

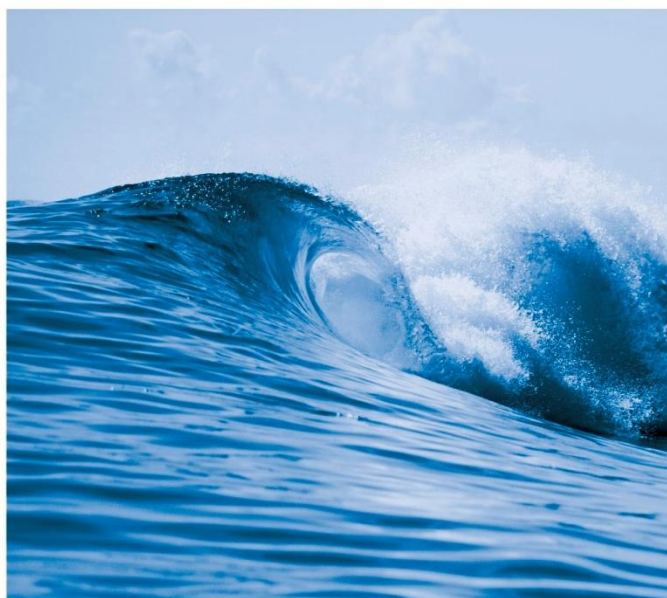


Net Zero for Social Housing WP4 Final Report

North East and Yorkshire Net Zero Hub

April 2022

Document reference: 22-637-4893



Process

	Name	Date
Prepared by	Alex Savidis	2022-04-07
Reviewed by	Phil Norval	2022-04-20
Approved by	Tom Bradley	2022-04-25

Version History

Version	Date	Author	Reason for Issue
1.0	2022-04-25	A.Savidis	Document release
1.1	2022-04-25	A.Savidis	Energy hub name change

Contract Details

Purchase order	2007472

CONFIDENTIALITY

The information in this document is the property of Narec Distributed Energy and the specific client who commissioned this work. It may not be copied, transmitted, or communicated in any form whatsoever to a third party or used for any purpose other than that for which it is supplied, without the express written consent of Narec Distributed Energy or our client.

LIABILITY DISCLAIMER

Whilst this information is given in good faith, no warranty or representation is given concerning such information, which must not be taken as establishing any contractual or other commitment binding upon Narec Distributed Energy.

Contents

1	Introduction.....	4
1.1	About this report	4
1.2	Background.....	4
1.3	Report Structure	5
2	Key Findings and Recommendations	6
3	Defining Net Zero in Social Housing	8
3.1	Context	8
3.2	Definition	8
4	Measuring Net Zero in Social Housing	10
4.1	Quantifying embodied emissions	10
4.2	Net zero case study	11
5	Data and Software Tools for Net Zero Planning.....	14
5.1	Detailed Assessment of the Ambue software platform	17
5.1.1	<i>Surveys and tenant experience - Ambue</i>	<i>19</i>
5.1.2	<i>Costs - Ambue</i>	<i>19</i>
5.1.3	<i>Challenges and Opportunities - Ambue</i>	<i>19</i>
6	Stepped Approach to Net Zero using EPC band C.....	20
7	Post Occupancy Monitoring and Evaluation (POME).....	22
7.1	POME and Energy Performance	22
8	Digital Components of Social Housing Retrofits	23
8.1	Going beyond SAP	23
9	Coalitions between housing providers and other parties	24
10	Net Zero Funding Options for Housing Providers	25
10.1	Social Housing Decarbonisation Fund (SHDF)	25
10.2	Energy Companies Obligation (ECO).....	25
10.3	Home Upgrade Grants	26
10.4	Green Homes Grant Local Authority Delivery (LAD) Scheme	26
10.5	Boiler Upgrade Scheme	26
10.6	Green Heat Network Fund.....	27
10.7	Other finance options.....	27
10.7.1	<i>ESCO</i>	<i>27</i>
10.7.2	<i>Internal funding models</i>	<i>28</i>
	Glossary of Terms.....	29
	Bibliography.....	30

1 Introduction

1.1 About this report

This report has been commissioned by the North East and Yorkshire Net Zero Hub and has been funded through the Technical Assistance Facility established by BEIS as part of The Social Housing Decarbonisation Fund (SHDF). The SHDF has been set up for Registered Providers (RPs)/Registered Social Landlords (RSLs) of social housing to apply for funding to improve the energy performance of their social housing stock, and to decarbonise their housing.

This is the final report in a series of work packages which have the overall aim of answering the question:

“On the basis that the great majority of dwellings in England need to undergo a dramatic transformation in terms of the amount of carbon dioxide associated with their use in occupation, and that homes are a relatively untapped source of emissions reduction, what tools exist that can help understand the transformation required in terms of net zero buildings?”

Aside from this question, the report also includes a number of other topics associated with the decarbonisation of social housing:

- Defining net zero in social housing.
- Measuring progress against net zero.
- Technology measures.
- The relative merits of reaching net zero using EPC C as a stepping stone.
- Post Occupancy Monitoring and Evaluation considerations.
- Digital Components of net zero.
- Coalitions between housing providers and other parties.
- Net zero funding options for housing providers.

The intended audience for the report is Registered (social housing) Providers (RPs). It is envisaged that the report will also be useful for BEIS as part of an evidence base to inform future policy.

1.2 Background

The UK Government has outlined high level targets for the whole of the UK to achieve net zero emissions by 2050, with midway targets of achieving 68% emissions reduction by 2030 and 78% reduction by 2035 when compared with 1990 levels. All sectors must make changes and begin their journey towards net zero, with housing being no exception.

Social housing makes up 17% of UK housing but comes with unique challenges when it comes to installing energy efficiency measures and low carbon upgrades. In December 2020, the Climate Change Committee published the ***Sixth Carbon Budget***, which sets out the emissions limits for the period between 2033 and 2037. Policies to achieve the required levels of emissions cuts are proposed in this carbon budget. Over 80% of the dwellings that will be used in 2050 have already been built today, meaning that the decarbonisation of the UK's housing stock needs to begin now, and a robust strategy must be implemented to ensure that this happens.

Heating UK homes makes up 17% of the UK's greenhouse gas emissions alone, and the challenges of decarbonising space heating in social housing are of paramount importance. In September 2021, the ***Heat***

and Buildings Strategy was published. This strategy, in conjunction with the **Net Zero Strategy**, considers how the future of UK heating will change and the strategies we need to implement to achieve net zero. The document acknowledges that the way forward to net zero for some types of buildings (for example, new builds) is relatively straightforward but that the route to be taken to achieve net zero is less clear for others, particularly existing dwellings.

Aside from the obvious benefit of reducing greenhouse gas emissions and therefore reducing the impact UK social housing has on climate change, decarbonising social housing has other benefits. In 2014, Tees Valley Combined Authority reported that 12.2% of the households living in their region were living in fuel poverty and with the recent hike in the energy price cap, this situation is likely to get worse. Aside from fuel poverty alleviation and reduction of greenhouse gas emissions, there are further benefits such as improved health outcomes.

1.3 Report Structure

This final report builds upon the interim work package 1, 2 and 3 reports:

- Work Package 1: Social Housing Net Zero Definition, Narec DE document reference 21-637-4856.
- Work Package 2: Assessment of Tools, Narec DE document reference 22-637-4877.
- Work Package 3: Net Zero for Social Housing, Narec DE document reference 22-637-4886.

The first section of this report (Section 2) is an overall summary of the findings of the work and gives recommendations addressed to social housing providers as well as policymakers. The recommendations are based upon the analyses carried out by Narec DE during the earlier stages of the project.

Section 3 summarises Narec DE's work on creating a definition of net zero in social housing.

Section 4 summarises Narec DE's exploration of the methods by which net zero progress in social housing can be measured. This work exposes the weaknesses of using the current Standard Assessment Protocol methodology.

Section 5 explores the software tools that are available to social housing providers to assist with net zero planning and implementation.

The remaining sections 7, 8, 9 and 10 address the additional questions posed by the project brief as detailed in Section 1.1.



2 Key Findings and Recommendations

Finding	Recommendations for housing providers	Recommendations for policymakers
Net zero in the context of social housing is ill-defined.	Lobby BEIS via industry partners such as NHC and NHF for a clear definition.	Publish an unambiguous position paper to clearly define net zero in social housing. Clarify the role of offsetting in achieving net zero, possibly with reference to work previously carried out by Zero Carbon Hub on Allowable Solutions.
The scale of the social housing decarbonisation challenge is unclear.	Immediately begin data gathering, cleansing and consolidation. Consider commissioning new, up-to-date EPCs for all properties.	
EPCs are a poor way to set targets and measure progress in housing decarbonisation projects.	Lobby BEIS via industry partners such as NHC and NHF to accelerate and prioritise the development and deployment of SAP 11.	Reconsider the role of EPC band C as a stepping-stone to net zero in the Social Housing Decarbonisation Fund (SHDF)
True net zero cannot be achieved without using offsite power generation or carbon offsetting.	Lobby BEIS via industry partners such as NHC and NHF for clarity.	Provide clarity on definitions, offsetting and allowable solutions.
Two broad categories of software tools for net zero planning have been identified: whole stock tools and detailed retrofit planning tools.	Engage with software vendors at an early stage. For whole stock software planning tools, consider data compatibility with stock asset management databases. For detailed retrofit planning, software vendors offer a range of professional consultancy services to support their software products. It is recommended that software vendors are selected and appointed as strategic partners.	



Finding	Recommendations for housing providers	Recommendations for policymakers
Supply chains are ill-prepared for the scale of the challenge	<p>Gain familiarity with PAS2035, train retrofit co-ordinators internally or appoint sub-consultants.</p> <p>Engage with software tool vendors at an early stage and understand and solve data interoperability issues between asset management platforms and software tools.</p>	<p>Make PAS2035 and associated British Standards freely available to reduce barriers in the supply chain.</p> <p>Commission an evidence base of sector skills shortages and review the availability of independent training providers of low carbon and renewable energy technologies.</p>
Risks of sunk investment from using EPC C as a stepping stone, or through other refurbishment schemes.	Immediately review spending plans to avoid risks of sunk investment.	Review all policies which include EPC C as a net zero milestone.
Lack of tenant engagement.	<p>Begin consultation and engagement with tenants.</p> <p>Promote smart meters to help engagement and avoid future delays in assessing technical opportunities such as demand-side management.</p>	<p>National or regional campaign to promote awareness of housing energy efficiency.</p> <p>One-stop-shop for advice about energy efficiency grants and funding for all tenures through EST or CAB.</p> <p>Review barriers to smart meter deployment.</p>
Heat pumps are more costly to run than gas boilers	Consider heat pumps only with adequately sized heat emitters and well-insulated properties. Heat pumps are likely to suit tenants who are home all day more than tenants with intermittent occupancy.	<p>Narrow the differential between gas and electricity tariffs by re-allocation of non-commodity elements of bills.</p> <p>Promote and fund independent specifier and installer skills base.</p>
The social housing funding landscape is excessively complex	Refer to this work and work commissioned by other Net Zero Hubs through TAF, and engage consultants as required.	Streamline the funding landscape. Provide increased clarity on areas of overlap, eligibility, future rounds and timescales.

3 Defining Net Zero in Social Housing

3.1 Context

Net zero in social housing is a goal which is poorly defined. Different organisations and stakeholders are using different definitions, which invariably do not reflect the true spirit and intent of net zero. Narec DE has proposed a full definition of net zero in the context of social housing. The work was carried out in December 2021, and the rationale for the definition is given in **Narec DE: Social Housing Net Zero Definition 21-637-4856**. It was concluded that with the existing housing stock, it would not be possible to achieve net zero without using offsetting measures such as offsite solar PV generation or tree planting.

3.2 Definition

The “Whole Life” Emissions from social housing can be categorised into “Operational Emissions” and “Embodied Emissions”, as indicated in Figure 1.

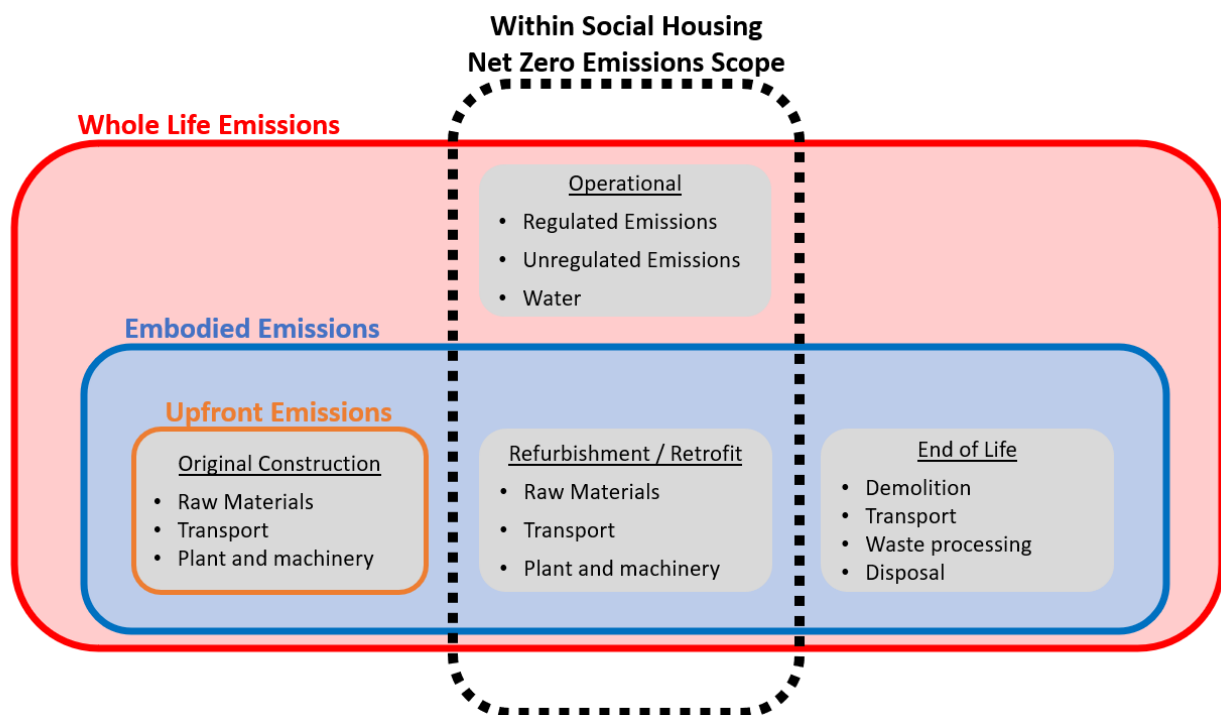


Figure 1: Whole life emissions in social housing

Embodied emissions are broken down into three further classifications:

- Upfront Emissions – arising from the manufacture, transport and installation of the materials used in the original build of the houses.
- Refurbishment/Retrofit Emissions – arising from the manufacture, transport and installation of the materials used in upgrading the houses to meet environmental targets such as net zero.
- End of Life Emissions – arising from the ultimate demolition and disposal of the houses.

The proposed definition for net zero in social housing is given by the dotted black line and is summarised as shown in Table 1.

Table 1: Definition of Net Zero in Social Housing

<p>Included within the scope:</p> <ul style="list-style-type: none"> ➤ The emissions arising from the operation of the buildings. ➤ The embodied emissions associated with refurbishment and future maintenance of the stock, including end of life emissions.
<p>Excluded from the scope:</p> <ul style="list-style-type: none"> ➤ The “upfront” embodied emissions associated with the original construction and eventual demolition of the houses.

In the definition, the operational emissions can be further categorised into “Regulated” and “Unregulated” emissions. Regulated emissions relate to emissions which arise from the fixed services in the property, including the heating system, lighting, pumps and ventilation fans. Unregulated emissions are those which arise from electricity use in the building from the occupants’ appliances. This is summarised in Figure 2.

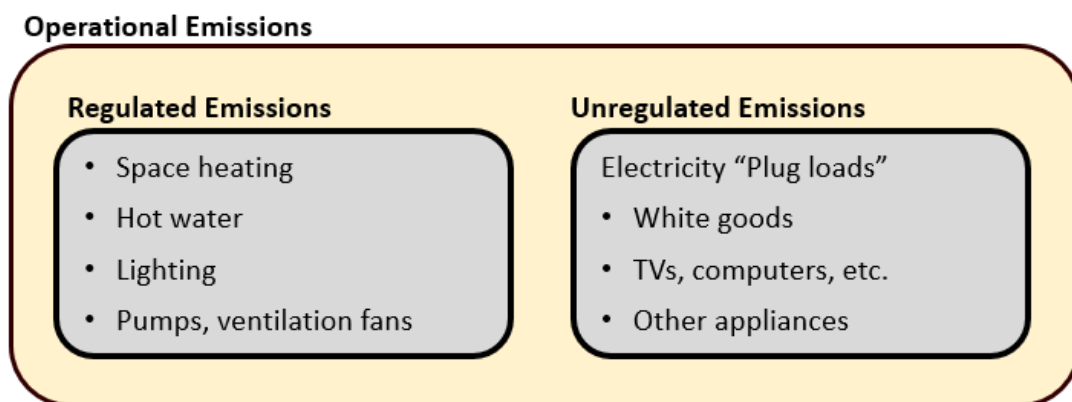


Figure 2: Breakdown of Operational Emissions

The National Housing Federation published a paper on net zero in social housing, which asserts that offsetting is not required and that the embodied carbon within materials used for retrofitting should also be excluded. Narec DE believes that an effective definition of net zero needs to include the embodied emissions associated with the materials and labour used in the retrofitting process. If these emissions are excluded, there is a significant risk that the retrofit measures could generate higher emissions on aggregate through their manufacture and installation than they would reduce operationally. 1kgCO₂e emitted in the production and delivery of materials is arguably more significant than 1kgCO₂e emitted in operation. Embodied emissions are a serious cause for concern as they are already ‘baked in’ at the point of being procured and installed, whereas operational emissions can usually be monitored and managed over time to reduce their magnitude. Clients, contractors and suppliers should avoid assuming that these emissions will be reduced or eliminated elsewhere in the supply chain by the time the products reach site.

4 Measuring Net Zero in Social Housing

Having defined what net zero means in the context of social housing, it is essential that a robust and reliable way to measure progress against it is established.

The only practical way in which progress against net zero can be measured across a large volume of social housing stock is to use the Standard Assessment Procedure, SAP which informs the EPC band of a property. This is far from ideal since SAP scores are based entirely on the running costs of the property, normalised for floor area. Aside from the SAP score and EPC banding, the SAP methodology does provide an environmental impact rating for a property in terms of the anticipated annual operational emissions in tonnes of CO₂ per year. A primary energy use figure is also given in units of kWh of primary energy per square metre, but this does not affect the EPC banding. The primary energy figure in SAP calculations is defined as “energy from renewable and non-renewable sources which has not undergone any conversion or transformation process”. The graphic in Figure 3 highlights the difference between SAP score, EPC band and emissions.

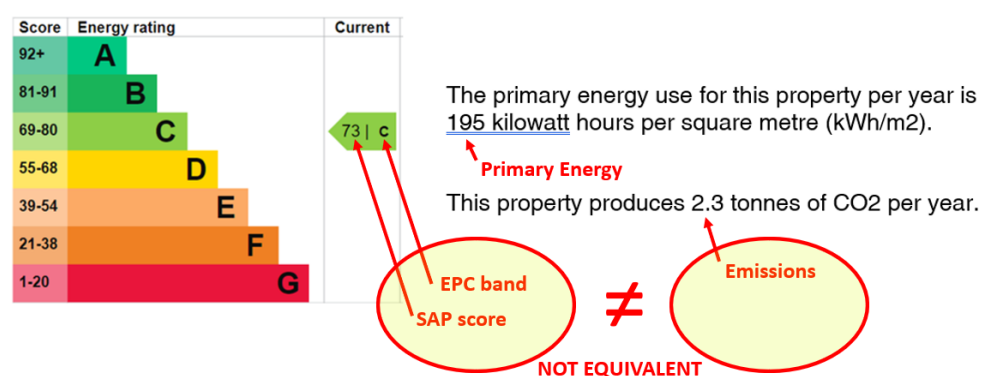


Figure 3: SAP score, EPC band and Emissions

EPC bands are being used in government policy to drive carbon reduction in social housing. However, it is widely recognised that EPC bands are not strongly connected with actual emissions from homes. The appropriateness of using EPCs for decarbonisation programmes becomes much more questionable when low carbon interventions and high-performance building fabric is introduced. There are some alternatives to SAP and EPCs, and these were discussed in **Narec DE: Social Housing Net Zero Definition 21-637-4856**. However, despite the limitations of SAP and EPCs, there is no practical alternative to measure progress against net zero, given the scale of the challenge and ambitious timescales.

It is concluded that the most appropriate course of action would be to reform SAP and EPCs to make them more suitable for net zero planning. The Passivhaus Trust published a paper in April 2020 which concluded that SAP should be adapted so that it uses space heating demand as the primary metric as this would avoid a situation where houses with a high EPC band could still produce high levels of emissions. BEIS also commissioned a report In June 2021 entitled **Making SAP and RdSAP 11 fit for Net Zero**, which made similar recommendations. It is hoped that these recommendations will be swiftly adopted, but historically, changes to SAP have been very slow to implement. It is therefore recommended that housing providers should commission EPCs for all of their properties without delay to establish a baseline from which planning can be started.

4.1 Quantifying embodied emissions

The social housing sector has little experience in assessing embodied emissions in retrofit products and solutions, but information is becoming more widely available. Some recent developments in the tools available to assess embodied emissions include the following:

- CIBSE: **TM65.1 Embodied carbon in building services: residential heating.**
- Woodknowledge Wales Ltd: **Embodied Carbon - Guidance for Welsh Social Housing Developers, their design teams, contractors and suppliers.**
- Institution of Structural Engineers: **The Structural Carbon Tool Version 2.**
- International Standards Organisation: **Environmental Product Declaration (EPD).**

Few consultants have the necessary skills and experience to carry out proper life cycle assessments of products, but this area of consultancy is now growing, and housing providers can expect that it will be possible to adequately quantify embodied emissions for the purposes of their net zero transition plans within the next few years.

4.2 Net zero case study

As part of the work carried out by Narec DE, a single sample property was identified and modelled with various interventions. This property was chosen as it represents a typical example of one of the most common types of dwelling found in northeast social housing stock. The house has also already had typical upgrade works carried out, namely loft insulation, replacement (mains gas) combi boiler and double glazed uPVC windows. This property was modelled in SAP 2012 and in a beta version of SAP 10.

The sample property is a two-storey, semi-detached, traditionally constructed house with a hipped pitched roof and a small, single-storey utility room. Originally built around 1955, it has had some improvement works carried out to the heating system and the external fabric and has a total floor area of 98m². There is a small, single-storeyed area of the house that was probably an unheated store originally. This is constructed with solid walls and a concrete roof.

The EPC band of the property was calculated to be “D”, which provides a suitable opportunity to assess the measures needed to meet a target for a “C” energy rating, as well as further assessment for higher SAP ratings. The sample property floorplan is given in Figure 4, and a photo of the property is in Figure 5.

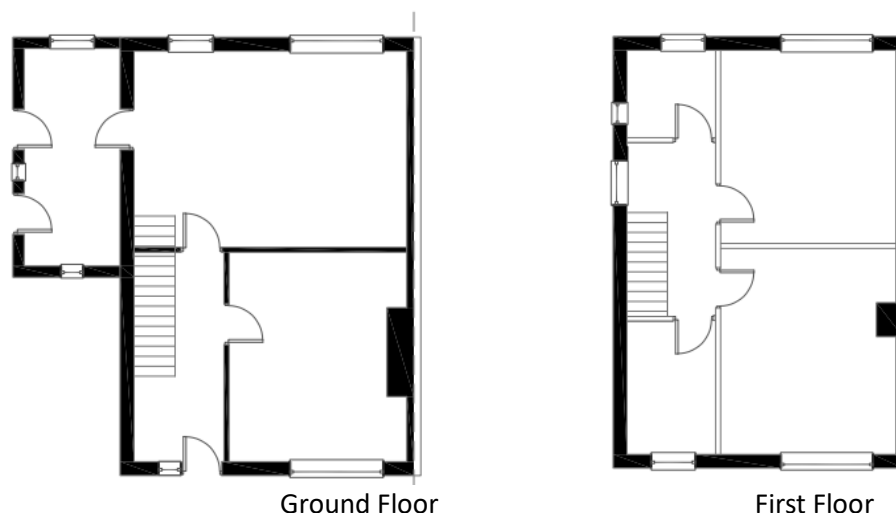


Figure 4: Sample property floorplan



Figure 5: Photo of sample property

Improving the property from EPC D to EPC C was relatively easy and only required the addition of cavity wall insulation. In order to see how far the property could be taken in terms of SAP and also emissions, the following retrofit intervention measures were modelled in a phased approach:

- Cavity wall insulation plus external wall insulation.
- Flat roof insulation.
- Ground floor (overlaid) insulation.
- Replacement high-performance windows and doors.
- Mechanical ventilation heat recovery.
- Air source heat pump.
- LED lights in all fittings.
- 2.9kWp Solar PV.
- 15kWh battery.

The results are summarised in Table 2, which shows the SAP scores from the current version of SAP (SAP2012) as well as the forthcoming new SAP 10. As can be seen, even with all the interventions that are practical to install in the property, the EPC rating can only be improved from band D to band B. Estimating the capital costs of implementing the interventions is outside the scope of this work, but it is likely to exceed £50,000 for a property of this type.

It is also apparent that the addition of an air source heat pump has very little impact on the SAP rating of the property (even in SAP 10), although the overall carbon emissions are dramatically reduced. This is because the SAP rating is an estimate of how much it costs to run a property rather than carbon emissions and is a powerful illustration of the inadequacy of using SAP for net zero planning.

The residual carbon dioxide emissions as reported by SAP10 amount to 0.27tCO₂e per year. With additional on-site generation of renewable energy (i.e., more solar PV), this could be reduced. However, social housing properties tend not to have roofs which can accommodate more than 2 or 3kWp of solar PV. This means it would be absolutely necessary to offset these residual emissions through other means to achieve the basic definition of net zero. For example, an offsite solar generation plant could be considered.



Table 2: Summary of sample property – impact of phased interventions on SAP scores

Stage	Improvement	SAP 2012		SAP 10	
		SAP/EPC	tCO ₂ /year	SAP/EPC	tCO ₂ /year
0	Base scenario – no improvements	65/D	4.68	66/D	4.64
1	Cavity wall insulation	73/C	3.50	72/C	3.56
2	Stage 1 plus: External insulation to solid walls Warm roof insulation to concrete flat roof Overlay ground floor with insulation Install LED to all light fittings	77/C	2.84	80/C	2.38
3	Stage 2 plus: Replacement windows and external doors	80/C	2.38	81/B	2.20
4	Stage 3 plus: Whole house MHVR	79/C	2.41	79/C	2.23
5	Stage 4 plus: Air source heat pump & upgraded controls	79/C	2.19	75/C	0.58
6	Stage 5 plus: 2.9kWp south facing solar PV	92/A	1.00	85/B	0.27
7	Stage 6 plus: 15kWh battery capacity for PV array ^a	NA	NA	90/B	0.27

^a SAP2012 does not have any provision for battery storage within its methodology but it has now been included in SAP10.

5 Data and Software Tools for Net Zero Planning

Social housing providers need to collect high-quality base data about their existing stock before embarking on their net zero programmes. Careful planning is required to avoid a situation where tenants are expected to host multiple overlapping survey visits.

Numerous software tools exist for providers to assess their stock and inform decarbonisation strategy. The tools can be broadly categorised into those which can help with strategy and budgeting at the whole stock level and those which can be used during a PAS2035 compliant retrofit process on individual houses.

In January 2022, Narec DE provisionally reviewed the following tools, which service a variety of different needs and are a mixture of databases with limited functionality right through to detailed planning tools which are used in conjunction with specialist professional services:

A list of the tools that were provisionally assessed is given below:

- EnerPHit^b.
- RETScreen Clean Energy Management Software^c.
- Portfolio by Parity Projects^d.
- Home Energy Dynamics by Energy Systems Catapult^e.
- Green Building Studio by Autodesk^f.
- Intelligent Energy by Sava^g.
- Streamline by Elmhurst Energy^h.
- North Qⁱ.
- Home Analytics & PEAT by Energy Savings Trust^j.
- Ambue^k.

The ideal tool would be able to profile the entire stock of a housing provider and take the user through to detailed planning for each individual property with minimal involvement from the software provider. However, during the assessment of the options, it became clear that the various tools occupy different positions in terms of their applicability in a provider's overall decarbonisation programme.

The law of diminishing returns is a common phenomenon in the energy-efficient retrofitting of housing. Furthermore, as a property is nudged closer to net zero, the methods for analysing the potential benefits of further interventions become increasingly complex. Funding streams available to decarbonise social housing stock (see section 10) require that PAS2035 compliant processes are used. This has important implications for the choice of software tool that is selected for the deeper decarbonisation stages that are required. Tools which use processes that are well aligned with the PAS2035 standard are likely to be more useable at these later stages.

^b [Passivhaus Retrofit \(passivhaustrust.org.uk\)](https://passivhaustrust.org.uk)

^c [RETScreen \(nrcan.gc.ca\)](https://nrcan.gc.ca)

^d [Portfolio - Parity Projects](#)

^e [Home Energy Dynamics - People Lab by ESC](#)

^f [Green Building Studio \(autodesk.com\)](https://autodesk.com)

^g [Intelligent Energy \(sava.co.uk\)](https://sava.co.uk)

^h [Elmhurst's Streamline Demo \(elmhurstenergy.co.uk\)](https://elmhurstenergy.co.uk)

ⁱ [NorthQ - Intelligent Energy Management Solutions](#)

^j [Home Analytics housing stock data - Energy Saving Trust](#)

^k [Make your housing energy efficient | Ambue](#)



Further details of the provisional assessment of tools can be found in **Narec DE: Assessment of Tools, Narec DE document reference 22-637-4877**. A brief summary is presented here.

One of the first considerations when comparing the tools was to assess how they are positioned in terms of their suitability for assessing a large volume of stock (i.e., thousands of units) compared with their suitability for planning detailed interventions at the individual property level. In between these two extremes, there are tools which are intended to provide useful results at the property archetype level or estimates of performance at the dwelling level. An infographic presenting the positioning of the tools on this continuum is given in Figure 6.

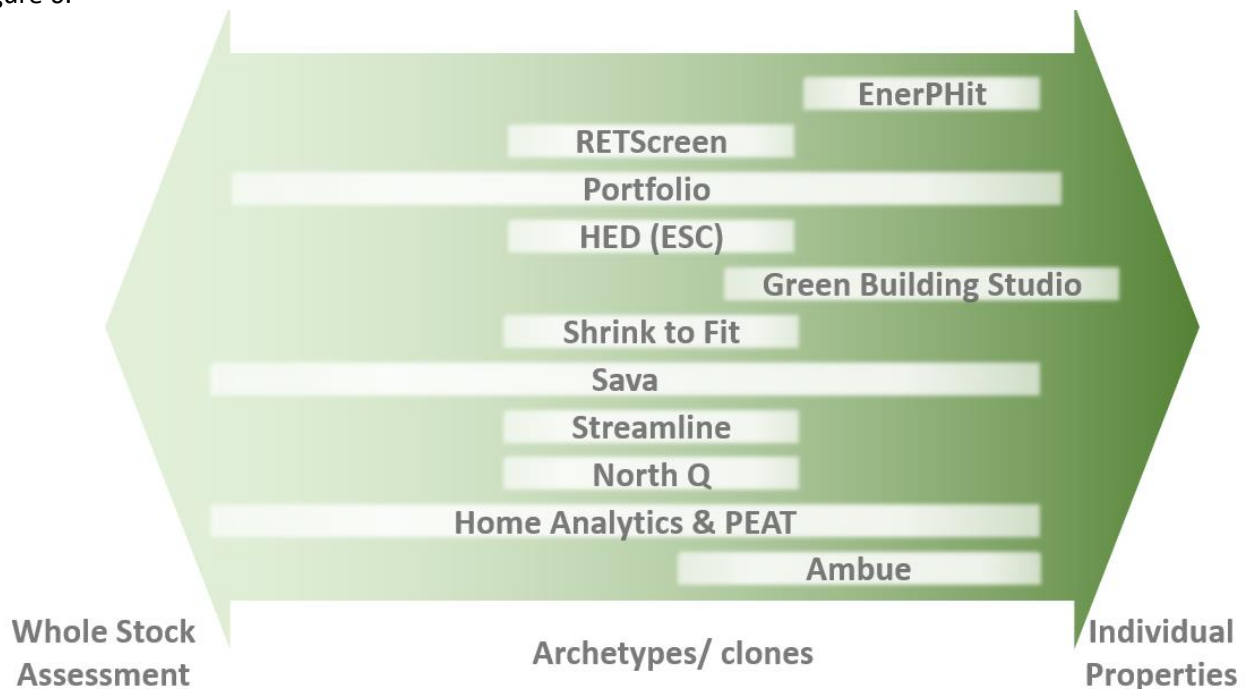


Figure 6: Assessment of tools - suitability for whole stock assessment vs individual properties

When the tools listed are considered alongside each other, their functionality in respect of SAP assessment can be compared. At one end of the spectrum are tools which do not relate to SAP. There are then tools which have been equipped with SAP2012 and SAP10 functionality. At the other end of the spectrum, there are tools which are likely to be more suited to net zero planning at the individual property level. This is expressed through the infographic in Figure 7.

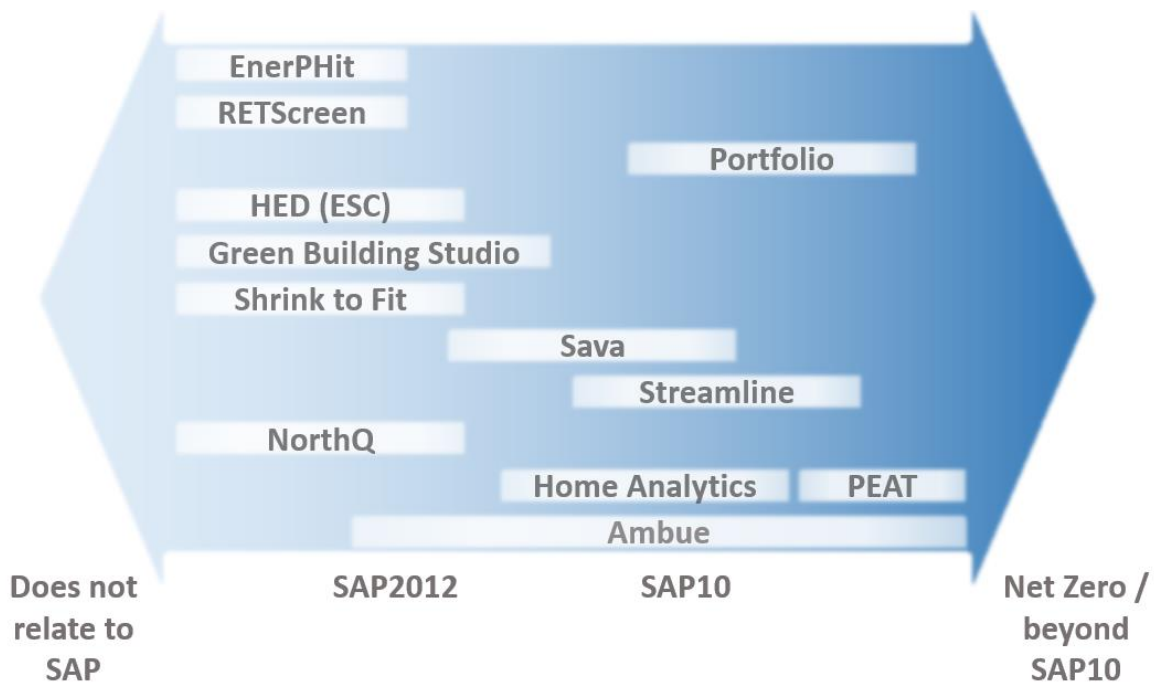


Figure 7: Positioning of the tools in terms of assessment of SAP2012, SAP10 and net zero

A further assessment of the relative merit of the tools can be made by comparing the level of involvement and interaction that is required between the housing provider and the software tool provider. This varies from virtually no interaction to a high level of professional services required. The position of the tools within this landscape is illustrated through the infographic in Figure 8.

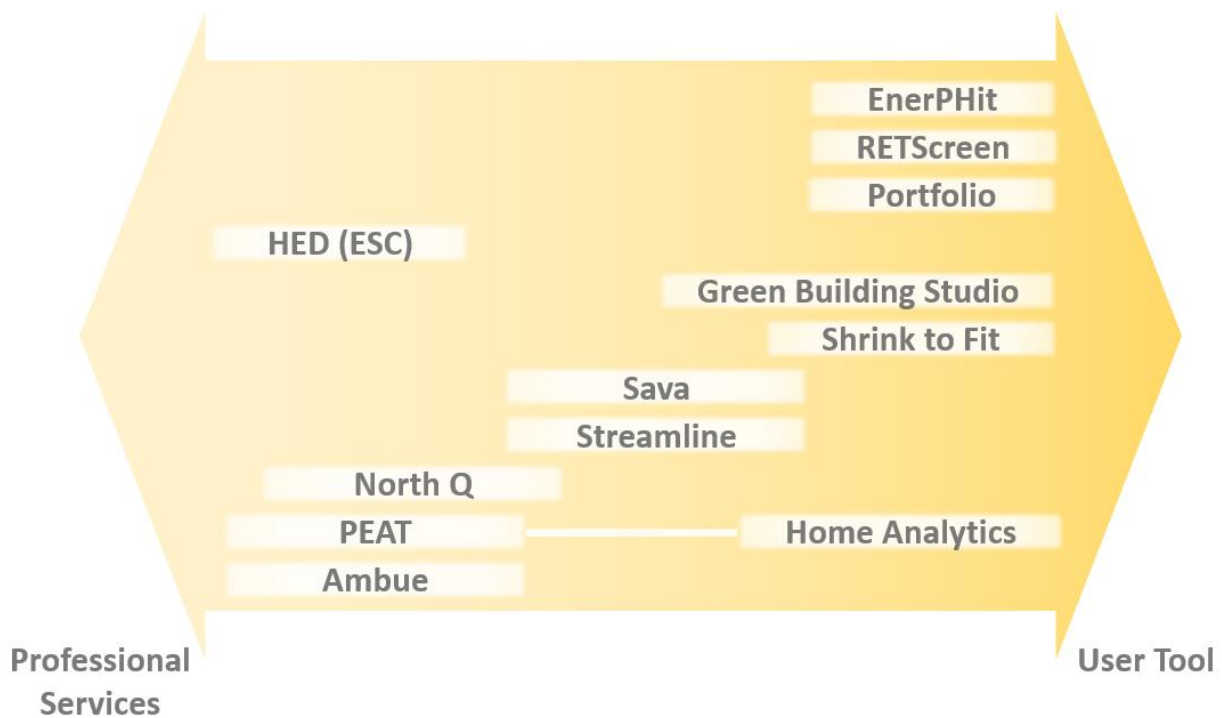


Figure 8: Level of professional service required to use tools

The final element that the different tools have been compared against is the cost for processing per property. This is expressed in the infographic in Figure 9.

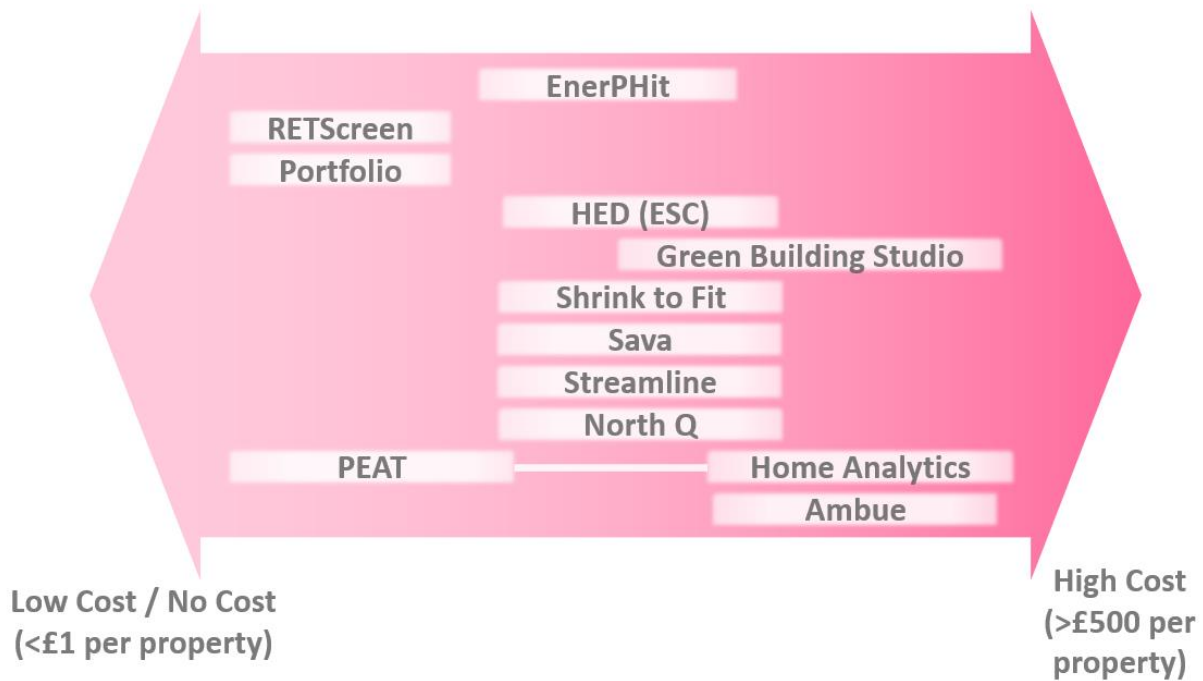


Figure 9: Range of costs for software tools per property

5.1 Detailed Assessment of the Ambue software platform

The Ambue platform was assessed in detail. It should be considered a PAS2035 retrofit services package rather than a net zero planning software platform per se. This makes it difficult to compare with other products because it is so deeply integrated with the PAS2035 standard. The level of involvement from Ambue's professional services team for each property within each project is significant, and the platform does not lend itself to being used by a housing provider independently.

The basic workflow is summarised in Figure 10.

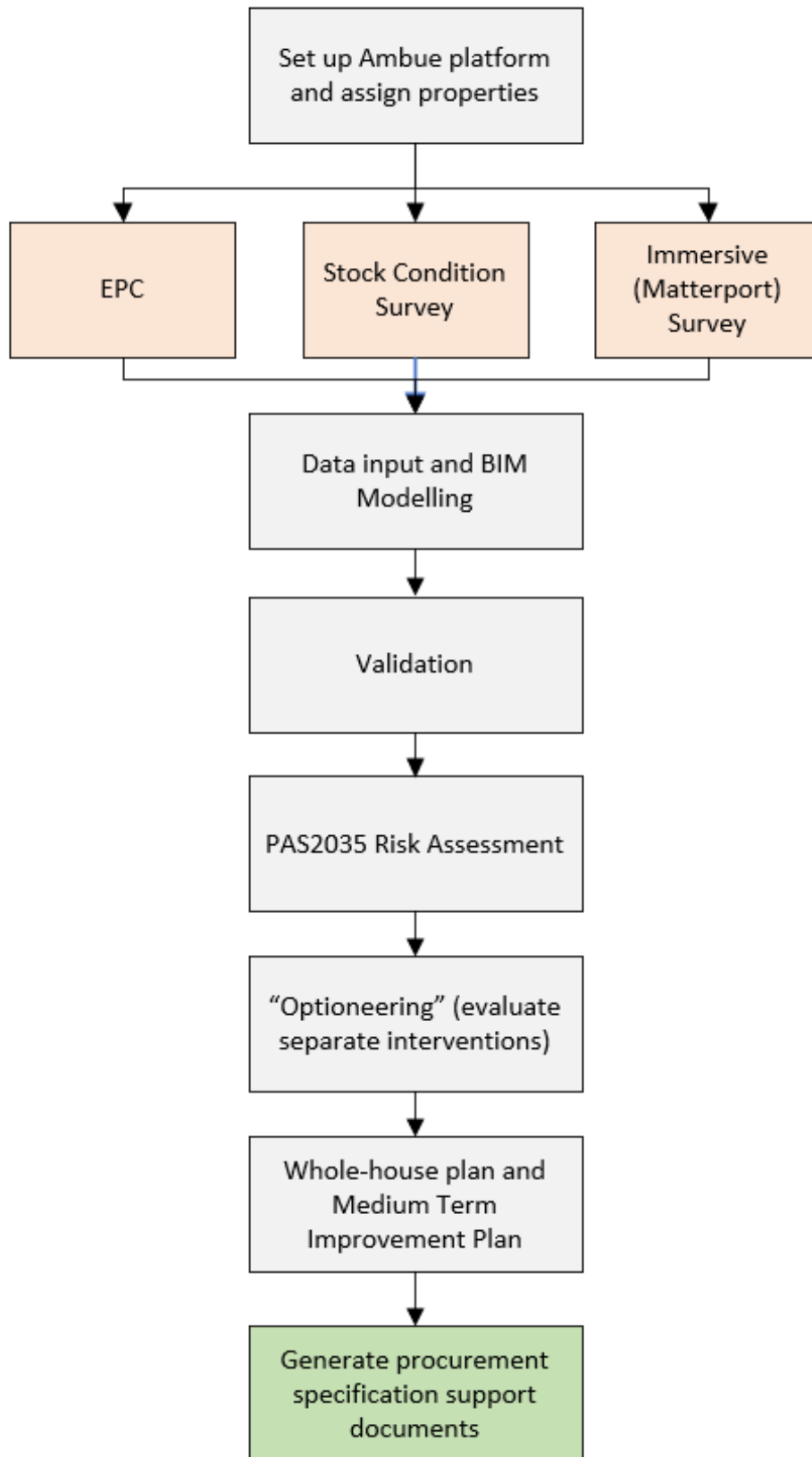


Figure 10: Ambue overall process flow

5.1.1 Surveys and tenant experience - Ambue

The platform relies on high-quality inputs from site surveys, and these are best harvested through a single site survey which combines the collection of data to inform an accurate and up to date baseline EPC, a property condition survey and an immersive 3D survey using the Matterport LIDAR/photogrammetric scanning system. By combining the surveys into a single visit, the tenant experience is greatly improved.

5.1.2 Costs - Ambue

Access to the Ambue platform attracts an annual fee which includes data hosting, database management and technical support. The costs range between £1,000 per year (for up to 50 properties) to £40,000 for 20,000+ properties.

Taking all the costs into account, the overall costs of accessing the platform and professional services will be in the region of £500 to £1,345 per property, depending on the level of professional services in respect of the requirements of the PAS2035 standard that are needed. However, most of these costs would always be required, irrespective of which software platform was used, so it may not be appropriate to attempt to make direct cost comparisons with other software providers' tools.

5.1.3 Challenges and Opportunities - Ambue

It is acknowledged that there will be a need to scale up the capability to provide a service which goes beyond pilot schemes and small stock volumes. Ambue is therefore exploring options for sub-contracting this part of the service, but it remains a potential constraint for larger housing providers who are considering using the platform. Ambue is considering outsourcing external Retrofit Assessors to carry out the data collection and is also in discussions with other consultants from Scotland through to the South West, including some with national coverage. Their intention is to develop a network of outsourced BIM consultants and architects with freelance architects/ sole practitioners. They are also exploring the potential to use Architectural Assistants and Part 1 Architecture Students to help with the BIM modelling stage. For the Retrofit Co-ordinator and Designer stages, Ambue is in discussion with potential regional partners who will be able to deliver the Retrofit Co-ordinator role. As their business expands, they will need to increase their network of partners for it to be possible for them to scale up to the required levels. For housing providers who need full professional consultancy services, Ambue has a very limited capacity to offer these services, and the scale-up of these services will take some considerable time to implement.

As a relatively new company incorporated in June 2020, Ambue has a limited user base. They have worked with Oxford City Council in a pilot study of 60 archetypes/100 properties and are currently completing projects for four other housing providers. It is understood that Ambue is also in negotiations with over 20 other housing providers, so the user base is small but growing.

Further details of the assessment of the Ambue platform can be found in **Narec DE: Assessment of Tools, Narec DE document reference 22-637-4877.**

6 Stepped Approach to Net Zero using EPC band C

As explained in section 4, SAP scores and EPC bandings are not equivalent to a particular level of carbon emissions from a property. Government documents such as the Clean Growth Strategy imply that EPC ratings offer a forward path to net zero, with the requirement for social housing to reach EPC level C by 2035 (and 2030 for fuel poor households). The unwritten implication is that EPC level A is approaching net zero, but this is an incorrect and inappropriate assumption for three reasons:

- The SAP score indicates the expected running cost of a property, not the emissions.
- The SAP methodology does not consider embodied emissions.
- The SAP methodology does not have provision for offsetting residual emissions.

EPC band C as a stepping-stone to net zero could be considered in the following very limited circumstances:

- The reduction in emissions following the introduction of retrofit interventions is proportional to the reduction in running costs. Crucially, this assumption is invalid where heat pumps are used.
- A definition of net zero, which does not include the embodied emissions of the retrofit materials and installation is used. This is not advisable since it could lead to environmental own-goals.

If these assumptions are adopted, however, a tenuous relationship between EPC band C and net zero can be made, as illustrated in Figure 11. The increments between EPC bands G through to C are relatively small and linear in nature, but a very large and hard to quantify step change is required to go from EPC C to even the most rudimentary and flawed definition of net zero:

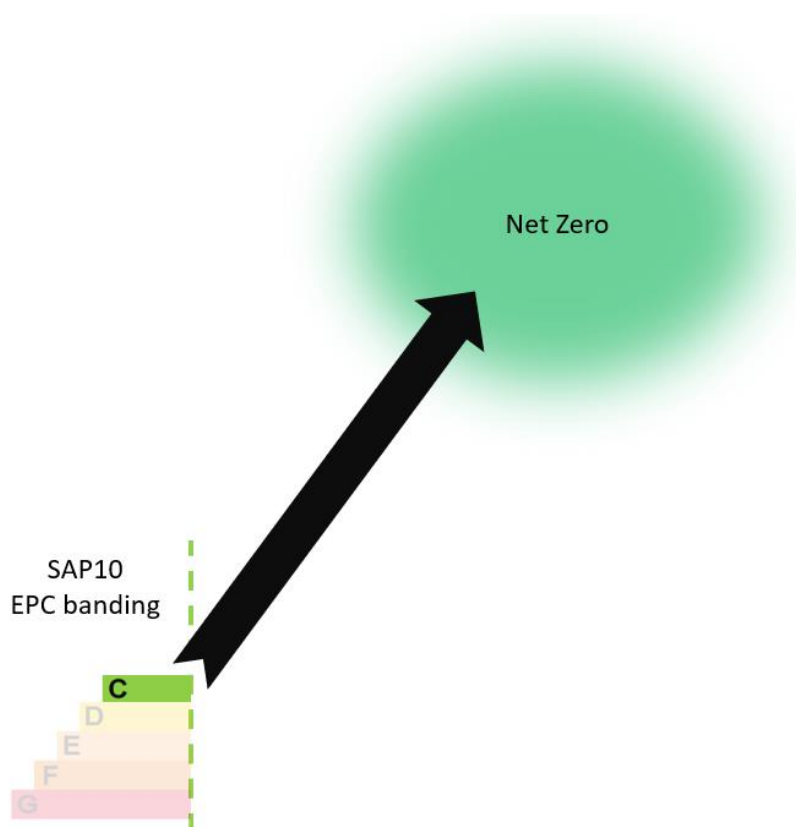


Figure 11: Flawed conceptual model of the relationship between EPC C and Net Zero



A further reason why using EPC C as a stepping stone to net zero might be ill-advised is because of the risk of sunk investment. At the most basic level, a housing provider should consider suspending general property improvements that might need to be subsequently stripped out when a major net zero refurbishment is initiated. For example, a housing association that is planning to replace front doors in their stock would be advised to postpone this work until decarbonisation planning has been completed to avoid having to replace or reposition the new door following a subsequent installation of solid wall insulation.

Considering a property which has reached an EPC band of a high D, it may only need a modest intervention to bring it to a band C (this is illustrated in the case study in section 4.2).

There are some types of interventions which would clearly be a sunk investment when a future net zero plan is required for the property. For example, a flue gas heat recovery system attached to the existing gas boiler might be a cost-effective way to bring the property up from EPC band D to EPC band C, but when the property needs to be later upgraded to reach net zero, this intervention would be removed alongside the boiler and replaced with a fossil fuel free heating system (i.e. a heat pump or hydrogen boiler). The investment would therefore be sunk. There are numerous other situations where this could be the case.



7 Post Occupancy Monitoring and Evaluation (POME)

7.1 POME and Energy Performance

Previous experience of low carbon social housing retrofit projects has shown there to be a significant “performance gap” between the expected energy performance of the upgraded homes and the actual consumption. This performance gap in terms of energy consumption translates directly to emissions. The capital investment then fails to realise the benefits in terms of tenant savings and emissions reductions that were envisaged.

Post occupancy monitoring and evaluation is extremely important to ensure retrofits perform as designed and that a continual improvement cycle is established so that mistakes are not repeated.

Narec DE: Assessment of Tools, Narec DE document reference 22-637-4877 cited a specific example of how a social housing retrofit project could fail to deliver. The example showed that an air source heat pump, which is ostensibly a very well-established retrofit technology measure, could fail to deliver either emissions or tenant utility cost reductions if it is not specified, installed, commissioned, operated and maintained correctly. The quality standards which are mandatory for government-funded retrofit projects ought to eliminate such risks, but the supply chains are relatively immature, and several field trials have demonstrated that actual performance falls short of expectations.

Supply chains are slowly building capacity to deliver retrofit programmes which meet the requirements of the PAS2035 standard, and it is gaining traction. This is helpful because the standard provides a clear framework of requirements for POME.

Despite its name, the **Publicly Available Standard PAS2035** is not freely available and has to be purchased for £190 per licensed user. Furthermore, it references around 50 other British Standards which a contractor may need to purchase. This forms a significant barrier to supply chain upskilling. It is noted that BEIS recently made 100,000 copies of the **Energy Management Standard BS ISO 50005** free to download – this is not relevant to social housing decarbonisation, but it shows that BEIS have recognised that the costs of standards are a barrier to achieving long term decarbonisation goals in all sectors. Policymakers are encouraged to explore ways in which standards can be made more widely available.

The 2021 version of the Part L Building Regulations will be introduced from June 2022, and these will include a number of elements which relate to post-occupancy monitoring. The big changes, however, relate to the new build sector, so there will be a limited impact on retrofit schemes.



8 Digital Components of Social Housing Retrofits

Data is the key starting point for any social housing decarbonisation project. However, a great many social housing properties in the North East and Yorkshire area do not have an up to date EPC. Cohesive and consistent data across all properties owned by a housing provider will be an essential element of any retrofit project.

At the most basic level, the address or UPRN is the minimum data requirement, but the following data items will also be hugely beneficial:

- Dwelling age.
- EPC.
- Floor area.
- Indication of fuel poverty (available only to postcode level).
- Geographical data (orientation of house, daylight hours, average rainfall etc.).
- Data from stock condition surveys.
- Dwelling type (HMO, flats, bungalows etc.).
- Building fabric details.
- Any property alterations.
- Decent Homes/Housing Heat and Safety Rating System data.
- Repair records.
- Planned maintenance/interventions.

Other data may be available from third party sources, including:

- Occupier profiles.
- Billing information and existing energy demand.
- Other EPC data that has not been included as part of the EPC report.
- Any information the tenants can provide about a property.

It is unlikely that any social housing provider will be able to provide a complete list of all of the above data points; however, effort should be made to gather as much information as possible about their housing stock prior to beginning any decarbonisation projects. Unlocking financing will become far easier as the quality of initial data improves, so presenting a good level of initial information about the provider's stock should not be underestimated.

8.1 Going beyond SAP

SAP uses a steady-state calculation methodology to estimate heat losses. This is adequate for traditionally constructed buildings which do not have high levels of thermal performance. However, as buildings approach net zero, it is necessary to take into account not only the thermal transmittance of fabric elements but also details of their thermal mass, thermal bridging, solar gains and other passive gains, as well as detailed occupancy profiles. This type of analysis can only be done properly using dynamic thermal modelling (software) tools. This requires a considerable investment of time as well as a sound understanding of the underlying building physics. It would, however, be very time consuming and expensive to build detailed thermal models of each individual property, so a compromise position is required; perhaps with the majority of archetypes and situations being managed using approved software tools such as SAP and more complex situations assessed using dynamic thermal modelling software tools.

9 Coalitions between housing providers and other parties

Achieving net zero across a large stock portfolio is an unprecedented challenge which is going to require strong coalitions between a range of stakeholders. The main parties who are involved are:

- The tenant – the success of the overall scheme hinges on having positive tenant engagement at all stages of the process. Housing providers will want tenants to be at the centre of any decarbonisation programme.
- Registered Provider – the housing association or local authority who own the stock is the main coordinating body and funder of the works. They may already have tenant liaison officers and other tenant/community engagement staff who will play an important role in keeping the flow of communication across the various different parties.
- The funding bodies, including SHDF, ECO and other grant/loan providers.
- Software vendors – where whole stock assessment or individual property assessment software tools are used, it will be essential for the housing providers to engage with the software vendors. As explained in *Narec DE: Assessment of Tools, Narec DE document reference 22-637-4877*, some of the software tools that are available are a combination of user tools and professional support/consultancy packages.
- Depending upon the choice of software tools, various sub-contractors are likely to be needed during the lifecycle of a retrofit scheme. This could include site survey sub-contractors, POME sub-contractors and other professional services providers (e.g. retrofit co-ordinator).
- The retrofit equipment suppliers and installers also need to be involved and brought into the chain of communication at the appropriate time.
- Utility companies may need to be involved with the installation of SMETS2 smart meters so that opportunities for proper POME (e.g. half-hourly electricity data analysis) can be realised.
- Industry bodies may need to be involved – for example, RICS, RIBA, Solar Energy UK, Heat Pump Association, etc.

Underpinning the entire retrofit process for each scheme will be a project management function. For the majority of schemes that are to benefit from government funding, such as SHDF or ECO4, the requirements of PAS2035 apply. In this case, the pivotal role in the project is the Retrofit Co-ordinator. The PAS2035 standard is very prescriptive about the qualifications that a Retrofit Co-ordinator needs to hold and recognises the need for this role to protect the interests of the housing provider (i.e. the client) as well as the public. Apart from the project management aspects of this role, there are very significant technical requirements, including the need to clarify the housing providers project objectives and technical outcomes. These can include topics which are directly related to the net zero agenda (energy use, SAP ratings, etc.) as well as tangential topics such as the risks of the building deteriorating (e.g. through rot caused by uncontrolled condensation).

PAS2035 also specifies other mandatory roles which each retrofit scheme or project must have in place. These include the Retrofit Assessor, Retrofit Designer, Retrofit Installer and Retrofit Evaluator.

10 Net Zero Funding Options for Housing Providers

In June 2021, BEIS published an online resource entitled *Home Energy Performance Retrofit: funding for local authorities and housing associations*. At the time of writing, it does not list any active funding sources, with the listed schemes all now having closed to new applications - these include the Green Homes Grant Local Authority Delivery Scheme, Phases 1A, 1B and 2 and the Social Housing Decarbonisation Fund Demonstrator and Wave 1. There has been no further update to this resource since October 2021, however, which could be either due to there being no live funding rounds to highlight or the page is no longer being maintained.

The funding schemes that have been available recently and those that are expected in the near future are summarised in the following sections.

10.1 Social Housing Decarbonisation Fund (SHDF)

The Social Housing Decarbonisation Fund (SHDF) was announced in 2019 and commits the UK government to spend £3.8 billion over 10 years to improve the energy performance of social housing in line with the wider aim of reaching Net Zero by 2050. As an interim target, the fund aims to facilitate improving all social housing to an EPC rating of C or better by 2030.

To date, there have been two rounds of funding as part of the SHDF: a £62m UK-wide Demonstrator scheme, which came to an end in December 2021, and a £160m, England-only Wave 1 scheme which runs until January 2023. Beyond this, it is expected that Wave 2 will provide £800m of funding to cover the financial years 2022/23 to 2024/25, and the remaining £2.8bn to be allocated for the following five years' delivery. Given that the Demonstrator and Wave 1 have demanded a fabric-first approach to retrofit and have excluded fossil fuel installations from their list of eligible measures, it is certain that this will be the case in all future SHDF campaigns.

Bids for the SHDF require a detailed assessment of the housing stock for which housing providers are responsible, modelling of the impact from the funding in terms of the number of households treated, and their EPC rating uplift. Delivery must be carried out following PAS2030/2035 standards.

A summary of the scheme is given below:

Campaign	Total fund value	Opening date	Application deadline	Delivery deadline	Maximum fund per property	Bid leader	Primary Aim	No. homes treated
Demonstrator	£62m	Sep 2020	Nov 2020	Dec 2021	£15,000-£30,000	RPs	≥ EPC C	2,100
Wave 1	£179m		Oct 2021	Mar 2023	2/3 of costs up to £10,000 - £16,000	RPs	≥ EPC C	20,000
Wave 2	£800m	Tbc	tbc	Dec 2025 (expected)	tbc	RPs	≥ EPC C	tbc
2025-2030	£2,778m	Tbc	tbc	2030	tbc	RPs	≥ EPC C	tbc

10.2 Energy Companies Obligation (ECO)

Following on from previous Energy Company Obligation (ECO) schemes (ECO1, ECO2, ECO2t and ECO3), ECO4 will run for 4 years, from 2022 to 2026. The scheme is worth £1bn per year, a significant increase over the £640m per year that the previous ECO scheme was worth. It will apply across England, Wales, and Scotland, and funding comes via medium and large energy suppliers. ECO4 is primarily intended to reduce the cost of

heating homes in accordance with the Home Heating Cost Reduction Obligation (HHCRO). Net Zero is not an explicit aim of ECO4, but its aims of bringing households out of fuel poverty are aligned with aiming to achieve an EPC rating of C for as many homes as possible. A summary of the ECO3 and ECO4 campaigns is given below.

Campaign	Total fund value	Delivery deadline	Bid leader	Primary Aim
ECO3	£640m/yr	Mar 2022	50% from LAs	fuel poverty and ≥ EPC D
ECO4	£1,000m/yr	Mar 2026	50% from LAs	fuel poverty and ≥ EPC D

10.3 Home Upgrade Grants

The Home Upgrade Grant (HUG) in total has been allocated £950m to be spent between 2022 and 2025. The first phase of this scheme, HUG 1, has been allocated £150m to help improve the efficiency of off-gas grid homes to EPC D or C (depending on their starting point) and has been absorbed into the Sustainable Warmth Competition along with LAD 3 (see below). This phase is now closed to new bids, and delivery must be complete by March 2023. Future rounds of HUG funding are yet to be announced.

10.4 Green Homes Grant Local Authority Delivery (LAD) Scheme

To be eligible for the Green Homes Grant LAD scheme, homes must be occupied by individuals earning a combined income of no more than £30,000 and have an EPC rating of E, F or G. For owner-occupied homes, the intervention level is 100% of the cost of the measures being installed, up to £10,000. For social and private landlords, funding is offered at two-thirds of the capital cost, up to £5,000.

Funding via the LAD scheme has been announced in 4 phases to date, all of which are now closed to applications. Funding for the more recent Phase 2 was allocated via the 5 Net Zero Hubs and came to an end on 31st March 2022. A third phase of LAD was absorbed, along with the first phase of the HUG, into the Sustainable Warmth Competition, which closed for bids in August 2021 and delivery is scheduled to conclude in March 2023. In addition to schemes specifically set up to support the decarbonisation of social housing and alleviating fuel poverty, other funding schemes may provide funding options for housing providers. A summary of the scheme is given below.

Campaign	Fund Manager	Total fund value	Opening date	Application deadline	Delivery deadline	Maximum fund per property	Primary Aim
LAD 1A	BEIS via LAs	£74m	Jul 2020		Mar 2021		Fuel poverty
LAD 1B	BEIS via LAs	£126m	Aug 2020	Nov 2020	Sep 2021	2/3 of costs up to £5,000	Fuel poverty
LAD 2	BEIS via EHs	£300m			Mar 2022	2/3 of costs up to £5,000	Fuel poverty
LAD3+HUG1 - Sustainable Warmth Competition	BEIS	£200m	Jun 2021	Aug 2021	Mar 2023	2/3 of costs up to £5,000	EPC D or C
	BEIS	£150m	Jun 2021	Aug 2021	Mar 2023	2/3 of costs up to £6,667-£16,667	EPC D or C

10.5 Boiler Upgrade Scheme

The Boiler Upgrade Scheme (BUS) is not set to be available for social housing but is designed to incentivise privately owned or rented households to decarbonise their heating systems. It takes the form of an upfront grant of £5,000 or £6,000 towards installing an air source or ground source heat pump, or in some cases, a

biomass boiler. The higher grant rate of £6,000 is reserved for the installation of ground source heat pumps in recognition of their substantially higher cost compared with other low carbon heating options. There is currently no announced deadline for project delivery, however. The implication of the budgeted total fund of £450m is that the scheme will deliver approximately 90,000 low carbon heating systems. In comparison with the Climate Change Committee's statement that the UK needs to install 3.3 million new heat pumps by 2030, the impact on the heat pump industry due to the BUS needs to be a substantial lowering of the cost of new systems if it is to generate sufficient interest for this wider goal to be achievable without further grant funding.

Despite this scheme not being directly applicable to housing providers, it could be relied upon, with sufficient coordination, to support 'in-fill' measures where there are areas of mixed tenure so that isolated properties are not left untreated and to allow possible economies of scale due to a contractor carrying out a greater number of installations in one area.

Total fund value	Opening date	Delivery deadline	Maximum fund per property	Bid leader	Primary Aim	Homes treated
£450m	Apr 2022	2025	£5,000 - £6,000	Householder/owner	heat decarbonisation	up to 90,000

10.6 Green Heat Network Fund

Limited opportunities to decarbonise certain elements of a housing provider's stock through the implementation of heat networks exist. The Green Heat Network fund may be able to contribute in these situations. It is intended for delivery between 2022 and 2025 and is expected to provide at least £270 million in funding for up to 50% of the cost of new heat network schemes. The scheme can be applied for by a range of public and private sector organisations and is to support complete installations rather than to fund connections to an existing network.

Campaign	Total fund value	Opening date	Application deadline	Intervention rate	Bid leader	Primary Aim
Round 1	£270m	Mar 2022	May 2022	50% project cost	Public or Private organisations, Third Sector etc.	heat decarbonisation
Rounds 2-11		June 2022	Dec 2024			

10.7 Other finance options

To progress much beyond alleviating fuel poverty and bringing all social housing up to EPC band C, the £100bn or so of capital required will need to be available through a mixture of grant funding and financial instruments that are appropriate for the timescales and impacts of large scale retrofit projects. The finance options available to housing providers are likely to fall into one of a few categories, which are discussed below.

10.7.1 ESCO

An Energy Service Company (ESCO) is an organisation that provides energy-related services to a third party. Unlike a typical installation of energy efficiency or renewables technology, where the client pays for the equipment and installation as a capital investment, an ESCO can be used to provide the end-user with the energy savings or renewably generated heat or power as a service. This means, therefore, that any equipment installed is owned and maintained by the ESCO to ensure it performs well enough to deliver the anticipated energy cost savings. In this way, the risk of underperformance or breakdown of equipment is shouldered by the ESCO rather than the client. The ESCO recovers their capital and operating costs via a service charge paid

by the client. This charge is normally guaranteed to be lower than the amount saved through reduced energy consumption costs.

This model ensures that the ESCO has a vested interest in ensuring the project delivers the expected energy savings and is therefore responsible for the maintenance and management of the installed technologies. This is one key difference from the Green Deal scheme, which was, in basic terms, a loan for energy efficiency improvements for households that was paid back via their energy bills, but with the assurance that due to the energy saved, their bills would never be higher than before the measures were installed. The Green Deal, however, put none of the responsibility for maintenance or energy performance onto the Green Deal provider or energy supplier other than potential cost implications. The Green Deal was also designed for delivery at the individual dwelling level rather than over a whole portfolio of properties. There is a strong likelihood, therefore, that ESCO financing could achieve better value for money and stronger uptake than the largely unpopular Green Deal.

The model needs tailoring somewhat to allow for the fact that the end-users, in this case, are the households occupying houses owned by the housing providers. Recouping the costs, therefore, must be done in as simple a way as possible via the householders' energy bills. This financing model can only be used following a period of energy consumption monitoring for the housing stock in question so that energy savings can be identified and measured to ensure that energy bills do not exceed those from before the energy-saving measures were installed. In this way, households can continue to pay the same total amount for their energy bills as before, but the ESCO's costs are recouped due to lower energy consumption. Clearly, the most convenient company to act as the ESCO in this situation would be the energy supplier, as no third party would be needed.

10.7.2 Internal funding models

Should a housing provider be required to internally fund a decarbonisation scheme, one option would be for them to recoup the costs over the long term from tenants through service charge increases or rent increases. However, this is unlikely to be politically acceptable and is not compatible with the ambition for a just transition to net zero.

Glossary of Terms

Housing Provider – used in this report to describe a Registered Provider (e.g. housing association or local authority).

Net Zero and **Carbon Neutral** – these terms are used interchangeably but represent two different goals. Net zero is an overall balance between the **greenhouse gases** being emitted and removed from the atmosphere, whereas carbon neutral refers to there being a balance between the amount of **carbon dioxide** being emitted and removed from the atmosphere. The term **emissions** has been used in this document to refer to all greenhouse gases.

Sequestered Carbon – this refers to carbon that is trapped in materials, most frequently timber. Sequestered carbon has found a “safe store” for itself in the material, which prevents it from being released into the atmosphere. However, if the material decays or is burnt, this carbon can be released as methane (CH₄) or carbon dioxide (CO₂).

Whole-life Emissions – these emissions make up the full set of emissions associated with housing from construction, through use and maintenance, to disposal at the end of the material’s life.

Embodied Emissions – emissions arising from producing, procuring, and installing the materials and components that make up a structure. This includes the lifetime emissions from maintenance, repair, replacement, demolition, and disposal.

Upfront Emissions – these make up a smaller part of embodied greenhouse gases, referring solely to the producing, procuring, and installing materials.

Operational Emissions – refers to the emissions associated with the energy used to run a building. This includes regulated and unregulated energy use (see below). Emissions arising from the use of water in the operation of the buildings are also considered and are often referred to as Operational Water.

Regulated Energy Use – The regulated energy use associated with a building is the controlled energy it requires to run. This comes from fixed building services, such as space heating, ventilation, hot water, and lighting¹.

Unregulated Energy Use – Unregulated energy use is associated with systems or processes that are not controlled, and that Building Regulations do not impose a requirement on. This can include lighting, appliances, and cooking.

¹<https://www.homequalitymark.com/wp-content/uploads/2018/09/HQM-ONE-Technical-Manual-England.pdf>

Bibliography

Introduction

Inside Housing, Cost of Retrofitting all Social Homes in the UK to Zero Carbon, November 2020.

MHCLG: English Housing Survey, 2018-2019

Net Zero Definition

Narec DE: Social Housing Net Zero Definition 21-637-4856 v3.0, February 2022.

Northumbria University: Decarbonising Social Housing in North East England, October 2021.

Climate Change Committee - Sixth Carbon Budget, December 2020.

IET: Scaling up Retrofit 2050 , 2020.

Baily Garner: Retrofitting Existing Homes, A Practical Toolkit Towards Net Zero, 2021.

HM Government: Heat and Buildings Strategy , October 2021.

HM Government: Net Zero Strategy: Build Back Greener, 2021.

Tees Valley Combined Authority: Households in Fuel Poverty, 2014.

BRE Group: The Cost of Poor Housing in England, 2021.

Cotswold District Council: Net Zero Carbon Toolkit

Narec DE: Sinclair Meadows Carbon Negative Community, 2012.

Scottish Government: Achieving Net Zero in Social Housing, The Zero Emissions Social Housing Taskforce Report, August 2021.

National Housing Federation: Decarbonisation: a guide for housing associations, October 2021.

London Energy Transformation Initiative: A Net Zero Carbon Buildings A Framework Definition, April 2019.

Bioregional: How we helped two housing associations create zero-carbon roadmaps, 2019.

Zero Carbon Hub: Zero Carbon Policy, 2015.

RICS: Whole Life Carbon Assessment for The Built Environment, November 2017.

The Climate Change Committee: Options for Incorporating Embodied and Sequestered Carbon into the building standards framework, 2019.

Latif, E. ,A Review of Low Energy Thermal Insulation Materials For Building Applications, Proceedings of International Conference, Bangkok, Thailand, February 2020.



Woodknowledge Wales: The Home-Grown Homes Project: Embodied Carbon, 2020.

The Institution of Structural Engineers: The Structural Carbon Tool Version 2, March 2022.

HM Government: Net Zero Estate Playbook, November 2021.

Knauf Insulation: Blowing Wool insulation, January 2021.

UK Green Building Council: Whole Life Carbon Roadmap Technical Report, November 2021.

UK Government: Clean Growth Strategy, October 2017.

Passivhaus Trust: Hindolveston Road Housing Project, 2014.

Passipedia: EnerPHit – the Passive House Certificate for retrofits, 2022.

BRE Group: Home Quality Mark ONE Technical Manual, August 2018.

Measuring Net Zero

BRE Group: Briefing note on the derivation of primary energy factors, October 2019.

Passivhaus Trust: EPCs as Efficiency Targets, April 2020.

Assessment of tools

Narec DE: Assessment of Tools, Narec DE document reference 22-637-4877, February 2022.

Unity: Real-Time Development Platform | 3D, 2D VR & AR Engine, 2022.

Digital Components of Net Zero, Funding Options

Narec DE: Net Zero for Social Housing, Narec DE document reference 22-637-4886, March 2022.

HACT: UK Housing Data Standards, 2022.

Housing Innovation Programme and Catapult Connected Places: The Role of Data in Delivering Net Zero Social Housing Retrofit, March 2021.

UK Government: Home Energy Performance Retrofit: funding for local authorities and housing associations to help improve the energy performance of homes, June 2021.

Advancing Renewable Energy



Narec Distributed Energy Ltd, Charles Parsons Technology Centre, High Quay, Blyth, Northumberland, NE24 2AZ

Tel: +44 (0)1670 543 009 / Email: info@narecde.co.uk

Narec is the registered trademark of the UK **National Renewable Energy Centre**