island also defines the extent of the electricity network and the community it serves. So the entire generation, distribution and control system is owned and managed by a small group of people *who know each other*. More generally, the particular circumstances of island communities – including small populations, mutual reliance and close community ties - are well suited to developing high levels of energy engagement and grid sensitivity and so supporting flexible demand.

"It is easier for an island to have a human scale sense of identity, to have a simpler governance structure that can get on with doing things without getting bogged down in political processes. Island communities often have a culture of local resilience and self-sufficiency, born of necessity" (BuroHappold Engineering, 2016). The community campaign and buy-out of Eigg in 1997 strengthened community bonds and established a strong culture of democratic engagement. However, like other community energy projects, the electricity system on Eigg has itself played a role in building community cohesion. *"That was a huge part of it. It's because it actually affects everybody. A lot of projects here don't affect everybody"* (Maggie Fyffe, Isle of Eigg Heritage Trust, Interview).

> *"The innovation taking place in these islands is often transferable to other locations where the need is less pressing,"* (BuroHappold Engineering, 2016).

Talking to Eigg islanders, it is clear that many residents do feel a real sense of ownership over the electricity system. They have at least a cursory understanding of how the system is tracking - *"I heard one of the generators was down last night,"* (Interviewee 40) - and are sensitive to how their energy use impacts the system. Eigg provides a demonstration of how an engaged and grid sensitive community, accepting demand constraints and providing flexibility, can facilitate a network supplied

by 90% variable renewable generation (Eigg Electric Ltd., 2020). It may also provide some clues as to how the necessary level of engagement might be developed in a larger and more diverse populations.

> *"I think it's all about people using less really isn't it, or thinking more about what they're using and what they're doing"* (Maggie Fyffe, Isle of Eigg Heritage Trust, Interview).

4.2.4   Repowering

Repowering is a community energy organisation based in London. Like many Community Energy (CE) organisations, their core business model involves raising funds through a share offer to install renewable generation on community buildings and selling the energy to the building occupants. They have a strong focus on inclusion and on creating opportunities for people who otherwise might not benefit from the energy transition. Most of their projects involve social housing, in contrast to many community energy projects which are skewed towards middle class participants. Repowering have initiated a number of flexibility trials, including:

- Home Response, a trial of smart technologies including smart controls for existing electric hot water systems. They estimate these controls could provide over 600MW of flexible demand from existing electric properties in London (London Assembly, 2022). In the trial of 40 properties, savings from TOU tariffs were more significant than flexible response.
- CommUNITY, a local energy trading project, with social housing residents in Brixton buying generation from a community solar installation on the roof of their building. Urban Energy Club is an extension of this project – a trial of a small community battery alongside the existing solar. Participants already engaged can opt into flexibility revenue from the battery or choose to pass the benefit to a community fund. The trial had relatively low participation, but served as a proof of concept.

For all these projects, Repowering work in partnership with local councils and social housing landlords to engage with residents. Rather than seeing flexibility projects in isolation, they hope to build opportunities for flexibility into the business models they are developing for energy efficiency and low carbon heat through community retrofit projects.

4.2.5   Energy Local Clubs

Energy Local is a community interest company started in Bethseda, Wales to enable households to purchase locally generated renewable energy at a discount price. It involves an arrangement between generators, Octopus Energy (as the retailer) and Local Energy Clubs, which are co-operatives of local residents. Club members are able to purchase an allocation of local energy at a time-varying discounted rate discounted electricity.

The rates, times and amounts of the local energy pricing may be based on a fixed time of use tariff, or dynamically linked to the actual output of the local generator. The generator is paid a small premium on the wholesale market price for the electricity sold to the club. It is not clear where the saving comes from. Some observers describe innovative use of a multi-point connection agreement intended for commercial customers sharing energy across multiple sites; others suggest Octopus may be foregoing part of their margin to support the initiative and for customer acquisition.

Households are given visibility of their own energy usage, and of the local generation, through a dashboard, as well as information on how to shift flexible loads. This also gives them the ability to control smart plugs through their energy dashboard, manually, by time, or based on forecast generation. The initiative now has 9 active clubs across Wales and Southern England.

4.3   Understanding

4.3.1   Lack of understanding

> *"People are having to understand new concepts and about the way energy system works, this idea that there's only so much capacity in the energy system is a really new one for people to understand"* (Saskya Huggins, Low Carbon Hub, Interview).

Because of the complexity inherent in flexibility and the diversity of approaches, it is not surprising that many households are not confident in their understanding of the available opportunities, with less than half of consumers surveyed by Citizens Advice saying they feel confident in understanding Time of Use tariffs (see Figure 1). To judge the best offer for them, households need to be able to assess their own flexibility capability (Citizens Advice, 2022b) which is demonstrably difficult for experts and researchers, let alone households, particularly when considering the interactions and combined impacts of multiple technologies – solar, batteries, heat pumps, Evs, tariffs, etc.
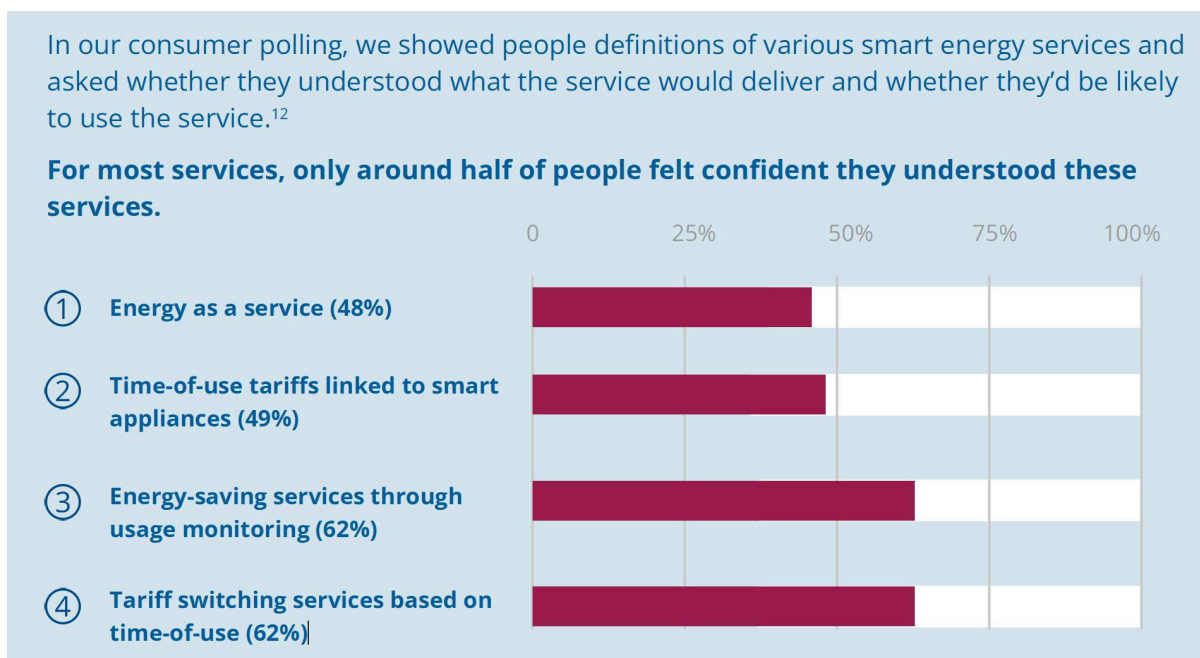
In our consumer polling, we showed people definitions of various smart energy services and asked whether they understood what the service would deliver and whether they'd be likely to use the service.[12]

For most services, only around half of people felt confident they understood these services.

1. **Energy as a service (48%)**
2. **Time-of-use tariffs linked to smart appliances (49%)**
3. **Energy-saving services through usage monitoring (62%)**
4. **Tariff switching services based on time-of-use (62%)**

Figure 1 Consumer confidence in their understanding of innovative technologies and services (Citizens Advice, 2022c)

Evidence from trials suggests that, while people are willing to participate in flexibility or in local energy systems, these complexities can be overwhelming.

> *"People are willing to participate. But I don't think people are willing to get their heads around the very complex stuff – and why would you? I think people come to it and they're like, "Oh, yeah, great, solar panels – yeah, I'm totally up for selling it to my neighbours. Of course, I wanna do that. In our neighbourhood, we're all gonna have solar and we're all gonna share the electricity. It's gonna be cheap for us. And we'll have a system that we like – that makes it fair and –" whatever. I think most people are really up for that.[…]As soon as they're up for it, you have to hit them with the financial details, and the network charging and the balancing <laughs>. And then they're like, 'I don't know what you're talking about. Go away'"* (Interviewee 21).

Conflicting messaging from different service providers can add to the confusion.

"So the green tariff sale is another message that massively outweighs anything we say about the time or incidence variation in carbon intensity of electricity, and so it's a bit of a struggle to get that idea across sometimes" (Chris Carus, Loco Home Retrofit Community Interest Company, Interview).

4.3.2   How much understanding is needed?

The extent to which it is necessary, achievable or even desirable, for households to understand flexibility is also contested.

"The common assumption used to be that the public have a deficit of understanding that needs to be corrected with improved communication or bypassed altogether. While information and awareness are necessary, this traditional emphasis on communication to the public has proven to be problematic and limited in empowering societal transformations" (Chilvers, Pallett et al., 2022).

"I have a slight frustration with how a lot of market players see consumers as like 'They don't know. They don't understand. They don't want to know. They don't want to understand.' And I'm sure there are those types of consumers, but I also think that there's a really important messaging around – what does this whole balancing of the grid actually mean?" (Interviewee 08).

Different levels of understanding are needed for different modes of engagement. On one hand, Energy as a Service (EaaS) and bundled offerings, with flexibility automated and managed by third parties, require little understanding from households. Indeed, a household signing up to EaaS may be prepared to pay a premium precisely to avoid having to think about how and when they use energy. However, the new technologies themselves may require increased understanding from a range of stakeholders. There may be a need to educate households in how to use the new technology, as well as to train plumbers, electricians and engineers to design and install them.

Conversely, engaging households in behavioural demand response requires them to understand, at least, *what* actions are being asked of them and *when* they need to happen. Crawley, Johnson et al. (2021) discuss how the need for understanding can be distributed between different actors, such as energy companies, aggregators and installers as well as households, with implications for capacity building, including education and training, in different parts of the energy system.

"There was a tendency to try and explain all the features of flexibility when we're trying to involve communities, and they didn't need to know any of that. You need to be able to explain it if they ask but actually they need to know what do you want me to do, and when, and how would that help, or what will it cost. It's like classic marketing point that you sell benefits, you don't sell features. We have to learn: how do we get better explaining to people what is it that we're asking them to do" (Saskya Huggins, Low Carbon Hub, Interview).

The reasons why flexibility is needed can be understood at different levels. While a full technical explanation includes discussion of frequency, inertia, real and reactive power, etc., simple analogies and models can provide sufficient understanding to justify engagement. *"It is actually really difficult for most people to actually understand what physics of the grid is doing. So it's this question of how far do you simplify to get that balance?"* (Interviewee 30). The academic literature relating to 'Social Licence to Automate' describes *"the ways that the acceptance of automated DSM depends on users' knowledge of why the program is being implemented and how all the actors involved – including themselves – may benefit."* (Adams, Kuch et al., 2021)

Other researchers describe the need for messaging about the energy system to be both *true* and *meaningful*. Truth (or *enough truth*) is needed to underpin trust, while meaning is necessary to motivate engagement. For example, *"many people would say [green tariffs are] somewhat meaningful to quite a few people, but a lot of them aren't really true when it comes to the meaning people attach to them"* (Interviewee 30). This has implications for designing characteristics of flexibility schemes, such as geographic scale; for example, the truth of energy sharing is easier to see – and therefore more meaningful for people – if it takes place in a small locality. The idea of energy citizenship can make sense to people if it is linked to a sense of place or community. *"We need to teach communities that they need to know their network, which they didn't before"* (Nick Banks, Environmental Change Institute, Oxford, Interview).

4.3.3   Understanding through engagement

Rather than being a pre-requisite for meaningful engagement, understanding can be the *result* of some types of engagement. There is evidence that ownership of distributed energy resources, particularly solar, can lead to development of sensitivity to the relationship between renewable generation and energy use, with solar households intuitively shifting their demand to maximise solar self-consumption.

> *"I've often believed that the more you're exposed to distributed energy assets, particularly PV on your roof – and particularly if you have a sense of ownership with those assets – that that will change your behaviour. Because it's a bit like growing vegetables in your own yard, electricity always tastes better when you've grown it on your own roof, kind of thing"* (David Shipworth, University College London, Interview).

However, this increased sensitivity is not inevitable and is sometimes limited by traditional gender roles (Sovacool, Barnacle et al., 2022). There is also some evidence of a rebound effect, whereby households increase their energy consumption after installing rooftop solar, increasing appliance such as televisions, tumble driers or hot tubs, justified by their solar generation (Sovacool, Barnacle et al., 2022), although it is worth noting that the environmental impacts of this apparently adverse behaviour change depends, of course, on the degree of temporal alignment between the increased consumption and solar generation.

This type of sensitivity is not restricted to individual DER. On the Isle of Eigg, understanding of the energy used by different appliances is widespread.

> *"I was at the Centre for Alternative Technology and I was in the wee room that they've got like a little doll's house, and they've got all these different things throughout the house and you could press a button and it lights up and it tells you how much and I just found it fascinating. I was standing just watching other people press. There was just one elderly lady and, 'Look how much an iron uses? I'm gonna stop ironing,' people don't have that notion whereas we do, but that's because of our situation really."* (Maggie Fyffe, Isle of Eigg Heritage Trust, Interview)

4.4   Automation & technology

Automation is seen by many as an alternative to engaging households. If technology can be used to automate flexibility, then households don't need to engage; they can simply set their preferences and carry on with their lives.

But this analysis is based on an overly narrow definition of engagement. Certainly, automation can remove the need for households to respond directly and manually to a price signal by reducing their energy use, but they first need to 'take up the offer' (Roberts, Passey et al., 2021). This can require multiple forms of engagement such as signing up for a tariff or a bundled energy service; buying an

EV and smart charger; or insulating a house and installing a heat pump. Automation does not remove this step, and it may add barriers – some people will be *less* comfortable with an automated response than a manual one.

More generally, the Social Licence to Automate literature suggests that *"the expectation that automation can achieve flexibility 'behind the scenes' overlooks the extent to which it also requires of users a new kind of flexibility, assuming [people] to be unbothered by the alteration to household energy practices, undesirable indirect effects, and additional 'flexibility labor'[sic] that automated demand side management can bring"* (Adams, Kuch et al., 2021).

4.5 Community motivations

"People are more than homo economicus – they work better when you appeal to their better selves, rather than small financial returns with the suspicion that someone else is making more money than they are" (Mark Luntley, Energy4All / RESCOOP / Westmill, Interview).

Just as households engage in the energy system in many different ways, they do so for diverse reasons. While individual financial benefit is one consideration, it may not be sufficient to overcome barriers. *"Users' requirements for a sense of control may not simply be satisfied or offset by financial compensation or other measures"* (Adams, Kuch et al., 2021). The need to consider other motivations is particularly relevant in the context of small - or uncertain - financial rewards (Section 3.2), but is important in securing widespread participation even if the financial benefits are significant. In Australia, for example, households commonly deploy rooftop solar because the financial and environmental benefits align. Multiple studies suggest that "*targeted value framing that applies altruistic, biospheric, and hedonistic messages in a selective manner, could be a key component in recruiting more consumers to participate in flexibility programs"* (Adams, Kuch et al., 2021).

"It might be that it's a civic thing to do, wherever it is, because you're a global citizen and climate change, or it's about helping your neighbours get access in creating capacity" (Saskya Huggins, Low Carbon Hub, Interview).

Households may also be motivated by an appeal to community – rather than individual – benefits. In this context, 'community' could be local, national or global. At the local level, this can include aggregating small or negligible individual flexibility payments into a community fund that can finance local (energy or non-energy) infrastructure, from EV chargers to children's playgrounds. "*If you can do something that benefits your local community, the importance of place in all of this is gonna come out"* (Saskya Huggins, Low Carbon Hub, Interview).

Households may be motivated by shared community action as well as shared community benefits. *"Community action shows promise as an alternative or supplementary motivation to price signals. […]* Participants "*were motivated by the idea that they were not acting alone, but as part of a collective effort and welcoming of comparison with neighbours for the purposes of sharing knowledge and supporting each other"* (Melville, Christie et al., 2017).

Meanwhile, European researchers (SONNET, 2022) are exploring the idea of energy communities based on shared interests or motivations, rather than locality. *"Energy communities don't have to be communities of place; they can be digital communities. And those types of digital communities, that collective self-consumption, collective virtual power plants are extremely appealing, and cross space and time in ways that get around some of these issues of markets, and some even transcend countries"* (Interviewee 25).

Certainly, while local community benefit can help motivate engagement, understanding of wider considerations is also important. *"In the UK context, the current grid infrastructure […] will not be able to cope with the electrification of heat and transport. So, unless there's flexibility online, there will be taxpayers' money going into building out the infrastructure, which again, is a message to put across, right?"* (Interviewee 08).

The management of water during extended periods of low rainfall that result in low reservoir levels may provide lessons for the management of electricity. Water, like electricity, is an essential service, but not all water use is essential. *"When you get a drought, they don't just do it through pricing. They say, 'Don't wash your car'"* (Maggie Fyffe, Isle of Eigg Heritage Trust, Interview). In the first instance, this messaging is often framed in terms of community responsibility, and although it is sometimes backed up by sanctions or enforced through social pressure, its effectiveness is testament to household understanding of their shared responsibility for a common resource. People are invested in water *"Well, we all use water […] We all like to have a nice clean river!"* (Cat Hobbs, WeOwnIt, Interview).

> *"And if you can see that you really are helping, and it felt these small changes collectively are making some really massive changes to our ability to de-carbonised the grid and put more renewables, and use the energy we got more efficiently, I think for some people, that would be really motivating"* (Saskya Huggins, Low Carbon Hub, Interview).

However, appreciation of the benefits of flexibility at a national or global scale may require a greater level of understanding and, perhaps, abstraction. Engagement with smaller local (or virtual) energy communities may be a necessary first step towards building this wider understanding. "*Taking a place-based (or neighbourhood) approach to re-imagining the energy system is key to achieving benefits for everyone. It helps entire communities come together to pool resources into new flexibility markets, whilst identifying and negotiating the benefits they want to receive for helping balance the local energy system*" (Huggins, 2020).

4.6   Flex and resilience

The intersection of flexibility and energy resilience is developing as an area in need of detailed exploration. In the UK, as in much of Europe, concerns about security of energy supply have been exacerbated by the war in Ukraine and are shifting the conversation away from decarbonisation. "*The only mitigation measures that will become politically acceptable fairly soon will be those that address adaptation and resilience, so energy security and climate adaptation as well as delivering mitigation, which is narrowing the subset*" (David Shipworth, University College London, Interview).

Moreover, supply insecurity raises the question of how households will behave in a future hypothetical scenario. It is well documented that households prefer to retain the ability to opt out of flexibility schemes including automated demand response and VPPs, and that, for many, having this ability to opt-out may be a pre-condition of participation. *"The concern is that people's behaviour will change as circumstances change and so that you might get participation and buy-in, particularly if it's very transactional for an economic reason, up until such point as other societal drivers overwhelm any economic considerations. And then you might get large scale market defection from flexibility markets at exactly that point when you need the flexibility markets […] If we grant them an opt-out clause in order to increase participation, then do we risk those assets defecting from the market when we need them?"* (David Shipworth, University College London, Interview).

Conversely, research (CEEM, 2021) and trials (ITP Renewables, 2021) in Australia are exploring the role that flexibility can play in increasing community resilience to grid outages due to fires, floods and other extreme weather events. To some extent, households may be *more* willing to behave

flexibly or curtail their demand to support a local microgrid during a period when it disconnects from the main network due to a weather event. If engagement in flexibility is strongly motivated by considerations of *local* community benefit, it may increase precisely at the time when it is needed.

"If we think about a hierarchically balanced bottom-up network, if it decomposes hierarchically as well, so it fails into a set of islanded – individual islanded systems – then as that failure occurs, potentially the social implications or the social requirements to behave well increases as the system fails, which is interesting" (David Shipworth, University College London, Interview).

5   Fairness

This section explores the relationship between fairness and flexibility, including diverse viewpoints on whether fairness and inclusivity are necessary to the development of a flexible energy system (Sections 5.1 and 5.2), different approaches to combining these two apparently conflicting aims (Sections 5.3, 5.4, 5.5 and 5.6), and an emerging framework for assessing the inclusivity of smart energy systems (Section 5.7).

5.1   The need for fairness

The importance of fairness to households has been well documented, including, for example, in relation to shared battery storage (Hoffmann and Mohaupt, 2020), VPPs (Roberts, Adams et al., 2020), and peer-to-peer energy trading (Temby and Ransan-Cooper, 2021). Households are more willing and able to engage with new energy technologies and business models if they are – and are perceived to be – fair. This includes fairness of opportunity and process (who is able to engage and how this is facilitated) as well as fairness of treatment and outcomes – fairness of compensation for providing flexibility in terms of both the value offered relative to the effort required, and the distribution of benefits across different households and between different stakeholders.

> *"For this transition to work, it needs public consent […] and that, in this country in particular, is heavily dependent on it being seen - possibly through a misguided lens - but being seen to be fair both in terms of who gets to gain and who gets to pay, but also in terms of who gets to take part"*(Interviewee 20).

Fairness should be included as a principle in designing local energy systems.

> *"The success of a service offering will depend on the efforts of many stakeholders. The value created by the service, and costs that arise, should be fairly distributed amongst those stakeholders"*(Huggins).

Ensuring fairness in flexibility offerings is challenging, not least because people's perceptions of what is fair are diverse and are not fixed. While equal reward for flexibility delivered might appear fair, it does not account for the multiple factors which affect a household's ability to both engage with and respond to a flexibility offering. These include social, health, cultural factors affecting their abilities, and technical, economic and physical aspects of their circumstances affecting their opportunities and access to enabling technologies (Roberts, Passey et al., 2021).

The concept of 'flexibility capital', well established in the academic literature (Powells and Fell, 2019), describes how a household's ability to engage in flexibility may be derived from social means (including sacrificing comfort or inconvenience) or through financial resources, and highlights the unfair outcomes that can arise from superimposing a flexibility market on underlying inequities.

5.2 Who gets left behind (and does it matter)?

"The energy transition is creating 1,000 new ways for unfairness to be entrenched in the energy system because some groups, vulnerable groups, are not gonna have either the finances or the other skills that you need to participate in the smart local energy systems and are therefore at risk of being left behind" (Nick Banks, Environmental Change Institute, Oxford, Interview).

It is widely perceived that a tension exists between a smart energy system and a fair or equitable one. At one level, both flexibility itself and the local energy systems that might help deliver it are *inherently* unfair. If incentives are given for flexible energy use or for ownership of automated appliances, then those whose behaviour or expenditure is constrained are – unfairly – excluded from access those incentives. Similarly, households outside the geographic boundaries of local (smart) energy systems (whether these are aligned with community or political boundaries or with electricity distribution infrastructure) are excluded from the benefits of participating in the system.

> *"It is in all our interests that no one is left behind in the transition to a zero-carbon energy system. Opportunities must be available to all businesses, households, and communities. Any new, locally balanced energy system, needs to benefit and be fair for everyone, not just a minority with their own solar panels, battery storage or electric vehicles"* (Huggins, 2020).

There is little consensus on how best to address this tension, or even that it can or should be addressed.

The energy transition is urgent and, some argue, cannot wait for everyone. Moreover, introducing flexibility into the energy system will facilitate greater (low cost) renewable penetration and reduce distribution costs, and thereby improve outcomes for everybody. *"You can't roll anything out if you want it equal to everybody unless you're going to give everybody the same... I think you have to say that this participation in the system actually reduces the cost for everybody […] perfection shouldn't be the enemy of the good"* (Laura Sandys, Interview). This approach underpins Octopus's strategy. *"Academic research suggests that we could be saving 16 billion pounds a year if we create a flexible energy system […] the overall cost of energy system will shrink and everybody will benefit, whether you're providing demand side response yourself or not"* (Rachel Fletcher, Octopus Energy , Interview). Although Octopus are sharing data with the Centre for Sustainable Energy (CSE) to support research and development of their capability framework, they don't currently target specific households. *"The approach we tend to take is we tend not to segment our customers and push products their way. We tend to put products out and see who comes"* (Rachel Fletcher, Octopus Energy, Interview).

This approach relies on the market to enable households to find flexibility offerings – and levels of engagement - that suit their capabilities and preferences.

> *"We're gonna have a mixed economy where you've got some […] incredibly sophisticated customers managing their half hourly energy use through technology they've bought, cobbled together, built themselves; people that want an easy plug and play – so I plug my EV in or I set my heat pump for it to be warm at this time; others that might dip in occasionally to participate in the turndown service or might have 80 quid off their annual bill to be called on six times a year to provide turndown service, and others who, for whatever reason, continue to pay a pence per kilowatt hour fee and not really engage in this perhaps 'cause they can afford to or whatever."* (Laura Sandys, Interview)

While this approach certainly offers choice to some households, it fails to address those whose lack of engagement is not a choice, but is the result of financial, social or other constraints. In an

unconstrained market of flexibility offerings, some people may *choose* to pay a premium to avoid the inconvenience of providing flexibility, but others will forego comfort and risk their health to reduce their bills and those who are unable to provide flexibility will be penalised.

However, if the flexibility brought about by this market reduces network costs, increases hosting capacity for renewables, reduces emissions and drives down energy costs for *everyone*, does it matter if some benefit more than others? Some argue that addressing inequality is not the job of the energy system, and should be dealt with through social policy. But a pure market approach is not neutral in its impacts on fairness; it is likely to entrench and exacerbate existing inequities, and create new ones.

5.3   Smart and fair: the capability approach

The 'capability lens' is a related framework developed by the Centre for Sustainable Energy (CSE) for understanding the *ability, suitability and willingness* of households to participate in flexibility or other types of smart energy offer necessary to the energy transition (Roberts, Bridgeman et al., 2020). It organises capabilities into five clusters: energy usage and technology; dwelling and local area; financial; personal and social; digital tech readiness. Using this lens, CSE have built an "offer profiling tool" which analyses the capabilities needed for households to participate in a particular offer. The tool is intended to be used in designing and targeting offers.

Building on this, CSE have also created a "consumer classification model" which identifies the types and locations of households most likely to take up and benefit from a particular offer, and determines the impact of mitigation strategies to extend participation beyond those most likely to engage. The tool is linked to spatial household demographic data so the information it generates relates to specific localities.

Using this model, CSE have estimated that 49% of UK households are likely to take up 1 of 6 smart energy offers, (dynamic TOU pricing, storage as a service, EV smart charging with TOU tariff, hybrid heating as a service, PV with an aggregator-owned battery, or vehicle to grid EV leasing. However, 8% are only likely to do so given suitable mitigation strategies, which include grants or low-cost loans, increased high-speed broadband roll-out, and regulation to support tenants to install smart meters and DER. Importantly, the group of households who would not access any of these 6 offers, although diverse in many characteristics, has low average income, high rates of fuel poverty, financial stress and poor health (Roberts, Bridgeman et al., 2020).

The capability approach has also been used to analyse Project LEO (section 4.2.1) and further developed to include capabilities of communities and systems, as well as individual households and businesses, to participate in smart local energy systems and local energy markets. This enables identification of suitable interventions to overcome inequity or unfairness that "*either, a) change actor capability so that the energy services or […] benefits become accessible or b) change the […] offer itself to meet and work with the communities' capabilities as they stand.*" (Banks and Derby, 2021). System capabilities can be increased, for example, by introducing actors into the marketplace with business models and value propositions more likely to enable participation of households with low capability levels. This could include models that are not based on maximising financial returns, such as a not-for-profit community aggregator.

CSE's *Smart and Fair* approach aims to strike a balance:

> *"A lot of people are pushing the smart thing but ignoring the fair thing. There's also quite a lot of people who are pushing the fair thing and ignoring that you do need it to get smarter, and if you push fair too hard too early and insist everything is equitable and anyone can*

participate and you're making sure every offer coming into the market is fair in the sense of who can join in, then they will not ever come forward" (Interviewee 20).

Their *Smart and Fair* approach involves creation of a diverse market of flexibility offers that will be attractive and accessible to different types of household, while tempering the worst inequities of this market with targeted interventions, recognising the limitations of the market in delivering fairness.

> *"It would be unreasonable and unhelpful to expect or require 'smartness' to align with 'fairness' at the micro level of each offer; we will not secure a smart energy system if we do. However, this brings with it an uncomfortable (but perhaps obvious) corollary: If we can't expect to require or deliver fairness in the particular of each smart energy offer coming into the market, we can't expect fairness to be achieved across the generality of offers in the market"* (Roberts, Bridgeman et al., 2020).

5.4   Fair flex

The concept of "fast and fair" originated in the Australian Community Energy Movement. *"Fast and Fair, that really came from Nicky [Ison] and Erland [Howden] in planning the 2007 Community Energy Congress"* (Tom Nockolds, Energy4All, Interview). It is used to describe the benefit of community ownership in driving the development of renewable energy generation.

> *"It becomes really self-referencing and quite circular, because the only way the transition to clean energy can be fair is if it is fast. So it can only be fair if it's fast, it can only be fast if it's fair, and the reason it has to be fast to be fair is because of climate change and the injustices that come from not acting fast enough"* (Tom Nockolds, Energy4All, Interview).

Discussion of flexibility, by contrast, often assumes that, while fairness may be a beneficial outcome in itself, it can conflict with or hold back the transition to a smart energy system – Smart and Fair is a balancing act. However, others see fairness as *necessary* for ensuring the transition takes place.

> *"Any arrangement considered fair is more likely to meet with social approval. Social licence to operate not only then makes it more likely that local energy solutions will be agreed and implemented, but that we will achieve the mass participation required to deliver a locally balanced energy system at sufficient scale. The pursuit of energy equity therefore is not only an admirable goal for the energy transition – but also a means to our end"* (Huggins, 2020).

Indeed, even if fairness were not a worthwhile aim in itself, it may be necessary to achieve the social licence required for multiple aspects of the transition: building renewable energy generation, deployment of distributed energy resources, digitization and data access, and automation. *"The environmentalist in me thinks the first priority is to get the carbon out of the atmosphere - if some people end up better or worse off, that's a secondary effect. And then I think: 'Well, hang on a sec, we'll never get the carbon out of the atmosphere unless we make sure it's done equitably.' I tend to be quite utilitarian about this. I want to reduce atmospheric carbon, and if doing this equitably increases public acceptance then that's the strategy we should adopt."* (David Shipworth, University College London, Interview).

There are parallels between the 'fast and fair' framing of community energy and the 'smart and fair' approach of CSE. 'Smartness' and flexibility are needed to ensure the speed of transition; at least some degree of fairness is needed to engage households and thereby facilitate that flexibility; and the resulting fast transition ensures benefits for all. But the outcomes of the transition are not

automatically fair, and fairness is important in its own right – not only for facilitating speed and smartness.

> *"There's a presumption that communities are just, like, someone to be involved, potentially because they might object and that could slow you down. It's only part of the thinking, I think. You've only got the pathway there. And for me, it just really cuts to the heart of the whole just transition question […] The transition to clean energy is creating a once in a lifetime opportunity to not only decarbonise, but to build a fairer energy system. […] Put another way, if all we do is replicating the same systems, ownership structures, business models, etcetera, that led us to the current outcome (run-away climate change, over extraction), then we're just gonna end up with another problem down the line"* (Tom Nockolds, Energy4All, Interview).

Rather than seeing flexibility and fairness as oppositional, a 'fair flex' approach can be proposed which might focus on how they can reinforce each other. Demonstrable fairness can help secure social licence for flexibility and household engagement in flex opportunities and local energy initiatives. In return, flexibility might help increase fairness in two ways: First, the value unlocked by flexibility – through reduced network costs, lower emissions and cheaper generation – could be used to increase access to distributed energy resources, improve housing fabric and accelerate electrification, increasing fairness in the process. And, second, the network benefits of flexibility can increase capacity for hosting, for example, rooftop PV or electric loads - and so enable fairer access to the network. *"If all the people who already have a heat pump are prepared to be flexible about how their heat pumps are operated in the streets, so that for the people in the street who hadn't yet got one, there's now capacity in the grid"* (Saskya Huggins, Low Carbon Hub, Interview).

A 'fair flex' approach would give equal importance to flexibility and fairness. It would use fairness to engage households in flexibility, and ensure that the value of that flexibility was distributed fairly. But, to avoid penalising (and therefore excluding) households with limited capabilities or lower levels of flexibility capital it should go beyond offering a 'fair' reward for flexibility delivered, to fairly distributing the benefits of the transition, regardless of capability.

5.5   Life flex

Many of the constraints on household flexibility are the result of inflexible social schedules. Households sleep, eat, wash and travel to fit routines that are largely dictated by work and school times. *"When you look at the energy curve for the country, we've got this very intense use of energy which means you have to turn the gas on and so on to pump out enough electricity to power everyone being at work"* (Interviewee 36).

But assumed behaviours and practices also vary between countries and across cultures. For example, in Germany, the main meal is usually taken in the middle of the day rather than the evening. This has health and productivity benefits, but also has major implications for energy. Practices change and can be changed by interventions. For example, providing good food at subsidised rates in works canteens supports this behaviour. Similarly, providing communal laundries (which could use heat from co-generation) could affect how and when people do laundry (Philipp Grunewald, University of Oxford, Interview).

> *"I'd be keen to look at flexibility in a wider system sense than just straightforwardly energy, because, quite often, we don't have a choice about when we do all our laundry and stuff. But then I think there's the behaviour change aspect to energy use as well, like, 'Do we all need to have a washing machine in the house?' These are quite embedded cultural ways of behaving."* (Interviewee 36).

The Covid pandemic gave a hint of how usual routines of work and travel – and therefore of energy use – can be disrupted. Less rigid social routines would enable greater participation in flexible energy use. *"It's frustrating that the flexibility aspect of it I think could also extend into social life, everyday life, the wider systems than just simply energy where if people had flexible working. Some of the trials that have been done in Scandinavia with four day working weeks, and so on, which means that everyone's more flexible across the week"* (Interviewee 36).

5.6   Social tariff

To provide a fair foundation for flexibility requires a commitment that those who cannot engage will not be disadvantaged or deprived of essential levels of services or comfort. One proposed approach that goes some way to ensuring a base level of energy services is the social tariff. Although the term is used to mean different things, the core concept includes a basic level of low-cost (or free) energy provision, available to everyone and subsidised by high energy users.

For proponents of a diverse market of bundled products and services, a social tariff could provide a safety-net to catch those unable or unwilling to participate. This might take the form of an inclining block tariff, such as the 'slab tariff' (Ahmed, 2008) introduced in Dubai and other Emirates (Laura Sandys, Interview). The TUC propose a social tariff with an initial free energy allowance and bills capped at 5% of income for low-income households (TUC, 2022), subsidised by increased tariffs for high energy users. Additional allowances or subsidy would be needed for low-income households with high *essential* energy needs (e.g., to support home kidney dialysis or other medical equipment).

Such a model could be extended to include a capacity allowance, just as households on Eigg have a 5kW capacity limit. This could be time-specific and include the option to purchase additional capacity at a premium rate. This model disincentivises excessive demand during peak periods, without penalising households for accessing essential energy services.

Another approach to increasing fairness proposed by consumer advocates in the UK is to remove fixed charges and support sunk and future costs of network investment and/or levies through general taxation. Existing fixed charges are neither cost reflective nor related to ability to pay, so arguably result in the worst of all possible worlds. *"The standing charge effectively penalises low energy usage,"* (Mark Luntley, Energy4All / RESCOOP / Westmill Wind, Interview).

> *" The tax system is incredibly flawed and there are issues with it, but in theory, it's designed to make sure those who can afford to pay more, and those who can't, don't, […] in theory, that's what it's there to do, which is a better tool than an energy bill, because if so much of your energy bill is dominated by non-commodity, it doesn't matter how much you use"* (Tom Hoines, Younity, Interview).

These approaches are undeniably popular. 75% of the public support free energy for basic needs (while only 10% oppose it) and 81% support abolition of the standing charge (Fuel Poverty Action, 2022).

5.7   Inclusive innovation

Adrian Smith and others at University of Sussex, working through the **ROLES** programme, are applying an inclusive innovation framework, shown in Figure 2 (Heeks, Amalia et al., 2013). This was developed in other spheres (Heeks, Foster et al., 2014), based on a 'ladder of citizen participation' (Arnstein, 1969) to explore how digital energy and smart local energy systems are – or could be – designed to enable greater and more participation (Smith, 2022).

Higher levels of inclusive innovation are based on the perspectives of marginalised and excluded groups, or involve co-design of structures to include those groups. These levels allow consideration of alternatives to the existing electricity market paradigm and may include more "social-collectivist" approaches (Levidow and Papaioannou, 2017), including commons and public goods – although adopting a social-collectivist approach does not guarantee high levels of inclusive innovation.

At lower levels of inclusive innovation, *"insights useful for co-designing new institutions, alternative models of economic value, and conceiving electricity as a public good, for example, tend to be eclipsed by priorities to develop technologies and move households along adoption curves understood within prevailing market, policy and regulatory norms"* (Smith, Contreras et al., 2022).
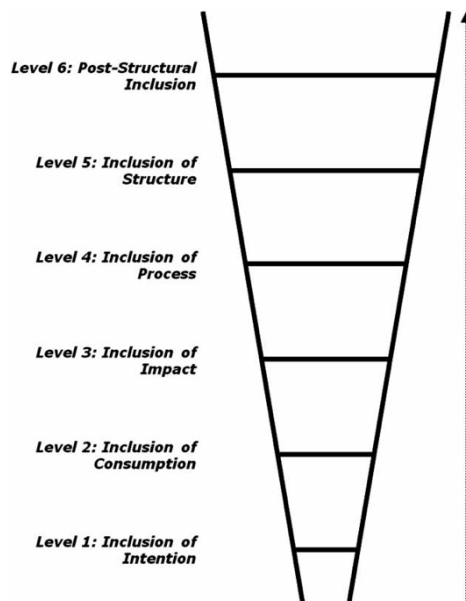

Figure 2 Different levels of inclusive innovation (Heeks et al., 2013)

This approach to inclusive innovation, described as "liberal-individualist" (Levidow and Papaioannou, 2017) *"takes the electricity market regime as an immutable context for innovation"* (Smith, Contreras et al., 2022). And focuses on *"incentivising some financialised, market-based and technology-led solutions to be attentive to low income and vulnerable households"* (Smith, Contreras et al., 2022).

In the UK, as in Australia, "liberal-individualist" approaches dominate flexibility and SLES trials and demonstrations. There are *some* exceptions amongst community energy demonstrations involving collective ownership and control of assets, data and/or flexibility services. Examples include Repower's *CommUNITY* trial in London, and Carbon Co-op's Community Aggregator Service in Manchester. *"But they remain hobbled by a regime context privileging liberal-individualist arrangements"* (Smith, Contreras et al., 2022).

6   The role of governance

This section examines the potential for different governance models to engender a sense of responsibility for, and agency towards, the energy system and thereby motivate engagement in flexibility. It draws on learnings from the case studies described in Section 4.2, different approaches from the world of Community Energy (Section 6.2), diverse models of public ownership (Section 6.3),

nested governance structures (Section 6.4) and systems of representation (Section 6.5) proposed by consumer advocates, trades unions and others.

6.1 A stake in the energy system

If electricity is an essential resource, then households have the right to a safe, reliable and affordable electricity supply. But rights come with responsibilities.

> *"Where rights come, I think also responsibilities, so how we might be able to tap into that, and so everyone should have the right, not just to be able to connect to electricity, but to have a certain share of that space in the grid, but if you've got that, then you've also got the responsibility to use that in a responsible way, that enables everyone to benefit, and then have an interest in that, the stewardship of that local area energy"* (Saskya Huggins, Low Carbon Hub, Interview).

Asking households to provide flexibility is asking them to take some responsibility for the energy system. There is evidence that many households in the UK and Australia (Roberts, 2020) are willing to take on this responsibility but, in return, they want some control over how they engage, and to see fairness in who contributes and how benefits are distributed. This relates to the extensive literature around 'energy citizenship' which, in one framing, describes people's *"orientation to the energy system—that is to say their knowledge, and meanings of the system and their role within it"* (Goulden, Bedwell et al., 2014).

Residents on the Isle of Eigg accept the need to manage their energy use within a capacity limit and in response to real time information about power generation, in part, because they have part ownership of the electricity system – and therefore take some responsibility for managing it.

> *"It's ours and so it's up to us all to make it work!"* (Maggie Fyffe, Isle of Eigg Heritage Trust, Interview).

Eigg is not the UK (and nor is it Australia) and, clearly, the governance arrangements for Eigg Electric cannot be applied directly to the mainland electricity system. However, if common ownership and shared accountability play a significant role in securing household engagement in flexibility on Eigg, are there governance models with these characteristics that might facilitate greater flexibility in a national energy system?

> *"People are ready to take responsibility, assign responsibility to themselves and fellow citizens, but it needs to be in a context where they can see the government and big industrial parties taking their responsibility. I think most people are ready to say, 'We all have a responsibility'"* (Interviewee 08).

6.2 Community energy

Community Energy describes a wide range of models that often involve co-ownership of, and shared responsibility for, elements of the energy system, and so support energy citizenship behaviours (Goulden, Bedwell et al., 2014).

> *"The thing that we're trying to work towards is an energy system or experience of the energy system which has […] care and trust as its starting point, and recognises energy as an essential good, a public service and something that can connect people - so all the things that it isn't at the moment. And it's a really hard thing to do!"* (Duncan Law, Community Energy England, Interview)

Community energy (CE) has had great success in the UK with 495 CE organisations across England, Scotland and Wales in 2021 (Community Energy England, Community Energy Scotland et al., 2022). UK CE organisations are involved in renewable heat (including heat networks and heat pump bulk buys), low carbon transport, energy efficiency (advice and education, subsidies for energy efficiency and building upgrades) and, to a lesser extent, energy storage and flexibility.

> *"It seems like there is two very distinct things that community energy groups do in UK. One of them is fuel poverty which is a very people-focused business model where it is really about ensuring that people are [...] able to access certain benefits within the system that they're entitled to because they are on very low incomes and they're paying a large share of their income on energy."* (Colin Nolden, Environmental Change Institute, Oxford, Interview)

However, as in Australia, the dominant CRE model in the UK involves community ownership of renewable generation assets. These are mostly solar and onshore wind, but including hydroelectric and biomass, with an offshore wind project under development. In the UK, 271 CRE organisations own 331MW of generation capacity. Community members invest in a share of the generation assets (which may be wholly community owned or shared with a developer or landowner) and receive a return on their investment from sale of the generated electricity. The legal structures are diverse, but include co-operatives, community benefit societies and community interest companies. However, lack of regulatory support, including the removal of solar feed-in tariffs, have made it more difficult to develop effective business models and have slowed the development of new CE generation projects (Community Energy England, Community Energy Scotland et al., 2022).

As well as its environmental benefits (143kt/year avoided carbon emissions), revenues from some CRE generation projects are channelled to community benefit funds, energy efficiency and other projects, as well as to investor returns, so that a high proportion of the value of generated electricity stays in the local area. *"CE shortens supply chains and enables local, social control of the means of energy production,"* (Mark Luntley, Energy4All / RESCOOP / Westmill Wind, Interview).

One of the great strengths of CE is its ability to engage households and communities in the energy system. UK CE organisations have 58,000 members, investors and shareholders, while the sector is driven by the activities of 3,325 active volunteers. As well as being a vehicle for distribution of financial returns, the strength of co-op (and other community benefit structures) is to give members agency in decision making, with a strong emphasis on transparency and openness.

One of the criticisms levelled at CE is that it is inherently inequitable. Although it is typically organised by geographic area, engaging communities close to the site of renewable generation, *"locational inequities are less significant than age and wealth inequities"* (Mark Luntley, Energy4All / RESCOOP / Westmill Wind, Interview). Investment in CE is obviously restricted to those with sufficient financial resources; the time commitment needed means volunteers are disproportionately retired; and the extensive set of skills and social capital required to develop a renewable generation project favours the professional classes.

> *"Not all communities are the same. Low-income communities have been shown to be much less politically active, much less sort of confident to engage in a process of governance for their area. They don't have the professional skills and resources embedded amongst the community members that will give them the confidence to say, "Look, this is a kind of energy project that we'd like to happen here. Come in and help us develop it." So, there's a sort of inequity there that's waiting to happen at community scale."* (Nick Banks, Environmental Change Institute, Oxford, Interview).

However, in London, *Repowering London* is focused on *"how to create opportunities for people who might not otherwise benefit from or participate in the transition to a low carbon energy system and might not otherwise participate"* because of structural, economic or social barriers (Felix Wight, Repowering London, Interview).

"Community energy starts to break down the 'what's in it for me?' approach." (Mark Luntley, Energy4All / RESCOOP / Westmill Wind, Interview). Given the small (perhaps inadequate) market returns currently available for flexibility services (Section 3.2), this alternative approach could be helpful in enabling household flexibility. If CE participants are motivated by social and environmental, as well as economic, benefits, they might be well placed to engage in flexibility on the basis of shared responsibility for the network. Indeed, active engagement in demand management and response could be a better fit for community engagement than the traditional investment model of CE, which requires a more transactional engagement. *"Members are aware of the energy system and are willing to change their behaviour – to take collective responsibility: We own this energy – how do we use it more effectively"* (Mark Luntley, Energy4All / RESCOOP / Westmill Wind, Interview).

But achieving widespread and ongoing engagement in flexibility may be more difficult than securing community investment for generation. Developing an RE project is *"a one-hit project. […] You've got to sell the financial alongside the social environmental impact because you wouldn't see the financial returns that you might expect from a commercial project, so you've got to put that with the wider benefits. But, actually, once you've done this big push of effort […] you're then left managing a large asset but it just keeps ticking over and doing its thing, whereas something like flexibility needs constant input so it's actually a much bigger ask of whichever community group is involved"* (Saskya Huggins, Low Carbon Hub, Interview). The size of this ask is perhaps greatest for communities with more social constraints on their energy practices, but might be reduced by automation. *"We've done 2 demand side response projects and both of them, the core idea was that people wouldn't require ongoing engagement. It required a decision to participate, but then the demands and response were basic, could be provided through automation … you can make it as easy for them as possible rather than asking them […] to start changing their lifestyle, which is quite an ask."* (Felix Wight, Repowering London, Interview).

A significant challenge for CE organisations developing flexibility projects is the uncertainty of returns (Mark Luntley, Energy4All / RESCOOP / Westmill Wind, Interview). While the early state of market development makes this an issue for all flexibility offerings, CE organisations are, perhaps, least well placed to manage this risk, due to their small size, lack of financial reserves and reliance on volunteers. Moreover, the potential future decline in value of flexibility means that business models are likely to need constant refinement and development. *"If there is a lot of flexibility around and a lot of organisations with high skillsets providing flexibility, obviously the marginal profit will shrink and ultimately will be, of course, zero. So that means that in the long run, logically, there can't be a sustainable business model in there. Whatever your business models, they are always about keeping one step ahead of your competitors, and that's not community energy."* (Colin Nolden, Environmental Change Institute, Oxford, Interview).

Despite these challenges, the CE sector sees an important role for itself in the future of smart local energy systems markets (Community Energy England, Community Energy Scotland et al., 2022). Whether that involvement includes facilitating community engagement for other actors (such as aggregators), providing a test ground for technical and social aspects of new flexibility business models, or allows CE to develop into a significant flexibility provider in its own right, remains to be seen. There is certainly a need for greater policy support for CE to enable its participation in

developing flexibility. This requires restoring CE as a government priority. *"You need a community energy department within BEIS [the Department of business, Environment, Industrial Strategy]. There used to be a community energy team"* (Tom Hoines, Younity, Interview). Potential routes to increasing CE participation might be for social and environmental outcomes of flexibility to be valued and included in tender processes for flexibility markets (Community Energy England, Community Energy Scotland et al., 2022). Alternatively, "*some form of long-term security mechanism, for community groups who wanted to have equity in projects"* (Tom Hoines, Younity, Interview) might help de-risk community flexibility projects.

> *"My feeling is that community energy is the alchemy in the system, that because of its local knowledge and its local focus, and its intent to extract benefit, and its entrepreneurialism, it is able to create or identify potential synergies and opportunities, and with a little bit of help, realise that."* (Duncan Law, Community Energy England, Interview).

While Community Energy's ownership of generation assets could assist it in engaging households in flexibility, it currently operates at the fringes of the energy system. Some advocates suggest that supporting CE to grow its share of the market would bring its broader benefits to the energy system. *"CE should be playing a significant role in the energy generation ecosystem; we should be one of the 'Big 6'. In England, CE is too focused on village hall projects – which allows market domination by big business"* (Mark Luntley, Energy4All / RESCOOP / Westmill Wind, Interview).

6.3   Public ownership

> *"The question for me is always who owns it, who owns what, and that goes all the way down to smart meter data and who has access to all that stuff"* (Interviewee 36).

The transition from centralised fossil-fuel generation to distributed renewable generation is commonly described as a shift from state ownership and centralised control to a liberalised, market-driven network of privately-owned distributed generators. This implies that taking the energy system back into public control would also be a step backwards on the path to a decentralised, decarbonised and democratic system. The traditional model of a centralised, state-controlled energy utility is certainly not appropriate for governance of a distributed energy system, and it is hard to see how it would support engagement in flexibility at the household or community level. However, diverse models of public and community ownership are emerging, each with its own potential impact on the energy system in general and on the provision of household flexibility in particular, as well as its own financial and political implementation costs.

 Public ownership of energy is overwhelmingly popular in the UK, with support from 66% of the public, compared to just 22% who think it should be in private ownership (Survation, 2022). The collapse of numerous small – and some large – retailers, as well as massive household bill increases alongside expensive government intervention to cap prices, suggests that the UK electricity market as it stands is failing to serve customer interests.

> *"[People] don't trust the electricity market. And if you like, that's off the agenda. [...] When I talk to community groups, they kind of get that and they're up for new ownership or institutional reforms or new regulations, but it's almost like that's maybe swearing in church a bit [...] and so, if you like, it's okay to conceive and work on a radically different electricity system technologically - and maybe even what happens inside households - but politically, economically, some new forms of collective ownership – we just aren't there"* (Interviewee 24).

Public ownership could include any or all of the generation, transmission and distribution (T&D), or retail / supply parts of the electricity system. Advocates for public ownership understand that the complexity of the system demands a nuanced approach. *"[Public ownership] is the way forward, but it's not like you just flick your fingers and it's publicly owned and everything's lovely, [...] it's really important, especially with the transition, that we look at what the evidence base says about its role in the energy sector overall and what best practice looks like in countries that are using public ownership to achieve better outcomes."* (Cat Hobbs, WeOwnIt, Interview).

The idea that households – and business customers – manage their electricity use differently when they own the generating assets has been demonstrated at a micro-scale (such as on Eigg) but is untested at large scale. While there is currently no serious discussion of taking existing generation into public ownership, the opposition Labour Party has announced its policy of establishing a government agency to invest directly in renewable generation, with the aim of reducing costs and accelerating development of clean technologies.

6.3.1   Transmission and distribution network

> *"The interesting part of the system is the network and the way that's managed - that's the asset!"* (Interviewee 20).

Flexibility has a role in balancing generation and demand at the system level, but is also important in supporting management of the transmission and distribution (T&D) network. Public perceptions of the role played by the network, both in the UK and Australia, are diverse. While some people do not distinguish between suppliers and DNO's (i.e., retailers and DNSPs), others see the role of network companies as managing a public asset for public good, distinct from the more commercial role of suppliers.

While many people might be keen to contribute to balancing the grid, they are wary of a private network company profiting from their contribution, or of unfair distribution of contributions and benefits between users. Studies suggest that *"the idea that demand side management is necessary to maintain the electricity grid in the interests of all stakeholders may have resonance with energy users. It has been observed that people may be more engaged where there is a sense of 'being part of something bigger'"* (Adams, Kuch et al., 2021).

As a natural monopoly, the T&D network could be an obvious candidate to be returned to public ownership, as it is in many European countries. Although the cost of buying back the infrastructure would be high, and so presents a significant political barrier, the network's high profits and overseas ownership (Baines and Hsager, 2022) could make nationalisation a popular strategy. At the 2019 election, this was the policy of the Labour Party (The Labour Party, 2019), who saw public ownership and democratic control of the network as a means to prevent decentralisation from exacerbating existing inequities. *"For example, there is a risk of creating gated energy communities or 'local energy islands', where communities with the financial and physical resources to generate and supply electricity opt out of energy networks, leaving poorer communities with the disproportionate burden of financing wider infrastructure. Public ownership is thus required as a backstop to community control, to ensure that decentralisation reinforces rather than undermines shared regional and national infrastructure, and allows for the pooling of resources needed to guarantee universality of supply most efficiently"* (The Labour Party, 2019). However, the Labour Party has since dropped this

proposal, due to concerns about public perception of the cost involved. *"Politically, public ownership of retail and generation is easier"* (Cat Hobbs, WeOwnIt, Interview).

6.3.2   Retail

The past 8 years have seen the rise and fall of a number of publicly owned energy suppliers (retailers) in the UK. The first, *Robin Hood Energy*, was established in 2015 by Nottingham City Council as a not-for-profit entity with the aim of providing low-cost energy to residents of Nottingham, and grew its customer base to 130,000 households. Similarly, Bristol City Council established *Bristol Energy*; a group of housing associations, councils and community groups launched *Our Power*, with backing from the Scottish government; and *Robin Hood Energy* established a number of white label partnerships with other councils.

These suppliers were popular with the public, benefiting from public distrust of the 'Big 6' suppliers (*Robin Hood* was ranked second nationally for customer satisfaction in 2019). However, none of them survived the market turmoil of the past few years which has seen the collapse of over 30 suppliers. While the various councils' lack of energy market experience may have been a contributing factor, it is apparent that local (and therefore relatively small) suppliers are unable to managed market risk and are therefore disadvantaged under current arrangements. *"There was this rule of thumb about five years ago which suggested that you need at least 200,000 customers to operate as a supplier. But that feels like that figure has risen now, given that 30 or 40 companies have folded in the last year and a half"* (Colin Nolden, Environmental Change Institute, Oxford, Interview).

The government decision to place *Bulb Energy*, the country's seventh largest retailer, into Energy Supply Administration to avoid its collapse may present an opportunity to create a *national*, publicly owned supplier, backed by government to manage market risk. *"You don't need to buy out the big six. You just create a default state structure and allow it to take up a good chunk of the market, […] and it's national. And it can just mop up customers as other companies collapse"* (Cat Hobbs, WeOwnIt, Interview). Meanwhile, the Trades Union Congress (TUC) goes further, with a proposal to nationalise the Big 5 suppliers (serving 70% of household customers), with an estimated cost of £7.8billion, comparable to the costs to customers of recent failed suppliers (TUC, 2022).

Although the political opportunity for public ownership of energy suppliers (whether a single supplier or the Big 5) is the result of high energy prices and public perceptions of profiteering, the potential benefits go beyond reducing household bills, with significant implications for provision of residential flexibility.

A national electricity supplier under democratic public ownership could go a long way to restoring public trust in the energy system, whether accountable to local government or at a national level. Moreover, the TUC proposal includes introduction of a social tariff to help address energy poverty and increase energy efficiency by providing all households with an initial free energy allowance and increasing costs for high-consumption households. With careful design to avoid penalising households with low capabilities, such a tariff could be extended to include flexibility incentives.

More significantly, a publicly owned supplier could accelerate the massive programme of housing retrofits necessary to underpin the development of residential flexibility services. This could include acting as a vehicle for training and employing the necessary workforce, deploying fabric-first, whole house retrofits at scale and, importantly, overcoming distrust and concerns about disruption to engage households.

"In entering almost every home in the UK and conducting significant disruptive building works, the drive to win public hearts and minds should not be underestimated. Publicly owned supply companies would allow a level of engagement with consumers that we've not seen before. Customers would be more willing to engage knowing this was not a commercial drive but a matter of public interest in which they could save the planet and cut their costs" (TUC, 2022).

6.4   Nested governance

Melville, Christie et al. (2017) and BuroHappold Engineering (2016) explored the application of Elinor Ostrom's design principles (Ostrom, 1990) to management of energy as a common pool resource. As well as clear boundaries for ownership and sharing of assets and information, collective participation in designing rules appropriate to local social and environmental conditions, and appropriate graduated sanctions and conflict-resolution mechanisms, Ostrom proposed that *"appropriation, provision, monitoring, enforcement, conflict resolution, and governance activities are organized in multiple layers of nested enterprises"* (Ostrom, 1990). BuroHappold Engineering (2016) built on the example of island communities (such as Eigg) where localism and community engagement enable shared responsibility for infrastructure to develop a model of a spatially nested energy system with congruent boundaries of governance, infrastructure and data aggregation.

Water, like electricity, is an essential service, with both local and centralised supplies feeding into a distribution network, and with interdependent users in competition for a finite supply. The OECD have developed 12 principles for "good" governance of natural resources such as water across the dimensions of effectiveness, efficiency and engagement. With some provisos, these principles can be applied to governance of a distributed energy system (Brisbois, 2020). In particular, each aspect of the system should be governed at an appropriate level. *"Decentralisation will be most appropriate if governing tasks are broadly participatory, allocated to the lowest appropriate level, designed with adequate internal accountability mechanisms, and with attention to ensuring adequate capacities, financing and powers"* (Brisbois, 2020).

> *"In effective electricity governance regimes, central coordinating authorities will likely cede considerable autonomy to decentralised authorities who are best placed to manage issues like siting, grid access, and local balancing. However, there is also a need for a clear structure for ensuring negotiation of best overall system functioning that balances local and larger system concerns and ensures policy coherence across scales"* (Brisbois, 2020).

The UK Labour Party's 2019 manifesto proposed a nested governance structure for a publicly owned energy system (The Labour Party, 2019), combining decentralised, local participation with national regulation and regional planning. In this model, Local Energy Communities (LECs) and Municipal Energy Agencies (MEAs), accountable at a local level, develop and operate renewable generation, local microgrids and SLES; Regional Energy Agencies own and manage the wider distribution network with responsibility for decarbonisation of heat and electricity; and a National Energy Agency is responsible for the transmission network, system regulation and setting decarbonisation targets. *"The guiding principle is subsidiarity, where decisions are taken as closely as possible to citizens and communities, with central authorities performing tasks not deliverable at more local levels"* (The Labour Party, 2019).

Such a nested system would give households and businesses a stake in their LEC or MEA, participating in community ownership of the local generation and distribution system. Inclusive participation across different communities would be supported by providing skills development and low-cost finance. This could create opportunities and motivation to provide flexibility at the local

level, aggregated to provide services to the distribution network. It could also increase network resilience, as described in Section 4.6.

Importantly, the right combination of central co-ordination and local governance can give households a genuine stake in the system, supporting their active engagement, while ensuring equity and fairness in the distribution of costs and benefits across the whole system.

> *"If the balance between participation and system coordination is not well managed (i.e. if accountable authorities tend toward too much control, if authorities unduly restrict the scope of governance activities undertaken by collaborative bodies), there is the potential for grid defection by those with sufficient resources"* (Brisbois, 2020).

Determining the right balance may be challenging and highly dependent on context.

6.5   Accountability & representation

While the issue of ownership of the energy system is important, and some form of public or community ownership could contribute to engaging households in flexibility, public ownership does not automatically result in public benefit, and there are other important aspects to energy governance.

> *"It'd be lovely if [the energy companies] were all owned by us all in some collective way, but they aren't, and it seems a little bit unlikely that they ever will be. And, therefore, the exact model of ownership is less important than how well they are controlled, managed and regulated it, particularly for the monopolies"* (Interviewee 20).

Whether the energy system is under public or private ownership (or a hybrid of both), there is a need for new governance arrangements to ensure accountability, fairness, social acceptance, and agency, if we want households to participate as energy citizens. *"Our democratic institutions have grown up with this energy system where we became centralised and so […] we created these institutions and these systems to ensure a more equal society with a centralised model. So, that's not to say that we couldn't have [equity] with a decentralised model, it's just that our institutions, our structures, our markets are suited to the centralised model and so it's just a question of evolving them. But we would have to have the same values that we had in the post-war era where we wanted life to be better for everybody"* (Interviewee 23).

"Public services have this kind of overall impact on the whole of society, and so, you need this range of different groups to be represented" (Cat Hobbs, WeOwnIt, Interview). Advocates propose multi-party representation in governance structures, with participation from government (at a level appropriate to the infrastructure being managed), users (households and businesses), utility workers (management and unions, bringing operational expertise) and civil society (including community groups, social or environmental organisations bringing specific public interest perspectives) (WeOwnIt, 2019). This model borrows from the governance of the Paris water supply: *"It's called an observatoire, and then the idea is that you have scrutiny by different relevant sectors of society. So you have the water users, you have water workers (those two groups aren't always agreeing also) […] They also have water scientists involved in the governance. So making sure that you've got professionals and experts but you've also got the people who use the services, people who work in services, and broader social, environmental interests represented is really important"* (Cat Hobbs, WeOwnIt , Interview).

Diverse modes of engagement may be needed to ensure participation is widely accessible. *"We thought there should be an organisation that represents the users of public services, […] gives them a voice, and they elect people to stand up for them and fight their corner on a range of public services.*

And those people would then also sit on boards and be accountable to their members. We talked about shopfronts on high streets where people can kind of pop in and say, 'Here's what's going on with my energy system?' or that sort of thing. We talked about public meetings" (Cat Hobbs, WeOwnIt, Interview).

"Perhaps most importantly, participatory governance can help facilitate social acceptance of the rules required to ensure a functional electricity grid that can provide sufficient and reliable supply" (Brisbois, 2020).

7   Conclusion

"And all we're trying to do is point out: there's a bit of a lack of imagination in this, in the way we're thinking about transformations" (Interviewee 24).

In the UK, as in Australia, the old, centralised, fossil fuel dominated electricity system is dying, and the new distributed, decarbonised, digitised system struggles to be born; now is the time of monstrous energy bills!

Despite their significant differences – in climate, generation mix, population density, building structure and technologies – the problems facing these 2 countries are remarkably similar. There is an urgent need to unlock flexible demand to enable full decarbonisation and ensure a resilient and affordable energy supply.

It is increasingly clear that price signals alone will not overcome the many barriers to flexibility. Upgrading building fabric, electrifying heating, cooling and cooking, and deploying smart technologies requires massive financial investment, training and skills development and regulation. More than anything, it requires engaging households in the project, giving them a reason to invest time and money, put up with disruption to their homes and their routines, and change the way they use and think about energy.

The success of community energy projects in the UK and the high penetration of rooftop solar in Australia demonstrate that households are willing to engage. In return, they need fairness in the distribution of costs and benefits, inclusive and accessible processes and technologies that compensate for (rather than exacerbate) existing inequalities, as well as a stake in the system, agency in decision making and a reason to make it work.

The energy price crisis is having a huge and devastating impact on UK households, with average annual energy bills forecast to reach $4,200 (over AUD7,000) and an estimated 45 million people likely to be pushed into energy poverty (defined as spending over 10% of income on energy costs) by January 2023 (Crerar, 2022).

"And people have also started to understand that the net zero and the energy price crisis are driven by the same common factor that we haven't really dealt with - our reliance on fossil fuels" (Interviewee 20).

As much as the current crisis fuels public anger towards the energy system, it also provides a political opportunity to start reshaping that system into one where people have a stake and a reason to engage. A nested network of smart local energy systems, with devolved and democratised governance structures accountable to government, communities and households could give people the capability – and, more importantly, the motivation – to unlock the flexibility in their homes.

Acknowledgements

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