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WESTERN POWER DISTRIBUTION

Low Carbon Heat Workshop: In-Person and Online

2 March 2022

WESTERN POWER DISTRIBUTION

Serving the Midlands, South West and Wales

Contents

Introduction

On 2 March 2022, Western Power Distribution (WPD) hosted a hybrid in-person and virtual workshop on the decarbonisation of heat. The workshop was designed to seek feedback from stakeholders on the following topics: connecting to the WPD network; retrofitting for net zero; the development of heat pumps; and alternative, low carbon heating technologies.

The workshop was hosted simultaneously in-person, in Birmingham, and online, using Zoom. Each session consisted of a short presentation given by WPD representatives (broadcast as a live feed to delegates participating online), followed by facilitated roundtable discussions or discussions in virtual breakout rooms. In addition, stakeholders were asked to vote on a number of topics in an online poll using Slido.

For the purposes of this report, no differentiation will be made between feedback gathered from the virtual and in-person elements of the workshop.

WPD instructed EQ Communications, a specialist stakeholder engagement consultancy, to independently facilitate the workshop and to take notes of the comments made by stakeholders. Every effort has been made to faithfully record the feedback given. In order to encourage candour and open debate, comments have not been ascribed to individuals. Instead, notes have been made of the type of organisation each stakeholder represents.

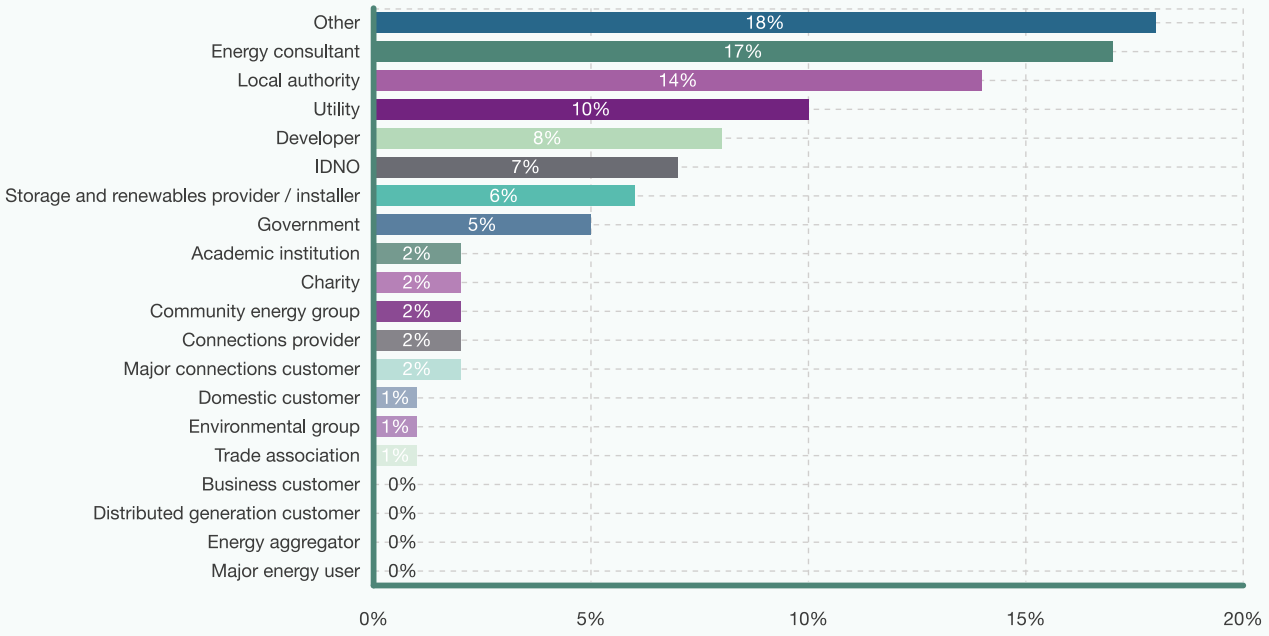
The full presentation can be found here.

Executive Summary

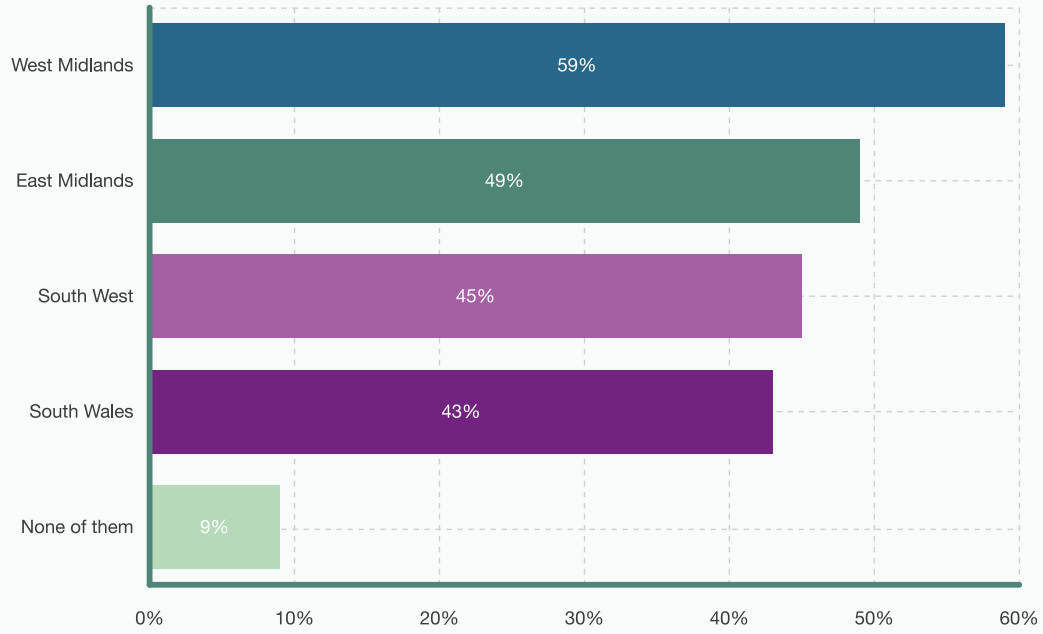
Participants

- A total of 95 stakeholders participated in the workshop, representing 54 organisations.
- 70% of stakeholders attended online, and 30% came to the in-person event.
- The most widely represented stakeholder types were ‘other’ (18%), followed by energy consultants (17%), local authorities (14%) and utilities (10%).
- 59% stated that the West Midlands region was relevant to them, with 49% opting for the East Midlands.
- 84% of attendees who filled out a feedback form told us that they found the workshop to be ‘very interesting’, with the remaining 16% opting for ‘interesting’.

What type of stakeholder are you?



Which WPD region is relevant to you?



Session One: Connecting to the WPD Network

The workshop began with a presentation from Peter White, System Development Engineer at WPD, who explained that the current connections notification process is a paper system, with six different notification routes. He then outlined a cross-utility effort to digitise and streamline this process using an app called iDentify, developed by SP Energy Networks. He explained that the objective of integrating this system at WPD was to simplify and improve the process of connecting low carbon heat sources to WPD's network.

Following Peter's presentation, Seth Treasure, Policy Engineer at WPD, walked delegates through some of the technical requirements of heat pumps, showing that in cases where larger heat pumps are connected to the low-voltage (LV) network, the suitability of the electrical connection needs to be further assessed. He explained that failure to properly consider this issue could result in power quality issues; in order to mitigate them, he urged commercial customers to contact WPD to discuss their connections plans and proposed equipment.

- When asked to rank in order of importance the low carbon heat sources that they thought would form part of the UK's decarbonisation of heat strategy in the future, stakeholders ranked heat pumps highest, with an average score of 6.55 out of 7, followed by district heating and heat networks with 4.80, and thermal storage with 3.89.
- When discussing the realisation, scope and ambition of their plans to decarbonise heat, local authorities noted that the decarbonisation of heat was at the top of their agenda, but the funding and roll-out of heat pumps was facing setbacks owing to a lack of knowledge and expertise, as well as a fear of installing obsolete technology that is expensive to run.
- Stakeholders representing independent distribution network operators (IDNOs), energy consultants, and estates managers pointed to a similar race for decarbonisation in the commercial sector, with the pressures here lying in timescales and the supply chain, due to the reinforcement works needed to secure the required power and a shortage of heat pumps and components compounded by Brexit, the pandemic and the war in Ukraine.
- When stakeholders ranked elements that would present challenges when decarbonising heat in buildings, housing stock emerged as the biggest challenge, with 3.32 out of 9. This was followed by lack of distribution network operator (DNO) data, with 2.35, and then libraries, schools and local authority owned buildings, with 2.2.

- There was support for the iDentify App during the discussions and the electronic voting, where 60% agreed or strongly agreed that the move from a paper-based system to the iDentify app would be helpful to them in their role.

Session Two: Retrofit Net Zero

Malcolm Davies, Senior Programme Manager in Housing Decarbonisation for the Welsh Government, introduced the second session, walking delegates through the Optimised Retrofit Programme (ORP), which has been adopted as Welsh Government flagship policy. The overarching principles guiding ORP are solutions that are green from inception; small, to manage space planning; as non-disruptive as possible; and user-friendly for residents.

Next, Andy Sutton, Co-Founder and Chief Innovation Officer at Sero, a company working with the Welsh Government on the delivery of ORP, presented via video. He explained Sero's role of providing digital products to support housing providers and the construction industry in delivering net zero carbon. He then introduced the Sero Passport, which enables homeowners to view their property data on a granular basis and provides an aggregated view for assessing and managing an entire portfolio, enabling them to effectively manage and understand their net zero carbon journey.

- There was broad support for the Welsh Government's proposed approach to optimised retrofit, with 72% agreeing or strongly agreeing that it is appropriate.
- Delegates were adamant that any successful retrofitting project, rolled out at scale, would need to involve a drive to upskill and train the workforce needed to advise on, install, monitor and service low carbon heating systems and insulation, along with an education piece for customers introducing them to new approaches to domestic heating, such as maintaining ambient temperatures throughout the day, sharing usage data, using setback controls and surrendering some individual control via district heating.
- Stakeholders reported a positive response from customers to greater use of automation and smart technology in home heating, and it was felt that a user-friendly approach that kept systems as simple and as automated as possible would be widely accepted.
- Throughout the discussions, it was clear that a wide network and package of support is necessary to drive decarbonisation, and this was reflected in the electronic voting, where 75% agreed or strongly agreed that their organisation would welcome assistance with retrofit in the future.

Session Three: Development of Heat Pumps

Bean Beanland, Director for Growth and External Affairs at the Heat Pump Federation, presented the third session of the day. With a focus on the affordability of heat pumps, he outlined the domestic consumer challenge, with resistance to change, operational costs and historically poor funding policies the key barriers to wider uptake. He suggested that, in order to deliver 60,000 heat pumps by 2028, in line with government targets, we need to move away from the idea of subsidies and incentives and towards long-term loans, which stimulate private investment for public good.

- There was consensus that the affordability of heat pumps was a pressing concern across all sectors, exacerbated by the cost-of-living crisis and the spiralling price of energy. Many felt that central government should take a leading role by introducing tax breaks or deductibles on heat pumps; scrapping VAT on energy efficiency payments and refurbishing existing buildings with decarbonised heating; and implementing incentives by, for example, reducing the stamp duty on houses with good efficiency and energy performance certificates (EPCs).
- During the electronic vote on appropriate mechanisms for enabling decarbonised heat, government grants came out top, with a score of 3 out of 4, followed by government subsidies (2.46) and government loans (2.28).
- It was felt that providing long-term loans to owner occupiers to fund the decarbonisation of their homes is an appropriate option for mitigating the high upfront costs associated with installation, so long as the loans are long-term, interest-free and government-backed.

- Delegates were clear that the priority for any mechanism has to be certainty, which enables the greatest number of sectors to implement plans for the long term and avoids subjecting consumers, manufacturers, installers and local government to cliff edges. Certainty would also give manufacturers the confidence to step up the production of heat pumps, which would have the benefit of bringing costs down over time.

Session Four: Alternative Technologies

Cuan Rowlands, System Development Engineer at WPD, presented the final session of the day. Expanding on delegates' knowledge of heat pumps, he explained some other low carbon heat sources on the market, along with their pros and cons, such as district heating, electric boilers, solar thermal panels, and combined heat and power. He finished by introducing some technologies currently being trialled that may mature, such as Tepeo, a zero-emission boiler, and infrared heating panels.

- When stakeholders were asked to rank alternative technologies in order of priority for WPD to include in its system design, district heating came out top, with 4.19 out of 5. In second place was direct electric heating, with 3.11, and third was solar thermal, with 2.53.
- District heating was favoured because while it is expensive and disruptive to install, it was felt that it delivers better outcomes, lends itself to new technologies, and can be combined with any both air and ground source heat pumps.
- The idea of direct electric heating engendered some debate: while some saw that it was relatively cheap to install and replace, and very low carbon, others argued that it is punitively expensive to run and uses excessive grid capacity at the expense of capacity needed for electric vehicle (EV) roll-out and heat decarbonisation.
- Delegates made it clear that no emergent technology should be excluded at this stage, with a key comment being: "you need your plans and available technology to be flexible for a home-by-home, project-by-project basis. You shouldn't take anything off the table."

Session One:
Connecting to the WPD Network

During the first session, delegates were asked about their experience of connecting low carbon heating systems to the network and gave feedback on WPD's plans and processes.

Summary

Future plans to decarbonise heat

Unsurprisingly given the subject of the workshop, most delegates had plans to decarbonise heat in their homes, constituencies, organisations or communities, or for their clients. For most, the focus was on heat pumps; during the electronic voting, stakeholders indicated that they would be the top low carbon heat source under the UK's future decarbonisation of heat strategy, with an average score of 6.55 out of 7, followed by district heating and heating networks (4.80) and thermal storage (3.89).

The level of realisation, scope and ambition of plans tended to vary by stakeholder type. Local authorities explained that decarbonisation of heat was a priority, but government funding was met with a lack of knowledge and expertise on the ground. There was concern that the air and ground source heat pumps being rolled out to public housing were "immature" and a fear of investing in technology that may become obsolete or difficult to manage. Other local authorities, firmer in their decision to install a combination of photovoltaic (PV) devices and storage, had run into issues with reinforcement and capacity, particularly with upgrades to connections where PV is designed to discharge into the grid. Some communities, such as Bridport, had implemented district heating schemes. While these were viewed as positive developments, concerns remained around the lack of reliable advice and the shortage of low carbon heat installers.

Stakeholders specialised in low carbon heat, such as IDNOs, energy consultants and estate managers, described a similar race for decarbonisation in the commercial sector, with large companies like Amazon demanding low carbon heat for green hubs and warehouses. The issues here were not with funding but with timescales owing to the reinforcement works needed to secure the required power. Large users, such as universities and hospitals, were considering a combination of district heating, heat pumps, storage and heat recovery from processes, using data

centres to manage demand peaks. Smarter use of data fed into other plans, including one for an automated system to provide a specific voltage to homes based on historic usage, particularly within the LV network. Other plans included test schemes for hydrogen heating systems and innovative graphene heating solutions, as well as broader schemes to reduce demand, alongside comprehensive insulation programmes.

Experience of working with WPD

The majority of stakeholders only had positive experiences of working with WPD. The connections process was singled out for praise, and many described WPD as by far the best DNO from this perspective. Stakeholders reported that the local offices and depots enable them to build a rapport with local WPD managers, planners and engineers, and it is easy to have a productive phone call with the right person. Delegates highlighted the quality of the heat maps generated by WPD but wanted more engagement with and access to monitoring data on the LV network. Larger users felt that the connections forms for heat pumps can be cumbersome. While the forms are helpful and simple to use for domestic installations, from a commercial perspective, where a more bespoke unit might be needed, the process drags. It was suggested that an email interaction, rather than a standardised approach, would speed up the offer process.

Current and future challenges with connecting low carbon heat

Delegates felt that housing stock would present the biggest challenge when decarbonising heat in buildings, awarding this element an average score of 3.32 out of 9 in the electronic vote, followed by lack of DNO data (2.35) and libraries, schools and local authority owned buildings (2.20).

Business customers and energy consultants reported pressure from clients on lead times, but reported challenges related to the supply chain and sourcing equipment, compounded by factors such as Brexit and the pandemic, while the lack of capacity in the UK had led to higher quotes for reinforcement costs. There was also concern that supply of raw materials from Russia and Ukraine, such as copper and aluminium, would inevitably contract, leading to a shortage of technologies such as transformers and cabling and a concomitant rise in prices. A number of delegates were experiencing issues with flicker and harmonics, with many heat pumps on the market not yet type tested and therefore not included in the WPD database, making it difficult for installers to foresee potential problems.

Some noted that larger users, such as hospitals and universities, were quickly moving to heat pumps, which funding can easily be secured for, without considering whether it is the most appropriate option for the type of building or the long-term running costs. Some older, poorly insulated buildings, such as hospitals, now have to run two heat pumps to reach the right temperature, which drives up costs at a time of historically high energy prices, while, according to charity groups, the decision to install heat pumps in older, poorly insulated housing stock is hitting households on very tight budgets.

Consideration of the challenges identified by WPD

While energy consultants and business representatives had mostly considered challenges such as flicker and harmonics, those working in local authorities were still getting to grips with the technical side; in this sense, delegates explained, workshops like these are critical for information gathering. Some delegates felt that these were problems for WPD to solve, but others noted that manufacturers needed to play their part, and that dialogue with manufacturers would be key moving forward. Generally, stakeholders wanted to improve their understanding of what thresholds and tolerances DNOs are willing to accept on low carbon heat products, explaining that this would enable them to relay the information to manufacturers and streamline processes.

Sectors or buildings presenting the biggest challenges

Each sector and building type was felt to present discrete challenges for low carbon heating. For libraries, schools and local authority owned buildings, the main challenge was cost. With stretched budgets across the board, there were questions over subsidies and willingness to pay, who should be responsible for paying for upgrades and reinforcement costs, and the costs shouldered by private tenants living in council-owned buildings. For commercial buildings, the problem lay in capacity, with many big companies now expecting combined heat and power (CHP) and EV chargers as a minimum. An IDNO representative reported that the issue lies in understanding and managing the load requirement, because they operate as an intermediary between WPD and users. For existing housing stock, the challenges lay in the practicality of using heat pumps in old, draughty housing, particularly terraces. While insulation

was seen as a partial solution, there were problems with listed buildings, and with the fact that over-insulating older houses can cause mould and condensation problems.

Support from WPD

Access to quality data and information on findings and pilot projects, particularly from the LV networks, were key areas where delegates wanted more support from WPD. Stakeholders also wanted to see more engagement and clearer communication pathways. Surgeries were seen as very useful, and there were calls for more resources for engaging with local planning, and research groups on affordability.

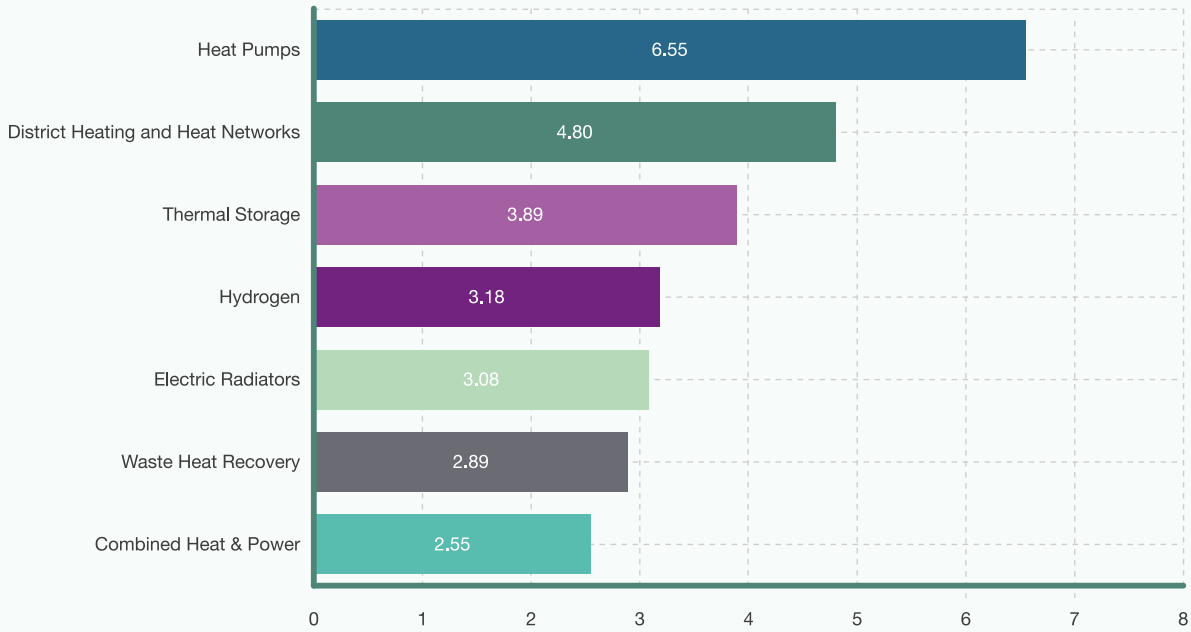
Improving the process for customers looking to connect low carbon heating systems to the network

In order to improve the process for connecting smaller heating systems to the network, stakeholders strongly urged WPD to take advantage of smart-grid solutions and smart technology. They wanted WPD to foster innovation by enabling partners to develop creative ways of moving excess power around the network as part of an automated process. There was broad support for the iDentify App, with many delegates reporting negative experiences with the paper-based connections application process, and 60% of stakeholders agreeing or strongly agreeing that moving from a paper-based system to the iDentify app would help them in their role. However, 36 out of the 87 voters responded 'don't know, can't say', indicating that more work needs to be done to make the app a plausible option. Stakeholders urged WPD to ensure any software and digitisation processes are streamlined, accessible and easy to use, with one stating, "It's got to work, hasn't it?".

Verbatim comments and voting

1. What are your future plans to decarbonise heat?

Which of the following do you think will form part of the UK's decarbonisation of heat strategy in the future? (Please rank these in order)



- "We are doing projects where we are looking to be able to control power on a number of aspects within properties, such as solar panels and a whole suite of green technologies. With the green project, we want to be able to monitor individual homes and move energy supplies about in a way that is tailored to each property. Through this automated system, we want to provide suitable voltage to these homes to meet their needs, particularly within the LV network." **IDNO**
- "Decarbonising housing stock is massively on our agenda. We are tapping into every different technology at the moment, and I'm well aware that it's all quite immature. We are using funding money through the Department for Business, Energy & Industrial Strategy to help us do pilot schemes and decarbonise early. Contractors are telling us that the properties where there are vulnerable people with blankets over their knees aren't the right ones to target, but I have concerns about that. We are trying to find the best solution." **Local authority**
- "We mainly work with NHS authorities. No one is looking at the infrastructure, they are just grabbing the funding. Then there are big companies like Amazon and Hello Fresh that want to set up these big hubs. They only want to occupy buildings that are green and have all the badges and certifications, mainly because their clients are looking at social value. The biggest issue at the moment is that the funding is coming out at pace, but the time limits are crazy. 12 months to complete is too short." **Energy consultant**
- "A bit of everything, also going down the hydrogen route. Hard down in London, that's going to be the biggest challenge. 60% of London can't have heat pumps." **Domestic customer**
- "When we started the scheme, initially the idea was to put heat pumps in everywhere and now we're trying to look at different solutions, including hydrogen." **Developer**
- "In Newcastle listed buildings and city centres in general are starting to move to a hydrogen infrastructure." **Major connections customer**
- "It's not written in stone, but fossil fuel won't get approved now by local authorities, so hydrogen will make up more of a percentage." **Charity**
- "We are working to decarbonise heating to large industrial warehouse spaces without increasing demand for electricity. We need to transition from gas to electricity, and we think heat pumps are the way forward." **Business customer**
- "There are lots of opportunities, we're interested in whatever's out there. We are looking into smart grids, and what we can plug into that to help a business park tap into heat." **Business customer**
- "Our driver is getting people out of fuel poverty and reducing greenhouse gases and climate change. We have a cost dilemma at the moment, and until that cost dilemma levels out, that's still going to be gas boilers. We have 12 houses who all want heat pumps and want fuel economy. That block of 12 properties would be a larger heat pump for a district heating solution." **Energy consultant**
- "A lot of NHS trusts wish to connect heat pumps. WPD's capacity is already at 80–90%. The cost is huge, and the question is where to put the funding." **Energy consultant**
- "Obviously, there are places where we are going to be using district heat when it becomes available in our area, and there are areas where we are going to be using heat pumps. We are acutely aware of the constraints on capacity, and it's good to learn from the presentation about harmonics and to think about flicker, and it made me think about the ways that we could use heat pumps in tandem with storage, or even power conditioning methods to make sure our harmonics and our voltage drops don't propagate back on to the network." **Academic institution**
- "I think in the future we are going to have to put low levels of heat in 24 hours a day over the winter. We will probably be looking for heat pump connections further down the line, but we are aware that we have work to do first. We have some situations maybe in the same way that hospitals and supermarkets have, where we could recover heat from processes. We have data centres and things like that. We would be interested in working together to make sure our demands peaks aren't out of kilter with everybody else's. We could work towards having a control system so we could use the cabling to better effect." **Academic institution**

- "For Bridport, the town council have a climate action plan and we're laying out at the moment a scheme of energy champions. The biggest problem we're facing is that in our area, there are no advisers available for moving on to retrofit, and there's only one installer that is very overworked. Within Bridport there are schemes now to develop some district heating in small but significant ways. We've got a lot of streets moving on to energy generated from a local wind turbine." **Environmental group**
- "We're looking at a PV, battery, and storage programme to 13,000 homes. Our biggest concern is upgrades to connections for properties where we have PV discharging into the grid. We need to upgrade and cost." **Local authority**
- "I've got a number of decarbonisation projects, but probably the largest one we're working on is Kettering hospital, so we're probably talking around 4,000¬–5,000 kW of heat which we've got to change to a lower system, so we'll have to integrate some heat pumps to decarbonise it." **Energy consultant**
- "What we are seeing is that, because of the higher temperatures that you often need when retrofitting plants into an existing building, it's impossible to get the temperatures down to 50 degrees, or whatever you need. So, we're looking at hybrid systems to decarbonise it that way, and sometimes that's a more efficient system." **Energy consultant**
- "Another area we're looking at is domestic water across the estate. Do we need all of the water, and can we potentially convert it to electricity?" **Energy consultant**
- "We are working with Bristol City Council on their heat decarbonisation delivery plan, looking at decarbonisation for the whole city, partly with respect to heat networks and future government policy on heat network zoning, but also the electrification of heat outside of heat networks." **Energy consultant**

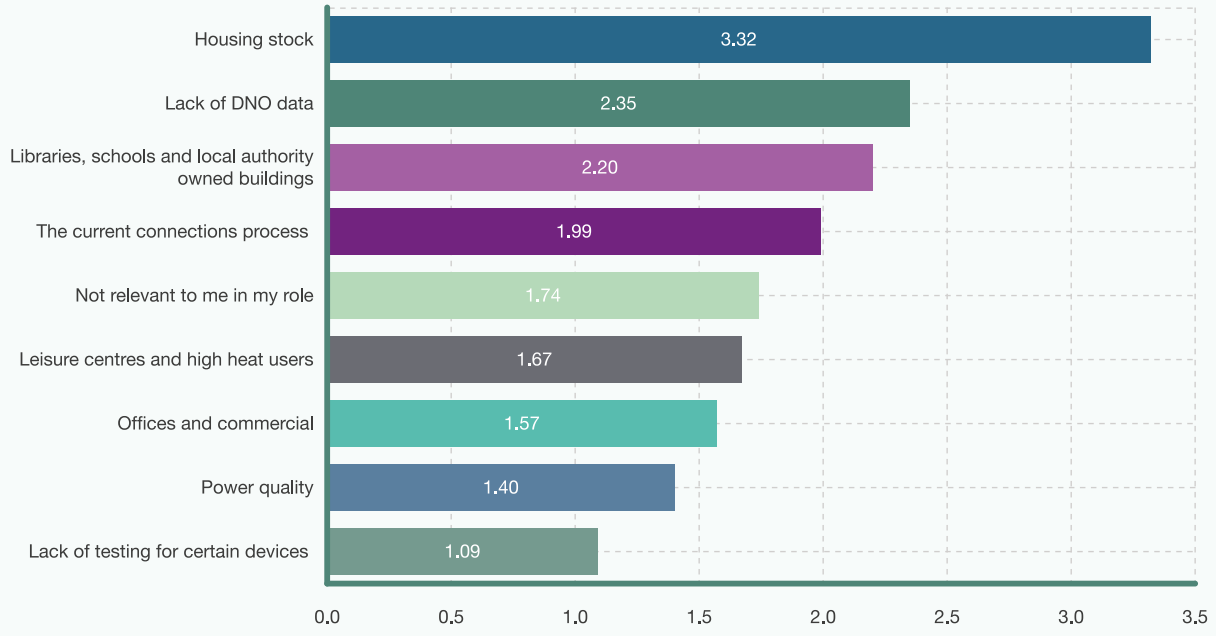
2. Have you had any experience of interacting with us before – how has it been?

- "With the connections, things have been very good historically. I would say that WPD are the easiest DNO to work with. It's much more straightforward to deal with WPD than Scottish and Southern Electricity Networks, for example." **Connections provider**
- "WPD's local offices make things easier from a connection standpoint and you have a rapport with the local depot managers." **IDNO**
- "WPD are good at picking up the phone and they're helpful when we have issues." **IDNO**
- "WPD have been really helpful – any information we've asked for has been answered and there have been no issues." **Local authority**
- "WPD are really good at responding to our queries. Being able to pick up the phone and have those conversations is really helpful." **Connections provider**
- "Heat maps are good, and WPD's heat maps are very, very good. They are among the better ones, but there are still certain areas where not all the information is there."
  Storage and renewables provider / installer
- "WPD are one of the most advanced DNOs in the UK. They are one of the leading ones in terms of thinking about the future." **Energy consultant**

- "We've been talking to them about some ongoing and upcoming work for the next round of the Optimised Retrofit Programme and what is required from the DNO side on that in terms of notifications and making sure they're happy with these novel technologies. WPD have been nice enough to give us a letter of support." **Academic institution**
- "My only interaction was as a domestic user. I spoke to seven different people within the organisation, which was a bit laborious, but everyone was absolutely charming and helpful and eventually we got a result that we could work with." **Environmental group**
- "I have some experience a few years ago within your catchment, where we applied for a new connection. We got all the way through to completing the design and WPD said they couldn't support CHP on their network, so we had to completely redesign it all. The issue wasn't communicated by WPD, and it caused us a major issue." **Energy consultant**
- "From a manufacturing perspective, the forms that you ask us to fill in are quite cumbersome. A lot of times we can't meet what you require. The forms are great for domestic installations, but from a commercial perspective where you might be using a more bespoke unit, on heat pumps some sort of email interaction would reduce the back and forth." **Energy consultant**

3. What problems are you currently facing or would you anticipate facing when trying to connect low carbon heating systems to the network?

Which of the following do you think will present the biggest challenge when decarbonising heat in buildings?



- "Lead times are a challenge. There's pressure to get these projects under way but suppliers are struggling to get hold of the kit to get things built. It's tough in terms of managing the supply chain." **Business customer**
- "It's all unstable at the moment what with the pandemic and everything going on with Russia. I don't think it's going to get any easier. We always try to get advance notice of constraints. The more notice we have, the better chance we have of achieving a project." **Business customer**
- "Russia and Ukraine supply an awful lot of raw materials, such as copper and aluminium. This will impact on the supply chain and will also impact on prices." **Energy consultant**
- "There is a lack of capacity now demand has gone up." **Charity**
- "Also understanding requirements for EV charging. There's a planning element which will be simpler now that every house needs an EV charger, but mostly capacity is what we're coming up against." **Energy consultant**
- "In North Wales we have major issues with the grid where we have to pay them in advance for any work we have to do. Sometimes we are told the costs required to update the grid to the required level for our work and the onus is on us to help find that funding. We've just found out that Scottish Power in North Wales have upgraded the grid now but they're going to put their own solar panels in, so it's very frustrating." **Local authority**
- "One example of an application we made, which was complex as it had embedded generators. One issue was the equipment was not type tested, so it's not in the database. You guys don't have access to the information to see whether it's going to cause flickers, etc. So, we had to do a hugely protracted process. It took four to five months just to fill out the form. We had to go back to the people who made the inverters, who had then been bought out by a company in the Netherlands, which caused communication issues. I can see more of this happening if the new products aren't type tested." **Energy consultant**
- "We've had some issues, namely where we've had refusals on commercial air source heat pumps because they aren't type tested because manufacturers aren't in place to get this. The problem we've had is that certain heat pumps have been vetted by DNOs, they tend to be on the approved list, easier to connect, but with larger ones that need to be connected, they're harder to get approved in that way because they aren't readily available." **Energy consultant**
- "We're currently looking into large air source heat pumps for a university. We've had a lot of problems with flicker and harmonics and there are a lot of restrictions. There's a chicken and egg situation; the DNO wants information about the equipment, and the equipment manufacturers want information from the DNO about capacity." **Energy consultant**
- "I'm concerned with this flicker problem. This is a difficult problem to deal with for those that don't know the ins and outs of the energy industry." **Community energy group**

4. Have you considered the challenges we've identified?

- "We've considered the harmonics on the networks for EVs, but we haven't considered it for heat pumps." **IDNO**
- "It's something we're becoming more and more aware of. I certainly see it as more of a barrier with schools and commercial buildings than domestic installations." **Community energy group**

- "We have considered them. We've worked with WPD on several schemes. Harmonics and flicker, flicker, today is the first time I've had touch with that one, but I understand it now. More needs to be done to understand what thresholds DNOs are wanting to make sure products don't exceed those. If we could understand that better, we could relay it to manufacturers and streamline the process." **Energy consultant**
- "I've never heard of the issues involved with connecting the systems, such as flicker and power quality, before." **Local authority**
- "We did know there is a fairly rigorous process for testing, and WPD have been good to work with so far." **Energy consultant**
- "The challenges are certainly something that's going to grow." **Charity**

5. Which sector or type of building do you think will present the biggest challenges?

Libraries, schools and local authority owned buildings

- "We have started a pan-Wales programme to decarbonise all public sector buildings, which has been a big challenge. People are increasingly embracing the idea that you should retrofit buildings rather than demolishing them owing to the embodied carbon." **Government**
- "If you're just a tenant, where is the money coming from to do things like this." **Charity**
- "I see it more of a problem with the size of the equipment. When you're doing very large-scale things, it can cost an absolute fortune and have a huge amount of criteria to meet." **Energy consultant**
- "We do have a number of high-rise blocks and sheltered units. Seventy to eighty contained in one building with commercial heat systems. One debate we're having is where responsibility starts and stops. Particularly in high-rise blocks, where the responsibility for submains lies. We've had discussions with colleagues at WPD about that. If upgrades are required, where does that lie because potentially that's a major additional cost for us?" **Local authority**
- "Schools cause quite a few problems. Primary schools in particular have a very small supply, which is increasing rapidly." **Local authority**
- "Listed buildings." **Energy consultant**

Leisure centres and high heat users

- "Heat pumps can be expensive because of the heated pools. No thermal stores are an issue." **Local authority**
- "In this race to decarbonise, the easiest way for organisations to secure funding is to apply for a heat pump. The problem is that most clients just look at that short-term initial saving. They don't consider whether heat pumps are the right choice or think about the long-term implications. Take hospitals, for example. They are generally really old buildings with single-pane glass and poor insulation. However, what you see happening is that they are having to put in two sets of heat pumps because, given the heat loss, it takes a double heat pump to get the buildings up to the right temperature." **Energy consultant**

Offices and commercial

- "These large depots now have to tick all the boxes. These big companies now want CHP and EV chargers as a minimum. For me, it's trying to understand and manage the load requirement because we sit in between you guys, the DNO, and them, the users. Also, we often get asked, 'Why do you want all this power?' and you have to explain that it's down to all these requirements and forecasts for future demand." **IDNO**
- "A big issue is the commercial entities in a city who potentially are mandated to connect to a heat network, but there may not be one for 20 years, so they're looking for interim solutions. There's a big policy gap on how we bridge the want for heat decarbonisation and how it actually happens." **Energy consultant**

Housing stock

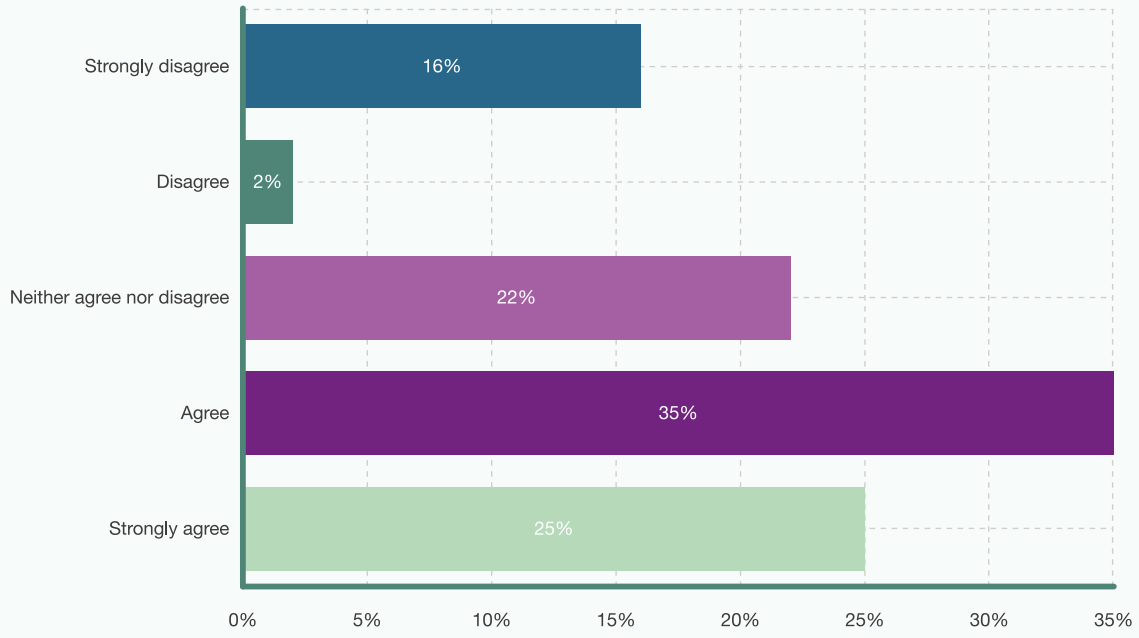
- "We're seeing air source heat pumps being put in by social landlords and it's hitting households already on tight budgets, particularly if they take the Economy 7 out. The second problem is the inadequacy of thermal insulation in properties, and particularly in Cornwall the preservation orders and historic buildings add a whole new level of problems." **Charity**
- "It should be a two-pronged attack, how do we deal with our existing stock, and how do we take everything forward, everything new should be built to certain standards. There's margin in there, but margins that go directly to the shareholders. From a village level, every village should take into account where they get their energy from." **Developer**
- "Social landlords put in solar panels, smart hot water and smart heating, but they don't think about preparing their homes for EVs. Therefore, I would look to roll out education campaigns to make these social landlords aware of the bigger picture." **Connections provider**
- "We feel that the diversity in the different types of heat pumps available will be a big challenge for decarbonising household heating systems. As these schemes need to be rolled out quickly and there are so many heat pumps available, I fear that it will be difficult for networks to cope, and this could cause some of them to collapse." **IDNO**
- "For me, the main issue is that air source heat pumps won't work for old draughty and badly insulated homes in the UK, in my opinion." **IDNO**
- "For us it's going to be housing. They have an unusual supply. Our biggest challenge is the roll-out and funding. £70,000 per asset; that is not sustainable for a local authority to subsidise. There are certainly things that WPD can do to help us." **Local authority**
- "Terraced houses are the worst because you might not be able to put a heat pump on the front of the property and then the issue is how do you get the equipment to the back of the property. If you're doing the middle house of a row of eight terraced houses, you might have to dig up all the gardens to install the cable for that one house." **Energy consultant**
- "Our concern would be installers who don't know what they're doing giving the customer a bad experience and complaining to WPD." **Government**
- "Very old housing stock is the issue. The solid walls don't have any air cavities. Once you heat the brickwork up, it takes a long time to dissipate. It's hard to heat very old buildings because they're so leaky and solid." **Energy consultant**
- "We've got some of the oldest housing stock in the UK and the measures we're being asked to put in for insulation, how do we do that for older properties? We're going to have mould and condensation problems." **Local authority**

6. What more can WPD, as a DNO, do to support you?

- "I think the LV monitoring is going to be key for anything to be implemented on the network." **Energy consultant**
- "Share data and findings. It would be great to see that." **IDNO**
- "Quality of data really." **Energy consultant**
- "I think WPD need to accept data that isn't on their network, you should be able to transfer information. In theory it's just a heat pump, it doesn't necessarily matter whereabouts it is. It could really reduce reinforcements, and it's always good to look at other players." **Developer**
- "DNOs need enough resources to engage with local planning to make sure that can go ahead." **Charity**
- "Easy way to talk to you. The app is a good idea." **Academic institution**
- "Start a research group to identify affordability." **Charity**
- "On the engagement side for cities, I'd be keen to see more of an established process. From a local authority perspective, they might be a bit concerned about the idea of just going to a generic contact centre every time they have a request." **Energy consultant**
- "We don't want to start filling forms out if it's only an enquiry. But if we get an enquiry for a heat pump, the first thing we want to know is if there's the capacity, so surgeries are good to tell us if it's viable to go forward. Sometimes you just want to talk to someone." **Storage and renewables provider / installer**

7. How we can we further improve the process for customers looking to connect low carbon heating systems to the network?

How do you feel about the following statement? "The move away from a paper-based system to the iDentify app will be helpful to me in my role."



Don't know / can't say: 36 / 87

- "Within a smart network, you should be able to sell excess energy from solar panels to others that need it for heating purposes as part of an automated process." **IDNO**
- "I think that the barriers to selling electricity from solar gain is a tricky issue that needs to be resolved. I'm hoping that the approach to smarter networks will enable us to come up with creative ways to move this excess power around the network as part of an automated process." **Government**
- "Better working group to maximise power distribution and insulation, affordability needs to be on the agenda." **Charity**

What do you think of the iDentify App? Would you use it?

- "We get a lot of these apps and the processes involved are normally quite long-winded, with lots of forms involved. The main thing that I would like to know is how the information on the app interacts with all of our different systems." **IDNO**
- "It's a no brainer for me as it saves me a lot of leg work." **Major connections customer**

- "I think it will be refreshing and make some systems less painful." **Distributed generation customer**
- "It needs to move, capture the right data. You know 600,000 heat pumps a year by 2028, it's phenomenal. We've gone through the old paper process, and it wasn't fun." **Government**
- "I think it's good if we can move to a digital system, as long as there's still a paper system for those who don't have access to digital. Or some other back-up system, especially for residential households." **Local authority**
- "I think that this app will be fine for applications for domestic EVs." **IDNO**
- "It seems practical to have a digitised version. Usability is important." **Energy consultant**
- "It sounds good, but it has to work, doesn't it? Even with major companies, often app software doesn't work." **Community energy group**
- "It will probably not make connecting easier for us, as we are too far on the other end of the scale." **Business customer**

Session Two:
Retrofit Net Zero

During the second session, delegates were asked for feedback about retrofit solutions and challenges associated with retrofitting.

Summary

Suggestions for retrofit solutions

There was widespread support for the Welsh Government's proposed approach to optimised retrofit, with 72% agreeing or strongly agreeing that it is appropriate. Delegates were clear that any successful net zero retrofitting project, rolled out at scale, would need to be accompanied by a drive to upskill and train the workforce needed to advise on, install, monitor and service low carbon heating systems and insulation. It was felt that the UK is lagging behind other European countries in this regard, and this was stymieing progress. Others pointed to a need to educate customers to enable them to get to grips with brand new approaches to heating their homes, such as maintaining ambient temperatures throughout the day, sharing vast quantities of usage data, using setback controls and surrendering some individual control via district heating. Delegates felt that working to scale across communities, along with partnering with councils and planners to implement schemes, would encourage buy-in and engagement. On a practical level, stakeholders advised power flushing the system post-heat pump installation to get the pump working to capacity. Interestingly, while battery storage plays a big part in many plans for retrofitting for net zero, some felt that it was merely a placeholder before the inevitable nationwide upgrade to the three-phase cabling needed to power decarbonised heat.

Making these systems user friendly

Again, stakeholders stressed the importance of training and awareness-building for customers, working on the behavioural and cultural changes required to adapt to a different way of heating homes. Charity sector representatives reported a positive response to greater use of automation and smart technology, indicating that an approach that keeps systems as simple and automated as possible would be widely accepted, although local authorities noted that getting people on board can be challenging. Some felt that more needed to be done to explain the long game

to customers and show the benefits of energy efficiency by explaining that cost savings would register over the longer term. Some were sceptical that any systems could be made user friendly, citing technologies like mechanical ventilation and heat recovery, which, while effective, can also be difficult for customers with limited mobility to manage. It was apparent that, whatever the approach, a wide network of support would be necessary to drive effective change, with 75% of attendees agreeing or strongly agreeing that their organisation would welcome assistance with retrofit in the future.

The challenges of retrofit

Prevalent among the challenges identified by delegates were the attitudes preventing customers from getting on board with retrofitting their homes, including a fear of new technologies and concern over disruption, and concern that fitting heat pumps into unsuitable homes would increase energy bills and expose more households to fuel poverty. Some pointed to severe challenges with the supply chain, with delays reported in procuring low carbon heating technologies and parts. Another shortage lay in skills and capacity, with a lack of technicians, engineers, fitters and advisers, which affects all aspects of the process, including the work needed to assess the fabric and output of existing properties. Moreover, the dearth of retrofit coordinators and designers was seen as a stumbling block, with calls to prioritise a 'fabric first' approach and demand management as key drivers. In this case, it was suggested innovation was vital, with one stakeholder noting that apps could be used to collect the data needed to assess properties prior to carrying out a retrofit. Other suggestions included more apprenticeships in this emergent field, and steps to encourage more women into the industry, which would tackle the gender and skills gap in one move. Stakeholders were strongly in favour of partnering with the Centrica Energy for Tomorrow project, which educates schoolchildren about STEM careers. For many, the lack of a qualified workforce had led to poorly installed insulation and retrofits, contributing to a lack of trust in customers and further costs down the line. Some saw a looming problem given the scale and complexity of dealing with private landlords, suggesting that starting with the retrofit of social housing is a good solution as long as learning is transferred in future. For others, the challenges were technical, with questions over the reliability of the new generation of high-temperature heat pumps and the availability of enough power and capacity to run the systems, and concern over the cost of upgrading equipment and the network to accommodate the use of decarbonised heat across large estates.

Retrofitting in harmony with the grid

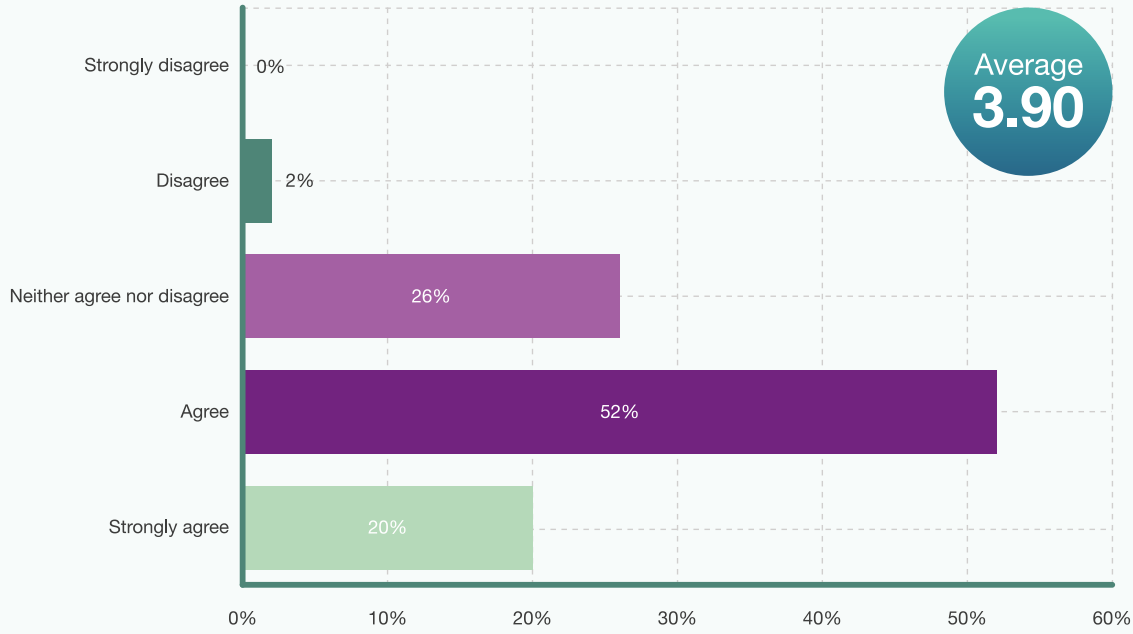
Some delegates put problems with harmonics down to a lack of interface with manufacturers, particularly following supply chain changes when installing a more bespoke decarbonised heating system, which make it impossible to assess harmonics until the units are delivered. Better dialogue and chains of communication were advocated here. Many felt that district heating was a key solution to balancing the effects of decarbonisation with the demands on the grid. While it was recognised that more needed to be done to bring communities on this journey, particularly with regard to surrendering individual heating controls, it was felt that the communal aspect could also be a galvanising force, alongside efforts such as knocking on people's doors and providing demonstration homes showing the new radiators and heat pumps at work. WPD was advised to make data open source, thereby equipping innovators with the information and tools required to develop ambitious ways to automate and balance supply and demand on the grid. Other avenues for smoothing demand lay in battery and thermal storage, although delegates accepted that these had both spatial and cost implications.

Reforming EPCs

There was consensus that EPCs are currently not fit for purpose, as they analyse the cost of energy, rather than the efficiency of the building, with EPC ratings going down when heat pumps are installed as the cost of the energy rises. Delegates agreed the system needs reform, with suggestions to make EPCs a standard product with everyone eligible for a free assessment, and to connect them more concretely to network performance by using building-specific and location-specific information.

Verbatim comments and voting

How do you feel about the following statement? "The Welsh Government's proposed approach to Optimised Retrofit is appropriate."



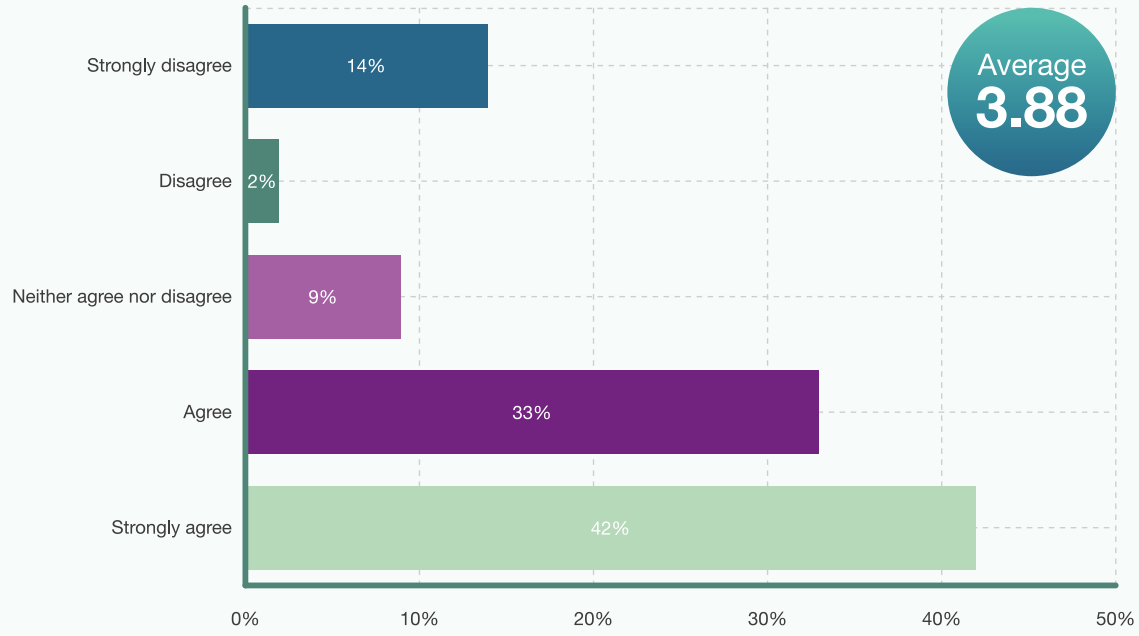
Don't know / can't say: 10 / 71

1. We are seeking solutions that are green from inception, small, and will bring as little disruption as possible. Do you have any suggestions?

- "The scale of the entire approach is far too small, with everything being done in piecemeal. You need to take it to a national scale, which will enable you to do things more cost efficiently." **IDNO**
- "In my opinion, we should be thinking about making buildings more efficient to start with. That means lobbying housebuilders to build houses using the right materials and technologies in the first place so that we don't have to amend things later." **Connections provider**
- "Academics have been assessing external building fabrics and how they weather differently. In particular, a big research piece has revealed that rain doesn't fall, but drives instead, and that different building fabrics react differently to various types of weather." **Government**
- "In South Wales, a lot of the housing isn't suitable for heat-pump-type solutions, as they're old terrace houses. District heating would be much better in energy terms, but we have an issue with wanting our homes to be our castles and to be able to turn the heat on and off at will. This means that a change of mindset is required, so WPD should help to drive this through educational pieces." **IDNO**
- "One of the main issues with heat pumps is that the installers haven't cleansed and flushed the system, so the system is not working to full capacity. If you have proper power flush, I think the heat from heat pumps is adequate." **Domestic customer**

- "The first thing is to look at the efficiency of the house and insulate the house. Once it's warm, then 50 degrees is quite adequate. Maintaining the temperature throughout the day is the key element to the transition." **Storage and renewables provider / installer**
- "From previous experience, it's important to do a whole area, to engage the whole community and get them on board. That gets more buy-in from the community. It's much easier if it's a social landlord that owns the whole area." **Government**
- "It's bringing the councils and the planners on board as well. The councils have set very tough targets for themselves to get lower carbon for their constituencies. Actually planning it out gives you more opportunity to get partners on-side and do it as a staged approach. And if you do it that way, you can build up the supply chain and a broader portfolio of work. The supply chain issue is a massive problem." **Government**
- "Fabric first. We have got to look at financing those that have particularly difficult structures to deal with. Another thing is engagement with the users and helping them to understand how this is going to work and how they can operate it. Have setback controls, they're very cheap these days, so educate the end user." **Storage and renewables provider / installer**
- "I'd say microgeneration. It's not easy, but it's the most easily implemented in terms of solar farms and storage. It's the big one, because we need to manage the peaks and troughs in use. It's not currently feasible to increase national grid capacity four- or fivefold to electrify heating, but we would need to look at generation and storage." **Energy consultant**
- "A lot of authorities are looking to install battery storage, and the DNOs will give a price for this, and because there is no legislation for how much of this can be drawn from the batteries, a lot of this is done in off-peak times and doesn't release the pressure on the grid in peak times." **Energy consultant**
- "All battery storage is doing is buying time before we can upgrade to the bigger cables in order to increase the capacity fivefold as is necessary for decarbonising heating." **Energy consultant**
- "It would be handy to do a home assessment about what goods and power you use, and then see how much you offset. If you can start by cleansing your own house by looking at the most efficient technologies, and then looking into getting heat pumps." **IDNO**
- "If we can manage demand, then we can reduce the reliance on gas and therefore decrease people's bills." **Energy consultant**

How do you feel about the following statement?
"My organisation would welcome assistance with retrofit in the future."



Don't know / can't say: 16 / 73

2. How do we make sure these systems are user-friendly for the residents / your organisation?

- "I've done a lot of work with social housing for providing energy upgrades. What we found was people accepted it because it was all automated and they didn't have to do anything. The intelligence looked after it all for them. They all loved it." **Charity**
- "That sounds like a lot of equipment. A lot of houses complain about having a meter on the front because they don't have space for it, so I don't know how you're going to get people to adopt all this technology." **IDNO**
- "New builds aren't so much of an issue, but if people are used to living in a home with a boiler and we say we're going try and switch your energy source, they tell us no, they don't want it. We have to get them to opt in and it's tricky. People are sceptical about technology. We don't have an outcome yet so it's a hard sell to people." **Local authority**
- "It's hassle for them – they have to come home from work early to let these guys in and that's the real-life constraint of it. Trying to sell this to people who are struggling with their bills is hard – there are no guarantees and we're concerned that if it doesn't work and doesn't reduce their bills, we'll be hitting the local headlines, there will be outrage." **Local authority**
- "I'm seeing this already. You have to start early and educate schoolchildren on what needs to be done so that they can nag their parents." **Energy consultant**
- "I think it is more the older generation that struggle, so you need to educate them in a way that they get it." **Domestic customer**
- "If you could show people how heat pumps are the more efficient option and work out how long term they are more cost effective." **Domestic customer**

- "I'm not sure you can make this user friendly. There are so many aspects, it's not easy." **Local authority**
- "The mechanical ventilation heat recovery system. It runs by itself, but you have to change the filters every few months. For an older person or anyone with mobility issues, it's very difficult to get into the loft to do that." **Community energy group**

3. Do you think we've covered all the challenges faced with retrofit?

- "Developers are only interested in finance and risk, so trying to do anything different and build houses that are fit for the future is a major challenge." **Local authority**
- "There is a policy position from central Government, they are actively trying to shoehorn heat pumps into properties that are currently not fit for heat pumps and run the risk of plunging them into fuel poverty a bit further. There also aren't enough heat pumps being produced. There is a real supply chain side of things that needs to be factored in." **Local authority**
- "We're working on a project in the West Midlands. It's a detailed design smart local energy system. We got to about £250 million worth of investment. Three quarters of that is retrofit. It's a different approach by taking a town-wide approach instead of an individual one. That helps. We tried to do a commercial model but there's a massive shortfall in the amount of grants and support to cover that." **Charity**
- "The other thing is the behavioural aspect, because people thought it was just like a radiator. But they don't work like that because it's a low ambient temperature that slowly rises. People need to realise it's not just like switching the boiler on for an hour and getting that sudden shot of heat." **Energy consultant**
- "There's the problem with assessing existing properties and working out what you have got in terms of the output of radiators. It's not difficult, but it's quite a laborious project. I've been trying to push some organisations to make some apps that could make this very simple, and I think that would really help." **Storage and renewables provider / installer**
- "Older engineers are retiring, and there is a big gap where no apprentices were taken on, so there is no one to train the young ones coming in." **Domestic customer**
- "The one thing we've really struggled with is retrofit coordinators and designers – we're looking at bringing them in and doing in-house training, but that's going to take years." **Local authority**
- "Another issue is a lack of skills and training to obtain these skills. For comparison, take the skills drive for HS2: we have the Birmingham Skills School helping with the training on that, and it is bearing fruit. Why don't we have the same drive for the skills to push forward decarbonised heat systems?" **IDNO**
- "We don't have the teachers to pass on these skills in the first place. We're about 20 years behind other European nations in this regard." **Government**
- "We need to get more women into heating to fill that gap and now it's a clean industry, it's more attractive." **Local authority**
- "The Centrica Energy for Tomorrow project will provide a perfect solution, as it goes into schools to sell STEM careers to children to get them interested in our industry." **Government**
- "WPD should be using mass events, such as community street parties, which I imagine will happen during the Jubilee weekend. There's so much exciting stuff going on, but we just need to get the knowledge out there." **Government**

- "I know we've been fitting air source heat pumps; we do that within the council, but we need to invest similarly in people understanding the technologies. We need to be sure that the properties are ready for that technology first, otherwise we can seriously get that wrong. I think there's a minimum threshold at cost per square metre. You need to get the threshold before you put anything at risk." **Local authority**
- "Engaging with private landlords has been a particular nightmare, so we need to engage directly with residents. There should be a standardised approach by the Government to make people consider these options." **Local authority**
- "There is also the issue of the viability, and the externalities involved with affordability." **Local authority**
- "We're finding the main issues are the supply chain and homeowner engagement, who are struggling to embrace the new technology." **Local authority**
- "The scale and complexity with private landlords are really challenging, so we're putting off the harder stuff until later. Starting with the social housing is a good solution as long as that learning gets transferred, and I've yet to see that happen." **Charity**
- "In order for a property to be compatible, you need to insulate the property first. It's an issue of capacity for the building works. Ecologists are very critical of schools as the career path is written off by schools, and so there is a major gap in filling the employment amongst the supply chain." **Charity**
- "Educating people is not the way to go, it's a waste of money. The fabric of the buildings is the be-all and end-all." **Energy consultant**
- "Biggest concerns are that our own incumbent teams don't have those skills, they're rushing back to get their teams skilled on it. We don't have the incumbent engineers to maintain these pumps. We're going to struggle to get teams to come and do this work." **Local authority**
- "You have to guarantee that they're going to be there for 10 years. The prices will come down when more people get them." **Domestic customer**
- "I think you've got to have an element of morality, rather than getting your money back." **Energy consultant**
- "You've got to be careful to do retrofits correctly. We've found lots of people not doing it correctly and just cutting corners. The issue is there is not enough infrastructure around installer training. There's no training plan." **Domestic customer**
- "How reliable is the new generation of high-temperature heat pumps?" **Academic institution**
- "The problem is whether you can supply enough power without the big spikes to run this system. Across our estate, I hate to think how many megawatts of heating systems we have across 800 buildings. If they're all electric, how do you supply it? You'd have to upgrade your transformers and underground network to accommodate it." **Academic institution**
- "Great what they're doing in Wales, but it's costing £50,000 per home. Who is going to pay for this?" **Local authority**
- "Retrofit is disruptive. I've seen programmes where we've had to take out the whole of the ground floor walls while the work is done. The whole thing about engaging with residents, and having a hand-holding process, too often that gets overlooked. Where key decisions are being made, that needs to be clearly communicated for the project not to fail." **Charity**
- "There needs to be a recognition there's a significant part of our population that don't use digital tools in the way that we would use a computer. Old-fashioned letters and door-to-door can't be discounted." **Charity**
- "One of the major challenges is when we are going through and retrofitting large schools with air source heat pumps." **Energy consultant**

- "Right to buy has become a big bugbear because we've got what was a council estate controlled by a single entity, pepper potted with privately owned and privately rented properties. So, when a social landlord is looking at installing a unified system, the whole thing can fall apart because we can't get a shared ground loop. Some of the regulations that organisations have to live with aren't flexible enough." **Charity**

4. How do we get retrofit to work in harmony with the grid?

- "It's more of an interface with major manufacturers; when it's something more bespoke where the supply chain changes, it then gets extremely hard to test for harmonics and get it put on the power grid. The harmonics and problems can't be assessed until the units are actually delivered." **Energy consultant**
- "District heating will be a good way to achieve this, but there must be buy-in from communities so that people agree when the heating goes on and off. As a result, WPD needs to create these communities and get them engaged around running their area heating." **Government**
- "IDNOs are looking to adopt every part of the network as part of community schemes in future." **IDNO**
- "Some of the work I've done previously has been around district heating schemes. Some of the most success in getting people on board has been going and knocking on people's doors, having demonstrator homes so you can see what the radiators and heat pumps look like, and taking people to see what a warm home looks like." **Energy consultant**
- "It's all about talking, about having the conversation. Making the WPD data open source, so that other innovators can come in." **Energy consultant**
- "I think battery storage is important, whether on the smaller scale in individual houses or on the larger scale on the grid." **Local authority**
- "If you want to smooth out the demand, you need some kind of storage. Either battery or thermal. We need solutions that are predesigned like a boiler. At the moment it's all bespoke and the hydraulics can be really complex. And it's very difficult for people to understand, particularly for the end users who have to maintain it. So, it needs a more wholesale approach and a kind of kit that can be easily maintained and understood. On a smaller domestic scale, there is some movement to standardisation, but it's not gone far enough." **Energy consultant**

5. How do we overcome the fact that EPCs (which review how energy efficient buildings are) have no regard for the network?

- "EPC ratings go down when heat pumps are installed, which is to do with the cost of the energy. When I gave an energy quote to a school last week, they simply couldn't afford a higher electricity bill. Unfortunately, it's a problem with underfunded schools being asked to front the bill for our shift to clean energy." **Energy consultant**
- "It always comes back to fabric first. Old buildings will always have a very poor EPC. To upgrade sufficiently is cost prohibitive, so most people aren't going to do it." **Energy consultant**
- "Only way this could work with regard to integrating the certificates would be using the EPC as a benchmark for seeing whether they could be upgraded." **Energy consultant**

- "You can fit the heat pumps in any property, so fitting them in already energy-efficient homes provides more benefit." **Energy consultant**
- "Where we're at with EPCs is they're not really fit for purpose. I keep seeing proposals to do a complete refresh, but until we see something, that one is a big sticking point." **Charity**
- "I am not sure there is or needs to be a relationship with EPCs and network but would be interested to understand if there could be." **Local authority**
- "We bought our house before EPCs, and it seems odd that you only have to do them when you sell your house. If everybody had one, maybe that would help people, because they'd have a plan." **Distributed generation customer**
- "If the EPC became a standard product and everyone had a free assessment, maybe there'd be an opportunity to apply for grants and start that work." **Distributed generation customer**
- "I'd never heard you could over-insulate a house before. Information like that would be fantastic just to give to ordinary people." **Distributed generation customer**
- "One of the problems with EPCs is the advice they give is very generic. A lot of the costs they give for measures are generic." **Charity**
- "For a household to actually use the EPC, it needs to be for a specific property and use prices relevant to that location rather than vaguely across the country. It would need to be more specific to be of any value." **Charity**

Session Three:
Development of Heat Pumps

During the third session, delegates were asked how heat pumps can be made affordable for various sectors and customers. Discussions also focused on mechanisms for improving affordability, such as loans and grants, and ways to ensure that no customers are left behind.

Summary

Making heat pumps affordable

There was widespread consensus across all sectors that the affordability of heat pumps was a pressing concern, and that the issue would be exacerbated by the cost-of-living crisis and rising energy prices. For many, action needed to start with central government, with some advocating a coordinated approach to ensure that no profits are made on heat pump installation. Other ways that government could bring down costs included introducing tax breaks or deductibles for heat pumps; scrapping VAT on energy efficiency payments and refurbishing buildings with decarbonised heating; and applying incentives such as reducing the stamp duty on highly efficient houses with good EPC ratings. Some felt that the government should significantly improve the consistency of its decarbonised grant schemes and avoid subjecting consumers, manufacturers, installers and local government to cliff edges. This, in turn, would give manufacturers the confidence to step up the production of heat pumps, bringing costs down in the longer term. Some stakeholders suggested that the low-hanging fruit lies in building decarbonised new housing, with lobbying needed to change planning regulations in order to get the efficiency standards of future homes right; again, it was felt that this would reduce the costs of installation for consumers in the longer term.

There was some approval for the idea of long-term loans for owner occupiers to fund the process of decarbonising homes as a way of taking the sting out of the high upfront costs of installation; however, loans would have to be long-term, interest-free and structured in a similar way to student loans in order to build trust among consumers. There was still some wariness about the idea of the bulk of the cost falling to the customer, and questions arose over the age of applicants (would those over 60 be approved?) and the length of time people tend to live in their homes (a loan spread out over seven years won't suit those who wish to move after five). However, many saw loans as a solution to the problem of cliff-edge grants and subsidies and a way to embed a longer-term approach and effectively fund

insulation and heat pump programmes for those who can afford them. On a philosophical level, some noted that cost was not the only factor, with one stakeholder pointing out that "we need to separate out the cost from the cost to the environment."

For social housing, the costs and responsibilities fall to local authorities, and there was considerable anxiety around this. Delegates shared stories of removing heat pumps from houses installed five years ago, as the costs of running them are prohibitive and many were installed incorrectly. Here, the issues lay around a lack of skilled preparation and knowledge among installers, in some cases preventing the house from heating adequately and causing bills to escalate. A poignant comment here was: "It's too late – it's already been installed. He's in social housing and no one is listening to him. He's been sold a dream." Other local authorities were waiting for the cost of heat pumps to fall before investing, while some were running their programmes from social housing rental income, and if the operational energy bills go up, their tenants get pushed into fuel poverty and cannot afford their rent, rendering the schemes redundant. In these cases, it was felt that it was "money going round in circles", and that councils would benefit from local delivery schemes being extended, better access for lower income households to grants and subsidies, and more complete support for district heating programmes.

It was felt that the commercial sector would lead the way in installing heat pumps, causing production and manufacturing costs to fall across the spectrum. However, in a similar predicament to domestic settings, there is a utility cost disparity to contend with between gas and electricity – a 'spark gap' – meaning that operating costs increase with heat pumps over gas. Although the price of gas is currently very high, it was felt that government must do more to economically incentivise electricity over gas.

It was clear that the subsidy process for large public sector buildings also needs considerable reform. The public sector decarbonisation fund was seen as prohibitively difficult for schools and universities to access without large cash and skills reserves, with delegates noting that "it's first-come-first-served". It was felt that the frantic nature of the application system should be better managed, with increased support and access for smaller schools to increase their chance of securing funding.

Mechanisms to make heat pumps affordable

As in previous discussions, stakeholders stressed that central government, with its ability to create interest-free loan schemes, subsidies, grants, incentives and tax breaks, is critical in enabling appropriate mechanisms. Attendees indicated that government grants are the most effective way to encourage the move to low-carbon heating solutions, with a score of 3 out of 4, followed by government subsidies (2.46) and government loans (2.28). Some felt that a blended solution of government-backed loans supported by the banking system, with 0% interest rates, would be feasible. However, many delegates reported a kind of "wild west" in decarbonisation as a result of heat pump grants and subsidies, with talk of a "rush" and "cliff edges", all of which is bad for business, communities, industry and customers. It was therefore stressed that any system must first prioritise the creation of suitable solutions for each type of building. Others pointed to the boom in solar in 2010, which brought costs down with the scale of production, as proof that subsidies work; many even reported that they would install solar now but there was no longer the incentive to do so. Above all, delegates wanted any mechanism to prioritise certainty, which enables the greatest number of sectors to implement long-term plans, with greater lead times to deliver and longer timescales for implementation.

Fairness and leaving no one behind

Fairness was a pressing issue for stakeholders, particularly when considering those on low incomes, or the older generation, who are not necessarily digitally adept. Some indicated that less home ownership, rather than more, might be a solution, as maintenance and retrofit costs are passed on to the landlord. Others felt that heat pumps were not viable for lower-income customers unless they were free, and that a focus on fabric first, rolled out carefully, but at pace, would ensure no one is left behind. A number of attendees felt that a skills and education drive and greater support were necessary to take customers of all generations on the same path towards greater automation and digitisation and enhance visibility and understanding of the installation process and timeframe for connections, along with support for field teams to deal with the incoming applications. Some asked whether the costs of upgrading to three-phase cabling could be shared, or socialised, as is done with connections, with a view to reducing inequalities in the system.

Verbatim quotes and voting

1. How do we make heat pumps affordable?

- "One issue is capacity in the marketplace. If you want a boiler changing, there are plenty of gas fitters. Air source though we don't have the volume of tradespeople and the supply chain is not secure. Also, the supply chain might be overheated if we're all chasing it." **Local authority**
- "We've got to try and get a sense of not considering costs above everything. If we wanted to use the cheapest fuel, we would be burning coal. So, we need to separate out the cost from the cost to the environment." **Storage and renewables provider / installer**
- "In essence, there aren't enough heat pump manufacturers or installers. The whole supply chain needs to be massively ramped up." **Local authority**

For owner occupiers

- "Governments should start by making house developers redesign their homes, and they need to press them financially on it. Governments can choose to push housing policies in the direction of their choice." **IDNO**
- "Loans may seem like a good idea on the surface, but if you're a 65-year-old homeowner, are you really going to be given a loan? And what about funding the maintenance?" **IDNO**
- "Coming back to the idea of incorporating it into the mortgage. A subsidised approach to support things as well as a loan would be a good approach." **Developer**
- "So many people ask me for help. People are spending a fortune using technology that they don't know how to use." **Energy consultant**
- "Fuel poverty is going to become a massive issue in this country." **Energy consultant**
- "Encouraging more people to install them is the obvious way. If you use them more, they'll become cheaper, like any mass product." **Local authority**
- "How much does it cost to heat your house using the energy from an air source heat pump? It's the capital cost which is the problem. If it's £15,000 to put one in, that's never going to win out over a £2,500 boiler. But with long-term cheap loans, that £15,000 could be spread over many years and you wouldn't notice the cost as much." **Energy consultant**
- "If the money isn't coming from anywhere, then all WPD could do is to lobby government on customers' behalf I suppose. Maybe a tax reduction on the equipment you've brought." **IDNO**
- "It works out a lot cheaper for people to have heat pumps in new homes as you're offsetting it against the cost of installing a boiler and traditional heating systems." **DNO**
- "We focus a lot on the equipment cost, but I still think there's a huge saving to be had in the actual procurement side." **Storage and renewables provider / installer**
- "Basically, I think it's just recognising that it's not just the cost of the heat pump, it's also the electrical supply upgrade, it's improving the thermal insulation of the building, or the fabric performance, but also replacing heat emitters with something larger." **Energy consultant**

- "Long-term, interest-free loans from the government similar to student loans. If you don't pay it back until you can afford to, that would make it even better, but I'm not sure that would work. Realistically, it will be 0% loan paid back over a long time. Then it's offset against savings in power consumption." **Energy consultant**
- "Particularly on retrofit, the cost of fabric-first measures is the prohibitive cost. Therefore, if there was an agreed system, for example, if you have an EPC of grade C or above, you qualify for this kind of pump. A bit more clarity on where you need to be on the EPC to get that heat pump past the economically viable level." **Energy consultant**
- "There's a flaw in the argument of loans. Even with mine, the payments were made over seven years, which was a leap of faith. People tend to move after around five years I think, so that's a stumbling block." **Energy consultant**
- "It's becoming more prevalent, the quest for zero carbon, so surely the value of your house will increase if it's close to carbon neutral." **Energy consultant**
- "I think it would have to be a government incentive, like reducing the stamp duty on houses that had good efficiency and EPCs." **Energy consultant**
- "There's a cliff edge and we have people trying to rush things through. The long-term approach of a loan scheme is a good idea." **Storage and renewables provider / installer**
- "Within the domestic sector, a fabric-first approach is the correct way forward, using the EPC to decide what the priorities should be." **Energy consultant**

For social housing

- "Depending on the size of the properties, you could have mandated district heating, for example." **IDNO**
- "We're doing funded work for air source heat pumps but have been advised not to invest yet because the market is too immature. I'm not sure if the value of a heat pump at the moment reflects its true value – it's overinflated. Demand is driving the price higher and higher. It seems that everyone is waiting and wants to get stuck in, but they are waiting." **Local authority**
- "People are trying to retrofit heat pumps even though their radiators aren't big enough, so that's an issue because the house doesn't get hot enough. My friend's electricity bills are ridiculous, and he now knows why that is but it's too late – it's already been installed. He's in social housing and no one is listening to him. He's been sold a dream." **Energy consultant**
- "Newark have taken out heat pumps that were installed five years ago because the cost was too high on residents, because the essential prep hadn't been identified ahead of their installation. They're not affordable. There needs to be more transparency within the industry." **Local authority**
- "There might be a limited number of grants available for those who can't afford it as much, e.g. those on benefits, in social housing." **Local authority**
- "There are already some schemes available from energy and water companies for some relief on bills." **Local authority**
- "It's money going round in circles. Electricity companies have an obligation to pull money out to help people in fuel poverty to get lower carbon technology. So far energy companies are doing it through more efficient boilers, but they could be doing it with PV or heat pumps instead. These are all macroeconomic or political decisions unfortunately, not WPD's decision." **Energy consultant**

- "In Swansea the primary concern is operational: once you install, is it affordable for tenants? Operationally, we don't get taxpayer funding, all our funding is through rental income, so if we can understand that, it sort of pays for itself. We're playing a waiting game. Not in a position to install without placing tenants at risk of being fuel poor. Our stock runs from being built in 1919 to today so we have all sorts of types, ages and states of repair." **Local authority**
- "Local delivery schemes have been extended. Proposing a period of five to ten years between which a programme is delivered and finished." **Local authority**
- "Shouldn't we be investing in heat pumps on social housing? The rents for them are cheaper than private rents after all. In addition, by having a large landlord, you'd be able to operate on economies of scale, and that would enable you to make savings." **IDNO**

For the commercial sector

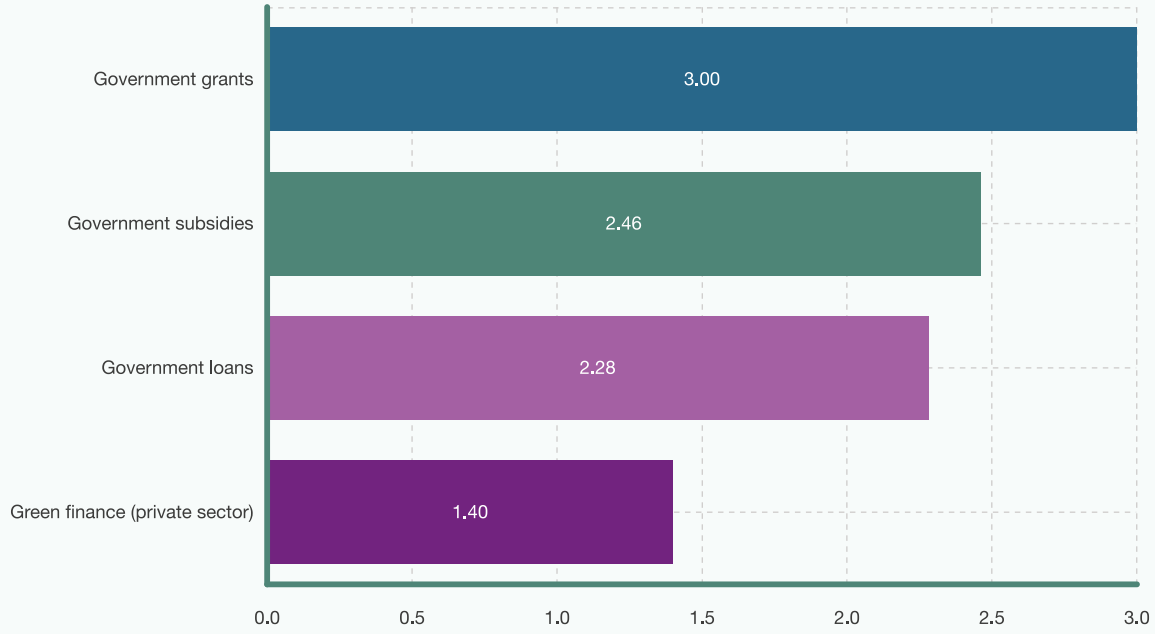
- "The government need to help manufacturers out. It's for everyone's benefit, not just ours." **Domestic customer**
- "We will be the ones that start the ball rolling on bringing costs down. The conversations we're having with manufacturers, they're suggesting they won't have a problem in meeting developer demand. It's the privileged people moving in and paying for pumps that will be the initial ones bringing costs down." **Business customer**
- "The major issue we see on commercial installations is utility cost disparity. Gas tends to be 3p/kWh, but we see electricity tariffs of up to 14p/kWh and above. This is a 'spark gap' of 4.6, higher than the coefficient of performance of most heat pumps, this means operating costs increase with heat pumps over gas." **Energy consultant**
- "We need to make sure we're going to be installing commercial units that won't cost an absolute fortune to run." **Business customer**

For large public sector buildings

- "Homes are going to be difficult; schools will have to be funded." **Distributed generation customer**
- "Schools have the public sector decarbonisation fund. I think it's in the fourth round of funding and applied for through local government." **Energy consultant**
- "It's impossible to get funding through that. Basically, you need your application ready within an hour or two of the schemes coming out. You've got a few months to deliver, but it all goes into a big pile when it's released, and it's first-come-first-served." **Energy consultant**
- "There's funding available, it's difficult to get access to and difficult for smaller schools to approach, so single schools have no chance." **Energy consultant**

2. What is an appropriate mechanism to make heat pumps affordable?

Which do you think are the most effective ways to encourage customers to move to low carbon heating solutions?



- "Manufacturers do need some certainty, they do not need stop-and-start policies or incentives, it is the worst possible thing. They're planning production lines, and it can take two to three years. They need stability." **Storage and renewables provider / installer**
- "I like the idea of a loan scheme. We never see massive uptake in year 1, in year 2 and 3 is when we start to see massive interest." **Local authority**
- "What I've found dealing with schemes over the last 20 years or so, people have got used to having grants. When the grants stop, they're waiting for them to start again." **Charity**
- "Too often the government promises things, and they change their minds, or they make it so complicated people can't be bothered. There needs to be consistency." **Charity**
- "I think that this should be delivered through a centrally coordinated approach from the government and ensure that no profits are made on installing these heat pumps. In theory that should keep the costs down." **IDNO**
- "We need to have a blended solution, which needs to be government backed and supported by the banks too. In addition, before doing anything else, you need to really make sure that you have a suitable solution in place for each type of building before proceeding." **Business customer**
- "You need to create certainty. The idea of loans, quite a lot of people won't engage with this. You need a level of understanding and education. You need to work out the installation cost versus the potential savings on your electricity bill. Also, this idea of shifting the levy from electricity to alternative sources, there needs to be a huge education programme led by government. It comes back to the schools as well." **Business customer**
- "It's a bit like the wild west. There's no legislative standard here and there are meetings between all sorts of people who wouldn't normally interact with one another." **Business customer**

- "Some form of green finance will hopefully be coming, but these schemes have been talked about for 15 years, and they've never really taken off. It is mainly having more long-term stable goals, so we can run programmes properly." **Local Authority**
- "May need to model the financing on each of the sectors, with longer times to deliver and a longer time to implement for some of these schemes." **Energy consultant**
- "In terms of government loans, the 0% scheme in Scotland sounds like a good idea, but it's not promoted enough." **IDNO**
- "In social housing loans are not an option." **Local authority**
- "It worked well for solar. There was a massive solar boom in 2010. I don't understand why they aren't doing things like that for heat pumps." **Energy consultant**
- "Solar was expensive in the beginning, and it came down because the subsidies brought the volume into the market. For me, that's a proven market that has worked." **Energy consultant**
- "I know my property is ideal for solar, but there's not been an incentive to do it." **Energy consultant**
- "I think government incentive. Something like a 50% grant may help." **Community energy group**
- "A heat pump energy tariff would be a good idea. That also makes operational tax lower." **Charity**
- "It's all of the above. As long as you can get a longer-term supply chain, companies will invest, new companies will spring up and do it in a digital way." **Energy consultant**
- "It's another bill, isn't it: utility bills, student loans, mortgage repayments, potentially rising interest rates. So, for people who can afford it, it's okay, but for others it might be yet another bill." **Local authority**
- "There needs to be more of an emphasis put to the government and end users on what WPD's very long-term economic plans are. The education on new technologies is an important part of this." **IDNO**
- "Give them away for free! A lot of councils do good interest-free loans, so we should be looking at things like that." **Local authority**
- "On a smaller level, you could look at taxes/VAT. And if you can lower the costs of the individual parts, that might be another way to keep the costs down." **Local authority**
- "The easiest way to bring the costs down is to produce a heat pump that does high-temperature water. Then you can just take the boiler off the wall and simply replace it with the heat pump." **Academic institution**

3. How can we make this fair so that no customers are left behind?

- "I really like the 'Energiesprong' model, which involves placing pre-fabricated panels on the outside of a home or block and would help to insulate it. Then, a company could buy your home or block, and then rent it back to you. That means that you will no longer need to pay to maintain your home. The lack of maintenance costs would be a big plus here, as external wall insulation means that you have to replace the roof and change the windows in order to line everything up." **Government**
- "I've never thought about it before, but not owning a home makes a lot of sense to me, particularly as I'm coming into my sixties. The idea of not having worry about maintenance costs is appealing too." **Connections provider**

- "There's an issue of regulation of these installations and ensuring we're not putting heat pumps in homes that aren't suitable and don't yet have the retrofitting capabilities and insulation to support the installation of heat pumps." **Charity**
- "I think it's about the no-customers-left-behind from a cost perspective, but also from a digital perspective. Elderly people don't necessarily know what to do. So, it's about making the products easy to use. One reason heat pumps have been taken out of schools is that janitors have not been taught how to operate them. So it's about passing on knowledge and skills, education and training." **Energy consultant**
- "To be honest, I don't think it's feasible to put heat pumps in for low-income families unless it's free. We should install insulation before even considering retrofitting heat pumps. I have many reservations about this due to the long-term affordability." **Energy consultant**
- "We should be funding these in a consistent and long-term way. We have to turn applications and grants around in such a short time, and that isn't the way forward." **Local authority**
- "Support with visibility, understanding the process of installation and how fast the connections can be made. Streamlining assessment of people's products through picture taking. Propping up field teams to deal with the incoming applications; needs more savviness and technological advancement. Make policies clear in layman's terms." **Utility**
- "Could the costs of upgrade to three-phase be shared or socialised, as is proposed for new connections?" **Local authority**
- "We do need to separate out those who are able to pay and get them to move first. We need the market to grow significantly to get those economies of scale to address those who are being left out. The student loan example proves we can do it over a long time." **Charity**

Session Four:
Alternative Technologies

During the final session, stakeholders were asked about other low carbon heat sources on the market, such as district heating, electric boilers, solar thermal panels and CHP, and their role in WPD's system design.

Summary

Prioritising new technologies in terms of system design

Delegates were asked to rank alternative technologies in order of priority for WPD to include in its system design, and district heating came out top, with 4.19 out of 5. This was backed up by the discussion sessions, where district heating was the most widely debated option. In second place was direct electric heating (3.11), and in third was solar thermal (2.53).

Delegates highlighted the importance of blended, integrated solutions, given the nationwide variation in housing stock, commercial buildings, geography and infrastructure, with one stakeholder noting that it would be "naive to discount any one particular technology, because they all have benefits in certain environments". There was also an emphasis on storage as a key asset that will assist with the roll-out of different technologies. Some felt that it was too soon to confidently predict the future of alternative heat sources, and many argued that, despite the other options available, heat pumps would still be the cornerstone of decarbonisation of heat.

Stakeholders recognised that district heating is expensive and disruptive to install, although some pointed out that despite these factors, it delivers positive outcomes. Others were more wary, especially since countries that rely more heavily on district heating, such as Denmark, Norway and Sweden, built their cities to accommodate these systems, whereas the UK would have to take a retrofit approach. It was clear that new builds could be better planned to accommodate district heating networks, and many felt that building regulations should reflect this. The real positives of this system were felt to be that it lends itself to new technology and could be combined with any type of heat pump.

There were mixed views on direct electric heating. Some saw it as a very attractive option, since direct electric heating works more efficiently than heat pumps in insulated buildings and is cheaper to install and replace, making

it a sensible option for large apartment blocks with elderly residents, for example. Interestingly, a delegate reported that the heat pump industry is "petrified" of this cheap, low carbon solution. However, many reported that it is too expensive to run and uses up grid capacity that is badly needed for EV roll-out and heat decarbonisation, with a local authority representative reporting that its use in new builds was being discouraged for this reason.

The picture surrounding solar thermal was more complex, with some feeling that it lacks the versatility of solar PV as water is heated during the day, leading to substantial energy waste if the water is not used, meaning that it may be more suitable for warmer climates. Furthermore, solar thermal requires huge storage facilities for use during winter, and with very little roof space left per dwelling, there is understandably some debate over which technologies should take precedence. Although CHP was not a priority for stakeholders, scoring just 1.75 in the electronic voting, it was noted that it can be an efficient approach that minimises transmission losses.

Potential difficulties with new technologies

With a few exceptions, the major difficulties identified by delegates tended to relate to implementation, rather than the technologies themselves. Delegates expressed concern over supply chain issues and the notable skills gap in the green energy sector, contributing to a lack of skills and knowledge in the drive to net zero. Others foresaw real difficulties with supporting fuel poor customers, whose numbers are rising rapidly with the cost-of-living crisis and the spike in energy prices, with the costs of installing and running decarbonised heating technologies. While the DNOs, and WPD in particular, were seen to be offering real help in this area, attendees called for more support and engagement with suppliers. There was also concern over the resilience of these new electrified technologies, particularly in the light of severe weather events, such as flooding and storms.

Technologies not worthy of system design

Delegates were very clear that at this stage, WPD "shouldn't take anything off the table" in terms of technology, as a one-size-fits-all approach is evidently not sensible in the journey to decarbonise heat; instead, solutions should be applied on a "home-by-home, project-by-project basis". Despite some technology-specific concerns, such as the cost of running electric boilers, the available roof space for solar thermal and the complexity of implementing domestic infrared heating panels, stakeholders were firm that these concerns should not preclude further development, as these "aren't the finished products yet".

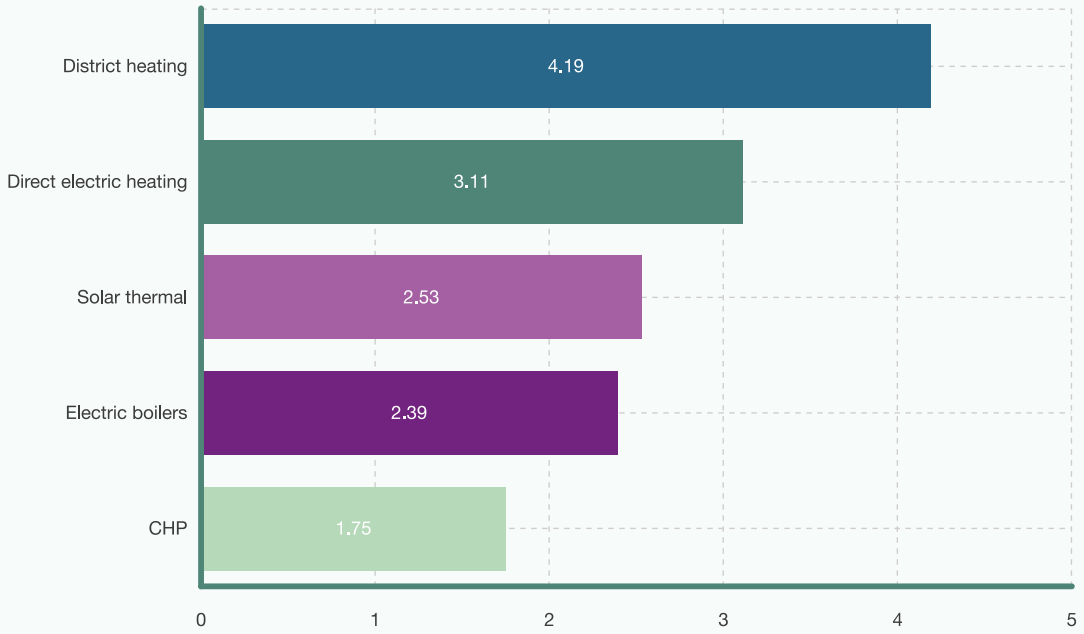
Other options for electric heating technology

Stakeholders suggested a wide range of alternative technologies that could contribute to the overall decarbonised heating picture. Graphene heating technology, currently being trialled by the Welsh Government, had been shown to perform well in test conditions, with the further option of adding hydrogen, distributed via the gas network and generated using wastewater. Many delegates felt that hydrogen should be a higher priority as an alternative fuel. Phase change storage technology was being researched by delegates from the academic sector, who are looking at thermal storage that is electrical inductively heated, as well as thermal chemical storage, which have zero standing losses and avoids the environmental impact of lithium-ion batteries. Another innovative product is a heat pump with a solar drive, which places battery storage, PV generation, solar drives, heating and cooling in a single box, significantly improving efficiency through the absence of invertor drives. Some felt that solar has untapped potential, with suggestions to mandate solar for every house, adopting an opt-out system, rather than opt-in. Others pointed to the capacity of tidal stream and tidal power projects, given the UK's geography, and wanted to see nuclear options taken far more seriously for clean energy generation. Heat reclaim and recovery was also widely advocated, with many rueing the current lack of incentives, which makes it "physically available but financially unviable".

Verbatim quotes and voting

1. Which of the new technologies do you think we should prioritise in terms of our system design?

Please rank the following alternative heating technologies in order of priority for WPD to include in their System Design.



- "All of the solutions presented are viable, but we need to tailor them to the different types of geography, infrastructure and technologies available. Storage will be a big silver bullet and will assist with the roll-out of these different technologies." **IDNO**
- "I don't know if it's WPD's job to prioritise. It's their job to react to the government. They need to be able to say to government, "Look, if you do this, then this will be the impact on our network." So, they need to influence government, and if you influence government, you will influence Ofgem automatically." **Energy consultant**
- "I've seen a couple of infrared panels, but very few. Demand tends to be for heat pumps. We've had some people coming in and looking for an electric boiler hybrid to get the available electricity tariffs. We get a lot of apartment blocks going with direct electric heating." **DNO**
- "I think it's just too soon to say with these alternative heat sources. Two years ago, it was biomass boilers. Now it's heat pumps. They might not last." **Domestic consultant**
- "I think heat pumps are going to form the cornerstone of any decarbonisation of heat and there is a place for hydrogen but it's niche, and heat networks are going to be relatively small scale in comparison. It's the fringes of the network that are going to have most relevance for those different technologies of storage." **Local authority**
- "We need to embrace more technology. There are situations where one alternative won't suit everyone. There's such a variation in housing stock and commercial. So, I think it will be naive to discount any one particular technology, because they all have benefits in certain environments." **Business customer**

- "I think a hybrid solution with a gas boiler and a heat pump in the same box in a kitchen cupboard would solve all of the problems. WPD wouldn't have sudden rush when it's cold because gas kicks in. Heat pumps can be 400% efficient in summer and less than 200% in winter, so you can use them when they're most efficient and use gas when it's cold outside. It shouldn't be too expensive." **Energy consultant**

District heating

- "They're expensive pieces of kit but deliver better outcomes. While they may take up a lot of space, I do feel that it is worth it." **Connections provider**
- "I still have issues with costing and funding. People I know on district networks have not got low energy fuels but they're actually paying more than I am for that privilege. When you look at Denmark, Norway, Sweden, they were building their cities to accommodate this, whereas we never did, so we're playing catch up. Effectively, we are looking at retrofitting district network schemes." **Storage and renewables provider / installer**
- "It's major infrastructure work. In Bristol they dug up and repositioned roads." **Charity**
- "We are going to go down the route of this I think." **IDNO**
- "With all the new houses being built, the government just needs to say that they've got to be put on to a district heating network." **Storage and renewables provider / installer**
- "Perhaps they're more viable now that modern housing is more heat efficient." **Local authority**
- "District or communal heating does lend itself to new technology; we are currently installing shoebox ground source heat pumps into tower blocks in Leeds, and we're looking at the potential of large CO2 air source units, which produce higher flow temperatures and again lend themselves to district heating, although they are expensive to purchase." **Energy consultant**
- "I think this is a good option because you can combine it with any source of heat pump, and you can start applying diversities. One thing that should be in there is exhaust air heat pumps because if you build something really tight, you can put an MVA charger in there and it extracts the heat back in before it goes out. For one and two bed apartments, that's the way to go." **Energy consultant**
- "In Europe, they do manage to redistribute heat using super insulated cables, so there should be a way of doing that. Battersea Power Station didn't have cooling towers because they used the excess heat to heat the houses around the area." **Energy consultant**
- "We pulled out of district heating schemes, as they were leaking and too old." **Local authority**
- "District heating would probably work better on new builds, as retrofitting would incur significant extra costs." **Energy consultant**

Direct electric heating

- "The other positives are that these units won't take up all of the space and won't make a lot of noise like heat pumps do." **IDNO**

- "If you have insulation and direct electric heating, you would be heating the home more efficiently than using heat pumps. In addition, it's cheap to install and replace." **IDNO**
- "Yes, WPD should be investing in direct electric heating." **Connections provider**
- "We do a lot of large-scale apartment blocks for elderly residents, and they don't have any value in long-term investments, so they will opt for direct heating." **Energy consultant**
- "In the heat pump industry, we are petrified by direct electric because it's so cheap and so easy, and so low carbon." **Storage and renewables provider / installer**
- "The new building regulations that are coming out in London don't even allow direct electric heating, so I don't think it's even an option." **Energy consultant**
- "I agree that direct electric at peak rate is unlikely to be much more than a top-up, but there is direct heat storage which could be incorporated into it." **Energy consultant**
- "Direct electric heating is far easier to retrofit, with a relatively low cost for installation, but it is slightly more expensive to operate." **Energy consultant**
- "We discourage developers from installing direct electric, which they like as it's very cheap, as it's so expensive to run for consumers – three or more times – and uses up lots of grid capacity needed for EV roll-out and heat decarbonisation." **Local authority**

Solar thermal

- "I don't think that they're the future in this country, as you're heating water during the day when it's hot. They're not versatile like PV." **IDNO**
- "We have solar thermal. We end up throwing away a lot of the energy because we don't use a huge amount of domestic water. We need a big thermal store." **Community energy group**
- "I think the area we are going to really need to focus on is thermal storage, because we're going to have to try and store energy to smooth out demand." **Storage and renewables provider / installer**
- "You've got smart heating cylinders now, which manage the heat usage much better using algorithms which work out when you're using them the most. You've also got electric showers which manage this more effectively. We're trying to get away from storing large amounts of water in that sense." **Energy consultant**
- "In our area, a lot of new builds are multiple stories, so there isn't the space on the roof to put enough solar panels on there. It would be a good technology in the south-west, where buildings are mostly low-rise, but not in the Midlands." **Energy consultant**
- "I guess we rarely put it into buildings these days as it's expensive and complicated hydraulically. It's just a bolt-on to reduce carbon when the sun's out, so you might as well just use solar PV." **Energy consultant**

CHP

- "CHP is quite a good idea. Media City in Salford is using that system at the moment, as they are taking water from the Manchester Ship Canal for their air conditioning, which seems to be working amazingly well. It's an efficient approach, as you get a lot out of it." **IDNO**
- "There is still a place for CHP because there is only 85% of energy lost through transmission and it takes the pressure off the grid." **Energy consultant**

2. Do you anticipate any potential difficulties with any of the new technologies we are considering?

- "I see possibilities in installing the new technology, but I'm not sure how they could be financed." **Local authority**
- "District heating can be expensive and can take up lots of space, but those negatives are far outweighed by the positives." **IDNO**
- "The main con for direct electric heating is that the coefficients are not particularly great for heat purposes." **IDNO**
- "The supply chain issues for materials are a nightmare." **Connections provider**
- "We're having an issue with getting people through the sector. Jointers don't need to have an electrical qualification and I feel that that's ridiculous, so we don't have the right skills or knowledge in place to drive this." **IDNO**
- "The Welsh Government is providing fully funded programmes for developing green skills, but people are not taking them up." **Government**
- "Already with vulnerable customers, WPD are being proactive. Where are the energy suppliers within this discussion and within supporting vulnerable customers, despite the DNOs doing more and more to support them?" **Charity**
- "It's bizarre that we are still building houses that aren't hitting the highest ratings. This event is fantastic but there aren't enough housing developers here." **Local authority**
- "Solar thermal panels are a mess, although they are good in certain areas. Most of the technology is meant for warm climates." **Storage and renewables provider / installer**
- "In the recent storm, all electricity and cell signal were out, and without an internal combustion engine, I would've been completely stuck in the event of an emergency." **Energy consultant**
- "Anything that mirrors current approaches will be most readily taken up. Make it as easy as possible for people. The least level of adjustment." **Local authority**
- "Network capacity will always be an issue." **Energy consultant**
- "For Cornwall, because we're 50% off-gas, we've got a high percentage of properties that still use night storage heaters using Economy 7. A lot of people are quite wary of the new technologies. Things like the infrared heating piece, we've had people selling them in, then people come to us and say we're not sure what we've bought and then when we unpack it, it's not suitable. There's a whole education piece we need." **Charity**

- "Energy Action did a trial where they were matching Tesla batteries to storage heaters, so technically they were trying to maximise night-time tariffs. There are some possibilities of trialling things that have a role to play in this." **Charity**

3. Are any of these technologies not worthy of inclusion in our system design?

- "The electric boiler. I don't think that has a place in the market." **IDNO**
- "They aren't the finished products yet." **Major connections customer**
- "One size won't fit all, so you need your plans and available technology to be flexible for a home-by-home, project-by-project basis. You shouldn't take anything off the table." **IDNO**
- "The more variety gives us more flexibility as engineers to tailor to our clients." **Energy consultant**
- "I think all of the mentioned technologies need to be considered, as each case is completely different. Things like infrared heating panels will be difficult to implement in homes. Things like CHP are not going to go away, but they don't offer the benefits others do." **Local authority**
- "Do not install an electric boiler, customers are spending up to £120 a week. A lot of them are on prepayment meters, having it on for eight hours a day with young kids, and it eats through the money. Doesn't factor in the expenses." **Local authority**
- "For smaller properties, having an updated form of storage heater does make sense. It's that capital cost versus running cost argument and whether it's always a good idea. The infrared heating doesn't heat up the fabric of the home and that often can lead to other issues within the fabric of the property. Having something that's radiant is probably a better idea than infrared." **Storage and renewables provider / installer**

4. Is there any new electric heating technology that we have missed?

- "In Scandinavia, Nilsson Energy has been dead impressive with off-grid hydrogen and fuel cells in schools. I think those advancements will start being seen here because they sell packages with all that tech in it." **Business customer**
- "I would be looking at the electric storage systems, whichever they might be. They've got the beauty of being able to absorb surplus energy. You can talk to them directly and tell them to switch on and off." **Charity**
- "The use of the gas network for hydrogen. Based on the timescales, we have targets for net zero, I can't see these being feasible unless we consider a gap which I think hydrogen can fill. Is there any way that WPD could get involved?" **Connections provider**
- "A few people cling on to the hydrogen debate, but it doesn't really stack up. The Climate Change Committee just said it does not stack up. The one benefit of hydrogen is that it's a storable fuel, so you could potentially produce it when you have high wind demands, and I think it should be reserved for vehicles. Vehicles can store it and take it, which they can't with heat pumps." **Energy consultant**

- "Graphene heating technology could be really great. In tests performed by the Welsh Government, graphene was performing amazingly, even in leaky homes which had not yet been retrofitted, so that does have a lot of promise. In addition, Welsh Water are using wastewater for generating hydrogen. This shows that all of these different utilities are there to harness. All we need to do is join the dots and use them effectively." **Government**
- "There are companies that think they can get solar too in windows now." **Major connections customer**
- "If the government changed the way it does things to mandate solar in every house (an opt-out system, rather than opt-in), that would always contribute at all times, and you could always draw from this." **Energy consultant**
- "There is definitely potential in tidal stream and tidal power projects, despite a number of previous plans being shelved due to environmental, design and cost concerns. However, they would generate huge amounts of energy and should be considered." **Government**
- "In France it's standard practice to have turbines in rivers." **Community energy group**
- "There's warm air above a sewer and warm water in a sewer, it's thermal energy which is there to be used." **Charity**
- "Heat reclaim needs more investment." **Domestic customer**
- "Getting access to heat reclaim is an issue too. In Birmingham there's a massive heat network, but only the hospitals use it because there's a massive bill to tap into it. It's physically available but financially unviable, it's a great shame." **Business customer**
- "They're talking about mini nuclear reactors now." **Local authority**
- "And the old-fashioned idea of redistributing heat between parts of the building that have more and that have less." **Local authority**
- "And heat recovery as well, so that ventilation doesn't remove heat along with the air being ventilated out." **Energy consultant**
- "We're looking at another version of a phase change store. It's a thermal store but it's got to be electrical inductively heated. We're also looking at a thermal chemical store. It has zero standing losses. It's cheaper without the environmental impact of lithium-ion batteries." **Academic institution**
- "The thermal chemical side, it means you can store a few days of thermal energy, there are a lot of things you can play with. WPD should prioritise those that have capacity for storage to help with flexibility and services." **Academic institution**
- "One that's come forward recently is looking at a shared ground source heat pump where if you've got a play area or a communal space, you could have all your pipe work under there and each house could share the heat that comes out of that." **Local authority**
- "Battery technology at the moment is becoming more and more efficient and it will only increase exponentially. The ideas and intelligence are already there, we're just waiting for the market and legislation to catch up." **IDNO**
- "I'm working with a company near Cambridge that's developed a heat pump with a solar drive. It uses the direct current generated by PV directly to drive the motors for the pumps. It misses out the invertor drives you'd usually associate with this kit and significantly improves the efficiency. Obviously, there's losses in all that kit. So, it's all in one box: battery storage, PV generation, solar drives, heating, cooling. They're called Arriba." **Energy consultant**

Appendix 1
Attendees

A total of 95 stakeholders attended the workshop, representing 55 organisations. The organisations represented on the day are shown below:

AES Smart Metering
Anthesis
Bristol City Council
Brush Power Distribution
Canal & River Trust
Cannock Chase Council
Cardiff Capital Region Skills Partnership
Cenergist
Centre for Sustainable Energy
Community Energy Plus
Couch Perry and Wilkes
Energy Assets Utilities
Energy4All
EQUANS
ESP Electricity Ltd
European Utilities Telecom Council
Flintshire County Council
Floh Consulting
Fundamentals Ltd
GTC
Heat Pumps Association
Herefordshire Council
Homes in Sedgemoor
HSE
Jacobs
Llangattock Green Valleys
Mansfield District Council
Morrison Energy Services
North East Derbyshire District Council
North Somerset Council
Orangehouse Renewables Ltd
Pinnacle Power
Plymouth City Council
Power On
Ramboll UK
Redrow Homes
Renewergy
RES Group
Sheffield University Active Building Centre Research Programme
Smart Energy GB
South East Wales Energy Agency
South Hams District Council
Spencer West
SSEN
St. Modwen Logistics
Swansea Council
Thornbury Orchard Group - Sustainable Thornbury
TUSC Ltd
UK Power Solutions
University of Bristol
Vale of Glamorgan Council
Warwick District Council
Welsh Government
Worcestershire County Council
YES Energy Solutions CIC

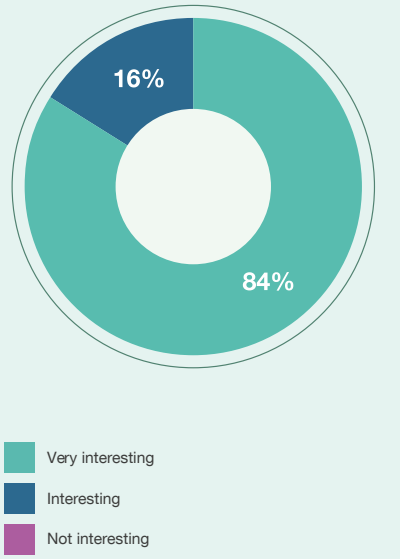
Appendix 2
Workshop feedback

After the workshops, stakeholders were asked to complete a short feedback form. The feedback was as follows:

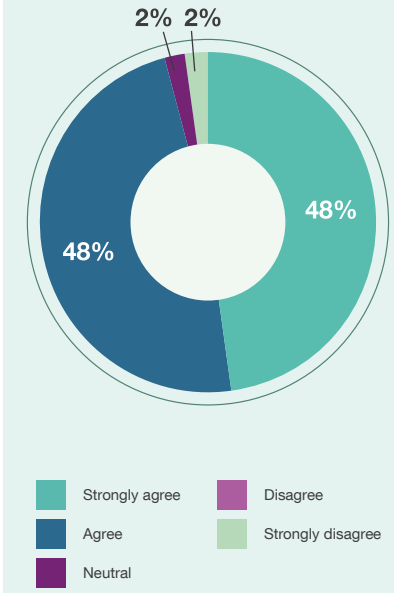
1. Overall, how satisfied were you with today's workshop?

When asked how satisfied they were on a scale of 1–10, 82% of stakeholders gave a score between 8 and 10.

2. Overall, did you find this workshop to be:

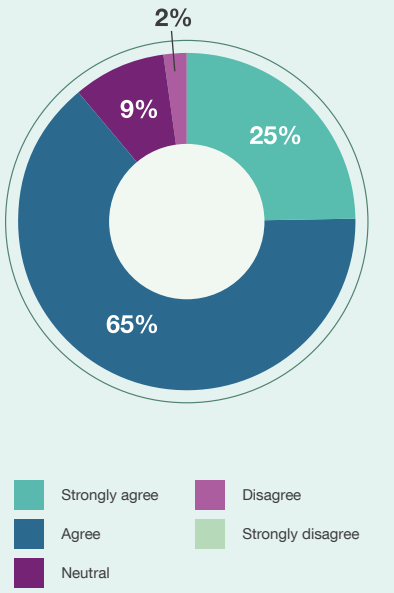


3. Did you feel that you had the opportunity to make your points and ask questions?



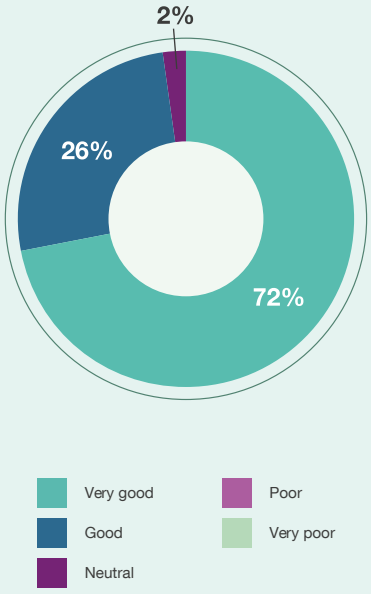
- "Plenty of opportunity to ask questions and respond."
- "A lot of discussion surrounding retrofit of insulation, whereas I have more of an interest in new build."
- "Good roundtable discussions, well led."
- "Would have liked to see some Q&A as well."
- "Very engaging, great presentations and great networking opportunities."
- "Very good to hear all the experience and opinions from industry stakeholders."
- "Good mix of people on table, good parts of discussion on the difficulties associated with decarbonisation projects."

4. Did we cover the right topics for you on the day?



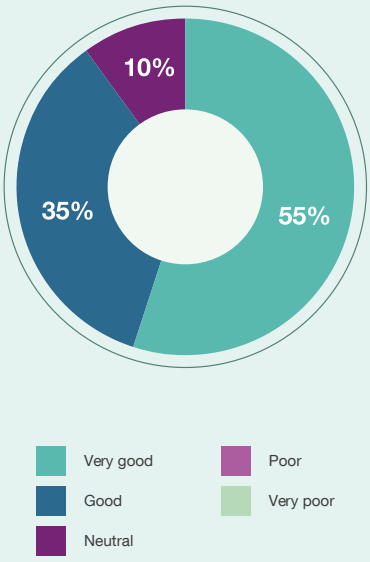
- "Yes, a growing area of relevance in new and existing developments."
- "Session could be split into existing housing stock and new homes to go into more niche."
- "Yes, but probably needs to be widened for other market sectors (industrial and commercial)."
- "Amazing knowledge exchange."
- "More technical in-depth discussion on power quality would be more useful to really understand real-world problems on projects and delivery."
- "More perspectives from impact on the grid and grid connections. Summary of new policies implemented by WPD with regards to heat pumps."

5. What did you think of the way the workshop was chaired by your facilitator?



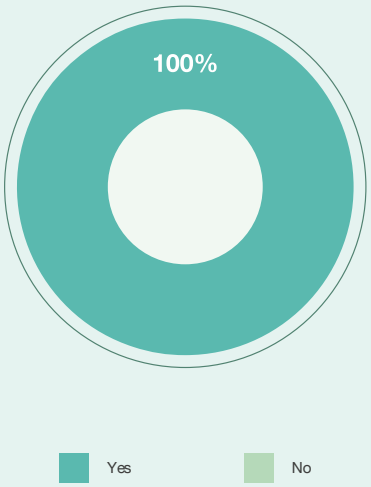
- "Excellent."
- "Very beneficial to have guest speaker at table, might be good to align tables to speakers."
- "Fantastic."

6. What did you think of the way the hybrid approach to this workshop worked?



- "In person, but good to have the option to attend remotely – to get better variety of input."
- "Very useful to have both options, though I can only comment on a physical event."
- "The way of the world these days."
- "Hybrid does open up to a wider audience."
- "You can't beat people being present."

7. Would you be interested in engaging with us in the future?



8. Any other comments?

- "Fantastic presentation. Good to get local authorities' point of view."
- "Very interesting day, very informative."
- "Excellent that WPD is grasping these topics."
- "Ensuring that the participants around a table have the right diversity."
- "Great workshop, well done."

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