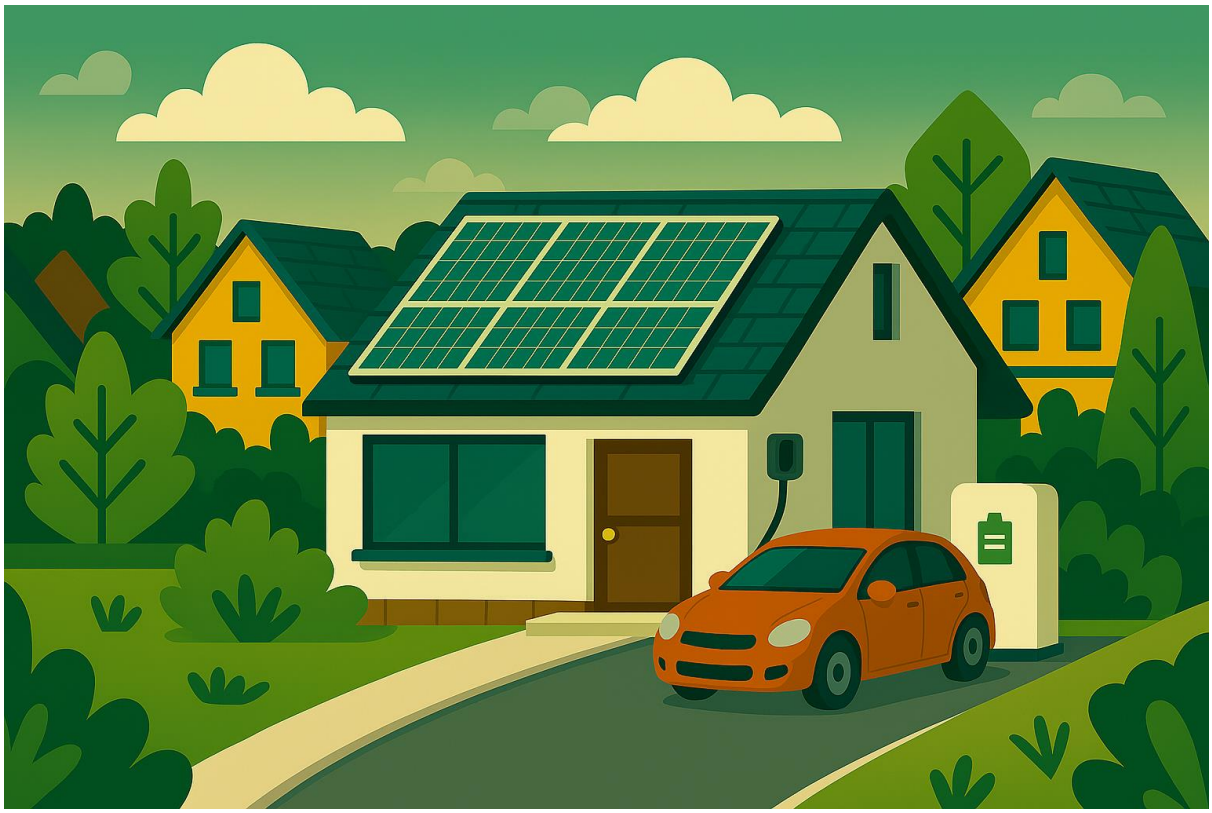
PROJECT: LIVING WELL IN LOW CARBON HOMES (LWLCH) RESIDENTS EXPERIENCES, RESPONSIVE DESIGN AND THE SWITCH TO NET ZERO BUILDINGS



RESIDENT EXPERIENCES OF ACTIVE HOMES: INSIGHTS FOR CURRENT AND FUTURE DEVELOPMENTS

Project team: Professor Karen Henwood, Professor Nick Pidgeon, Dr Fiona Shirani,
School of Social Sciences and School of Psychology, Cardiff University
Report prepared by Fiona Shirani, May 2025
fionashirani@cardiff.ac.uk

Acknowledgements

This work was funded by the EPSRC (EP/Y024060/1) as part of the Place Based Impact Acceleration Account: The SWITCH to Net Zero Buildings.

We gratefully acknowledge the contributions of the residents who participated in research interviews.

1. Introduction

Meeting the UK net-zero target for addressing climate change requires fundamental changes to housing and domestic energy use. Whilst retrofitting existing homes will be crucial, up to 8 million new homes will be needed by 2050. This includes active homes, which incorporate energy generation and storage, grid-linked smart monitoring and control, and energy efficient building design. Such homes are positioned as integral elements of a future decarbonised energy system. However, a wider rollout will only be successful if they are accepted by residents as homes in which they can live well. It is therefore crucial to explore the lived experiences of active home residents, learning from early developments in order to inform future iterations and designs. The importance of residents views is reflected in existing Welsh Government policy documentation, such as WHQS 2023, while understanding how resident behaviours and lifestyles can influence the success of innovative home designs is identified as a key lesson from IHP monitoring research. While the lessons learnt report emphasises the importance of tenant education, it is important to consider the full range of resident experiences to provide a comprehensive overview of life in an active home.

This report builds on our previous work and reporting as part of the Living Well in Low Carbon Homes (LWLCH) project within the Active Building Centre Research Programme to explore resident experiences over the first few years of active home occupancy in detail. Whilst LWLCH yielded multiple relevant insights, in our final interviews at 12 months post-occupancy, participants indicated that they were 'still learning' to live in their active home and a number of elements remained uncertain, unresolved or unrealized. A longer-term perspective is therefore crucial for a more detailed view of if and how active homes can support sustainable lifestyles over time. This longer-term view is provided by our work on the project Living Well in Low Carbon Homes (LWLCH): Residents Experiences, Responsive Design and the SWITCH to Net Zero Buildings, part of the EPSRC funded Place-Based Impact Acceleration Account: The SWITCH to Net Zero Buildings. As part of this project we have undertaken further interviews with a number of our original LWLCH participants several years post-occupancy.

The report sets out some contextual detail before providing detailed findings, a summary of key points and implications based on these longer-term interviews with active home residents. Despite the focus on new build homes, many of the report insights will also have broader relevance for retrofit programmes, which are likely to involve a number of the same technologies.

2. Case Sites

The project encompasses three active home case sites in South Wales that received funding as part of the Welsh Government's Innovative Housing Programme. The case sites differ in their built design (fabrics, layout, aesthetics), combination of energy sources and technologies, and location. The sites also range in scale; from developments of under 20 homes, to a site that will encompass over 200 homes once completed. Common to all case sites is solar PV, intelligent battery storage and electric vehicle (EV) charging. One site has ground source heat pumps (GSHP) and underfloor heating on the ground floor of homes, while the others use electric radiators. All developments aimed to include some communal green space as well as private gardens. The three sites encompass properties for both private sale, including via shared ownership, and social rent. This means that Registered Social Landlords (RSLs) have ongoing contact with tenants in some properties, whereas residents of the private sale homes had little or no ongoing contact with home developers. One site initially had an energy service to manage the energy production, demand, and storage for each home, with households able to adjust heating and hot water demands using in-home controls and a bespoke app. However, just under four years after the initial residents moved in, the company were withdrawing from the site and participants were transferred to a commercial energy supplier. This also resulted in changes to in home and digital controls in these homes, which were discussed in the interviews.

3. Approach and Sample

Our initial Living Well in Low Carbon Homes (LWLCH) project involved interviews with 37 residents from across the three sites, once before and twice within the first year after occupying their active home. In 2024, 15 of these participants were interviewed again, approximately two and a half to four years post-occupancy. Participants range in age from their 20s to 60s and have a variety of living situations, including living alone, in couples or family groups. Of the 15 participants, five are men and ten are women. Resources prohibited us from re-interviewing all original participants, but participants were selected from our original sample to represent a range of experiences; from those who had explicitly chosen to move to an active home because of its energy and environmental credentials, to those who had moved to the property because of its size, location or price, for whom the active aspects were a secondary consideration. Participants were also selected to represent a range of views; from those who had been very positive about their active homes in initial LWLCH interviews, to those who had described more concerns or challenges. A small number of original participants had left their active homes and moved elsewhere and were not included in the latest round of interviews. Participants described a number of advantages to moving to a newbuild active

home as opposed to retrofitting an existing property, including cost and convenience. Overall, newbuild homes were seen as an easier option than retrofit, not requiring residents to identify suitable contractors to undertake retrofit and take on the risk of this, or to live through disruption.

Some of the issues raised in the original interviews were echoed several years post-occupancy. Rather than reiterating these points, we refer back to our original project report where these issues were covered. In the current report we focus on new issues that emerged, or changes over time in resident experience that became evident with a longer-term perspective.

4. Findings

Overall, participants were positive about their active homes and the technologies that they encompassed, suggesting that they were pleasant to live in and that they envisaged staying in the homes in the longer-term. A number of different elements influenced the experience of active home living, as we consider in the sections below. In this report, we raise participants' concerns and challenges in order to highlight opportunities for learning to inform future developments. A number of participants said that these were relatively minor considerations, which did not impinge on their overall positive experience of the homes. However, for a small number, ongoing issues were more problematic.

4.1 Design, layout and aesthetic

Participants were still largely positive about their homes several years post-occupancy, particularly the design, layout and natural light. Most also commented on the homes being good quality and feeling happy or fortunate to live there. However, some of the concerns raised initially were reiterated in the most recent interviews as ongoing or increasing challenges. For example, lack of storage space because cupboards were used to house equipment such as a water tank or GSHP, which was unclear to residents from initial property plans.

For some in smaller properties, having a limited number of rooms, particularly if the home had an open-plan layout, could be challenging. For example, lack of a separate space for home working, or to accommodate residents who had restricted mobility through ill-health or accident meant that some residents were spending a lot of time in a single room. The inclusion of a downstairs wet room in properties at one site was praised by residents for ensuring the properties were accessible for those with restricted mobility.

Some participants indicated that the layout of their home made it more challenging to heat. For example, open plan homes with no way of shutting off rooms or the staircase, or homes where there was no source of heating in the hallway, meant participants felt that heat was lost to these spaces, which could create difficulty in maintaining a feeling of cosiness. Some of the participants in homes with radiators suggested that they would have preferred underfloor heating from an aesthetic perspective, and to provide greater flexibility over the use of space. For example, a radiator positioned in the middle of a wall limited where furniture could be placed and therefore the function of the room. However, participants recognised that underfloor heating was likely to be more costly, impacting the feasibility of its inclusion. As with initial comments about the poor quality of some of the finishes or white goods included, some participants suggested future homes should offer a range of options for residents to choose from, including underfloor heating, which would be reflected in different price ranges. Participants suggested that this could reduce waste associated with replacing finishes or goods that they were unsatisfied with, or which were not considered fit for purpose.

Several years post-occupancy, the importance of the orientation of the homes had become more evident to participants. A significant part of this was the properties' exposure to sunlight, for both solar PV generation and passive thermal gain. Participants described how their home's orientation therefore had an impact on their energy generation and demand, which was felt by some to have significant financial implications in terms of income from export tariffs and required heating costs.

> "the location of how these houses are built has got a huge influence on each house … [neighbours] just get more solar. That's huge. I think that's really pivotal. Majorly pivotal. 100%. … it makes a huge impact where the house is placed." (PARTICIPANT A)

> "we get the sun directly sort of through the day and, you know, it's constantly on, if it's not on the front, it's on the side or the back, and you can follow the sun round through the day. And I find that, you know, we get a lot of sunlight. And I think, you know, we're not in any shade, there's no trees overhanging, there's, so I think possibly we have got a better positioning." (PARTICIPANT B)

> "I've got a neighbour, and they are the same house as ours, but it's completely the other direction. It's 90 degrees the other way … their panels are west facing. So, they're having half the efficiency we're having. Well, I didn't pick the house for this reason, but I'm glad I did." (PARTICIPANT J)

Like participant J, most said that they were unaware of the difference that the home's orientation would make pre-occupancy, but given the impact it made on their bills, felt that this information would have influenced their choice of plot if it had been available to them. For example, those purchasing homes thought that energy generation potential could be reflected in the market value of the property, with varying prices between plots.

At one site, homes were described by residents as ‘template houses’ with the same design, encompassing the majority of glazing and solar panels on the south facing side. As homes were either side of a central street, this meant the identical layout worked differently for residents depending on which side of the street they were on. For example, some participants had the heavily glazed side of their home facing the street, which raised issues of privacy as some described something of a ‘fishbowl’ effect. Whereas for others, the main entrance to their house was via a utility space, which was not conducive to how they wanted to use the space. Replicating the same design for differently positioned homes also meant that certain elements were not ideally situated for some homes (e.g. outdoor taps were not always adjacent to gardens). Participants raised these issues with orientation and situation as important considerations for future ‘template houses’.

4.2 Outdoor spaces

The majority of properties within our sample had private garden spaces. Pre-occupancy, participants moving to social housing, particularly flats, were enthusiastic about access to outdoor space as something that they had not always had in previous homes. Post-occupancy, many participants expressed disappointment with the usability of garden spaces. At two sites, participants experienced gardens as waterlogged and boggy, which made them difficult to use even in summer. Accessibility was a particular concern for residents with limited mobility, or who had young children or pets who wanted to use the space independently. Residents at one site also mentioned an insect infestation as having caused substantial damage to lawns. Several years post-occupancy, a number of participants at two of the sites had removed their turf because of these issues and had replaced it with astroturf or hardstanding surfaces and most were positive about how these changes had made garden areas more usable. Some residents had made these changes reluctantly, as they were concerned that astroturf or hard landscaping was less environmentally friendly than lawns but felt that outdoor spaces were otherwise unusable.

Other participants who had retained their lawns described efforts to find ‘eco solutions’ to problems with the garden spaces (such as introducing feeders to encourage birds to the garden, which would in turn eat the problematic insects). Others felt that introduction of astroturf and hard landscaping in their neighbourhoods had meant a reduction in wildlife, which was seen as contrary to the aims of a sustainable development:

> “And there are lots of birds on the, on the hill. There’s actually, I think it’s magpies mostly, or is it crows, something like that, a huge colony. You hear

> them at night, but in the gardens here, zero, nothing. Absolutely nothing." (PARTICIPANT F)
>
> "People don't plant anything, I guess it's, because it's a bog… They did the contrary of, because they put astroturf. It's so disgusting," (PARTICIPANT G)

Participants also raised the issue of external water access/collection, in some cases due to lack of or poorly situated outdoor taps, which made watering plants more challenging. Others suggested more could have been done in the initial design in terms of water recycling, which they felt would be in line with the homes' eco or sustainable ethos.

> "I think that water is one of the key things. You know, every year we have a little bit of sun and we're on water shortages, we can have a drought, and we have so much water. So, I think yes, they could have done more. They could have encouraged us to do more with water butts and things like that." (PARTICIPANT E)

Few participants had installed water collection measures themselves but were supportive of the idea of including this in future designs.

All sites had been planned with communal green spaces, but these had not all materialised as anticipated. Where green spaces were located made a difference to their usability, with a sense that the houses bordering these spaces had greater ownership of them. Participants also mentioned that where spaces were not designed for a specific purpose, they were less likely to be used. For example, participants suggested they were unlikely to use a communal seating area a few minutes from their own home when they could sit in private gardens instead. Two sites had initially intended to include allotment or communal garden spaces. Participants at one site had described their disappointment when this hadn't materialised. However, revisiting several years later, participants were more sanguine about this, suggesting that it would have been challenging for many residents to find the time and skills necessary to maintain an allotment. Instead they were positive about the developer's decision to plant a number of fruit trees, which would provide benefit to the site.

4.3 Thermal comfort and hot water

After several years of residency, most participants described how they had established heating routines that they were happy with and no longer had to make regular adjustments to timings or temperature to achieve a comfortable living environment.

> "Like, the temperature can get really, really warm, like you can feel it as soon as you walk into the house and it's really nice then to know that you can have a nice like, cosy night in if you need to when it's freezing cold outside or like, if it's soaking wet as well, it's nice to just come in and just feel that heat as you walk through the door." (PARTICIPANT D)

This participant described the heating system as ‘really straightforward’; a sentiment echoed by others. Systems like participant D’s that enabled centralised and remote control were generally viewed more favourably than systems that required individual control of radiators or different zones of the house. Having separate controls was described as being more complicated, meaning it was easier for heating to accidently be left on if residents forgot to turn off all separate devices, compromising efficiency.

> “it’s not central heating because you can’t control them all and you need a degree of physics to operate them. I’ve never set them up for a time, you know, for Monday, Tuesday, just because I look at it and I think I can’t figure that out, so I just put them on a thermostat so if it drops below 19, 20 degrees, they come on. And I’m sure that’s not a very efficient way of doing it, but God, you know, you’d be endlessly setting them, I think. So, yeah, if I was thinking, you know, of improvements, I’d put a central heating, and I’m sure in terms of energy efficiency that would make a big difference,” (PARTICIPANT N)

> “I think actually, if all I had to do, you know, at night was just turn the control down, rather than remember which radiators I've left on and which ones I haven't left on, I don't know. I think that whole heating side of things could be better thought out. And I'm not complaining. I've got zero energy bills throughout the year. It's just more how much I can make by, you know, optimising how I use the heat.” (PARTICIPANT L)

For these participants, individual heating controls were inconvenient and possibly lacking efficiency, but, as participant L articulates, this was often described as a relatively minor concern given their low overall bills. Instead, participants raised it as something to be considered for future developments looking to learn from initial active home sites. Where residents saw overall benefits to the homes, such as significant bill savings, they often described being prepared to live with minor inconveniences. However, other participants continued to find their heating systems inefficient or difficult to operate and adopted other approaches to maintain thermal comfort.

> “To be honest, we rely mainly on, we bought, you know like little fan heaters? We bought them to use in the end, because it was simpler, so you know, which is a bit sad, but yeah. I'll put one in my bedroom, wherever, you know, warm it up before going upstairs, or what have you, and one for the living room …. It literally come down to the settings for the radiators. Because they just seem to have like mind of their own, do what they want.” (PARTICIPANT C)

Participants described how particular aspects of their home design limited heating efficacy – such as large unheated hall spaces or open plan layouts, as discussed in section 1 – which could be difficult to mediate.

At one case site where residents were being moved from the site’s energy service to a mainstream energy supplier, they were also having in-home thermostats replaced. Residents were generally positive about the change to a thermostatic dial that showed the temperature, whereas the previous system did not provide numerical detail. Our participants felt that the

new system provided greater information and control, as opposed to the previous arrangement of adjusting temperature via notches on a dial, with no visual information as to how this related to numerical temperature measurement. This relates to broader discussion of the user friendliness of different technological apps and controls, as discussed in section 4.7.

Participants described mixed experiences with the supply and temperature of hot water. Some spoke of how their homes had been set with safety limits to the water temperature, which affected their routines. For example, some households found that they could not get the water hot enough for a bath and resorted to boiling a kettle for this. Others found that there was an insufficient quantity of water and compared their new systems unfavourably to previous homes with combi boilers that provided instant hot water.

> “So, your guaranteed worst time, I'll come home from work, go and run my bath, no hot water. And it always, it's not good. And I have said several times to give me a combi boiler” (PARTICIPANT C)

Other participants spoke of how they had adapted to being more restricted with water than in previous homes but did not find this problematic and accepted it as part of how the homes work.

> “And then the only thing that, like I said, we had to get used to was the limited hot water … if you want to have one bath, or say you had a whole tank, it’ll take a couple of hours to fill back up and heat back up again. So, like, we got used to that after couple of months. So it's something that's non-optionable … And then the hot water side of it, you just, you adapt to that … it's ingrained in us now. You know, if she does the dishes in the morning, or again in the afternoon, and then the kids have baths, she knows right, check the app before she even bothers running a bath. And if I'm having a shower, it’s in and out.” (PARTICIPANT J)

Finally, some households were satisfied with their water pressure, temperature and control.

4.4 Overheating

With increasing global temperatures and extreme weather events, it is important to consider the ability of active homes to provide a comfortable living environment across different conditions. Several participants described their homes as becoming unbearably hot during warm weather, suggesting that the high levels of insulation that kept homes warm in the winter also meant heat was retained during the summer. Some participants at two of the case sites spoke about making additional investments in fans and air conditioning to stay comfortable, noting that their neighbours appeared to have done the same.

> “I got aircon units … I bought aircon, but I’ve bought cold fans as well, because the aircon units are loud in the night … So, yeah, aircon units, a must. And in

> the summer when it's warm, you can walk round the site and see the tubes coming out the windows." (PARTICIPANT E)

Some who had not yet installed air conditioning were considering this as a future investment as they thought periods of extreme heat were likely to become a more regular occurrence.

> "I did price up, and I'm still considering it this year, actually having aircon fitted, because, just upstairs, just for when we're sleeping … so I'm still considering actually having aircon, but it's, because it just gets too hot. And it's only going to get hotter. Despite my best efforts with my eco home, global warming is still going to happen, so I'm still considering the air con." (PARTICIPANT O)

The installation of air conditioning has implications for the performance of the homes and their energy demand. Some participants felt it was unproblematic to expend energy on air conditioning and other high-consuming technologies such as hot tubs because their homes were so efficient. Others saw it as somewhat contradicting the eco nature of the homes but felt that this had to be balanced against being comfortable.

Other participants described how the homes did become uncomfortable during hot weather, but not significantly more so than conventional housing. As this was a small number of days overall, compared to significant periods of cold weather where the homes performed well, these participants suggested that overheating was a minor inconvenience and did not require additional cooling technologies.

> "But like, in the summer, obviously, the in, you can't, I would never moan about it, I would never be like, oh my God, my house is so warm, it's doing my head in. Because ultimately, you know, the other six months of, well, ten months, really, in this country, the other ten months of the year, the insulation is saving money you know? … I just thought, oh well, what the, why the hell would you buy aircon when we have six days of hot weather a year?" (PARTICIPANT J)

Participants at the third case site were more positive about their homes in hot weather as being manageable. This was attributed to the design of the homes having canopies over glazing and having windows and doors on the north side of the building, which enabled a through draft to be created. Because of the high levels of glazing, maintaining a comfortable temperature did require some management on the resident's side.

> "And I, you do have to remember just to go around closing all the blinds through the daytime on those really hot days to stop the heat. And closing doors and kind of, you know, you have to kind of be a bit active with it. But I guess you do with all houses, really." (PARTICIPANT L)

Residents in the flats at this side described more challenges in keeping cool as they did not have the same north facing ventilation options as the houses.

4.5 Ventilation and air quality

With highly insulated homes, adequate ventilation is particularly important. One site included mechanical ventilation and heat recovery (MVHR) which provided filtered air to the homes. Our previous report described mixed views of this system, with some residents finding the filtered air beneficial for respiratory conditions, while others viewed it as competing against heating systems, reducing thermal efficiency. Four years post-occupancy, some participants had asked for their MVHR to be turned off, viewing it as unnecessary.

> "I said, I want you to go and turn the MVHR off. Because, you know, we're not living in a house that doesn't have any windows or any air circulation … I wake up in the morning, and my windows are open. We sleep with our windows open. You know, I'm not stupid. I open my windows. I like fresh air. I want fresh air in my house. So, I kind of saw it a bit kind of null and void." (PARTICIPANT A)

Like participant A, others spoke of opening windows as being their preferred way to ventilate the home, rendering MVHR unnecessary. Conversely, some participants at other sites felt that their homes would have benefited from mechanical ventilation systems, particularly if they found it difficult to have windows open due to allergies, road noise or other disturbances.

Participant A's quote suggests that mechanical ventilation would be necessary for windowless rooms and several properties across all three sites had windowless spaces, predominantly bathrooms. Some had initially raised concerns about these rooms being difficult to ventilate adequately and this had become more problematic after several years when there were issues with extractor fans.

> "It hasn't got any windows. And the extractor fan is broken … So, the room is like, it's hot all the time. It's damp all the time. And like the lack of window has become a problem, for sure." (PARTICIPANT H)

Some homes had vented windows, which participants felt helped with air flow and quality when it wasn't possible to open a window, noting that there was a balance between ventilating and heating the home.

> "You need, the windows are all vented and that helps a lot, and the bottom line is, you know, open a window. Because they are well-sealed, the houses, they can occasionally get a little bit stuffy, but you just trade off retaining the heat against freshening them up a bit, so then obviously they have to reheat a bit, but it's okay. I mean, I think, you know, I think because they're not as leaky as old houses, the flipside is that, you know, they can get a little bit stuffy because there's no air circulation because they're active, not passive houses." (PARTICIPANT N)

As with participant N, others noted that the active nature of the homes required some active management in terms of ventilation, as noted in section 4.4. As covered in our previous report, participants often felt that they had not been given sufficient information about the homes, including the best ways to ventilate, and instead learned through experimentation.

> “They've got good trickle vents on all the doors. And again, nobody tells you about these trickle vents, but you just learn by, I think when the first year I was here, I had them all closed in the winter, and then you realise there's some condensation building up inside, and you think, okay, and then you know you have to leave some, you know, a couple open. And then it's just a bit of an experimentation. If the wind's blowing from the north, you, they come through those trickle vents. And you close them off, and then when that wind dies down, you can kind of open them back again. So, it's just, yeah, paying attention to which direction the wind’s blowing. And so there is an active element in that.” (PARTICIPANT L)

Our interviews suggest that participants were largely happy with manual ventilation through opening windows but could benefit from greater information in the early stages post-occupancy about ventilation as active homes may require a different approach to previous properties.

4.6 Information and learning

Several years post-occupancy, participants had different levels of understanding about how their homes work, which was influenced by the information available to them. All participants across the three case sites said that they would like more information about their homes and how to use them most efficiently; particularly things like when to use appliances and if the batteries made a difference to the advantage of using solar generated energy during the day.

> “We don’t really have a lot of information about it. At least not that I’m aware…. I think it would be useful. Because obviously like, for example, if the battery is like fully charged from the solar panels from the sun, or whatever, then I’d be like, oh, that’s a good opportunity to like put the, I don’t know, washing machine on, or whatever. Because obviously once it’s full, like you can’t get any more like power from the solar panels, do you know what I mean? So you’ve kind of got to use it. I, so, I think, yeah, that would be useful.” (PARTICIPANT H)

Participants suggested that future developments should include an information pack for residents that advised on these issues, otherwise residents were basing their use on what they thought was best, which was not always the most efficient.

> “I guess our expectation was you’d have a kind of pack, and also, you know, how to get the best out of the system, for instance, that was something we were all interested in because you’re thinking am I using this right and should I do the dishwasher, should I do it in the middle of the night or should I, you know, what should I do with the battery, should I keep it fully charged, keep it partially charged? … hopefully [developers] would think a bit about that and, you know, that handover point where people move in, give them a little bit more information. Because they are unusual houses.” (PARTICIPANT N)

In addition to desiring more information during the early stages of occupancy, some participants felt that there was a place for ongoing support from developers and landlords to ensure that residents fully understood and were making the best use of their homes.

> “So, the lack of communication is something that I think they could be a lot better at. It seems like, oh, okay, it's all in now, it's running okay, we don't have to bother sort of thing, you know … They need to be a bit more proactive … rather than leaving us in limbo.” (PARTICIPANT I)

Where participants were social housing tenants, some felt that the RSLs did not fully understand the homes and technology in order to adequately advise residents and that this was a missed opportunity for informing residents as to how to make the best use of the homes.

> “We were given some information by the developer, and I think [RSL] as well, but theirs, it wasn't specific to these eco houses, it was specific to just, you know, like not running the tap when you're brushing your teeth. You know, it wasn't actually anything to do with an eco-house … I think it's immoral to have all this incredible equipment and not have anyone at [RSL] have, know what's doing, what's happening, and educating these people who live in it. It seems crazy. It seems like, effectively, it's just lip service as opposed to, yeah. And I'm sure they have their reasons for not doing it. Like they're probably just overloaded and over-stressed.” (PARTICIPANT M)

At all three sites there were apps that participants could in principle access to monitor and adjust their energy generation, storage and use. For two sites, this was a Tesla app connected to the household batteries. Some participants had not installed this app, because they did not know about it, did not have a smartphone, or did not feel the need for that level of detailed information. Some also described having little motivation to make changes that might improve efficiency as they were paying less than in previous homes, or in comparison to others in conventional homes. Others who had had higher than anticipated bills initially spoke of reliance on the apps to monitor and adjust their usage in order to keep bills at a manageable level, requiring their active engagement.

At the third site, participants were in the process of moving from one app run by the site’s initial energy service provider to several apps that would control different aspects of their home and technology. This meant that residents were able to compare their experience across different apps in terms of user friendliness. While the initial app was described positively for displaying information in comprehensible units (such as number of showers), the new app for controlling hot water appeared more difficult to understand.

> “Yeah, yeah, it’s more complicated, absolutely. And the Mixergy app for the tank is a disaster, it’s really bad … In the Mixergy app, everything is expressed in percentage of the cylinder volume, and how on earth am I going to know what percentage of the cylinder volume I need of hot water? I have no clue. So, that is really, it’s literally incomprehensible.” (PARTICIPANT F)

Several participants lamented the lack of information and control that they had had with the original app, describing it as something of a ‘black box’. Instead, residents were positive about moving to a new app that provided them with more detail.

> “I'm quite looking forward to what I've been told anyway that some of the new apps that we're going to be having, we can actually see what it's doing. So, you’ll be able to see on one day that you've used, say, for instance, the capacity is like 5 kilowatts, I don't know how all the capacities are now. But if the capacity’s like 5 kilowatts, and you use 10 kilowatts in a day, you know, you’ve bought 10 and you've used 10 from the battery. Or you could be able to see how much solar is pulling in, or whatever. I wanted to since we first moved in. And I asked about it and they were like, “that's not really something we do.” But I'm hoping with this new, the new thing that's coming in now next week for us, that we'll be able to track that a little bit.” (PARTICIPANT J)

> “We could never see anything; we had an app for the house which was basically a black box. You’d expect from a modern house that has its own app that you could actually get more insight than you ever could, you’d see how much energy am I using here and there and, you know, where could I save some or what’s going wrong here. No, we can see absolutely nothing, and now we will be, and the battery is one of those … So, that will change now and that should give us some insight into the battery to see if it’s actually working.” (PARTICIPANT F)

Other residents were also positive that the new apps would offer greater control and compatibility with other systems and devices.

> “I was hoping they were going to switch it to being like, a better app, because the app, you couldn’t link it to any kind of geofencing or any kind of, like, you couldn’t link it to Alexa, you couldn’t link it to Apple Home, nothing, it was just this is the app and it’s very basic. And now the thermostats can be linked to Alexa, Amazon, Apple Home Kit, all of that, it can do geofencing, so it tells when you’re nearly home, when you’re not, blah blah blah, all of this. So, that’s a lot better, if you like to have tech doing everything for you,” (PARTICIPANT O)

Our previous report explored participants’ frustrations with the technical monitoring that was being undertaken in some of the homes. For many, this was largely due to lack of information being shared with residents about the monitoring data and lack of clarity about how the information was being used. At one site, participants had not received information about monitoring and whether it was still ongoing but noticed that a panel within their homes was no longer working so assumed the monitoring had ceased. The ability to have access to more information about their home’s performance was something that all participants felt should be available to residents.

4.7 Technology

The homes varied between sites and between designs in where technical equipment was located. For some homes, batteries were located externally or in locked sheds, whereas others had batteries within the living space. Where batteries were in the living space, some described them as being overly noisy and disruptive:

> “I mean, all this noise business, normally this would be easily taken care of if you had some, a garage or something and you would put all the stuff in there

> and the noise, it's not noise like a tractor trailer in front of your home, so if you put it in an outbuilding, you wouldn't hear it at all. But it is right, right here, in the middle of the house, and of course then you hear it all the time." (PARTICIPANT F)

However, others found that they had become accustomed to the noise and light of the battery and didn't mind its presence given the extent to which they felt that they benefitted from it. Overall, participants expressed a preference for technology such as the battery to be located outside the living space, but that it should still be accessible to residents. Several felt that the battery was a crucial part of the benefits they saw from their home:

> "I think [battery] does make a difference, especially to bills. Like I say, they're really low. They're always really low. And there isn't as much, maybe, of a difference between summer and winter … But there isn't like a massive like spike that you might get if you, yeah, if you didn't have the battery. Well, and the solar panels as well, I guess. You don't get like a spike in the winter while using a lot more electricity." (PARTICIPANT K)

One aspect of the technology that participants were initially enthused about was the battery being able to ensure the homes still had access to energy in the event of a power cut. However, early post-occupancy experiences showed that this often did not happen in practice, with some homes at different sites losing all power and water during power cuts. Following initial power cuts, some residents in the sites with Tesla batteries learned about a storm watch function that would purportedly ensure the batteries were fully charged in the event of a storm, enabling the homes to run off grid. However, several found that this function did not work as anticipated:

> "Really frustratingly, my Tesla system, which is all very clever, sent me a message saying 'there's a storm coming, I'm going to charge my battery up in case you get a power cut,' and got a power cut in the middle of the night and the Tesla battery shut down … which is ironic because of course the whole point of it is you get power when you get a power cut. … So, yeah, I can, I can now, through the app I can turn, I can go offline, so I know it works, I can go offline, I get power, but what I don't know is if you get a sudden power loss through the storm or whatever whether it will work, because obviously I can't, you know, I can't sort of replicate that. So, yeah, it was a bit frustrating," (PARTICIPANT N)

As participant N indicates, some residents had done what they thought was the correct procedure to make changes to their setup but were unable to gauge the efficacy of this without another power cut. Others spoke of how they had adapted the way they used their batteries in light of their experiences during power cuts:

> "I think the storm watch didn't work. It, they were supposed to, it's, we shouldn't have to do any of that. It's supposed to notice when the storm's coming and then adjust accordingly. And maybe it wasn't accurate enough or couldn't do that. So, yeah, I mean, that was a good learning curve, really, to see that actually if the battery runs to zero, it, even if we generate electricity, it can't top the battery up whilst the grid's down. And knowing that is really useful to know now to watch out for that. Even if I'd only got 15%, I would then, rather than think, oh, I've got 15%, I could use that because it's sunny today, and I'll

> generate more, I'm thinking, I can't let that run down to zero, otherwise I'm stuffed." (PARTICIPANT L)

Other residents were not aware of storm watch or similar functions on their batteries but again expressed frustration at not being able to run off grid during power disruptions.

4.8 Maintenance

Several years post-occupancy, questions about maintenance of the homes were more prominent than they had been in early interviews. In some cases where multiple organisations were involved in the development, residents were unsure who to contact when they needed assistance with technology or to report an issue with the building. One theme raised by several participants at two of the sites was that, as the developments involved a number of different organisations, it could be challenging to know who was responsible for different elements and for any one company to take accountability.

> "I just think because this, this property or this estate was built with so many like, people's input… it just seemed like because there's so many like, cooks in the kitchen, nobody knows, or nobody wants to take responsibility maybe when things go wrong. That's what it felt like. So, yeah, it did seem a bit confusing. Like, I didn't know who to speak to, and it wasn't made clear to me when I first moved in like, about who's in charge of this, who's in charge of that when you need issues sorted, you know what I mean." (PARTICIPANT D)

In addition, some suggested that the number of organisations involved meant that the technologies did not necessarily work together in the way they envisaged that they would if a single company was responsible for a holistic design:

> "I think with these houses, because it was a pilot, and there were so many different companies putting their stuff into these houses, it didn't, it wasn't joined up." (PARTICIPANT A)

Some participants suggested that the complexity of the homes' systems meant that organisations involved in the developments did not always seem to fully understand how they worked, which meant that they could not then inform residents as to how to make the best use of their homes.

At one site where there had been changes to the way services were managed, some participants expressed concern that they no longer had recourse to getting problems addressed. For some, this was seen to renege on initial service agreements, which were an important reassurance when purchasing the house.

> "when we went to buy the house, they sold the houses to us on these fantastic benefits that we have, our solar panels, our ground floor heating, the battery, the EV chargers, and there was going to be a service agreement put in place for us, very similar to British Gas, you know, you pay monthly, they come out,

> they do it, they fix it, so we just keep paying monthly and we haven't got no worries. No, no, no, that was not the case. They had no infrastructure in place at all to support us when the two years was up, and two years one week, guess what happened. We had no heating, no hot water for over a week, nobody would help us. We didn't know where to go." (PARTICIPANT E)

However, a number of participants appeared unconcerned about this change in service provision.

The challenge that residents across the sites were experiencing was in trying to find companies that could understand and service the homes' technology. Several residents described difficulties with this, finding that some plumbers or electricians were unable or unwilling to service the homes because they were unfamiliar with the technology.

> "We have contacted a few different electricians, but no-one is willing to come to our house to work on it because they don't know the system. Because it's all linked into like sprinklers and stuff…. I think one of the major problems is finding people who can, who are willing to like come and look at it, because it's relatively new, and the technology is new, nobody really knows what's going on." (PARTICIPANT H)

This was compounded by residents' reluctance to try addressing issues themselves, as they might have done in a conventional home, given the complexity of the technology and the extent to which the homes relied on it.

> "The only thing I do worry is obviously like, because obviously I'm not a trained plumber or trained electrician, I just worry that if anything does go wrong, because it's a lot more advanced to what it used to be in normal houses, like in the past I could maybe watch a YouTube video and do stuff myself, whereas now I wouldn't want to risk that because it's a lot of like, dangerous things in the house, do you know what I mean, so I wouldn't want to, to meddle with things like that," (PARTICIPANT D)

In a small number of households, participants described considering or requesting the installation of conventional fossil fuel heating systems because they were concerned about their current system's performance or their inability to get problems addressed, although no heating systems had actually been changed.

As residents described many companies being unfamiliar with their home's technology, there were limited options for maintenance agreements, with some concerns that this could lead to monopoly pricing. Some participants had established maintenance agreements for different elements of their home, while others preferred to deal with maintenance issues as they arose.

> "since our like guarantee or whatever has run out on our heat pump, we had to try and find somebody to have a contract for that with as well. So, it's actually quite expensive overall, because we've had to like different, because there's, because there is so much technology, and the house relies on it so much. We've got to have like a few different sort of like plans with different people to get everything covered, and it's, yeah, it does rack up." (PARTICIPANT H)

While social housing tenants could contact their RSL to address any maintenance issues, several expressed concern that the maintenance operatives sent out to properties were unfamiliar with the homes and technologies and therefore not always able to address problems. As a recommendation for future developments, participants highlighted the importance of having staff members trained in maintenance of active home technologies and companies that can provide service agreements. This supports IHP lessons learnt insights concerning gaps in workforce expertise.

> “Nobody knows how to fix it. And, yeah, that would have been the best thing. You know, moving forward, if they build more, that they actually have people who are trained and know what they’re doing. And this is, no thing on the you know, the workmen they’ve sent out, it's not their fault. When they turn up they’re expecting something else. And then it's something they've never seen before … when workmen are coming out we shouldn’t have to give them a handbook.” (PARTICIPANT C)

Relatedly, some participants described how they, or neighbouring residents, had learned about the technology and had to impart details to maintenance operatives.

> “The first person who came to see it, he had a look, and he couldn't even open the battery. So, it's, there's like a panel, and it's got a door, and you open it. He didn't really, yeah, he didn't realise, and he didn't know how to open it. So, my neighbour had the same problem, and she just happened to say, “well, this is how you open it,” and she showed him how to open it ... And, yeah, it's just it takes a long time to get kind of things like that sorted. I don't know if that's because they don't have many people with, yeah, specialty or in that field. I think that's, yeah, that's probably the only problem that I would say.” (PARTICIPANT K)

This highlights the importance of the residents having a good understanding of their homes and technologies. While some residents had learned more about their homes over the course of their occupancy, several participants again reiterated how it would be helpful to have this information upfront when they first moved in.

Soundproofing and noise levels were raised by all the participants in flats, who commented that they could hear from neighbouring flats. This could be disruptive when residents had significantly different routines (e.g. working night shifts) and some participants commented that they were very conscious of making noise in their homes.

> “I'm sure that the builders did use all sorts of fabulous membranes, I'm sure they're not lying. However, there is a fundamental flaw, because these buildings are like, they're like a loudspeaker … I would say there is definitely, no matter how many amazing, you know, people came and did tests, but I think the test must have been rigged a certain way, because they said, oh, it's fine. And we all knew it's not. So, there's something there that's not right in the sound proofing, that's for sure.” (PARTICIPANT M)

As participant M indicates, some properties had been assessed in relation to sound proofing or other issues and found to be performing to the expected standard. Other participants echoed similar experiences; where they had found something within their home to be problematic but that testing indicated that the home was performing as anticipated, so it was decided that no action needed to be taken:

> "And [maintenance company], when they turned up and they did all their checks, they went on for days, and they said, it's absolutely running fine, da-de-da-de-da. But it wasn't in reality, there was not enough water. It was not enough hot water for a family more than two." (PARTICIPANT A)

> "I find it cold. So, like I think our front door is quite draughty. We spoke to like [developers] like not long after we moved in, because we noticed it was draughty, and they did something, and it didn't change anything. And then, they did something, and it's still draughty, and they were like, "Oh, we've looked at this. It's not a problem now." But yeah, that is. Like so if you go into like the sort of like little hallway bit, it is very cold." (PARTICIPANT H)

> "But this floor gets warm, so I can't see why it would be a difference if this floor gets warm, the whole gets warm, it's just the living room that doesn't. They made me feel stupid, which is why I probably never went back and pushed it again." (PARTICIPANT E)

As participant E states, sometimes participants said that they were made to feel as if they were imagining a problem, complaining unnecessarily, or being 'stupid', which put them off pursuing the issue further, even if it had an impact on their everyday lives. Relatedly, when participants had asked for information about their home's performance or discrepancies, they described feeling dismissed or not listened to.

> "I queried it with them. They said, yeah, well, if it says it, then you must have done it. So, it's like, there was no investigation into it, there was no anything. They were just saying that you needed to buy at that time. But so I thought, I remember thinking myself at the time, well, if that's the only answer I'm going to get, then what's the point in me ever querying things?" (PARTICIPANT J)

This illustrates a challenge arising when residents' lived experiences are at odds with technical measures of performance.

4.9 Ownership

A further matter that had become apparent to increasing numbers of residents over time, linked to the issues outlined above, related to ownership and control over the home technology. Some social housing tenants described how they had not been able to have any information about, or control over their household batteries, which were located externally in locked units. This led to some residents feeling unsure as to how, or if, the batteries were providing any benefit:

> “We've got, no. It says in like the handbook we had that we could have like the Tesla app, but we've got no, we can't access the batteries. They’re nothing to do with us, basically. So they’re kind of pointless. We don't know nothing that’s going on with them.” (PARTICIPANT C)

Others at the same site had been advised about using the Tesla app to access information about their battery when a new company became involved in the site several years post-occupancy. While this enabled residents who installed the app to have greater insights into their battery performance, some expressed frustration that it had taken so long to know about this, when they felt that they could have benefited from this earlier in their tenancy:

> “I just wish I'd had the Tesla battery information on my, on the app. I think we were told we would have that from the beginning, you see. So, to go in with the knowledge that we would have that, and then be told, well, no, you can't have that, that's not going to happen until X, Y and Z is put in place, that I felt, yes, I think the frustration, I don't know. I wish I'd had that, because I would have been able to, it was out of my control in the beginning. Whereas now at least I feel I have some control on it.” (PARTICIPANT A)

Participants at other sites that included privately purchased homes described how they had had difficulty establishing ownership of the solar panels and EV chargers and how paperwork for warranties had been difficult to get hold of. Some participants were still trying to establish ownership and suggested that without this, they were unable to change their energy service provider:

> “I’ve got an email off them saying I own the panels, but ultimately, I cannot ever change from Octopus because I cannot provide evidence that I own my panels.” (PARTICIPANT E)

Others described how trying to establish ownership had exposed errors in how the technology was initially set up, which restricted their potential use. Again, they highlighted the importance of learning from this for future developments:

> “I mean, that’s been a logistical nightmare for me. They haven’t been able to get the export readings for the solar power that’s exported from my solar panels, and they’ve now discovered they never put a QR code on my electric car charging points, I can’t actually use that. There have been a few little glitches, yes, but other than that, fine, still love my house and I still love everything it can do. But yeah, just those sorts of things I think that maybe are good learning curves for things that hopefully won’t go wrong with the houses that they’re now building” (PARTICIPANT O)

Like participant O, several others described being unable to use their EV charger or being unable to use its full functionality because of the way it was set up. This was described as limiting residents’ potential to use these devices most efficiently.

> “from my point of view, the most outrageous consequence of that was the car charger, because that is an intelligent car charger, so you could actually program it to stop at, start at certain times and stop at certain times and stop at certain levels and, which is exactly what I would like to do, because my car

> cannot do it itself, it has old software, it doesn't do that, and you can never use any of this because it's all registered to [company] and I don't have any access to it." (PARTICIPANT F)

Some participants suggested that this inability to prove ownership meant that they were concerned about investing in an EV, in case they encountered a problem with their charger that they were unable to rectify.

> "I didn't have an electric car originally, but I did buy one, and to be honest it's been a massive saving financially. I was putting approximately £70 worth of fuel in my car a week and my monthly electric bill now is, I pay £78 a month and I'm in credit. … But, so when the car can go back, I think it'll be a fuel car, unless I can get a certificate off them saying I actually own [the EV charger] … I've got no way really of, if they ask for proof of ownership to repair it, I haven't got that, and it's a big risk then, isn't it, if you've replaced your car. Which is a shame, because one, it probably saves me a lot of money, or it does save me a lot of money, and two, it was the environmental thing." (PARTICIPANT E)

While a small number of residents like participant E had invested in EVs, most participants suggested that the initial outlay was unaffordable and several expressed concerns that the range would be insufficient for their needs. There was also some scepticism about the need for EVs more generally. Of our participants, only a small number were making use of their EV chargers. However, even if not using them, some participants described how they valued the EV chargers as future-proofing their home, anticipating that EVs would be used more in future.

4.10 Community, knowledge sharing and place

Initially, some participants spoke about how they were discussing homes and technologies with their neighbours, sharing details of operation and performance. This had helped to highlight differences between homes and identify potential faults, or disparity in export tariffs related to how the connections were set up. While some of these conversations were still happening, particularly regarding maintenance issues as discussed above, several years post-occupancy participants reflected how there were less frequent discussions of the homes' technical performance as the novelty of this had worn off. Nevertheless, participants described how residents offered to help one another when experiencing technical difficulties. Many of the community discussions now appeared to focus on regular aspects of everyday life, such as conversations about pets and parcels.

> "We've got a good community here, and I think that people will, other people will say that, is that that has been one of the saving graces through when there's been problems, is the community. People have, so, I've offered people to shower here when their electrics have, when the water's gone down, other people have offered that as well. One of the boys was away and he, he said so and so got a key, go and shower in my house. You know, parcel wise, you know,

> if, we'll all take parcels in for everybody, and you don't feel worried about it." (PARTICIPANT E)

Several years post-occupancy, it became apparent that at two of the sites there were specific residents who were known as being informed about the homes, who others could call on if they needed information or guidance. Often it was because these individuals had spent considerable time seeking out information, which they then passed on to others either in person or via online community groups.

> "And I know [neighbour] she's with Octopus now. And she was telling me about this flux tariff that she's on and actually working really well for her. So, I am in the process of hopefully I'm changing my supply to going over to Octopus … If I need to know anything, I'll go see [neighbour] she's excellent, in fairness." (PARTICIPANT I)

> "Yeah, I mean the good thing about here is there is like, I get on very well with the neighbours and like, we discuss things, and obviously we've got the Facebook groups so there is a lot of knowledge sharing going on, if anyone's got a problem you just chuck it in the Facebook group, someone will comment and have the answer for you. So, that's the good part of where I live," (PARTICIPANT O)

> "Luckily, somebody on the group chat knows how to reset, so all you do is you just go how do you reset the battery, and then they talk, they put the instructions there for us, and it saves us going back through probably a year's worth of messages. So, in all fairness, we are lucky there. If they move off sight, we're shafted." (PARTICIPANT E)

As participant E notes, this resulted in some residents feeling somewhat reliant on these individuals, with concern about what would happen if they left. At the third site, a resident who was described as particularly knowledgeable about the homes had left, with some participants feeling that this had left a void in their information resources.

Residents at one site spoke of the challenges in establishing community communications, with many people seemingly disinterested. This meant that it was challenging to share information about the homes, which would have been particularly valuable for new residents moving in:

> "I mean, the new people that moved in over the road, you know, they didn't know anything about how to use the houses. They've had to kind of, to a degree, tap into our knowledge … I think that [knowledge sharing] was settled down in the first year or two, really. I mean, I think there could have been a lot more possibility for us to be sharing information across everyone … there would be things that we could offer information to new people that moved in. Say, hey, we see you've just moved in, if you want some help setting up your, you know, electricity tariff, we could help you. But there's no method." (PARTICIPANT L)

Several participants, like participant L above, reflected that while they would have liked more information about their homes, later residents moving into the sites (e.g. people who bought or moved into previously occupied homes, as opposed to those moving into new homes in a later phase of the development), seemed to receive even less information about how the

homes and technologies worked and relied on information from neighbours. Therefore, they suggested that an important learning was not just about finding ways to impart information to initial residents, but to subsequent occupants as well, if residents were to make the best use of the homes over time.

Some participants, particularly those who felt that their home was performing well and providing significant bill savings, were vocal about the benefits of active homes and advocated them to others. This was not just in relation to cost saving, but a broader sense of the home as making a positive contribution through renewable energy generation.

> "I find that yes, I am more aware of it because I keep on saying to people, you know, we've moved and this house does this and it's got the solar and it's got the battery, and you know, people are interested. Then you get the, well, obviously, you know, the app and you know, and the amount of people I've said, you know, you should use Octopus and, you know, have a look at these things, you know, because you know, it is fascinating to know that, you know, you created something that is giving back." (PARTICIPANT B)

This sentiment was echoed by participants who described a sense of pride in their active home because opting to live in these homes was seen as doing something positive for the environment.

> "I think we were willing to tell others like, about things they could bring in that would make their lives maybe a bit more responsible. So, it's definitely made me a bit more focused on it than I was previously, and having like, this house has been a good example to others on how they could do things, so I feel more confident telling other people what they should do. And like, [daughter] at school, they do so much around being good for the environment and doing all of this, and it's really nice that she can… [say] well we live in eco homes and we've got this and we've got that, and that will make her feel much better because she is very much about the environment and helping others and being respectful of the world, and I think that's going to be a massive thing for her when she's old enough to understand properly that not everyone's house is like our house, so that makes me quite proud." (PARTICIPANT O)

Several participants spoke about trying to persuade family members to move to an active home. This was particularly evident at the large site where further construction was underway and they had friends and relatives living locally.

> "So, my mum said like if they were building more of them, she'd quite, like because she's considering moving. Like she'd like consider buying one, for sure." (PARTICIPANT H)

> "I've been persuading my brother to try and buy a house here. Like, I know the cost of buying them are more expensive, as in, like, the price of the houses are more expensive than what you could get for like a terraced house for. But that's offset by your energy bills then." (PARTICIPANT J)

Some participants had initially described how the external appearance of homes at two of the sites had been somewhat controversial with the wider community. However, several years later this was less of an issue as the homes appeared to have become accepted.

> "I think maybe we're kind of an old thing now… that's not a bad thing, I think. If people just kind of accept them I think that's fine. And there's even people from a bit further afield who you kind of come across and they ask you where you live… And maybe a couple of years ago, they might have said, oh yeah, the, you know, the green houses or the eco houses, or what are they like? And they'd ask questions about them. Now they just kind of, oh, yeah, yeah, I know where you are … I guess it would be quite good that people were interested in them and kind of heard how good they are, if that made them think, oh, actually, yeah, it might be a good idea to put solar panels on, or to look into that kind of housing if I was ever going to build a house. But the same time, maybe they've just kind of accepted them. And that actually is a good thing as well." (PARTICIPANT K)

Others, particularly those who regularly engaged with members of the wider community through their work, found they were still asked about their active homes, or that there appeared to be wider discussions about the benefits of the homes.

> "I think it's one of these places to live now, where people are like, oh, I've heard about, I know someone who lives there, or I know someone who knows someone who lives there. They're really cheap to run. And I'm like, yeah, yeah, they're awesome." (PARTICIPANT J)

In initial interviews, participants discussed the significance of the location of their homes, with the implications this had for their transport needs and access to amenities. Views on this remained largely unchanged over the first few years, although had implications for health and wellbeing, as discussed below.

4.11 Health and wellbeing

Participants were asked at all interviews about whether they felt that moving to an active home had had an impact on their health and wellbeing. Several of the social housing tenants emphasised the importance of having a good quality home with a secure tenancy for their sense of health and wellbeing.

> "It's the first time I've ever actually felt that I'm really secure … in my house, that it's my home. You know, previously we've had so much damp and, you know, it's been really hard to sort of settle into places where things don't work properly." (PARTICIPANT B)

Across the sample, participants reflected on how having a home that they enjoyed and felt comfortable being in had a positive impact on their health and wellbeing. For some participants, the home's layout was described as having made a difference to their lives. This

was principally evident at one case site with downstairs wet rooms, which were particularly valuable to residents with limited mobility, through long-term conditions, accident, illness or when recuperating from surgery. The design of these homes was therefore described by some participants as being futureproof, if mobility became increasingly restricted over time.

Other aspects of the home design, such as light and warmth were described as having a positive impact on health and wellbeing. Low or non-existent energy bills also made a big difference by reducing financial stress, as we consider in the following section.

> "I love the spaciousness of this room and the big windows, and the fact that you get so much light. I love the fact that I cook myself a meal and it heats up the room, and then it holds the heat. You know, I love the fact that I can come back from having been out all day in winter, and the sun has been out and it's heated the room. You know, that's amazing. I love the fact that that connects me more to what's going on outside and nature, because I'm aware of when it's sunny, okay, get the washing, you know, get the washing machine on. And I'm hugely, hugely grateful, because I'm in credit with my electricity. And that's major, isn't it? That is a major, major benefit." (PARTICIPANT M)

The location of the properties was described by participants as making a big difference to health and wellbeing. This related to proximity to natural landscapes and local amenities, which in turn impacted on travel routines and costs. Participants in a central urban location were particularly positive about the benefits of their homes' location.

> "I would definitely say that it's made 100% improvement on both our health and wellbeing. Mainly because things are so close to town and the park. And we are able to just, you know, like I said, it took me an hour to walk from the house up into park round the bottom. So, nice little hour exercise, healthy, wellbeing, fresh air. Yeah. Living here has made a big improvement, to be honest." (PARTICIPANT I)

Conversely, a small number of participants who lived at sites that were hard to access via public transport and were not within walking distance of amenities, expressed dissatisfaction with the location and a resultant sense of isolation.

One issue raised by a minority of participants in two of the sites was concern about the amount of technology in the homes and potential health impacts of EMF emissions.

> "I know for a fact that Wi-Fi, smart meters, smartphones and electrical wiring all have an enormous impact on our health and wellbeing. And there is absolutely no awareness of that in these houses … there's the smart meters and there's the Wi-Fi, and then there's the Wi-Fi that I have no control over that is the Wi-Fi for the Tesla equipment. And that has its own Wi-Fi to communicate to the electric, to Octopus. Yeah. So, that's something that I find pretty concerning. I just try not to think about it." (PARTICIPANT M)

While this was a concern, these participants suggested that there were limits to what they could do about it, given the homes relied on the technology to function and therefore this could not easily be turned off. There was also a question of where the technology was situated (e.g.

within the homes or externally, close to sleeping or relaxing areas) and how much was included (e.g. blocks of flats had a similar footprint to detached houses but the former contained technology for each of the households, while the latter was only for one household, therefore potentially a much greater concentration of EMFs). Like participant M, often they 'just try not to think about it' but it did raise questions for these participants about their ability to live in the homes long-term.

4.12 Energy demand and cost

As in previous interviews, it was clear that energy costs are a fundamental element of how participants view and experience their home. What was increasingly evident several years post-occupancy is the importance of residents getting the right energy tariff, which enabled them to benefit from exporting energy. Several residents across all three sites spoke about how moving to the Octopus Flux tariff made a significant difference to their bills, and some had subsequently advocated this to their neighbours:

> "I was going to sign up with another supplier. But somebody else happened to mention that it would, it had been recommended to them by somebody not on the site to go with Octopus, because they did the export tariff. And I think she was telling people. And it was kind of, yeah, we were kind of all told, ah, yeah, go with Octopus because, yeah, they do the export tariff. So, yeah, that's why I went with them." (PARTICIPANT K)

Despite some participants sharing information about tariffs with their neighbours, they described how several households were still with energy providers that did not offer an export tariff, which was seen as a missed opportunity, particularly for low-income households.

> "I think there's other families here, you know, older families, older people that, or other people that are not on that tariff, and they've got, they owe hundreds and hundreds to their providers. And it's such a shame, because if they were on the flux tariff, at least they've got a bit of control and at least getting a bit of money back. I think that is quite a big thing, because that's the whole point of these properties." (PARTICIPANT A)

Some participants also said that they had been informed that they were unable to access certain tariffs because of the type and brand of technology their home had, which again they felt limited their ability to benefit from the active home.

> "I'm, when I looked at it, the features that we've got, I think it's certain brands that they use. So, like the technology we've got, like when I tried to like, link it to my account, it wouldn't work. So, they said that there's only like, certain brands of like, heat pumps or things like that you can actually link to your account to get like, better rates or to get, so that's one thing I found … it seemed like there was like, one or two brands that they use, and if you haven't got them

> ones, it wasn't, it wouldn't seem to let me have the option of adding things to kind of get a better rate or to kind of save more money on like, solar panelling or, do you know what I mean…. I was a little bit annoyed, obviously having all these features you want to make the most of it, do you know what I mean, and get the best rates you can. So, yeah, it did feel a little bit frustrating that we couldn't apply ours to the, to the app or to their tariff." (PARTICIPANT D)

Several participants who had been on export tariffs from early in their occupancy had noticed a reduction in the amount they were paid for export over time. Some attributed this to energy companies 'getting wise' to increasing numbers of households looking to benefit from exporting energy.

> "I literally made money in the first year. Which, who the hell can say they make money on the electric, right? And I said, this is amazing. And then the year after then they were like, oh, we're changing tariffs and standing charge is going up, and what, so whatever. And then I looked at the selling rate, and it's gone down to like 8 pence from like 20 odd pence. And I was like, well, that's a joke. I don't want that, I want to sell. I want to keep my selling price the same. And they were like, oh, look, they, obviously a lot more people in that year, I guess, had started getting solar. Not just ourselves, it was all around the country. So, you know, the energy companies were like, well, we're going to have to lower this price." (PARTICIPANT J)

This also meant that some participants felt they had to be proactive in noticing tariff rates to make the most efficient use of their home.

> "I was going to say about the electricity, that last year, I was on the variable tariff, and it suddenly all dropped in the, I was getting very small amount of export tariff. And I had to kind of proactively notice and think, this has been going on quite a while, maybe I need to go onto a fixed tariff … I think that if I had switched sooner or noticed that sooner, I would have had a better credit through the winter to get me through the winter." (PARTICIPANT L)

Participants across all three sites were largely positive about their energy bills as being considerably lower than conventional housing, which played a significant role in how they viewed the house overall. For example, some described being able to overlook other challenges with the homes because of overall bill savings, which made a 'phenomenal' impact.

> "I think none of us will be paying energy bills and in that sense, it's been a massive success." (PARTICIPANT N)

> "with the electric and things, you know, it's been phenomenal. You know, we've actually got to a point where we are having money back on the electric. You know, it's been resold, so that's incredible. You know, people are really struggling and I almost feel a bit guilty that I can say, you know, we're actually having money back" (PARTICIPANT B)

> "I mean, I don't know many people whose bills are £78 a month, which includes the heating and the hot water. So, all my cooking, my fuel, my, my car, that's in that as well. You know, that's quite, you know, for me, I think that's, that's phenomenal, that is. So, it's hard to be too cross." (PARTICIPANT E)

> “Like we still really like the technology, even though there’s been like problems and whatever. I think overall, like we’re still happy with the choice we made. Like I like the house, I like the technology, it’s, I think compared to other houses, it’s saved us a lot of money on like, in terms of our like electric bills and stuff.” (PARTICIPANT H)

Our previous report showed how some residents expressed concern at the amount of their initial energy bills, particularly if they moved in during winter, and how at 12 months post-occupancy, not all residents had an accurate idea of their energy bills. Several years post-occupancy, participants described greater familiarity with the way their homes performed in different seasons and the impact that this had on bills, highlighting the importance of a longer-term view that accounts for different seasons and weather conditions.

> “I'm definitely more relaxed now I've had a couple of years’ cycles to see how it works. I'm not like constantly thinking, oh my God, should I be turning my heating off? Because I'm like, no, I'm pretty sure it's going to be fine … It [initially] seems like, oh my God, these are really expensive houses to run. But, yeah, in the 12-month period, they're actually, you know, I probably make a credit, and that includes charging my car. So, yeah, it's inaccurate just to look at the winter period.” (PARTICIPANT L)

Some participants indicated that the bills were so low that they did not feel motivated to try to change suppliers, improve the home’s export capacity or make changes to energy use. For these residents it was possible to forget about energy costs because overall they found the home enabled them to make significant savings on energy expenditure in comparison to conventional housing.

> “[initially] I couldn’t get the export tariff set up because there was some confusion over the export meter … so for a while I didn’t have the benefit of the export tariff, and that probably meant the first year was a little bit more expensive than the subsequent years. But because it’s, I’m so much in credit, I’m comfortably in credit, I haven’t bothered to sort of hunt around to see if there’s a better tariff available from a different supplier. I mean, I suppose it’s the nicest thing to, or the most positive thing to say you forget about it, you forget about the energy costs because, you know, you don’t worry about a bill coming because you know you’re in credit so you don’t have to budget for it. … The system has been, you know, working flawlessly, you’re not paying any money, so you just forget that they’re there, or you know, it’s different. The house rarely feels cold, you know, it’s not draughty, and that’s, so it’s very comfortable, and it’s comfortable without having to do anything really, which I suppose again is, you know, it’s kind of endorsing the concept really.” (PARTICIPANT N)

> “I don't monitor things. I probably could do more. But, yeah, maybe because you have to think less about it. Maybe if I had to use more electricity and more heating, I probably would monitor it more. But because it's quite a low, it's, I think, yeah, maybe I don't monitor as much as I would. And I don't feel I have, yeah, maybe that's what it is, I don't feel I have to kind of oh, shall I switch the heating on or not? You don't, because it's quite low cost anyway, you don't have to think about that as much.” (PARTICIPANT K)

Like participant K, a number of participants said that they did not have to monitor or think about their energy use now that they had found a routine that worked for their lifestyle and meant low energy costs.

> “I literally haven't been on the app to mess with the timings of the heating since maybe well over a year now. So, that's a good thing, I guess. That's what you want, right? You want to be able to set, put your settings in and then forget about it. … Like, I guess you could argue that there's a constant reminder here about energy. But then because the homes are so, like they’re so well insulated, the heating doesn't have to come on, like it's all automatic anyway, so it doesn't come on often because it doesn't need to.” (PARTICIPANT J)

> “I quite like that, that I can just ignore it and it just runs quietly in the background and does what it’s supposed to do and I never come home to a cold house.” (PARTICIPANT O)

These participants’ experiences suggest that the homes did appear to be working ‘in the background’ without much intervention from residents, in the way some of the developers initially intended. Some participants suggested that while the house was largely operating without intervention, they still wanted to understand what it was doing and ‘collaborate’ with the home to use it most effectively.

> “It's a collaboration [with the house]. And sometimes it feels like it's just doing it in the background. But I feel like I want to be and need to be aware of what I'm doing. Yeah. Yeah. But it's comfortable. It's not, doesn't feel like a pressure.” (PARTICIPANT M)

A small number of participants described a much more active role, needing to be ‘on top of it all the time’ in order to manage the home’s energy use and cost. For these participants, regular monitoring and adjustment was crucial.

> “So, by the time it gets to 4 to 7, I look at my battery and if it's on 50%, and I know that I'm going to put that cooker on, and that cooker’s going to take it down to 22 during the peak time, the last thing I want to do is run out of electric during peak time when, because it's going to the grid, because it's exporting. Because I know I've got to put my cooker on, I know I'm cooking, so I kind of do a bit of a check, I do, I check it. And then I'll go, okay, there's plenty in the solar in the battery to be able to put that on and let it export. But if it's very low because we haven't had much sun, then I will flip it over so it's not exporting, and I've got enough battery to put my oven on. And to put a bit of heating on if I needed it. So that's how I constantly look at it.” (PARTICIPANT A)

This section has illustrated the fundamental impact that energy costs have on residents experiences of active homes, how cost impacts the extent to which residents feel they have to actively manage their energy storage and consumption, and how the benefits of energy bill savings can override other concerns about the homes.

4.13 The future of active homes

Several participants thought that their active homes were some of the first in what they anticipated would be a wider rollout of these developments and initially described their pride in being part of this pioneering innovation. However, several years post-occupancy, participants were largely unaware of any other active home developments and expressed some disappointment over this, particularly when they lived in homes that they felt worked well.

> "I kind of felt like we were sold this thing that it was like an innovation, and like it was going to change things. And it's kind of just started and ended with us, sort of thing." (PARTICIPANT A)

> "But when it's, you know, people's life savings or huge chunks of money, people are obviously very, have understandably high expectations. And I think, on reflection, they were met, so I think it's a shame that they're not doing more developments … And you know, it's a shame because I don't, everybody at least I've spoken to who's lived in these houses would probably endorse that and say yeah, they're fabulous and go ahead." (PARTICIPANT N)

> "There's another development in another village, what is it, about three miles away? It's going to be about 40 houses there. That's another housing association again. And they haven't got any plans for anything, yeah, any solar panels or anything, local materials, sustainable materials, or anything. I don't know if that's because they are going to be expensive to put on. But yeah, it is kind of disappointing that this has obviously been done, and it works, and it's good ... But it's, yeah, it's not been taken on more widely." (PARTICIPANT K)

Like participant K, others wondered if costs were limiting a wider rollout as active homes were more expensive than conventional new builds, and without Welsh Government IHP funding it would not be viable for developers to build active homes.

> "I can't see them doing that again, because the cost is so, I, like you know, the people building it are making, they're choosing to make less money, you know, by, and, you know, in a world where everyone wants to make as much money as possible, I can't, unless the technology becomes cheaper, I can't see many projects like this where they put in all of this infrastructure in homes, like. But if someone come to me and said, oh, look, I'm looking to buy a house and it's got all the stuff that you've got in yours, I'd be like, do it, mate, 100% do it." (PARTICIPANT J)

Participants also expressed concern about the apparent absence of other active home developments in terms of the aforementioned issues with maintenance of technology. Some participants suggested that they thought a wider rollout would lead to a greater number of companies and operatives having the requisite skills to maintain active home technologies. However, without a critical mass of developments, and given the challenges some residents had already experienced around maintenance as discussed above, there were some concerns that companies would not see it as sufficiently worthwhile to train staff in how to maintain active

home technologies, leaving residents in a potentially precarious position if something went wrong with their home.

Participants were largely keen for there to be a wider rollout of active homes. However, they were clear that they wanted developers to learn from these early sites and make changes to improve resident experiences in future. Participants suggested that they were living in the testing phase of these homes. While some were unconcerned about this, or even keen to be some of the earliest adopters, others expressed concern that they had been 'guinea pigs.'

> "I really hope that the mistakes and the lesson that there's lessons learned here, so that what you put into the next ones, it is going to work. You know, because I think it is, we are, we were the guinea pigs." (PARTICIPANT A)

> "Like I said, the idea is brilliant. Just wish that, you know, we've, they'd have good tests. They'd been tested, you know, as a home rather than, you know, rather than us move in and find like this has breaking down, this isn't working." (PARTICIPANT C)

In all interviews, participants were asked about their plans for staying in the homes and any issues that they anticipated arising in future. In the most recent interviews, several participants raised questions about the longevity of the homes' technology and what would happen when elements or devices needed replacing. For some residents, this was seen as a potential opportunity to upgrade to what were perceived to be better brands of technology, as well as bigger storage capacity to maximise the benefits of solar PV generation. However, others were concerned that, without the Welsh Government funding that had made these developments possible, technology would potentially be replaced with lower quality elements or brands, which could impact performance of the home and therefore bills.

> "And what he said was that the Tesla battery is like three times as much power in it than most people need, three or four, that is, it's all in one. And it's that much more expensive as well. You know, it's top of the range one, apparently. So, it will be interesting when that goes down, what they will replace it with. I hope they replace it with like for like. (PARTICIPANT A)

Another potential concern that participants raised about the future, was an increase in EVs in society more widely leading to unauthorized use of residents' EV chargers, connected to some of the issues and concerns about ownership and access covered in section 4.9.

> "I think before long; we'll have people turning up with electric cars and trying to plug themselves in." (PARTICIPANT B)

Despite some of the challenges that participants described experiencing, all wanted to remain living in their active homes for the foreseeable future. However, some participants said that it would be challenging when they wanted a bigger home and more space as they may not be able to find a suitable active home but would be reluctant to return to conventional housing.

> "I don't really know where we go from here, because we are reluctant to sort of leave the technology because, I guess, it's made our bills cheaper. I've got an electric car, so it's convenient for that purpose. So, yeah, I don't. That, I think that that makes it difficult because I think we've got used to it as well. And I think if we went back to like a sort of like normal house with like, with gas and stuff, it would be weird." (PARTICIPANT H)

Our research suggests therefore that our participants are supportive of a wider rollout of active homes, which they see as beneficial for other potential residents, as well as existing home residents in terms of creating a critical mass for maintenance. However, participants were clear that lessons should be learned from these initial sites to optimise future developments. In the following section we highlight the main insights from across our case sites.

5. Cross-site learning highlights

Design:

Home design and layout was key to residents' experience, with participants valuing natural light, accessibility and layouts that enabled targeted or consistent heating. The orientation of homes was described as making a significant difference to performance, which had financial implications.

- Participants suggested that information about how orientation and layout would affect the home's performance should be available pre-occupancy to inform plot choice. Potentially this could also be reflected in price differences between the homes as performance differences impacted energy generation and consumption, which impacted bills and income from export tariffs.
- Template houses may be experienced quite differently depending on their position. For example, where particular rooms and features are located in relation to roads, other neighbours, entranceways affect the usability of these spaces. Therefore attention must be paid to the positioning as well as orientation of template homes.
- Participants valued the ability to separate spaces and heat only certain areas of their homes, or shut off cold spaces, which was more challenging with open plan layouts. Designs that enable this separation of space could help residents to achieve greater thermal comfort.

Outdoor space:

Participants valued having outdoor space, particularly their own private gardens. Communal spaces were seen as a nice feature but were not necessarily considered usable spaces for residents.

- Accessible design should extend beyond the home interior to the outdoor space, ensuring ease of access, use and maintenance.
- Many residents had replaced turf with astroturf or hard landscaping, even if they would have preferred to keep the turf, to ensure that gardens were accessible and usable spaces. Some residents felt this to have implications for nature and undermine the 'eco' ethos of active homes. Design solutions for drainage, pest control and support for garden

maintenance (e.g. installation of outdoor taps and water butts) could potentially support residents to maintain turf and planted areas, supporting biodiversity.

Control and ownership:

Participants described the importance of being able to have central overall control of their heating system, even if it was possible to also set different temperatures and routines for distinct zones within the home. Having to control areas separately was described as complex and inefficient, as heating could easily be unintentionally left on. Several residents also anticipated being able to control their heating remotely and link devices and were surprised if their homes systems did not support this functionality. Participants raised the importance of access to and ownership of active home technologies (e.g. EV chargers, solar generation, batteries) in order to make efficient use of and benefit from their active home.

- Active homes should enable residents to centrally control their heating systems, with additional provision for setting different routines for distinct zones of the home.
- Apps should provide information in units that are meaningful to residents (e.g. number of showers as opposed to percentage of a water tank)
- Active homes should support functions commonplace in other control systems (e.g. several participants cited British Gas's 'Hive' remote control functionality that they had been used to in previous homes)
- To avoid digital exclusion, homes should not solely be controlled via apps but allow for manual adjustment such as thermostatic dials with clearly displayed temperature information.
- Ownership of active home technologies should be clarified at the earliest possible stage, with residents given the information they require (MPAN numbers, QR codes) to register, utilise and benefit from various devices.

Heating:

Homes were largely described as well insulated and easy to heat, meaning they were experienced as warm during winter. When this was not the case, participants suggested this related to undersized and poorly positioned radiators. Participants liked the idea of underfloor heating, although recognised that there were cost implications of its installation, whereas radiators could restrict the placement of furniture and subsequent use of space.

- Some early active home sites have successfully delivered thermal comfort for residents, suggesting potential learnings relating to the building design and envelope.
- Developers could consider the potential to include underfloor heating, reflected in additional costs for buyers.
- Where underfloor heating is not feasible, radiator placement should be carefully considered to avoid restricting accessibility or potential use of space.

Overheating and ventilation:

Homes at two of the case sites were described as getting excessively hot during warmer weather, with some residents investing in additional cooling technology. Conversely, the residents at the third site felt that their homes performed well due to the design of shading canopies and windows on opposite sides facilitating through drafts. Opening windows was the

preferred ventilation approach for the majority of participants and windowless spaces (such as bathrooms) were described by some as becoming problematic in terms of damp.

- Design lessons could be learned from the site where residents felt that their homes performed well during hot weather and potentially applied to other sites.
- Where possible, the inclusion of windowless spaces should be avoided. Where windowless spaces are included, extractor fans must perform to a sufficient standard.
- Residents would value information about how best to ventilate their homes for air quality and temperature control.

Information provision:

All participants wanted more information in the early stages of moving to their active home in order to understand how to make the best use of it. This included information about how to efficiently use appliances or run technology, how to make effective use of the battery (including how it could operate off-grid in the event of a power cut) and guidance on appropriate tariffs to enable residents to benefit from solar exports.

- Residents should be provided with information about their homes, the different technologies and, crucially, how these interrelate. Manuals for individual technologies and appliances are not sufficient for providing this information.
- Residents would welcome guidance on efficient use of their homes. This could be delivered in different formats, such as initial written instructions, reminder via email or text message, and via in-person support visits post-occupancy.
- Participants expected their batteries to provide power in the event of a power cut. Residents need information as to how to set up their battery systems to enable this.

Maintenance:

Several years post-occupancy, residents were increasingly raising questions about maintenance of their homes and technologies, including who to contact to get issues addressed. Residents were concerned that without a wider rollout of active homes across Wales, it would be difficult to find companies that could understand and maintain active home technologies.

- Some residents indicated that they were unsure who to contact to get problems or maintenance issues addressed, particularly when multiple companies were involved in the development, or that maintenance operatives were unable or unwilling to service their home due to lack of familiarity with the technology. This suggests the importance of appropriate maintenance training, particularly within RSLs. Residents were appreciative when directed towards companies that could provide maintenance services.
- Participants often had to provide some information to maintenance workers directly and having manuals available assisted with this.

Community:

Residents had a range of motivations for moving to an active home and different expectations as to how they would interact with the site and wider community. All participants valued some level of communication with their neighbours but varied in the extent to which they were interested in discussing the homes, technologies and performance.

- Over time, some residents became known as a source of information about active homes that others could turn to if they needed operation and maintenance guidance. These residents were described as becoming informed through their own research and information seeking, but some had also sought to engage with developers and RSLs. Opportunities could be sought to better support these informed residents, who appear to play a crucial role in information dispersal at active home sites.
- Residents who were satisfied with their active homes described advocating the homes to others, including encouraging family members to buy or move to similar homes. However, residents also described how complaints or dissatisfaction could proliferate through communication networks.

Health and wellbeing:

In discussing health and wellbeing, residents often pointed to elements that were not specific to active homes, for example, the benefits of a secure tenancy, having a high-quality home free from damp and mould, and the impact of the home's location for travel and access to amenities. However, some aspects specific to the active home were also described as having health and wellbeing impacts; particularly energy bill savings as providing security and reducing financial stress.

- Health and wellbeing benefits of good quality homes (such as security, thermal comfort, air quality) can be expanded in active home designs, which have the potential to also offer financial and energy security benefits through energy generation capacity, efficiency savings and income from export tariffs.
- It is important to listen to and take account of residents' lived experiences, particularly when these differ from technological monitoring data. Residents should be able to raise questions and concerns without feeling dismissed.
- Evidence (including lived experience of residents) regarding the implications that active home technologies have should be sought and considered to inform future active home design decisions.
- Concerns about technological security, longevity and maintenance could potentially have a negative impact on wellbeing, therefore further support for residents in these areas could be beneficial.

Energy costs:

Energy costs were crucial to participants' overall views and experiences of their home. Where bills were described as low, or even non-existent, participants were pleased with the performance of their home and the financial benefits that they saw, particularly in the context of wider energy price rises. Energy bills also appeared related to how 'active' residents felt they had to be in managing their energy use.

- Energy costs played a significant role in participants' overall view and experience of their home. As part of this, finding the right tariff, where residents benefited from exporting electricity, was seen as crucial. However, several years post-occupancy, some residents were still not benefiting from this. This suggests that greater support for residents in finding a suitable tariff early in their occupancy could help them maximise benefits from their active homes and play an important role in their overall experience.

- Where bills were not as low as residents had hoped, some were spending considerable time monitoring, managing and adjusting their energy use, experiencing this as more demanding than a conventional home.

Wider rollout:

All participants were supportive of a wider rollout of active homes, suggesting that it was important for homes to be built in a more sustainable way. Those who expressed satisfaction with their homes suggested that this demonstrated the success of the home design, which could be replicated elsewhere and would be a missed opportunity not to do so.

- Participants were supportive of a wider active home rollout and wanted lessons to be learned about what does and does not work well from initial sites to inform subsequent developments.
- Some participants were concerned about the implications for their households and neighbourhoods if this wider rollout did not materialise. This partly related to having a 'critical mass' of homes, which was seen to improve the likelihood of having a sufficient maintenance workforce trained to deal with active homes. It also related to a sense of 'missed opportunity' if further active homes were not developed, when many residents felt that such homes could offer considerable benefits.

6. Next Steps

The next phase of the research will involve interviews with prospective residents of the Biophilic building currently under construction in Swansea city centre. We have been working with the building developers for several years and previously conducted community focus groups to gather early views on the development, reported here. We will be supporting public engagement activities for the building.

The research team will be publishing and presenting insights from the research through both academic and publicly available channels. We will be presenting insights to stakeholders and welcome contact from anyone who would like to hear more about our research.

We are developing collaborative work with Stride Treglown architects and Welsh Government to ensure that insights from early active home developments are integrated into the Tai ar y Cyd programme.

7. Contact details

For further information or to discuss any aspect of this report, please contact Dr Fiona Shirani via fionashirani@cardiff.ac.uk or 02922 510129.