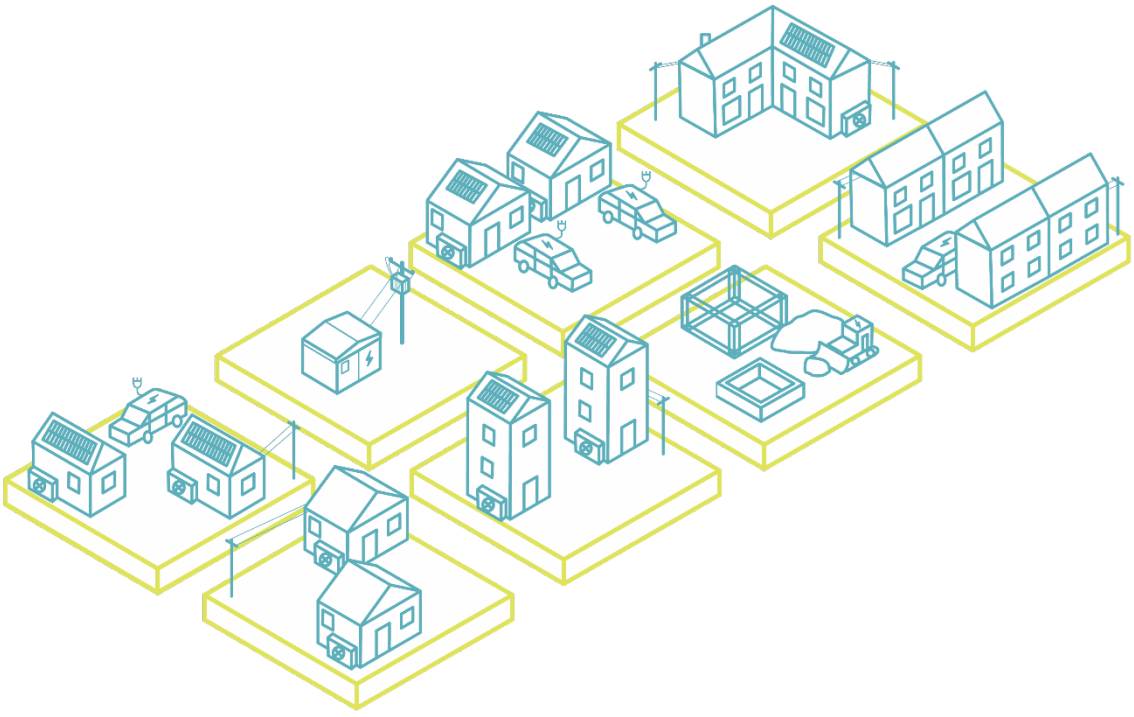
JUST TRANSITION, VULNERABILITY AND FUTURE ENERGY SCENARIOS

Planning for a fairer net zero future

April 2024



About Regen

Regen is an independent centre of energy expertise with a mission to accelerate the transition to a zero-carbon energy system. We have nearly 20 years of experience in transforming the energy system for net zero, delivering expert advice and market insight on the systemic challenges of decarbonising power, heat and transport.

Regen is also a membership organisation, managing the Regen members network and the Electricity Storage Network (ESN) – the voice of the UK storage industry. We have over 150 members who share our mission, including clean energy developers, businesses, local authorities, community energy groups, academic institutions and research organisations across the energy sector.

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Contents

Executive summary

Key messages

1. **Network planning has a vital role to play in delivering a socially just transformation in the energy system.** As the UK ramps up efforts to deliver on its critical 2050 net-zero targets, where and when we build the distribution network to support this determines who can connect and reap the benefits of the future energy system, versus who is at risk of being left behind in the process.

2. **This study presents an innovative new modelling approach to develop scenarios that support more targeted investment ahead of need in vulnerable and lower-income areas.** Through boosting projected uptake of low-carbon technologies among groups in low-income and vulnerable circumstances, we have shown how scenario modelling can lay the groundwork for a just transition in practice.

3. **Broadening engagement with a greater emphasis on vulnerability and the just transition can increase inclusivity and transparency in the network planning process.** More targeted engagement with stakeholders, such as fuel poverty charities, social justice organisations, housing associations and just transition practitioners, can enable networks to better understand emerging vulnerability or just transition issues, creating a 'fairer' network planning process.

4. **Just transition and vulnerability analysis should become even more of a standard in network planning processes, in DFES and beyond.** This can enable more targeted network investment ahead of need and ensure that the net zero transition is delivered in a way that unlocks value for people across the board.

Planning the network for a just transition

Network planning has a vital role to play in delivering a socially just transformation in the energy system. As the UK ramps up efforts to deliver on its critical net zero by 2050 targets, where and when we build the distribution network to support this determines who can connect and reap the benefits of the future energy system, versus who is at risk of being left behind in the process.

Distribution Future Energy Scenarios (DFES) are a core component of the electricity network planning process. SSEN's DFES currently projects the uptake of low-carbon technologies such as heat pumps, electric vehicles (EVs) and solar PV out to 2050. These projections then inform investment in the network.

Many factors influence these projections, including housing type and tenure, and the wider policy context. However, scenario projections do not consistently report on social and economic information, such as income or vulnerability. This means there is limited sight of **who** is expected to transition to different technologies by **when** within scenarios today. As such, there is limited understanding of how 'just' our network planning scenarios are and where these could go further to enable a more equitable net zero transition.

Overview of study

In this pioneering study, network planning methodologies have been evaluated and evolved to make just transition and vulnerability central to SSEN's DFES. By prioritising a just transition within scenario modelling and network planning processes, resources and investments can be strategically made to reduce barriers to net zero for less affluent or vulnerable communities, ensuring everyone can experience the benefits on offer.

The purpose of this study is to understand how to better embed a just transition within the DFES so that networks can better plan for this at the start of their activities. It provides tangible lessons and recommendations for SSEN and the wider sector to make just transitions central to network and investment planning in RIIO-ED3 and beyond.

It does this through:

- Reviewing just transition and low-carbon technology literature and policy.
- Engagement with network planning, just transition and vulnerability stakeholders.
- Conducting new socioeconomic analysis of current future energy scenarios.
- Updating the Consumer Transformation model to create a scenario that better reflects a just transition in practice.

Main findings and conclusions

If we plan the network predominantly for where people have typically adopted low-carbon technologies quickest, there is a risk of building injustice into the energy system. More affluent households have traditionally adopted low-carbon technologies sooner than others. However, planning the network to reflect this risks delaying the transition for less affluent communities, leaving them stuck with the rising costs of an ageing fossil fuel system while cross-subsidising others to transition through their energy bills. The DFES methodology does not use affluence as a significant factor, but this analysis provides evidence of how network load growth could look if customers in vulnerable circumstances with low incomes were supported to uptake low-carbon technologies more rapidly. This is an important scenario for SSEN and other DNOs to consider in their network planning processes.

There is an increasing trend towards innovation and policy support to enable low-income households to participate and benefit from a net zero energy system. As such, there are grounds for reflecting more targeted efforts in scenario projections, ensuring the network is also prepared to unlock value for the communities that have traditionally been at risk of being left behind.

There is a need to unpack current scenario assumptions to better account for a just transition. Within the current National Grid ESO Future Energy Scenarios (FES) framework and SSEN's DFES there is a limited consideration of just transition or vulnerability issues. This means that scenarios risk making blanket assumptions about who will transition to low-carbon technologies and when – overlooking where inequalities may be emerging and where there are opportunities to strategically plan for more equitable outcomes.

By building just transition and vulnerability more explicitly into DFES processes as a standard, networks can better plan for a more inclusive, equitable net zero future. This study proposes a new modelling approach that prioritises lower-income areas, to ensure that the infrastructure required to enable them to transition is in place when it is needed.

Recommendations

From this research and new analysis, some recommendations could be made to SSEN and other distribution networks for how to better embed the just transition into DFES modelling and wider network planning activities in the future. These are:

Recommendation 1: Make just transition and vulnerability analysis and reporting part of DFES processes as standard, including creating a 'fairer' scenario. With visibility of this information, networks can monitor emerging inequalities year-on-year. By creating a 'just transition' scenario, networks can strategically plan to deliver a fairer energy system. This could be an augmented version of an existing scenario pathway or a separate pathway.

Recommendation 2: Advocate to incorporate socio-economic analysis into ESO's FES and pathway reporting. ESO's national FES provides the building blocks and assumptions for DFES. At present, these assumptions do not explicitly distinguish between different groups of people or the support that may be required – nor do they report on social or economic factors. Alignment in national FES scenarios and pathways can help standardise this practice across networks and give better insight into national socio-economic trends.

Recommendation 3: Broaden stakeholder engagement to account for emerging trends and issues around vulnerability and the just transition. Within the network planning process, more in-depth engagement with fuel poverty charities and social justice-focused organisations can help provide stronger insights into how the transition is playing out and likely to play out in the future for low-income and vulnerable groups, as well as the reality of low-carbon technology adoption/use by fuel poor consumers. This may require tailored engagement and additional support in communicating the technical aspects of network planning, to ensure non-expert groups can engage on a meaningful basis.

Recommendation 4: Appraise next steps in the network planning process to understand current vulnerability and just transition considerations and highlight opportunities to go further. DFES is an early step in the network planning process. Exploring the steps after this (Distribution Networks Options Assessment (DNOA), for instance) and how they factor vulnerability and just transition issues today would help to ensure that these are accounted for at all levels.

Introduction

As we plan, invest in and build the critical infrastructure required to meet the UK's 2050 net zero targets, attention is turning increasingly towards ensuring this process is fair and just. The social impacts of the net zero transition will be substantial and far-reaching. The shift from fossil fuels to low-carbon alternatives will require changes everywhere – from how we heat our homes and travel around towns and cities, how we power industry and the economy, and how we ensure the electricity system we rely on is operable and stable.

These impacts will not be felt equally across society. People from different backgrounds will engage differently with a new, smarter energy system. Without dedicated attention, there is a risk that those who cannot afford to transition to low-carbon technologies end up paying for others to do so[1] and find themselves bearing the brunt of any rising costs associated with an ageing fossil fuel system[2] [3].

This is the crux of a just transition - delivering net zero in a socially just way that ensures those already on the margins of society are not left behind or penalised, or, better still, can actively benefit as a priority from a clean energy system[4].

A just transition is not solely about the cost of low-carbon technologies. How we plan and build infrastructure will determine who can participate in the transition and when. For example, if investment in the distribution network is planned predominantly to support heat pumps in areas where they have been adopted so far (i.e. where people can afford them), then there is a risk of effectively building injustices into the physical energy system itself.

As such, there is a need to ensure that a just transition sits at the centre of network planning and investment processes. By making a just transition central to these processes, networks can better target support and investment ahead of need in specific areas to ensure that those at risk of exclusion or vulnerability can also reap the benefits of a smarter, cleaner energy system.

Building fairness into the DFES

This study explores how a 'just transition' features within the SSEN DFES process today and where networks can go further to plan for a more equitable net zero future.

DFES is a critical component of network investment planning (Figure 1). The DFES produces high-granularity scenarios to understand how demand on the distribution network will change over the next decade and beyond (across multiple voltage tiers), enabling distribution network companies to better plan for where and when to invest to support a net zero energy system[5].

These scenarios are produced through a rigorous process of reviewing project pipelines, energy plans, market activity and market insights, engaging with stakeholders, such as local authorities, and reviewing local and national policies and targets. This provides a strong on-the-ground view of how the energy system is changing and is likely to change in the future. Networks then use these scenarios to inform their follow-on network impact, options assessment, flexibility procurement and network investment activities.

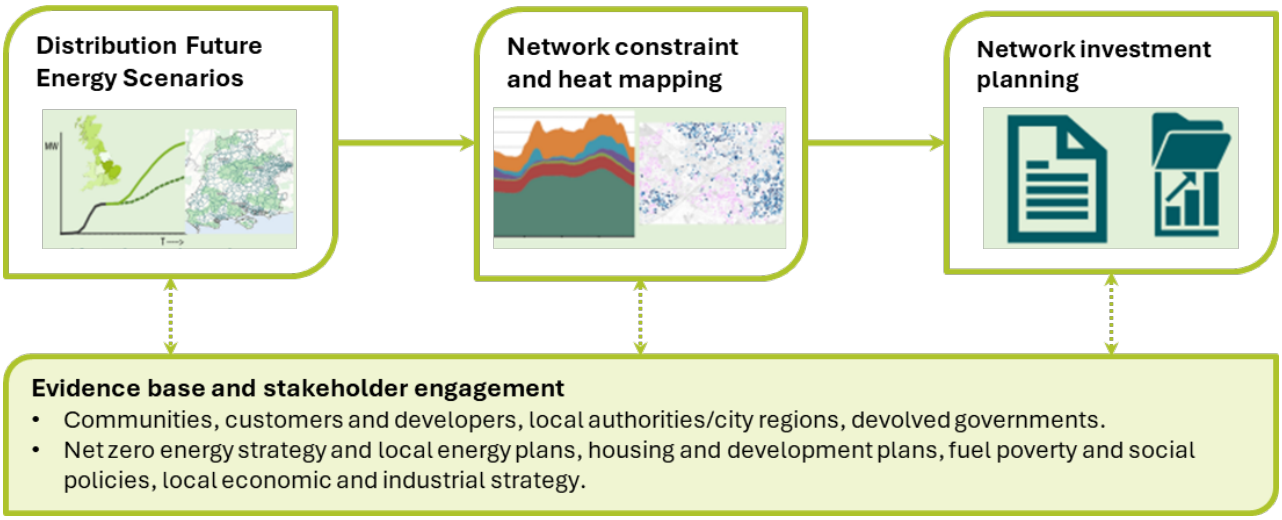

Figure 1. SSEN's current network investment process.

A key element of the DFES process is modelling the uptake and spatial distribution of low-carbon energy technologies out to 2050. For domestic technologies, multiple factors are used to anticipate where households are likely to uptake low-carbon heating, residential solar PV and EVs. These factors include, but are not limited to, the current connections pipeline/notifications, housing type and tenure, Energy Performance Certificate (EPC) ratings, direct stakeholder engagement, and local and national policy context.

For its rigorous and evolving processes, **there is limited reporting at present on the social and economic distribution of modelled scenarios**, for instance across different income groups or categories of vulnerability. This means there is no consistent, detailed view of what scenario projections mean for different people and communities. In turn, there is limited insight into potential social justice issues within the DFES – or where networks can better plan for a just transition going forward.

The SSEN DFES process extensively accounts for the wider relevant policy context and conducts a significant amount of stakeholder engagement, see Table 1. As part of this, Regen engages fuel poverty and community energy charities within stakeholder workshops. We also appraise local and national policies with tangible technology-specific targets [6]. Social housing (which is typically occupied by people with lower incomes) is given specific consideration, reflecting targeted support for social housing decarbonisation where it currently exists. Beyond this, social and economic factors play a fairly limited role in current uptake and spatial modelling in the DFES.

In previous iterations of the DFES, the 'affluence' of an area has been used (albeit to a limited degree) as a factor when modelling the spatial distribution of the uptake of EVs and heat pumps. This has meant that more affluent areas are predicted to have greater uptake of low-carbon technologies in the very near term, creating the potential for investment to be targeted predominantly in more affluent areas. This factor has been removed from heat pump modelling in recent years in an effort to combat this.

The current DFES methodology could potentially go further to understand who is impacted, and how, by the scenario methodology. The DFES assumptions could also specifically aim to capture emerging trends in innovation and support for low-carbon technologies in lower-income and vulnerable households. From this, the DFES process can continue to evolve to produce scenarios that better reflect a just transition in practice.

DFES process	How vulnerability/just transition feature today
Scenario framework	▪ Limited consideration of socioeconomic distribution of uptake of low-carbon technologies, instead assuming broad increased engagement.
Policy review	▪ Identifying vulnerability and just transition policy at UK and devolved-levels (e.g. the Scottish Energy Strategy and Just Transition Plan). ▪ Implementing technology-specific targets outlined within these, typically within Consumer Transformation and Leading the Way.
Stakeholder engagement	▪ Fuel poverty charities and community energy groups are included in general stakeholder workshops. ▪ Questions on fuel poverty initiatives on place-specific engagements e.g. Scottish Islands.
Local authority input	▪ Question in local authority survey about fuel poverty or low-income targeted initiatives. ▪ Boost in uptake of low-carbon heating technologies for local authorities with Local Heat and Energy Efficiency Strategies or Local Area Energy Plans.
Modelling and analysis	▪ Spatial distribution of uptake across Energy Supply and local authority area, for example. ▪ Acceleration factor applied to social housing. ▪ 'Affluence' used to predict uptake of EVs and solar PV (no longer featured in the heat model).

Table 1. How SSEN DFES processes currently account for a just transition.

National Grid ESO's Future Energy Scenarios (FES)

National Grid's FES provides the technology 'building blocks' for the DFES analysis. It also sets out the core underlying assumptions for scenario modelling, which the DFES then uses to guide its evidence-based forecasting.

Within National Grid ESO's 2023 FES scenario framework, there is some consideration of social and economic themes around consumer engagement and potential costs of electricity or policy support. These do not make assumptions about the level of participation or impact expected across different social or economic groups, but rather assumer broader engagement with low-carbon technologies overall.

The FES does assume that, under a more ambitious Consumer Transformation scenario, there would be higher levels of public subsidies to support electrification, although it does not go so far as to outline how these subsidies may be targeted or distributed.

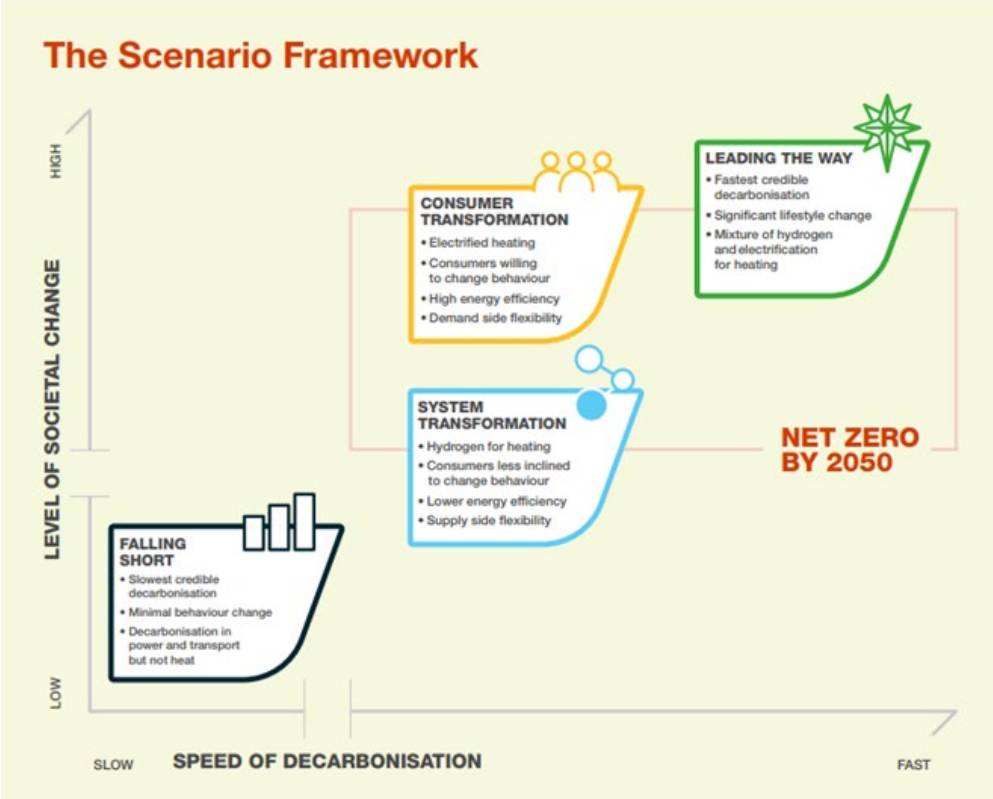

Figure 2. FES 2023 scenario framework (source: National Grid ESO).

Methodology

This study built on the standard DFES engagement and modelling process, with a specific focus on just transition and vulnerability issues (see Figure 2).

To do this, we:

1. **Reviewed literature and policy relating to just transition and vulnerability in the uptake of low-carbon technologies.** The purpose of this was to identify developments in the anticipated uptake of low-carbon technologies to understand emerging trends and challenges. This included reviewing National Grid ESO's FES processes and assumptions to understand how just transition and vulnerability feature within the existing scenarios framework and the resultant projections across GB.

2. **Stakeholders from fuel poverty charities and social justice-focused organisations were interviewed.** These included one UK-wide fuel poverty charity, one local Scottish fuel poverty charity, a UK-wide organisation working to support minority and ethnic communities and an expert from a national body that steers Scottish Government just transition policy. The purpose of these engagements was to glean insights into how the net zero transition is playing out both in communities and in policy, to understand key issues around low-carbon technology uptake.

3. **Workshops were held with Regen and SSEN representatives who work on the DFES and wider network planning activities.** The purpose of this was to explore how social and economic factors are used within current network planning processes and where these could be updated to reflect a just transition both in scenario modelling and associated engagement processes.

4. **The Consumer Transformation scenario was updated to reflect potential differences in low-carbon technology uptake between different groups and new projections were made to prioritise uptake in less affluent and more vulnerable areas.** The full modelling approach is set out in the Analysis section.

Focus area: heat

Within the scope of this study, heat is used as an illustrative example. Because the heat transition will impact most households in one way or another, heat was selected as a low-carbon technology that has the most direct impact on, and linkages with, vulnerability and just transition outcomes.

This is considered to be a pilot study, to demonstrate the feasibility of an adjusted approach to scenario analysis and the merits of embedding just transition and vulnerability more centrally within DFES processes. The wider aim is to build on this in future years to capture the full range of low-carbon technologies that should be considered and deliver this analysis as standard.

SSEN's Vulnerability Future Energy Scenarios (VFES)

This study follows directly from SSEN's VFES. Working with National Energy Action, Imperial College London and the Smith Institute, SSEN has developed a process for identifying geographic clusters of vulnerable groups and how these groups may be impacted by net zero.

Using innovative forecasting, the VFES project takes vulnerability data held by SSEN in the Priority Services Register (PSR), combined with external inputs such as census data, and identifies areas where certain vulnerabilities are particularly prevalent across SSEN's licence areas, down to a Lower Super Output Area (LSOA) level.

By clustering vulnerable groups in this way, SSEN can better target support, engagement or network investment to address these vulnerabilities directly, as per its RIIO-ED2 business plan obligations, and ensure that resilience of supply for these clusters is prioritised.

This study builds on SSEN's VFES work, by applying a similar principle. With a just transition focus, this study explores how just transition themes feature in the DFES today and makes adjustments to core scenarios to ensure those at risk of being left behind in the net zero transition are prioritised.

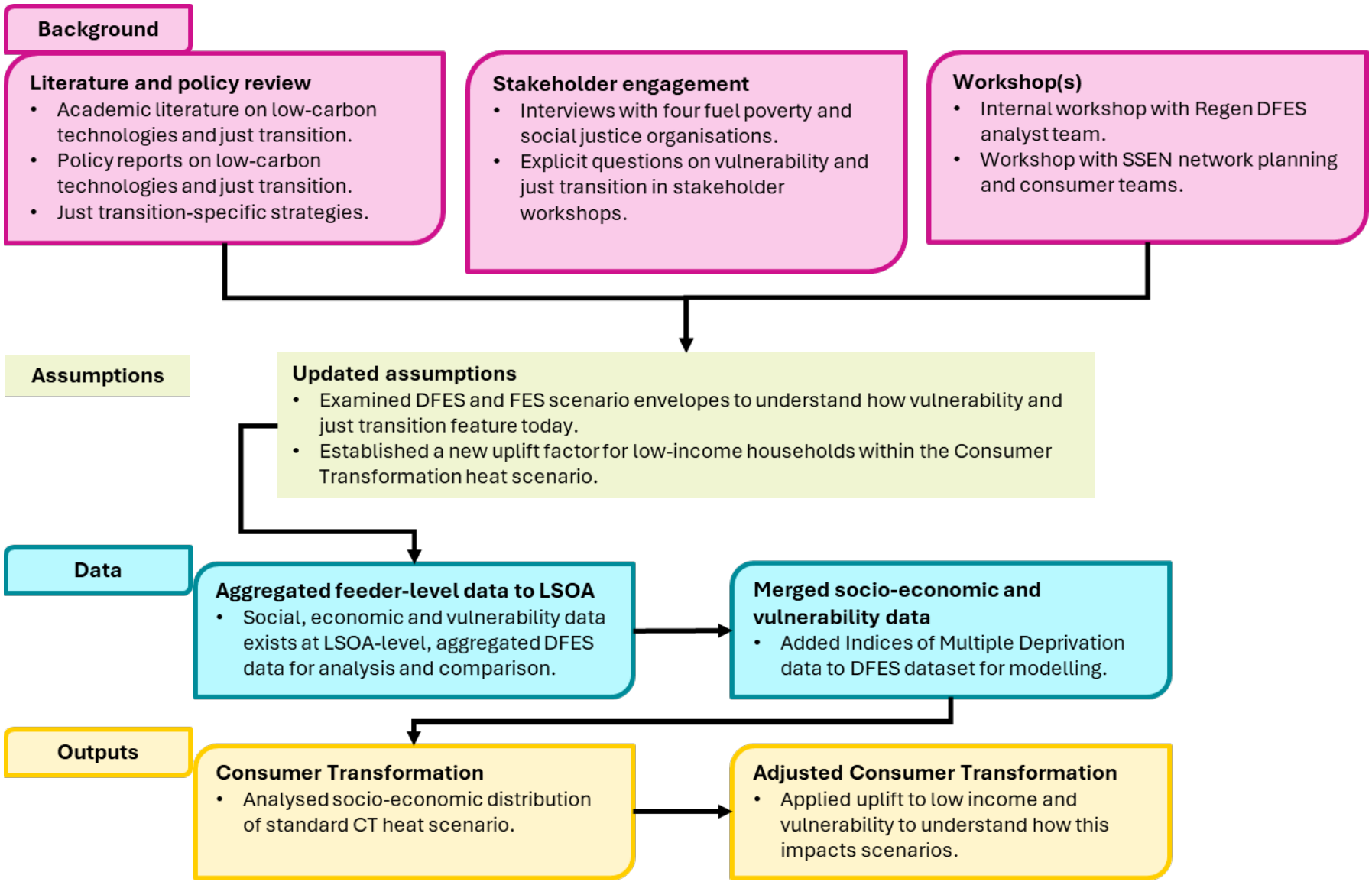

Figure 3. Full report process and methodology.

Just transition, vulnerability and network planning

Definitions

This report discusses two key themes within the DFES - vulnerability and just transition. These refer to slightly different things, as described in Table 2.

Vulnerability	Just transition
"Consumer circumstances which make them less able to protect or represent their own interests, or more likely to suffer more substantial detriment" (Ofgem, 2020)	"Reaching net zero in the fairest way possible for working people, consumers and communities, ensuring benefits… are shared widely whilst preventing unfair burden of costs on those with the least" (SSE, 2023)

Table 2. Definitions.

Vulnerability

Ofgem's Consumer Vulnerability Strategy defines vulnerability as "consumer circumstances which make them less able to protect or represent their own interests, or more likely to suffer more substantial detriment" within the energy system [7]. This may be from rising costs, such as experienced through the recent energy crisis, or from issues with resilience or security of energy supply. Various factors can lead to a person or household being considered 'vulnerable' or experiencing vulnerability. Groups considered most likely to experience 'vulnerable situations' include, but are not limited to [8]:

- People who use medical equipment reliant on electricity or water.
- Households with children under five years of age.
- People with disabilities or chronic illnesses.
- People with anxiety, depression or any mental health issues.
- People of pensionable age.
- People for whom English is not a first language.
- People on low incomes or means-tested benefits.

Energy suppliers, networks and other utilities collect information on these criteria from their customers via the PSR. This ensures that consumers who fall into these categories are given priority support in the event of supply outages or significant price changes.

Just transition

A just transition to net zero is then about ensuring those already on the margins of society are not penalised in the process of decarbonisation and that costs and benefits are fairly distributed. It is also about the process for delivering net zero policies and initiatives (i.e. who gets a say in decision-making, whose needs are considered and to what end)[9].

All networks have a duty to address vulnerability within their RIIO-ED2 business plans[10], although just transition is not explicitly mentioned within this. SSE has published a specific just transition strategy, see Figure 4, and others such as SP Energy Networks and National Grid Electricity Distribution also hold their own equivalent strategies[11] [12].

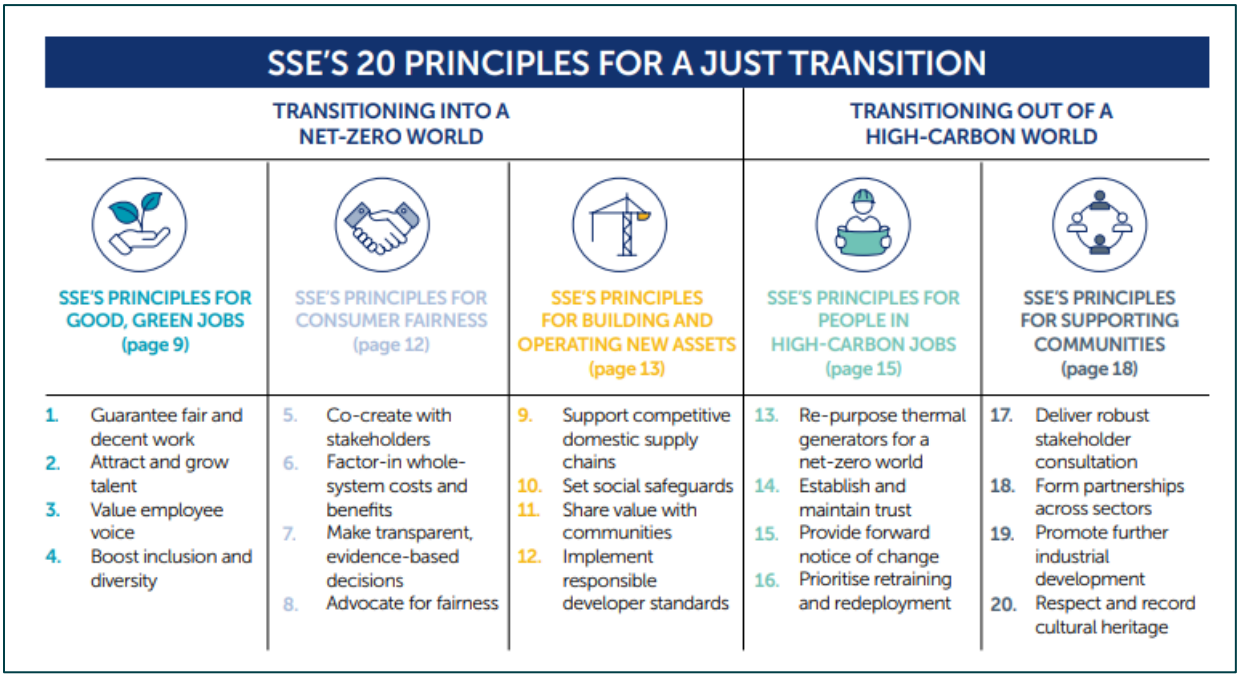

Figure 4. SSE's 20 Principles for a Just Transition.

While differing in definitions, vulnerability and just transition are linked. Those experiencing vulnerability as outlined above are also often the people most adversely impacted under the energy system today (e.g. struggling with energy bills or living in poorer quality housing). They are also often more at risk of exclusion in the net zero transition.

Vulnerability and other factors may make certain groups less able to effectively participate in, or benefit from, low-carbon technologies, without additional support (Table 3)[13]. In turn, this can leave them exposed to volatile fossil fuel prices or cross-subsidising other, more affluent groups to transition via policy costs recouped on bills.

Group	Just transition barrier
People on low incomes or means-tested benefits	Material time and resources to install low-carbon technologies; potential increased running costs of low-carbon heat under today's prices.
Households with children under five years of age	Material time and resources to install low-carbon technologies; increased running costs of low-carbon heat under today's prices.
People with disabilities or chronic illnesses	Additional and/or unique energy needs; material time and resources to install new technologies.
People with anxiety, depression or any mental health issue	Lack of confidence or capacity to engage with new technologies, policies or processes.
People for whom English is not a first language	Language, communication and engagement with energy systems and markets; ownership and legal rights such as housing, making it challenging to install new technologies.
People of a pensionable age	Engagement with new technologies or systems; material time and resources to install new technologies.
People living in the private rented sector	Ownership and legal rights over housing, making it challenging to install new technologies.
Residents of flats and tenements	Ownership and legal rights over housing, making it challenging to install new technologies.

Table 3. Barriers faced to engaging with low-carbon technologies by group.

Extensive research shows that low-carbon technologies can support lower bills, healthier homes and more comfortable living conditions for those who face injustice in the energy system today. However, there are also potential issues that the transition may create if left unchecked. For example, one fuel poverty charity interviewed as part of this process highlighted that, given the current high cost of electricity, protections such as a social tariff need to be in place to ensure that those who can least afford higher bills do not end up paying more in the short-term.

Innovation and policy for a just transition

Recognising this, discussions around net zero are increasingly turning towards the theme of fairness[14], with extensive work being undertaken to overcome the barriers faced by potentially disadvantaged consumers.

In innovation, SSEN and the Centre for Sustainable Energy have been delivering the **Smart and Fair** programme[13], which explores how to open-up smart energy technology access to groups who may face additional barriers in the energy transition. UK Power Networks' **Socially Green** project[15] worked with target groups to understand barriers and develop new solutions to broaden low-carbon technology access and value. The **Energy Systems Catapult** recently launched a new funding programme designed to support the co-creation of innovative smart energy solutions[16].

In policy, the National Infrastructure Commission recently outlined a need for the UK government to spend £1.6 billion per year to deliver low-carbon heating technologies to low-income households specifically[17]. Several Local Area Energy Plans (LAEPs) and Local Heat and Energy Efficiency Strategies (LHEES)[18] developed by local authorities similarly set out initiatives to target low-carbon technologies and energy efficiency in low-income households.
These are in addition to existing support for lower-income households, such as the Energy Company Obligation scheme (which includes upgrading heating technologies), the UK government's Social Housing Decarbonisation Fund[19] and the Scottish Energy Efficiency Standard in Social Housing – soon to be replaced with the Social Housing Net Zero Standard[20].

> "The smart, flexible energy system is also going to create new types of vulnerability. We need to be agile in responding to those new types of vulnerability and designing solutions that work for different people, not waiting to reverse engineer the solutions onto the system." – **Energy Systems Catapult, 2024.**

What this means for planning the network

Ensuring a just transition to a net zero energy system means understanding the different barriers people face and how these can be alleviated or addressed within the energy transition. Innovation and policy are ramping up to address this, to ensure that access to the benefits of the net zero transition is open to all. **This raises key questions for who will transition to net zero and when, and how networks can best plan for this.**

People who can afford and are minded to install low-carbon technologies, such as heat pumps, will generally move first within the net zero transition. These early adopters play an important role in absorbing some of the risk of novel technologies and demonstrating their viability to others through user experience and word of mouth[21].

Once early adopters have moved, however, there is a question about who is forecast to move next. Research suggests that more affluent groups tend to adopt low-carbon technologies more quickly than those who face additional barriers, although there is limited evidence for how this plays out at a national scale over time[22]. Views from stakeholders engaged as part of this study highlighted that planning for this within the distribution network may lead to prioritising investment in more affluent areas. As a result, this could lead to forecasting an 'unjust' transition that creates an additional barrier, namely a lack of appropriate distribution network infrastructure, that further delays lower-income groups in the process (see Figure 5).

Instead, stakeholders noted that lower-income and vulnerable groups should be at the foreground of the transition, ensuring that the value of the transition can be passed onto them as a priority. **More targeted investment ahead of need in less affluent areas can ensure that the necessary distribution network infrastructure is in place to enable this value sooner rather than later.**

Recent developments in innovation and policy provide some grounds to reflect this in scenario modelling. SSEN's just transition strategy and obligations to address vulnerability under RIIO-ED2 Business Plans also provide grounds to better account for this going forward. Better sight of socio-economic information and engagement can likewise support networks to make more targeted decisions on where and when to plan for investment in the network versus where to prioritise flexibility.

> "Smart meter rollout deprioritised fuel poor and vulnerable households and, as a result, support that could have been delivered via a smart meter during the cost of living crisis couldn't be. I get the principle of not testing new capability on those who are vulnerable but, once tested, you can choose to prioritise vulnerable households if you want. The problem with smart metering is that nobody really did…. And so the poor lost out. Let's not make the same mistake again." – **Fuel poverty charity interview response, 2024.**

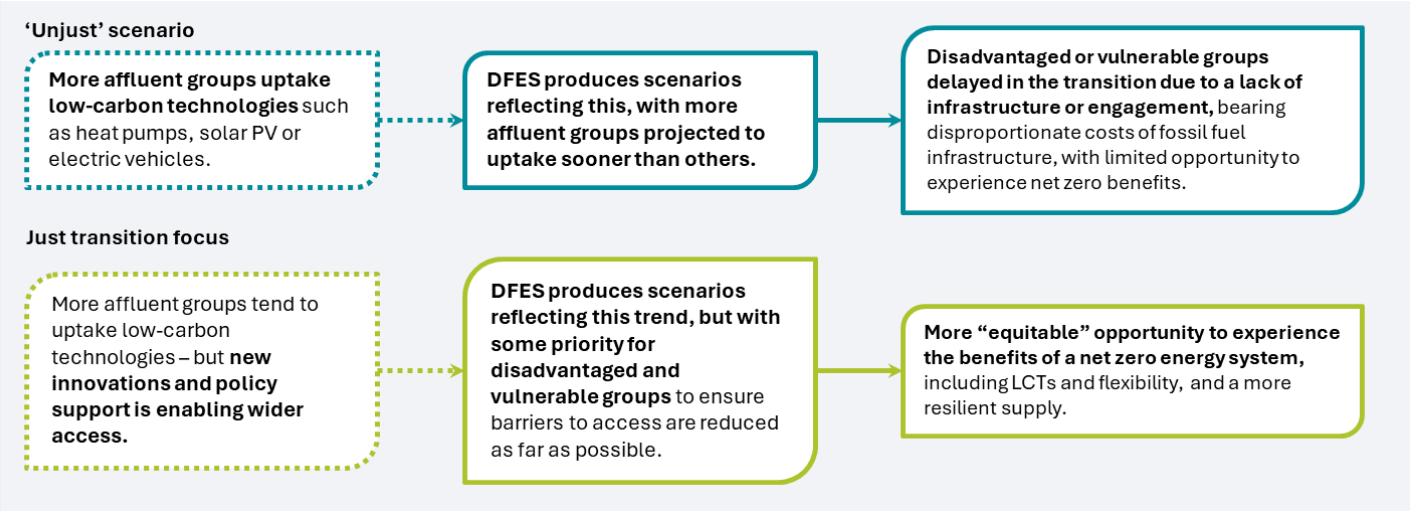

Figure 5. Example of how DFES processes could differ with and without a just transition focus.

Analysis

SSEN and other networks have made enabling a just transition and tackling vulnerability key priority areas in their planning and investment activities. Research conducted in this study indicates that inequalities may emerge between groups of varying wealth levels in the transition to low-carbon technologies if left unchecked. As a result, innovation and policy are evolving to reduce barriers to participation in the net zero energy system, to ensure the transition is fair and just.

The DFES provides a baseline for network planning and investment activities but does not currently explicitly account for just transition or vulnerability issues in its assumptions or final scenarios. To rectify this, this study puts forward new analysis. The purpose of this analysis is to understand who is impacted under projections today and to put forward an augmented scenario that prioritises lower-income and vulnerable groups in its uptake and spatial distribution assumptions.

Updating the Consumer Transformation scenario

Based on National Grid's FES, the SSEN DFES models four different future scenarios. These scenarios reflect varying degrees of net zero ambition, deliverability and technological pathways (see Figure 6).

Changes are made to the Consumer Transformation scenario specifically. This was selected as the most appropriate scenario for four key reasons.

- Consumer Transformation is the **central scenario used in SSEN's network planning process**.
- It most closely **reflects Scottish-level policy ambitions**, which include earlier net zero targets than UK-level as well as just transition commitments.
- It has a **nearer-term impact on the low-voltage distribution network**, with greater rate of change and expected shifts in residential consumer behaviour.
- It is the most **consumer-focused** overall scenario, in terms of household impacts and engagement, and so is most relevant to just transition and vulnerability outcomes.

Within the Consumer Transformation scenario today, it is assumed that consumers will generally be more engaged in the net zero transition. The National Grid ESO FES assumes that this will be a high-subsidy environment[23], with price signals (e.g. cheaper electricity, higher cost gas) balanced to incentivise behaviour change.

Rather than assuming blanket increases in engagement with the heat transition and non-targeted subsidies, the research set out in this report suggests that there are grounds for considering **that high-subsidy and high-engagement scenarios should include support targeted more specifically towards lower-income and more vulnerable groups**.

It is assumed that this support will be in place earlier to enable lower-income groups to transition before external costs become too great, and that price signals along with more general support will encourage those who would transition of their own accord (i.e. higher-income groups) to do so at a similar rate. These updated Consumer Transformation assumptions are outlined in Table 4 .

Current CT assumptions	Updated assumptions
▪ Engaged consumers willing to change behaviour.	▪ Engaged consumers willing to change behaviour, **recognising that different groups will engage in different ways.**
▪ Price signals encouraging people to switch to low-carbon technologies.	▪ **Price signals encouraging those who have the means and capacity** to voluntarily switch to low-carbon technologies.
▪ "High subsidy" environment.	▪ **Targeted innovation and support for low-income and vulnerable households.**

Table 4. Current and updated Consumer Transformation assumptions.

Modelling approach

To conduct the analysis, DFES feeder-level information was aggregated up to Low Super Output Areas (LSOA). LSOAs cover areas of roughly 500-1000 people. At this level, vulnerability information such as that developed in the VFES project and wider social and economic information (census, indices of deprivation etc.) can be overlayed. This is done for both of SSEN's licence areas: North of Scotland (SHEPD) and Southern (SEPD).

Income deprivation from the Indices of Multiple Deprivation[24] and Scottish Indices of Multiple Deprivation[25] was used as the main socio-economic factor in this analysis. Income deprivation is measured as the proportion of people within an LSOA on means-tested benefits, which is taken as a proxy for lower-income groups. This also correlates with various measures of vulnerability and fuel poverty[26]. This measure was then split into evenly populated deciles to support better illustration of outputs.

Applying an uplift to lower income areas

The analysis then took two steps. First, the **current socio-economic distribution** of heating technologies as they stand today and under the standard Consumer Transformation scenario was modelled. An **'Adjusted Consumer Transformation' scenario was then created**, in which an uplift was applied to lower-income groups to accelerate the rate of uptake of heat pumps specifically. This uplift was applied at a rate of 35%. That is, uptake of heat pumps in lower-income groups was boosted by 35% compared to the standard Consumer Transformation scenario.

This figure was chosen as the same figure used to boost local authorities with LAEPs. **It is not a perfect measure and** more rigorous effort to quantify the impact of just transition policy support on actual changes in the uptake of low-carbon technologies would make this more robust in the future.

This uplift does not change the overall number of heat pumps expected to be adopted by 2050 but accelerates uptake among households projected to have heat pumps installed in lower-income areas by 2035.

The analysis is divided into **two themes**:

- Understanding the current socio-economic-driven spatial distribution of Consumer Transformation projections, in the context of other physical spatial factors applied.
- Modelling new assumptions with more targeted subsidies for low-income and vulnerable households.

Current spatial distribution of scenarios across income groups

Summary

- **Heat pump uptake today is highly unevenly distributed**, with 4-5% of mid-to-high-income groups adopting heat pumps to date, versus 1% of lower-income groups. The uptake of rooftop solar PV and EVs shows a similar uptake variance.
- **Heat pump uptake by 2035 and 2040 is relatively flat in the current Consumer Transformation scenario, with a slightly higher rate of adoption in higher-income groups.** This means that current assumptions about society-wide adoption of heat pumps perform well from a 'fairness' perspective, although there is room to improve.
- **Under current projections, 20-25% of lower-income groups are expected to connect to district heat networks by 2050 compared to 5-10% of more affluent groups**. This partially reflects that lower-income groups tend to live in flats where district heat solutions are more appropriate, but raises questions over where investment in both the electricity distribution network and heat network infrastructure will be required.

Heat pump uptake today

The spatial distribution of heat pump uptake to date across income deciles is presented inFigure 7. From the charts below, higher-income groups are significantly more likely to already have a heat pump than lower-income groups. This is specifically notable in the North of Scotland licence area, with a ratio of approximately 4:1, higher to lower income groups.

This echoes research demonstrating that higher-income groups generally adopt low-carbon technologies sooner and at a higher rate than others, due largely to being better able to afford the up-front capital costs, owning their homes and being more confident with accessing policy support such as the Boiler Upgrade Scheme. This is consistent also across EV and solar PV uptake (see Figure 8 and Figure 9).

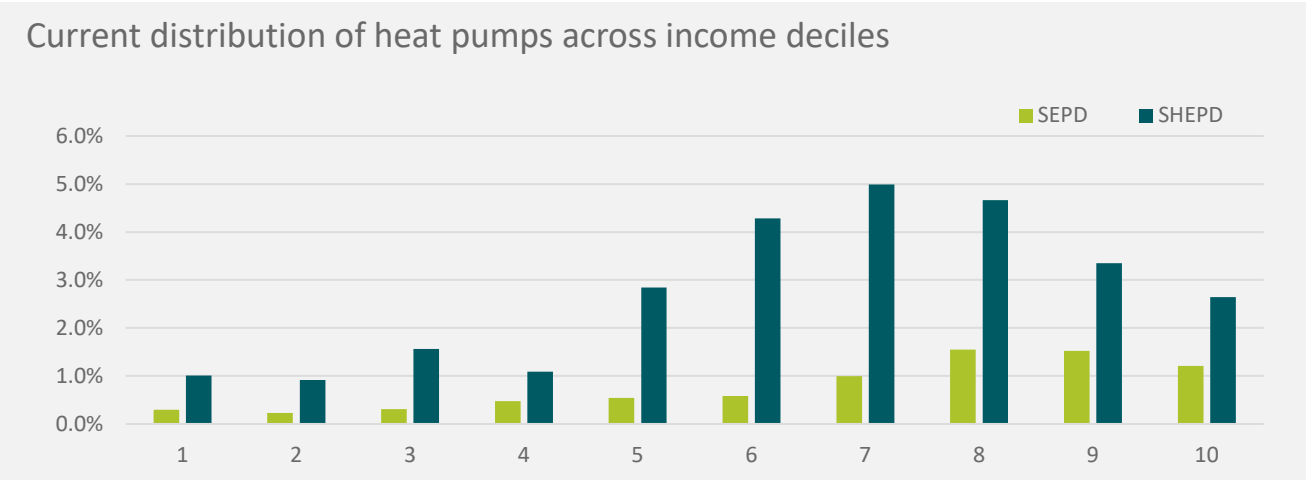

Figure 6. Heat pump uptake by income decile to date.

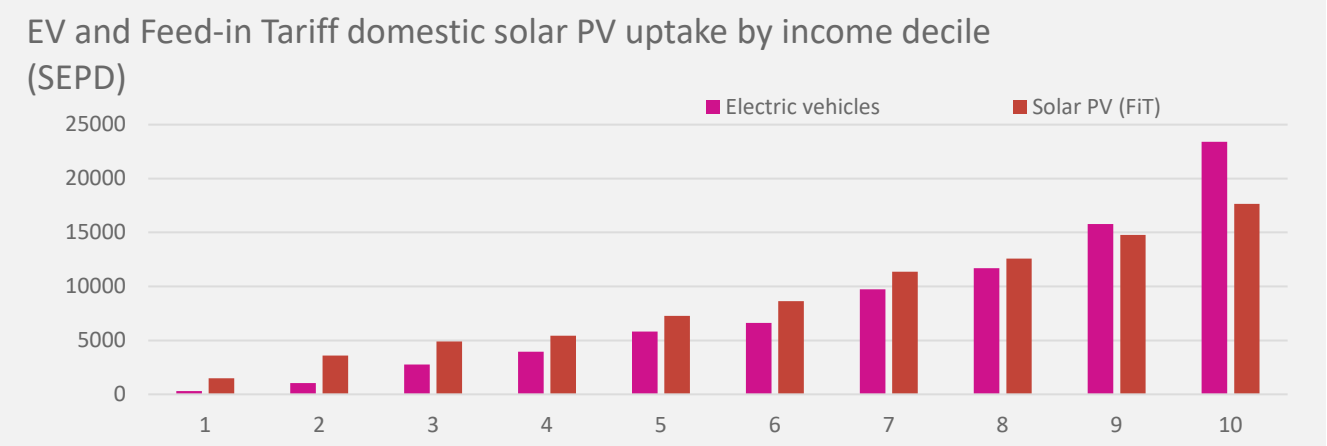

Figure 7. EV and solar PV uptake by income decile to date (SEPD).

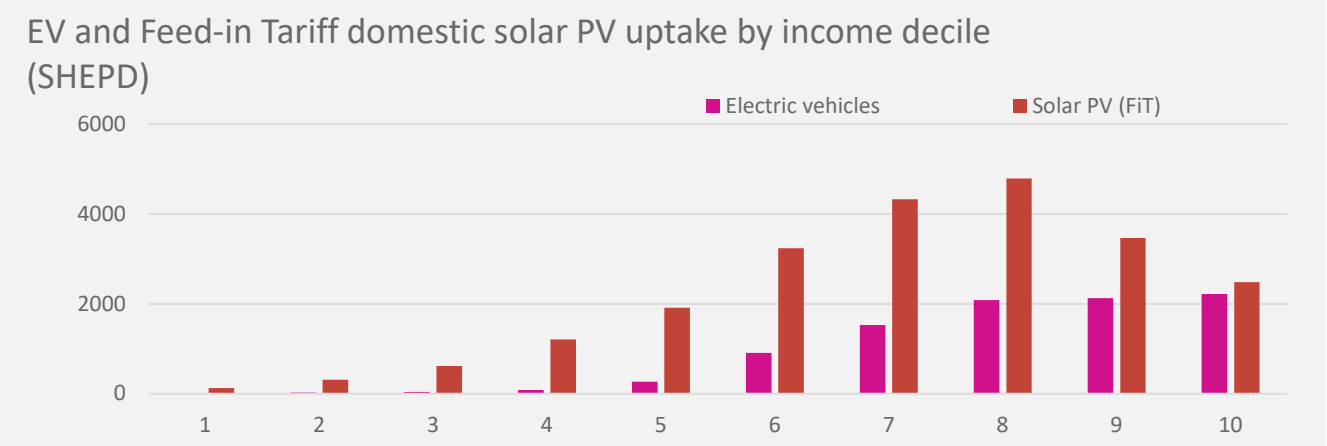

Figure 8. EV and solar PV uptake by income decile to date (SHEPD).

Technology uptake under the existing Consumer Transformation scenario

By 2050, it is projected within Consumer Transformation that the vast majority of households will have installed a non-hybrid heat pump (see Figure 10 and Figure 11). This figure is slightly lower in lower-income groups (65-70% in the lowest three deciles versus 70-87% in other income groups), particularly those in flats and metropolitan areas, where district heat networks are likely to be more suitable.

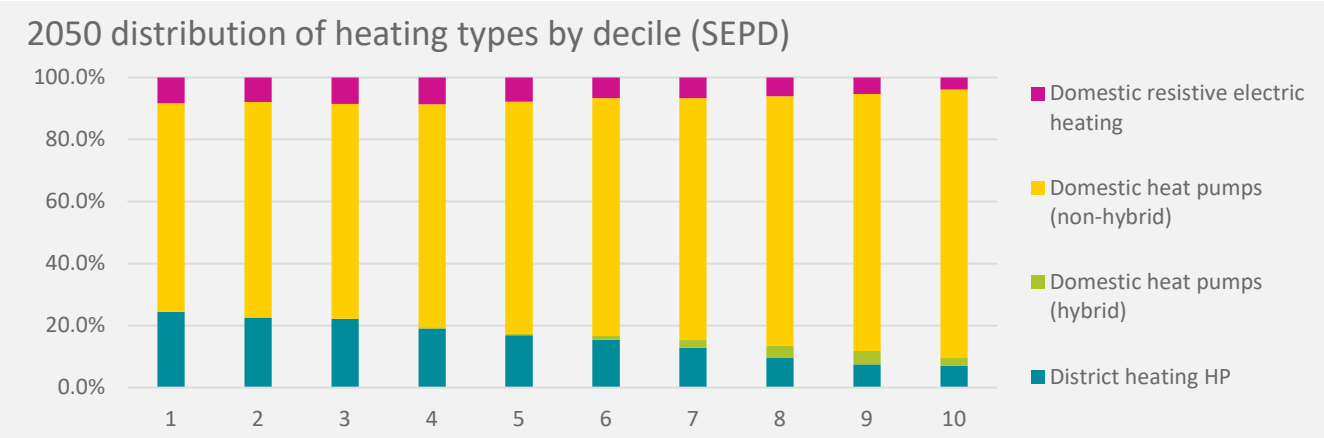

Figure 9. Projected 2050 heating technology uptake by income decile (SEPD).

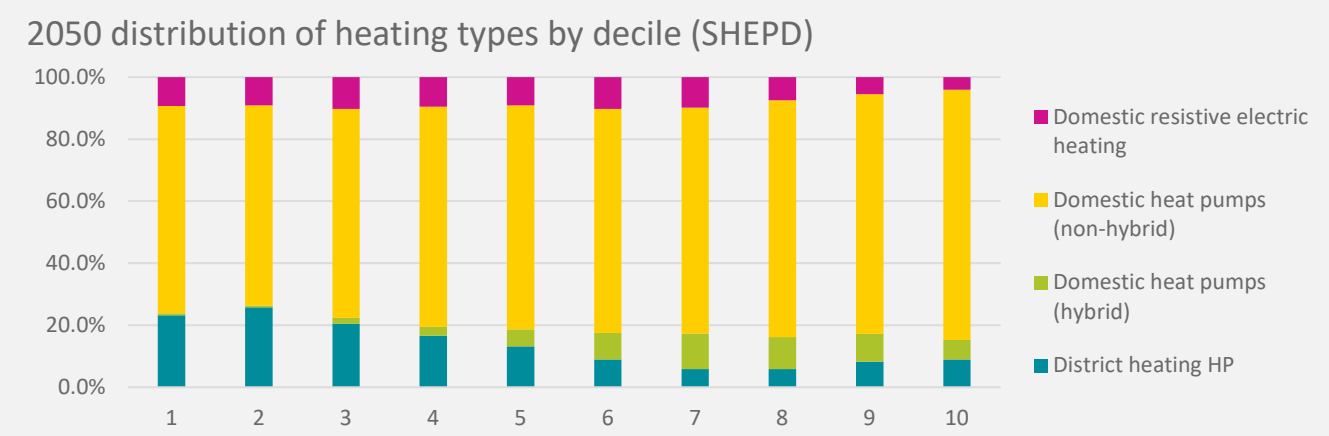

Figure 10. Projected 2050 heating technology uptake by income decile (SEPD).

As a proportion of households expected to have heat pumps by 2050, the current Consumer Transformation scenario projects a relatively even distribution by 2035 (see Figure 12). There is a

slight uptick in the higher-income groups, particularly in the SHEPD licence area, although this is by a difference of between 5-10%. SEPD is generally flatter with less variation.

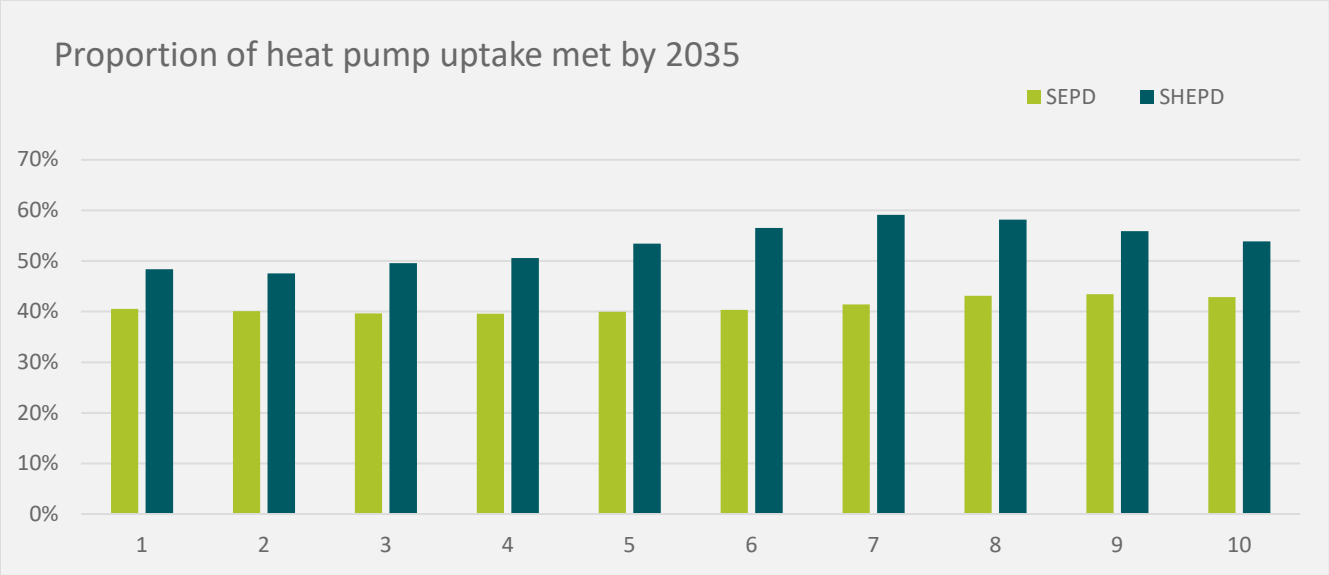

Figure 11. Proportion of heat pumps installed by 2035 by income decile.

Just transitionadjusted Consumer Transformation scenario

This section presents the outputs from this new Adjusted Consumer Transformation scenario. An uplift factor was applied to the three lowest income deciles out to 2035, to show how the original Consumer Transformation scenario compares to the adjusted version. This is illustrated by showing the original and Adjusted Consumer Transformation scenarios side-by-side in the following series of charts.

Summary

- With the uplift applied, there is an **increase of 63,190 heat pumps in lower-income households by 2035:** 46,321 in SEPD and 16,869 in SHEPD, respectively.
- This would mean planning for an additional **10-15% of lower-income households** transitioning to heat pumps within the next decade.
- Local authorities most affected by the uplift are **Isle of Wight, Havant, Southampton and Hillingdon in SEPD**; and **Dundee City, Highland, Argyll and Bute, and North Ayrshire in SHEPD**.

Heat pump uptake over the next decade

Figure 13 shows the expected uptake of heat pumps by 2035. This is predominantly non-hybrid, but also including hybrid and district heating heat pumps.

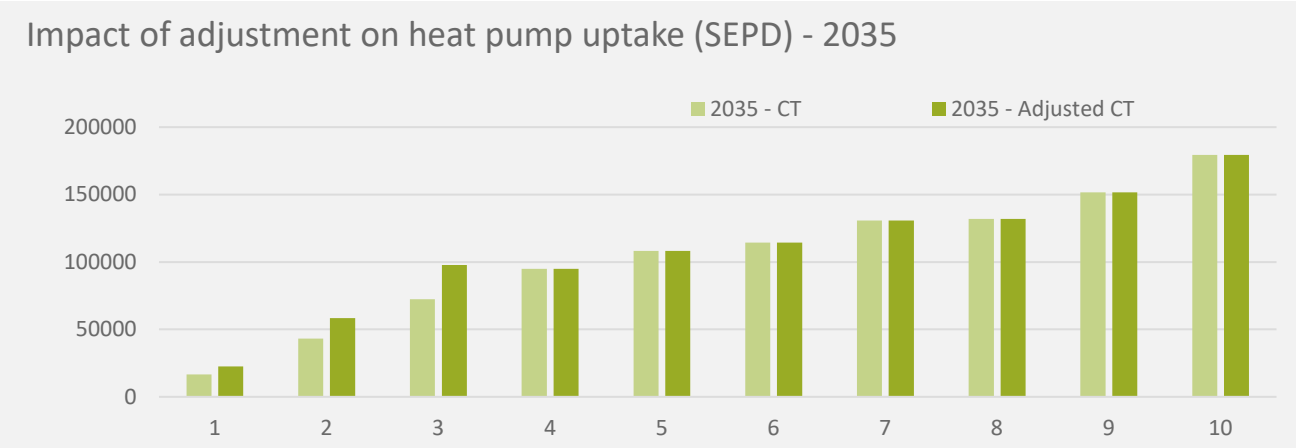

Figure 12. Impact of adjustment on 2035 heat pump uptake by income decile (SEPD).

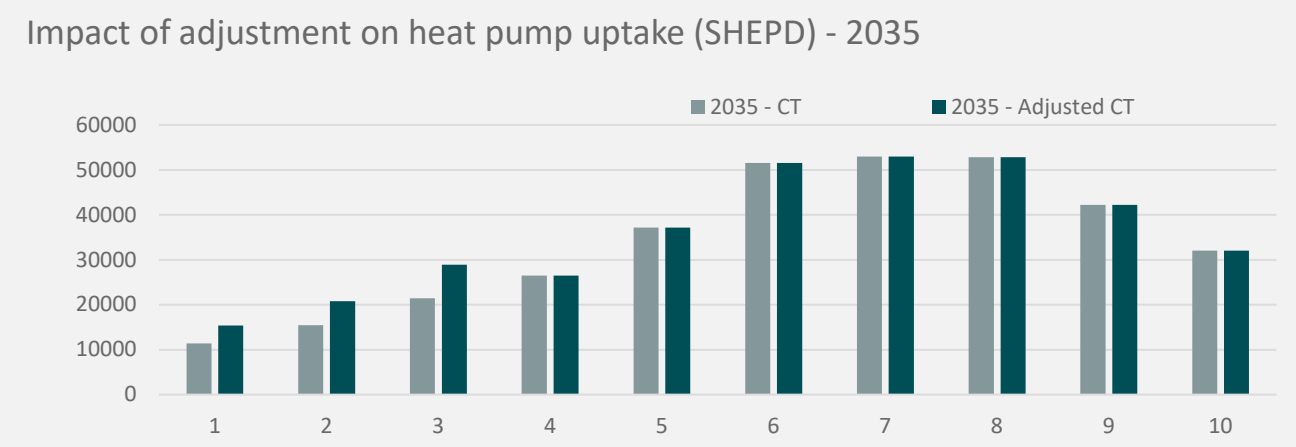

Figure 13. Impact of adjustment on 2035 heat pump uptake by income decile (SHEPD).

There is still an expectation that higher-income groups will transition to heat pumps in greater total numbers than lower-income households. However, with the uplift applied and assuming more targeted support over the next decade, there is an increase of 63,190 heat pumps installed by 2035 across both licence areas: 46,321 in SEPD and 16,869 in SHEPD respectively. By 2040, this would lead to an increase of 67,222 heat pumps overall (Table 5).

Income Decile	2030 - CT	2030 - Adjusted	2035 - CT	2035 - Adjusted	2040 - CT	2040 - Adjusted	2045 - CT	2045 - Adjusted
1	5745	7756	16717	22567	27974	34501	33012	36863
2	15011	20264	43244	58379	72053	88865	86344	96418
3	25646	34622	72387	97723	120913	149127	145344	162300

Table 5. Total number of heat pumps in lowest income deciles under standard and Adjusted Consumer Transformation scenarios.

The impact of this uplift is particularly prominent in the third lowest income decile, where there is a greater number of people living in detached/semi-detached and terraced housing. In the two lowest income groups there is a higher number of people in socially rented homes. In the third decile, there is a significantly greater number of owner-occupier and private-rented tenures (approximately 70%, with 50-55% in the lowest two deciles - see Appendix for full breakdown).

This is a significant uplift that could lead to a relatively high amount of additional uptake within the next decade. As a proportion of each decile, the Adjusted Consumer Transformation scenario increases uptake in low-income households by an average of 10% over other groups.

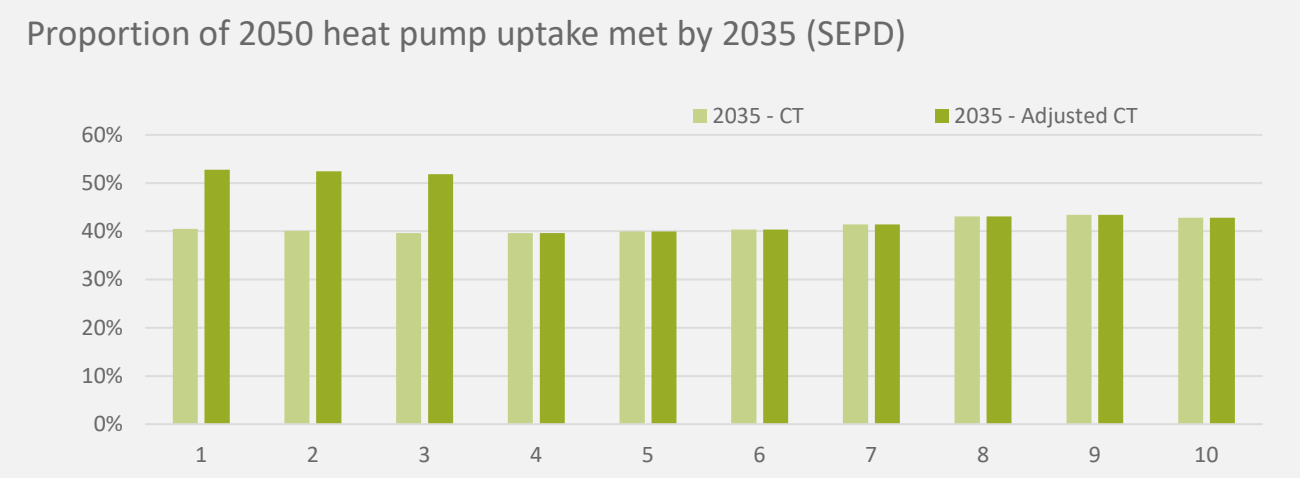

Figure 14. Proportion of heat pump uptake by 2035 under Adjusted CT (SEPD).

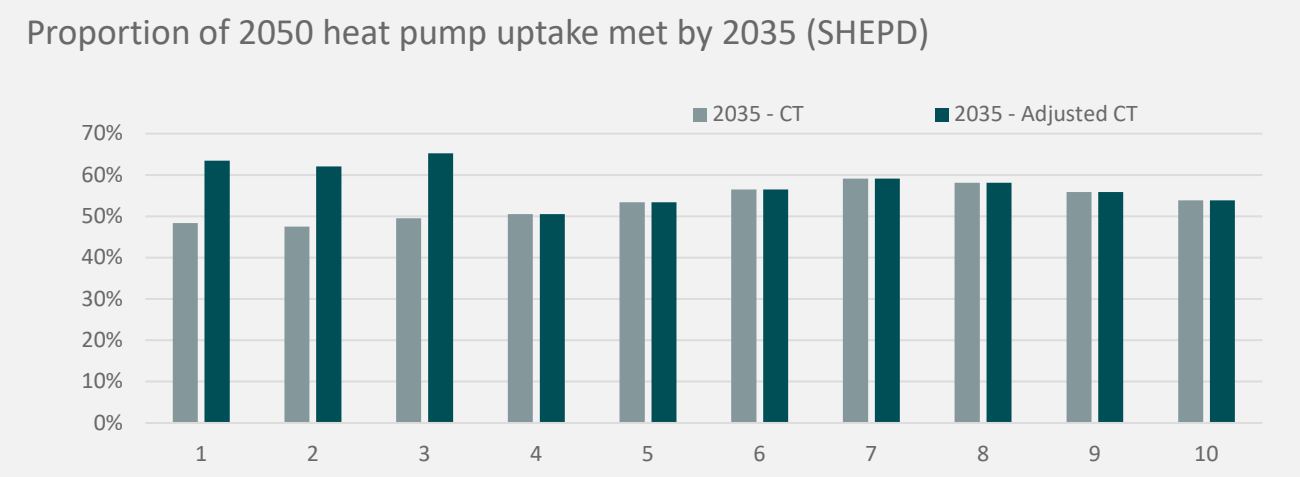

Figure 15. Proportion of heat pump uptake by 2035 under Adjusted CT (SHEPD).

Most affected local authorities under the Adjusted Consumer Transformation scenario

As a final step, Adjusted Consumer Transformation projections were aggregated to local authority level, to highlight which local authority areas are most impacted by the updated figures (i.e. where uptake is increasing most significantly in low-income areas in the next decade). These projections are presented in Figure 17 and Figure 18, which show the percentage of overall increase in heat pump uptake within a local authority area.

In the SEPD licence area, the Isle of Wight has the highest percentage increase in heat pump uptake, with slightly over 1.5% compared to the standard Consumer Transformation scenario. Havant, Southampton and Hillingdon then follow with 1.3-1.4% respectively(see Figure 21).

In the North of Scotland licence area, Dundee is most impacted by some distance, reflecting the higher population and greater levels of income deprivation compared to other local authority areas. The increase in Dundee City is 3.3% - almost double the next two local authority areas combined. SHEPD local authority impacts are mapped in Figure 19, with Dundee highlighted in Figure 20, and SEPD local authorities mapped in Figure 21 followed by the Isle of Wight in Figure 22.

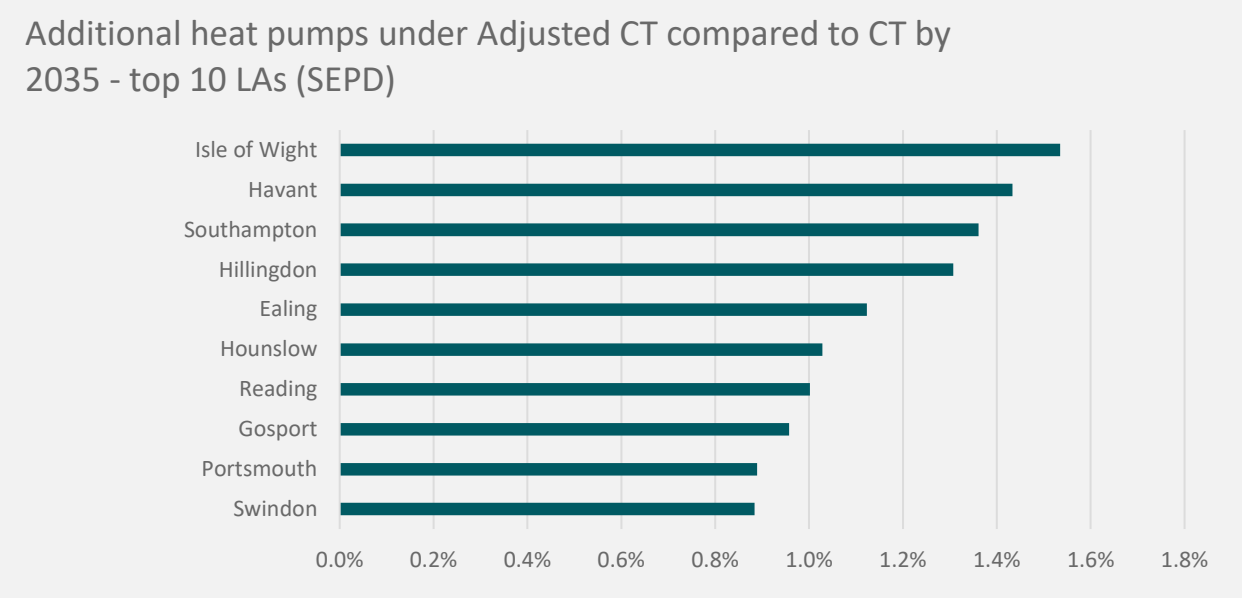

Figure 16. Local authority areas most impacted by Adjusted scenario (SEPD).

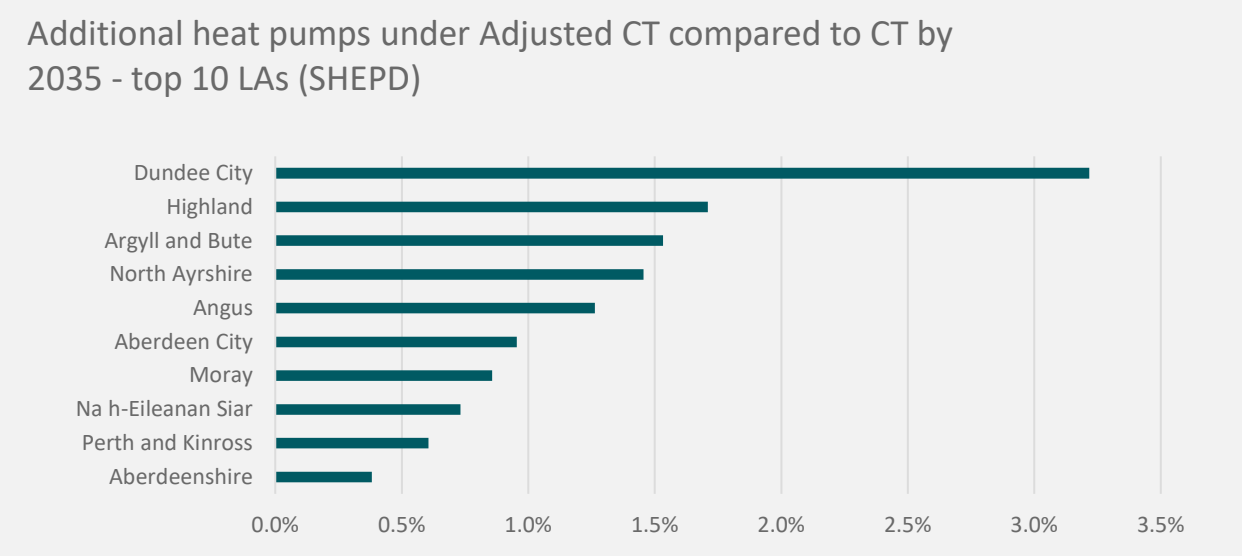

Figure 17. Local authority areas most impacted by Adjusted scenario (SHEPD).

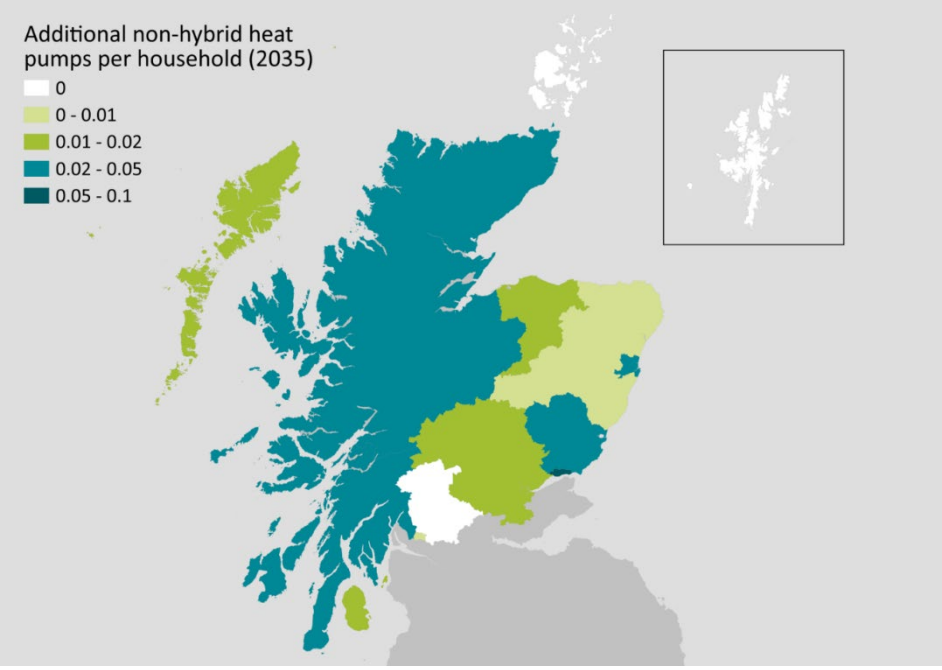

Figure 18. Percentage increase in heat pump uptake in SHEPD local authorities.

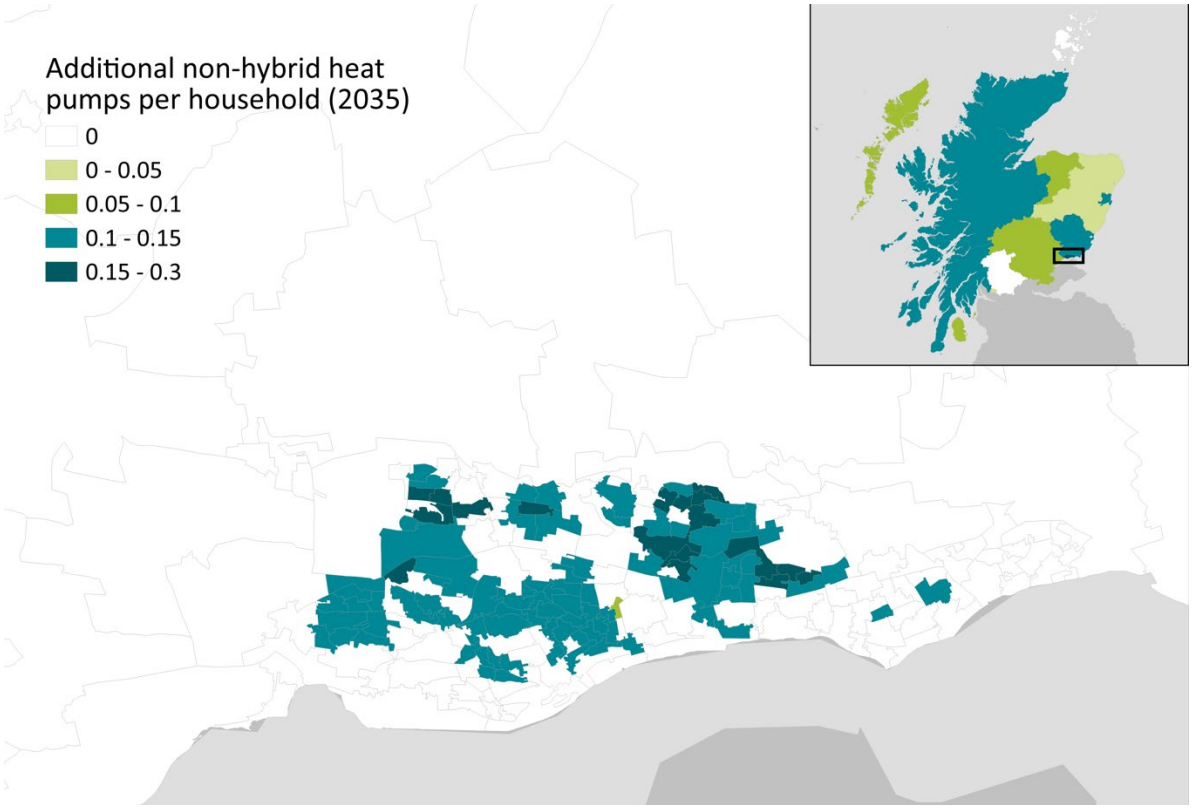

Figure 19. Percentage increase in heat pump uptake in LSOAs in the Dundee City local authority area.

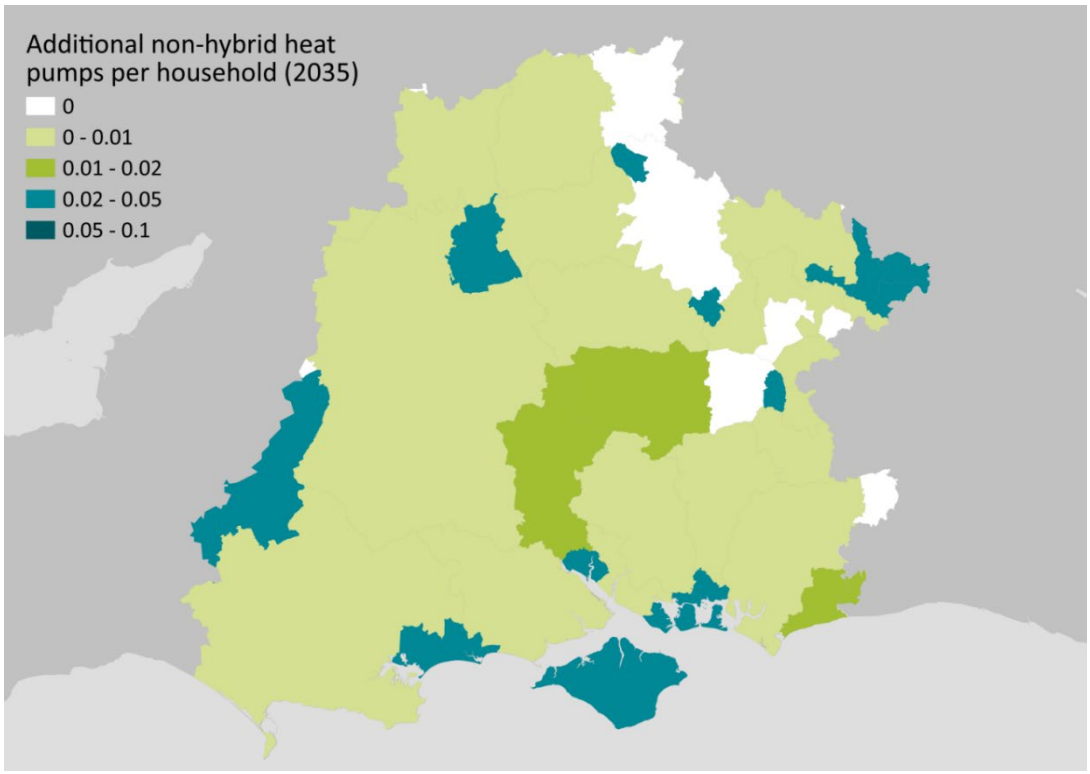

Figure 20. Percentage increase in heat pump uptake in SEPD local authorities.

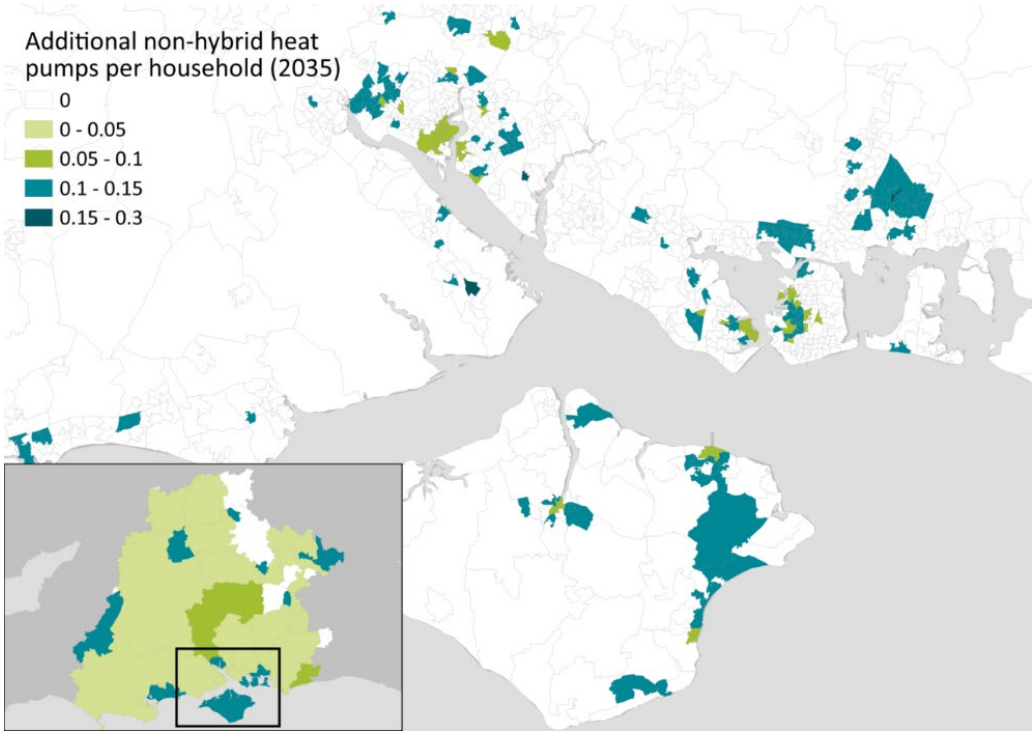

Figure 21. Percentage increase in heat pump uptake in LSOAs in the Isle of Wight local authority area.

Conclusions and recommendations

This study explored how just transition and vulnerability feature within the SSEN DFES today and where this could be better embedded within the current modelling processes.

Through policy and literature review, targeted stakeholder engagement and a review of the scenario modelling process, we have found that just transition plays a limited role within the current DFES. As a result, there is limited understanding of what different scenarios mean for different social and economic groups. By better accounting for this, networks can plan to ensure that participation in a net zero energy system is as open and equitable as possible.

Within the SSEN DFES today, projections of heat pump uptake by 2035 are relatively evenly distributed across income deciles as a proportion of those expected to transition to heat pumps by 2050, with a slight bias towards higher-income groups. To ensure lower-income groups are prioritised, this study has sought to accelerate heat pump uptake among lower-income households by 2035.

Doing so can lay the foundation for network investment planning that tackles potential inequalities before they emerge. However, stakeholders highlight that achieving a just transition will require not just network investment, but also specific support targeted at groups who will struggle to otherwise transition of their own accord. Such support is emerging but, per SSE's just transition principles, this may require greater advocacy for fairness within network planning as well as energy policy, decision-making and innovation.

Limitations

Whilst some key insights and results can be seen, there are some inherent limitations with this analysis. Evidence shows that different groups will engage and be impacted differently within the net zero transition. Lower-income and more vulnerable groups in particular will require additional support to make the switch to low-carbon technologies and be protected from any potentially increased costs in the switch from gas to electricity. However, there is no guarantee that this support will be forthcoming at scale.

This means that the policy basis for these assumptions is less certain than e.g. connections pipeline information or specific household or technology adoption targets within government policies and strategies. The uplift factor has also been applied without a rigorous quantitative process. More dedicated effort to quantify the impact of just transition policy support on actual changes in the uptake of low-carbon technologies could make this more robust.

Next steps for vulnerability and just transition in the SSEN DFES

Through this process, Regen has identified where just transition can be better built into the DFES going forward (Table 6). After a further review with the SSEN team, it is the intention for these developments to become a standard part of future SSEN DFES assessments.

DFES process	Going further on vulnerability and the just transition
Scenario framework	▪ Building socio-economic assumptions into scenario envelopes. ▪ Reviewing the latest vulnerability and just transition literature and reports to understand emerging trends. ▪ Making 'fairer' assumptions within more ambitious scenario envelopes, where justified.
Policy review	▪ Identifying vulnerability- and just transition-specific policies and better assessing the potential impact on modelled outputs.
Stakeholder engagement	▪ More dedicated outreach to fuel poverty, housing association, equalities and social justice charities to understand emerging issues and trends. ▪ Workshop on vulnerability and just transition in the annual engagement process, to establish where updated assumptions can be made across all low-carbon technologies.
Local authority input	▪ Standard question in local authority engagement about fuel poverty or low-income targeted initiatives, including funding and number of affected households, where information is known.
Modelling and analysis	▪ Acceleration factor applied to specific groups such as those on low incomes, where evidence supports this. ▪ Analysis of socio-economic distribution of all pathways, reported as a core component of future DFES outputs. ▪ Expand analysis beyond heat pumps to cover all low-carbon technologies and vulnerability types.

Table 6. Opportunities to better embed vulnerability and just transition in DFES processes.

Engagement and network planning

Engaging with stakeholders working in the just transition space was a key component of this study. The main aim of this engagement was to capture emerging trends in low-carbon technology and just transition/fuel poverty policy, as well as innovation and lived experience among citizens on the ground.

The engagement was seeking to understand how network planning can better account for these trends and experiences. These engagements are valuable in gleaning insights from those working with citizens and policymakers directly and can in turn lead to more accurate network investment planning. A just transition is also about inclusion and transparency in processes – widening this engagement to better bring such organisations into the fold can support this.

However, among such organisations, there is varied understanding of the network planning process and how this may impact the people they work with. Some organisations, such as national fuel poverty charities, already engage with network planning to varying degrees and so can more meaningfully contribute than those who do not. Other organisations are generally less familiar with the technical aspects of energy overall. As such, engaging at scale may require building on existing network relationships with fuel poverty, social justice and just transition stakeholders (including academia and policy) to provide preliminary and clear communication about:

- What network planning is and how it is used, building on local authority engagement conducted to inform SSEN's ED2 business plan.
- How it can impact a just transition and what scenarios mean for different groups.
- Where and how network planning can be influenced by non-expert organisations.

This could be supported by dedicated workshop engagement with vulnerability and just transition stakeholders, similar to those conducted with Scottish Island and local authority stakeholders within the existing SSEN DFES engagement process.

Future focus areas

In addition to the future DFES process, Regen aims to develop this work across two key areas.

Building vulnerability into DFES analysis

First, the aim is to broaden this analysis beyond income alone to capture different categories of vulnerability. Following on from SSEN's VFES project, and leveraging data outputs from it, Regen will conduct this analysis across different vulnerable groups.

This will allow SSEN to understand which people in vulnerable situations are affected by projections today – beyond low-income households – and where adjustments can be made to better reflect the needs of different groups in the network planning process.

Expanding the analysis to capture a broader range of low-carbon technologies

This study has focused on heat technologies as a pilot area to demonstrate the process and methodology. However, other low-carbon technologies also have key just transition implications. Who is predicted to transition to electric vehicles versus who is expected to use public transport, for instance, will vary across social and economic groups. Future iterations will thus expand to cover the full suite of low-carbon technologies, to similarly understand emerging issues and update assumptions where this is justified in evidence (see Figure 23).

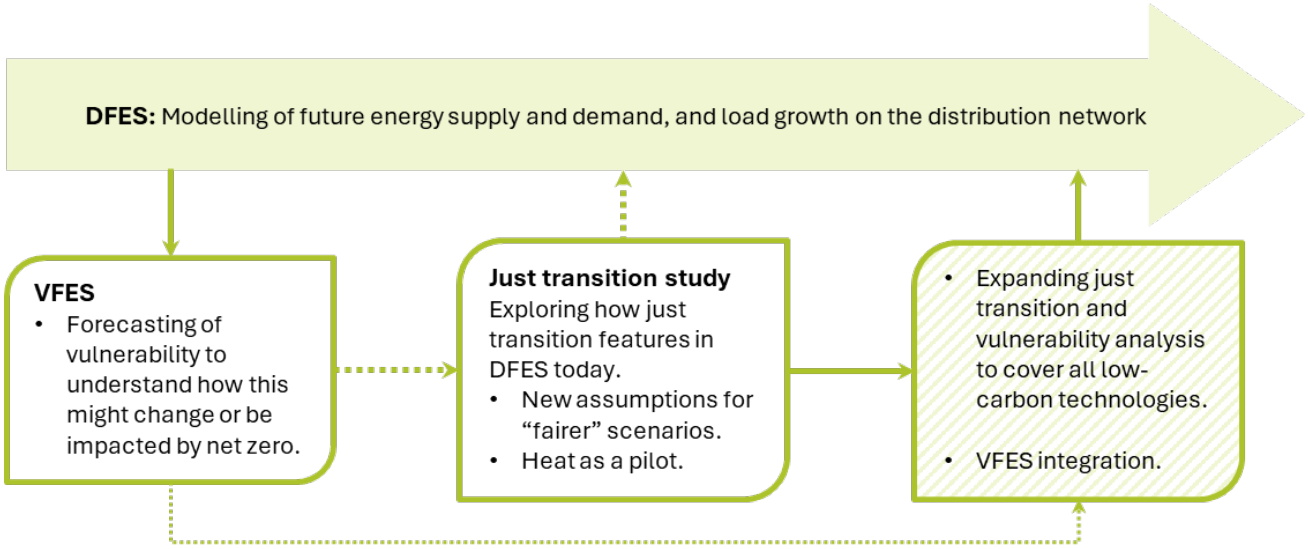

Figure 22. Future developments to further reflect vulnerability analysis in the DFES.

Recommendations for delivering a just transition in network planning across the sector

Beyond the SSEN DFES, making just transition analysis standard practice across the industry can help track progress versus projections and tackle potential emerging issues. From this research, the following recommendations are made for broader network planning analysis:

Recommendation 1: Make just transition and vulnerability analysis and reporting part of DFES processes as standard, including creating a 'fairer' scenario. With visibility of this information, networks can monitor emerging inequalities year-on-year. By creating a 'just transition' scenario, networks can strategically plan to deliver a fairer energy system. This could be an augmented version of an existing scenario pathway or a separate pathway.

Recommendation 2: Advocate to incorporate socio-economic analysis into ESO's FES and pathway reporting. ESO's national FES provides the building blocks and assumptions for DFES. At present, these assumptions do not explicitly distinguish between different groups of people or the support that may be required – nor do they report on social or economic factors. Alignment in national FES scenarios and pathways can help standardise this practice across networks and give better insight into national socio-economic trends.

Recommendation 3: Broaden stakeholder engagement to account for emerging trends and issues around vulnerability and the just transition. Within the network planning process, more in-depth engagement with fuel poverty charities and social justice-focused organisations can help provide stronger insights into how the transition is playing out and likely to play out in the future for low-income and vulnerable groups, as well as the reality of low-carbon technology adoption/use by fuel poor consumers. This may require tailored engagement and additional support in communicating the technical aspects of network planning, to ensure non-expert groups can engage on a meaningful basis.

Recommendation 4: Appraise next steps in the network planning process to understand current vulnerability and just transition considerations and highlight opportunities to go further. DFES is an early step in the network planning process. Exploring the steps after this (DNOA, for instance) and how they factor vulnerability and just transition issues today would help to ensure that these are accounted for at all levels.

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