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DFES 2023 stakeholder consultation webinar summary report

South Wales licence area

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Introduction

Scope of this report

This report summarises four regional stakeholder consultation webinars run by Regen and National Grid Electricity Distribution (NGED). These webinars were held in June 2023 as part of the 2023 edition of NGED's Distribution Future Energy Scenarios (DFES) analysis. This report includes the results of a series of polling questions that stakeholders were asked in each regional webinar, alongside the comments and questions received during the events. In each case, the impact of responses to the polls and broader stakeholder consultation on the DFES modelling process is detailed.

DFES project summary

DFES is a key aspect of NGED's strategic network investment planning. Having worked closely with NGED since 2015 to develop the DFES methodology and analysis, Regen is now delivering the 2023 DFES analysis for NGED's South West, South Wales, East Midlands and West Midlands licence areas.

The DFES analysis aims to model the uptake of technologies connecting to the distribution network under four credible future scenarios, based on National Grid Electricity System Operator's (ESO) Future Energy Scenarios framework. This includes renewable, low carbon and fossil fuel power generation, electricity storage, low carbon heating technologies, electric vehicles (EVs) and EV chargers, and hydrogen electrolysers, as well as planned new housing and non-domestic property developments.

Regional and local

Each region in Great Britain has distinct characteristics and resources. As part of the transition to net zero, each region will see unique deployment of electricity generation, storage and demand technologies. The DFES modelling we undertake adopts the scenario framework of the National Grid ESO's Future Energy Scenarios (FES) and is undertaken at a high granularity across over 2,000 geographic areas for most technologies and over 200,000 low voltage areas for domestic-scale Low Carbon Technologies (LCTs) such as rooftop solar PV, heat pumps, electric vehicles and home batteries. This analysis is informed throughout by detailed local and regional factors and stakeholder feedback, allowing NGED to plan strategically and invest appropriately in the electricity distribution network at a local level.

Stakeholder engagement

Engagement and consultation with local stakeholders are vital to the DFES methodology, ensuring that local and regional factors are accurately reflected in our scenario analysis. This includes local and national government, project developers, technology installers, commercial and industrial consumers, academia, trade bodies and community energy groups. For 2023, Regen engaged stakeholders through a series of online workshops — summarised in this report — and through targeted engagement with individual project developers, asset owners and other relevant industry representatives. Regen also engages with every local authority within NGED's licence areas to understand local energy strategies, climate ambitions, and planned new housing and non-domestic developments.

To find out more information about the webinars or the DFES project, or if you have any questions, please contact:

nged.networkstrategy@nationalgrid.co.uk

Stakeholders

The sectors represented by the stakeholders that registered for the webinars are shown in Figure 1. Delegates from the energy industry (such as grid consultants, engineering contractors, and energy services providers), local government and project developers made up the majority of registrants in each webinar, with varying levels of representation from community utilities, academia and community energy groups.

The 'Other' attendees include independent consultants, landowners, legal and finance and non-energy industries such as minerals and aggregates. Stakeholders were invited to attend multiple webinars if they were interested in more than one region.

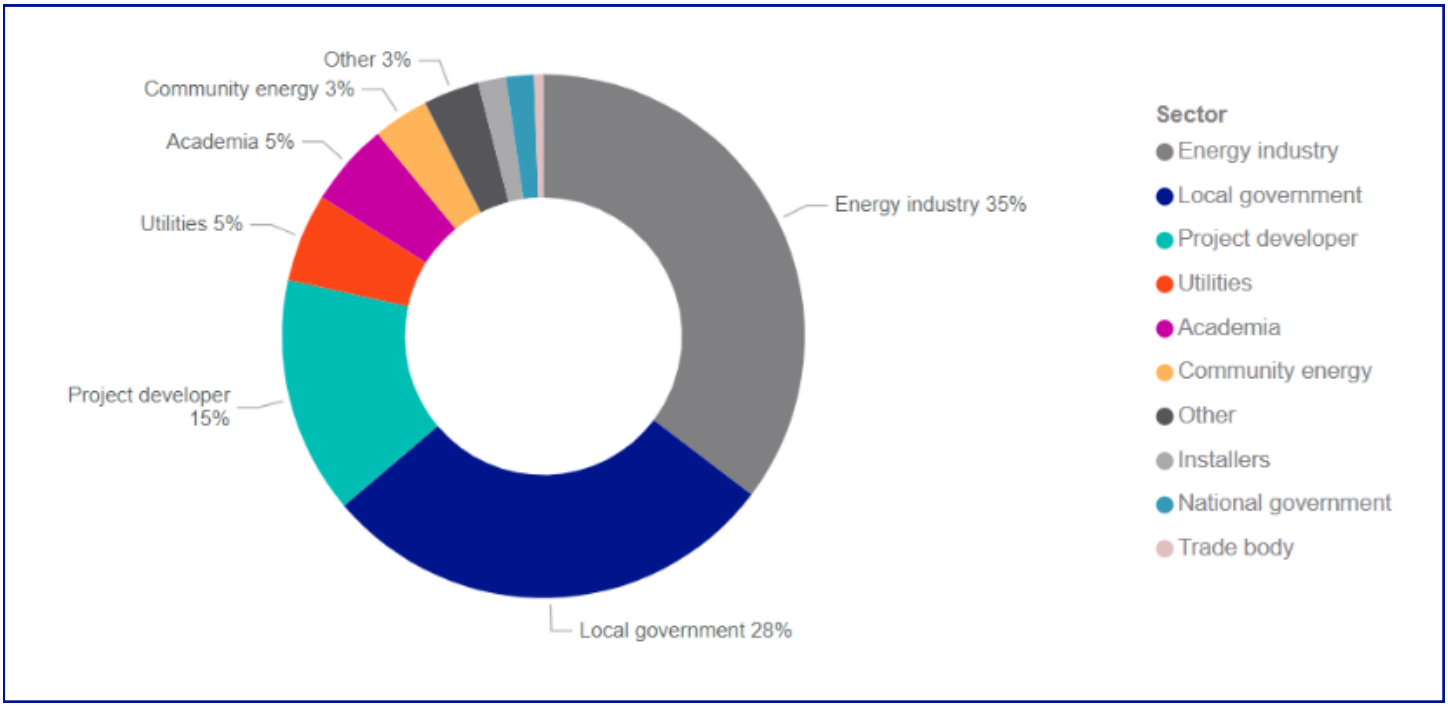

Figure 1 - Breakdown of total registrants across the four NGED DFES 2023 consultation webinars

South Wales licence area

DFES stakeholder consultation webinar summary report

Date: 28 June 2023
Attendees: 43, including panellists
Session: A link to the session recording is available here
NGED contact: nged.energyplanning@nationalgrid.co.uk
Regen contact: jhaynes@regen.co.uk

The current NGED DFES interactive map application is available here

The engagement webinar provided stakeholders in the South Wales licence area with an overview of the DFES process, as well as a summary of the current position and potential future outcomes for key distributed generation, storage and demand technologies in the area. Stakeholder participation was facilitated through a combination of polls, open-form questions and a Q&A session, allowing stakeholders to feed directly into the DFES analysis. This engagement was mainly focused on the near-term uptake of key renewable and flexible electricity generation, battery storage and new electricity demand in the form of EVs and heat pumps. Attendees were also asked about the broader characteristics of the South Wales licence area that could impact energy generation and demand in the future.

Hannah Lewis, Network Strategy Engineer at NGED, presented an overview of the DFES process and explained how the DFES continues to evolve through the inclusion of new technologies and highly granular low voltage analysis. Hannah summarised the current suite of published outputs from the analysis. She was joined by **Kathryn Thomas**, DSO Strategic Engagement Officer for South Wales, who outlined the role of Local Area Energy Plans and NGED's new Strategic Engagement Officer roles.

Jonty Haynes, Principal Analyst at Regen, provided some context for the licence area, illustrating the scale of the pipeline of potential new project connections and future capacity. Stakeholders were asked for their views on the key energy characteristics of the licence area, alongside their existing knowledge of DFES and level of engagement with NGED around DFES and wider topics.

Meagan Reasoner, Energy Analyst at Regen, presented a series of maps detailing the scale and location of existing renewable generation sites and the pipeline renewable of additional contracted projects in the licence area. Stakeholders were invited to provide views, via online polling, on:

- The rollout of large-scale solar and wind projects in the development pipeline
- The factors influencing domestic rooftop solar PV uptake.

Frank Hodgson, Senior Analyst at Regen, presented some context for flexibility technologies such as gas peaking plants and battery storage in the licence area, followed by an overview of the rollout of EVs and associated EV chargers. Stakeholders were invited to provide views on:

- The planning landscape for new fossil fuel electricity generation (diesel/natural gas)
- The potential conversion of fossil fuel generation sites to low carbon fuels
- The potential location of EV charging infrastructure for EV company cars and EV van fleets
- The future location of electric HGV chargers.

Jonty Haynes then presented the current uptake of domestic heat pumps in the licence area, alongside the latest policies and ambitions influencing the uptake of low carbon heating technologies. Stakeholders were asked to provide views on:

- The factors impacting the uptake of heat pumps in on-gas homes
- What factors might impact the location of future heat networks in South Wales.

Stakeholders were also invited to share any other general views on electricity generation, flexibility, low carbon transport and low carbon heat in the licence area, aiming to capture the broader sector knowledge from the attendees present at the event.

The webinar concluded with a Q+A session with members of the Regen and NGED teams. The poll results, stakeholder comments, questions posed and answers provided from all four licence areas are summarised in the stakeholder feedback section of this report, categorised by theme, including how this feedback will likely impact the DFES modelling going forward.

Initial feedback

At the beginning of the webinar, stakeholders were asked to rate:

- Their level of engagement with NGED
- Their awareness of the DFES process and its outputs
- Their understanding of the role of the DFES in strategic planning.

The results are summarised in Figure 2.

Stakeholders were also asked about the main characteristics of the licence area, see Table 1.

Compared to the 2022 webinars, the average level of engagement in the licence area has decreased from 3.1 out of 5.0 to 2.8 out of 5.0. However, in the same period, the awareness of DFES increased from 2.9 out of 5.0 to 3.0 out of 5.0.

Figure 2 - South Wales licence area responses around the DFES and engagement with NGED. Scored out of 5.

South Wales	
Stakeholder feedback	**Impact of DFES analysis**
South Wales hosts major industry, such as Port Talbot steelworks and many ports and docks. These areas could be hotspots for low carbon technologies.	The South Wales industrial cluster strongly features in many DFES technology analyses, particularly as a hotspot for hydrogen production and consumption, heavy transport, onsite solar PV generation, and battery storage.
Welsh government policy and influence are key in South Wales. Stakeholders also noted that domestic heat pumps are supported more by Welsh Government compared to the UK Government.	Where devolved policy differs from UK policy, this is directly reflected in the DFES scenarios in the licence area. For example, Welsh Government policies related to renewable energy zoning and low carbon heat strategies are directly reflected in the DFES uptake and locational modelling.
Rural areas such as mid-Wales have high potential for renewable energy generation if the grid capacity is available.	The DFES analysis aims to help NGED strategically plan the network to account for areas with high generation potential. Regen's resource assessments for solar PV and onshore wind capture areas with high potential, even if historic deployment has been limited.
South Wales has a high proportion of terraced homes, especially in the South Wales Valleys, which makes home EV charging difficult.	The DFES transport modelling aims to model on-street and off-street vehicles separately, so areas with a high proportion of on-street parked vehicles will be projected to have higher amounts of on-street chargers and other charging hubs.
South Wales has a range of geographies, from very urban to very remote.	The range of urban and rural geographies in the South Wales licence area is reflected in a wide range of factors used to distribute the capacity of technologies spatially across the licence area. Examples include EVs, heat pumps and rooftop PV in urban population centres, through to larger-scale renewable generation in more rural areas.

Table 1 – The key energy characteristics of the South Wales licence area as defined by stakeholders, and their impact on the DFES modelling

South Wales (continued)

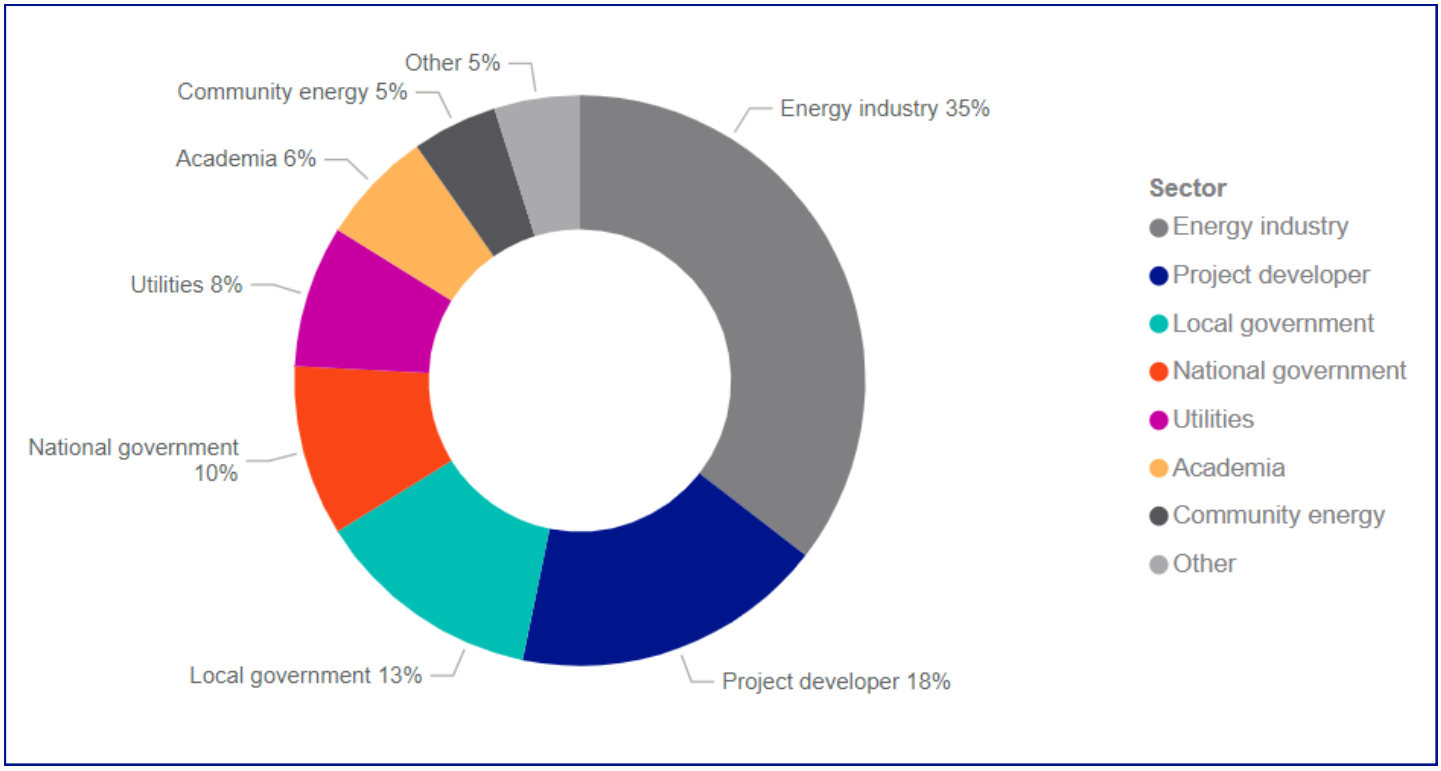

Figure 3 – Breakdown of registrants for the South Wales NGED DFES 2023 consultation webinar

Stakeholder feedback

Inputs into the DFES process

The following tables present feedback from the webinars for all four licence areas, categorised by theme. This feedback was gathered through the responses to the live polls, open-form questions posed by Regen, and comments and questions submitted by stakeholders during the webinars.

Ground-mounted solar PV

Stakeholder feedback	Impact of DFES analysis
The consensus from stakeholders was that around half of the solar pipeline would end up being built, but this would occur over a relatively long timeframe throughout the 2020s. Comparing this to the DFES 2022 webinars, this represents a slight reduction in anticipated build-out; stakeholders previously considered that most of the pipeline would end up commissioning at some point. Stakeholders in the West Midlands were more positive about the amount of the solar pipeline that would move to build-out and connection. This may reflect lower levels of historic deployment in the West Midlands, with stakeholders in the South West and South Wales previously highlighting network constraints in those regions.	The pipeline scenario modelling will directly reflect the envelope of views around the pipelines of solar assets from stakeholder polling. This will be combined with site-specific research on individual pipeline project progress and direct engagement with project developers. The resultant projections for each licence area will be tailored for each region based on the stakeholder polling results.
Stakeholders felt that when solar farms reached the end of their planned operational life, they would most likely be repowered with additional capacity using higher power yield panels or potentially extend the operational life of the existing panels.	Our projections directly include repowering of existing projects at the end of their planned operational life. The scenarios will be used to model these potential long-term capacity outcomes by repowering sites with additional capacity in the more ambitious scenarios and extending the operational life of existing assets in the less ambitious scenarios.
The planning environment in AONBs and National Parks is tricky for renewables.	Based on stakeholder feedback and historic deployment, we assume that large-scale onshore wind and solar PV will not be deployed in protected areas such as AONBs and National Parks unless they are already in the pipeline. This is reflected in the renewable energy spatial resource assessment that we undertake to inform the long-term projections for technologies like solar and wind, which discounts AONBs, National Parks and other protected areas.

Ground-mounted solar PV (continued)

Stakeholder feedback	Impact of DFES analysis
Several stakeholders highlighted that renewable schemes may have to be co-located with battery storage to avoid grid constraints and connection issues.	The battery storage projections include a proportion of solar and wind capacity that has co-located battery storage in the scenarios. The analysis will also consider whether co-located projects are more likely to progress in the next few years in response to constraints.
Stakeholders highlighted that major energy users could deploy solar PV or other renewables to reduce electricity imports and costs.	Our solar PV modelling is split into three categories, one of which is commercial-scale solar PV (10 kW to 1 MW). This category is targeted to reflect commercial rooftop PV and small-scale ground-mounted solar PV connecting to businesses and industrial sites. The spatial distribution of this 'commercial solar' capacity will include industrial sites and high-demand centres as key locational factors.

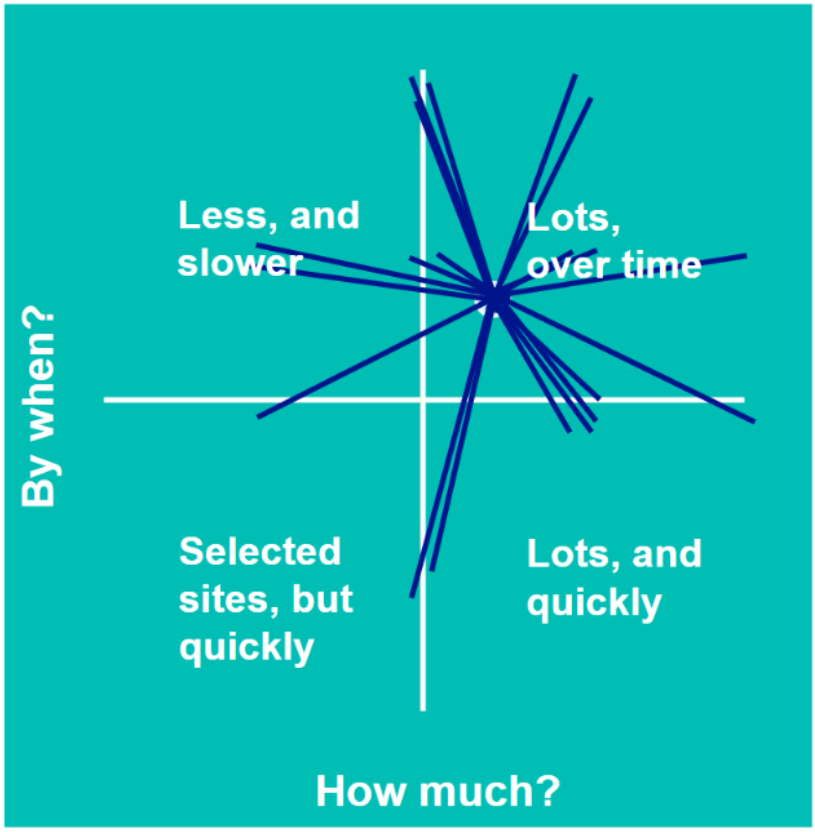

Figure 4 – West Midlands licence area webinar responses regarding the pipeline of large-scale solar PV

Rooftop solar PV

Stakeholder feedback	Impact of DFES analysis
Stakeholders across multiple licence areas agreed that household income and high electricity bills would be the main factors driving domestic rooftop solar PV uptake in the next near-term. Owner-occupied and socially rented homes, and households with EVs, were seen as less impactful.	We will continue to directly use building type, household income indicators and EV ownership as key factors to model the spatial distribution of domestic rooftop solar PV in the near term under all scenarios.
Stakeholders felt domestic rooftop solar PV installations would accelerate as installations become cheaper.	Rooftop solar uptake at both a domestic and commercial scale is currently increasing. This trend will be modelled to continue in all scenarios, and an accelerated uptake will be modelled specifically under Consumer Transformation and Leading the Way, as these scenarios have the most ambitious consumer-driven decarbonisation pathways.
Stakeholders thought that non-domestic installations would equally be focussed on properties with large areas of suitable roof space, such as warehouses, and properties with high energy consumption, such as supermarkets and larger schools/universities. However, stakeholders did note that almost any non-domestic building could have roof-mounted or wall-mounted solar panels.	The location of these types of properties will be directly reflected in the commercial-scale rooftop solar spatial modelling. Whilst we may include a weighting towards these property types, we will ensure that all suitable non-domestic property types are broadly included in the modelling.
In the open-form section of the online polling, stakeholders highlighted warehouse roofs, factory roofs and car park canopies as strong potential areas for new rooftop solar PV.	We will ensure that these non-domestic property types are directly included in our commercial solar spatial distribution.
Stakeholders highlighted that there could be a move to ‘smart homes’ with solar PV, battery storage, heat pumps and EVs being taken up in homes.	This shift to domestic low carbon technologies is reflected most under the Consumer Transformation and Leading the Way scenarios, which feature a high level of change in how households and people interact with energy.

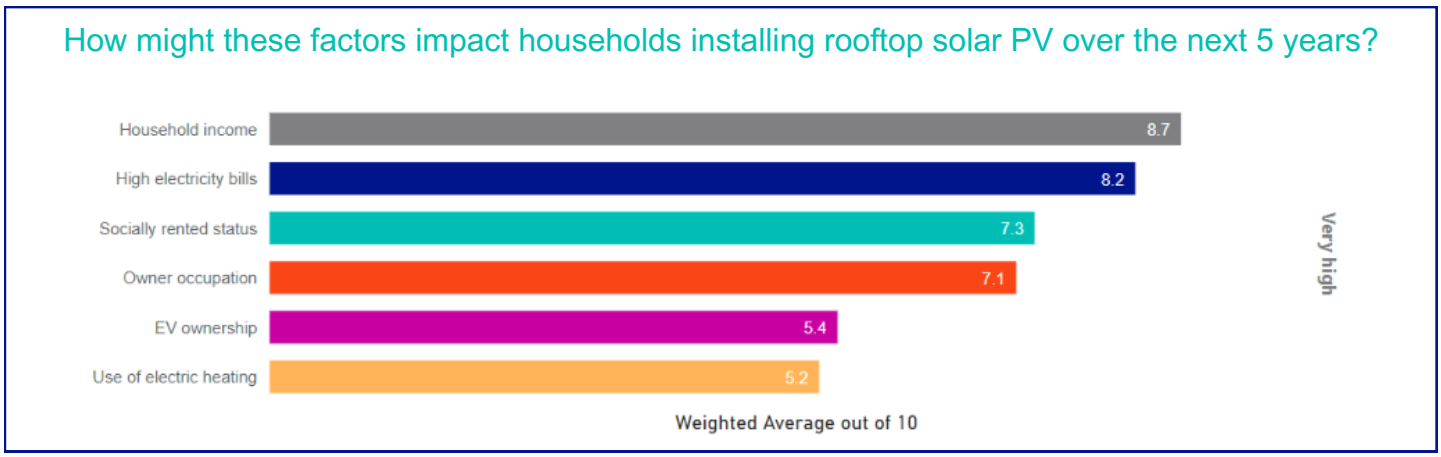

Figure 5 – South Wales licence area webinar responses regarding near-term factors for rooftop solar PV

Onshore wind

Stakeholder feedback	Impact of DFES analysis
Stakeholders in South Wales felt that the onshore wind pipeline could be built out on a similar timescale to the ground-mounted solar PV pipeline, completing in the late 2020s and early 2030s. Stakeholders also felt that around half of the current pipeline of projects would connect, though there was a broad range of answers.	The envelope of onshore wind pipeline deployment shown from the results of stakeholder polling will be reflected in the pipeline scenario modelling. This will be combined with individual pipeline project progress research and direct engagement with project developers.
Stakeholders felt that when wind farms reached the end of their planned operational life, they would most likely be repowered with additional capacity using higher power turbines, or site operators would extend the operational life of the existing turbines.	Our projections directly include the repowering of existing projects at the end of their planned operational life. The scenarios will be used to model these potential long-term capacity outcomes by repowering sites with additional capacity in the more ambitious scenarios and extending the operational life of existing assets in the less ambitious scenarios.
Stakeholders in the East Midlands strongly felt there would be local support for onshore wind if planning policy in England changed, with none of the 43 respondents saying there was insufficient local support. Stakeholders felt that this could equally be driven by community energy groups or support in areas that already have wind farms.	This feedback is already captured within the assumptions and analysis behind our onshore wind scenario modelling. Regen's resource assessment for onshore wind aims to capture areas with high potential where wind projects do not exist. It could be driven forward by community energy groups and in areas that have already seen onshore wind deployment.
Stakeholders noted that the planning system hampers onshore wind in England compared to solar PV.	The scenarios reflect a range of possible outcomes for onshore wind, including ones where existing planning constraints in England are removed. Our onshore wind resource assessment also includes protected and designated areas to understand which parts of the licence area are less likely to host onshore wind, regardless of a positive spatial planning policy environment.

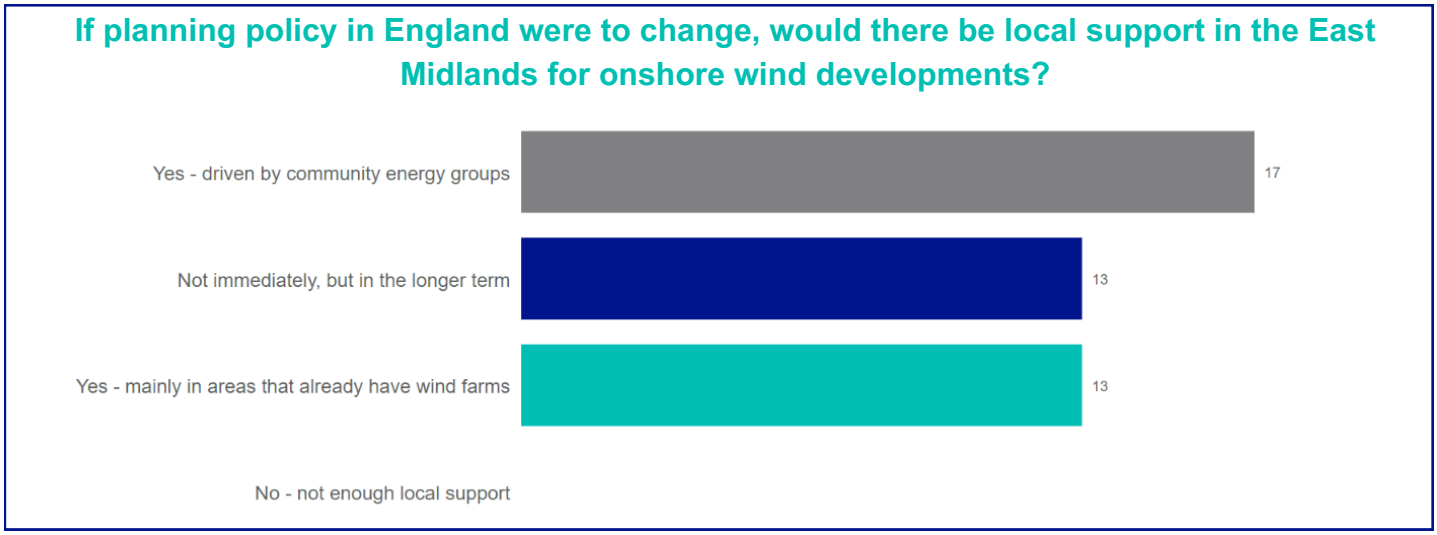

Figure 6 – East Midlands licence area webinar responses regarding local support for onshore wind development

Fossil-fuelled generation

Stakeholder feedback	Impact of DFES analysis
Stakeholders across multiple licence areas felt that existing fossil fuel electricity generation was most likely to decommission or convert to electricity storage in the long term, and less likely to convert to hydrogen/bioenergy or continue to operate with strict emissions controls.	We will model a range of scenarios for the decommissioning of existing fossil fuel generation, with sites converting to battery storage under some scenarios. Conversions to hydrogen-fuelled generation will depend on national-scale scenario assumptions on the future energy system.
All stakeholders across multiple webinars felt that new fossil fuel electricity generation would either struggle to attain planning permission, or at least take longer to achieve planning permission. Stakeholders were evenly split on these two potential outcomes. This question was broken down by stakeholder sectors in the South Wales webinar. Notably, most stakeholders working in local authorities felt that fossil fuel generation sites would struggle to attain planning permission. This is a significant change in sentiment compared to the 2022 DFES webinars, where a sizeable majority of stakeholders felt that fossil fuel generation would have no issues securing planning approval.	Where fossil fuel electricity generation sites in the pipeline haven't yet attained planning permission, these sites will be modelled to only go forward to connect in Falling Short (and possibly to some extent in System Transformation), depending on other evidence of progress identified through research of each individual project.

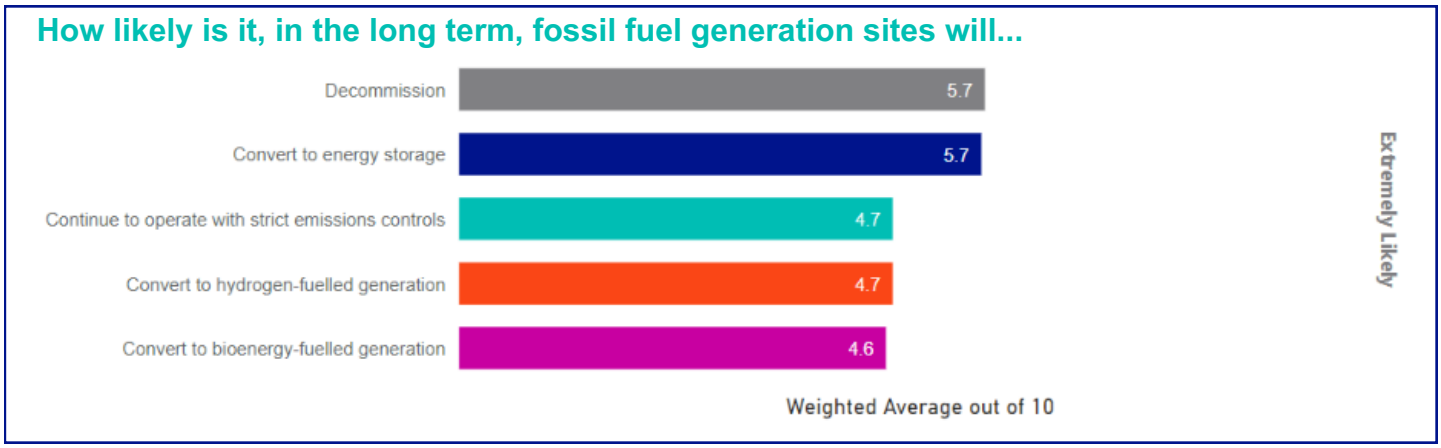

Figure 7 – East Midlands licence area webinar responses regarding the fate of fossil fuel electricity generation

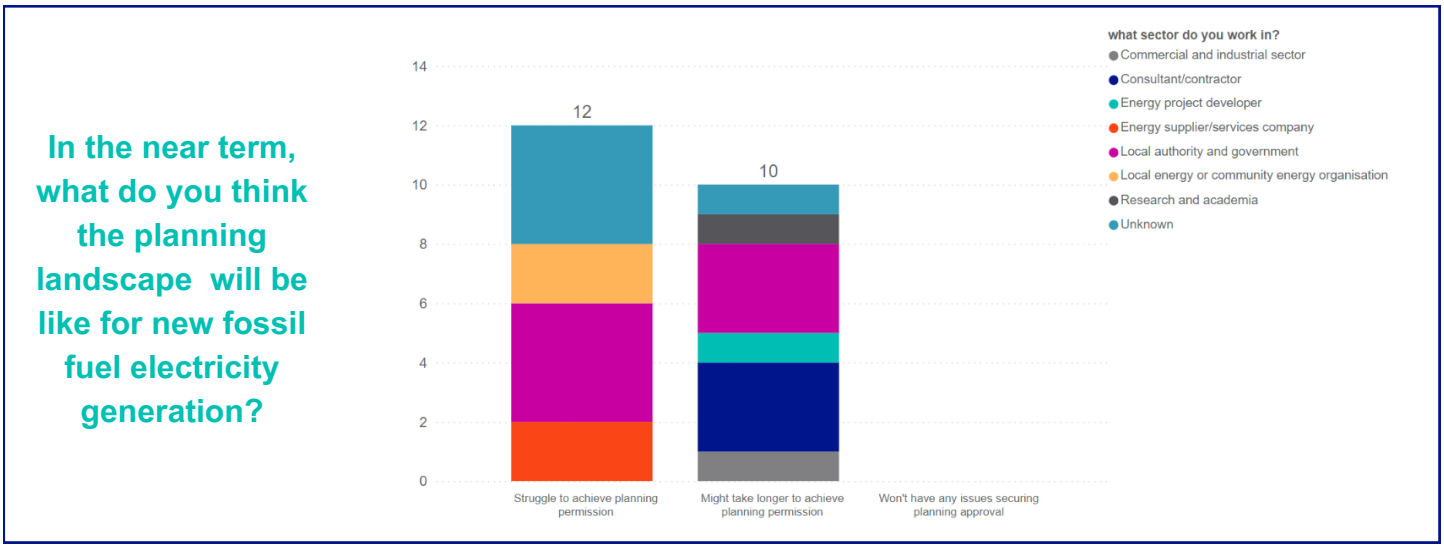

Figure 8 – South Wales licence area webinar responses regarding the planning landscape for new fossil fuel electricity generation, categorised by the sector each stakeholder works in

Electricity storage

Stakeholder feedback	Impact of DFES analysis
As described in the previous section, stakeholders across multiple licence areas felt that existing fossil fuel electricity generation was most likely to decommission or convert to electricity storage in the long term.	We will model a range of scenarios for the decommissioning of existing fossil fuel generation, with many sites converting to battery storage. Conversions to hydrogen generation will depend on national-scale scenario assumptions on the future energy system.
Stakeholders fed back that storage co-located with solar PV will be an increasingly popular business model as a route to achieving better prices for the sale of solar generation and to share grid connection costs.	Analysis and scenario modelling for the contracted pipeline of solar and battery co-located projects will reflect the popularity of co-located storage in the near and medium term.
Stakeholders said that major energy users would most likely install battery storage to participate in flexibility services such as demand-side response and avoiding high electricity prices. Maximising onsite power generation was also seen as a significant driver. Notably, using battery storage to decarbonise backup power was the least popular response to this question.	We will consider these drivers in the spatial distribution of high energy user battery storage capacity projections in all scenarios.
Stakeholders said that the uptake of domestic batteries would be most strongly guided by the presence of rooftop PV at the property and the cost of a domestic battery storage system. Being part of a wider 'green tech' ecosystem, such as having an EV or a heat pump, was also seen as an impactful factor in installing a home battery. The ease of installation and rurality of households were not seen as such influential factors.	We directly link the uptake of domestic battery storage systems with the uptake of domestic rooftop solar PV in our modelling. The cost of the battery system will be considered in the overall level of uptake of domestic batteries under each scenario.
Several stakeholders highlighted that domestic battery storage may become the norm when installing solar PV.	This will be directly reflected in the scenarios through increased uptake of domestic battery storage as solar PV uptake increases under some scenarios. The uptake of domestic batteries will also be geographically linked to the uptake of domestic solar PV in the spatial modelling.
Stakeholders pointed out that non-battery electricity storage such as high-density pumped storage, compressed air and flywheels should be considered.	We aim to model these technologies under an 'Other storage' category in the DFES based on analysing the pipeline of accepted connections to the NGED distribution network.
Stakeholders noted that hydrogen electrolysis could be used as long-term energy storage and to 'soak up' excess renewable generation.	Hydrogen electrolysis is one of the technologies modelled in the DFES. The scenarios present a range of use cases for low carbon hydrogen, including energy storage and excess generation.

Electricity storage (continued)

Stakeholder feedback	Impact of DFES analysis
In the open-form section of the polling, several stakeholders across all four webinars referenced the high potential for Vehicle-to-Grid (V2G) and Vehicle-to-Home (V2H) and whether this might reduce demand for standalone battery storage.	We will consider whether the presence of V2G and V2H technology might dampen the demand for standalone battery storage in certain areas. It is likely that an increased presence of "V2X" technology is already considered in the envelope of the DFES scenarios for standalone batteries.
Stakeholders suggested that storage could help mitigate grid constraints for major energy users.	The battery storage modelling features a 'high energy user' business model, which considers the uptake of batteries behind the meter at high energy user premises. In addition to avoiding constraints or connection costs, another driver considered is the potential to reduce electricity costs through avoiding grid imports during high-cost periods of the day or maximising the self-consumption of onsite generation.

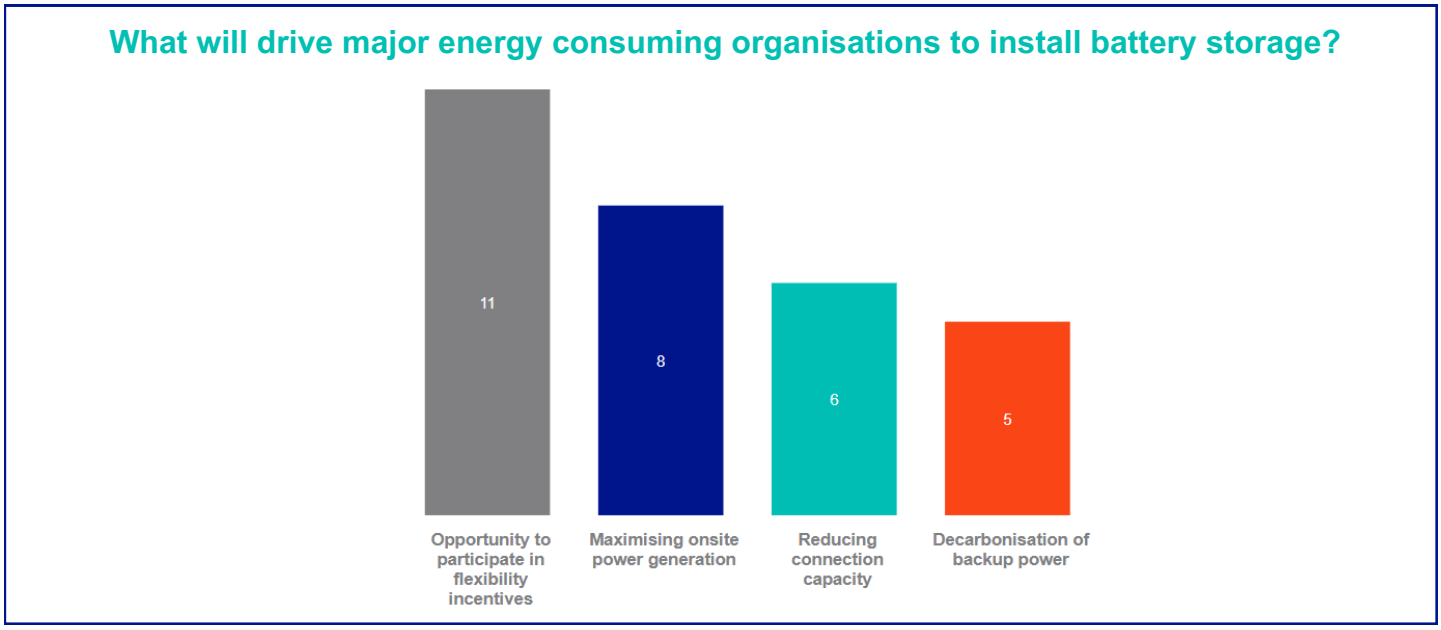

Figure 9 – West Midlands licence area webinar responses regarding major energy user battery storage installation

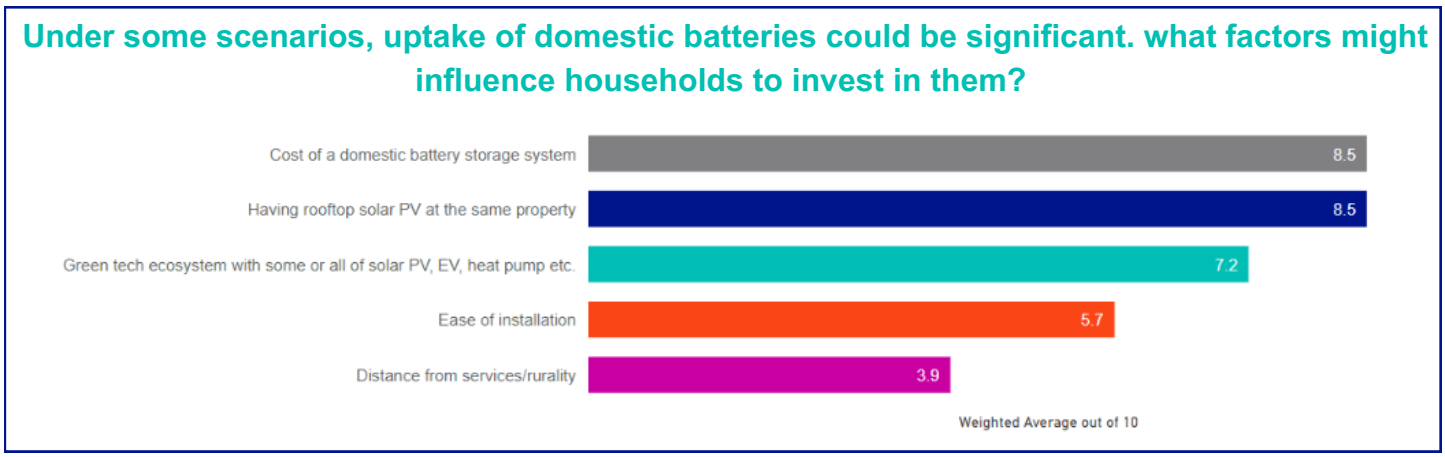

Figure 10 – West Midlands licence area webinar responses regarding major energy user battery storage installation

Electric vehicles and EV chargers

Stakeholder feedback	Impact of DFES analysis
Stakeholders thought business car and van fleets would most commonly be charged at company depots, followed by employees' homes via domestic chargepoints. En-route rapid charging was seen as likely, but not making up a majority of charging use cases.	We will use these inputs to guide the proportions of the types of charging capacity modelled for company-owned vehicles in our EV charging scenario projections.
While there was a wide range of responses, stakeholders generally felt that en-route charging for EVs would occur across many charging stations rather than a small number of large-scale charging hubs. Stakeholders also felt that most EV owners would charge at or close to home rather than consistently charging en route.	We will use these inputs to guide the proportions of charging modelled for private vehicles in our EV charging model.
Stakeholders were split on whether on-street chargers outside of homes, rapid en-route charging hubs or opportunistic charging at car parks and workplaces would be the most popular solution for EV owners without off-street parking. However, stakeholders did not feel local neighbourhood charging hubs would be a popular solution.	In our EV charging model, we will use these inputs to guide the proportions of charging modelled for on-street parked vehicles.
Stakeholders strongly felt that most future electric HGV charging would occur overnight at depots, with the remainder equally split across overnight charging at service stations and rapid charging at depots or service stations.	This feedback will guide the modelling of HGV charging projections. This was previously included under en-route EV chargers and chargers at depots and has since been broken out into a specific new technology projection for DFES 2023.
When asked about future private vehicle ownership, stakeholders strongly felt that vehicle ownership would be lower in major cities due to low emissions zones and congestion charging. Stakeholders also thought increased public transport and car-sharing levels could reduce vehicle ownership in other urban areas.	In our EV modelling, we will use these inputs to guide the uptake of EVs specifically in urban areas.
In the open-form section of the online polling, several stakeholders referenced the high potential for V2G and V2H in all four webinars.	V2X is being included within the scope of DFES for the first time this year, albeit at a high level looking at the proportion of V2X-enabled chargers. As the use cases and potential uptake of V2G become clearer in the coming years, this will likely expand into a full technology analysis.
Stakeholders highlighted that EV hire schemes, car clubs and future automation of vehicles could result in lower overall vehicle ownership.	This is directly reflected in the Consumer Transformation and Leading the Way scenarios, which see lower levels of private vehicle ownership in the latter years of the projections.

Electric vehicles and EV chargers

Stakeholder feedback	Impact of DFES analysis
There were a range of views around the speed of electrification of HGVs. In the open-form section of the polling, this included views: • That the HGV switch to electric will happen ahead of the UK target for net zero emission HGVs by 2040 • That the 2040 target will not be met, and some HGV usage could move to rail freight • That HGVs will be mostly electric due to the pace of improvements in battery technology • That battery HGVs are not currently practical • That HGVs would be more likely to use biofuels or synthetic fuels rather than hydrogen or electrification • That there is a high level of uncertainty around the future decarbonisation of HGVs.	As shown by the range of views, the decarbonisation of HGVs is far less clear than that of cars and LGVs. As a result, the envelope of potential future scenarios for the uptake of electric HGVs in the DFES analysis will have a wide range, from near-full electrification to a mixed blend of hydrogen, biofuels, synthetic fuels and electrification.
Stakeholders felt that non-domestic EV charging, including on-street charging, would see high demand in the future, especially for business vehicles and dwellings without access to off-street parking. It was noted that local authorities could rapidly scale this via the government's Local Electric Vehicle Infrastructure (LEVI) fund.	Our DFES EV charger modelling aims to reflect the wide range of domestic and non-domestic EV charger types required to match EV uptake under each scenario. This is based on the EV uptake in each local area; as a result, areas with high levels of business vehicles or on-street parked vehicles will be modelled to have a higher uptake of non-domestic charge points.

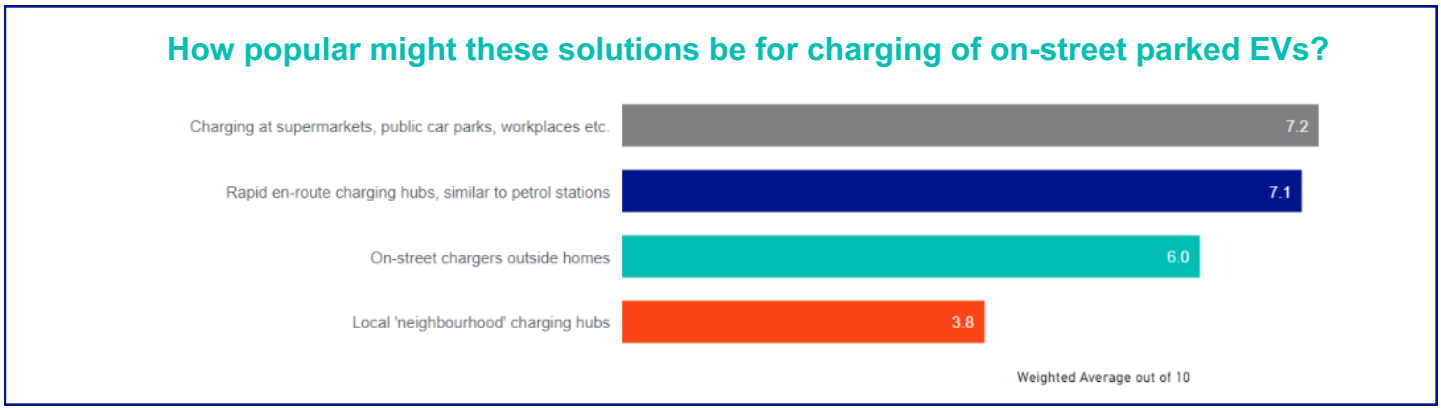

Figure 11 – West Midlands licence area webinar responses regarding the solutions for on-street parked electric vehicles

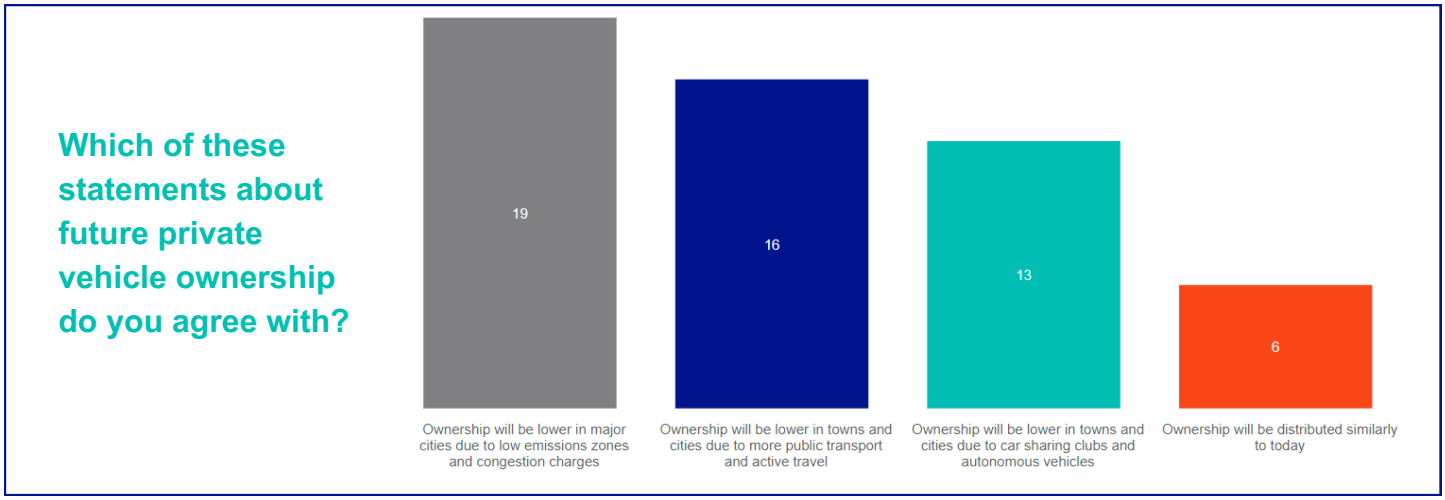

Figure 12 – East Midlands licence area webinar responses regarding future private vehicle ownership

Low carbon heat

Stakeholder feedback	Impact of DFES analysis
Stakeholders felt that off-gas, fossil fuel heated housing and new build housing would most likely see heat pump uptake in the near term. Socially rented houses were identified by stakeholders as a potential type of property that could see moderate near-term heat pump uptake. On-gas houses were seen as unlikely to be targeted for heat pump installations in the near term. Stakeholders in South Wales were asked specifically about what would drive on-gas houses to switch to a heat pump. The most popular answer was that most switches would result from gas boiler bans and emissions limits.	We will directly use these results in the spatial distribution of our heat pump projections, focusing on off-gas fossil fuel heated properties and new builds in the near term and on-gas homes in the longer term. The net zero scenarios will also reflect the potential ban on gas boiler installations from 2035.
When asked about the factors impacting the current uptake of heat pumps, stakeholders said that upfront costs, lack of consumer confidence, perceived building unsuitability and a disconnect between the property owner and property occupier were all major factors. Conversely, uncertainty over the potential role of hydrogen for heating in the future was not seen as impactful.	We will consider these results in the spatial distribution of heat pumps, especially where uptake is directly related to capital or property tenure availability. System Transformation will also remain a scenario that reflects a higher uptake of hydrogen-fuelled domestic heating, resulting in a lower uptake of heat pumps and resistive electric heating.
Stakeholders in the East Midlands thought air conditioning (AC) would become increasingly popular in the UK but likely won't be the main heating source in most homes. Stakeholders also felt AC could be especially popular in homes with rooftop solar PV.	We will continue to model AC as primarily a cooling technology. We will consider whether the distribution of AC should be more strongly weighted towards homes with solar PV.
Stakeholders in the West Midlands were asked what low carbon heating technologies might be most popular in urban terraces and flats. While there was no consensus on one technology, stakeholders saw the most potential for ground-source heat pumps connected to a shared ground loop. Hydrogen boilers were the least popular technology.	We will consider these results in the spatial distribution of heat pumps, weighting urban areas towards shared ambient loop ground-source heat pumps alongside other solutions like air source heat pumps, smart electric heating and district heat networks.
Stakeholders felt that non-domestic heat pump uptake would be slightly faster than domestic heat pump uptake, especially in public buildings.	We will consider how to reflect an accelerated uptake, likely under one scenario, in modelling non-domestic heat pumps.
Stakeholders in South Wales thought that the location of future heat networks would be primarily driven by ease of installation, such as in new build developments. Stakeholders also felt that location would also be strongly driven by local government planning and the presence of anchor loads such as public buildings.	These factors will be directly used in modelling large-scale heat pumps for district heating, alongside the homes and businesses modelled to connect to a district heat network.

Low carbon heat (continued)

Stakeholder feedback	Impact of DFES analysis
Stakeholders noted that heat pumps for non-domestic buildings could also be a major source of demand.	Non-domestic heat pumps are included as a specific projection in the technology scope of the DFES 2023 modelling.
Several stakeholders said that energy efficiency measures were key to heat pump uptake.	The scenarios that include a high level of heat pump uptake also assume accelerated rollout of energy efficiency measures. However, due to recent studies on the suitability of homes for heat pumps, such as from Energy Systems Catapult, the modelling does not assume that a home has to be highly insulated before a heat pump is installed.
The role of geothermal heat in the South West (via geothermal wells) and South Wales (via coal mine heat) for heat networks was highlighted as an underrepresented opportunity area.	We will consider these heat sources directly in our heat network resource assessment and associated modelling.
Stakeholders asked whether rural, off-gas properties might be more suited to hydrogen or biogas due to being harder to retrofit.	We assume that a higher proportion of rural properties will use non-electric low carbon heating fuels such as biomass and bio-LPG. We assume that currently off-gas areas will be unlikely to have access to hydrogen for domestic heating in any scenario.
Several stakeholders flagged that hydrogen for heating was unlikely and that the focus should be on heat pumps and energy efficiency.	This is reflected in the scenarios, with only System Transformation seeing a high proportion of homes heated by hydrogen. This will be reviewed each year to consider whether this remains a credible outcome.
One stakeholder noted that rural areas may not have the LV network capacity to enable heat pump uptake.	The DFES modelling aims to be network-agnostic to allow the results to be used to identify areas of the network that may require investment. In addition to this, Regen will be modelling the spatial distribution of domestic heating projections (and other key low carbon technologies) down to low voltage levels for the first time in DFES 2023. This will be fed through the secondary system planning process to identify areas requiring investment.
The topic of low carbon heat brought up several comments around fuel poverty, vulnerability and fairness, with some stakeholders highlighting that heat pump uptake will be low if it is not addressing these issues. However, one stakeholder noted that heat pumps are cheaper than gas boilers in some instances.	This is an extremely important topic. The scenarios with high levels of heat pump uptake also feature high levels of retrofit. Heat pumps are likely to be the most affordable form of domestic heating in these scenarios.

Low carbon heat (continued)

Stakeholder feedback	Impact of DFES analysis
Stakeholders said that the uptake of heat pumps could often be packaged with rooftop PV and domestic battery storage.	We will consider whether the uptake of these technologies should be linked. Currently, the uptake of these technologies share several attributes, such as the building type and tenure.
One stakeholder noted that landlords of socially and privately rented buildings may replace gas boilers with electric resistive heating or infrared heating panels. Stakeholders also highlighted that direct electric heating could increase in hard-to-heat buildings or buildings with limited space.	Resistive electric heating is modelled as a specific heating technology in the DFES. This is modelled to decrease in every scenario as heat pumps and district heat networks become more widespread. However, we will continue engaging on this subject to ensure this assumption remains valid.
One stakeholder noted that new houses should be designed to significantly limit the demand for heating and cooling.	We model new homes based on the Future Homes Standard and Welsh Building Regulations Part L in all net zero scenarios. While this is not Passive House standard, it assumes cooling to be provided through passive methods and high insulation levels to reduce heat and cooling demand.
Heat networks could be especially popular in new developments, fed by heat pumps or waste heat. These could use thermal storage to reduce peak demand on the electricity network.	In the net zero scenarios, we assume that a high proportion of heat network uptake occurs in new homes driven by large-scale heat pumps. Previous engagement suggests that waste heat will be utilised where possible, but not as the primary heat source or without a backup heat source.
One stakeholder felt that hydrogen for heating would be less of a change for the consumer than heat pumps.	This outcome is reflected under the System Transformation scenario, which features lower levels of societal change and higher uptake of hydrogen boilers in homes.
The role of hybrid heat pumps, either with mains gas or hydrogen alongside electricity, was highlighted as potentially having a role.	The System Transformation and Leading the Way scenarios have substantial hybrid heat pump uptake in the DFES.
Thermal storage was highlighted as a key facilitator in the uptake of heat pumps, as well as reducing the impact on the electricity network and potentially providing demand flexibility.	Our heat modelling includes heat pumps with and without thermal storage, with thermal storage uptake increasing over time under all scenarios.

Low carbon heat (continued)

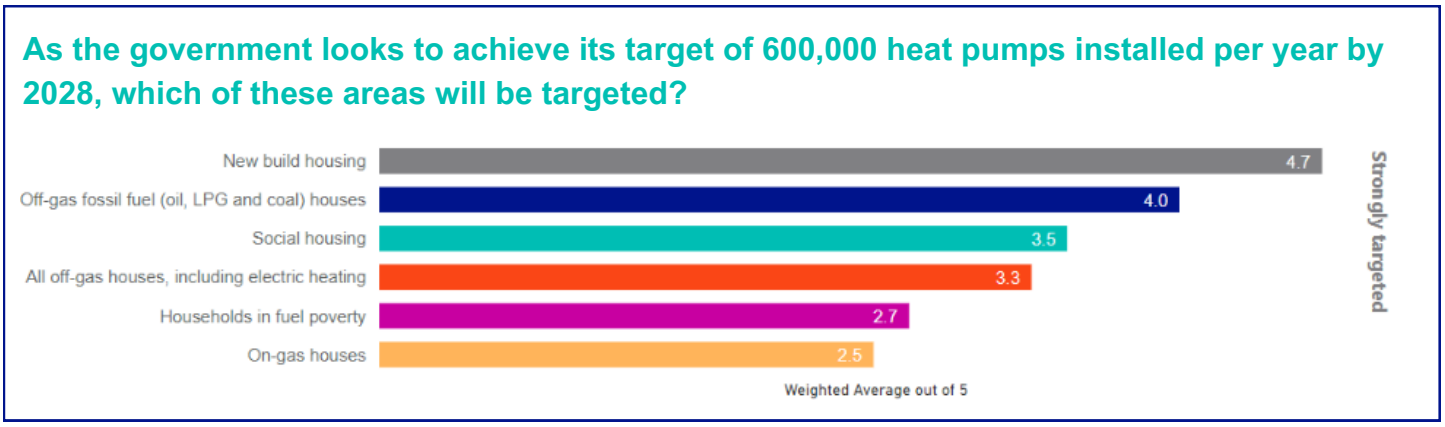

Figure 13 – South West licence area webinar responses regarding the types of homes likely to be targeted for heat pump deployment in the near term

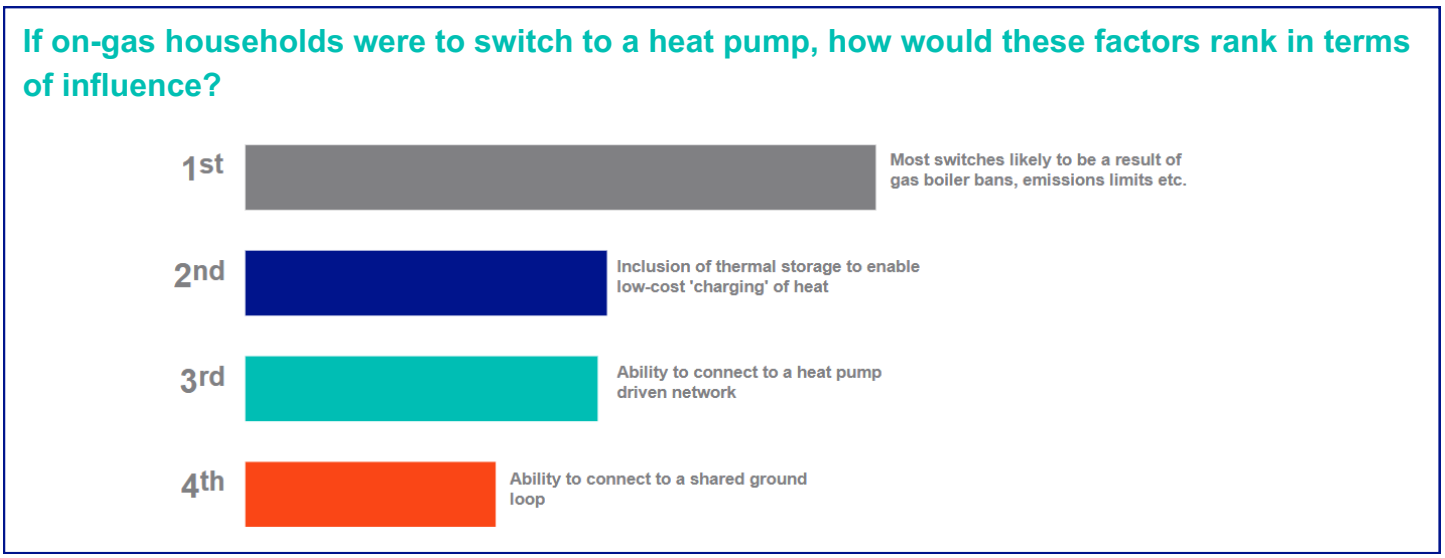

Figure 14 – South Wales licence area webinar responses regarding the factors influencing on-gas households to switch to a heat pump in the future

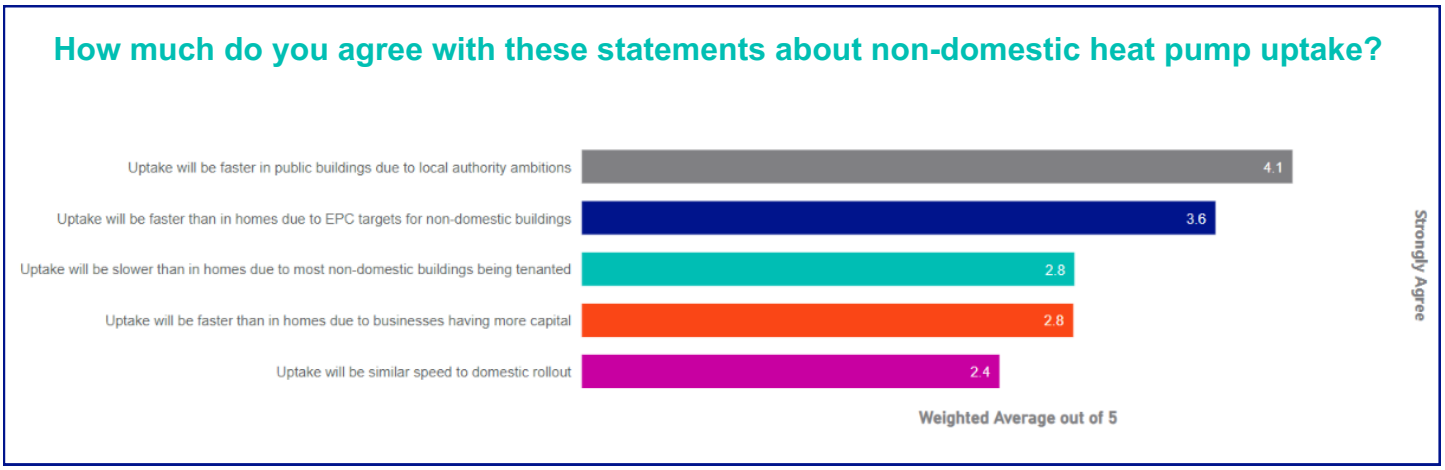

Figure 15 – East Midlands licence area webinar responses regarding the speed of non-domestic heat pump uptake

Energy system

Stakeholder feedback	Impact of DFES analysis
Stakeholders highlighted the potential of micro-grids for local renewable generation, storage and flexibility.	While this isn't directly modelled in the technology scope of the DFES, it could be a wider network solution for NGED to consider in the future.
Stakeholders noted that hydrogen electrolysis could be used as long-term energy storage and to 'soak up' excess renewable generation.	Hydrogen electrolysis is a specific demand technology that is modelled in the DFES. The scenarios assess a range of use cases for low carbon hydrogen, including for energy storage and making use of excess renewable generation. These factors, and others, are used to inform the potential for electrolyser deployment in each licence area.
Some stakeholders felt that areas without industrial uses for hydrogen would not see hydrogen playing a role in heating or transport.	While the scenarios consider multiple potential roles for hydrogen, we will focus our hydrogen availability areas in each scenario towards regions with potential for industrial-scale hydrogen use.
Stakeholders flagged that hydrogen-fuelled vehicles might be popular for logistics hubs. However, they also said that this may be limited to HGVs.	While the scenarios consider multiple roles for hydrogen for transport, this is mainly as a fuel for HGVs. This year's DFES analysis breaks out e-HGV chargers as a specific subtechnology, enabling us to further understand those scenarios where the uptake of e-HGVs will be lower.

Thank you

We would like to thank everyone who attended our webinar sessions and shared their views with us. If you have any questions about this report please contact us at nged.networkstrategy@nationalgrid.co.uk.

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