Inclusive Innovation: Safeguarding the Switch to Domestic Hydrogen

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DISCLAIMER

1. ACKNOWLEDGEMENT

In addition to drawing on expertise across Wales & West Utilities and the Energy Systems Catapult, this project has also utilised knowledge and understanding from a broad range of experts external to the project. These have included experts across energy sector as well as organisations familiar with how best to support people who find themselves in a vulnerable situation. The project would like to acknowledge the valuable contributions made by the following organisations

- Cadent
- Care & Repair Cymru
- Citizens Advice
- Department for Business Energy & Industrial Strategy (BEIS)
- Institution of Gas Engineers and Managers (IGEM)
- Mindset Research
- Ministry of Defence (MoD)
- National Energy Action (NEA)
- Northern Gas Networks
- Office of Gas & Electricity Markets (Ofgem)
- Progressive Energy
- Research Institution for Disabled Customers (RIDC)
- Royal College of Occupational Therapists
- Salisbury Group
- Warm Wales

Furthermore, the proposed switchover process has incorporated feedback from many people who find themselves in a wide variety of vulnerable situations. Their feedback has helped to understand the types of challenges people could face if their homes were to be converted to hydrogen, and consequently has been invaluable in helping to shape and design a process that attempts to mitigate these issues.

2. EXECUTIVE SUMMARY

The UK Government is exploring the possibility of switching some homes from natural gas to hydrogen to help the country reach net zero carbon emissions. Wales & West Utilities commissioned the Energy Systems Catapult to run a project to understand how to enable this transition to work well for vulnerable consumers, if it is undertaken.

To do this, the Energy Systems Catapult engaged with a series of industry experts and reviewed the available evidence. This helped to understand what a transition of domestic properties from natural gas to hydrogen is likely to entail for consumers, and what steps should be considered to enable the transition to go well. Once the process was defined, we then engaged with consumers in a variety of vulnerable situations to discuss any challenges the proposed process may present to them. In understanding these challenges, the project then sought to further engage with both a range of experts and vulnerable consumers to co-create appropriate packages of support to preserve wellbeing during a transition to hydrogen.

The project was able to successfully map out the key consumer touch points during a transition and identify what demands could be placed on consumers. This enabled appropriate packages of support to be designed that should be considered when seeking to support affected residents during each of the following eventualities - that could occur during a transition to domestic hydrogen.

- Enabling a surveyor to access and conduct a survey at the property prior to the conversion
- What to do if an unsafe gas appliance is discovered during the property survey, and must be disconnected until it can be repaired or replaced
- How best to capture important information about the personal circumstances of those who live in the home (e.g. health, finances) to understand how best to support them during the conversion
- Occupant expectation if a gas appliance in the home is deemed incompatible with hydrogen so cannot be adapted, and must be replaced
- What support is needed if an occupant does not have gas for cooking, heating or hot water for a few days
- How best to navigate and safeguard residents if more complex works at required at the property e.g. upgrading the existing pipework

Many concerns were identified when discussing the different consumer touch points. These included issues with increased anxiety, the impact of any disruption to important daily routines, a range of potential cost implications for residents, and the heightened risk of accident or injury due to a variety of impairments. For each consumer touch point, three tiers of support were co-created in order to mitigate these issues. The lower tier being offered to everyone, with the other tiers used for people with more specific needs. The support offered included the provision of temporary equipment, help to access local community support, involving 3rd parties to support consumers at certain points, and in some instances the offer to take the occupant away from the property whilst the work is ongoing.

The project was further able to establish some of the challenges that may arise if seeking to deploy hydrogen on a larger scale across the UK, as well as identifying several key factors that should be considered in parallel to the conversion, to ensure it goes as smoothly as possible.

3. INTRODUCTION

The UK have committed to Net Zero carbon emissions by the year 2050[1]. As part of the process of achieving this target, several different solutions will be introduced into people's homes across the UK to help them stop using natural gas for things like heating, hot water and cooking. One solution being considered is replacing natural gas with hydrogen, which can have no carbon emissions. Some experts feel this is a good alternative because, unlike some of the other solutions being considered, it should not require significant changes to people's homes[2]. Furthermore, hydrogen can make use of the existing (natural) gas network meaning fewer changes are needed to the UK's electricity distribution networks, compared to some of the other alternatives being considered.

Whilst moving to a hydrogen supply may offer less disruption than some of the other alternatives being considered, there are still a few challenges that need to be overcome. In particular, there would be period during a transition when households do not have either natural gas or hydrogen connected to their home. This would introduce a range of challenges that must be supported, including access to heating, hot water and hot food. These challenges are likely to present a greater risk to consumers who find themselves in a vulnerable position.

Wales & West Utilities have commissioned the Energy Systems Catapult to explore the risks a hydrogen switchover could present to vulnerable customers and, once these risks are understood, design appropriate solutions. The work was undertaken as part of the Energy Systems Catapults Fair Futures programme, which was created in 2016 to predict and prevent risks that can come from innovation in the energy sector, to ensure everyone can enjoy the benefits. The findings from the project will be shared with other Gas Distribution Networks, including Northern Gas Networks. They will have the opportunity to consider the findings as part of the process of planning and delivering a domestic hydrogen trial in the North East of England, which Wales & West Utilities will be helping to deliver. This trial, along with another trial being delivered by Cadent, will be the first opportunity to test the process to convert an area to domestic hydrogen. The lessons drawn from these trials will in turn help refine the conversion process and the support measures that should be offered so that larger scale trials may be considered in the future.

The approach taken by the Energy Systems Catapult for this project involved engaging with industry experts and vulnerable consumers to understand the challenges that could be faced. Then, once these issues are understood, work with these same groups to co-create and test possible solutions. This method of working with experts and customers to generate and test ideas to create a process which works, is an approach followed by Innovate UK and Ofgem[3]. They indicate it is a good way of making sure innovation projects work well for low income and vulnerable customers.

[1] Committee on Climate Change (2019), "Net Zero Technical Report,".
[2] Committee on Climate Change (2018) "Hydrogen in a low-carbon economy"
[3] Ofgem (2021) RIO-2 Strategic Innovation Fund. Link.

4. RAPID REVIEW

4.1. EXPERTS AND EVIDENCE

Prior to commencing the project, a rapid review on the topic of converting households in a vulnerable situation to hydrogen was conducted. This was to ensure the project was not repeating research that has already been conducted, and additionally to capture any relevant learnings that the project could incorporate into the new process. The approach consisted of reviewing the available literature and engaging with a series of appropriate experts.

To be included within the review the evidence or expert had to be able to speak with some authority on one or more of the following topics.

- What the switch over process will likely entail, and how this could impact customers
- How transitions of this nature have worked in the past, and any lessons we can draw from them
- How best to support (vulnerable) customers during gas outages, and the processes that currently exist
- Any processes or types of support that are offered in other relevant emergency situations i.e. where households are unable to heat their home, cook using gas appliances or do not have hot water (e.g. flooding)

This approach meant the following types of evidence and experts were deemed appropriate and taken into consideration when developing the switchover process.

- Hydrogen experts/technical reports (e.g. those with exposure to other domestic hydrogen trials).
- Consumer studies that explore the prospect of moving to hydrogen.
- Case studies that discuss best practice when supporting vulnerable customers who find themselves without heating, hot water etc.
- Published advice on how best to engage with vulnerable customers in the energy sector
- Energy supplier/network policies and processes for supporting customers during interruptions
- Gas history experts/reports with knowledge of previous gas transitions

4.2. REVIEW: KEY CONCLUSIONS

The following insights were derived from the evidence reviewed and the expert feedback provided.

There are many lessons the project can build upon. The anticipated technical steps to transition a home from natural gas to hydrogen are reasonably well defined, albeit with a few disagreements. These include how long the process is expected to take and the specific *sequence* of events e.g. when is best to adapt in home gas appliances. The individual events that must occur to transition a home to hydrogen do not appear to be disputed.

This study appears to be the first of its kind. Whilst there are studies with overlapping themes, the review was unable to find a project that was comparable to this project. Often this was because studies tended to focus on the technical feasibility of the conversion and tend not to engage with consumers. Those that do engage with consumers did not engage with consumers in a vulnerable situation, meaning little is reported in this area. Furthermore, consumer studies tend to focus on attitudes and perception of hydrogen, rather than the logistics that are involved to convert.

Support for gas outages is generally reactive, rather than proactive. There is little publicly available evidence on how to plan for larger scale outages. The evidence that is available tends to be for brief interruptions, be for circumstances that impact relatively few households and/or be based on learnings that may be outdated e.g. the previous gas conversion in the 1960-1970s. A consequence of taking reactive, rather than proactive, measures also means the support offered is generally bespoke to individual circumstance, rather than being a standardised approach that can be rolled out on a much larger scale.

Advice is often generalised and whilst some lessons can be learned, they are not specific enough to address the needs of this project. Polices and processes to support customers during outages are based on natural gas, rather than hydrogen. There may be nuances to the hydrogen conversion that render some of the advice unsuitable. Advice on how to engage with customers in a vulnerable situation again tends to be quite broadly focused. Many of the specific experience's customers are expected to face during a hydrogen conversion are not explored. Furthermore, the diverse nature of the challenges those in a vulnerable situation may face means that some conditions/circumstances are overlooked and therefore not well understood.

4.3. IMPLICATIONS FOR THE SWITCHOVER PROCESS

In evaluating the available evidence and expert opinion, several important considerations were identified that should be embedded into the end-to-end switchover process.

Engagement with residents should start well in advance of starting the conversion process. This is for several reasons that relate to gaining access to the property and acquiring permissions to carry out the required works.

- The previous conversion found a large proportion of residents were not home to enable access for surveys etc. Family dynamics have changed since the previous conversion (1960-70s) and it is now more common for more than one adult to be in full time employment. This *may* mean it is even more likely that homes will be unoccupied during the day, although the Covid-19 pandemic may also mean home working is more common.

"You'd expect people to be home more in that era [when the previous conversion took place]."

- Gas History Expert

- Some residents are reluctant to enable access to their properties. This can be for any number of reasons including mental health, substance abuse and issues with hoarding. Experts suggest that involving trusted 3rd parties (e.g. family member, social worker) early on, to build trust, should be considered
- Some financially vulnerable households are known to be reluctant to enable access to their properties, fearful the survey may have cost implications e.g. if a boiler is condemned. Early engagement to build trust and offer assurances could help mitigate this.
- Multiple occupancy buildings i.e. a block of flats, require all homes to convert in unison, as do all homes on the same piece of the distribution network. Careful planning to coordinate the transition with all occupants will therefore be required.
- Tenants may not be the decision maker for any works required at the property, yet they will be the ones impacted by any disruption. The process to convert these properties will therefore be more complex and require early engagement.

The process will have to be flexible in how it is deployed to account for the increased complexity faced by some. Prior to converting a property to hydrogen, a property survey will

have to be conducted to establish what works are required. Certain conclusions from this survey will mean the process to convert may be more challenging, and ultimately more time consuming, for some households than others.

- During the previous conversion in the 1960-70s, 40 million appliances were not compatible and had to be substantially adapted or replaced[4]. This was at a time when most gas appliances were supplied by British Gas and only around 14 million homes and businesses across the whole of the UK had gas central heating at all. The greater variety of appliance models and manufacturers in the modern age may mean this issue will be exacerbated and a greater challenge faced in some instances. It is expected that at present, most appliances will require replacing as they will not work with hydrogen. However, in the future "hydrogen ready" appliances may become more common, making a transition simpler.
- The time to prepare properties could vary significantly. The number and types of appliances owned, how easy they are to access, and whether they can be upgraded in situ will all factor. Age of property may also impact how long the works will take e.g. older properties are more likely to require new pipework.
- The Oban Project, when the island of Oban established its own gas network, found 2% of all appliances surveyed prior to conversion were deemed highly dangerous and had to be condemned. Using this observation, it has been estimated 4% of all gas appliances across the UK would be considered "at risk"[5]. If surveyors find boilers are unsafe, they may condemn the heating system, disconnecting it, but not paying for a new one. Residents might decide not to participate to avoid the risk they end up without a working heating system.
- The population and gas network are much larger than during the previous conversion. This will mean the number of those affected will be significantly greater, but also that more engineers, and support services will be required to support the transition. Furthermore, in areas where large numbers of people are without gas at the same time, the scale of support required may exceed the capability of locally available services, meaning out of area support may have to be brought in.
- Some properties may have to have their ventilation improved so it is safe to use hydrogen, although the experts we interviewed thought this would be quite rare.

Some aspects of the conversion present a heightened risk to wellbeing and will have to be mitigated in the process. This can relate to the conversion itself, which will limit access to heating, hot water and hot food, but also challenges that may arise because of the support being offered. These needs will have to be considered in the switchover process.

- Reduced access to hot water will present hygiene challenges to residents. This is a particular risk to those who cannot easily bathe themselves (especially if they need to bathe regularly) or do not own a dishwasher, especially if they are in poor health. The inability to heat water can also introduce additional risk e.g. Legionella.
- Unfamiliar devices present a risk to vulnerable occupants. Solutions need to consider individual circumstance e.g. a portable radiator will present a trip hazard to all occupants, but in particular to those who face increased risk from falls.
- Support should be offered to ensure temporary appliances can be (safely) operated. This includes teaching customers *how* to use new devices, but also adapting them to ensure they *can* be used e.g. a portable hob with controls a blind person can navigate.

"I mean, we see it in emergencies, we can kind of appeal to the blitz, spirit, etc. But after three days of being cold, people tend to lose their sense of humour."

- Safety & Strategy Expert

[4] Fraser-Nash Consultancy (2018) "Logistics of Domestic Hydrogen Conversion"
[5] SGN (formerly Scotia Gas Networks) (2016) "Opening up the Gas Market"

- One expert suggested morale is known to drop if outages last more than three days. Mental health support may therefore be needed if the process is expected to take longer.

Vulnerability is not static, nor is it always easily identified. The switchover process will have to support people being identified as vulnerable at different stages. This is for several reasons.

- There are said to be low levels of awareness of the Priority Services Register amongst vulnerable groups. This may mean many eligible households are not registered so are not known to be vulnerable.
- Some of those who are vulnerable do not consider themselves as such and may not see a need to seek additional support.
- Unpredictable life events can mean vulnerabilities can arise at any time e.g. a bereavement or injury. Similarly, those who are vulnerable may recover and no longer require additional support.

The areas that those affected live in, and who they live with, will often dictate what type of support is most appropriate. These considerations may mean that on some occasions it is appropriate to provide the highest level of support to consumers regardless of their specific vulnerability.

- Those who live in populous areas may have more local amenities available. This means challenges such as being able to access hot food and hot water may be less problematic. However, some other potential challenges may be more common e.g. busier streets could mean an increased risk if people have to leave their home more often to access support.
- For suburban or even rural areas (assuming they are still connected to mains gas), amenities are likely to be fewer. Additionally, community support may present a challenge if there is some distance between properties.
- Some property types may also render some solutions less appropriate. Those living in a high-rise apartment for example may have increased difficulty accessing support provided at street level.
- Households who have to account for the needs of multiple occupants e.g. a large family, may also find leaving the property to access support impractical.

4.4. IMPLICATIONS FOR THE PROJECT

In addition to uncovering several important insights to influence the design of the conversion process, the rapid review also helped to unearth several important considerations for how best to collect feedback from those in a vulnerable situation. Initially, a co-creation workshop had been planned, where aspects of the switchover process could be shared with those in a vulnerable situation and they could reflect on how they could best be supported during this stage. The rapid review however indicated this was not an appropriate methodology, due to several factors.

- Focus groups can be problematic for vulnerable customers. They are often digitally excluded, so may struggle to join sessions held online. Sessions held in person can place an increased burden on them if they are unable to travel easily or suffer from anxiety. It should be noted that this project took place during the Covid-19 pandemic, meaning heightened concern was likely.
- Vulnerable people often don't recognise themselves as such, this may mean they may struggle to anticipate issues before they emerge. The rapid review suggested that in some cases it is best to speak with those who know the individual such as a carer or family member, especially if the individual suffers from a neurodiversity issue such as dementia.
- In home interviews are perceived to be the best approach to collecting feedback from those in a vulnerable situation. This is because it helps contextualise the challenges they face on a daily basis, negates the burden of travel and technology, and enables a trusted friend or family member to be

present for support. The Covid-19 pandemic however means this may not be a method favoured by all.

As a consequence of these findings, a new approach to collecting feedback was taken. Those in a vulnerable situation, who wished to participate, were spoken with on a one-to-one basis. They were given the choice of a face-to face interview in their home, or a remote interview (telephone or video chat), with around half choosing an in-home interview.

5. BUILDING THE BLUEPRINT

To blueprint the process to safeguard customers during a network switch to hydrogen, two key processes were undertaken. The first was to define the necessary technical steps, specifically the consumer touch points, that the conversion would involve. Once these were understood, the approach was then to consult with consumer experts who added additional detail to each customer touch point to indicate how it may have to differ for those who find themselves in a variety of vulnerable situations.

5.1. MAPPING THE CONSUMER TOUCH POINTS

The process of mapping out the consumer touch points to convert from natural gas to hydrogen required several steps.

Step 1: Wales & West Utilities existing end-to-end process to navigate issues such as gas line maintenance were mapped out.

Step 2: This process was then adapted based on the learnings from the rapid review, which indicated how the conversion to hydrogen is expected to go. Broadly this consisted of the following key touch points:

- A visit to the property to conduct an initial survey. This is to conduct a gas tightness test, check the pipework and gas appliances to establish what work will be required.
- Engineers then visit the property to conduct any preparatory works to appliances, meters, and/or pipework, in advance of disconnecting the gas supply.
- The gas supply is then disconnected, and the network purged of natural gas. Estimates for how long this will take range between 1 day and 2 weeks, although most feel it will take between 3 and 5 days.
- The supply of hydrogen is then activated and the supply to domestic properties begins.
- A final visit to the property is then required, to conduct a safety check and complete some final works e.g. re-calibrating gas cooker hobs.

Step 3: The role of those who will support each stage of the end-to-end journey was then considered and included in the process. This not only included those who work for Wales & West Utilities, but also 3rd party services such as local community groups, emergency services and the Priority Services Register.

Step 4: The updated process was then shared with Wales & West Utilities, specifically those in roles who would be tasked with supporting and delivering the process. Any oversights or challenges the amended process presented were captured and the process further updated.

Step 5: The draft end-to-end process was then shared with some of the industry experts who had provided feedback as part of the rapid review to inform whether the process proposed was feasible, with further changes made where necessary.

Details of the the blueprint to transition vulnerable customers from natural gas to hydrogen can be found in the appendix.

5.2. ACCOUNTING FOR A VARIETY OF VULNERABILITIES

Once the consumer touch points in the process were mapped out, consumer experts were then consulted. They were asked to reflect on each point in the journey and consider whether it would have to be adapted to account for those who have additional support needs. Many different types of vulnerability are prevalent across the UK, which the switchover process will need to account for (Figure 1). Once these additional needs were identified the process was updated to better address them.

An emerging theme from the rapid review conducted prior to developing the switchover process, was that the journey vulnerable customers follow should be informed by their category of functional loss, rather than being based on their specific vulnerability[6]. This means that it is the barriers that the vulnerability puts in their way that decides the best course of action. For example, someone who is mute has the functional loss of communication (through sound at least). Someone with arthritis may have the functional loss of mobility. Categorising vulnerabilities by functional loss will help ensure the blueprint is comprehensive and improves the quality of the switching solution.

Five categories were identified as most relevant to consider when developing the process. Note that it may be that other categories of functional loss are later identified once the process starts to be deployed and additional needs identified. The switchover process will therefore have to be constantly updated and refined based on what is discovered.

- **Communication:** This may include those who speak a different language, have difficulty speaking or hearing (e.g. deaf or mute), but also those who struggle to read and/or write (e.g. blind, learning disability). Reduced ability to communicate may mean that a different approach is required when sharing information with the resident or conversing with them to facilitate the work.

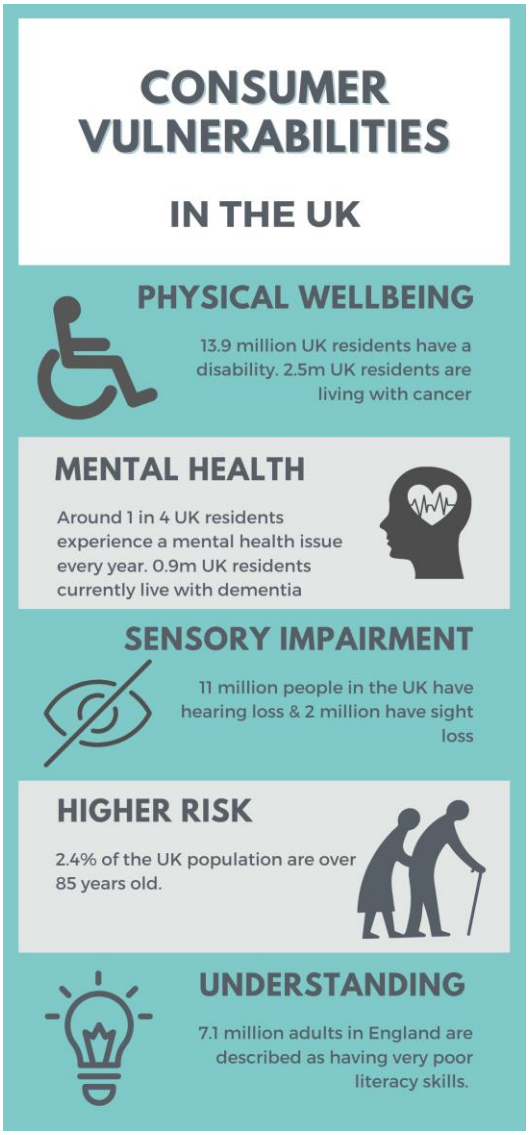

Figure 1 displays the frequency at which some vulnerabilities occur in the UK[7]

"So, impairment, for example, is PTSD. It's polio, it's cerebral palsy. It's the lists are endless. Every disease known to man and woman are impairments. Disability tends to be more about a functional loss. We need to be thinking more about the functional barriers that the person's condition puts in their way [rather than the specific diagnosis]."

- Disability Expert

[6] Wales & West Utilities (2020) "Engaging with customers in vulnerable situations: a research guide"
[7] Ofgem (2019) "Consumer Vulnerability Strategy

- **Decision making (neurodiverse):** This would be those with mental health conditions that make it more difficult to understand and retain information e.g. dementia. This in turn presents a challenge when it comes to making an informed decision. This would impact all consumer decision points in the switchover process, and therefore a solution is required.
- **Mobility:** This would include those who have conditions such as multiple sclerosis or arthritis, essentially any condition which limits their physical abilities and makes it harder to move. This would mean any consumer touch points which place a physical demand on the occupant would have to be considered. For example, clearing a cupboard space so that an engineer can access the meter, or even answering the door to enable property access.
- **Increased risk from fall/accident:** This category is for those who are more likely to experience and/or be seriously harmed if they have an accident in their home. It includes those with certain medical issues e.g. haemophilia, but also certain common demographics e.g. the elderly or those with young children. For these households any work or support measures deployed in their home during the conversion will have to be carefully considered to be sure they don't present any undue risk.
- **High dependency needs**. This category would be for those who are at a heightened risk if they are without heat for even a short spell. This is because a cold home, even briefly, could be detrimental to their health. This could include a wide range of conditions, including cardiovascular and respiratory issues. For this group any point in the process where the ability to heat the home is disturbed, will have to be navigated with extreme caution.

It is important to recognise that these categories are not mutually exclusive, and that some residents may have more than one functional loss themselves or live with others who fall into different categories.

6. ENGAGING WITH VULNERABLE CONSUMERS

The next step in the project was to approach some consumers who are in a vulnerable situation to discuss what the converting their homes to hydrogen is likely to entail. This afforded the opportunity to understand if aspects of the journey would present them with a challenge and therefore additional support is required.

6.1. RECRUITMENT

To understand the risks of being without gas, 30 consumers in vulnerable situations were recruited to provide feedback on the proposed switchover method. The sample was balanced to ensure each of the five categories of functional loss were represented. In approximately two thirds of cases those interviewed fell into more than one category. The sample was also balanced for gender, homeowner status, age group and region (Wales or western England). Some vulnerabilities not specifically targeted also presented in the sample including autism, life events (recent unemployment), and a history of substance abuse issues.

Those recruited were given the choice of how they would like the interview to be conducted, with around half choosing a discussion in person and the rest preferring remote methods (telephone or video chat). In some cases, it was deemed more appropriate to speak with carers or family members e.g. for those with dementia.

6.2. METHODOLOGY

Those participating in the research activity were presented with eight different scenarios that may occur during the process of converting their property to hydrogen (for an example, see Figure 2). These had been identified during the rapid review. Participants were asked to reflect on the demands each scenario would place on them and discuss any issues this may cause. They were then asked to indicate what additional support they may find useful during this time.

For the discussion, interviewees were asked to assume that their energy bills would not change after moving to hydrogen and that any costs incurred e.g. replacement pipework, were not paid by them. This was to ensure the conversation focused on the logistics of the transition and not acceptability of the broader concept.

The following scenarios were discussed with those participating.

- Enabling a surveyor to visit the property and ensuring they can access what they need to, to perform the survey e.g. a gas meter in a cupboard
- An unsafe gas appliance is discovered during the property survey and must be disconnected until it can be repaired or replaced
- Questions are asked about the occupant's personal circumstances (health, finances) to help understand how best to support them during the conversion to hydrogen
- A gas appliance in the home is deemed incompatible with hydrogen so cannot be adapted and must be replaced
- Unable to cook using gas appliances for up to five days
- Unable to access gas fired hot water for up to five days for bathing and cleaning
- No gas central heating to warm the home for up to five days

- Some pipework at the property requires upgrading before a hydrogen supply can be safely connected

In addition to the eight scenarios, participants were asked to reflect whether the area they live in meant some challenges may be greater, or types of support measure less feasible, than others. Furthermore, they were introduced to the concept of a hybrid heating system (hydrogen + electricity) to see whether it was an option that would appeal to them.

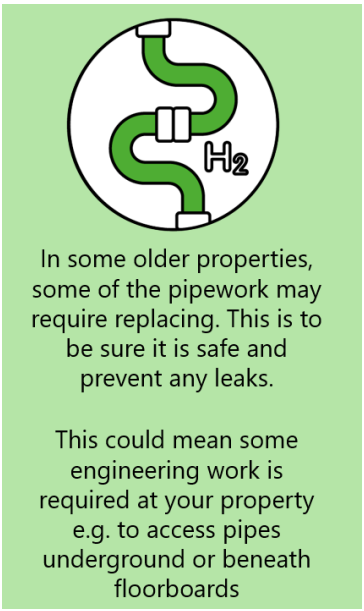

Figure 2 displays an example of one of the scenarios presented during the research activity to understand the impact the hydrogen conversion could have on those in a vulnerable situation

6.3. KEY CONSUMER CONCERNS

Reduced access to hot water during the switchover was amongst the most concerning prospects for interviewees if they did not have an electric shower. It was felt that if the period where they had no gas or hydrogen supply was more than 48 hours, it would cause a range of issues.

- Some indicated they need to bathe daily, and an inability to do so would be particularly problematic for their wellbeing.
- Similarly, those who had a need to sterilise equipment or relied on hot water for other hygiene issues such as washing dishes worried about the impact this would have on them.
- Boiling a kettle for a wash presented a scalding risk to some, others felt the prospect of refilling the kettle multiple times for one wash meant bathing would be an arduous process.
- Leaving the property to bath elsewhere was considered impractical, e.g. at a local leisure centre, especially for those who have larger families.

"I couldn't move hot water. It's like if I have a cup of tea. I don't carry the tea through from the kitchen into the front room. I'd only end up with a third of a cup, it would be literally spilling everywhere."

- The use of public shower facilities was also considered unsafe, unclean and difficult to access because of certain limitations their conditions placed upon them e.g. unable to access a shower that hasn't been adapted for a wheelchair.

The prospect of replacing pipework was another scenario many interviewees found to be concerning. This was made worse by the fact most interviewees indicated they did not wish to vacate the property whilst work was ongoing.

- Interviewees worried they would not easily be able to access rooms in their property that they could not be without for an extended period, such as bedrooms and bathrooms.
- The noise disruption meant those who often need to rest, worried they would be unable to do so whilst the work was ongoing.
- Those with anxiety or issues that cause them confusion would feel stress if they were restricted from accessing parts of their property. Some also indicate accessing pipework will mean damaging their property (beneath tiles etc) which would cause further distress if it could not be returned to how it looked prior to conducting the work.
- Some who are bedridden (e.g. palliative care) simply cannot vacate certain rooms. If the pipework has to be accessed in these rooms, they simply cannot comply.

"I only have an upstairs toilet so the only access I've got to a toilet is upstairs. So, if it affected any room upstairs, or even on the landing That would be a bit of an issue."

Generally, most had little concern about the prospect of an engineer visiting their home to conduct a survey. This was on the assumption that sufficient notice was given so they could ensure they were home. Some considerations about when the survey will take place, and who could be present were however raised.

- Some who suffered with issues such as anxiety or dementia would worry about unfamiliar visitors if they are home alone. Similarly, a deaf respondent indicated she would worry about what was going on out of sight (e.g. in the attic) if she was the only one present for the survey.
- Some interviewees with limited mobility are simply unable to clear furniture themselves to ensure appliances, meters and pipework can be easily accessed by the surveyor.
- Some have medical issues that mean the timing of the visit must coincide with their needs. Furthermore, some indicate they have "good days and bad days" and require the ability to reschedule a planned visit at very short notice if they are no longer able to accommodate the visit.

"I'd be happier for the survey to be done in the morning, if it all possible. It's because I've got MS which effects my ability. In the afternoon I'm a waste of space, I need to go sleep."

If an unsafe gas appliance was found during the survey, most indicated they would reflect positively on the discovery. Whilst inconvenient, they ultimately felt if this was to occur, it would be a valuable outcome for them as it would ensure their safety. Most respondents were however unwilling to vacate the property to access temporary support whilst the issue was resolved. This was for a number of different reasons.

- That any temporary accommodation may not be adapted for their specific medical needs e.g. the need for a wet room rather than a shower
- Difficulties transporting important equipment from the property e.g. office equipment if they work from home, important medications, or medical equipment.
- Those with autistic occupants are keen to minimise any break in routine as it can cause extreme distress for those with the condition. Disrupting school routines was also a common concern for those with families.
- An unwillingness to board family pets, even for a short period of time.

"I honestly think it would be more disruptive being moved out of the property. I think as long as you've got sufficient heating, where you are, then I think that's adequate."

Interviewees were generally happy to share details about their circumstances, to help understand any additional support they may need. They felt that it was ultimately in their best interest to do so. How the information was taken was what most concerned the respondents.

- Some with anxiety, preferred minimal engagement. They wished to be able to provide the required information without having to speak with anybody.
- Others were worried about sharing private information anywhere their responses could be overheard e.g. answering questions on the doorstep.
- Digital exclusion or low digital literacy meant the idea of providing the information online was a worry for some.
- The ability to provide context or ask questions was seen as important by some. This meant they did not like the idea of filling in a form.
- Some preferred a face-to-face conversation to provide the information, but worried about the prospect of having a stranger in their home if they were alone in the property.
- In some cases, respondents indicated they would like visibility of the questions before the discussion. This was so they could prepare themselves.

"It's just my mental health, this anxiety. I think I would prefer to fill a form in. Although I think you'd get more over if you're actually talking to somebody so whether that be on the phone or whether that be face to face"

If a gas appliance at the property could not be adapted to work with hydrogen and must be replaced, respondents indicated they would expect to be offered a "fair" replacement. Generally, this meant a device of similar value and specifications, but there were some other worries raised that would have to be considered if offering a new model.

- Some worried that the new appliance may present a hazard if it was a different size or had to be positioned in a different location. This was because they may be more likely to bump into it or could present other safety risks e.g. having to move a pot full of water from the sink to a stove that's been positioned further away.
- The location and simplicity of controls was also cited as important. Those who could not easily bend down wanted to ensure any replacement had controls that they could access whilst standing.
- Some suggested they would need support evaluating whether the replacement was suitable for their specific requirements as they struggle to define their needs.

"If it [the controls] was lower, that would be a problem to me. Because if I do fall, I am scuppered, I have a devil of a job to get back up. "

- In some cases, interviewees were wary of modern or unfamiliar technology, worrying they would struggle to use unfamiliar appliances.
- Some worried the choices they were offered may be limited/poor and desired an option to source their own replacement if need be.

Being unable to cook using gas for up to five days was generally something respondents felt they would be able to manage. This was typically because they felt they could simply use electric cooking devices such as microwaves or order hot food from elsewhere for a few days.

- Whilst some saw the prospect of relying on takeaway food as a treat, others were less keen indicating they didn't look favourably on the quality of takeaway food.
- Some with mobility issues worried about the prospect of having to leave their property to collect hot food as it could prove challenging e.g. having to walk up a hill.
- Some felt that if they had to use electrical cooking equipment whilst they were without gas, they would struggle to find space in their kitchen to place it. Others indicated using unfamiliar cooking equipment, would make them worry e.g. if they were loaned an electrical cooking hob. This was because they had specific usability needs that might not be catered for, meaning it may be hard to read or operate the controls. Others worried about the risk of a fire if they were unfamiliar with how to operate the device safely.
- Another emerging theme was that people's needs may differ day-to-day. Meaning the type of support that is needed on one day, may be less suitable on another day, for example if school was closed and they had their children at home. Whilst this was raised in the context of hot food, it may also be applicable to other support needs.

"One day you might not feel like a certain thing or might not want to venture too far. Obviously, kids can be quite fussy, so there might not be something the kids would even like or eat. I think it is important to have a choice. I think, if you did, that would definitely be the best-case scenario."

The inability to use gas central heating for a few days was a deemed to be a worry, however most felt the issue could be easily managed. For many the prospect of using portable radiators for a few days was considered a suitable solution. Some issues were however raised.

- Most indicated the time of year the conversion took place would be crucial in minimising issue, indicating they would be worried about their comfort if it was to occur in the colder seasons
- Energy bill concerns were raised, if expected to use more expensive (portable) radiators for an extended period people worried they could be left out of pocket.
- Some who cannot easily move around worry about maintaining their temperature. Any temporary radiator would have to be powerful enough to offer the same level of comfort.
- A few indicated they require their whole home to warm, as it can detrimental to their health if they enter a colder room. For this reason, portable radiators were deemed unsuitable as heat is localised.
- It was felt by some that using unfamiliar portable radiators for a period of time presented additional risk to vulnerable residents. Unfamiliarity with how to operate the device may mean an increased fire risk i.e. if residents don't know how to turn it

"I'm on disability allowance with my chest and I'm on pension credit and that's basically my income. At the end of the day, If I have to have heating, and if it does cost a lot more then that needs to be sorted out because I couldn't afford to pay for extra electricity."

down or off. Additionally, portable radiators placed around the home can present a trip hazard if residents bump into the device or trip over wires.

The areas respondents lived in, meant variability in some of the challenges they faced. For some it meant that a new risk could present, whilst for others it meant they were limited in the type of support they could access.

- Some worried that any on-street disruption associated with the conversion would mean they might have to park their car further away e.g. if there were engineer's vans parked outside their home. For those with mobility issues, the prospect of having to walk further was a particular concern.
- Those who live in areas with minimal facilities felt that accessing support could cause them difficulties e.g. if there were no community leisure centres to shower in and/or minimal takeaway food options.
- Similarly, some in areas with modest amenities available worried that if too many households were without gas (and therefore in need of support) at the same time, local business would struggle to cope. This issue would be further exacerbated if some of the local amenities were disconnected from mains gas at the same time as the local residents.

"I think the problem would be, if they took all the parking outside the house, my car would be further away from the house and would be a problem for me walking back to be honest."

Interviewees were generally enthusiastic about the idea of a hybrid heating system. They liked the security of having a backup heating system, being able to reduce their carbon emissions and cutting their energy costs i.e. if the system could opt to use whichever fuel was less costly. A few concerns were however raised if this was an option they were offered.

- The idea of a higher upfront cost was a considerable deterrent for many, but some felt if this could be spread out over several years, it would alleviate their concerns.
- The disruption arising from installation was a worry for some, due to the challenges it would present for them moving around their property, as well as introducing other issues such as noise and dust. Many however indicated they would be willing to endure some degree of disruption to reduce their environmental impact.
- Some felt they would need support to help them understand how to operate an unfamiliar heating system to ensure they were able to be warm. They further wished to speak with someone who already had the system so they could ask questions and discuss certain practicalities in order to feel more confident.
- Some enthusiastic interviewees conceded they felt it simply would not be possible to install a hybrid heating system where they live. This was because of issues such as living in a conversation area, having limited or no outdoor space, gaining permission from their landlord, or living in very old and inefficient properties.
- For some older interviewees, they indicated they felt it was too late in their life to embrace something so unfamiliar and were simply not receptive to the idea no matter what.

"I do really like the sounds of it. I think for multiple reasons, especially with energy costs as wild as they are at the moment. I think any way in which you can reduce the cost, the better, even if it does involve a bit of an investment to start with."

Several interviewees expressed concern with respect to the broader concept of swapping to hydrogen. Despite attempts to focus the discussion on the logistics of the conversation, some concerns were raised about the day-to-day practicalities of replacing natural gas with hydrogen.

- Some worry that using hydrogen will be unsafe. A few perceived hydrogen as being more dangerous than natural gas, and therefore an accident may be more likely to occur. Others indicated they simply did not know enough about hydrogen to feel confident that it was a safe alternative. One interviewee further worried that engineers will be relatively inexperienced working with hydrogen initially, and therefore the possibility of an accident may be higher. Ensuring early communications with residents address these safety concerns will be key in convincing them to engage with a conversion.

"I don't know a lot about it. I mean, is it safe? Is it like the gas that we use now?"

- Energy costs were a particular concern for many. The feedback was captured during a time when rising energy prices were receiving a lot of media scrutiny. They sought reassurance that the cost to run hydrogen would result in cost savings (or at the very least no increase) compared to what they pay currently. If this could not be offered, they would have considerable objections.
- A carefully considered campaign was regarded as important leading up to any transition. This is because it will help ensure the transition goes as smoothly as possible. Many worried about embracing the unfamiliar and required a lot of information to reduce their anxiety.

7. MITIGATING THE RISKS

Once the key concerns with the proposed switchover process were identified, the next stage in the project was to find a way to better manage these issues. During the interviews, respondents had indicated what kind of support they would find to be useful. It is worth noting however the type of support desired in one scenario often differed between respondents, usually dictated by their specific circumstances. Furthermore, some individuals indicated they would need a *range* of support measures available at certain points in the switchover journey. This was because their needs were variable, meaning the best way to support them may change day-to-day.

In addition to discussing potential support measures during the initial interviews with those in a vulnerable situation, expert opinion was also sought. Typically, these experts were those with hands-on experience of solving some of the challenges that are expected to emerge during the hydrogen transition. These included those who provide disaster relief efforts, who can share methods of providing access to hot water, heating and hot food to those who find themselves without. Medical professionals and wellbeing experts, who have experience of engaging with individuals with challenging health conditions to help them navigate in-home issues and provide support. Charities and support services, who those in a vulnerable situation can call on for help if they find themselves in a perilous position e.g. a boiler breakdown in the middle of winter.

Once the feedback from experts and those in a vulnerable situation had been collated, packages of support were created and agreed with Wales & West Utilities. These packages were then shared with some of the vulnerable consumers spoken with earlier in the project to discuss if they felt the proposed measures would be suitable for their needs. For each scenario three tiers of support were created which could be offered to those in a vulnerable situation at different points if they were converted to hydrogen. The lowest tier would be support that is made available to everyone, the middle tier is support that is offered on an occasional basis, and the highest tier is support that would be rare to offer and only apply to people in more specific circumstances.

It is worth noting the issue of "fairness" did arise earlier in the project, with some indicating they may feel aggrieved if they felt they had been treated less favourably than others e.g. being offered microwave meals, rather than takeaway restaurant vouchers. This should be carefully considered when choosing how to deploy support measures in an area to reduce dissatisfaction.

7.1. PROPOSED MEASURES AND FEEDBACK

For all proposed support measures, respondents indicated they felt what was offered was appropriate for their needs, with only minor changes desired. It is therefore recommended that all the measures discussed in this section be considered for inclusion during any conversion to hydrogen.

Scenario explored: An engineer must be able to gain access to the property to conduct a survey:

Everyone	Advanced notice of the survey is given, with the occupant allowed to choose a date and time for the visit. A phone call is made shortly before visit to check if the occupant is still ok to proceed.

Occasional	Engage with friend, family member or carer of the resident as well so they can also be present to provide reassurance during survey (if desired)
Rare	Engage with community support (e.g. social worker) so they can speak with the occupant to negotiate and agree access prior to visit

All respondents were happy the proposed measures to visit their home and conduct a property survey, with only a few minor adjustments desired.

- Some desired a checklist of what the survey would likely entail prior to the visit so they knew what to expect beforehand and had no surprises
- It was assumed that any visiting engineers would be prepared to move some obstacles to gain access to the areas required if the occupant was physically unable to do so themselves. If this was not the case, an additional visit from someone to help clear access was desired
- Any additional expense incurred as a result of asking a carer to be present during the survey was a worry for some. Additionally, issues with both the availability and demand for carers in the UK led some to conclude they may need assistance to find a carer able to be present.

"I think that's fair enough. It's sort of evident isn't it, that people have good and bad days and might have to reschedule? "

Scenario explored: An appliance is discovered to be unsafe and disconnected during the property survey.

Everyone	Help is offered to find an appropriate engineer who can visit the property quickly and attempt to resolve the issue. Temporary equipment will be offered whilst the issue remains unresolved, such as portable radiators and electric cooking hobs. Safety switches and clear labelling would be included on any equipment loaned to be sure residents know how to operate the device and that it will be safe.
Occasional	An offer is made to transport the occupant to friend or family members address until the issue is resolved.
Rare	An offer is made to put the occupant in a hotel or assisted living facility until the issue is resolved

Respondents were generally happy with the support measures on offer if an appliance in their home was found to be unsafe and had to be disconnected until it could be repaired or replaced.

- The only additional support measure desired was for help if additional costs were incurred whilst repairs were ongoing. For example, if placed with a family member for a few days, petrol costs may increase if they had further to drive a non-negotiable journey, such as taking their children to school.

"I really like the fact that you can have like, friends or family that but if not that they'll offer you community support."

Scenario explored: A gas appliance at the property cannot be adapted to work with hydrogen and must be replaced.

Everyone	If a gas appliance cannot be adapted, occupants will be offered a "fair" replacement. This will have similar specifications, be of a similar value and can be arranged on their behalf. A payment equal to value of device can also be arranged if the available replacements are not accepted.
Occasional	To help those who struggle to evaluate whether the available replacement's will suit their needs – a representative can get in contact to better understand the individual's needs and aid them with their selection.
Rare	If both parties fail to agree a solution, an independent 3rd party can be brought in to take a neutral decision on what replacement/compensation is fair.

The support measures for this possible eventuality were considered adequate, although there was some concern about the possibility of being left with an unreliable or hard to operate appliance.

- Despite the offer of support to find an appropriate replacement appliance, some respondents indicated they worried they would experience issues after they began to use the device and may require additional support later on.
- Some worried that for older appliances, the "value" would be very low, as appliances may be decades old. They felt any compensation should reflect the cost to buy a modern device of similar specification regardless of the value of their current device.
- One respondent worried that those who seek to arrange their own replacement may encounter difficulties if they purchase an appliance from a less reputable (cheaper) seller or may be inclined to buy a second-hand model which has a higher likelihood of breaking down. They felt those who wanted to arrange their own replacement should only be able to go to well-known shops and brands, who would offer a warranty and good aftersales care.

"I suppose you are going to get a lot of times where people aren't going to be necessarily happy with what they've been offered. So, I do like the fact that they you've got the option of an independent, because obviously, their job is to make sure it's a fair outcome for both parties"

Scenario explored: Questions are asked to understand the personal circumstances of the resident, so appropriate support can be offered

Everyone	Occupants can be sent a form with questions which they can answer online or offline e.g. a paper form. They can also provide the answers over the phone and ask questions if they desire. Additional support is also available online and over the phone e.g. FAQ, chat facilities
Occasional	For those who prefer a face-to-face discussion, a home visit can be offered, and the information collected in person.
Rare	If a home visit is desired, but the occupants wish to have a trusted friend or 3rd party present – then this can be accommodated by attempting to schedule a time that suits all parties

Almost no issues were raised with the support process available to residents when being asked to provide information about their personal circumstances.

- One respondent indicated they would like the chance to review the responses after they had been captured. This was to ensure no errors had been made and that no support needs were overlooked later in the process.

"I think having a third party is definitely the way forward on it. It's so difficult, because vulnerable people don't [always] take on or don't understand anything new. It takes them a long time to settle with it. "

Scenario explored: The household will be unable to cook using gas at the property for a period of up to five days.

Everyone	A food voucher is provided, which is redeemable at local supermarkets, and takeaway restaurants. In areas where there are not many restaurants, vouchers can be used at hot food vans positioned around the community during the transition.
Occasional	Residents can be loaned electric cooking equipment e.g. microwave, cooking hob to use during the transition. Safety switches and clear labelling would be included on any equipment loaned to be sure residents know how to operate the device and that it will be safe.
Rare	A bespoke food delivery service can deliver warm food to a resident's door (accounting for any special dietary needs) e.g. meals on wheels. Where residents may struggle to answer the door, food can be delivered to 3rd parties on their behalf e.g. a carer or family member, who can ensure the food is received.

There were no issues raised with the support offered for this scenario, and no changes desired.

"That all sounds more than fair to me. I mean, yeah. How could you complain really, because they're offering you so many ways around it?"

Scenario explored: Unable to access hot water for up to five days

Everyone	Access to community shower facilities is arranged, so local residents can visit leisure centres and hotels in the community to bathe.
Occasional	Where residents have medical issues, which mean they may struggle to get to a community shower facility or if the facilities are located far away, a shuttle bus to transport residents is provided. Compensation is also made available for those who can make their own arrangements but may incur additional costs e.g. petrol money to drive to friend's home to shower.
Rare	Occupants can be loaned hot water technologies including electric water urns and camping showers. A temporary stay elsewhere can also be supported (hotel, family members home etc).

Once again, no changes to the proposed support measures were raised. However, several respondents indicated they would be unlikely to use any of the measures on offer, and instead look to resolve the issue themselves e.g. by boiling a kettle to bathe in the sink.

"I would prefer to have the equipment lent to me. I'd rather stay in my own home. If it's at all possible I would stay here whilst the work was being done"

Scenario explored: No gas central heating to warm the home for up to five days

Everyone	Portable electric radiators are loaned to occupants so they can be warm. Safety switches and clear labelling would be included on any equipment provided to be sure residents know how to operate the device and that it will be safe.
Occasional	A risk assessment visit is conducted at the property prior to placing the portable radiators e.g. to minimising trip hazards. An energy bill credit may also be offered to those who net energy costs are expected to increase.

Rare	An offer is made to re-home the occupant at a friend or family members property or if this isn't an option a hotel or assisted living facility until issue resolved

For this scenario, most indicated the package was appropriate on the assumption that the switchover would take place outside the coldest months of the year. One concern was however raised.

- Some worried what type of measures the risk assessment may result in. If physical changes were required in their property, concerns were raised about any resulting damage e.g. pinning a portable radiator to the wall.

Scenario explored: Some pipework at the property requires upgrading before a hydrogen supply can be safely connected

Everyone	The project to upgrade pipework is managed in such a way that reduced access to key spaces (bedrooms and bathrooms) is for as little time as is possible. This may mean having additional workers onsite for any work required in these rooms to complete the work more quickly. The plan will also be shared upfront with the resident e.g. "you won't be able to access bathroom between 9am-11am", to enable them to plan accordingly.
Occasional	The occupant can temporarily move out of their property whilst works are ongoing e.g. taken to a friend or family members home, or to a community centre.
Rare	If the disruption is deemed intolerable, the occupant can abandon the conversion to hydrogen and consider another low carbon alternative e.g. an electric heat pump.

Whilst this scenario was always deemed to be an annoyance by respondents, little change to the support measures proposed was desired.

- One request was that the time when access to key rooms was restricted could be negotiated. For example, if the work was expected to mean the bathroom could not be accessed for a few hours, this could occur after any children at the home had washed before going to school.
- Similarly, some hoped the option to stagger the work could be offered if it was expected to take a considerable period. This was so they could rest or access key rooms in between rather than being without access for too long.

"If you've got children with additional learning needs, or a parent in a wheelchair, they would definitely welcome not being there when this all kicks off"

- One respondent worried that the electricity may be disconnected (either by accident or on purpose) whilst work was ongoing. They were reliant on electricity for life preserving medical equipment. They indicated a need to know of these risks ahead of time, to ensure they have a backup supply or could arrange to vacate the property.

- If the work to convert the pipework was deemed intolerable by the resident, but they must still change from natural gas, a need for support to evaluate and understand the other options available was also discussed e.g. speak with a heat pump installer.

7.2. DELIVERING AT SCALE

The support measures discussed in the previous section will help navigate many of the issues faced by individual households during a conversion to hydrogen. It is important to recognise however that deploying these support measures on a larger scale, to support *all* of those in the affected area, may present a series of logistical challenges. This will present an even greater challenge, should the smaller trials due to be delivered by Northern Gas Networks and Cadent lead to larger scale town projects in the future. As such, the following will need to be carefully managed.

The preceding communication campaign will be key to winning support, and as such will have to be managed with caution. A switch to hydrogen would be unfamiliar territory. Naturally, people will have questions and concerns. Equally, people will have different perceptions on the Net Zero agenda and have varying levels of tolerance for any associated disruption. Failure to alleviate concerns and provide a positive experience will undermine confidence in the conversion and increase the likelihood of encountering resistance should news of any issue spread in the community. This in turn will make the transition more challenging to deploy. To install confidence, the campaign will have to appropriately set expectations on all possible outcomes for customers and clearly communicate how diverse consumer needs will be met during the conversion. Furthermore, it will need to address concerns with the cost and safety of using domestic hydrogen, not just the logistics to convert a property.

Some of the support measures are limited in the relief they can offer. Specifically, portable electric radiators were presented as a possible solution to the absence of gas central heating during the conversion. The increase in power demand however will mean that properties are limited in how many that can be used at any one time. This is because the increase in power demand could cause the property circuit breakers to trip. This would mean that unless residents can confine themselves to only a few rooms, or the conversion takes place in the milder seasons, this solution may not be able to meet the needs of everyone. Similarly, the electricity network may encounter issues meeting a significant increase in demand in the affected region.

"You can get away with two radiators per circuit along with everything else that's running, but that will be your limit. If you start putting in three along with the usual TV watching etc, then the circuits start to go pop."

- Emergency relief expert

Some communities have minimal amenities. The support measures discussed previously include the use of takeaway restaurants to provide hot food and access to communal shower facilities in hotels and leisure centres to bathe. For this to be a feasible option, the area affected will require the availability of support to match the size of the affected population. For example, a village with one or two hotels may struggle to meet the bathing needs of even 50-100 residents, especially if they already have their own guests to accommodate.

Local support services may struggle to meet demand. Some of the key roles residents may turn to for support during the transition are already in considerable demand (carers, mental health support workers etc). In some areas the availability will be more constrained than others, for example not all doctor's surgeries have their own mental health specialists. This will mean temporary additional support may have to be brought in to the community to facilitate the different stages of the transition.

"Some GPs have got specialist mental health in reach workers in their practice. Not all of them have that, but some of them do."

- *Medical professional*

There may not be somewhere locally where residents can be temporarily re-housed. Should residents elect to vacate their property whilst work is ongoing, suitable temporary accommodation will be required. For those with additional needs this could take the form of a care home, assisted living facility or a day centre (if the disruption is only for a few hours e.g. upgrading pipework). However, not all areas have facilities such as these. Additionally, many assisted living facilities may not have capacity to support more residents than they do currently. This may mean additional support of this nature has to be brought into the community during the conversion to hydrogen, or that residents will have to be placed further away.

In some areas the number of affected households will be larger and therefore it could be more challenging to coordinate support. This could simply be because the affected area has a high population density. Some experts also expressed concern that in some regions there are relatively few gas valves at present. This would mean a higher number of homes are disconnected at the same time, when these valves are turned off. Wales & West Utilities are however already aware of this challenge and are considering options to mitigate the issue by installing more valves. Doing this will mean converting in smaller and more easily manageable batches is possible. It may also mean that some other issues that could occur if conversions had to be done on a larger scale can be minimised e.g. more engineer work vehicles in the area may result in more on street disruption.

"There's going to be a time period where everybody who will be receiving gas from that particular tap, needs to go through this logistical interference. The network's will be driven to have fewer number of taps, because it's easier to manage and it's more cost effective. But then obviously, it means that you're dealing with more customers"

- *Networks Engineer*

8. CONCLUSION

A transition to hydrogen will present a range of challenges that need to be managed with care. The diverse and dynamic nature of vulnerability, and the subsequent barriers that this can cause an individual, mean that designing a catch-all process may be an unrealistic ambition at this stage. The measures discussed in this report should therefore be considered as a foundation for the level of support networks will have to provide in the forthcoming domestic hydrogen trials. The consumer touch points, and the support that is offered at each stage in the conversion process should be constantly under review and refined based on the feedback from those who deliver it as well as consumers in vulnerable situations. There are also several key steps than can be taken to maximise the likelihood for success.

The communication campaign should be clear and transparent. The potential for any disruption associated with a conversion to domestic hydrogen is high. The communication campaign will have to make clear how it will adequately support the variable needs of those within the community. It will have to be honest about any anticipated inconvenience to consumers. Failure to disclose this information upfront will cause mistrust and potential fallout. Any arising reputational damage would be damaging for any broader ambitions.

A broad range of support measures should be made available. There are many variables that influence what support is best for an individual. Furthermore, their needs, and subsequently the most appropriate measure, may vary day-to-day. It may also be influenced by other factors, such as the needs of others who live at the same property. This will mean it is necessary to have a wide variety of offerings to cover a broader range of eventualities. This may even require deviating from the usual offerings at times, to provide a bespoke solution to overcome a unique challenge.

Work closely with the affected community and maximise the value of the resources at your disposal. The process to convert a region to hydrogen will require the expertise and skill sets of a wide variety of individuals and organisations beyond those who operate the gas distribution networks. This will include local support services (e.g. those who provide carers), but also national and regional services (e.g. the Priority Services Register). Ultimately, how well these organisations perform their roles will influence how well the gas distribution networks can perform there's. Working closely to understand and overcome any constraints they may face, or even helping to boost awareness of the services that are available, will ultimately result in a smoother transition.

Be observant – look for vulnerabilities at every opportunity. Vulnerability is not static, it is not always obvious, and the same vulnerability may affect different people in different ways. This means identifying those with additional needs to offer appropriate support will be an ongoing challenge. To minimise the possibility of overlooking the additional needs of an individual, every consumer touch point should be considered an opportunity and utilised to explore and identify any additional needs a consumer may have.

Recognise that no matter what, consumers will still face challenges. Regardless of the support that is on offer, and how unobtrusive the conversion may be in some instances, any disruption to people's daily routines will always cause some degree of anxiety and stress. If those affected are not treated with sensitivity and understanding by fitters and technicians, or anyone else involved in the transition, this issue will be exacerbated. It is important therefore that great patience and understanding is shown throughout the process to ensure the best possible experience.

9. APPENDIX 1

THE SWITCHOVER BLUEPRINT

Due to the size of the switchover blueprint, this has been issued separate to this report. It can be downloaded from the following URL: https://smarter.energynetworks.org/projects/nia_wwu_2_05/.

The table in appendix 2 (Table 1) summarises the key actions suggested in the switchover process during each stage, to support vulnerable consumers.

10. APPENDIX 2

10.1. SUMMARY OF ACTIONS

Communication campaign	Property survey	Preparation works	Disconnection	Reconnections & aftercare
Communication material of switchover available in a variety of formats to ensure accessible e.g. large print, braille, alternative languages.	If occupant has neurodiversity issue e.g. dementia, engage with trusted friend or family member where information is shared/captured, or a decision is required	Communication material of works required available in a variety of formats to ensure accessible e.g. large print, braille, alternative languages.	Local support measures deployed in advance of disconnection for heating, hot water, hot food **(please see section 7.1. for support measures)**	If occupant has mobility issues, arrange visit when 3rd party (carer, family member) can be present to enable access
Information shared through a variety of channels, post, web, in person to account for issues such as digital exclusion	If occupant has mobility issues, arrange visit when 3rd party (carer, family member) can be present to enable access	If proposed works to the property are deemed to be too disruptive occupant may need to be placed elsewhere temporarily **(please see section 7.1. for support measures)**	Communication material to discuss visit to property after disconnection for final checks/changes. Available in a variety of formats to ensure accessible e.g. large print, braille, alternative languages.	Support measures deployed if final property survey finds any issues **(please see section 7.1. for support measures)**
Ability to speak with an independent body to understand rights if object to hydrogen proposition	Engage with local support services to negotiate property access with resident if necessary, e.g. social worker, if issue with hoarding or substance abuse	If occupant has neurodiversity issue e.g. dementia, engage with trusted friend or family member where information is shared/ captured, or a decision is required	If occupant has mobility issues, arrange visit when 3rd party (carer, family member) can be present to enable access	Provision of advice for any ongoing needs consumers may have e.g. servicing and maintenance, or issues with new appliances
Access to independent technical advice if wish to understand/ consider options other than hydrogen e.g. electric heat pump	If occupant suffers from anxiety, arrange visit when 3rd party can also be present	Information should be available through a variety of channels, post, web, phone call etc.		

Communication campaign	Property survey	Preparation works	Disconnection	Reconnections & aftercare
Ability to visit demonstrator home to see hydrogen working in a residential property	Support to help clear access to areas for property survey if occupant cannot do so themselves e.g. a gas meter in a cupboard that has obstacles in the way	Engage with landlord or social housing provider where the occupant is not the decision maker (but still involve occupant in the discussion)		
	If appliance is found to be unsafe during survey, and condemned, suitable replacement or other support must be offered **(please see section 7.1. for support measures)**	Help to source suitable replacement for any appliance not compatible. Ensure appliance meets usability needs and can be safely operated. Offer customer support if required to help occupant identify a suitable model		
	A complaints body will be required if the occupant is unhappy with any aspect of the survey	If occupant has mobility issues, arrange visit when 3rd party (carer, family member) can be present to enable access		

Table 1 displays a summary of the support actions proposed to safeguard vulnerable consumers during a domestic conversion from natural gas to hydrogen.

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TO UNLEASH INNOVATION AND OPEN NEW MARKETS TO CAPTURE THE CLEAN GROWTH OPPORTUNITY.

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