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ZERO CARBON RUGELEY SLES – A RETROFIT ROADMAP

SHAP

SUSTAINABLE HOUSING ACTION PARTNERSHIP

April 2023

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EXECUTIVE SUMMARY

Introduction

Zero Carbon Rugeley (ZCR) is one of 14 Smart Local Energy System (SLES) research projects funded by the government through Innovate UK as part of a Prospering From the Energy Revolution challenge.[1] This aimed to investigate investable, scalable local business models using integrated approaches to deliver cleaner, cheaper energy services in more prosperous and resilient communities that also serve to benefit the energy system as a whole.

Zero Carbon Rugeley has delivered a detailed energy system design for the Rugeley area which is sustainable, low carbon, and helps to drive the regeneration of the town and local energy infrastructure while offering additional services and value to residents and business. The project has put the involvement of the local community at its heart, working actively and creatively with local groups to identify what those living and working in Rugeley want from a future energy system. It responds to the town's rich energy heritage and was intended to respond to the ambitious low carbon plans for redevelopment of the site of a coal power station which closed in 2016 by creating an equally ambitious low carbon plan for the existing town through research into a SLES.

The ZCR SLES project looked at a number of elements to build a detailed understanding of their interdependencies and the integration of solutions to form the SLES model. SHAP took the lead on domestic buildings.

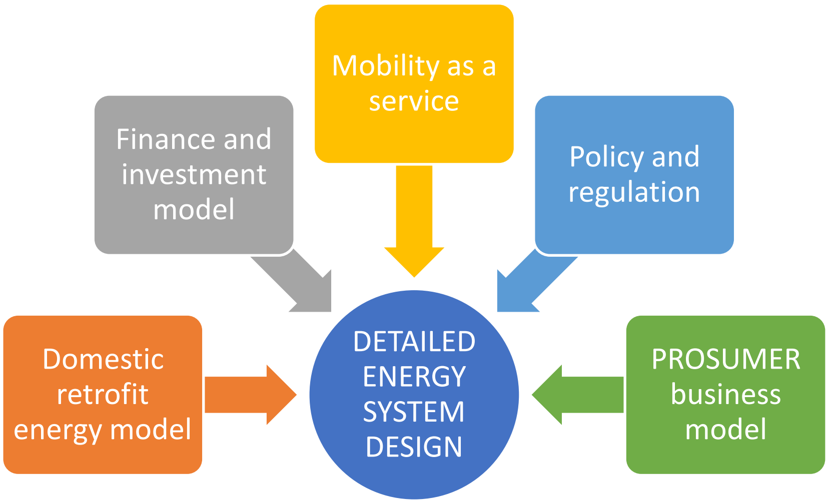

Figure 1 – The role of retrofit within a SLES system

The SHAP research resulted in confirmation of the need for retrofit system change, not as a discrete activity but within the wider context of a place-based approach to decarbonisation. The dependencies of a place-based decarbonisation approach requires that demand reduction of energy used in buildings is balanced against the existing grid capacity together

[1] https://www.ukri.org/what-we-offer/browse-our-areas-of-investment-and-support/prospering-from-the-energy-revolution/

with proposals for new energy generation and storage, and forecast future demand due to electrification of mobility.

The key SHAP deliverable within ZCR was to create a retrofit roadmap for Rugeley. The headline learning was that there are multiple systemic and market failures in retrofit. These are well reported and have persisted over many years. System change is therefore essential in order to realise the objective of scaling up retrofit. A number of building blocks/component need to be developed in parallel and collaboratively to deliver the system change needed.

The Zero Carbon Rugeley retrofit roadmap

The Rugeley retrofit roadmap sets out a process for the creation of a robust approach to scaling up retrofit for 10,500 homes in Rugeley, that can be replicated and scaled up across the Cannock Chase District Council area and more widely. The roadmap focusses in detail on data collection, analysis and modelling but touches on other building block/components that need to be developed in order to create a new approach to scaling up retrofit. Some actions can be taken forward by residents, businesses and the Council, while many are dependent on activity by others locally, regionally and nationally. All require resourcing and the Rugeley retrofit roadmap sets out a list of next steps in the creation of a retrofit strategy and programme to create the necessary conditions for success in realising an all tenure retrofit programme for Rugeley.

It should be noted that current stock/area level modelling and architype-led approaches tend to be high level. This is important for strategic planning and provides guidance information for starting to plan for delivery of building-by-building retrofit. However, every property is different due to how it has been adapted over years and this needs to be considered when moving to specification and delivery of measures.

The SHAP retrofit roadmap therefore started with high level modelling but has iterated through several more detailed models to end up with a data set that is calibrated against actual energy use at a property level to provide three investment scenarios balanced against the current capacity of the electric grid at a local substation level. Experience shows that it is not enough to design and fund renewable energy projects such as PV installations if the local substation cannot accept the additional incoming energy generation, or energy demand through transitioning to electric heating or electrification of mobility.

A deep retrofit (reducing energy demand to a point where a property can become a net zero emitter of carbon emissions) is expensive for individual properties and so costs for a plan for a town will be extremely expensive. As a result, there is a danger that short-term, lower-cost improvements are developed for properties that create some improvements but can create larger retrofit needs in the future. For example, a gas boiler upgrade or new double glazing will improve the current efficiency of a poor energy efficient property, but it will mean expenditure on measures that will have to be removed and changed for later necessary upgrades. SHAP has designed its retrofit plans to ensure that these ‘no regrets’ costs are included. A plan, held as a 'building passport'[2], can be developed providing a pathway to net zero with all phased improvements documented as an alternative to a very expensive 'deep' refurbishment expected to be delivered in one step.

The ZCR retrofit roadmap needs to leave Rugeley with the most effective retrofit improvements that are needed on a property-by-property basis, responding to individual property characteristics, while being delivered at scale.

Modelled retrofit scenarios

Recognising that there will be different investment potential and drivers for retrofit for each individual or group of properties, we chose three scenarios for the detailed modelling, all on a pathway to net zero and delivering the UK 2050 climate emissions reduction target:

1. Energy Performance Certificate rating of C (currently a target for rental properties for first let after 2030) but allowing for further retrofit at a later stage.
2. A deep retrofit with a target of 55 kWh/m^2/yr with potential for further reduction in greenhouse gas emissions. This is close to the LETI standard[3] of 50kWh/m2/yr but reflects Rugeley stock and constraints.
3. A deeper net zero retrofit of 30 kWh/m^2/yr. This is close to the passive house Enerphit retrofit standard of 25kWh/m2/yr but reflects Rugeley stock and constraints.

Key learning 1 – retrofit modelling outcomes

The models have shown that:

- Payback on investment recouped by energy bill savings for all scenarios averages 16 years with a range of 12 to 21 years depending on price and retrofit cost scenarios.
- Payback is quicker with variable tariffs compared to non-variable tariffs by between 1 to 3 years quicker. The deep scenario is 1-3 years quicker while the deeper scenario is 1-2 years quicker.
- The EPC C scenario has been modelled to ensure that interim improvements can be installed that do not significantly compromise further work later to get to net zero.
- The standing charge makes up a considerable proportion of the overall energy bill in the deep and deeper scenarios of between 40 and 45% respectively (averaged across the 190 houses).

Key learning 2 – addressing systemic failure through retrofit system change

Whilst the technology is already available and future energy scenarios are available, general experience and that of delivering BEIS-funded energy efficiency improvement projects over the last two years (evidenced by engagement with the national retrofit stakeholders group) confirms that a range of issues including lack of reliable data, reluctance of residents to engage, lack of supply chain capacity, costing for risk in innovation projects and other contextual changes and challenges often results in retrofit projects underachieving

[2] Note that the concept of a 'building passport' recording every change to a building from a detailed baseline created by in depth survey is widely discussed but there is no template for this yet.
[3] https://www.leti.uk/retrofit

significantly or costing considerably more than planned. Most recently, the government's Social Housing Decarbonisation Fund (SHDF) Wave 1 has been extended as only 7% of 20,000 measures have been installed.[4]

Delivering a roadmap that can effectively be delivered requires more than modelled property improvement, no matter how detailed these are. SHAP's team of associates stress the need for a systems perspective when considering the scaling up of retrofit and energy systems. These are complex and require diverse stakeholders to work together on factors that do not immediately seem connected but need to be considered collectively to enable scaling of retrofit activities. SHAP used the Cynefin framework to illuminate the retrofit system which is particularly relevant to the development of retrofit within a SLES as it offers decision-makers a 'sense of place'. While technical solutions exist to improve properties (which the energy modelling activities demonstrated), successful retrofit programme will need to consider the many non-technical barriers and enablers that exist and act as a catalyst to the scaling up of retrofit. The role of residents to support, communicate and benefit from retrofit is critical but also complicated and requires resources and experts.

These issues collectively show the challenge for SHAP when developing a retrofit roadmap for Rugeley:

- The need for the roadmap to understand issues relevant to designing and delivering retrofit within Rugeley alongside broader issues that affect retrofit at a regional and national level, such as skills, training and regulations.
- The need to develop detailed, accurate retrofit plans at an area level before resourcing individual property surveys.
- The need to create a roadmap that can be flexible in its implementation but still achieve a longer-term objective of achieving net zero properties.
- The ability to create a local plan that can be delivered alongside national factors – including positive enablers and negative barriers.
- Despite these challenges and with a retrofit infrastructure that is largely unfunded, to create a legacy of awareness, skills and next steps that prepare Rugeley for large-scale retrofit works.

Finally, the roadmap has created some legacy resources that help the preparation of future retrofit delivery, along with the energy modelling and broader retrofit systems perspective.

[4] https://www.insidehousing.co.uk/news/deadlines-extended-on-governments-social-housing-decarbonisation-fund-with-just-7-of-jobs-complete-80262

1. CHALLENGE

1.1 The Zero Carbon Rugeley SLES challenge

The development of Smart Local Energy Systems (SLES) are important as the UK decarbonises its energy systems and combines technical approaches to energy efficiency and energy security of supply with a new emphasis on the importance of place making and community health and wellbeing. The growth in renewable energy generation and the increasing importance of decarbonising heat and transport, means a focus on local needs and opportunities is very important. Working with existing national approaches to policy, regulatory, investment models and skill-bases does not always prove to be the most effective way to design a new energy system at a local level.

In March 2020, the Zero Carbon Rugeley (ZCR) project was established after receiving government funds to create the design of a town-wide SLES in Rugeley.[5] This aimed to create a detailed energy system design for the Rugeley area which is sustainable, low carbon, and helps to drive the regeneration of the town and local energy infrastructure. It needed to demonstrate what can work and what might not, where the biggest benefits and the most challenging barriers are likely to be.

Rugeley is a former industrial town situated on the North-Eastern edge of Cannock Chase. The demolition of the former power station presented an opportunity for a large new brownfield development giving the opportunity to assess options for a smart local energy system. One objective of the ZCR programme was to ensure the existing town of Rugeley and the 10,500 domestic properties could also benefit from the design of a SLES.

The SLES is intended to take full advantage of the latest renewable energy technologies and smart control systems and demonstrate how carbon emissions and energy costs can be reduced whilst also providing a boost to local regeneration. ZCR has embedded a 'user-centric design' focus to ensure the wants and needs of the community are understood and can inform the design.

Equans (formerly Engie) was tasked with bringing together a consortium of partners that would support with the design of the scheme, which included Cannock Chase District Council, Staffordshire County Council, Keele University, Connected Places Catapult, West Midlands Combined Authority (WMCA), Cadent, Opus One Solutions, Conigital, Chase Community Solar, Regen, New Vic Borderlines and Sustainable Housing Action Partnership (SHAP).

1.2 Role of SHAP

SHAP is a not-for-profit organisation made up of an independent network of innovators and leaders working in public and private organisations across a range of disciplines involved in the housing sector. SHAP's members include housing associations, local authorities, businesses and third sector organisations.

[5] https://www.ukri.org/about-us/how-we-are-doing/research-outcomes-and-impact/innovate-uk/zero-carbon-rugeley/

SHAP has been researching and providing policy advice on retrofit at neighbourhood scale since 2009. Local authorities and their wider partners have been at the core of the research and thinking. Based on research from 2009 and 2010, SHAP facilitated a West Midlands Regional Retrofit forum during 2014 and has continued to develop the discussion since then.

SHAP has experience of working with three combined authorities (West Yorkshire, Greater Manchester and West Midlands) and their local authority and social housing partnerships, developing retrofit programmes and harnessing combined authority budgets such as Adult Skills funds, reorienting some spend to development of retrofit skills.

The SHAP team working on ZCR has considerable experience working with and alongside local authorities and social housing providers on issues relevant to scaling up retrofit design and delivery including a focus on developing able to pay models for scaling up retrofit. The team has facilitated extended stakeholder engagement to develop innovative proposals to address fuel poverty alongside retrofit development.[6]

The team bring experience of developing green finance options for retrofit of all tenures which sets out the business case and strategy for financing retrofit and the economic benefits of a sustained retrofit project.[7] The team also has expertise in energy modelling with experience of working for national energy infrastructure organisations and direct experience in the delivery of low carbon housing innovation projects including retrofit at scale.

SHAP's team of associates stress the need for a systems perspective when considering the scaling up of retrofit and energy systems. These are complex and require diverse stakeholders to work together on factors that do not immediately seem connected but need to be considered collectively to enable scaling of retrofit activities.

1.3 What is SHAP's retrofit roadmap?

The SHAP team role was to create a retrofit roadmap that describes the pathways and activities needed to decarbonise the town's domestic dwellings.

The ZCR programme has enhanced thinking about the relationship between technical approaches and use of low carbon technologies and the market failures holding back investment, which includes a number of non-technical barriers.

The roadmap therefore details a technical modelling approach to develop a clear picture of the fabric and technology investment required, in what order, to achieve different levels of carbon savings against different investment envelopes along with a number of initial actions to build local capacity to address a series of non-technical barriers.

The modelling results in a set of investment elements for each house, creating a clear 'offer' to industry of what a pipeline retrofit programme for Rugeley look like. This is critical so that

[6] https://shap.uk.com/fuel-poverty/
[7] https://shap.uk.com/wp-content/uploads/2018/07/finance-models-for-retrofit-of-all-housing-tenures.pdf and https://shap.uk.com/retrofit/

scaling up of skills development and product production can be programmed in with confidence.

The actions to address non-technical barriers look at a number of issues that all need to be tackled to create an environment within which demand for investment can be built to incentivise investment in skills development and a supply chain response.

This was delivered through four stages as shown below.

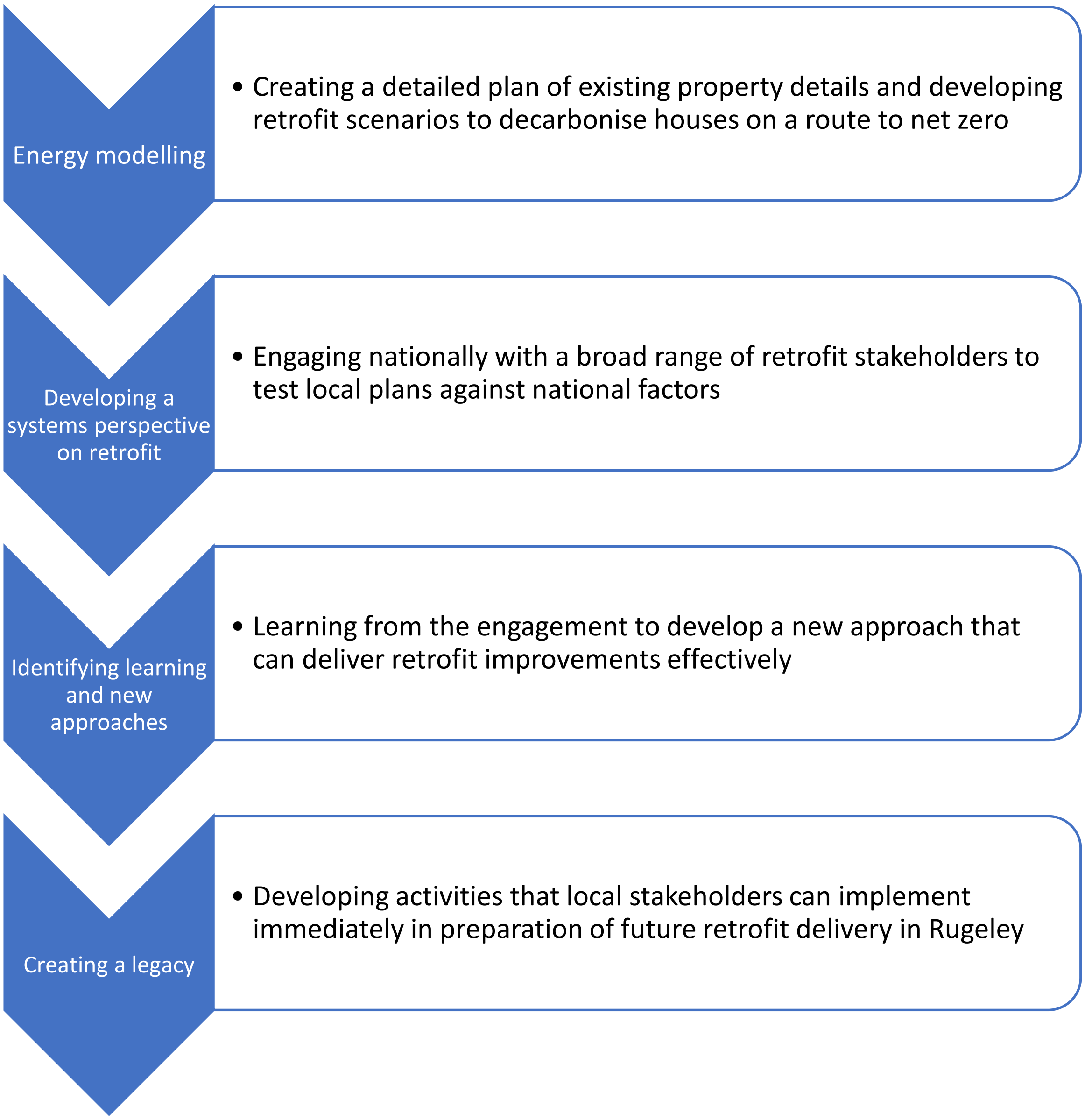

Figure 2 – Four elements for creating the retrofit roadmap

The difficulties of developing a roadmap that contributes to a SLES arise from the interdependence of local circumstances versus national needs, such as existing infrastructure and potential opportunities. SHAP's roadmap needs to create retrofit improvements for all domestic properties showing detail at a property level but also understanding the broader issues that either enable retrofit to be delivered or the barriers that restrict the delivery of retrofit. SHAP investigated the significance of these local and national issues on proposals to scale up retrofit by engaging with a range of retrofit, governance, housing stockholders, local authorities and construction stakeholders to identify and examine the wider range of actions that are needed to be considered by key local actors when preparing to deliver retrofit programmes in the future. These stakeholders have extensive experience of designing and delivering retrofit across several regions in England and include social housing asset managers, local authority officers and elected members, supply chain representatives and other retrofit stakeholders. This enabled the Rugeley retrofit roadmap to take a systemic view of retrofit, ensuring that factors not immediately obvious at a local level were incorporated.

The roadmap needs to leave Rugeley with the most effective retrofit improvements that are needed for individual properties. We chose three scenarios for the modelling, all on a pathway to net zero and delivering the UK 2050 climate emissions reduction target:

1. Energy Performance Certificate rating of C (currently a target for rental properties for first let after 2030) but allowing for further retrofit at a later stage.
2. A deep retrofit with a target of 55 kWh/m^2/yr with potential for further reduction in greenhouse gas emissions. This is close to the LETI standard[8] of 50kWh/m2/yr but reflects Rugeley stock and constraints.
3. A deeper net zero retrofit of 30 kWh/m^2/yr. This is close to the Passive House EnerPHit retrofit standard of 25kWh/m2/yr but reflects Rugeley stock and constraints.

These different scenarios were designed to be applied to properties and allow a medium-term plan to be developed avoiding 'no regrets' improvements.

While the improvement measures for the ten thousand properties are modelled using approaches outlined in section 2.1, they have been calibrated using actual energy use and sample property assessments.

Addressing non-technical barriers
SHAP's systemic perspective on retrofit has shown that there are actions that can be developed in the short term that will enable future retrofit programmes to be delivered effectively. The roadmap includes these actions as priorities for local stakeholders, which broadly fall under three categories:

a) **Skills development and training**. Retrofit is complex, relatively recent and changing. Key stakeholders need training activities that create awareness of the complex arrangement of retrofit.
   - For local authorities and social housing providers on stock-wide no regrets improvements.
   - For the supply chain on technologies and capabilities to deliver whole-house improvements.

[8] https://www.leti.uk/retrofit

- For colleges, the need to demonstrate the career opportunities retrofit can offer and offer courses useful to industry and with proven routes to high quality careers.

b) **Awareness and engagement**. Local communities and businesses are generally unfamiliar of retrofit. Efficient rollout of retrofit programmes needs residents, communities and businesses to be positively willing to engage and understand the disruption that retrofit brings during the installation process. Residents and decisionmakers need to understand what retrofit means, how it changes buildings, how residents need to live differently in a highly energy efficient property.

c) **Partnership development and co-ordination**. In an area such as Rugeley there are different property tenures, many different property owners, a range of local authority tiers and a dispersed supply chain with no incentive to engage. Effective retrofit delivery programmes will need collaboration to be developed to increase skills, training and awareness, and develop a series of delivery schedules that create greater efficiency by co-ordinating the wide supply chain with investment programmes (buildings and energy infrastructure).

The roadmap includes a series of actions that are suggested to take place with local stakeholders to ensure the technical elements of the property plans can be implemented effectively. The road map combines the 'what needs to be done' with a 'how it can be delivered' to ensure domestic properties can have a pathway to net zero in Rugeley.

1.4 The ZCR challenge for SHAP

SHAP's experience of developing scaling up models for retrofit have shown that a broad understanding of the different factors that need to interact to enable retrofit to be scaled up should be integrated into the detailed design. For example, supply chain factors have been a significant barrier to the delivery of recent retrofit schemes, for both availability of labour and access to appropriate heating and generation equipment.

At the same time as considering broader issues, successful retrofit delivery needs correct and detailed data of the properties that will be improved. Every house is different, and every house needs a high-quality retrofit design and building passport[9] that would track retrofit investments to reduce energy use, create better living conditions, satisfy householders and avoid unintended consequences such as condensation or damage by other work on the building. The ZCR project was not expected to produce individual assessments and plans for every house (this is resource intensive and currently faces a range of non-technical and digital barriers) but the need to understand detail and data at a town-wide level is a very important success factor for planning to scale up retrofit.

[9] The concept of a building passport has been discussed nationally for some time. At present there is no standard template. The building passport should set out the current baseline energy performance and structural/fabric integrity of a building. It should then be updated with all material changes made, including full specifications and detail drawings of the products used and how they have been installed, with recommendations for future investment to enable the building to reach net zero also updated.

A deep retrofit (reducing energy demand to a point where a property can become a net zero emitter of carbon emissions) is expensive for individual properties and so costs for a plan for a town will be extremely expensive. There is a danger that short-term, lower-cost improvements are developed for properties that create some improvements but can create larger retrofit needs in the future. For example, a gas boiler upgrade or new double glazing will improve the current efficiency of a poor energy efficient property, but it will mean expenditure on measures that will have to be removed and changed for later necessary upgrades. SHAP has designed its retrofit plans to ensure that there are only 'no regret' measures included. A plan can be developed as a pathway to net zero properties rather than a very expensive refurbishment expected to be delivered in one step held as a 'building passport'.

Experience of delivering BEIS-funded energy efficiency improvement projects over the last two years confirms a range of issues including lack of reliable data, reluctance of residents to engage, lack of supply chain capacity, costing for risk in innovation projects and other contextual changes and challenges. Most recently, the government's Social Housing Decarbonisation Fund (SHDF) Wave 1 has been extended as only 7% of 20,000 measures have been installed.[10]

These issues collectively show the challenge for SHAP when developing a retrofit roadmap for Rugeley:

- The need for the roadmap to understand issues relevant to designing and delivering retrofit within Rugeley alongside broader issues that affect retrofit at a regional and national level, such as skills, training and regulations.
- The need to develop detailed, accurate retrofit plans at a geographical level before resourcing individual property surveys.
- The need to create a roadmap that can be flexible in its implementation but still achieve a longer-term objective of achieving net zero properties.
- The ability to create a local plan that can be delivered alongside national factors – including positive enablers and negative barriers.
- Despite these challenges and with a retrofit infrastructure that is largely unfunded, to create a legacy of awareness, skills and next steps that prepare Rugeley for large-scale retrofit works.

[10] https://www.insidehousing.co.uk/news/deadlines-extended-on-governments-social-housing-decarbonisation-fund-with-just-7-of-jobs-complete-80262

2. PROJECT ACTIVITIES

2.1 Energy modelling

Energy modelling was a critical major activity for SHAP as it directly created the retrofit plan for the domestic properties in Rugeley, developing two scenarios in the first iteration and three in the second.

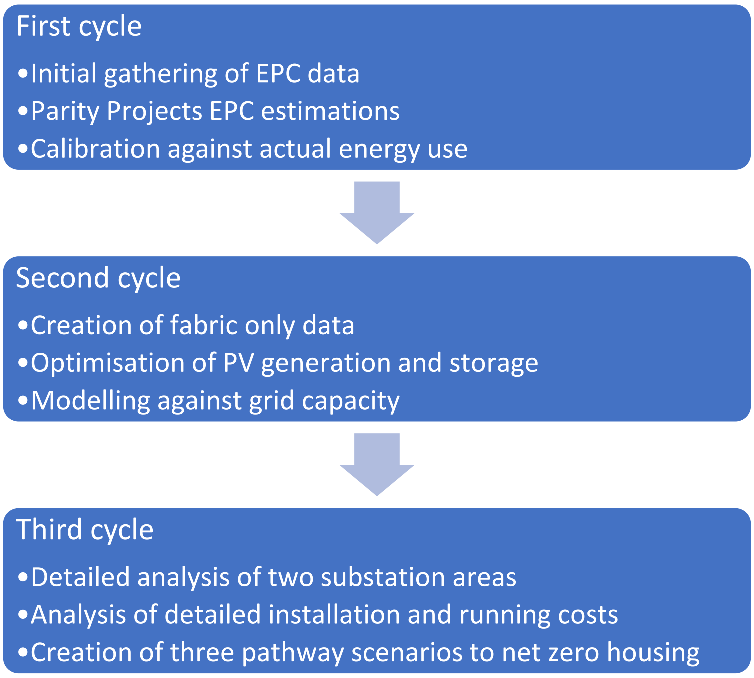

Figure 3 – Iterative cycling approach to energy modelling

2.1.1 First iteration of energy modelling

The production of a first proposition of retrofit designs for domestic properties supported the ZCR design cycle iteration and optimisation process. It aimed to develop an accurate baseline understanding of the existing domestic properties in the project area to then develop a pathway to decarbonising domestic energy demand.

Only about half of the domestic properties in Rugeley had an Energy Performance Certificate (EPC) estimating their current energy efficiency rating. The Parity Projects housing stock assessment process created a baseline energy performance assessment for all domestic properties in Rugeley based on data from the domestic Energy Performance Certificate (EPC) database as well as OS data, LSOA defaults and LIDAR data. The Parity Projects tool then went through several iterations to generate missing data to provide a baseline energy performance data set with scenarios created to generate recommendations for energy efficiency improvements. See Appendix 2 for details of the Parity Pathways report.

There are several weaknesses in the use of EPCs as the basis of retrofit modelling and planning. They may be out of date, the underlying software forces assumptions and the experience of EPC assessors varies. In order to increase the accuracy of the property assessments, therefore, actual gas demand per postcode for domestic properties was obtained from Cadent. This was converted to heat demand per property based on proportional heat demand per property per postcode, and the boiler efficiency data that we had from the Parity Pathway data. For electricity demand, as EPC ratings do not include small appliance use, we simplified this process, and applied the most recent Typical Domestic Consumption Values (TDCV) published by Ofgem.

There were also issues related to the two retrofit pathways (scenarios) generated through the modelling for EPC C and net zero. This was mainly as it followed the RdSAP methodology that generates building fabric and heating technology measures. This created some anomalies to the modelling created by Equan's PROSUMER software[11] that used the housing data but also selected different heating types, generation and storage.

The PROSUMER modelling also showed that moving to electric heating created significant grid constraint problems with around two-thirds of the 101 substations between 200-300% overcapacity.

2.1.2 Second iteration of energy modelling

As the EPC improvement methodology is known to difficulties in determining effective retrofit pathways, the SHAP team decided to create a revised property improvement methodology:

- Using only the calibrated fabric data (walls, roof, glazing and floors) from the housing stock analysis.
- Create a set of target fabric U-values to allow an overall heat demand of 50 kWh/m^2/yr to be produced.
- Consider other factors to be included to achieve the heat demand reductions including addressing thermal bridges, air tightness and controlled ventilation, based on sample property assessments.
- Include electric heat pump heating, solar PV generation and battery storage for every property to achieve the fabric demand to be achieved.

Running this set of property data through PROSUMER showed that the average house heat demand using this approach was 58 kWh/m^2/yr. The original previous net zero scenario using Parity data had heat demand averaging 63 kWh/m^2/yr.

If the PROSUMER model showed that heat demand needed to be lower in some substation areas due to substation capacity, it was possible to either upgrade the wall insulation to improved U-values or add extra thermal efficiency retrofit options alongside the essential retrofit priorities of improved air tightness and thermal bridging.

[11] PROSUMER was the modelling tool developed by Equans as part of ZCR. This used data from the broader energy modelling activities.

2.1.3 Third iteration of energy modelling

To develop a more detailed understanding of the efficacy of the modelling, two substation areas were selected in agreement with Cannock Chase District Council as the focus of a detailed analysis of residents' energy costs before and after the retrofit scenarios were applied, based on current tariffs and recent weather data. Both substations had limited capacity and so will be constrained by a transition to electric heating. The properties were of two broad types, 1940s-built steel-framed and 1970s brick-and-panel semi-detached houses, on a small cluster of streets, both part of post-war council housing estate developments. Most have a range of energy-saving measures, including some external insulation, but some remain unimproved.

They also represented the most typical housing in Rugeley and are also quite representative of much UK housing.

Figure 4 – Properties in Springfield Avenue, predominantly semi-detached solid wall properties, aging from 1930-1960

The modelling process required identifying the main archetypes from the 190 properties using the data from the second iteration. An optimum retrofit set of improvement measures were created for each archetype for each of the three scenarios created – EPC C rating, deep retrofit (55 kWh/m^2/yr) and deeper retrofit (30 kWh/m^2/yr). Actual running costs were then created using seven different energy tariffs (Including flat, Economy 7 and flexible tariffs) against historical weather data for a year at half-hour intervals. This created a detailed output of the required retrofit improvement measures together with PV generation and storage needed to get to EPC C rating, 55 kWh/m^2/yr and 30 kWh/m^2/yr heat demand together with capital costs, energy savings and carbon savings. In comparison, Passivhaus has a space heating demand of no greater than 15 kWh/m^2/yr and EnerPHit has a heating demand target of 25 kWh/m^2/yr.

Data was calibrated against ten actual retrofit assessments undertaken in the target area and then recalculated. Merging household data within each substation area allowed examination of peak demand and export to ensure the substation can operate within its intended capacity.

The output of the third modelling iteration was a detailed list of the 190 properties showing the different retrofit fabric, heating, generation and storage measures, costs of installation, energy savings, running costs savings, carbon savings and expected payback time, and also network upgrades requirements, which were now not required if some constraint was imposed on battery storage charging.

2.2 National retrofit stakeholder engagement

The energy modelling activities enabled a retrofit plan to be created for the 10,500 domestic properties showing the fabric improvements, generation and storage needed to achieve net zero housing. However, creating a plan, even with costs and payback times, does not mean that the retrofit activities can be delivered as this depends on other external factors such as willingness of residents to engage, availability and skills of the local supply chain, different tenure arrangements and the development of a local co-ordination programme.

SHAP tested the development of the roadmap over 12 months with several stakeholder groups it works with nationally to align the reasoning behind the development of the detailed, local plan along with factors that the stakeholder groups were involved with.

This included the following stakeholders:

- Social Housing Asset Managers Group – a group of officers from housing associations and local authorities that meet to develop good, shared practice of the need to improve the energy efficiency of social rented properties. This group has responsibility for over 300,000 properties mainly in the West Midlands but also in Yorkshire. This group has experience of developing stock assessment plans, tenant engagement and securing government grants such as Social Housing Decarbonisation Funds (SHDF) and Green Homes Grant Local Authority Delivery (LAD). This group have particular difficulties in engaging a supply chain to be able to deliver retrofit improvements within the often short timescale of grant-funded capital programmes.
- Supply Chain Working Group – a group of representatives from companies delivering retrofit improvement programmes. These PAS 2030 accredited contractors create delivery supply chains by engaging a range of subcontractors delivering to the PAS 2035 retrofit standard.
- Local authority officers co-ordinating retrofit improvements – engaged through the Local Government Association (LGA) regional retrofit action plan training programme where SHAP was a delivery partner.

The outcomes of the stakeholder engagement concluded that delivering an effective retrofit programme is complex, with many dependencies and well-understood but persistent barriers, many of which are non-technical. The current retrofit system is unlikely to improve housing at scale at the pace required, and has not over the last 15 years, meaning carbon reduction targets will not be met, householders will continue to face significant increases in energy bills and the health impacts of people living in cold, damp properties will not be addressed. The low carbon economy will fail to grow and the energy system transformation will not be optimised.

While the government's economic stimulus investment in retrofit has been successful in incentivising partnerships and collaboration and in stimulating some organisations to move forward fast in retrofit planning and delivery, the group regarded persistent barriers and market failures as very damaging. The need for continuity and long-term commitment are necessary to build a sustained retrofit industry. With a confirmed pipeline, the market will respond, but current approaches to funding retrofit was damaging many aspects with serious consequences for future delivery.

The groups identified the need for a systemic revision of the retrofit strategies, outlined in the learning in section 3.3 and detailed in Appendix 1.

2.3 Local stakeholder engagement

A strong element of the ZCR programme was user-centric design to ensure local stakeholders had a voice in the overall development of the SLES. Early SHAP engagement invited volunteers to come forward for a detailed property survey, designed to be Covid-19 safe, trialling new technical approaches such as LiDAR to capture data but shorten time on site. As SHAP's broader stakeholder work had shown that successful retrofit delivery required a customer experience that informed and engaged local residents, the project team developed several community engagement activities during the second half of the project. This included residents, schools and local businesses.

2.3.1 Residents and community groups

Alongside community engagement led by Keele University, Rugeley Rose theatre and other SHAP partners, SHAP engaged specifically with residents through the delivery of property assessments and retrofit assessments, particularly in the 190 property focus area identified by Cannock Chase District Council but also through an offer to the SLES ambassadors group created by Keele University.

Standard approaches to engagement with the community were followed including delivery of leaflets to each address, advertising drop-in sessions and an invitation to complete an online survey. This was followed up with door knocking, support from a local community centre and brokerage by a local community activist.

Five households received detailed bespoke property assessments and ten households received a PAS2035 retrofit assessment and EPC. Residents were given advice on the most important improvements needed for their properties, the costs of installation and the running costs after improvements.

Residents in the focus area also had the offer of a thermal image showing heat loss from their properties. Seeing where heat is actually being lost from a property and being able to compare to neighbouring properties can be a strong motivating factor in deciding to retrofit a property.

Two thermal imaging sessions led by SHAP have proved popular with residents and more training is required for effective use of the camera being left with the community by ZCR project partner Keele University.

2.3.2 Schools

The Chancel Primary School has been an enthusiastic partner within the ZCR programme and supported the development (with partners SHAP, Keele University and Urban Vision Enterprise CIC), to help young people actively experience, participate and learn about the challenges and positive benefits of creating a zero carbon community, called 'Energy for Change'.

The programme was designed to cover key areas of both core and foundational elements of the upper key stage 2 national curriculum. The workshops also aimed to go beyond the curriculum in aspects of PSHE (personal, social, health and economic education) such as understanding impact on our local and global environments as part of the UN Sustainable Development Goals (UNSDG) 4.7 Education for Sustainable development. In so doing, the programme aimed to form part of an ambitious curriculum for engaging pupils both with issues in sustainability and their local community.

The programme formed part of the preparation 'of pupils at the school for the opportunities, responsibilities and experiences of later life' (Primary National Curriculum 2013) in relation to their understanding of sustainable homes and energy generation. In so doing the programme was designed to both complement and extend the curriculum taught in school.

The areas of the curriculum covered are predominantly Y 5 and 6 Science, forces and materials, in sessions 1 and 2. Session 2 also covers design, make, evaluate, and technical knowledge from Design and Technology. Whilst session 3 drew predominantly from Maths addition and subtraction, multiplication and division, and measurement. Furthermore, the programme built positive relationships between students through collaborative work, investigation and problem solving.

Over 60 students took part in workshops, with the photograph below showing some of the outputs.

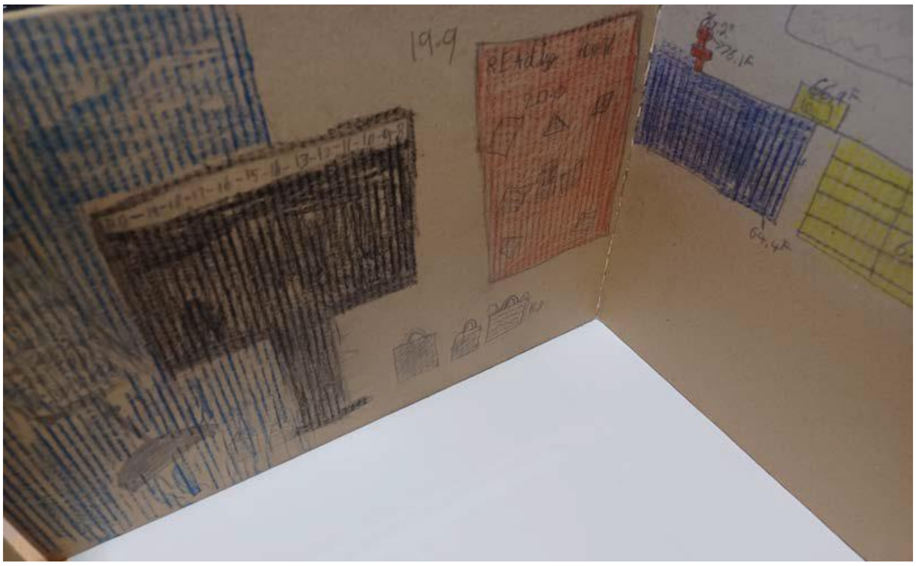

Figure 5 – A pupil's measurement of temperatures of walls and windows in a classroom

An additional training session was delivered to teachers from other Rugeley Schools to allow the curriculum and workshop materials to be used after the ZCR programme has finished. Five boxes of Energy for Change workshop materials were put together to be left with four schools and one community volunteer.

A separate report of the Energy for Change programme can be seen at Appendix 5.

To complement the classroom activities, the school also received a retrofit assessment and EPC. This detailed the energy efficiency of the school's buildings and heating system, and identified retrofit improvements necessary to reduce the energy use of the school.

Based on the learning from the work with Chancel School and with knowledge that all schools nationally have received energy efficiency capital investment funding in 2022-2023, all schools in Rugeley were contacted twice to offer a retrofit assessment and discussion about retrofit investment and interest in a solar PV scheme.

Retrofit assessments were completed at three other schools in Rugeley and a conversation started regarding installation of PV with ZCR partner Chase Community Solar.

2.3.3 Local supply chain engagement

SHAP's broader stakeholder engagement work has shown that an engaged and training local supply chain is necessary for effective retrofit delivery. SHAP offered PAS 2035 retrofit training for interested businesses based or working in the Rugeley area.

This training offer was co-ordinated through Staffordshire Chamber of Commerce with all business members receiving information about the training offer. SHAP also contacted businesses directly that advertised similar work to retrofit activities to offer the training activities.

Business interest in the training offer was low, which reinforced some of SHAP's stakeholder work that demonstrated that there was little incentive for businesses to increase their retrofit skills due to a limited long-term pipeline of work. Instead, the PAS 2035 training was offered to residents who could act as community ambassadors for retrofit and eventually be part of the retrofit supply chain. One local authority officer enrolled to complete a level 5 training in retrofit co-ordination.

To enable businesses to understand the potential retrofit works needed for their business properties, retrofit assessments and EPC surveys were offered to businesses in Rugeley. Four businesses and two community organisations (plus the four schools mentioned above) received a retrofit assessment detailing the priority measures needed for their properties.

2.4 Detailed survey of five dwellings

A detailed property assessment was undertaken at five properties across Rugeley, with the aim of contributing to the calibration of the energy modelling activities as well as engaging with local residents. The assessment was done to a SAP level and so included additional measurements and factors (such as ventilation and thermal bridging) that provides more data than an EPC assessment (using RdSAP).

The surveys gave a detailed assessment on the current property construction, heating type and current carbon emissions and energy use. A costed improvement plan showed how the residents could improve their property and what the resulting energy bills and carbon emissions are likely to be. They showed the main heat loss from the property's current fabric. The surveys were provided to volunteers, primarily as a result of engagement through the Rugeley SLES Ambassador's network. The spread of properties included examples of typical property types but also included two 'outliers' that would normally have been excluded from similar exercises either because so much work had already been perceived to have been done or because the property was so untypical. These properties were not rejected as they represent a sample of the total stock spread that needs to be included in programmes to scale up retrofit, particularly in a SLES approach.

The property assessments aimed to create a range of improvements that would reach a heating demand of around 50 kWh/m^2/yr using a SAP-based energy model that could be compared to the results from PROSUMER. This allowed a sense-checking of recommended improvements, such as the actual amount of usable roof space for PV installation, as well as understanding resident awareness of the level of changes to a property that a deep retrofit required.

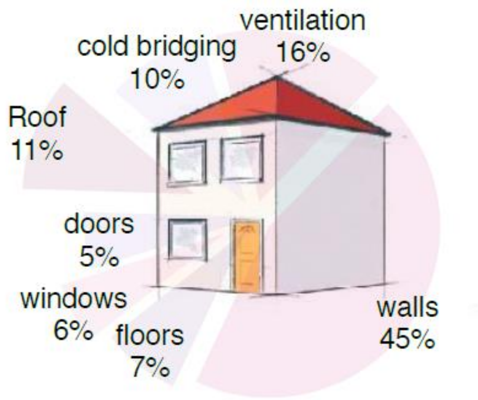

Figure 6 – Illustration from a property assessment showing heat loss

The assessments were also undertaken to understand the validity of creating archetypes for the modelling approach. Creating archetypes (groups of properties with similar characteristics such as age, wall construction, adjacency to neighbouring properties, etc.) can help simplify the energy modelling by reducing the number of separate property models that need to be generated. However, the selection of archetypes can also introduce inaccuracies if the archetypes are too broad (such as age ranges being too wide or simplifying wall types) that will reduce the accuracy of the overall modelling. Undertaking the assessments allowed the modelled archetypes to be compared against actual property details.

2.5 Development of a set of standard retrofit details

Not all retrofit improvements need government-funded programmes to be undertaken. There are several other triggers that could start retrofit activities at a property, such as:

- When a resident moves into a new property that requires improvements.
- When an extension is planned for a property.
- When significant repair or maintenance work is needed.
- In response to rising energy bills or a desire to reduce carbon emissions, particularly relevant for the able-to-pay sector.

A barrier to starting retrofit activities is access to detailed retrofit design details if it is not possible to engage an architect or designer for a whole-house assessment. This is particularly relevant when undertaking repair or maintenance work using competent building contractors who could incorporate retrofit improvements with access to standard designs. For example, when roof repairs are undertaken, it would be possible to improve insulation and heat loss but care must be taken not to reduce roof space ventilation.

A retrofit pattern book has been published for all Rugeley residents containing example plans of various different retrofit details. This allows residents to undertake work to a high standard. There are 36 retrofit designs published, including:

- Internal wall insulation
- External wall insulation
- Window detailing
- Roof and dormer details
- Guttering and soil stack details
- Door details.

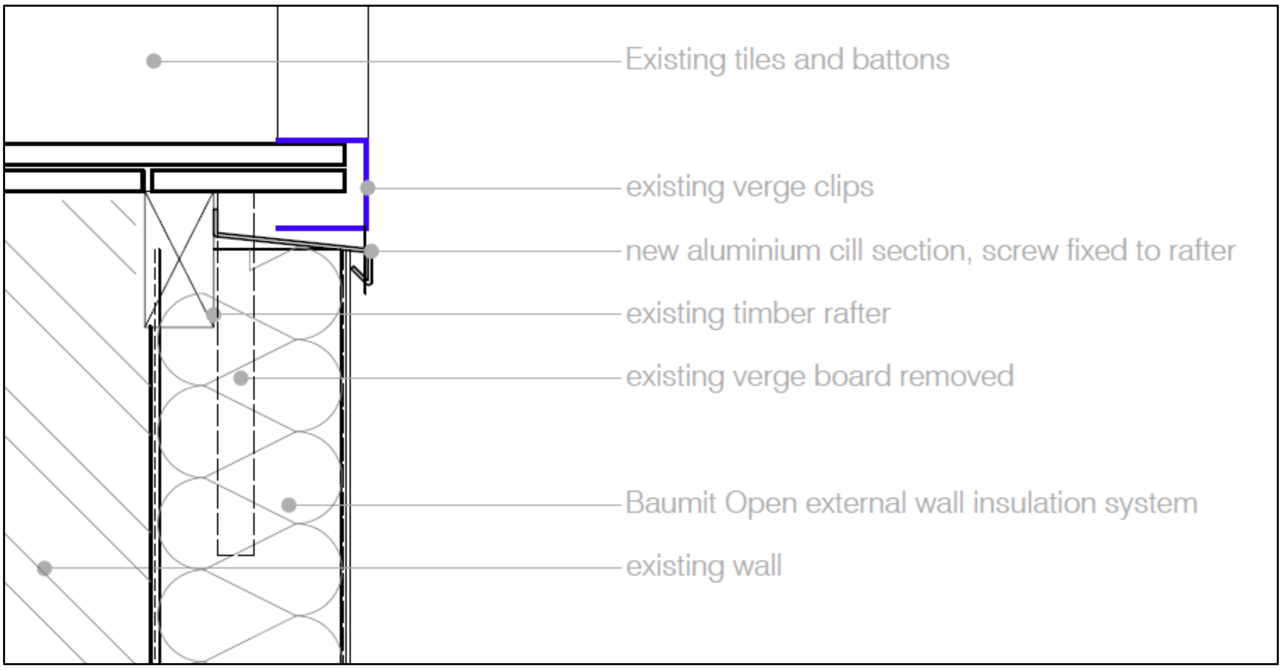

Figure 7 – Example of a retrofit detail for external wall insulation

These details set out how to overcome the risk of unintended consequences particularly at the interfaces of different energy efficiency interventions, so that a whole-house approach can be taken. Each detail in the pattern book will need to be reviewed for each individual circumstance but does provide a good starting point of 'what good looks like'.

3. LEARNING

3.1 Considering retrofit as a system

The engagement work with SHAP's retrofit stakeholders implied that retrofit should be regarded as a wide system when designing and implementing retrofit projects, particularly when at scale such as town level. This is due to the many different factors that can support or diminish the effectiveness of retrofit delivery. Following this conclusion, the SHAP team analysed the retrofit processes as a system.

A systems tool, the Cynefin framework (https://thecynefin.co/) has been used as a conceptual framework to aid decision-making and communication about the retrofit system. It is particularly relevant to the development of retrofit within a SLES as it offers decision-makers a 'sense of place' from which to view their perceptions and supports the potential conflict between local and national factors. The Cynefin framework offers five decision-making contexts or domains from which to analyse behaviour and make decisions, shown below.

Figure 8 – Cynefin framework[12]

The domains on the right, simple (also renamed as clear) and complicated, are 'ordered' meaning cause and effect are known or can be discovered. The domains on the left, complex and chaotic, are 'unordered' meaning cause and effect can be deduced only with hindsight or not at all.

[12] Image available at https://cynefin.io/wiki/File:Cynefin18FEB2021.png

The simple/clear domain refers to activities where the relationship between cause and effect is clear, such as simple improvements to a property. All qualified building contractors will be able to build an extension to a property from plans and the final result will be understood before the work starts.

The complicated domain could refer to a whole house retrofit installation. The relationship between cause and effect requires analysis or expertise and there are a range of possible solutions depending upon the level of retrofit required, type and age of property and expertise of designers and building contractors.

Designing and delivering retrofit at scale moves into the complex domain where there are many 'unknown unknowns', due to the range of property owners and tenure, willingness (or need) to collaborate, skills of the retrofit supply chain, availability of designers and installers, need to deliver across many local authority boundaries, etc. This domain has enabling constraints that are context sensitive – retrofit at scale in a city will not have the same constraints as retrofit in a dispersed rural community. The most effective implementation of retrofit at scale will emerge from testing ideas and experiments. Work in this domain also shows how many of the factors that affect successful retrofit delivery are non-technical, as opposed to the technical factors that contribute to a retrofit in a property.

This implies that learning from ZCR and the development of roadmap should be considered at primarily two levels:

- The detail that emerges from trying new approaches and collecting best practice from a range of other, external retrofit experiences.
- The understanding that applying retrofit at scale through the roadmap requires examination of the whole retrofit system along with the implementation of detailed, expert activities.

The retrofit roadmap delivered from SHAP needs to contain both detail of improvements to properties as well as guiding principles to enable retrofit can be delivered at scale across a town like Rugeley.

3.2 Energy modelling

The energy modelling process aimed to create a detailed understanding of the improvements needed for individual properties within the constraints of the known property data as well as external issues such as electric grid constraints. Creating the data on properties and retrofit improvements needed to go through three iterations, comparing results of modelling against these constraints.

The first iteration of energy modelling demonstrated how it is possible to create a database of likely energy efficiency ratings for all properties regardless of whether they already have an EPC lodged on the government's database. Calibrating the total estimated energy demand against actual energy consumption in the area brought a higher reassurance that the estimated energy efficiency ratings could be relied upon to do retrofit improvement calculations. However, assuming that properties will move away from gas heating to electric heat pumps showed that this created considerable stress on the existing electric grid with around two-thirds of substations significantly lacking capacity for this to be realised.

This information was in the more detailed second modelling iteration where the team focussed on the optimum building fabric improvements to reduce heating demand to a point where electric heating would not overload the electric grid by ensuring only smaller heating systems for residual heating and hot water demand would be required. This allowed some flexibility in the design for individual properties as it was possible to adjust different building factors, such as level of wall insulation, amount of PV generation, size of battery storage. To make sure these calculations were accurate, it was necessary to include other factors not normally included in a RdSAP including thermal bridges, air tightness and controlled ventilation, based on sample property assessments.

These calculations enabled us to reduce the average house heat demand using this approach as low as 30 kWh/m^2/yr for the deepest retrofit scenario.

The third iteration of modelling examined in detail the improvements needed to a focus area of 190 properties within two constrained substation areas. This included an updated set of retrofit installation costs and detailed analysis of seven different energy tariffs, modelled on historical weather conditions over a year. These were based on three retrofit scenarios of EPC C rating, deep retrofit (55 kWh/m^2/yr) and deeper retrofit (30 kWh/m^2/yr). Importantly it also included tariff charging of domestic batteries to further improve their payback, which was not included in the earlier iterations. A detailed domestic energy model, enabled all energy generation, demand and storage to be modelled half hourly across typical and non-typical years, to model understand the potential outputs, under a range of situations. A typical assessment of property data is shown below.

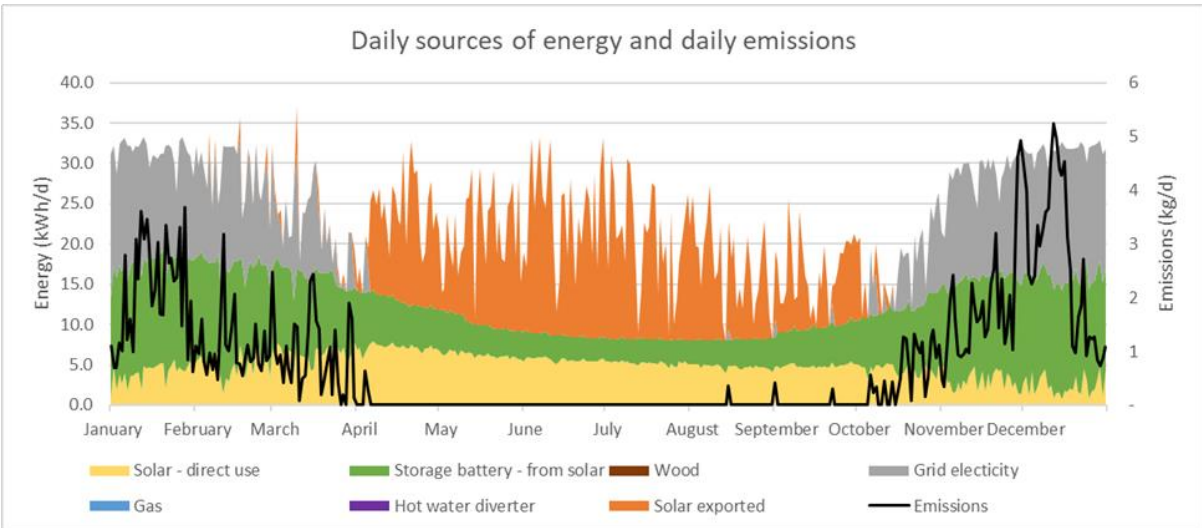

Figure 9 – Detailed property energy analysis

The detailed report of the third modelling iteration is included in Appendix 3, however, key learning points are listed below:

- Required network upgrades from electrification of heat can be significantly reduced via large thermal efficiency improvements and battery storage in a smart local energy system. This can be reduced to nothing in the areas that have been modelled, as long as a small limit (3 kW) is applied to battery charging.
- With lower demands and electrified heat, variable tariffs become more valuable to the end user and household. Switching from an Economy 7-type tariff to a more flexible time-of-use tariff has the potential to considerably reduce energy cost, although it is recognised that the end user needs to be very engaged with their energy use or have some automatic optimisation to fully realise these benefits.
- Whilst there are considerable variables at play, such as underlying energy prices, which make this hard to predict accurately, most scenarios return similar outputs.
- The benefits are likely to improve, as wider decarbonisation of the electricity network will increase volatility over the coming years, but there is uncertainty in predicting how technological and market-based solutions may reduce overall volatility in subsequent years by offering greater network flexibility. Modelling National Grid Future Energy Scenarios (FES) via National Grid's Electricity System Illustrator model (ELSI) suggests this is unlikely to reduce before early 2030s, and possibly well into the 2030s.
- Payback on investment recouped by energy bill savings for all scenarios averages 16 years with a range of 12 to 21 years depending on price and retrofit cost scenarios.
- Payback is quicker with variable tariffs compared to non-variable tariffs by between 1 to 3 years. The deep scenario is 1-3 years quicker while the deeper scenario is 1-2 years quicker.
- The EPC C scenario has been modelled to ensure that interim improvements can be installed that do not significantly compromise further work later to get to net zero.
- The standing charge makes up a considerable proportion of the overall energy bill in the deep and deeper scenarios of between 40 and 45% respectively (averaged across the 190 houses).

The overall conclusion of the modelling is that heat demand must be made significantly low through fabric improvements. Then, changing heating to electric heat pumps, installing PV generation and a battery and utilising a variable tariff will result in very considerable savings on carbon emissions and bills. Using one example tariff showed that savings averaged:

- 85% for the deep scenario
- 87% for the deeper scenario.
- Around 43% for the EPC C scenario allowing a route to net zero to be maintained.

3.3 Systemic enablers for retrofit delivery

The energy modelling activities created a detailed plan of retrofit improvements for properties, which need to be delivered as part of a systemic approach to retrofit if it is likely to be successful. The engagement work with the broad retrofit stakeholder group developed a systems change vision for retrofit based on learning from ZCR and their own experience.

This is shown below:

Figure 10 – SHAP's vision of a retrofit system

Details of each element are described on SHAP's website (https://shap.uk.com/retrofit-reports/). Many of these issues are outside of the control of local and regional stakeholders, but the key elements that can be understood and actioned locally are listed below.

Supportive regulation and legislation

- Planning policies that support and enable retrofit and energy demand reduction, energy generation and storage.

Sustainable financing

- A spectrum of funding options, from fully publicly funded through to private finance packages and blended options in between.
- A minimum of 10 years funded rolling programmes to create confidence for investors, supply chain and customers.

Geographical ownership

- Create geographical areas of excellence or cohorts with common characteristics.
- Apolitical, long-term delivery vehicles that promotes collaboration.
- Greater integration of funding and delivery, allowing cross-tenure coordination and targeting of all homes in an area.
- Consistent planning guidance across local authority boundaries.
- Whole-place low carbon solutions leading to net zero neighbourhoods, recognising the interface between buildings, mobility, etc.
- Recognise the timescales for adoption of new planning policy and work on interim solutions to facilitate retrofit.
- Sharing of data to enable housing stock assessment and planning.
- Regional awareness campaigns and shared energy advice centres.

- Local regional procurement frameworks tailored to smaller contractors' needs.

Needs-based technology

- Technology used appropriately for whole house retrofit.
- Fabric first approach taken, based on whole house retrofit plan, not SAP points.
- Learning from monitored outcomes fed back into decision-making processes and available on a central open-source resource showing detailed evaluation, learning and improvements.

Whole house property assessments

- Shared information to enable clear starting positions for retrofit design programmes.
- Easily accessible and visible retrofit design playbooks, based on data and designs gathered from publicly funded programmes.
- Detailed property assessments providing accurate information about a property and occupancy behaviour.
- Property assessments reflective of occupant behaviour and needs, with clear links to health.
- Building passports to provide pathways to net zero whole home approaches in Net Zero Neighbourhoods, also considering and adapted to wider stock condition needs.
- Increased emphasis on real-time performance (before/after improvements), e.g., through air tightness testing and thermal imaging.
- Ensure optimal delivery of PAS2035 accreditation through (for example) mentoring and spot checks.

Enhancing skills and quality

- A clear strategy that maps, plans, delivers and improves skills across the entire retrofit value chain, in line with delivery plans.
- Skills development roles delivered through colleges and universities.
- Access to free CPD/continuous learning to all involved in retrofit.
- Surveyors to be upskilled for retrofit assessment.

Enabling a green supply chain

- Longer-term certainty over funding and longer funding cycles to provide confidence for businesses to invest in green and invest in PAS 2030/2035 accreditations.
- Sustainable scaling up of demand, by aligning with planned programmes.
- Training funding aligned with local supply chain and delivery needs.
- Tenders that are clear and unambiguous to price.

Optimising customer experience

- Build on PAS 2035 requirements to create a customer journey excellence model to build trust.
- Minimum standards and specifications for all retrofit work.
- Defined and dedicated support for vulnerable customers.
- Clear routes and maximum times allowed for work remediation.
- Insurance-backed warranty scheme with low excess to increase householder confidence.

Zero carbon targets

- Clear targets for houses based on kWh/m^2 targets for house archetypes.
- Net zero, affordable goals with metrics based on running costs and carbon that allow for flexibility in how targets are met.

3.4 Communication as a barrier to retrofit

Throughout the project it became clear that the term 'retrofit' was not clearly understood and was particularly confusing during the community engagement activities. There were two challenges that existed with communication.

Firstly, the need to stress the complexity of retrofit as a system to stakeholders looking to engage in implementation of retrofit. As described in section 3.1, failing to understand the broad factors that need to be simultaneously addressed for effective retrofit will ultimately lead to inadequate and costly implementation.

Secondly, the communication to residents and community organisations needs to be tangible and explicit on what retrofit will do a property. This has been simplified by the SHAP team to five key tasks that having retrofit improvements will achieve:

- **Keep water out** – repairing the roof, gutters, windows, doors, pointing and drainage.
- **Make sure the heat stays in** – insulating the walls, roof and floors, and draft proofing windows, doors, chimneys and pipes passing through walls.
- **Move moisture out** – making sure good extraction stops moisture getting stuck in the wrong parts of the building.
- **Bring fresh air in** – good ventilation systems, ideally with heat recovery.
- **Install renewable technologies** – installing PV generation, energy storage and smart energy systems to create net zero properties.

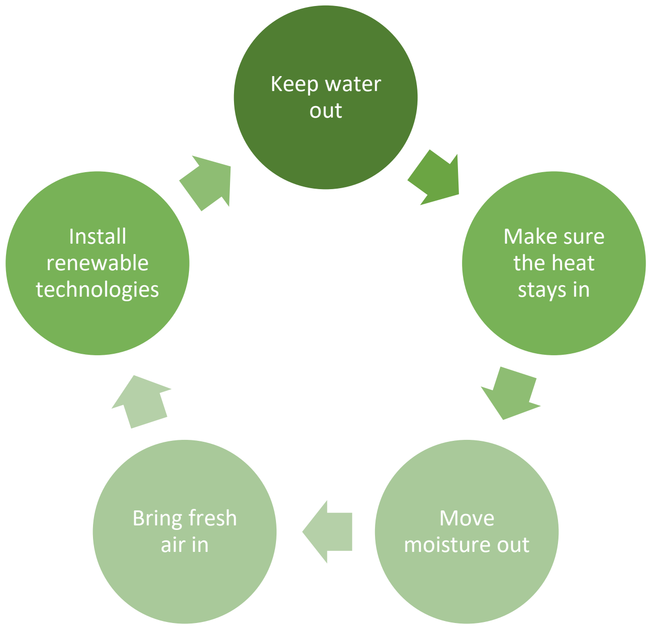

Figure 11 – Simplified communication about retrofit tasks

All of SHAP's community engagement activities in ZCR demonstrated the need to spend time communicating how retrofit will change how a property functions, and how this is affected by the living activities of residents. The property surveys and the thermal imaging sessions allowed the SHAP team to spend the necessary amount of time needed to explain retrofit and answering questions. Face-to-face interaction was found to be far more effective than questionnaires and leaflets, although leaflets may be necessary to provide an 'anchor' point for further discussions, especially where it provides a way for householders to authenticate a retrofit offer.

4. LEGACY

4.1 Legacy ownership

While the ZCR programme was intended to create a design of a SLES which the SHAP retrofit roadmap is a key part of, the SHAP team aimed to create a legacy from the work that can support the **preparation of retrofit delivery**. This included engaging with key community ambassadors, creating opportunities for skill development and assessing properties where residents may be early adopters of net zero retrofit in Rugeley.

This legacy will primarily be intended for Cannock Chase District Council as the key local governance and co-ordinator of future retrofit activities in the area. This will allow future retrofit activities to start quickly and with a high degree of confidence that data is correct.

4.2 Retrofit plan modelling

Modelling data has been created for 10,500 properties showing fabric improvements, PV generation and storage requirements for three scenarios on a pathway to net zero housing.

More detailed data on the focus area of 190 homes will allow CCDC to test and calibrate the model, contributing to their SHDF Wave 2.1 investment plans.

4.3 Community engagement

Engagement with residents helped increase the awareness and understanding of community ambassadors of the need and role of retrofit to housing. This included undertaking thermal imaging of the properties to show and explain where heat is being lost from their properties. A thermal imaging device has been left with the community centre to allow a wider number of residents to understand heat loss.

Ten residents received a PAS 2035 domestic retrofit assessment to enable them to understand their pathway to a net zero property and help them prioritise future improvements. Six businesses and community organisations received a commercial property retrofit assessment.

Community engagement can be continued through the promotion of the retrofit standard details when residents want to undertake their own improvements before large-scale improvements are planned.

4.4 Educational engagement

The Energy for Change curriculum developed and delivered initially for Chancel Primary School. Following the training, a train-the-teacher session took place to allow three further schools to deliver the activities. Three teachers' packs have been created for these schools for their delivery.

Four schools received a retrofit assessment and Energy Performance Certificate to enable them to understand their school building performance and prioritise future retrofit activities. SHAP will continue to work with the schools to support them to draw down government capital support grants for energy where they have not already done so.

4.5 Training

To enable local residents and new businesses to be part of a future retrofit supply chain, four people started retrofit training courses with the Retrofit Academy. This included the following training courses:

- Level 2 Award in Understanding Domestic Retrofit – two residents
- Level 3 Retrofit Advisor – one resident
- Level 5 Retrofit Diploma – one local authority officer.

Informal training was given to residents on introducing retrofit and thermal imaging.

4.6 Dissemination of learning

SHAP has engaged closely with Cannock Chase District Council (senior officers and the Climate Change Working Group plus individual officers from Planning, Housing and Economic Development particularly) and Staffordshire County Council over the final stages of the project to ensure the content and value of the legacy is valuable for the councils. Both the councils and SHAP will maintain a dialogue to ensure properties from within the ZCR area can be used for future retrofit programmes. SHAP has begun to discuss the development of green finance with Staffordshire County Council.

SHAP has also used the learning generated in ZCR for additional activities outside of the ZCR area. The approach to energy modelling resulted in a consortium bid for Dudley's Net Zero Neighbourhood being successful, for delivery on 200 properties during 2023 to 2025.

SHAP and partners have also done development and dissemination work around the non-technical barriers for retrofit. This has included a small consortium project working on non-technical barriers in the Staffordshire Net Zero Living project funded by Innovate UK. SHAP and Keele University are running a 12-week skills bootcamp in place-based decarbonisation including non-technical barriers and systems innovation for retrofit, funded by the West Midlands Combined Authority (WMCA).

4.7 Next steps for potential delivery

The roadmap should support Cannock Chase District Council (CCDC) in ***preparing to address*** the technical and non-technical barriers and enablers that will enable future retrofit programmes to be delivered effectively. There is direct correlation between SHAP's ZCR findings and recommendations and the AECOM costed housing action plan.

CCDC has secured SHDF Wave 2.1 funding for three sites including the 190 home focus area. This provides an opportunity to develop the actions in the AECOM costed housing action plan with detail from the SHAP ZCR research. Data will be shared with CCDC to help planning for delivery as well as SHAP supporting other aspects of retrofit design.

Some potential next steps that could be co-ordinated by CCDC and supported by partners is listed below:

- Supporting the local supply chain to understand new opportunities, access training and achieve accreditation, through workshops and breakfast events.
- Create a database of existing retrofit show homes in Cannock that promote the opportunities for local householders.
- Consider how a local revolving green loan scheme could be co-ordinated though the local authority.
- Create a forum of different tenure property owners that could collaborate to deliver retrofit locally.
- Support the implementation of retrofit assessments and modelling to support residents and property owners.
- Engage in the learning from the SNZL project on non-technical barriers for place-based improvements.
- Rollout the Energy for Change curriculum activities for schools across Cannock.

It is recognised that this requires resourcing. In support, SHAP is developing a 'Retrofit Readiness' framework that will provide guidance on checking the current understanding of the Council and its strategic partners on the activities to build a deliverable retrofit plan. This will include a range of non-technical barriers such as leadership, communication, internal business case as well as necessary building blocks such as finance, data and procurement.

5. REFLECTIONS

5.1 Complexity of retrofit

SHAP did not have a fixed approach to developing a retrofit roadmap within a SLES at the start of the project, other than a general methodology for energy modelling.

We are very clear at the end of the research that scaling up retrofit is not just complicated, it is complex. There are many dependencies and the known barriers have not been significantly addressed in the recent BEIS-funded and other retrofit programmes.

System change is therefore required, and a significant output was the retrofit stakeholder perspective on the vision, model and priorities of system change for retrofit.

Even more widely, it is clear that retrofit cannot be planned or delivered without full consideration of a whole place-based decarbonisation approach. The Rugeley SLES model has developed thinking and trialled tools. More work is needed to address known barriers and significant commitment is required to plan for delivery of place-based decarbonisation. The business case seems overwhelming but new ways of working together to create the building blocks are required with commitment required in the long term.

Successful retrofit programmes will need to integrate perspectives on detail (for individual properties) along with managing complex assemblages of delivery activities across different geographical areas and different tenures.

5.2 Replicating and scaling up Zero Carbon Rugeley

Zero Carbon Rugeley launched just before the Covid-19 pandemic restrictions were announced. Despite the complications this created for delivering a user-centric design-led approach to developing a SLES model for Rugeley, the consortium did find a way to work together. Keele University and the New Vic borderlines developed innovative approaches to establish a user-centric forum.

Going forward, it is essential that all parties involved in any part of developing a SLES collaborate early, commit to meet as often as required to both build trust and collaborate technically. ZCR did this largely through online meetings although some face-to-face meetings and workshops were possible, and the project benefitted from early relationship building and ongoing trust in collaboration.

Retrofit delivery is resource intensive and tried and tested routes to community engagement along with innovation in communication will be required to build the demand side that the supply chain will respond to. The complexity of retrofit means it is necessary to plan extensive community and resident engagement to prepare for future retrofit programmes.

Retrofit supply chain activity is low and there are currently limited incentives for businesses to diversify into retrofit without a commitment to long-term delivery. Positioning retrofit within a wider SLES approach is essential if benefits of energy infrastructure investment are to be taken while planning to deliver retrofit. Indeed, without wider SLES planning, retrofit will not be able to be delivered at scale, at least not without the risks of abortive or stranded investment.

The technology is available and opportunities of energy trading, tested in ZCR, are becoming realised through normal energy markets. Early adopters are already benefitting from income generation from agile tariffs associated with installation of low carbon energy generation and storage products. The SLES will allow this to be done at a neighbourhood scale with accurate retrofit modelling being discussed with energy infrastructure providers in conjunction with planning for electrification of mobility. Finance solutions are potentially achievable for effective retrofit implementation.

6. GLOSSARY

BEIS – Department for Business, Energy & Industrial Strategy
CCDC – Cannock Chase District Council
EPC – Energy Performance Certificate
kWh/m^2/yr – Kilowatt-hour per meter squared per year – a measurement of heat demand
LAD – Local Authority Delivery scheme
LGA – Local Government Association
FES scenarios – Future Energy Scenarios are a range of scenarios to decarbonise energy
PAS 2035 – British Standard for retrofit and energy efficiency
PROSUMER – computer model used by Engie to model energy
RdSAP – Reduced Data Standard Assessment Procedure for energy assessment
SAP – Standard Assessment Procedure to assess energy performance of dwellings
SHAP – Sustainable Housing Action Partnership
SHDF – Social Housing Decarbonisation Fund
SLES – Smart Local Energy System
SNZL – Staffordshire Net Zero Living project
WMCA – West Midlands Combined Authority

7. USEFUL LINKS

Beyond Decent Homes (2009) – targets and worked examples for retrofit at a neighbourhood level	Beyond_Decent_Homes_Introduction Beyond_Decent_Homes_Part_1_the_Standard Beyond_Decent_Homes_Part_2_Framework_of_benefits Beyond_Decent_Homes_Part_3_Implementation_planning Beyond_Decent_Homes_v1_Detailed_cost_estimates_0 Beyond_Decent_Homes_v1_Specification_Digest_0 Beyond_Decent_Homes_Case Studies Beyond_Decent_Homes_Bibliography_and_Appendices
Community Green Deal (2010) – building blocks of a holistic approach to scaling up retrofit	Community_Green_Deal__Part_1 Community_Green_Deal__Part_2 Community_Green_Deal__Part_3_ Community_Green_Deal_Appendix_example_areas Community_Green_Deal_Executive_summary
SHAP research into barriers to scaling up retrofit (2018)	https://shap.uk.com/wp-content/uploads/2018/07/maximising-outcomes-from-investment-in-domestic-retrofit.pdf https://shap.uk.com/wp-content/uploads/2018/07/finance-models-for-retrofit-of-all-housing-tenures.pdf
Warm Homes Save Lives (2020) – improving inclusion of fuel poor in retrofit	https://shap.uk.com/fuel-poverty/
Scaling up Better Homes West Yorkshire (2020) - model to build a deliverable programme to retrofit 1m homes	https://shap.uk.com/retrofit/
A retrofit system change proposal to Government (2022)	https://shap.uk.com/retrofit-reports/
Local government Association Retrofit Skills Programme	https://www.local.gov.uk/lga-building-housing-retrofit-skills-leadership-and-learning-programme-march-2022
Local Regional Retrofit Action Planning: outputs	https://www.local.gov.uk/our-support/climate-change-hub/lga-climate-change-sector-support-programme-regional-retrofit-5

Dudley Net Zero Neighbourhoods project	https://www.dudley.gov.uk/news/money-secured-for-carbon-busting-project
MISSION ZERO – Independent Review of Net Zero (Chris Skidmore 2023)	MISSION ZERO – Independent Review of Net Zero
Skills bootcamp in place-based decarbonisation	https://www.keele.ac.uk/study/cpdandleadership/cpd-bootcamp/skillsbootcampinplace-baseddecarbonisation/

8. APPENDICES

Appendices are incorporated in separate reports. They are listed below.

Appendix 1 – SHAP's systemic change proposal for retrofit

Appendix 2 – Parity Pathways report – high level modelling for strategic planning purposes

Appendix 3 – Energy modelling process

Appendix 4 – Retrofit detail designs – to inform retrofit design and specification

Appendix 5 – Energy for Change report

Appendix 6 – Domestic self-assessment survey

Appendix 7 – Communications materials

Appendix 8 – SHAP thermal imaging standard operating procedure

Appendix 9 – Summary of SHAP contracted deliverables

Appendix 10 – Schedule of uploaded outputs and their status (public/not public)